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Welcome to Delft

Dear readers and delegates at the ERES annual conference 2017,

It is with pleasure that we present you with this Book of Full papers. The refereed paper sessions at ERES were initiated for the first time in Regensburg 2016. This year, the call for full papers resulted in ca 60 full paper submissions, of which 25 were accepted and will be presented in the reviewed sessions. These contributions to the conference reflect the high quality of research of the real estate research community, and the aim to increase quality while still being important for knowledge sharing, brainstorming and networking. The ERES annual conference is the leading real estate research meeting in Europe and one of the largest property-related conferences worldwide.

The ERES Annual Conference provides an open forum for the exchange of ideas and the dissemination of research in areas such as real estate inance, management, development, economics, appraisal and investment. ERES incorporates national research societies, academic researchers, practitioners and doctoral students engaged in real estate.

We are looking forward to some intensive conference days with interesting conference presentations, lively discussions and productive exchanges of ideas and experiences.

We are happy to welcome you to the 24th annual conference in Delft, the Netherlands.

We would like to thank the ERES scientific committee who reviewed the full papers. Thanks also to previous organisers who contributed with good advice, and to Gunther Maier for maintaining the online submission interface. Finally, we would like to thank our sponsors for their contributions!

On behalf of the organising team,

Hilde Remøy

Chair

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Loss Aversion and Residential Property Development Decisions in China: A Semi-Parametric Estimation

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Abstract

Loss aversion is a core concept in prospect theory that refers to people's asymmetric attitudes with respect to gains and losses. More specifically, losses loom larger than gains. With the capability of loss aversion to explain economic phenomena, some of which are puzzling under expected utility theory, this concept has received significant attention. This study develops a behavioral model of loss aversion to explain the development decisions by residential property developers in the People's Republic of China. Under the leasehold property right system, real estate development has two stages—first to lease land from the government, and then to develop the property according to the lease terms. This presents a unique opportunity to test the presence and effect of loss aversion in real estate development decisions. More specifically, this study determines when the land premium paid by a developer is substantially higher than the market value, whether and how this "paper loss" will affect the pricing of the housing products and development time of the project in future development. We use a sample of land and house transaction records from Beijing to test the hypothesis. This is the first study to use a semi-parametric model in estimating developers' loss aversion. Results show that developers are most prone to loss aversion bias around the reference point or when facing large losses. The results also suggest that loss aversion contributes to the cyclical trading pattern in housing markets.

1. INTRODUCTION

Loss aversion is one of the core concepts in prospect theory. The theory is often suggested as an alternative paradigm to classical expected utility theory and has been proven to be more useful in explaining choice behavior under uncertainty. Under prospect theory, people's utility does not come from the absolute level of wealth but from the loss and gain that are derived from a comparison with a reference point. When the reference point is determined, the utility function that is defined based on the losses and gains is S-shaped, which determines the other two crucial features of prospect theory other than reference-dependence. One feature is the decrease in the marginal change of utility when gain or loss levels increase (*diminishing sensitivity*). The other feature is losses looming larger than gains; this phenomenon is usually referred to as *loss aversion*. In other words, a loss-averse decision maker would experience more utility drops when facing a loss than the utility increase from a gain of the same magnitude. This feature is the focus of this study. Solid evidence has confirmed that loss aversion plays an important role in decision-making processes under uncertainty (Bleichrodt, Pinto, and Wakker 2001; Berkelaar, Kouwenberg, and Post 2004; Abdellaoui, Bleichrodt, and Paraschiv 2007; Pope and Schweitzer 2011). The concept also helps to explain a variety of economic phenomena, some of which are puzzling circumstances under expected utility theory.[1]

We explored whether real estate developers' pricing behavior are prone to the behavioral bias of loss aversion. Previous research has revealed one puzzling feature of the housing market: house price and trading volume are positively correlated (Norman and Micbael 1986). In an up market, the trading volume would increase substantially despite the high selling prices. However, in a down market, most of the houses would sit on the market with a very high price and would be eventually pulled out without a sale. This cyclical trading pattern was demonstrated by Genesove and Mayer (2001) as the disposition effect on the housing market. Such effect implies that when prices are high in an up market, most sellers are in a gain domain and would obtain a deal quickly, whereas when prices are high in a down market, sellers are reluctant to adapt their selling price and would hold on to the property and spend more time waiting.

In this paper, we offer a behavioral explanation of this puzzling phenomenon by including three innovative elements: a new focus on property developers rather than household sellers and buyers, an expectation-based reference point rather than using initial purchase prices, and a semi-parametric estimation rather than an ordinary least squares estimation. A developer-focused perspective is very important, yet is missing in existing literature. Developers are extremely significant in determining market conditions, especially for a market dominated by new homes. A semi-parametric estimation model is used so as to allow the degree of loss aversion to vary with the magnitude of losses and gains.

One of the challenges faced by loss aversion studies on the real estate market, as well as other markets, is determining the reference point, the benchmark upon which each outcome is coded as a gain or a loss. The coding is crucial because it determines two features of the decision maker: (i) risk attitudes and (ii) sensitivity. The coding is

[1] Such economic puzzles include, among others, the equity premium puzzle (see, for example, Benartzi and Thaler 1995; Gneezy and Potters 1997; Gneezy, Kapteyn, and Potters 2003), the endowment effect (see, for example, Kahneman, Knetsch, and Thaler 1990; van Dijk and van Knippenberg 1996, 1998), and the disposition effect (see, for example, Odean 1998, Barberis and Xiong 2009, Da Costa et al. 2013).

important to risk attitudes because utility in the gain domain is concave, whereas it is convex in the loss domain, which implies risk aversion for gains and risk seeking for losses. Moreover, the coding is important to sensitivity because people are more sensitive to losses, which implies different slopes in the two domains and a kink at the reference point. However, no agreement has been reached on the location of the reference point in the existing literature. Potential candidates include the status quo, the certain equivalent, the previous purchase price, and the recent expectation. However, these candidates have not been compared. Real estate studies, such the influential study of Genesove and Mayer (2001) on the Boston condominium market and the follow-up studies by Bokhari and Geltner (2011), Leung and Tsang (2013), and Anenberg (2011), showed that the previous purchase price is the most used candidate. Undoubtedly, being the initial cost, previous purchase price could perform naturally as a benchmark for monetary gains and losses. More importantly, it is observable. Nonetheless, initial purchase prices do not incorporate new market information that could lead to adaptation of the reference point. Therefore, Koszegi and Rabin (2006) proposed an expectation-based reference point and argued that it is superior to previous purchase price. This study adopted the proposal by Koszegi and Rabin (2006) and used the expected selling price as the reference point. Specifically, we chose average land purchase price within 3 miles as the reference land price. The expectation-based selling price as the reference point is an alternative to the previous purchase price used by previous loss aversion studies; hence our finding helps to test whether the previous findings are robust, which is one of the contributions of this study.

The attempt to fill the research gap of loss aversion studies in the People's Republic of China (PRC) real estate market is another contribution of this study. The PRC has a booming and influential housing market with great potential. Therefore, understanding the behavior of the participants in this market is highly crucial for researchers, practitioners, and policy makers. However, many differences exist between developing and developed markets in terms of the market participants' knowledge and experience, market regulation, and market efficiency. These differences highlight the necessity to explore whether the findings derived from developed markets are applicable to the PRC. Two of the few behavioral studies on the PRC are those of Leung and Tsang (2013) and He and Asami (2014). The study conducted by Leung and Tsang (2013) empirically confirmed the existence of loss aversion. However, it is based on the data from the Hong Kong, China housing market, which differs from most cities in the PRC in the housing transaction system and trading preferences. Therefore, to determine whether the finding is applicable to PRC cities, further exploration is needed. The study of He and Asami (2014) focuses on the endowment effect and employs survey data instead of transaction data. Under the leasehold property right system, real estate development in the PRC has two stages—leasing land from the government and developing the property according to the lease terms. This two-stage nature presents a unique opportunity to test the presence and effect of loss aversion in real estate development decisions. Thus, this paper constructed a model based on this nature and contributes to the limited literature on the behavior of an important housing market participant in the PRC. Our research could assist developers, investors, and policy makers in judging the market better and in making more effective decisions.

We analyzed the September 2003–June 2014 market data of Beijing, which were derived from property development projects (land purchase, house construction, and sales). Semi-parametric estimation of the value function in prospect theory shows that the loss aversion level changes with the magnitude of the losses and gains. Specifically, developers are most loss averse around their reference point and when they face large losses or gains. When facing medium-sized losses or gains, the loss aversion effect disappears.

2. LITERATURE REVIEW

In this section, we first present an overview of prospect theory and an introduction to loss aversion. Second, we provide a discussion of two important issues in current loss aversion studies: determining the reference point and further methods of identifying or measuring loss aversion. Finally, we present an empirical implementation issue about the data collection method used in the current loss aversion studies.

2.1 Prospect Theory

Although expected utility theory has been regarded as a dominant descriptive and normative model that characterizes the rational choice behavior of agents (Friedman and Savage 1948), researchers often claim that the choices of people deviate systematically from the optimal outcome of expected utility theory (Allais 1953, Samuelson and Zeckhauser 1988). To account for the discrepancy, Kahneman and Tversky (1979) proposed prospect theory as an alternative. Both field and experiment data have shown that prospect theory is probably the most descriptively valid model to measure behavior under risk and uncertainty (Starmer 2000).

Prospect theory distinguishes two phases in the decision-making process: an early phase of editing and a subsequent phase of evaluation. In the editing phase, people reorganize and reformulate the given prospects to obtain a simpler presentation of these prospects. When the final presentation is obtained, the decision-making process proceeds to the second phase, in which people evaluate each of the edited prospects and then choose the prospect with the highest value.

The value of each prospect is a weighted average of the values of the outcomes. However, unlike expected utility theory, which uses given probabilities as weights and the levels of outcome as values to be weighted, prospect theory defines a new weighting function π and value function v.

Let $(x, p; y, q)$ denote a simple prospect or gamble with at most two non-zero outcomes.[2] The decision maker receives either x with a possibility of p or y with a possibility of q. If V represents the overall utility that one gains from this prospect or gamble, then the evaluation process described in the previous section can be formulated as Equation (1).

$$V(x, p; y, q) = \pi(p)v(x) + \pi(q)v(y) \quad (1)$$

The weighting function $\pi(\cdot)$ assigns each possibility p with a decision weight $\pi(p)$, which measures the level of people's subjective probability distortion. The function is monotonic and increasing with p, with $\pi(0) = 0$ and $\pi(1) = 1$. A salient property of π is that it is not equal to the pure likelihood of the event (i.e., $\pi(p) \neq p$) in most cases. Specifically, the weighting function overestimates low possibilities and underestimates moderate and high possibilities. A detailed discussion can be found in Kahneman and Tversky (1979), but it is omitted here because the weighting function is not related to loss aversion.

[2] An extended model with more than two outcomes is easily obtainable. For a model with a large number of outcomes, see discussions about cumulative prospect theory by Tversky and Kahneman (1992).

The value function $v(\cdot)$ assigns a value $v(x)$ to each outcome x, which reflects the subjective attitudes of the decision maker. The value function is characterized by the following properties:

(i) The value function is defined by the changes of wealth relative to a *reference point*, that is, x equals the gain or loss, instead of the absolute wealth level such as that in expected utility theory. If *r* represents the reference point and x_0 equals the wealth level after obtaining the outcome, then x equals $x_0 - r$. A detailed discussion on the different choices of the reference point is in section 2.2.

(ii) The value function exhibits *diminishing sensitivity* toward changes in *x* (either positive or negative) as magnitudes increase. For example, people experience more happiness or sadness when gains or losses increase from 100 to 200 than when the increase is from 1,000 to 1,100. This feature implies that the value function is generally concave for gains $(\text{i.e.}, v''(x) \leq 0, x > 0)$ and commonly convex for losses $(\text{i.e.}, v''(x) \geq 0, x < 0)$.

(iii) "Losses loom larger than gains." Therefore, with the same amount of change in *x*, the value change in the loss domain becomes larger than the value change in the gain domain. The value function is therefore steeper for losses than for gains, thus creating an imperfection at the reference point. This feature is commonly referred to as *loss aversion*.

There is no agreement on the functional form of the value function in the existing literature till now. A very widely accepted value function example that features the three abovementioned elements is suggested by Tversky and Kahneman (1992):

$$v(x) = \begin{cases} x^{\propto}, x \geq 0 \\ \lambda(-x)^{\beta}, \ x < 0 \end{cases} \tag{2}$$

where *x* is the gain or loss that is compared with the reference point, $\propto$ and β are positive values between 0 and 1, and λ is the coefficient that measures the degree of loss aversion. A λ that is greater than 1 captures the effect of loss aversion. The implementation of the equation and the measurement of loss aversion are crucial in verifying the existence and degree of loss aversion. Other alternatives of measurement are discussed in section 2.3.

The concept of loss aversion is widely employed in (i) the financial market (equity premium puzzle by Benartzi and Thaler [1995]; disposition effect by Odean [1998], Kyle et al. [2006], and Henderson [2012]); (ii) consumption choice problems (people's asymmetric response to price changes by Putler [1992] and Ray et al. [2015]; asymmetric response to promotions of different brands by Hardie, Johnson, and Fader [1993] and Bronnenberg and Wathieu [1996]; and endowment effect by Thaler [1980] and Kahneman, Knetsch, and Thaler [1990]); and (iii) effort provision problems (downward-sloping labor supply by Camerer et al. [1997], Kőszegi and Rabin [2006], Farber [2008], and Crawford and Meng [2011]). Other promising applications include the optimal contract form and compensation schemes for loss-averse chief executive officers (de Meza and Webb 2007, Dittmann et al. 2010, and Herweg et al. 2010); consumption insensitivity to bad news of future income (Bowman, Minehart, and Rabin 1999); optimal ordering when managers or news vendors are loss averse (Ho et al. 2010, Wang and Webster 2007, and Wang 2010); and so on.

Evidence shows that loss aversion bias exhibits different levels in different contexts. For example, the level depends on the nature of the outcome: in the context of monetary outcomes, the loss aversion level is estimated to be 2.25 by Tversky and Kahneman (1992); in the context of health decisions, the level is estimated to be 3.06 by Bleichrodt, Pinto, and Wakker (2001). Regional differences are also identified. Abdellaoui et al. (2013) estimate loss aversion in dimensions of risk and time and find that loss aversion levels are consistently higher in Rotterdam than in Paris. A number of other factors cause loss aversion to vary among individuals; examples include experience (Haigh and List 2005, List 2003), education (Booij and van de Kuilen 2009), gender (Booij and van de Kuilen 2009, Brooks and Zank 2005), framing (Keysar et al. 2012), and so on. The results highlight that loss aversion levels vary for different decisions and that they exhibit heterogeneity among individuals.

2.2 Role of Reference Points

As the starting point for prospective losses and gains, a reference point is essential to loss aversion studies. It is the benchmark that each outcome or wealth level is compared against prior to coding and evaluating as a gain or loss (Kahneman 1992). The coding determines two important features of the decision maker: (i) risk attitudes and (ii) sensitivity. The coding is significant to risk attitudes because utility in the gain domain is concave, whereas that in the loss domain is convex, which implies risk aversion for gains and risk seeking for losses. The coding is important to sensitivity because people are more sensitive to losses, which implies different slopes in the two domains and a kink at the reference point. Kahneman and Tversky (1979, 1992) mentioned a number of potential factors such as the status quo, the formulation of the offered prospects, and the expectations of the decision maker. However, they did not provide clear guidance regarding the reference point. Despite the increasing number of studies on people's irrational reaction toward the departures from the reference point, no agreement has been reached on the true nature of the reference point and the way it is formed. Precise determination of the reference point is difficult because the point is an intermediate variable and cannot be observed directly (Paraschiv and Chenavaz 2011). Such variables are unavailable from existing data sources and are difficult to measure accurately. Different people may use different reference points, and even the reference points of the same people may vary over time (Winer 1986; Hardie, Johnson, and Fader 1993); these situations increase the complexity of the problem. Evidence shows that reference points shift on different occasions. Most of the existing studies assumed that a reference point is set without discussion about the validity of the reference point and that the model and analysis are based on this assumption. Nonetheless, without the validity of the reference point, the whole analysis could be completely inaccurate and unreliable.

Several potential candidates for the reference point include the status quo, the initial cost for the same goods, the anticipated price, or the combination of the three. The most widely discussed and used reference point is the status quo (i.e., the current state of the decision maker) because it is believed that people generally intend to maintain the current state. Such belief parallels one of the behavioral anomalies called status quo bias, which refers to people's reluctance to move from the current status (Samuelson and Zeckhauser 1988). The status quo reference point has been used in various studies such as those of Ert and Erev (2013); Booij, van Praag, and van de Kuilen (2010); and Barberis et al. (2001).

Koszegi and Rabin (2006) proposed the decision maker's recent expectation of the outcome as an alternative for the reference point. Such a proposal was aimed at reconciling some seemingly contradictory predictions on risk attitudes and other behavioral biases. They argue that people's expectation, which is determined endogenously by the current economic environment, makes predictions that are better than those of the status quo. The existing studies that incorporate expectation as the reference point include those of Winer (1986); Paul and Koszegi (2008); Loomes and Sugden (1986); and Ang, Bekaert, and Liu (2005).[3] This type of reference point is advantageous because for fleeting activities where no ownership is involved, such as shopping, entertainment, travel, and surgery, status quo is absent. In these cases, expectation is the reasonable reference point (Koszegi and Rabin 2006). For example, when a person is told to undergo a dental surgery, an expectation is formed. Therefore, when a subsequent checkup confirms that the surgery is not necessary, a gain is experienced, which is different from the expectation. This example is beyond the reach of the status quo reference point.

In the housing market, measuring the reference point is even more difficult because of the high level of heterogeneity of housing products, infrequent transactions, and the subsequent lack of transaction data. In addition, intermediary evaluations of the house value as well as the future price expectation may also affect the reference formation. At present, two types of reference points have been proposed in the housing market: previous purchase price and anticipated future house price.

As the prior cost, the initial purchase price of the property is regarded as a natural reference because it marks clearly whether money is gained or lost through a transaction. When one obtains a higher price than the price one paid to acquire the property, a prospective gain exists; otherwise, a loss is expected. The initial purchase price has already been regarded as a reference in some highly influential studies on the housing market (Genesove and Mayer 2001, Leung and Tsang 2013, Anenberg 2011) and on the commercial real estate market (Bokhari and Geltner 2011).

However, the housing market is not constant, and therefore the seller's reference point should be regularly updated, especially when the time between two sales is relatively long. This situation resulted in the proposal of Koszegi and Rabin (2006) to use the expected house price as the reference point rather than the previous price or the adapted current price. Buyers would adapt the reference point because they would certainly gain information or stimuli about the new market condition. The problem has been pointed out by Genesove and Mayer (2001), who proposed that the fixed previous purchase price reference may cause the bizarre coefficients for housing price hedonic regressions. In this research, the practice of Koszegi and Rabin (2006) was followed; thus, we assumed that the developers use their anticipated price as reference point. The underlying reason for this assumption is that decision makers are fully aware of the market condition; thus, the expected price is determined endogenously by the market condition. This assumption is reasonable because the agents in our study are real estate developers who are very experienced and professional participants.

2.3 Identification of Loss Aversion

Numerous studies have explored the existence of loss aversion either in experimental settings or in real market conditions. Their identification methods are labeled by the

[3] Loomes and Sugden (1986) and Ang, Bekaert, and Liu (2005) used expectation that is endogenously determined by a certain equivalent as the reference point. We also considered it as expectation-based because, in some cases, people form their expectations based on the certain equivalent value.

authors as a direct measure or an indirect measure depending on whether these methods estimated the value function and loss aversion parameter itself. This section explores the different direct loss aversion measurements in the present literature as well as some indirect methods that have been used to identify loss aversion.

Table 1 lists some definitions of loss aversion for direct measurements from the existing literature. The first definition is introduced with prospect theory by Kahneman and Tversky (1979) and denotes that utility drop is greater than utility increase when the losses and gains have the same magnitude. This definition by Tversky and Kahneman (1992) is similar to a special case where $x = 1$. Wakker and Tversky (1993) were the first to use derivatives in loss aversion measurements. Their definition implies that, for the same level of losses and gains, the marginal increase caused by a small loss decrease, that is, the slope, should be at least the same as the marginal increase caused by the small gain increase. Subsequently, Bowman, Minehart, and Rabin (1999) proposed a significantly stronger measurement: the ratio of the lower bound of the slope of the value function in the loss domain and the upper bound of the slope of the value function in the gain domain. In this definition, loss aversion means that regardless of the losses and gains, a marginal change in the gain domain is lower than a marginal change in the loss domain. Köbberling and Wakker (2005) provided the first and only non-global definition, which states that loss aversion is the ratio between the left derivative and the right derivative of $v(\cdot)$ at the reference point.

Table 1: Definitions of Loss Aversion in Direct Measurements

Authors	Definition	Literature
Kahneman and Tversky (1979)	$\frac{-v(-x)}{v(x)}$	Bleichrodt, Pinto, and Wakker (2001)
Tversky and Kahneman (1992)	$\frac{-v(-1)}{v(1)}$	Booij, van Praag, and van de Kuilen (2010) Abdellaoui and Kemel (2014)
Wakker and Tversky (1993)	$\frac{v'(-x)}{v'(x)}$	Schmidt and Traub (2002) Pennings and Smidts (2003) Gurevich, Kliger, and Levy (2009) von Gaudecker, van Soest, and Wengström (2011)
Bowman, Minehart, and Rabin (1999)	$\frac{inf\ v'(-x)}{sup\ v'(y)}$	Abdellaoui, Bleichrodt, and Paraschiv (2007)
Köbberling and Wakker (2005)	$\frac{v'_+(0)}{v'_-(0)}$	Booij and van de Kuilen (2009) Abdellaoui et al. (2013)

Notes: $v(x)$ is the value function defined in *2.1.* All $x, y > 0$. $inf\ v'(-x)$ is the lower bound of the slope of the value function in the loss domain, whereas $supv'(y)$ is the upper bound of the slope of the value function in the gain domain. $v'_-(0)$ denotes the left derivative of $v(\cdot)$ at the reference point, and $v'_+(0)$ denotes the right derivative.

Two types of direct definitions are included: global and local. There is a clear difference between the two types. To attain the global index, as proposed by Kahneman and Tversky (1979); Tversky and Kahneman (1992); Wakker and Tversky (1993); and Bowman, Minehart, and Rabin (1999), the entire data range should be scanned, which leads to ambiguous results, depending on the different points chosen. However, as proposed by Köbberling and Wakker (2005), only one specific number is returned for the local reference point. Another difference lies in the incorporation of the curvature of the value function by the global measurements and the possibility of distinguishing loss aversion from the curvature by the local definitions. Furthermore, identification of loss aversion based on global definitions can be too strict for empirical purposes since it includes the whole domain of definition whereas the local definitions use only several points in the domain. Therefore, global definitions are suitable for theoretical purposes, whereas local definitions could remain empirical.

Another method of identifying loss aversion is the indirect way. Unlike the previous loss aversion measurement method that is based on estimation or hypothesis of the value function, the indirect way involves no value function but focuses on the direct effect of losses and gains on the final decision, such as price, time, or effort. This method is widely employed when transactional data instead of experimental data are used. For example, when housing studies probe whether sellers on the real estate market exhibit loss aversion, prices are assumed as a function of the value of gain and loss. The estimated coefficient of loss and gain captures the effect of loss aversion. The model can be summarized as follows:

$$p = f(\mu, Loss, Gain) \tag{3}$$

where *Loss* and *Gain* are defined as the truncated deviation from the reference point. In a loss, the variable *Loss* equals the deviation and *Gain* equals zero. In a gain, the variable *Gain* equals the deviation and *Loss* equals zero. When the magnitude of the coefficient of *Loss* is greater than that of *Gain*, sellers are prone to loss aversion.

The choice of using direct or indirect measurements in the empirical work depends largely on the type of data used. On the one hand, when experimental data are available, direct measurement of loss aversion is appropriate and reliable because under the specially designed experiments, controlling for a variety of disturbing factors and eliciting the utility function are significantly easier. In fact, all the literature listed in Table 1 is based on experiments. On the other hand, indirect measurement is more suitable for studies using transactional data because eliciting the utility function can be very difficult given the complexity of real-life decisions. In this sense, we followed the indirect method because our research is based on transactional data.

2.4 Data Collection Method

Apart from the theoretical issues discussed above, another crucial issue in the empirical implementation in loss aversion studies is related to data. Laboratory data are widely used in loss aversion studies because loss aversion is not directly observed and is difficult to distinguish from other related factors in real market settings. However, in a laboratory setting, researchers have the luxury of controlling for other factors and eliciting information to calculate the net effect of loss aversion. This approach enhances the conceptual validity of the study. Nonetheless, it is problematic and not applicable to housing studies. Nearly 80% of laboratory-based loss aversion studies recruited students as experimental subjects. Student participation is achieved by designing the experiment as an academic requirement or by giving a small monetary reward. This approach is easy to implement and cost-efficient for academic researchers. However, measurement errors may arise because of the lack of experience of the students. The problem worsens in the case of housing studies because most students do not have experience or involvement in buying houses. Another source of measurement error is the absence of a market mechanism (Berkelaar, Kouwenberg, and Post 2004). Therefore, using experimental data in housing studies may lead studies further away from the truth.

Due to the problem related to laboratory data, the efforts of researchers in using market data to empirically test loss aversion in real market settings have been growing. Genesove and Mayer (2001) are credited as the first and most influential researchers to have identified loss aversion in the residential housing market. They used weekly data from the Boston condominium market between 1990 and 1997. Losses and gains were calculated based on the previous purchase price. Therefore, only properties with repeated sales within the time period were included. Evidence proved that condominium sellers in Boston are subject to loss aversion. When exposed to a prospective loss, they set the asking price 25%–35% higher than the difference between the original purchase price and current expected selling price. Following their method, Bokhari and Geltner (2011) applied the same test to the United States commercial real estate market. Anenberg (2011) conducted similar tests on the San Francisco secondhand housing market and Leung and Tsang (2013) on the Hong Kong, China secondhand housing market. The results of those studies also confirmed the existence of loss aversion in the seller's behavior.

In the behavioral analysis of the real estate market, transaction data are more reliable than experiment data in various aspects. First, housing transactions are very different from the traditional goods market and the financial market in such aspects as the large stakes involved, the low frequency of transactions at the individual and market levels, and the combination of high heterogeneity of products and high information asymmetry. These aspects make prior knowledge and market experience extremely important to the reliability of the experiment data. In most cases, however, the subjects lack experience and provide answers based only on their imagination, as discussed earlier in this section. Therefore, the validity of such data is debatable. Second, even if all participants have been or are involved in similar decisions, their answers may still be random due to the lack of real incentive. By contrast, transaction data are decisions that have actually been made in market settings. Therefore, the issues stated above are not true for transaction data. The many advantages of transaction data over experiment data motivated us to use transaction data in our research.

3. CONCEPTUAL FRAMEWORK

In this study, we built a conceptual framework to test the hypothesis on whether loss aversion will affect house prices. Developers derive gain–loss utility from land purchase. They hold an expected land price as the reference price level. If the actual transaction land price is higher than the reference, they experience negative utility from the loss; otherwise, it is positive utility from the gains. In our model, for property i, a reference point (ref_i) is chosen as the log average land price of land purchase within a distance of 3 miles. Losses and gains are the difference between the reference point and the actual log land purchase price, that is, $ref - L_i$. If it is a positive value, it is a gain; otherwise, it is a loss.

We then divide the differences into two variables, namely, *gain* and *loss*, which represent perceived gains and losses, respectively, as depicted in Equation (4).

$$gain_i = \begin{cases} 0, ref < L_i \\ ref - L_i, ref \geq L_i \end{cases}, \; loss_i = \begin{cases} L_i - ref, ref < L_i \\ 0, \; ref \geq L_i \end{cases} \tag{4}$$

We assumed that the log housing price, *P*, is a linear function of the observable attributes, the indicator of the quarter of selling the house, and an indicator of loss or gain:

$$P_{it} = \alpha_0 + \boldsymbol{X}_i \beta + \delta_t + \alpha_{11} gain_i + \alpha_{12} loss_i + \varepsilon_{it} \tag{5}$$

where P_{it} is the log house selling price; $\boldsymbol{X}_i = (x_1, x_2, \dots)'$ is a matrix of house hedonic attributes; and δ_t are yearly dummies, which equals to 1 only in the year when the houses are sold and 0 otherwise. ε_{it} is the error term. If $\alpha_{11} > 0$, then a gain would increase the housing price, and vice versa. If $\alpha_{12} > 0$, then a loss would increase the housing price, and vice versa. If a loss aversion effect exists, α_{12} should be larger in magnitude than α_{11}.

We estimated Equation (5) using two methods: one using the entire dataset and the other using piecewise regression. For the piecewise regression, we divide the sample into the four groups that represent low losses/gains (Group 1), medium-low losses/gains (Group 2), medium-high losses/gains (Group 3), and high losses/gains (Group 4). Cutoff points for the division are chosen to give subsamples a similar sample size while retaining a decent size of each subsample (no less than 25). More specifically, Group 1 consists of the properties with losses and gains smaller than 0.3 in magnitude; Group 2 consists of the properties with losses and gains greater than 0.3 and smaller than 0.6 in magnitude; Group 3 consists of the properties with losses and gains greater than 0.6 and smaller than 0.9 in magnitude; and Group 4 consists of the properties with losses and gains greater than 0.9 in magnitude.

Given that the functional form of the loss aversion effect is unclear, we also employ a semi-parametric model to achieve a more accurate estimation of the loss–gain effect. We determine that the semi-parametric model performs better than the non-parametric model because the sample size required to yield reliable results becomes extremely large with the growing number of non-parametric regressors (the curse of dimensionality). Given that the Beijing dataset contains only 130 observations, the semi-parametric model is more reliable than non-parametric estimation.

The model for estimation is given in Equation (6). The actual log house prices are regressed on a vector of housing characteristics ($\boldsymbol{X}_i$) and a vector of gain and loss variables ($gain_i, loss_i$). This model is a partial linear model in which $g(gain_i, loss_i)$ is the non-parametric part, whereas all other attributes are linearly incorporated in the model as previously done in Equation (3).[4]

$$P_{it} = \alpha_0 + \boldsymbol{X}_i\beta + \delta_t + g(gain_i, loss_i) + \varepsilon_{it} \qquad (6)$$

We used thin plate smoothing spline, one of the penalized least squares estimation methods, to estimate the model. A smooth parameter λ is in the penalty to control the balance between the goodness of fit and the smoothness of the approximation.

4. DATA SOURCE AND SUMMARY

The data came from Beijing, the capital of the PRC. Beijing has experienced dramatic population growth and sprawled considerably in the last few years. The number of permanent residents jumped from 2.03 million in 1949 to 21.15 million in 2013, and the number of foreign residents increased from 0.06 million in 1949 to 8 million in 2013.[5] The growing population density pushed the demand for houses and gave rise to residential property developments. Consequently, land prices and house prices rapidly

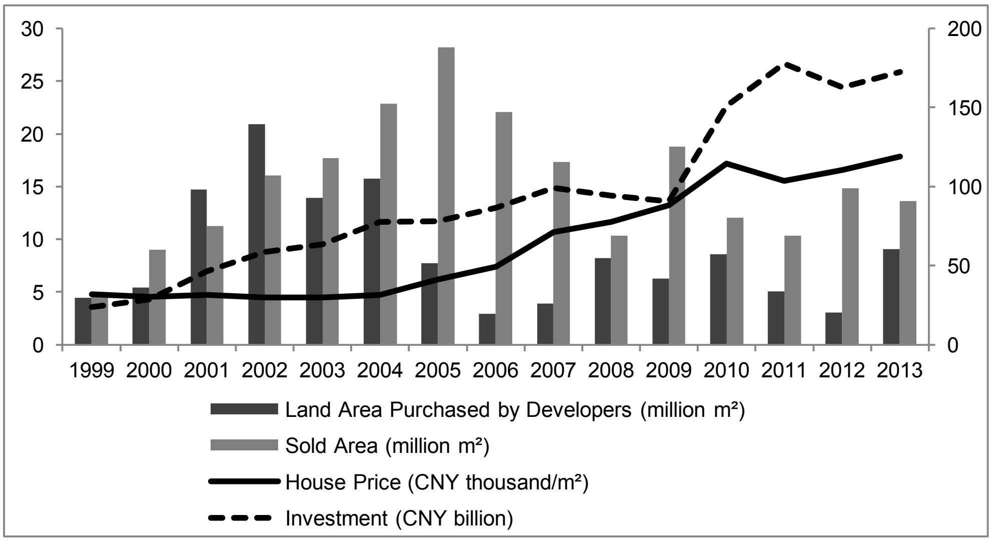
4 Ordinary least squares regression is actually a special case of partial linear regression when we impose a linear functional form for $g(gain_i, loss_i)$.

5 Beijing Municipal Bureau of Statistics, Beijing Statistical Information Net. http://www.bjstats.gov.cn (accessed 2 November 2016).

increased, especially after 2005. Thus, the residential property market has drawn much attention from both the government and the research field.

Figure 1 illustrates some important statistics for residential property development in Beijing. The figure shows the increasing housing prices in the past decade and the steady growth of the Beijing residential property market both on the supply side (investment and land purchase) and on the demand side (sold area). Included in the figure are the annual land area purchased by real estate developers, annual sold area of residential property, average price of residential property, and annual property investment. Residential property development investment grew steadily throughout the period, increasing sevenfold from 1999 (CNY23.66 billion) to 2013 (CNY172.46 billion). Land area purchased was highest in 2002 (20.93 million square meters [m^2]) and did not exhibit the sharp increase shown by sales and prices. However, the absolute area value remained very high (approximately 8 million m^2 every year). House prices tripled from CNY4,847/m^2 in 1999 to CNY17,854/m^2 in 2013. The increasing trend began in 2006 and peaked in 2013. Despite the extremely high house prices, the sold area remained stable at 10 million–15 million m^2 per year after peaking in 2005 (28 million m^2). Notably, a slight drop in the four statistics was observed during 2011 because of the house purchase restrictions issued in 2010. The restrictions were placed to control the excess demand and the extremely sharp house price increase in Beijing. However, the drop was only minor and the trend resumed its increase after 2 years. In conclusion, a massive increase in development projects and housing transactions is taking place in Beijing. This implies the great potential of the booming residential property market. Due to its significance and representativeness, we focused on the Beijing residential property market.

Figure 1: Annual Residential Property Development in Beijing (1999–2013)



CNY = yuan, m^2 = square meter.

Note: Annual residential property investment is on the right axis. The other three are on the left axis.

Sources: Beijing Municipal Bureau of Statistics and the National Bureau of Statistics of China.

Our sample consists of properties that were built between 2003 and 2010 and sold between 2006 and 2014. The variables include land and house characteristics, land purchase details (date and price), house transaction details (date and price), and developers' characteristics. The data were obtained from the Hang Lung Center for Real Estate of Tsinghua University (http://www.cre.tsinghua.edu.cn), a leading center for real estate research and education in the PRC. Official statistics, which supplemented the data, were obtained from the Beijing Municipal Bureau of Statistics (http://www.bjstats.gov.cn).

Table 2: Variable Definitions and Descriptive Statistics

Variable	Mean	Standard Deviation	Definitions
green	34.52	8.44	green area ratio = gross green area/gross land area
parking	0.96	0.35	no. of parking units/no. of flats
FAR	19.19	63.24	floor area ratio = gross floor area/gross land area
fee	120.57	388.97	property management fee per square meter per month
no.of houses	924.60	743.41	no. of flats in this development project
dist_underground	2,560.93	2,898.72	distance to the nearest underground station (*m*)
dist_center	21,749.76	10,219.48	distance to city center (*m*)
dist_hospital	12,653.20	7,984.79	distance to the nearest hospital (*m*)
dist_park	7,960.42	6,096.56	distance to the nearest park (*m*)
dist_school	12,440.65	8,511.00	distance to the nearest primary school (*m*)
land price	12,608.52	10,549.20	actual land price (CNY/m^2)
reference land price	11,872.56	6,646.37	reference land price (CNY/m^2)
house price	20,820.73	12,953.77	house sales price (CNY/m^2)

CNY = yuan, m = meter, m^2 = square meter.

We use house prices, the monthly average price (CNY/m^2) for each development project, as the dependent variables. The explanatory variables used in the estimation and the descriptive statistics are summarized in Table 2. Total house number (*housenum*) in a development project is a proxy for development size. Floor area ratio (*FAR*), green area ratio (*green*), parking space (*parking*), and property management fee (*fee*) are features of a project that affect the house prices. Spatial characteristics are represented by the natural logarithm of the distance to the nearest underground station (*dist_underground*); the city center, which is Tiananmen Square (*dist_center*); the hospital (*dist_hospital*); the park (*dist_park*); and the primary school (*dist_school*). The dataset also includes developer's features, such as the ownership of the developer (central state-owned enterprise, noncentral state-owned enterprise, or private enterprise) and whether the developer is a listed company. Although these data are not shown in the table, they are included in the regression, as are dummy variables. After dropping observations with missing values, we retained 130 property projects.

5. EMPIRICAL RESULTS

This section presents the empirical results of the models described in section 3. The first step is to calculate the expectation-based reference point. The *loss* and *gain* variables are firstly obtained after the reference point calculation. Subsequently, we tested the hypothesis about loss aversion and pricing decisions based on the linear regression of Equation (5) and semi-parametric regression of Equation (6).

A histogram to show the distribution of the gains and losses is given in Figure 2. They are the difference between the reference point and the actual log land purchase price, that is, $ref - L_i$. If it is a positive value, it is a gain; otherwise, it is a loss. The dotted line is the normal distribution curve fitted for the data.

Figure 2: Distribution of the Gains and Losses

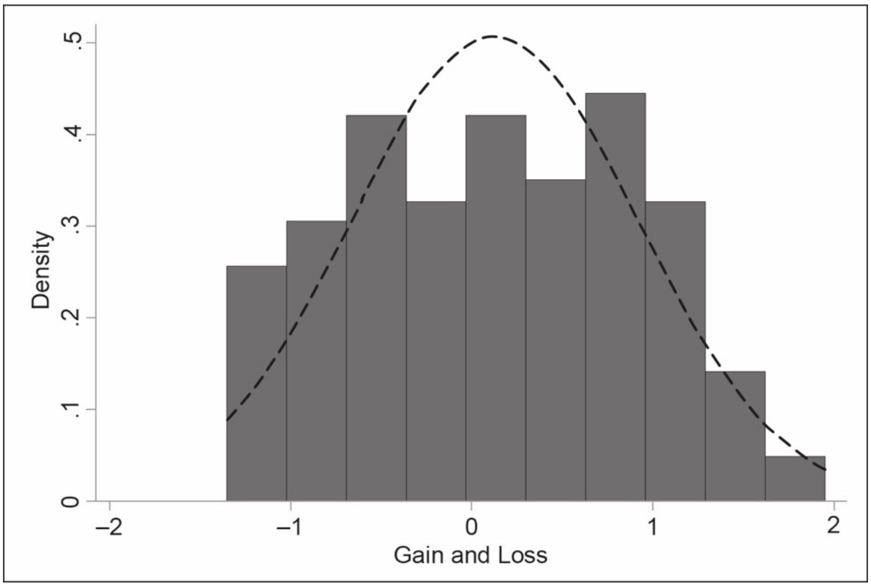


Table 3 presents the empirical results of testing based on Equation (5), which is the regression of log house transaction price onto the prospective gains (*gain*) and losses (*loss*) as well as onto the observable house attributes and variables for the quarter in which the house is sold. All of the variables were measured in logs except dummy variables. We also include yearly dummies for the house transaction time variable, δ_t.

Table 3: Ordinary Least Squares Regression Results

	Entire Dataset	**Absolute Value of Loss/Gain within Range of**			
		(0, 0.3)	**(0.3, 0.6)**	**(0.6, 0.9)**	**(0.9, +∞)**
gain coefficient	–0.627	0.13	–1.07	–2.39	–0.31
loss coefficient	0.488	0.91	0.03	–1.39	0.57
No. of observations	130	30	27	32	41
R-square (%)	78.5	63.70	44.40	82.50	91.20

We use both the entire dataset regression and piecewise regression to see if loss aversion levels change with the magnitude of the losses and gains. Coefficients for the observable attributes ($\boldsymbol{X}_i$) are reasonably consistent with those of the literature and are omitted from the table. The entire dataset regression does not appear to support the loss aversion effect. The coefficient on loss (0.488) is smaller in magnitude than the coefficient on gain (−0.627). One possibility is that the linear relationship between *loss/gain* and house price may not be globally the same. Therefore, the piecewise regression is employed to effectively capture the nonlinear relationship. The results show that small losses seem to loom larger than small gains (0.91 vs. 0.13); the same is true for large losses (0.57 vs. 0.31). However, when the magnitude falls between 0.3 and 0.9, the pattern seems to be reversed, that is, gains have a stronger effect than losses. However, the pattern we obtained is not rigorously justified if only piecewise regression is used. Either the cutoff point selection or the linearity imposed in each regression could bias the estimation results.

To capture the effect of losses and gains on house prices more accurately, a semi-parametric model based on Equation (6) is estimated using the TPSPLINE method. Figure 3 is an illustration of the results. It shows the utility from the land purchase implied in the house prices, with the assumption that other attributes are the same for all the projects. The negative values in the x-axis represent losses, whereas the positive values represent gains. In other words, it is $ref - L_i$ in the x-axis. This transformation aims to make the results easily comparable with the value functions in prospect theory, as the dotted line shown in Figure 3, and hence the loss aversion effect directly observable. Utility function is obtained through some basic assumptions: (i) at the reference point, *v*=0; and (ii) one unit of house price increase (holding all variables except loss/gain constant) implies one unit of negative utility, while one unit of house price decrease implies one unit of positive utility.

Figure 3: Value Function Estimated from the Semi-Parametric Estimation

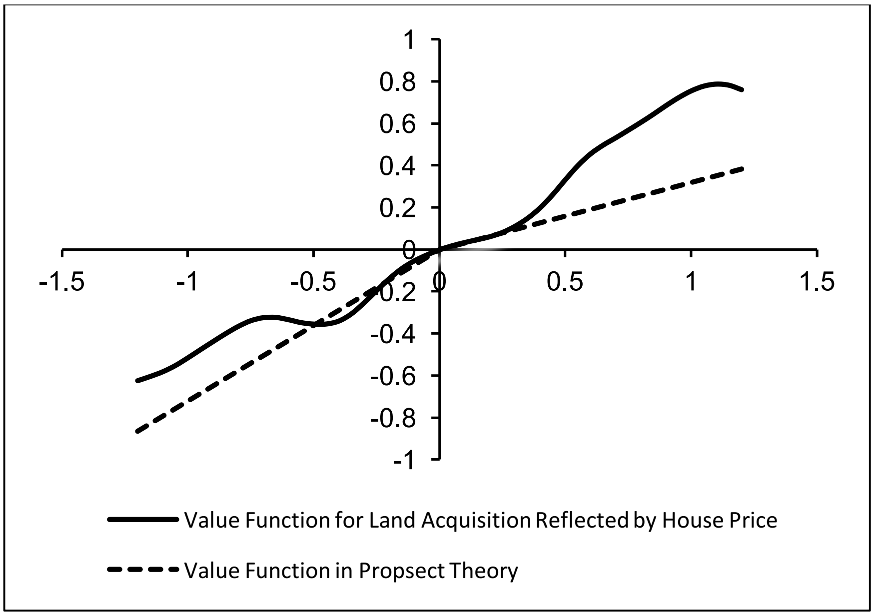


Figure 3 demonstrates that developers would set a price higher than the price they would otherwise set in response to a paper loss increase; however, they would set a price lower than the price they would otherwise set in response to a paper gain increase. As for the slopes, the biggest difference is around the reference point. Two dotted lines are added to show the slopes for the two domains. For gains, the marginal utility is 0.32, that is, a one-unit increase of gain from land purchase raises a developer's utility level by 0.32 unit. For losses, the slope is 0.6, that is, when a one-unit loss is experienced close to the reference point, a developer's utility drops by 0.6 unit. From this estimation, loss aversion level is nearly 2 around the reference point.

When the magnitudes of losses and gains grow, the effect of loss aversion disappears. This is from the decreasing slopes in the loss domain and increasing slopes in the gain domain around the magnitude of 0.5. When the magnitude is within the range of 0.5–1, loss effects and gain effects are almost the same. When developers face losses that are greater than 1, losses loom significantly larger than gains again. To conclude, developers are most loss averse under two circumstances: (i) around the reference point and (ii) when facing very high losses.

The findings show that transactions in the land market affect transactions in the house market. High land transaction prices would lead to a house price disposition effect. The impact takes the form of the loss aversion bias, and the level of the impact varies with the magnitude of the losses and gains. The loss aversion impact is the strongest around the market expectation price. As the magnitude of a loss or a gain grows, their impact is attenuated. But when land transaction prices deviate too much, the impact of loss aversion strengthens again.

6. CONCLUSION AND FUTURE RESEARCH DIRECTIONS

This study is an extension of previous loss aversion studies on the real estate market (e.g., Genesove and Mayer 2001, Bokhari and Geltner 2011, Leung and Tsang 2013, Anenberg 2011). Using the September 2003–June 2014 land purchase and house sales data from Beijing, this study has shown that loss aversion affects pricing decisions. Specifically, losses in the land purchase phase would lead to disposition behavior in the later stage of house sales. The effect is most distinct around the reference point as well as when losses or gains are high in magnitude.

We improve the previous studies in the following ways: employing a new expectation-based reference point, focusing on the property developers, and allowing for variant loss aversion levels using semi-parametric analysis. Moreover, our research adds validity to behavioral findings based on transaction data rather than on experiments. Despite the increasing number of studies on loss aversion since the concept's introduction, most of them have continued to use data from student experiments. The validity of the findings from these experiments in real market conditions has become debatable because (i) students lack the knowledge and experience; and (ii) most of these experiments were only concerned with small-stakes gambles, which are considerably simpler than real-life decisions. In housing studies, the problems related to experiment data have worsened; thus, such studies cannot produce ecologically valid findings, given the complexity of both the decision-making process and the nature of the product. Real market data, such as property transaction prices and dates, have become the preferred sources. In this sense, the use of Beijing property development and transaction data highlights the validity and significance of this research.

The results of this research have broad implications for our understanding of the PRC's real estate markets. First, housing prices are determined not only by house characteristics but also by the behavioral biases of developers and sellers as well. This implication indicates that the market is far from perfect and it is more complicated than the market predicted by classical economic theory. Second, the positive correlation between housing price and volume, which has been identified in previous research along with the strong stickiness of housing prices in a down market, cannot be explained by perfect asset models. The behavioral bias of the developer, namely loss aversion, plays a significant role in this cyclical trading pattern.

In this study, however, we failed to directly observe the reference points, and unknown measurement errors occurred. These are important areas to address in the future. Given the nature of the available data and existing literature, this study, at best, could only provide an indication of the underlying developer behavior. Future research should pay attention to the reference formation process and incorporate more elements that may affect the reference point. For instance, the historical peak of the changing outcome plays an important role in the reference adapting process (Gneezy 2005). In addition, the adaptation of reference point is a huge issue. As Chen and Rao (2002) highlighted in their experiments, although people's reference points shift immediately after a stimulus occurs, such a shift is incomplete. The magnitude of the shift depends on the time difference between two stimuli. Reference points are important to the validity of the whole research. Therefore, they should be given special attention.

After identifying the overall effect of loss aversion, another important future research topic is whether any moderating factors—for example, developer ownership and developer transparency—interact or influence the level of loss aversion. Such research will be crucial in providing instructive insights and practical guidelines for developers, policy makers, and home buyers.

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CEO Overconfidence in Real Estate Markets: A Curse or A Blessing?

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Abstract

This paper studies the influence of CEO overconfidence on firms' financial performance and corporate social responsibility (CSR) in the US real estate investment trust (REIT) market. CEO overconfidence has been shown to have both negative and positive influences on firms. This paper is the first to combine the two sides in a single framework. We find that firms with overconfident CEOs tend to have better CSR performance. In addition, better CSR performance can increase firms' financial performance, but this positive relationship is undermined by the existence of overconfident CEOs. Our results not only shed light on the two sides of CEO overconfidence in the real estate sector, but also provide a new prospective for research on the CSR–financial performance relationship.

Keywords: CEO overconfidence; CSR; financial performance; REIT

1. Introduction

Overconfidence is one of the most robust behavioral anomalies in the financial market. It is essential in determining investors' decision-making and market performance. In the decision-making process, overconfident investors attribute the past success to their superior ability instead of by chance; hence, they irrationally trade in the future (Odean 1998; Gervais & Odean 2001; Hilary & Menzly 2006; Statman *et al.* 2006). Such behavior reduces investment profits and utility (Odean 1998; Barber & Odean 2000, 2001). An overconfident investor also overestimates the precision of his private information at the expense of ignoring public information, which leads to suboptimal investment decisions (Daniel *et al.* 1998). In terms of market performance, overconfidence increases market depth and volatility (Odean 1998), generates excessive trading (Odean 1998; Statman *et al.* 2006; Griffin *et al.* 2007), and creates speculative bubbles (Scheinkman & Xiong 2003).

Similar to investors, chief executive officers (CEO) also suffer from overconfidence. Overconfident CEOs are more likely to overinvest than their non-overconfident counterpart. They view external fund as costly so that investment to cash sensitivity is higher in firms with overconfident CEOs (Malmendier & Tate 2005). Due to overconfidence, they believe the value of their firms are undervalued by the market, hence prefer debt financing than equity financing (Malmendier *et al.* 2011). This will lead to biased investment decisions, suboptimal capital structure and weak financial performance. On the other hand, however, overconfident CEO can benefit firms by increasing investment in risky projects, innovation, R&D expenditure, etc. (Galasso & Simcoe 2011; Hirshleifer *et al.* 2012). Studies on the second point mainly focus on innovation-intensive industries, while real estate sector is not usually considered in their sample. However, there is growing interest on corporate social responsibility (CSR) in real estate. CSR is similar to innovation in the sense that both of them require risk-taking decisions and long time commitment. Therefore, we make a hypothesis that CEO overconfidence is also associated with CSR performance.

Since CEO overconfidence is shown to have both positive and negative influence on firms, it's better to study the two effects at the same time. In this paper, we study the influence of CEO overconfidence on financial performance and CSR performance after controlling confounding factors such as CEO and firm characteristics. Additionally, we examine whether overconfidence is a moderator in the CSR–financial performance relationship. Overall, we find that CEO overconfidence positively influences firms' CSR performance. However, firms with overconfident CEOs have relatively weak financial performance compared with firms with non-overconfident CEOs. Moreover, CSR has a positive influence on financial performance, but the effect is undermined by CEO overconfidence.

This paper contributes to the existing literature in the following ways. First, although there is a wide variety of literature on CEO overconfidence in financial research, the study in the real estate sector is limited. Two papers have just documented the influence of CEO overconfidence on financial performance and financial policy (Eichholtz & Yonder 2015; Yung *et al*. 2015). No literature has yet connected CEO overconfidence with CSR. Our paper contributes to the scarce real estate literature on overconfidence.

Second, CEO overconfidence has both negative and positive sides. However, no study has yet explored the two sides at the same time, either in the real estate market or in the entire financial market. This paper builds a unified framework that encompasses both sides of CEO overconfidence. Hence our results shed light on the comprehensive role of CEO overconfidence in the real estate sector.

The remainder of the paper is structured as follows. Section 2 reviews the overconfidence literature. Section 3 describes data and methodology employed in this study. Section 4 discusses models and estimation results. Section 5 concludes the study.

2. Literature Review

2.1. CEO Overconfidence

Early studies on overconfidence almost exclusively focus on investor overconfidence. Since the pioneering work of Malmendier and Tate (2005), a wide variety of CEO overconfidence studies has appeared. Their topics can be classified in three categories, namely, biased investment decisions, weak financial performance, and innovation.

Biased investment decisions

Malmendier and Tate (2005) classify CEOs who fail to reduce their exposure to their own companies' risk as overconfident CEOs. They find that overconfident CEOs overestimate the return of their investment projects but view external funds as costly. Therefore, they overinvest when the internal cash flow is abundant. The sensitivity of investment to cash flow is positively affected by CEO overconfidence. After this seminal work, CEO overconfidence studies with extensive focuses emerged. Overconfident CEOs interpret projects with a negative net present value (NPV) as those with positive NPV to delay the recognition of losses (Ahmed & Duellman 2013). Dividend payout is lower when CEOs are overconfident because these CEOs view external financing as costly and tend to allocate more profit to further investment (Deshmukh *et al*. 2013). Overconfident CEOs tend to make low-quality acquisitions (Malmendier & Tate 2008). In summary, empirical findings suggest that overconfidence causes CEOs to make suboptimal decisions.

Weak financial performance

The finding that CEO overconfidence is negatively related to financial performance is not surprising. CEOs are optimistic about firms' future performance and frequently overestimate their contribution because of overconfidence (Libby & Rennekamp 2012). Fund managers who have made successful forecasts in the short run tend to be overconfident in their ability to forecast future earnings (Hilary & Hsu 2011). This inevitably leads to firm underperformance compared with earnings forecast. Chen *et al*. (2014) show that firms with overconfident CEOs fail to generate positive abnormal returns following a significant R&D expenditure increase. Thus, overconfident CEOs' decisions to increase investment in R&D do not produce returns as expected.

The above two streams of research focus on the negative side of CEO overconfidence. In real estate research, two recent articles use data from the US REIT market to explore the "value-destruction" side of CEO overconfidence. Their findings are also consistent with the conclusions reached in other markets. Eichholtz and Yonder (2015) find a significantly negative relationship between CEO overconfidence and firm performance. Yung *et al*. (2015) find that firms with overconfident CEOs have small dividend payouts, and that they use more debt financing than equity. These relationships are significant despite REITs' unique dividend policy and capital structure. The effect of overconfidence seems to be strong enough to overcome these regulatory constraints. This finding strongly supports the role of overconfidence in investment decisions by CEOs.

Innovation

The third subtopic of CEO overconfidence studies, "CEO overconfidence and innovation", warrants attentions from both academia and industry. The first two topics lead to either biased decision making or weak firm performance. The findings in this category suggest that overconfidence may add values to firms. Overconfident CEOs tend to lead firms in an innovative way. Holding the level of investments constant, they obtain more patents and citations (Galasso & Simcoe 2011). Hirshleifer *et al*. (2012) confirm these findings in their studies and further claim that CEO overconfidence may benefit shareholders in the long run by investing more in innovative and risky projects. These conclusions must be interpreted with caution because the positive relation between overconfidence and innovation may only hold true in innovative industries (Hirshleifer *et al*. 2012).

The existing findings on this topic are not related directly to real estate because the real estate sector is unusually treated as an innovation-intensive industry. However, a recent development in real estate research may benefit from overconfidence studies, that is, corporate social responsibility (CSR). Growing interest has been given in sustainable and responsible development and investment in real estate (see the discussions in Fuerst *et al*. [2014] and Deng and Wu [2014]). However, existing studies usually focus on physical and financial characteristics of firms or buildings, and the characteristics of decisions makers (e.g., CEOs) are often overlooked. In the decision-making process, CEOs usually have "total and unconditional control rights" (Stein 2003). Their role is crucial in determining firms' CSR strategy. Investing on CSR projects is risky and long term. It usually involves a significant amount of capital allocation. Facing such a level of uncertainty and stake, do bolder decision makers have the tendency to take on the challenge as suggested in the overconfidence literature? Researchers and policy makers have been struggling to discover what motivates the adoption of CSR projects (see the review by Revelli and Viviani [2015] for examples). Whether or not CEO overconfidence contributes positively to socially responsible investing is interesting to uncover given the significant role a CEO plays in these decisions.

Although innovation and CSR are different corporate behaviors, they share some common characteristics. First, both are risky and challenging in terms of the uncertainty of potential outcomes. Innovation-related activities require high R&D expenditure, but they cannot guarantee the production of new technologies, new patents, or high financial performance.

Similarly, in the conventional view, CSR investment does no good to shareholders' value. It only gives a good reputation to firms and CEOs. In recent decades, even when the importance of CSR has gained more public attention and when the potential long-term benefits of CSR are crucial to firms' financial performance, whether or not the "invisible" benefits of CSR deserve high investment remains unknown. In psychology studies, people are shown to be more overconfident when facing difficult rather than easy tasks (Griffin & Tversky 1992). Correspondingly, one can expect overconfident CEOs to be more passionate in risky and challenging investments, such as CSR activities. Furthermore, although CSR is rewarding, the investment toward it requires a long time to be converted into observable outcome. During the process, decision makers should constantly commit to efforts toward CSR. Adopting long-term projects, such as innovation or CSR-related activities, tends to appeal to overconfident managers because it may represent their superior managerial "vision" (Hirshleifer *et al*. 2012).

2.2. CSR

CSR has become increasingly popular over the past decades. Many firms have strategically increased CSR investment to gain good reputation, improve employee productivity, and reduce the threat of regulations (Eichholtz *et al*. 2010). Other firms have also done so because of the pressure of activist shareholders or government organizations (Baron 2001). In 2014, Global Fortune 500 companies in the United States and the United Kingdom spent $15.2 billion on CSR activities.[1] In 2015, 92% of the Global Fortune 250 companies published detailed CSR reports.[2] On the investor side, more investors have begun to screen firms' CSR criterion before they make investment decisions or use socially responsible investing (SRI) as an investment vehicle. They believe that investing in CSR can add value to their portfolios instead of wasting their money in the old view. According to a 2014 trend report on sustainable and responsible investing, $6.57 trillion in US-domiciled assets are under the management of SRI strategies, and this value is a 76% increase from $3.74 trillion in 2012.[3]

Despite the increasing popularity of CSR, the economic motivations behind CSR are mixed. Two types of opposing views have been proposed. The first view is the stakeholder value maximization view. It suggests that CSR can benefit the welfare of stakeholders such as

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[1] http://www.ft.com/cms/s/0/95239a6e-4fe0-11e4-a0a4-00144feab7de.html - axzz48M3tTFgM

[2] http://www.kpmg.com/CN/en/IssuesAndInsights/ArticlesPublications/Documents/kpmg-survey-of-corporate-responsibility-reporting-2015-O-201511.pdf

[3] http://www.ussif.org/Files/Publications/SIF_Trends_14.F.ES.pdf

workers and suppliers and therefore increase their incentives to support the firm (Deng *et al.* 2013). The second view is the shareholder expense view. In contrast to the first view, it suggests that managers engage in CSR activities to help stakeholders and themselves at the expense of shareholders (Surroga & Tribo 2008; Cronqvist *et al.* 2009).

Correspondingly, whether or not CSR can increase firms' financial performance is inconclusive. On the one hand, evidence shows that CSR can lower the cost of equity (El Ghoul *et al.* 2011; Cajias *et al.* 2014), lower the cost of bank loans (Goss & Roberts 2011), create rent premiums (Eichholtz *et al.* 2010), reduce stock price crash risk (Kim *et al.* 2014), and increase operating performance (Eichholtz *et al.* 2012). However, many studies have found no relationship between CSR and financial performance (see Margolis *et al.* [2009] for a review). Di Giuli and Kostovetsky (2014) even find that high CSR ratings are associated with negative future stock returns and low return on assets (ROA).

CEO overconfidence and CSR

Managerial decisions in CSR are crucial for firms' CSR strategy. As the most powerful person in the management board, the CEO sometimes can "unilaterally decide" a firm's CSR strategy. A wide variety of studies relate CEO characteristics to CSR. Huang (2013) finds that firms' CSR performance is associated with CEOs' educational background, tenure, and gender. Jiraporn and Chintrakarn (2013) relate CEO power to CSR and find that a powerful CEO has significantly higher CSR engagement than a less powerful one. However, the level of CSR investment decreases after CEO power reaches a threshold. Jian and Lee (2015) find that CEOs are rewarded with high compensation for investing in optimal CSR but receive low compensation for excessive CSR investment. Deckop *et al.* (2006) use pay structure to explain CSR. They argue that a short-term pay focus is negatively associated with CSR, whereas a long-term pay focus is positively related to CSR. In terms of pay structures among members of an executive team, firms with low payment disparity have higher CSR, whereas those with high payment disparity have lower CSR.

In addition to these "observable" CEO characteristics, CEO psychological characteristics may influence firm decisions, particularly CSR strategy. This statement is consistent with the upper echelons theory, which claims that executives' psychological characteristics are crucial determinants of firms' behavior and performance (Hambrick & Mason 1984; Hambrick 2007). However, the empirical evidence on the effect of managerial behavioral bias on CSR is limited.

Tang *et al*. (2015) claim to be the first to link CSR to managerial psychological bias. They find that CEO hubris is negatively associated with socially responsible investment but is positively associated with socially irresponsible investment.

CEO overconfidence as a moderator of CSR–financial performance relationship

We have shown that CSR has various influences on firm financial performance, although the results remain mixed. In addition, as the decision makers of firms, CEOs have behavioral bias that can be incorporated into firms' CSR strategy and firm financial performance. Therefore, CEO overconfidence may also moderate the CSR–financial performance relationship. To the best of our knowledge, no study has yet explored this moderating effect of CEO overconfidence. However, the study of the moderating effect of CEO overconfidence is greatly significant to both CSR research and CEO overconfidence research.

First, managerial overconfidence has drawn increasing attention in the past decade. Section 2.1 shows that many financial market phenomena are found to be related to managerial overconfidence (see also the discussion in Baker *et al*. [2012]). The CSR–financial performance relationship is an important topic in finance, and CEO traits are shown to be crucial in determining corporate outcomes. Therefore, adding CEO overconfidence to the studies of the effect of CSR on financial performance can help better understand the relationship between the two. Does managerial overconfidence reinforce or undermine the relation?

Second, previous studies documented various "value-destruction" sides of managerial overconfidence in financial perspectives and one "bright" side of managerial overconfidence: innovation. By introducing CEO overconfidence to CSR studies, we can add a new element, either a positive or a negative one, to overconfidence studies, which is a contribution to managerial overconfidence studies.

3. Data and Methodology

3.1. Data

The sample in this study are US REITs, all of which have the four-digit SIC code of 6798. Data are obtained from the intersection of Execucomp, MSCI ESG (formerly KLD), CRSP, and Compustat. Several steps are performed before the final database is formed. First, we obtain the CEO compensation data from Execucomp. Second, for every firm–year observation in Execucomp, we use the Compustat firm identifier "GVKEY" to merge it with financial data from Compustat and fiscal year-end price data from CRSP. [4] Third, we merge the abovementioned database with the MSCI ESG rating data. The last step is not straightforward. Only three firm identifiers are found in the MSCI ESG database: company name, ticker, and CUSIP. The first two identifiers are inconsistent because different databases may use different firm names and ticker names, and the same ticker name can be assigned to different firms. Some CUSIP values in the MSCI ESG database are missing or misreported, so they do not match for all observations. To solve this problem, we use the company ticker to link the two databases and then manually compare the CUSIP and company names for each observation.

The final database consists of 884 firm–year observations from 2001 to 2014, including financial and CSR rating information of 103 firms and compensation data of 156 CEOs.

3.2. Measurement CEO overconfidence

In CEO overconfidence research, the measurements of overconfidence can be obtained from both objective and subjective information. The first type of measure is based on the idea that overconfident CEOs are not able to diversify their high idiosyncratic risk. CEOs are already highly exposed to their own firms' risk. Therefore, failure to diversify the risk is considered to be associated with overconfidence. Examples include CEOs who fail to exercise their vested and "deep-in-the-money" stock options and those who are net buyers of their own firms' stocks (Malmendier & Tate 2005, 2008). The second type of measure is derived from CEO's earnings forecast. Overconfident CEOs overestimate the future firm performance under their management. Therefore, they often make irrationally high earnings forecast. Thus, the level of overconfidence can be reflected by the proportion of earnings forecasts that exceed the realized earnings. These two types of measurements are taken from readily available market data. The objective information can enhance the reliability and replicability of the findings. Alternatively, the third type of measure is obtained from the subjective rating of confidence. This line of research counts the press description of CEOs to determine the level of overconfidence (Galasso & Simcoe 2011; Malmendier *et al.* 2011; Shu *et al.* 2013). First, they choose some overconfidence-related keywords, such as "confident," "confidence," "optimistic," and "optimism," and some non-overconfidence-related keywords, such as "reliable," "cautious,"

[4] Firm identifier "GVKEY" for CRSP database can be obtained from the CRSP/Compustat Merged Database.

"practical," "frugal," "conservative," and "steady". Second, the overconfidence measure is determined by the difference between the counts of these two types of keywords. Similar to investor overconfidence, there are also studies that designed some psychological questions to calculate the overall score of overconfidence (Menkhoff *et al.* 2006).

Referring to Malmendier and Tate (2005), we use the option-based measure of CEO overconfidence. A CEO who fails to exercise vested options that are at least 67% in the money is classified as an overconfident CEO. This is because CEOs are already highly exposed to their firms' idiosyncratic risk. Rational CEOs prefer to diversify their risk by exercising their vested and "deep-in-the-money" options. However, overconfident CEOs will not do so in the hopes that their firms will have better performance under their management. Therefore, those who fail to exercise their vested options that are at least 67% in the money are classified as overconfident. The fraction of 67% is a threshold that corresponds to a CRRA value of 3 according to Hall and Murphy (2002). In consistent with Hirshleifer *et al.* (2012), a CEO who is identified as overconfident remains so for the full sample period because overconfidence is a personal trait.

Empirically, we use the Execucomp database to construct the overconfidence measure. First, the realizable value per option is calculated as the total realizable value of unexercised exercisable options divided by their total number. Second, the estimated exercise price is calculated as the fiscal year-end share price minus the realizable value per option calculated in the first step. Finally, the degree of "in-the-money" is the value of share price divided by exercise price minus 1.

$$average\ option\ value = \frac{unexercised\ exercisable\ value\ of\ options}{number\ of\ unexercised\ exercisable\ options}$$

$$\begin{aligned} oc &= \frac{Share\ price\ at\ the\ end\ of\ fiscal\ year}{share\ price\ at\ the\ end\ of\ fiscal\ year - average\ option\ value} - 1 \\ &= \frac{average\ option\ value}{share\ price\ at\ the\ end\ of\ fiscal\ year - average\ option\ value} \end{aligned}$$

After *oc* variable is calculated, an overconfidence indicator (*ocdummy*) is created for each CEO. If a CEO is identified as overconfident in a certain year, then *ocdummy* will be 1 for the whole career; otherwise, *ocdummy* will be 0.

3.3. Measurement of CSR performance

The MSCI ESG database is used to form the measure of corporate social performance. Initiated in 1991, MSCI ESG is one of the longest continuous ESG rating databases and widely used in academic studies on CSR. Based on the in-depth information from company disclosure, government, media, NGOs, and other stakeholder sources, MSCI ESG provides statistical ratings for a wide range of CSR-related items.

The database organizes items into two major categories: qualitative issues and controversial business issues. Seven categories are found in the qualitative issues area, including environmental performance, community, human rights, employee relations, diversity, product, and corporate governance. In each of the seven categories, MSCI ESG raises several strengths and concerns (the number and the type of strength and concern may vary) with binary ratings of 1 or 0. A strength variable with a value of 1 indicates an identified strength in a given year for that firm. The same applies to a concern variable. In the controversial business issues area, the database only has concerns in the following aspects: alcohol, gambling, tobacco, firearms, the military, and nuclear power. For each aspect, MSCI ESG assigns a binary variable indicating whether or not the firm is involved in certain controversial businesses.

To obtain a full view of a firm's CSR profile in a given year, we aggregate all ratings in strengths and concerns to a single CSR score. Several methods are used in the CSR-related literature. The commonly used method form the aggregate CSR score for each firm–year by subtracting the number of concerns from the number of strengths (El Ghoul *et al.* 2011; Kim *et al.* 2014; Jha & Cox 2015). However, as noted by Cajias *et al.* (2014), such an approach is not appropriate for real estate firms because some of the general ESG criteria are highly irrelevant to real estate firms. They revise the average aggregation method to a weighted average approach. The relative importance of each ESG criterion is determined by the total number of non-zero value appearing in the sample period for real estate firms only. This can ensure that some irrelevant issues in real estate (e.g., human rights violations) will only have a small proportion in the aggregate score. To be consistent with their approach, we calculate the aggregate CSR score using the following procedure.

First, ESG rating data are collected in the whole sample period. Second, the concern rating of 1 is converted to -1 to reflect the negative effect of concern variables on CSR. Finally, the weighted average of all the strength values and concern values of each firm is calculated. The weighting parameter is calculated as the summation of the value of the specific indicator variable across every firm–year divided by the summation of the value of all indicator variables across every firm–year.

4. Empirical analysis

This section presents the empirical analysis of the relationship among CEO overconfidence, CSR and financial performance.

4.1. Variable definitions and descriptive statistics

The variables employed in this research include CEO information, firm financial information, and firm CSR ratings. CEO information consists of overconfidence dummy, salary, bonus, gender, and CEO tenure. Financial information includes firm size, cash asset ratio, leverage ratio, capital expenditure asset ratio, and Tobin's q. CSR score is an aggregate indicator of a firm's CSR performance. Table 1 summarizes the definitions and descriptive statistics of these variables.

Table 1. Variable definitions and descriptive statistics

Variable	Definition	Obs	Mean	Std. Dev.	Min	Max
ocdummy	overconfidence dummy	884	0.3541	0.4785	0.0000	1.0000
score	CSR score	884	–0.0909	0.1239	–0.3594	0.1412
salary	CEO salary	884	607.2114	264.8369	0.0000	1459.6150
bonus	CSO bonus	884	385.5578	793.5763	0.0000	7500.0000
female1	female CEO or not	884	0.0271	0.1626	0.0000	1.0000
yasceo	CEO tenure	834	8.0372	5.8677	0.0000	28.0000
size	log(total assets)	884	8.1794	0.9926	5.2971	10.4141
ch_at	cash/total assets	791	0.0201	0.0282	0.0000	0.2449
lt_at	total debt scaled by total assets	884	0.5596	0.1584	0.0317	1.2073
capx_at	capital expenditure/total assets	878	0.0069	0.0278	0.0000	0.3167
tobinq	(market value of equity + total assets – book value of equity)/ total assets	884	1.4411	0.3794	0.7331	3.7214
roa	return on assets	884	0.0291	0.0301	-0.1039	0.2759
oc_score	interaction term between ocdummy and score	884	–0.0291	0.0831	–0.3594	0.1198

4.2. Estimation methods and results

CEO overconfidence and CSR

We use the two-sample t-test to test the mean difference of CSR between firms with overconfident CEOs and firms with non-overconfident CEOs. Table 2 summarizes the results. It is significant that firms with overconfident CEOs have a higher mean CSR score.

Table 2. Two-sample t-test on CSR

Group	Obs.	Mean	SE
0 (*ocdummy* = 0)	571	–0.0957	0.0052
1 (*ocdummy* = 1)	313	–0.0821	0.0070
total	884	–0.0909	0.0042
diff = mean(0)-mean(1)		–0.0135	0.0087
H0: diff = 0		t = –1.5551	
H1: diff < 0		p-value =0.0601	

To further investigate whether or not CEO overconfidence is related to CSR, we run the regression of CSR score on the overconfidence dummy and an array of control variables. Table 3 summarizes the results using the fixed-effects (FE) method and pooled ordinary least squares (OLS) method. On average, firms with overconfident CEOs have a significantly higher CSR score. The results are slightly different in the OLS and FE models. The FE estimator is more reliable because firm-specific unobservable factors may exist. Another finding from the two models is that large firms have a relatively high CSR score.

Table 3. Regression results of CEO overconfidence on CSR

	Fixed effect	Pooled OLS
salary	–0.00006*	0.00001
bonus	–0.00002*	–0.00002***
age	0.00106	0.00058
female1	–0.11002**	0.02642
yasceo	–0.00234	–0.00178***
size	0.04188**	0.02678***
ch_at	–0.20996**	–0.00023
lt_at	–0.06018	–0.04858*
capx_at	0.01043	–0.07655
ocdummy	0.03409**	0.02082***
Year fixed effect	Yes	--
Firm fixed effect	Yes	--

Notes: * p < 0.1, ** p < 0.05, *** p < 0.01

Relationship among CEO overconfidence, CSR, and financial performance

In investigating the relationship among CEO overconfidence, CSR, and financial performance, the following equation is estimated. As various studies show that financial performance can be influenced by both CEO overconfidence and CSR, we use it as the dependent variable. It is consistent with the focus of this study. The measure for financial performance is Tobin's q ratio because it is one of the most commonly used proxies for firms' financial performance (Eichholtz *et al.* 2012; Eichholtz & Yonder 2015; Yung *et al.* 2015). Its lagged term is included as a regressor to capture the dynamic nature of financial performance. To capture the potential moderating effect of CEO overconfidence on the CSR–financial performance relationship, we create an interaction term oc_score, which is the product of *ocdummy* and *score*. Financial control variables are included as right-hand side variables. μ_i is the firm fixed effect, and v_{it} is the error component.

$$tobinq_{it} = \beta_0 + \beta_1 tobinq_{it-1} + \beta_2 score_{it} + \beta_3 ocdummy_{it} + \beta_4 oc\_score_{it} + \beta_5 size_{it} + \beta_6 ch\_at_{it} + \beta_7 lt\_at_{it} + \beta_8 capx\_at_{it} + \mu_i + v_{it}$$

The estimation methods are dynamic panel data models that incorporate the dynamic relationship between financial performance and CSR, and account for the endogeneity issue. Dynamic panel data models have recently received increasing attention in corporate finance research (Flannery & Hankins 2013). The details of these models can be found in the Appendix.

The dynamic panel data models are applied for two reasons. First, in addition to the effect of CSR, overconfidence, and an array of control variables, the lag of financial performance in the previous year affects financial performance. A model with a dynamic nature can better fit the objectives of this research. Second, although CSR can influence firm performance, the causality relation of the opposite direction may also hold. This endogeneity issue of CSR is prevalent in related research (see, e.g., El Ghoul *et al.* [2011]). In either difference generalized method of moments (GMM) or system GMM of the dynamic panel approaches, the endogeneity issue of the right-hand-side variables can be addressed by including the lagged level as instruments for the difference equation and lagged difference as instruments for the level equation.

Table 4 summarizes the estimation results. The one-step and two-step estimators are reported for each estimation. Columns (1) and (2) report the Arellano–Bond difference GMM estimator.

Columns (3) and (4) report the Blundell–Bond system GMM estimator. The coefficients of CSR score are positive and highly significant in all the four columns. This finding confirms the hypothesis that REITs with higher CSR rating have better financial performance. The overconfidence dummy is significantly negative in the difference GMM models, reflecting the negative effect of managerial overconfidence on financial performance. This result is in accordance with the findings of Eichholtz and Yonder (2015). However, the coefficient remains insignificant in system GMM models. The interaction term between CEO overconfidence and CSR performance is negative and significant across models, thus indicating that the existence of overconfident CEOs undermines the positive effect of CSR on financial performance.

4.3. Robustness checks on the results

Dropping time-invariant dummy variables

A potential problem in this analysis is the inclusion of a dummy variable in the dynamic panel data model. Intuitively, differencing a dummy variable may generate zeros for almost all observations in a firm. This may cause the weak instrument problem. Roodman (2009) note that introducing explicit FE dummies in a dynamic panel with short time period may cause inaccurate estimation. In our dataset consisting of 103 firms and 156 CEOs, CEOs have either one or zero for their whole career in a firm. Unless a firm changes its CEO, there are little variations in *ocdummy*. Therefore, at least 50 firms do not change their CEOs over the sample period. For these firms, *ocdummy* is an explicitly FE dummy variable.

To verify the robustness of the findings, we run another four models without the variable *ocdummy*. The results are summarized in columns (5) to (8). Consistent with the results when *ocdummy* is included, the coefficients of CSR rating remain significantly positive for all models, and the interaction term is negative across models. This finding seems to offer an improvement to models 1–4.

Table 4. Dynamic panel data models result – Tobin's q as proxy for financial performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AB 1-step	AB 2-step	BB 1-step	BB 2-step	AB 1-step	AB 2-step	BB 1-step	BB 2-step
tobinq(–1)	0.2860***	0.2905***	0.6837***	0.6850***	0.2795***	0.2826***	0.6893***	0.6904***
score	0.6321***	0.5999***	0.4552***	0.4418***	0.5989***	0.5768***	0.4798***	0.4724***
size	–0.0955	–0.0986	–0.0175	–0.0170	–0.0796	–0.0831	–0.0147	–0.0147
ch_at	0.4512**	0.5249**	0.7215***	0.7179***	0.4367*	0.5052**	0.7577***	0.7637***
lt_at	–1.1388***	–1.1527***	–0.0089	–0.0129	–1.1697***	–1.1656***	0.0041	–0.0024
capx_at	–1.3844	–1.3909	–0.0805	–0.1035	–1.3811	–1.3931*	–0.1013	–0.1205
oc_score	–0.5536***	–0.5389***	–0.3076*	–0.3007*	–0.4914***	–0.4827***	–0.4004***	–0.4032***
ocdummy	–0.1168*	–0.1121*	0.0407	0.0435				
cons			0.6233***	0.6181***			0.5989***	0.6003***
N.Instruments	79		100		78		99	
N.Obs	589		689		589		689	
AR(1)	0.000	0.009	0.000	0.000	0.000	0.009	0.000	0.000
AR(2)	0.025	0.073	0.072	0.090	0.024	0.069	0.077	0.094
Hansen J	0.287	0.287	0.707	0.707	0.272	0.272	0.703	0.703

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 5. Dynamic panel data models result – ROA as proxy for financial performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	AB 1-step	AB 2-step	BB 1-step	BB 2-step	AB 1-step	AB 2-step	BB 1-step	BB 2-step
roa(−1)	0.3276***	0.3610***	0.3673***	0.3853***	0.3213***	0.3513***	0.3824***	0.4016***
score	0.0468*	0.0417*	0.0553***	0.0505***	0.0460*	0.0372*	0.0590***	0.0548***
size	-0.0041	-0.0063	-0.0039**	-0.0035**	-0.0035	-0.0052	-0.0036**	-0.0031**
ch_at	0.0858	0.0058	0.0773	0.0534	0.0840	0.0009	0.0812	0.0575
lt_at	-0.0925***	-0.0749**	-0.0361***	-0.0365**	-0.0934***	-0.0760**	-0.0339***	-0.0323***
capx_at	0.0033	0.0013	0.0412	0.0460	-0.0047	-0.0058	0.0390	0.0429
oc_score	-0.0458**	-0.0404*	-0.0431**	-0.0344*	-0.0411*	-0.0309	-0.0538***	-0.0472**
ocdummy	-0.0118**	-0.0148**	0.0039	0.0047				
cons			0.0709***	0.0661***			0.0682***	0.0617***
N.Instruments	47		68		46		67	
N.Obs	589		689		589		689	
AR(1)	0.000	0.002	0.000	0.000	0.001	0.002	0.000	0.000
AR(2)	0.847	0.953	0.937	0.953	0.813	0.901	0.990	0.980
Hansen J	0.318	0.318	0.425	0.425	0.311	0.311	0.396	0.396

Notes: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Using alternative proxy for financial performance

We further use the ROA of each firm as an alternative proxy for financial performance to verify the robustness of our previous findings. We present the results in Table 5. The coefficient of lagged dependent variables is positive and significant. The magnitude is quite close to each other in all eight models (all within the range of 0.33 to 0.40), which shows the significant dependence of financial performance on its own lag. CSR has a positive and significant influence on financial performance, with coefficients across models range between 0.0372 to 0.0590. This confirms that positive CSR could add value to REITs' financial performance.

The results on ocdummy and oc_score are also consistent with the previous findings. In models with both overconfidence dummy and interaction term, the overconfidence dummy is negative and significant in AB models but insignificant in BB models. The interaction terms between overconfidence and CSR remain significantly negative across models, reflecting the moderating role of overconfidence: the existence of overconfidence CEOs undermines the positive influence of CSR on financial performance.

5. Conclusions

A growing body of literature discusses the influence of CEO overconfidence on biased investment decisions, weak financial performance and innovation in the financial market. However, evidence is lacking in the real estate sector. This study considers the "value-destruction" side (i.e., weak financial performance) and "bright" side (i.e., CSR) of CEO overconfidence at the same time. We separate the net effect of each side to shed light on the role of CEO overconfidence. To the best of our knowledge, this study is the first to combine the two sides in a single framework and the first in behavioral economics to associate CSR–financial performance with CEO overconfidence.

In summary, the relationships among overconfidence, CSR, and firm performance are threefold. First, in both pooled OLS and firm FE models, firms with overconfident CEOs tend to have better CSR performance. This is similar to the relationship between CEO overconfidence and innovation. The finding provides the evidence of a positive effect of CEO overconfidence in the real estate sector. Second, the effect of CSR on increasing firm financial performance is significant across all model settings. Although studies of the relationship between the two are mixed, our finding in the REIT sector supports the positive influence of CSR on firm performance. Third, we find the positive relationship between CSR and financial performance identified in the previous step varies across firms. The existence of overconfident CEOs undermines the positive effect of CSR on financial performance.

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Appendix: Dynamic panel data models

The dynamic panel data models are characterized by the following equations in which a lagged term of the dependent variable appears among the regressors.

$$y_{it} = \alpha y_{it-1} + \boldsymbol{x}'_{it}\beta + \varepsilon_{it},$$

$$\varepsilon_{it} = \mu_i + v_{it},$$

where μ_i denotes the unobserved individual effects, v_{it} represents the idiosyncratic error component, and $\boldsymbol{x}_{it}$ is a vector that may contain both endogenous variables and exogenous variables.

Estimating the model using traditional approaches may lead to a biased estimator, that is, the dynamic panel bias (Nickell 1981), because of the dynamic relationship. The dependent variable is a function of the unobserved individual effect; therefore, the lagged dependent variable is also correlated with the error term. Thus, the OLS estimator is biased and inconsistent. A way to remove the individual fixed effects is using the within transformation in the FE approach. However, although the mean deviation transformation eliminates the individual fixed effects, $\ddot{y}_{it-1} = y_{it-1} - (y_{i1} + \cdots + y_{iT-1})/(T-1)$ is still correlated with $\ddot{v}_{it} = v_{it} - (v_{i2} + \cdots + v_{iT})/(T-1)$ (the latter contains v_{it-1}, which is correlated with y_{it-1} in $\ddot{y}_{it-1}$). An alternative transformation is the first-difference transformation. In fact, Anderson and Hsiao (1982) propose a first-difference based 2SLS estimator. They first use the first-difference transformation to remove the fixed effects as shown in the following equation. Thereafter, they use y_{it-2} as the instrument for Δy_{it-1} in the difference equation to perform the 2SLS estimation. In this approach, y_{it-2} is correlated with Δy_{it-1} but not with Δv_{it}. Therefore, the instruments are valid.

$$\Delta y_{it} = \alpha \Delta y_{it-1} + \Delta \boldsymbol{x}'_{it}\beta + \Delta v_{it.}$$

Although the Anderson–Hsiao estimator is consistent, it has some drawbacks. It is not an efficient estimator in the sense that it does not make use of all the available moment conditions (Ahn & Schmidt 1995). In addition, it does not consider the covariance structure of Δv_{it} (Baltagi 2013).

Arellano and Bond (1991) propose the difference GMM estimator, which is more efficient than the Anderson–Hsiao estimator. Instead of including only one lag variable as the instrument for observation in each time, they include all available lags of the untransformed variables as instruments. For example, they use y_{i1} as the instrument for $\Delta y_{i3} = \alpha \Delta y_{i2} + \Delta \boldsymbol{x}'_{i3}\beta + \Delta v_{i3}$; y_{i2} and y_{i1} as the instruments for $\Delta y_{i4} = \alpha \Delta y_{i3} + \Delta \boldsymbol{x}'_{i4}\beta + \Delta v_{i4}$; …; y_{it-2},…,y_{i2} and y_{i1} as the instruments for $\Delta y_{it} = \alpha \Delta y_{it-1} + \Delta \boldsymbol{x}'_{it}\beta + \Delta v_{it}$. Thereafter, they apply GMM to the equations. In the initial step of GMM regression, they assume that v_{it} are i.i.d., so that the covariance matrix of the differenced error takes the following form:

$$\begin{pmatrix} 2 & -1 & & \\ -1 & 2 & -1 & \\ & -1 & 2 & \ddots \\ & & \ddots & \ddots \end{pmatrix}.$$

One can use this covariance matrix to construct the weighting matrix in GMM and obtain the one-step GMM estimator.

One can also obtain a two-step GMM estimator by first obtaining the residuals from the first-step GMM regression and then using the residuals to construct a sandwich proxy for the covariance matrix for the second-step GMM estimation. The two-step estimator is shown to be efficient and robust to any pattern of heteroscedasticity.

Although the difference GMM performs well in estimating dynamic panel models, if the dependent variable is persistent over time, then the lagged levels will convey only little information about the current changes. This limitation is the so-called weak instrument problem. In the later studies of Arellano and Bover (1995) and Blundell and Bond (1998), a set of additional moment conditions is raised to solve the weak instrument problem. In addition to using lagged levels as instruments for differences in the Arellano–Bond model, the Blundell–Bond estimator also uses lagged differences as an instrument for the levels. This extended version is usually called the system GMM estimator.

The Impact of Misvaluation in the REIT Sector

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Abstract: By using the decomposing market-to-book model and the residual income model to estimate misvaluation, we find empirical evidence supporting the proposition that misvaluation has an impact on the financing decisions and liquidity management of REITs. Regarding the financing decisions, REITs experiencing a high increase in their stock prices will tend to increase their equity to exploit the low cost of capital relative to other financing forms. In addition, REITs are also more likely to increase debt issuances when their misvaluation is higher because overvalued REITs generally have easier access to debt. Finally, REITs use more cash than bank credit lines in liquidity management when they experience a misvaluation.

Keywords: financial decision, liquidity management, misvaluation, real estate investment trust (REIT)

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1. Introduction

Misvaluation is defined as the act of misspecifying the current value of an asset or a company. Shiller (2008) proposes that misvaluation is able to contribute to the emergence of a financial crisis because it warps investment. In a survey involving 392 chief financial officers (CFOs), Graham & Harvey (2001) report that misvaluation is one of the most important factors impacting on the decision of when and how to issue common stocks. Also, Rhodes-Kropf et al. (2005) document that misvaluation strongly affects merger activities. Therefore, misvaluation is a significant problem due to its macro and micro effects.

Within the REIT (real estate investment trust) sector, investors as outsiders have difficulty to accurately determine the market value of REITs because information asymmetries in the real estate market are high (Garmaise & Moskowitz, 2004). Moreover, REITs rely mainly on external financings for their investment or expansion activities because REITs have to distribute at least 90% of taxable income as dividends to shareholders (Feng et al., 2007; Ooi et al., 2010), and they always issue securities to cover a shortage of internal sources of capital (Boudry et al., 2010). Hence, misvaluation is more likely to be a significant problem for REITs. However, up to now, the effect of misvaluation on the REIT capital structure decisions has not been analyzed.

Using two different methods to measure misvaluation quantitatively, the present study conducts a comprehensive investigation of its impact in the REIT sector. First, we examine the impact of misvaluation on REITs' financing decisions because the capital structure of REITs is entirely different from non-REIT firms due to their tax-exempt status. Second, we analyze how misvaluation can influence cash holdings and the use of bank credit lines. These could be severe problems in the REIT sector because the mandatory payout is high (Feng et al., 2007; Ooi et al., 2010), and the ratio of cash to total assets of REITs is 12 times lower than that of non-REIT firms (Damodaran, 2005). Altogether our paper makes several contributions to the literature about the effect of misvaluation on the financing decisions and liquidity management policies of REITs.

To these ends, our sample consists of 2,163 firm-year observations and spans a 17-year period from 1999 to 2015. The necessary data is obtained from Thomson Reuters Eikon. By using the decomposing market-to-book model (DMM) of Rhodes-Kropf et al. (2005) and the residual income model (RIM) of Ohlson (1995) to estimate misvaluation, we find empirical evidence proving that misvaluation influences the financing decisions and liquidity management of REITs.

The main results can be summarized as follows: First, REITs experiencing a high appreciation of stock price would have a greater propensity to increase the likelihood of an equity issue, whose purpose could be to exploit the low cost of equity capital relative to other forms of capital. Second, REITs are more likely to increase debt issuances and have greater credit line availability when their stock is overvalued. These findings are contrary to the results of non-REIT firms that tend to issue debt when their stocks are undervalued (Elliott et al., 2008). The reason for this result appears to be that overvalued REITs generally have easier access to debt. Third, regarding the liquidity management policies, we find empirical evidence supporting that overvalued REITs use more cash than bank lines of credit for liquidity management because they can accumulate larger amounts of cash relative to other firms.

The remainder of this paper is organized as follows. Section 2 reviews the relevant theoretical background and makes hypotheses. Section 3 presents the models of measuring misvaluation. Section 4 shows the research design and data description. Section 5 discusses the empirical results, while Section 6 concludes.

2. Theoretical background and hypotheses

One may contend that information considerations are not important in real estate markets because there is "limited investment in human capital and growth options" (Feng et al., 2007). Therefore, tangible real estate assets are relatively easier to value than those of industrial or manufacturing firms. However, Garmaise & Moskowitz (2004) argue that the real estate market is highly illiquid, and real estate assets are idiosyncratic, so it is hard for outsiders to accurately value these assets. Han (2006) also posits that accurate valuation of real estate assets is complicated and requires special skills because there is the presence of illiquidity and heterogeneity that make the predictability of cash flow to be less precise. Hence, the problem of informational asymmetry is significant in real estate transactions. In addition, previous empirical research reports that REITs depend primarily on external financings for their activities always issue securities to cover a shortage of internal sources of capital.

The combination of high informational asymmetry and high dependence on external financings is likely to be a significant driver for misvaluation within the REIT industry. To the best of our knowledge, the effects of misvaluation have not been analyzed in the REIT literature yet. Accordingly, we conduct a comprehensive investigation of the impact of misvaluation in the REIT sector to make some contributions to the REIT literature. In particular, we analyze effects of misvaluation on the financing decisions and liquidity management policies of REITs.

The first subsection discusses the impact of misvaluation which is reported in the general financial literature. The second subsection reviews empirical studies on the financing decisions of REITs. The final one addresses research on liquidity management of REITs.

2.1 Empirical research on the effects of misvaluation

Misvaluation is an important problem because it has substantial impacts on particular firms as well as on the economy (Shiller, 2008). Using the method of decomposing the market-to-book ratio into components that capture misvaluation at the firm level and the industry level as well as a component that captures long-run growth opportunities, Rhodes-Kropf et al. (2005) report that misvaluation strongly affects merger activities, and this finding is consistent with the conclusion of Ben-David et al. (2015).

In a survey of Graham & Harvey (2001) involving 392 CFOs, the magnitude of equity undervaluation or overvaluation is one of the most important factors having an impact on the decision of when and how to issue common stocks, and more than 60% of CFOs admit that they would issue stocks when their firm's stock price has risen. Using an earnings-based valuation model to estimate the intrinsic value, D'Mello & Shroff (2000) show that firms repurchase shares when their stocks are undervalued. Using the market-to-book ratio as a proxy of market timing opportunities perceived by managers, Baker & Wurgler (2002) find that the effect of a higher market-to-book ratio is to increase net equity issues and to lower leverage. They explain that managers could time and raise equity when misvaluation happens and makes the cost of equity cheap relative to the cost of other capital. Therefore, misvaluation influences not only the capital structure of firms but also the merger activities and the whole economy.

2.2 Empirical studies on the financing decisions of REITs

There are several studies which research the financing decisions of REITs. What we can find so far is: Boudry et al. (2010) use a multinomial logistic model with four categories, namely common equity, preferred equity, public debt and private debt, to examine the determinants of REIT security issuance decisions. They find that market timing behavior has a strong influence on security choices of REITs. In particular, REITs would be more likely to issue stock after they experience high returns or high price-to-net asset value ratio. Using a similar model, Ooi et al. (2010) classify the financing events into eight categories, specifically equity issues, equity repurchases, debt issues, debt retirements, dual issues, debt issues accompanied by equity repurchases, equity issues accompanied by debt retirements, and no action. They document that REITs time the financing decisions according to the market conditions and adjust their capital structure towards the long run target leverage ratio.

Focusing on the equity repurchase decisions to provide an explanation why REITs repurchase their stocks, although there is not an apparently theoretical motive, Ghosh et al. (2008) provide empirical evidence supporting the notion that managers decide to repurchase their stock when they believe that their stocks are undervalued. This finding is consistent with that of Brau & Holmes (2006).

Because misvaluation is not the primary focus of these papers, the impact of misvaluation on the financing decisions is not investigated. Our article, thus, wants to shed light on this issue in the REIT sector by examining extensively how the act of misspecifying the current value of equity affects the REIT's financing decisions which are classified into nine categories, as discussed in Section 4.

Empirical evidence revealing that REITs exhibit market timing behavior is found. Therefore, we hypothesize that misvaluation has an effect on REIT capital structure. In particular, we expect that when the market value of equity is greater than the intrinsic value of equity, managers have the motivation to issue stocks and retire debt. In contrast, when the intrinsic value is higher the market value, managers will repurchase shares and issue debt, if necessary. We have the first hypothesis:

(H1) Misvaluation is positively related to equity issuance, debt retirement, and negatively related to equity repurchase and debt issuance.

2.3 The liquidity management of REITs

As discussed above, liquidity management could be a major issue in the REIT sector. To meet short-term liquidity requirements, REITs use net cash provided by operations, existing cash balances and bank credit lines. Accordingly, empirical research usually analyzes cash holdings and lines of credit when it investigates the liquidity management policies.

Hardin et al. (2009) investigate what determinants have effects on REIT cash holdings. They document that cash flow, growth opportunities, leverage, capital market access and lines of credit can influence cash holdings of REITs. Ghosh et al. (2012) examine the relationship between excess cash holdings and activities of merger and acquisition. They report that REITs that have a higher level of excess cash are probably to become bidders when their insider ownership is small. Because the focus of both papers is not on misvaluation, the effect of misvaluation on REIT cash holdings has not been captured. Hence, our paper provides a new contribution to the REIT cash holding literature.

When conditions in the capital market are favorable, firms could time the capital market and issue equity to exploit short-term variations in the cost of equity relative to the cost of other forms of capital, even when they have no immediate need for external funds (Bolton et al., 2013). Kasbi (2009) posits that past successful market timers tended to accumulate larger amounts of cash relative to other firms. Because market timing behavior is reported to exist in the REITs sector, we expect that the relation between misvaluation and REIT cash holdings is positive. We have the second hypothesis:

(H2) Misvaluation is positively related to REIT cash holdings.

The papers studying the management of corporate liquidity have mainly focused on cash holdings because the access to data of bank credit lines is often limited. In the REIT sector, lines of credit are important because they permit REITs to make fast decisions in property acquisitions and add "strategic value" to REITs (An et al., 2012). Therefore, it is insufficient if we do not analyze lines of credit when we study the liquidity management of REITs. Fortunately, in the REIT sector, information on bank credit lines is available.

Hardin & Wu (2010) examine how banking relationships affect the REIT capital structure. They document that REITs with bank relationships, specifically the bank lines of credit, effectively manage their debt ratio while keeping adequate liquidity level. Hardin & Hill (2011) try to determine the use pattern for bank credit lines and the determinants of the utilization of bank credit facilities of REITs over time. However, misvaluation is not the focus of both studies.

A closely related paper is An et al. (2012) which examines the effect of information asymmetry on the choice between the use of cash and of a line of credit to meet the liquidity requirements. They use the analyst forecast error and dispersion to capture the extent of the information asymmetry. They conclude that bank credit line use of REITs for liquidity management decreases when information asymmetry increases because banks ration to provide loans to the customers with higher information asymmetry.

The difference between the market value of equity and the intrinsic value of equity implies the fact that existing share prices do not reflect all relevant information. In other words, misvaluation may be a measure of information asymmetry. Therefore, we expect that overvalued REITs will use more cash holdings compared to a bank credit line in liquidity management because they keep more cash, as the second Hypothesis assumes, and have difficulty in obtaining a line of credit, as An et al. (2012) predict. Consequently, we postulate the third hypothesis:

(H3) Misvaluation is negatively related to the bank credit line component in liquidity management.

3. The models of measuring misvaluation

To measure misvaluation, we firstly determine the intrinsic value of a firm, then the ratio of the market value to the intrinsic value will directly capture misvaluation. We use two models which are widely used in the finance literature to measure the intrinsic value, specifically the decomposing market-to-book model (DMM) of Rhodes-Kropf et al. (2005) and the residual income model (RIM) of Ohlson (1995).

3.1 The decomposing market-to-book model

The market-to-book ratio has a dual role in empirical studies: It is both a proxy of misvaluation and a proxy of growth opportunities (Rhodes-Kropf et al., 2005; Mahajan & Tartaroglu, 2008). Recognizing this issue, Rhodes-Kropf et al. (2005) develop a method to decompose the market-to-book ratio (called the decomposing market-to-book model – DMM) to empirically examine the effect of misvaluation on merger activities (for more details, see Rhodes-Kropf et al., 2005).

The DMM decomposes the market-to-book ratio into three parts: firm misvaluation, sector misvaluation, and growth opportunities as:

Market-to-book ≡ Market-to-intrinsic x Intrinsic-to-long run intrinsic x Long run intrinsic-to-book. (1)

Rhodes-Kropf et al. (2005) hypothesize that a perfect measure of value exists, so the first part (Market-to-intrinsic), called "firm-specific error", expresses the discrepancy between the market value and the intrinsic value of a company at time t. This component reflects a firm's misvaluation at time t. The second part (Intrinsic-to-long run intrinsic), called "time-series sector error, expresses the discrepancy between a firm's intrinsic value at time t and its long-run intrinsic value. This part reflects whether a sector is overvalued. A sector can sometimes be overcooled or overheated, so companies in the same industry could share a mutual misvaluation component. The final part (Long run intrinsic-to-book) reflects the difference between the long-run intrinsic value of the company and its book value which captures growth opportunities.

To estimate the intrinsic value of equity, Rhodes-Kropf et al. (2005) follow a two-step procedure. They first run a regression model with the market value of equity as the dependent variable to obtain the estimated coefficients. They then use firm-specific accounting information and these estimated coefficients to determine the intrinsic value. The long-run intrinsic value is computed by firm-specific accounting information and the average of the estimated coefficients.

In particular, in the first step, Rhodes-Kropf et al. (2005) regress the time t market value of equity of firm i on its corresponding book value per share, its net income, and its leverage ratio as the following equation:

$$m_{it} = \alpha_{0t} + \alpha_{1t}b_{it} + \alpha_{2t}\ln(NI)^{+}_{it} + \alpha_{3t}I_{(<0)}\ln(NI)^{+}_{it} + \alpha_{4t}LEV_{it} + \varepsilon_{it}, \quad (2)$$

where m and b denote the firm's market value and its book value in natural logarithms, respectively; $\ln(NI)^{+}$ stands for the natural logarithm of the absolute value of net income; $I_{(<0)}$ is a dummy variable taking on the value of 1if NI < 0, and 0, otherwise; LEV is the leverage ratio which is defined as total debt scaled by total assets.

In the second step, they use the estimated coefficients, $\hat{\alpha}_{kt}, k = 0, 1, 2, 3, 4$, from Eq. (2) and annual firm-specific accounting information to calculate the intrinsic value.

$$\text{Intrinsic value}_{it} = \widehat{\alpha}_{0t} + \widehat{\alpha}_{1t} b_{it} + \widehat{\alpha}_{2t} \ln(NI)^{+}_{it} + \widehat{\alpha}_{3t} I_{(<0)} \ln(NI)^{+}_{it} + \widehat{\alpha}_{4t} LEV_{it}, \tag{3}$$

To estimate the long-run intrinsic value, they use the average of estimated coefficients, $\bar{\alpha}_k = 1/T \sum \hat{\alpha}_{kt}$ k = 0, 1, 2, 3, 4 from Eq. (2) and annual firm-specific accounting information.

$$\text{Long run intrinsic value}_i = \overline{\alpha}_0 + \overline{\alpha}_1 b_{it} + \overline{\alpha}_2 \ln(NI)^{+}_{it} + \overline{\alpha}_3 I_{(<0)} \ln(NI)^{+}_{it} + \overline{\alpha}_4 LEV_{it}, \tag{4}$$

The long-run intrinsic value captures the fundamental value of a firm which is implied by long-run industry averages.

The residual income model

The theoretical research of Ohlson (Feltham & Ohlson, 1995; Ohlson, 1995) makes the residual income model (RIM) popular as a fundamental valuation model (for more details, see D'Mello & Shroff, 2000). There are substantive empirical studies using the RIM to estimate the misvaluation of a firm, such as D'Mello & Shroff (2000), Dong et al. (2006), and Elliott et al. (2007 & 2008).

Following the RIM, the intrinsic value of a firm is estimated as:

$$IV_0 = BV_0 + \sum_{t=1}^{T} \frac{E_0[X_t - r\ BV_{t-1}]}{(1+r)^t} + \frac{TV}{r\ (1+r)^T}, \tag{5}$$

$$TV = \frac{E_0[(X_T - r\ BV_{T-1}) + (X_{T+1} - r\ BV_T)]}{2}. \tag{6}$$

where IV_0 is the intrinsic value of a firm's equity at time zero, BV_0 is the book value of equity at time zero, r is the cost of equity, $E_0(X_t)$ are the expected earnings for period t, as seen at time zero, T is the number of periods, and TV is a firm's terminal value.

D'Mello & Shroff (2000) and Elliott et al. (2007 & 2008) use the CAPM to calculate the cost of equity as follows:

$$r = r_f + \beta[E(r_m) \quad r_f], \tag{7}$$

The risk-free rate of interest, r_f, is defined as the short-term T-Bill, and the return of S&P 500 is the proxy for the expected market return, r_m. Beta, β, is the estimate of the firm's systematic risk, and $[E(r_m)- r_f]$ is the market risk premium.

We use the perfect foresight version of the RIM (D'Mello & Shroff, 2000; Elliott et al., 2007, 2008). Therefore, BV_0 is the book value per share at time zero, and X_t is defined as the earnings before interest, taxes, depreciation and amortization at time t, and T equals two years as in Elliott et al. (2007 & 2008).

Misvaluation is calculated as the market price of a stock at time zero, MV_0, scaled by the intrinsic value of a firm's equity at time zero.

$$\text{Misvaluation}_0 = \frac{MV_0}{IV_0}, \tag{8}$$

Misvaluation_0 should equal one if there is no mispricing. This variable should be less than one when a firm's equity is undervalued, and greater than one, otherwise.

4. Data and variables definition

Sample construction starts by determining firms against the National Association of Real Estate Investment Trusts database from 1999 to 2015. To reduce potential problems with a survivorship bias, we include all observations from REITs that are delisted, taken private or merged until changes of their status. Mortgage REITs are excluded from the sample because their capital structure is likely significantly different from other firms in the sample.

To empirically employ the models of Section 3, we obtain all necessary data from Thomson Reuters Eikon, except information on bank lines of credit (discussed below in detail). We drop observations which miss accounting data and stock prices. We further exclude firms with fewer than two consecutive years of data when running DMM, and firms with less than four consecutive years of data when running RIM.

When we examine the financing decisions of REITs, we remove observations with the financing events being less than US $1 million and less than 5% of total assets.

Data of bank lines of credit

The annual 10-K SEC filings provide complete information on bank credit lines, specifically the total borrowing capacity, the outstanding borrowings and the available amount or unused amount of credit lines. For instance, Kilroy Realty Corporation details its bank lines of credit in the FY 2015 10-K filing as follows:

> The following table summarizes the balance and terms of our unsecured revolving credit facility as of December 31, 2015, and December 31, 2014:

	December 31, 2015	**December 31, 2014**
	(in thousands)	
Outstanding borrowings	$ 0	$ 140,000
Remaining borrowing capacity	$ 600,000	$ 460,000
Total borrowing capacity	**$ 600,000**	**$ 600,000**

Although information on bank lines of credit is available in 10-K filings, the existing empirical studies considering the use of credit lines of REITs obtain this information from other data sources. For example, Hardin & Wu (2010) use the Loan Pricing Corporation's (LPC's) DealScan database and the SNL REIT database. Hardin & Hill (2011) and An et al. (2012) use the SNL REIT database. It is noted that there is no search software or application which supports us to automatically extract information on a credit line from annual 10-K SEC filings. Therefore, following Sufi (2009), we manually collect the data of bank credit lines from annual 10-K SEC filings.

Table 1 presents the summary statistics of firm characteristics. The columns 2, 3, and 4 report the summary statistics of the sample which is used to analyze the financing decisions of REITs. The columns 5, 6, and 7 show summary statistics of the sample used to examine the cash holdings of REITs. The columns 8, 9, and 10 inform about the data that is used to investigate the effect of misvaluation on the probability of a REIT having a credit line. The last three columns show the summary statistics of the sample which is utilized to investigate the liquidity management of REITs.

<< Insert Table 1 here >>

Financial decisions is an indicator variable that captures the financing activities of REITs. This variable takes the value of 1 when a REIT issues equity, 2 when it repurchases equity, 3 when it issues debt, 4 when a REIT retires debt, 5 when it issues both equity and debt, 6 when the company issues debt and repurchases equity, 7 when it issues equity and retire debt, 8 when it repurchases both equity and debt, and 0 when a REIT does nothing. Figure 1 presents the percentage of each financing activities of REITs in the sample. It is noted that net debt issues are the activity having the largest portion (22.8%), while pure equity issues take the second largest percentage, 14.4%. In general, debt issues take 35.7%, while equity issues entail 31.5%. This evidence shows that REITs use more debt financing than equity financing to meet capital requirements.

<< Insert Figure 1 here >>

Line of credit is the total amount of bank credit lines. In our sample, 93% of observations have bank credit lines. This number shows that the use of bank lines of credit is extensively popular in the REIT sector. Sufi (2009) reports that this portion for non-financial firms is 74.8%. *Total* is the total amount of bank credit lines scaled by the sum of total bank credit lines and cash and cash equivalent.

Firm misvaluation which is obtained from the DMM expresses the discrepancy between the market value and the intrinsic value of a REIT at time t. This variable reflects the misvaluation of a firm's equity at time t. *Sector misvaluation* takes the value from the DMM and reveals the discrepancy between the intrinsic value at time t and the long-run intrinsic value. This variable will be larger than one if contemporaneous multiples are higher than average, and, accordingly, reflects that this sector could be overvalued at a point in time. *Misvaluation* expresses the natural logarithm of the discrepancy between the market value and the intrinsic value of a REIT's equity at time t which is obtained from the RIM.

Cash is defined as the cash and cash equivalent scaled by total assets. *PPE/A* is the amount of property, plant, and equipment scaled by total assets. *EBITDA/A* is earnings before interest, taxes, depreciation, and amortization scaled by total assets. *Size* is the natural logarithm of total assets. *10-year T-Bill* is the yield of a 10-year government bond. *Term structure* is the difference between the yield of a 10-year government bond and a 3-month T-Bill. *Net Income* is the net income before extraordinary items scaled by total assets.

5. Models and empirical results

5.1 Misvaluation and financing decisions

To investigate the impact of misvaluation on the probability of a REIT choosing a certain financing activity, we use a multinomial logistic model (MNL).

$$\Pr(\text{Financing decision}_{i,t} = \{1, 2, \ldots, 8\} \mid X) = \beta_0 + \beta_1 \text{Mis}_{i,t-1} + \beta_2 \text{Inde}_{i,t-1} + \varepsilon_{i,t},$$

where Pr is the probability of a certain financing decision, Mis denotes *Firm Misvaluation* and *Sector Misvaluation* in the DMM or *Misvaluation* in the RIM. Inde contains a set of independent variables, specifically *PPE/A, EBITDA/A, Size, 10-year T-Bill*, and *Term structure* that are also used in Ooi et al. (2010).

We categorize financing events into nine groups. Firms that did not experience any changes in their capital structure are taken as the base option (0), while firms that made changes in their capital structure are classified into group (1) to group (8), as discussed above. We then perform eight different regression models to identifies how independent variables change the probability of a REIT choosing a financing event z which takes the values of {1, 2, …, 8} against the base option (0). It should be noted that a significantly positive coefficient in the MNL would imply that a higher value of the explanatory variable increases the likelihood of each of the potential financing decisions against a no change transaction, and vice versa.

<< Insert Table 2 here >>

Table 2 presents the results from the MNL. Regarding events involving equity, the estimated coefficients of *Firm Misvaluation* and *Misvaluation* are positive and statistically significant in the financing events 1 and 5. These findings imply that REITs experiencing a high appreciation of stock price would have a higher propensity to increase the likelihood of an equity issue against the no transaction alternative, which is consistent with the prediction of the market timing theory. The purpose of these decisions could be to exploit the low cost of equity capital relative to other forms of capital. The estimated coefficient of *Sector Misvaluation* is also positive and statistically significant in the financing event 5 which is consistent with that of *Firm Misvaluation* and *Misvaluation*. However, in the financing event 7, this coefficient is negative and contrary to our expectation.

Regarding events involving debt, the estimated coefficients of *Firm Misvaluation* and *Sector Misvaluation* are significantly positive in the financing event 3 and significantly negative in the financing event 4. These coefficients imply that REITs with higher misvaluation are more likely to increase their leverage ratio by increasing debt issues and decreasing debt retirements. These results are similar to that of Ooi et al. (2010). They find the empirical evidence supporting that a REIT has a higher propensity to issue debt when its stock price increases, but they give no explanation. In an investigation of the probability of the net debt issues against the pure equity issues which is not presented here, we also find the significant evidence indicating that REITs that have higher *Sector Misvaluation* (the intrinsic value is higher than the long-run intrinsic value), are more likely to issue debt.

These findings are quite strange and contrary to our expectation. Theoretically, a REIT has no motive to issue debt and is more advisable not to issue debt when its stock is overvalued. However, in the real world, REITs have debt issues and their leverage ratio is even greater than that of non-REIT firms (Alcock et al., 2014). The rationale for this action is still a question that needs to be settled by future research. We argue that one of the answers that appear to be reasonable is the mandatory high payout for REITs. With high payouts, REITs rely on external capital to finance their activities (Ooi et al., 2010), so they always issue securities to cover a shortage of internal sources of capital (Boudry et al., 2010). Because companies can raise debt more quickly than raise equity (Rapp et al., 2014), REITs should prioritize the choice of debt issues, and our finding appears to imply that overvalued REITs generally have easier access to debt.

When REIT profitability increases, the dependence on external sources of financing decreases due to the increase in retained earnings. This proposition is supported by the significantly estimated coefficients of *EBITDA/A*. In particular, when *EBITDA/A* increases, the likelihood of equity issuance, debt issuance, and dual issues against a no-change transaction decreases, and the probability of equity repurchases increases.

The estimated coefficients of *Size* are negative where they are statistically significant, suggesting that smaller REITs are more active in conducting financing activities. Small REITs could not be able to have enough cash flow, which is derived from sales of real property or from rents from real assets, to finance their activities and investments, so they have to be more active in raising external sources of financing to meet their capital requirements. This finding is inconsistent with Ooi et al. (2010).

Regarding the impact of the market interest rate on the choice of issuing debt, we find empirical evidence supporting the proposition that the increase in the interest rate or the risk premium for long-term debt would reduce events of debt issues because the cost of debt financing is relatively high. In particular, the estimated coefficient of *10-year T-Bill* is negative and significant for the financing event 5 (Dual issues), and *Term structure* is negatively related to the event 6 (Debt issues accompanied by equity repurchases).

However, Table 2 also shows that REITs have inconsistent actions to respond to fluctuations in the relative cost of debt regarding the choice of debt retirement. Specifically, in the group 7, the probability of debt retirement accompanied by equity issue vis-à-vis doing nothing decreases if the market interest rate increases, while this chance will increase if the risk premium for long-term debt increases.

Overall, we find the significantly positive relationship between misvaluation and equity issue which is consistent with Hypothesis 1. Nevertheless, we also find the empirical evidence contradicting Hypothesis 1 with respect to the relation between misvaluation and debt issue and retirement, and there is no evidence supporting the negative relationship between misvaluation and equity repurchase.

5.2 Misvaluation and cash holdings

When conditions in the capital market are favorable, firms could time the market and issue equity to exploit short-term variations in the cost of equity relative to the cost of other forms of capital, even when they have no immediate need for external funds (Bolton et al., 2013). Kasbi (2009) posits that past successful market timers, who successfully predicted stock price movements and performed a seasoned equity offering, tend to accumulate larger amounts of cash relative to other firms.

The existing REIT finance literature provides evidence supporting that REITs exhibit market timing behavior. As discussed above, we also find this empirical evidence; therefore, a positive relationship between cash holdings and misvaluation is expected. To test this expectation, we perform two OLS regressions for two valuation models (the DMM and the RIM) as follows:

$$\text{Cash}_{i,t} = \beta_0 + \beta_1\text{Mis}_{i,t} + \beta_2\text{Inde}_{i,t} + \varepsilon_{i,t},$$

The dependent variable is *Cash* which denotes cash and cash equivalent scaled by total assets. Mis denotes *Firm Misvaluation* and *Sector Misvaluation* in the DMM or *Misvaluation* in the RIM. Inde contains a set of independent variables, specifically *PPE/A, EBITDA/A*, and *Size.*

<< Insert Table 3 here >>

Table 3 reports the regression results from two OLS regression models. The estimated coefficients of *Firm Misvaluation* and *Sector Misvaluation* are positive and statistically significant at the 1% level. The result implies that REITs with higher misvaluation keep more cash than lower-misvaluation REITs, which could be explained by the proposition of Bolton et al. (2013) and Kasbi (2009). Moreover, these coefficients are also economically significant. For example, when *Firm Misvaluation* increases from a 1 to1.1, representing 10% overvaluation, cash and cash equivalent scaled by total assets will be expected, everything else being equal, to increase by 0.1%. Standardization is usually used to measure how much a dependent variable changes if an independent variable changes one standard deviation. However, in our study, the standard deviation of *Firm Misvaluation* is quite small, so we investigate the dependent variable for a 10% shift in *Firm Misvaluation*. The coefficient of *Misvaluation* has the expected sign but is statistically insignificant.

Hardin et al. (2009) assumed that the market-to-book ratio is a proxy for the degree of information asymmetry, and argue that REITs with a higher degree of information asymmetry could hoard more cash to prevent costly external sources. By using the DMM and the RIM to estimate the intrinsic value of equity, we find a positive relationship between misvaluation and cash holdings, which explains more clearly the result found by Hardin et al. (2009), because information asymmetry causes, in part, misvaluation.

The estimated coefficient for tangible assets is negative which supports the notion that REITs with higher tangible assets have more possibilities to access loans, so they do not need to accumulate cash. Similarly, REITs with higher profitability keep lower cash because they can generate positive cash flow and higher retained earnings.

Finally, the coefficient on the size variable is negative and significant, indicating that as REITs become larger, they keep less cash. This finding is consistent with the one of Hardin et al. (2009) which implies that large firms need less precautionary cash holdings due to diversification effects or capital market access.

Overall, we find empirical evidence that supports the Hypothesis 2: Misvaluation is positively related to REIT's cash holdings.

5.3 Misvaluation and bank lines of credit

We use an OLS regression to analyze the effect of misvaluation on the total amount of bank credit lines of REITs.

$$\text{Line of credit}_{it} = \beta_0 + \beta_1 \text{Mis}_{it} + \beta_2 \text{Inde}_{it} + \varepsilon_{i,t}$$

where *Line of credit* is the total amount of bank credit lines. Mis denotes *Firm Misvaluation* and *Sector Misvaluation* in the DMM or *Misvaluation* in the RIM, Inde contains a set of independent variables, specifically cash flow and *Size*. Following An et al. (2012), we use *EBITDA/A* and *Net Income* as two alternative measures of cash flow. *Net Income* is used for models 1 and 3, *EBITDA/A* is used for models 2 and 4.

<< Insert Table 4 here >>

Table 4 presents the estimation results from this OLS regression. The estimated coefficients of *Firm Misvaluation* and *Sector Misvaluation* are positive and statistically significant. These coefficients indicate that a REIT experiencing an overvaluation will obtain larger amounts of credit lines. This result is consistent with our above finding implying that overvalued REITs generally have easier access to debt.

If we consider misvaluation as a measure of information asymmetry, this finding is opposite to the result of An et al. (2012), which predicts that REITs with lower information asymmetry have a higher probability of access to bank credit lines. However, in an investigation of the impact of misvaluation on the likelihood of a REIT to obtain a bank credit line which is not reported here, we find the evidence supporting that overvalued REITs have a higher chance of access to bank credit. These finding can be explained as follows: Overvalued REITs may not need bank credit lines because they can meet their liquidity requirement by accumulating large amounts of cash, as discussed in Section 5.2, so the probability of an overvalued REIT having a credit line is lower. However, when an overvalued REIT has bank lines of credit, its total amount of bank credit lines will be larger than undervalued REITs, because overvalued REITs generally have easier access to debt. This finding may be due to the special regulatory environment of REITs and need to be settled by future research.

Borrowers having better cash flow have a higher possibility of receiving loans because financial institutions typically apply measures of cash flow to examine the repayment capacity of their customers. We find the positive relationship between the cash flow variables and *Line of credit*, which supports this proposition; however, these coefficients are not significant, except the coefficients of *EBITDA/A* in model 4. In addition, we also find the evidence supporting that larger REITs have greater total amount of credit lines.

5.4 Misvaluation and liquidity management

To meet short-term liquidity requirements, REITs use net cash provided by operations, existing cash balances, and bank credit lines. We investigate how misvaluation affects liquidity management, specifically the proportion of bank liquidity to total liquidity, by using the following model:

$$\text{Total}_{i,t} = \beta_0 + \beta_1 \text{Mis}_{i,t} + \beta_2 \text{Inde}_{i,t} + \varepsilon_{i,t},$$

Here, the dependent variable, *Total,* is defined as the total amount of bank credit lines scaled by the sum of this amount and the amount of cash and cash equivalents. *Firm Misvaluation* and *Sector Misvaluation* in the DMM or *Misvaluation* in the RIM is used as the proxy of misvaluation which is denoted by Mis. Inde includes the other independent variables, specifically cash flow (*EBITDA/A*, *Net Income*) and *Size*.

<< Insert Table 5 here >>

The regression results are reported in Table 5. The estimated coefficients of *Firm Misvaluation* are negative and statistically significant at the 10% and 1% in models 1 and 2, respectively. This finding indicates that REITs with higher misvaluation will have lower bank credit line component in liquidity management than REITs with lower misvaluation. For instance, in model 1, the estimated coefficient of *Firm Misvaluation*, -0.01, indicates that if the market price of a REIT's stock is higher 10% than the intrinsic value and all else equal, the total amount of credit lines scaled by the sum of total bank credit lines and cash and cash equivalent will decrease 0.1%.

The signs of the other independent variables are as expected and consistent with the results in previous sections. In particular, REITs having higher cash flow or larger size will hold less cash and have higher levels of credit lines capacity; therefore, their bank liquidity is greater than that of REITs with lower cash flow or smaller size.

In summary, we find the empirical evidence supporting that REITs with higher misvaluation will have lower bank credit line components in liquidity management than REITs with lower misvaluation.

6. Conclusion

This paper provides a comprehensive investigation of the effect of misvaluation in the REIT sector. In particular, we investigate whether misvaluation affects financing decisions and liquidity management policies of REITs. By using the decomposing market-to-book model and the residual income model to estimate misvaluation for 2,163 firm-year observations in the REIT sector from 1999 to 2015, we find empirical evidence proving that misvaluation has the effects on the financing decisions and liquidity management of REITs.

Regarding the financing decisions in the equity market, we find evidence supporting market timing behavior. Specifically, REITs experiencing a high appreciation of stock prices have a higher propensity to rely on equity issues, whose purpose could be to exploit the low cost of equity capital relative to other forms of capital. In the debt market, REITs are more likely to increase debt issuances or decrease debt retirements when their misvaluation is higher. Also, overvalued REITs have greater credit line availability. A potential explanation for this result is that overvalued REITs generally have easier access to debt. However, the questions of why REITs issue debt and why debt issues become more relevant for overvalued REITs need to be correctly settled by future research.

Finally, regarding the liquidity management policies, we find empirical evidence supporting that overvalued REITs use more cash than bank lines of credit for liquidity management because they can accumulate larger amounts of cash relative to undervalued firms.

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Table 1: Summary statistics

	Model of financial decision			Model of cash holdings			Model of line of credit			Model of total liquidity		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
					Panel A: Decomposing market-to-book							
Financial decisions	1,947	2.13	2.17									
Cash				2,163	0.02	0.04						
Line of Credit							1,973	463.28	567.37			
Total										1,888	0.81	0.26
Firm Misvaluation	1,947	1.30	0.89	2,163	1.29	1.04	1,973	1.30	1.21	1,888	1.30	1.22
Sector Misvaluation	1,947	1.04	0.47	2,163	1.04	0.48	1,973	1.11	0.50	1,888	1.11	0.50
PPE/A	1,947	0.82	0.17	2,163	0.81	0.17						
EBITDA/A	1,947	0.08	0.03	2,163	0.08	0.03	1,973	0.07	0.03	1,888	0.08	0.03
Size	1,947	21.43	1.14	2,163	21.26	1.32	1,973	21.48	1.17	1,888	21.49	1.18
10-year T-Bill	1,947	0.04	0.01									
Term structure	1,947	0.02	0.01									
Net Income							1,973	0.02	0.03	1,888	0.02	0.03
					Panel B: Residual income							
Financial decisions	1,295	2.11	2.22									
Cash				1,425	0.02	0.04						
Line of Credit							1,231	409.39	493.67			
Total										1,188	0.81	0.26
Misvaluation	1,295	-0.84	40.59	1,425	-0.74	38.70	1,231	-0.82	41.83	1,188	-0.91	42.51
PPE/A	1,295	0.82	0.17	1,425	0.82	0.17						
EBITDA/A	1,295	0.08	0.03	1,425	0.08	0.03	1,231	0.08	0.03	1,188	0.08	0.03
Size	1,295	21.40	1.10	1,425	21.27	1.24	1,231	21.40	1.11	1,188	21.41	1.13
10-year T-Bill	1,295	0.04	0.01									
Term structure	1,295	0.02	0.01									
Net Income							1,231	0.02	0.03	1,188	0.02	0.03

The table presents summary statistics for the sample from 1999 to 2015. *Financial decisions* is an indicator variable that captures the financing activities of REITs. This variable takes the value of 1 when a REIT issues equity, 2 when it repurchases equity, 3 when it issues debt, 4 when a REIT retires debt, 5 when it issues both equity and debt, 6 when the company issues debt and repurchases equity, 7 when it issues equity and retire debt, 8 when it repurchases both equity and debt, and 0 when a REIT does nothing. *Cash* is the cash and cash equivalent scaled by total assets. *Line of credit* is the total amount of bank credit lines. *Total* is the total bank credit lines scaled by the sum of total bank credit lines and cash and cash equivalent. *Firm misvaluation* which is obtained from the DMM expresses the discrepancy between the market value and the intrinsic value of a REIT at time t. *Sector misvaluation* takes the value from the DMM and reveals the discrepancy between the intrinsic value at time t and the long-run intrinsic value. *Misvaluation* expresses the natural logarithm of the discrepancy between the market value and the intrinsic value of a REIT's equity at time t which is obtained from the RIM. *PPE/A* is property, plant and equipment scaled by total assets. *EBITDA/A* is earnings before interest, taxes, depreciation, and amortization scaled by total assets. *Size* is natural logarithm of total assets. *10-year T-Bill* is the yields of 10-year government bond. *Risk Premium* is the difference between yields of 10-year and 1-year government bond. *Net Income* is the net income before extraordinary items scaled by total assets.

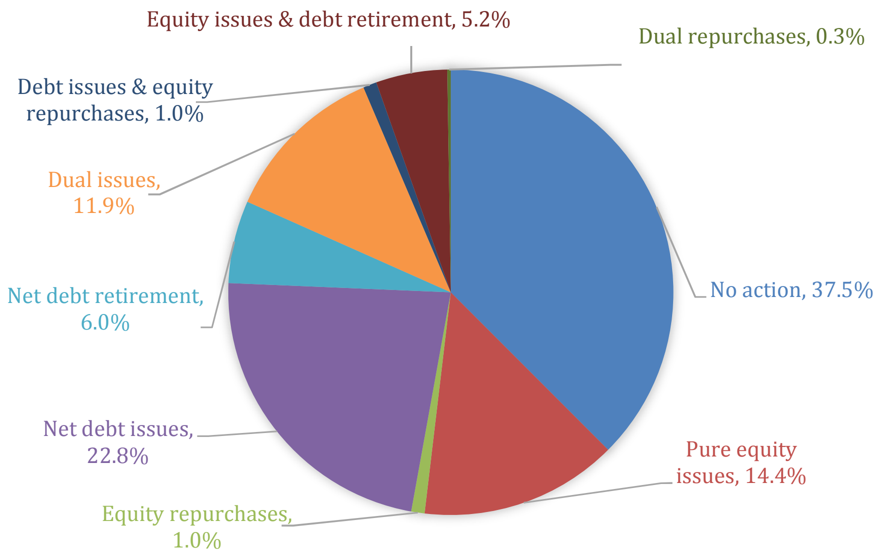

Figure 1: Financial decisions of REITs. This figure presents the percentage of nine financing activities of REITs

Table 2: The financing decisions of REITs

	Dependent variables (No action = 0)							
	[1] Equity issue	[2] Equity repurchase	[3] Debt issue	[4] Debt retirement	[5] Dual issue	[6] Debt issue & equity repurchase	[7] Equity issue & debt retirement	[8] Dual repurchase
	Panel A: Decomposing market-to-book model							
Firm Misvaluation	0.18*	-0.59	0.26***	-0.70***	0.25**	0.28	-0.14	-0.68
	(1.95)	(-1.49)	(3.41)	(-3.63)	(2.34)	(1.42)	(-0.83)	(-0.99)
Sector Misvaluation	-0.11	0.14	0.63***	-0.82**	0.65***	0.49	-1.63***	-1.96
	(-0.43)	(0.20)	(3.56)	(-2.26)	(3.06)	(1.02)	(-3.77)	(-0.84)
PPE/A	1.07**	-0.45	0.02	-2.12***	0.59	-1.74	0.10	-2.22
	(2.14)	(-0.32)	(0.05)	(-4.41)	(1.17)	(-1.59)	(0.16)	(-0.9)
EBITDA/A	-6.66**	13.24**	-5.6**	-6.27	-17.6***	7.14	-4.16	-21.5
	(-2.27)	(1.97)	(-2.34)	(-1.62)	(-5.59)	(1.12)	(-0.97)	(-1.12)
Size	-0.57***	0.12	-0.55***	-0.05	-1.01***	-0.40*	-0.55***	0.11
	(-7.63)	(0.48)	(-8.49)	(-0.46)	(-12.56)	(-1.70)	(-5.09)	(0.23)
10-year T-Bill	-45.73***	-3.79	1.63	-6.61	-33.28***	-25.13	-50.00***	155.29**
	(-6.46)	(-0.16)	(0.26)	(-0.65)	(-4.27)	(-1.05)	(-4.69)	(2.07)
Term structure	1.27	6.62	-3.23	14.73	7.46	-44.62*	25.55**	-29.61
	(0.18)	(0.30)	(-0.57)	(1.47)	(0.95)	(-1.91)	(2.22)	(-0.62)
Constant	12.46***	-6.47	10.70***	2.96	21.20***	6.33	13.04***	-8.63
	(7.16)	(-1.06)	(7.09)	(1.23)	(11.73)	(1.16)	(5.31)	(-0.76)
N	1,947							
Pseudo R^2	7.57%							
	Panel B: Residual income model							
Misvaluation	0.15***	0.01	0.04	0.00	0.14***	0.00	0.00	0.00
	(3.49)	(0.13)	(1.03)	(-0.09)	(3.05)	(0.10)	(0.27)	(-0.06)
PPE/A	0.84	-1.92	0.13	-2.63***	0.67	-3.1**	-0.21	-1.52
	(1.32)	(-1.3)	(0.24)	(-4.57)	(0.98)	(-2.56)	(-0.26)	(-0.61)
EBITDA/A	-2.86	8.29	-5.14*	-11.18***	-13.49***	12.54*	-4.76	-21.25
	(-0.9)	(1)	(-1.84)	(-2.83)	(-3.73)	(1.69)	(-1.12)	(-1.08)
Size	-0.56***	0.01	-0.48***	-0.22*	-0.89***	0.17	-0.58***	-0.07
	(-6.23)	(0.03)	(-6.09)	(-1.89)	(-9.22)	(0.57)	(-4.81)	(-0.15)
10-year T-Bill	-47.00***	13.27	9.72	-10.28	-32.94***	-14.70	-49.73***	173.16***
	(-5.62)	(0.43)	(1.21)	(-0.86)	(-3.43)	(-0.54)	(-4.03)	(2.64)
Term structure	4.07	2.24	-2.91	14.29	-4.17	-42.11*	38.04***	-23.12
	(0.54)	(0.09)	(-0.47)	(1.39)	(-0.50)	(-1.80)	(3.00)	(-0.51)
Constant	12.11***	-3.73	9.54***	6.08**	19.43***	-4.76	12.19***	-8.45
	(5.69)	(-0.5)	(5.12)	(2.21)	(8.73)	(-0.67)	(4.32)	(-0.75)
N	1,295							
Pseudo R^2	7.07%							

The table reports the result of the multinomial logistic model. The dependent variable is the financing events of a REIT. This variable takes the value 1 if a REIT issues equity, 2 if repurchases equity, 3 if issues debt, 4 if retires debt, 5 if issue both equity and debt, 6 if issues debt and repurchases equity, 7 if issues equity and retire debt, 8 if repurchases both equity and debt, and O if does nothing. The base option is 0. The definitions of variables are presented in Table 1.
*p=0.1; **p=0.05; ***p=0.01

Table 3: The cash holdings of REITs

Variables	Decomposing market-to-book model	Residual income model
Firm Misvaluation	0.01***	
	(12.95)	
Sector Misvaluation	0.01***	
	(3.38)	
Misvaluation		-0 .00
		(-1.19)
PPE/A	-0.07***	-0.07***
	(-14.35)	(-12.60)
EBITDA/A	-0.19***	-0.07**
	(-7.01)	(-2.29)
Size	-0.00***	-0.00**
	(-6.70)	(-2.27)
Constant	0.16***	0.13***
	(11.92)	(7.16)
N	2,163	1,425
R^2	18.44%	11.09%

The table shows OLS regressions predicting REIT cash holdings. The first regression is for the decomposing market-to-book model (DMM) and the second is for the residual income model (RIM). The definitions of variables are presented in Table 1.
*p=0.1; **p=0.05; ***p=0.01

Table 4: The bank credit line access

	Decomposing market-to-book		Residual income	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Firm Misvaluation	70.10***	69.02***		
	(8.49)	(8.31)		
Sector Misvaluation	42.30**	44.02**		
	(2.15)	(2.24)		
Misvaluation			-0.01	0.00
			(-0.05)	(0.00)
Net Income	131.43		495.3	
	(0.42)		(1.47)	
EBITDA/A		297.86		974.3***
		(0.95)		(2.82)
Size	299.11***	298.95***	288.06***	289.43***
	(35.68)	(35.79)	(29.44)	(29.75)
Constant	-6100.76***	-6117.66***	-5765.23***	-5861.75***
	(-34.21)	(-34.13)	(-27.35)	(-27.42)
N	1973	1973	1231	1231
R^2	43.66%	43.68%	41.69%	41.96%

The table reports OLS regressions. The dependent variable is *Line of credit*. The independent variables are misvaluation (*Firm Misvaluation, Sector Misvaluation* or *Misvaluation*), cash flow (*EBITDA/A* for model 1,3; *Net Income* for model 2, 4), and *Size*. The definitions of variables are presented in Table 1.
**p=0.1; **p=0.05; ***p=0.01*

Table 5: The liquidity management of REITs

	Decomposing market-to-book		Residual income	
	Model 1	**Model 2**	**Model 3**	**Model 4**
Firm Misvaluation	-0.01*	-0.02***		
	(-1.97)	(-4.30)		
Sector Misvaluation	-0.01	-0.00		
	(-1.22)	(-0.15)		
Misvaluation			0.00	0.00
			(0.36)	(0.60)
Net Income	0.70***		0.68***	
	(3.65)		(2.88)	
EBITDA/A		2.71***		2.52***
		(14.08)		(10.51)
Size	0.03***	0.03***	0.01	0.01**
	(5.59)	(5.70)	(1.11)	(2.09)
Constant	0.21*	0.04	0.64***	0.33**
	(1.92)	(0.36)	(4.39)	(2.28)
N	1,888	1,888	1,188	1,188
R^2	2.16%	10.67%	0.49%	8.57%

The table reports OLS regressions that examine how a REIT uses lines of credit and cash for liquidity management. The dependent variable is *Total*. The independent variables are misvaluation (*Firm Misvaluation, Sector Misvaluation* or *Misvaluation*), cash flow (*EBITDA/A* for model 1,3; *Net Income* for model 2, 4), and *Size*. The definitions of variables are presented in Table 1.
*p=0.1; **p=0.05; ***p=0.01

The Discount to NAV of distressed German open-ended real estate funds

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Rene-Ojas Woltering[1]

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Abstract

The German open-ended real estate fund industry was strongly hit by massive outflows in the course of the global financial crisis. In total, 18 public and institutional real estate funds had to stop the redemption of shares and were ultimately forced to liquidate their portfolios. Investors of these funds either have to await the stepwise liquidation of the funds' assets, which can take up to several years, or they can opt to sell their shares on the secondary market, often at a substantial discount to the Net Asset Value (NAV Spread). This paper attempts to explain the NAV Spread of distressed German public open-ended real estate funds. The unique monthly dataset contains fund specifics and macroeconomic indicators for the entire relevant period. Fundamentals like the leverage ratio and the liquidity ratio as well as industry-wide spillover effects from fund closures affect the NAV Spread. Moreover, we detect a considerably influence of macroeconomic uncertainty explaining the discount to NAV.

Keywords: Liquidity Transformation, Open-Ended Real Estate Funds, NAV Spread
Liquidity Crisis, Uncertainty, Spillover Effects
JEL classification:

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1. Introduction

Open-ended real estate funds are common in several countries. Multiple fund crises occurred due to the open-ended structure, for example in Australia in the nineties, in Germany in 2005/2006 and 2008 and recently in the United Kingdom (UK) in succession of the Brexit. Investors withdrew a considerable amount of capital from British open-ended real estate funds in June 2016. 7 public open-ended real estate funds, with a fund volume of GBP 18 bn., were forced to close.[1] These funds represent half of all public open-ended real estate funds in the UK. In contrast, German open-ended real estate funds have made a comeback with substantial capital inflows in the last years. High prices for direct real estate in Germany and the low interest rates have made an alternative investment in open-ended real estate funds more attractive. These funds are the predominant indirect real estate investment vehicle in Germany. According to the German Investment and Asset Management Association (BVI) about EUR 145 bn. are invested in the overall asset class.[2]

Nevertheless, this positive development in Germany is not much of a relief for investors of one of the several distressed German open-ended real estate funds, which were forced to close in succession of the global financial crisis in 2008. Moreover, investors of distressed British open-ended real estate funds now share the same fate. EUR 10 bn. invested in several German funds are still inaccessible to investors.[3] The property values of distressed funds differ considerable from the secondary market share prices. Therefore, investors can sell their shares only with a substantial discount on the secondary market. The aim of this study is to analyse the development of this NAV Spread for all distressed public open-ended real estate funds in Germany for the entire relevant period (October 2008 - October 2014).

Open-ended real estate funds invest in direct real estate. Investors were able to redeem their shares daily to the investment company whereas the share price was determined by the

[1] MG Property Portfolio, Henderson UK Property PAIF, Standard Life UK Real Estate Fund, Aviva Investors Property trust, Columbia Threadneedle UK Property Authorised Investment Fund (PAIF), Pramerica Property Investment, Canada Life UK Property Fund, Aberdeen UK Property Fund.

[2] BVI (2016); In addition, the German REITs has a market capitalization of EUR 1 bn. (2014).

[3] BVI 2016.

Net Asset Value (NAV) of the real estate assets. The liquidity transformation between the very illiquid direct real estate assets and the daily liquidity of the shares is a key advantage, but exhibits a potential "bank run" risk (Weistroffer & Sebastian (2015), Bannier et al. (2007), Sebastian & Tyrell (2006) and Sebastian (2003)).

In detail, the vehicle is structured as follows. First the funds are managed by an investment company (KVG).[4] Independent evaluators appraise the entire real estate portfolio once a year. In addition, one twelfth of the real estate portfolio is reappraised each month in order to increase the accuracy of potential changes in market value (Fecht et. al (2014). The investment company must keep at least 5 % of the invested capital as liquidity in form of cash and short-term money market deposits to diminish the "bank run" risk. An open-ended real estate fund closes if the daily redemption requests exceed the liquidity reserves.[5] After 24 months of being closed, the fund is forced to sell all properties and distribute the proceedings to the investors. Since October 2008, 18 public or semi-institutional funds closed and were forced to liquidate the funds‘ assets.[6] Usually the liquidation takes several years. For the liquidation, the national German banking supervision (BaFin) sets an individual time line for every distressed fund (between 3 and 5 years). Afterwards, the investment company is no longer in charge to manage the further liquidation. Instead, a third-party depository bank will sell the entire real estate portfolio.

Investors of these funds either have to await the stepwise liquidation of the funds‘ assets or they can opt to sell their shares on the secondary market. This induces a large supply of fund shares on the secondary market. Hence, market prices must be below the funds NAV to realign supply and demand, which caused substantial NAV Spreads. Moreover, a fund closing leads to a shift from relatively stable valuation based asset prices to more volatile

[4] Kapitalanlagegesellschaft (KVG).

[5] A "closed" fund no longer allows the investors to redeem their shares. From now on investors are forced to sell their shares on the secondary market.

[6] In succession of this open-ended real estate fund crisis the German law regime was modified several times. Nevertheless, all distressed open-ended German real estate funds are liquidated under the legal force of the former investment law (InvG, effective from 1/1/2004 - 7/22/2013). The continuous closing of these funds circumvent the law adjustment to the latest one (KAGB, effective since 7/22/2013).

transaction based share prices. Economically, the event of a fund closure can also be viewed as the loss of a "buy-back"-guarentee. Before the fund closure, the relatively stale NAV price was guarenteed to the investors. The loss of this "buy-back"-guarentee implies uncertainty, which requires a risk premium, namely the NAV Spread.

Figure 1 shows the average NAV Spread of all funds as the deviation of the "Total NAV Volume" and the "Total Market Capitalization" for all distressed open-ended real estate funds. The upper graph depicts the deviation between the NAV and the stock market value in billion Euro, while the lower graph indicates the percentage difference. Before the closure the stock market price approximately equals the NAV due to the absence of arbitrage opportunities. Figure 1 shows that both, the valuation (NAV) and the secondary market price, decline over time, which is due to two separate effects. First, property deacquisitions lead to a decrease of the funds substance, second we observed an impairment of the valuation of the remaining properties over time. After the first funds were forced to suspend the redemption of their shares (i.e. the share price is no longer guaranteed by the KVG), a substantial deviation of pricing and valuation occurs.

Starting near zero at the closure date of each fund between 2008 and 2010 the average NAV Spread rises up to 40 % around 2013.[7] Afterwards the average NAV Spread decreases again. Levels of 20-30 % can be observed at the end of the sample period.

Figure 2 shows the individual NAV Spread for each fund. According to Figure 2, the funds show a large degree of homogeneity over time. Nevertheless, at any given point in time the fund specific discounts are very heterogeneous.

We use fund specifics like the leverage ratio, the liquidity ratio, the share of institutional investors and the management costs to explain the fund specific, idiosyncratic part of the NAV Spread. In addition, we also introduce variables with no idiosyncratic variation. These variables are only dependent on the time dimension and will, therefore, explain the homogeneous part of the NAV Spread. Amongst these variables we use count variables for the

[7] On average, the stock prices drop to 60 % of the net asset values.

number of fund closures and the number of funds under liquidation. In addition, we control for the fund flows of the whole asset class. These variables are used as a proxy for spillover effects between open-ended real estate funds. In addition, we include macroeconomic uncertainty indices to take the ever-increasing role of economic uncertainty in the aftermath of the global financial crisis into account.

The reminder of this paper is organized as follows: In the next section, we present the used literature. Afterwards, we introduce the data and methodology and show the empirical results. Finally we end our analysis with a conclusion.

2. Literature Review

Closed-end mutual funds are traded on the secondary market often at a substantial discount to NAV. The Closed-End Fund Puzzle literature investigates these funds‘ discounts. In detail, the combined price of single stocks on the stock market differs from the price of a closed mutual fund, which simultaneously holds a variety of these stocks in a portfolio (Cherkes 2003). The pooling and a professional fund management seem to reduce the portfolio worth. Even though the environment for real estate funds is fundamentally different, the pricing of distressed open-ended real estate funds shows some similarity with the Closed-End Fund Puzzle described above.[8] Specifically, the price of those funds on the secondary market tends to be lower compared to the sum of the properties NAVs. According to Lee et al. (1991) closed-end fund discounts are caused by private investor sentiment, so called noise traders. An irrational change in investor sentiment lead to larger discounts. Therefore, holding a closed-end mutual fund portfolio exhibits a larger risk, hence uncertainty, than holding the underlying fund‘s assets. Additionally Lee et al. (1991) detect that individual fund discounts move together over time. Barkham and Ward (1999) find evidence for this noise trader hypothesis for listed property companies in the UK.

Figure 2 shows the development of the NAV Spread for each distressed open-ended public

[8] In contrast to common stocks and mutual funds there is no public market for the real estate assets alone.

real estate fund. The NAV Spread is defined as the percentage spread between the NAV and the stock market price. The graph illustrates a similar progression for each fund. As of the individual closing date, the particular NAV Spread emerges to significant values for all funds. Despite of the different closing dates, the individual NAV Spreads seem to be highly correlated between the funds. However, individual funds exhibit a considerable fund specific heterogeneity. Hence, in addition to macroeconomic and sentiment indicators as well as individual fund specifics seem to affect the NAV Spread.

We apply research about the Closed-End Fund Puzzle to the context of distressed open-ended real estate funds. Furthermore, we use the literature about the NAV Spread of Real Estate Investment Trusts (REITs) to derive further suitable indicators.

1. Fund Specifics

Clayton et al. (2000) find a positive influence of the debt to equity ratio to existing premia for REITs. An impairment of the fund‘s assets value reduce the value of the fund shares. A high leverage ratio amplifies this effect. For instance an impairment of the fund‘s real estate property values by 10 % given a leverage ratio of 50 % justifies a NAV Spread of 20 %. This leverage ratio risk should be considered in the market price. Therefore, we use the fund‘s leverage ratio as an influential factor to explain the NAV Spread.

A distressed fund is forced to sell the entire real estate property. As a result, the fund‘s liquidity always raises over time. The liquidity ratio has no market or appraisal risk and can be seen as safe money to the investors. After analysing the open-ended fund crisis in 2005/2006 in Germany Fecht et al. (2014) state, that a lower liquidity ratio lead to an increase of the redemption of shares by the investors. Therefore, we expect a negative relationship. Higher liquidity ratios should lead to lower NAV Spreads.

We use the management costs as an additional fund specific factor. Investors may consider the management fees as too expensive, which may lead to less demand on the secondary market. Nevertheless, Malkiel (1977) and Lee et al. (1991) find no significant influence of the management costs on the NAV Spread. In contrast, Gemmill and Thomas (2002) state that small closed-end funds, which often display large management costs, exhibit a larger discount. We include the fund specific total expense ratio (TER) and expect a positive influence on the NAV Spread.

According to Pontiff (1996), low dividend payouts lead to larger NAV Spreads. Gemmill and Thomas (2002) as well as Cherkes (2003) support this view. Malkiel and Xu (2005) confirm the negative relationship between the level of dividend payments and the NAV Spread. Investors receive so called extraordinary payouts from the stepwise liquidation of the fund‘s real estate assets. We suggest that distressed funds with considerable extraordinary payouts endure a shorter total repayment period for the total investment. Associated with the lower capital commitment there should be a lower risk premium (e.g. NAV Spread).

Barclay et al. (1993) conclude that closed-end funds with a large share of blockholder display a larger discount. In contrast, Morri et al. (2009) find an adverse effect of the share of institutional investors to a NAV Spread for Italian closed-end real estate funds. Brounen, et al. (2010) state that the share of institutional investors should diminish the effect of sentiment for NAV Premia in UK REITs. Due to the low price volatility, institutional investors abused the open-ended fund structure as a cash equivalent before the fund crisis. After closing, all funds show a substantial price volatility on the secondary market. Therefore, institutional investors will reevaluate the asset class and may potentially sell their shares. The fortitude of this supply shock depends on the extent of the institutional share holdings. This potential risk could affect the secondary market price and lead to a larger NAV Spread. On the other hand, the dataset consists exclusively of closed funds. A larger share of well informed professionals holding shares, despite of the closure, could indicate a high fund‘s quality. Hence, institutional investors consider the funds to be undervalued at their current secondary market price. We include the particular share of institutional investors to estimate the effect on the NAV Spread.

In addition, the fund size is used as a further fund specific factor. This is due to capture potential economies of scales and economies of scope. Furthermore, the fund size serves as a proxy for the liquidation time. After the fund closing, the banking supervision (BaFin) determines the liquidation time individually for each fund. Larger funds receive more time to liquidate their portfolio than smaller ones. Despite their portfolio volume, the larger funds could also use their longer liquidation time to employ a better market-timing strategy for their deaquisitions.

We use the following variables, which are related to the funds‘ real estate portfolio quality. The fund specific tenancy rate serves as a proxy for the current funds‘ portfolio quality. Wurtzebach et al. (1991) stated that high office vacancy rates, hence, low tenancy rates, diminish returns of commercial real estate in the United States. Furthermore, we consider the funds‘ past performance as a measure of the funds‘ past portfolio quality. In addition, we use the growth of the funds‘ target markets GDP as an estimator of the future development of the funds‘ real estate portfolio. We expect markets with higher growth rates to show lower NAV Spreads.

2. Industry-Wide

Downs et al. (2016) find a significant relationship between fund flows and fund performance for German open-ended real estate funds. We use the sum of net capital flows for all public and institutional open-ended real estate funds as an additional influential variable to explain the NAV Spread. The data provided by the BVI gives an overview about the current industry-wide market mood for open-ended real estate funds. We suspect that net capital inflows in the overall asset class indicate a larger general demand for healthy open-ended funds as well as for distressed funds. High industry-wide demand should lead to significant lower individual NAV Spreads.

Furthermore, we use count variables for the number of fund closures and the number of funds under liquidation. The count variables include both public and institutional distressed funds. These variables are used as a proxy for spillover effects between open-ended real estate funds. The events of closing or liquidation question the future development of the overall asset class.

3. Macroeconomic Uncertainty

The observation of a considerably uniform progression of the individual NAV Spreads strengthen the assumption that macroeconomic events contribute to the NAV Spread to a significant amount. Therefore, we use two popular uncertainty indices to control for macroeconomic influence. First, we employ the Economic Policy Uncertainty Index by Baker, Bloom and Davis. This index is used for a plethora of research (e.g. the European Central Bank (2013), the European Commission (2013) and the International Monetary Fund (2014).[9] Moreover, we employ the implied volatility index (VIX) for the Euro Stoxx 50 stock market. This index measures the anticipated (implied) stock market risk based on the difference of stock prices and stock price futures. This measure is of importance because the funds are subjected to the common stock market price mechanism after the event of closing. The index is widely used as a proxy for stock market uncertainty (e.g. Baker et al. (2015), Bekaert et al. (2013).

3. Data and Descriptive Statistics

Table 1 displays an overview of the fund closures and the liquidation process. Open-ended real estate funds faced substantial capital outflows of about EUR 4.3 bn. in October 2008. As a result, 9 of these funds closed. 7 funds opened again between February 2009 and October 2009. After a short opening period, all funds were forced to close for a second time. The redemption requests exceeded the provided funds‘ liquidity. Within the closing period of 24 months, the funds were not capable of providing sufficient liquidity. The funds announced the liquidation date, exactly 24 months after their individual last closure, between October 2010 and October 2011.

[9] full list: www.policyuncertainty.com/research.

1. *Data Sources and Sample*

We use a panel model framework to analyse 9 distressed funds over 73 months from October 2008 to October 2014. These 9 funds represents the entire population of all distressed public open-ended real estate funds in Germany. The dataset is generated based on monthly fact sheets provided by the individual fund‘s management as well as published half-year and annual fund‘s reports.[10] The panel dataset starts with the closing of the DEGI Europa fund and the Morgan Stanley P2 Value fund in October 2008. The dataset ends in October 2014. Several funds are now managed by a depository bank. The current reporting provided by these banks includes far less information about the funds‘ fundamentals.

2. *Definitions*

According to Lee et al. (1991) and Barkham & Ward (1999) the NAV Spread is calculated as the difference between the current NAV and the contemporary fund‘s market price divided by the current NAV. The fund‘s NAV is published by the KVG for each fund on a daily basis. Whereas the market prices are provided by the Hamburg-Hannover stock exchange. Prices and values in the dataset are based on the respective end of month figures.

2.1. Fund Specifics

The provided data displays several fundamental variables like the leverage ratio, the liquidity ratio, the tenancy rate, the total expense ratio (TER), the fund size as well as the fund performance. These key figures are calculated based on law-enforced industry standards. We also introduce the Economic Growth Target markets variable as well as the extraordinary payouts and the share of institutional investors. The leverage ratio is defined as the relation of the funds debt and the funds gross asset value (GAV). The liquidity ratio shows the relation between the fund‘s cash equivalents and the GAV. The Economic Growth Target

[10] Asset Management Deutschland, AXA Investment Managers Deutschland, Credit Suisse, KanAm Grund Kapitalanlagegesellschaft, Morgan Stanley Real Estate Investing, Pramerica Property Investment, SEB Asset Management, UBS Real Estate.

Markets variable is calculated as the weighted sum of the monthly GDP growth in the individual funds‘ target country markets. The GDP data is provided by the OECD. The tenancy rate shows the proportion of rented and overall space of the real estate fund assets, while the TER states the annual management costs for each investor in percent of the fund volume. Extraordinary payouts are defined as the monthly difference between the fund specific absolute payouts and the current NAV. The share of institutional investors is also considered. Morningstar provides the investment share of these investors for this purpose. Moreover, the fund size in billion Euro as well as the monthly fund performance measured by the 12 month BVI-performance are also considered.

2.2. Industry-Wide

The invested capital in the overall asset class provided by BVI serves as an additional influential factor. The BVI collects data about net flows directly from its members and represents the vast majority of the German mutual fund industry. The dataset includes the monthly net flows of 48 public and institutional German open-ended real estate funds in the sample period.[11] Count variables for fund closures or liquidation announcements are constructed in order to further account for the asset class specific sentiment.

2.3. Macroeconomic Uncertainty

We use the Economic Policy Uncertainty Index for Europe by Baker, Bloom and Davis. At first, the authors select two influential newspapers for each European country like "Le Monde" and "Le Figaro" for France, "Handelsblatt" and "Frankfurter Allgemeine Zeitung" for Germany etc. Thereafter, the authors count the number of articles including the items uncertain or uncertainty, economic or economy, and at least one policy-relevant item. The count is scaled by the overall number of articles in each newspaper. The Economic Policy Un-

[11] Since 2013, according to the German Central Bank, the extraordinary payouts of distressed funds were considered as capital outflows (BVI 2016). In contrast, all extraordinary payouts of distressed funds are set equal to zero to standardize the calculation for both, healthy and distressed funds.

certainty Index approximately illustrates the overall macroeconomic uncertainty in Europe. Furthermore, we employ a second uncertainty indicator, the Euro Stoxx 50 Volatility Index (VSTOXX), shortened VIX. This index measures the anticipated (implied) stock market risk based on the difference of stock prices and stock price futures.[12] Both indices are normalized (i.e. the mean was subtracted and all values are divided by their standard deviation subsequently). This transformation allows not only to interpret the sign and the statistical significance of the respective regression coefficients but also to compare both coefficients in magnitude.

3. *Descriptive Statistics*

According to Table 2, the NAV Spread shows a large heterogeneity between the funds. At the closing date, all funds exhibit a NAV Spread close to zero. In contrast, the TMW Immobilien Weltfonds fund displays a NAV Spread of about 60 % in January 2013. The average NAV Spread amounts to 31 %. The independent variables in Table 2 are separated in 3 categories: Fund Specifics, Industry-Wide and Macroeconomic Uncertainty. In addition, Figure 3 illustrates the progression of the average NAV Spread and all independent variables over time

The leverage ratio differs substantially between funds. The DEGI International fund reports a leverage ratio from zero in June 2014 while the Morgan Stanley P2 value fund exhibits a leverage ratio of 69 % at the beginning of 2014. The average leverage ratio of all funds is of 29.6 %. Figure 3 shows that the leverage ratio considerably diminishes over time. Selling real estate assets is associated with the repayment of loans.

The liquidity ratio also shows a considerable heterogeneity. The TMW Immobilien Weltfonds fund displays a liquidity ratio of 0.5 % in November 2011, which deceeds the regulatory threshold of 5.0 % and is only allowed for a short period of time. However, this fund shows a considerably low liquidity ratio over the entire sample period. In contrast, the DEGI In-

[12] Stoxx VSTOXX (2016).

ternational fund has a rising liquidity ratio of 10 % at the closing date up to 62.5 % in 2014. In parts, the fund‘s strategy causes these substantial differences. In the sample period, the DEGI International fund liquidates a significant portion of its assets without substantial extraordinary payouts until October 2014. On average, the liquidity ratio amounts to about 15.9 %. Figure 3 illustrates the considerable increase in the average liquidity ratio due to sales revenues beginning in Q3 2012.

The DEGI International fund made an extraordinary payment of about 53.4 % of the respective market value in October 2014. Other funds distributed their payouts more evenly over the sample period like the AXA Immoselect fund. The fund‘s management of the AXA fund continuously distributed about 3-4 % of the respective market value per share from 2008 until 2013. Figure 3 illustrates the significant increase in extraordinary payouts due to the advanced liquidation process also beginning in Q3 2012.

The Economic Growth (the GDP growth rate) of the funds target markets ranges from -3.2 % to +1.4 %. As Figure 3 already suggests this is mainly due to the economic rebound after the global financial crisis (variance over time). On the individual fund level the average target market growth rates only vary from -0.8 % (DEGI Europa fund) to + 0.4 % (KanAm grundinvest Fonds fund).

The tenancy rate serves as a proxy for the quality of the real estate properties as well as the operative asset management. The average tenancy rate amounts to 90.3 %. Higher tenancy rates suggest stable cash flows from the managed funds‘ assets. These funds may be less likely to devaluate vastly in the near future. We expect these funds to show lower NAV Spreads. Table 2 shows that the Morgan Stanley P2 Value fund exhibits a tenancy rate of 100 % in the period between June 2013 to December 2013, while the TMW Immobilien Weltfonds fund reports a tenancy rate ranging from 76 % to 69 % in the same period.

The funds‘ expense ratios range from 0.058 % to 0.13 % of the average annual fund volume. The KanAm grundinvest fund and the TMW Immobilien Weltfonds fund show the largest management fees at the end of the sample period in 2014, while the AXA Immoselect fund exhibits less than half of these fees with 0.058 %.

Institutional shareholders on average represent 10 % of all fund investors. The UBS 3 sector real estate fund reports an institutional share of up to 37 %, while the DEGI Europa fund and the DEGI International fund never exceed an institutional share of more than 5 %.

The fund size ranges from EUR 116 mn. up to EUR 6.4 bn.. The UBS 3 Sector Real Estate fund is the smallest fund with an average fund size of EUR 324 mn. (average over the entire sample period). The CS Euroreal A fund is the largest fund with an average fund size of EUR 5.33 bn. Despite of the negative time trend, the time dimension only explains a small part of the overall variance of the fund size variable.

The Performance (12 month rolling average according to BVI) of the funds ranges from -38.9 % to +5.0 %. Like the overall economic development the variance of this variable is mainly driven by the time dimension (namely the global financial crisis). On an individual level the funds show average performance figures from -11.9 % (TMW Immobilien Weltfonds fund) to -0.77 % (CS Euroreal A fund).

All funds show a considerably amount of individual heterogeneity regarding the variables mentioned above. Nevertheless, all funds share the same fate of closing and liquidation. We therefore also look at non fund specific influences. Naturally, these influences exhibit no individual heterogeneity but only vary over time.

The industry-wide variables, namely the asset class fund flows and two count variables for fund closure and liquidation, represent the asset class specific macro environment. The average asset class capital inflows are of EUR 178 mn. per month. The funds show a huge capital inflow of about EUR 1.69 bn. in January 2010, while in October 2008, we recognize a tremendous capital outflow of EUR 4.36 bn.

To account for the rising importance of economic uncertainty after the global financial crisis we introduce two widely used uncertainty indices. Figure 4 displays both, the Policy Uncertainty Index and the European VIX, as well as the average NAV Spread over time. On an aggregated level we observe a positive correlation between the absolute level of the NAV Spread and the European Policy Uncertainty Index (general uncertainty). On the other hand we observe an inverse relationship between the absolute level of the NAV Spread and the VIX (stock market uncertainty). Although both uncertainty indices peak in 2008 (global financial crisis) and 2012 (European debt crisis) they appear to be uncorrelated in general.

Table 3 shows the correlation between the NAV Spread and all independent variables. The NAV Spread shows a relatively strong negative correlation with the Economic Growth (-0.42), Fund Size (-0.42) and the Performance (-0.45) variables. Moreover, the NAV Spread proves to be relatively strong correlated with the events of fund closure (+0.53) and liquidation (+0.62). In order to enable a ceteris paribus interpretation for these effects, we employ a multivariate panel regression model in the next chapter. Moreover, we assume a certain lag structure for the independent variables in order to interpret their influences as causal effects.

4. Research Models and Methodology

Equation 1 displays the panel regression model with all applied variables. The fundamental variables should have a lagged influence on the NAV Spread. Investors need time to adjust their decision making process subsequent to changes in fund's key indicators. These fund specifics are published in monthly reports, which exhibit a time delay. We include a one month time lag to all published variables like the leverage ratio (Δ $Leverage_{i,t-1}$), the liquidity ratio (Δ $Liquidity_{i,t-1}$), the TER (Δ $TER_{i,t-1}$) etc. Moreover, the net capital inflows and the uncertainty indicators are also lagged by one month. In contrast, the count variables ($Event\ Fund\ Liquidation_{i,t}$; $Event\ Fund\ Closure_{i,t}$) are included without any lag. The closure or liquidation of one or more particular open-ended real estate funds is a sweeping event reported by the media. Therefore, investors both institutional as well as private investors recognize such an event and adjust their investment strategy within one month. In addition to the economic interpretation, the statistical significance of the coefficients as well as the overall fitness measures like AIC criteria also indicate the lag structure explained above.

$$
\begin{aligned}
NAV\ Spread_{i,t} = {} & \alpha + \beta_1\ \Delta\ Leverage_{i,t-1} + \beta_2\ \Delta\ Liquidity_{i,t-1} \\
& + \beta_3\ Economic\ Growth\ Target\ Markets_{i,t-1} \\
& + \beta_4\ \Delta\ Tenancy_{i,t-1} + \beta_5\ \Delta\ TER_{i,t-1} + \beta_6\ Extraordinary\ Payouts_{i,t-1} \\
& + \beta_7\ Institutional_{i,t-1} + \beta_8\ Institutional\ sq_{i,t-1} \\
& + \beta_9\ Log\ Fund\ Size_{i,t-1} + \beta_{10}\ \Delta\ Perform_{i,t-1} \\
& + \beta_{11}\ Flows\ Asset\ Class_{i,t-1} + \beta_{12}\ Event\ Fund\ Liquidation_{i,t} \\
& + \beta_{13}\ Event\ Fund\ Closure_{i,t} + \beta_{14}\ Policy\ Uncertainty\ Index\ Europe_{i,t-1} \\
& + \beta_{15}\ VIX\ Europe_{i,t-1} + \\
& + v_{i,t}
\end{aligned}
\tag{1}
$$

As stated before our research objective is to explain the NAV Spread in dependence of fund specific fundamentals as well as time specific economic indicators. In order to account for individual, cross-sectional heterogeneity as well as the time dimension, we employ a panel regression model with time fixed effects and heteroscedasticity robust standard errors. We use the first differences (Δ) of the leverage ratio, the liquidity ratio, the tenancy rate, the TER and the performance in order to correct for non-stationarity.

5. Results

Table 4 illustrates the results of the panel regression models (I-IV). The first model includes the fund-specific indicators (I). The second specification displays the fund-specific as well as industry-wide variables (II). The third model shows the fund-specific and the macroeconomic uncertainty variables (III). The final model includes all variables combined (IV). The significance and sign of all variables remain stable among all four models (I-IV), which indicate a robust model specification.[13]

1. Fund Specifics

The leverage ratio, the liquidity ratio and the share of institutional investors affects the NAV Spread, while the influences of the Economic Growth Target Markets variable, the tenancy rate and the management costs (TER) as well as the performance variable are statistically insignificant.

The leverage ratio (Δ $Leverage_{i,t-1}$) increases the NAV Spread. An increase in the absolute difference of the leverage ratio by one percent leads on average and c.p. to a 0.290 percent larger NAV Spread in the next period.

The liquidity ratio (Δ $Liquidity_{i,t-1}$) has a negative effect on the NAV Spread. A rise in the lagged absolute difference of the liquidity ratio by one percent leads on average and c.p. to a 0.361 percent lower NAV Spread. A larger share of cash and short term money market positions represent save money for fund investors. Larger liquidity ratios diminish the appraisal risk of the overall fund portfolio.

Real estate funds, which invest in well performing countries, should be more likely to see their assets appreciate in the future. Investors are informed about the target market mix by monthly, half-year and annual reports of the funds. Moreover, investors receive information about the economic development of the most important economies in the world by media.

[13] Moreover, we controll for the passed time until the liquidation date and the legal fund environment (selling restrictions of the real estate properties) in the Appendix (Table 6).

Both sources of information should lead in theory to higher demand for funds, which invest in prosperous markets, on the secondary market. Nevertheless, we cannot find a significant influence of the Economic Growth variable affecting the NAV Spread.

Extraordinary fund‘s payouts should have no influence. These payouts diminish the NAV and the stock market price in the same way. The effects are canceled out by taking the difference calculating the NAV Spread. Nevertheless, we find a significant impact of the extraordinary payouts. ($Extraordinary\ Payouts_{i,t-1}$). A one percent higher payout leads on average and c.p. to a 0.280 % lower NAV Spread next month. The practice of extraordinary payouts in times of closing differs considerably between the funds in the dataset. Some closed funds carry out substantial constant payments on a half-year or annual basis. Others disburse their payments not regularly or in low extent. The history of regular served distributions to the investors increases the trust in the funds management. This could be an argument for investors to remain invested.

The relationship between the share of institutional investors ($Institutional_{i,t-1}$; $Institutional\ sq_{i,t-1}$) and the NAV Spread follows a U-shape curve as a result of two offsetting effects: On one hand a large share of well-informed institutional investors serves as a signal for the funds quality, which justifies a low NAV Spread. On the other hand the concentration of very few institutional investors exhibits a blockholder risk (i.e. potential supply shocks), which justifies a high NAV Spread. Both effects cancel out at 24.85 %.

The fund size ($Log\ Fund\ Size_{i,t-1}$) shows a considerable influence. An one percent increase in the fund size leads to a 0.0174 percent larger NAV Spread. In accordance with the BaFin, larger funds have more time to liquidate their portfolio. Investors have to wait longer to obtain their capital and pay more fees, which justifies a larger NAV Spread.

The fund tenancy rates ($\Delta\ Tenancy_{i,t-1}$) and the TER ($\Delta\ TER_{i,t-1}$) as well as the past performance ($\Delta\ Perform_{i,t-1}$) remain insignificant. The tenancy rate in our model serves as a proxy variable for the quality of the funds real estate portfolio. In theory, an impairment of the real estate assets should be reflected in the NAV. The appraisal based NAV is reported with a time delay. Hence, changes in the tenancy rate could be recognized by investors before the more stale NAV is adjusted to changes in rental income. All funds in the dataset exhibit a high tenancy rate of at least 69 % up to 100 % with little variance over time. Therefore, we only control for the different levels of the tenancy rates. Moreover, the effect of the management costs (TER) has also little variance over time. We could not confirm an impact of the fund‘s fees.

2. *Industry-Wide*

Figure 5 shows the coefficients of the time dummies for all 61 periods (73 periods deducting 12 periods for the lag structure). Since the dummy variables have no economic interpretation, we consider the coefficients as the unexplained but yet time specific component of the NAV Spread. As the solid line (Model I) in Figure 5 indicates, a notable part of the NAV Spread cannot be explained by the cross sectional heterogeneity (fund specifics) alone. The unexplained time specific component of the NAV Spread diminishes notably after including industry-wide variables and uncertainty indicators (Model II-IV).

The net flows into the asset class show a negative relationship with the NAV Spread ($Flows\ Asset\ Class_{i,t-1}$). However, we obtain no significant results.

The count variables ($Event\ Fund\ Liquidation_{i,t}$; $Event\ Fund\ Closure_{i,t}$) indicate the dates of closure or liquidation of any public or institutional open-ended real estate fund in the sample period. After an additional fund announces the liquidation, the NAV Spread for all distressed funds rises c.p. and on average by 4.45 %. For an additional fund closure, we estimate c.p. and on average a 3.06 % larger NAV Spread. These results indicate considerable spillover effects. Nevertheless, fund specific and industry-wide variables together can still not sufficiently explain the time specific variance of the NAV Spread, as Figure 5 shows.

3. *Macroeconomic Uncertainty*

We use the European Policy Uncertainty index ($Policy\ Uncertainty\ Index\ Europe_{i,t-1}$) to measure overall economic uncertainty. In contrast, we use the VIX ($VIX\ Europe_{i,t-1}$) to measure the specific stock market risk. An increase in the Policy Uncertainty Index leads c.p. and on average to a larger NAV Spread in the next month. Moreover, we find a negative significant effect between the lagged VIX Europe and the NAV Spread. In contrast to common stocks open-ended real estate funds are considered as a different asset class and profit from a more risky investment universe, since we already control for the overall economic uncertainty.[14] The overall economic uncertainty seems to be more important than the stock market uncertainty since the coefficient for the Policy Uncertainty Index is larger in amplitude compared to the VIX Europe coefficient. [15]

The time dummies control for the unobserved time effects. Nevertheless, the use of monthly time dummies cause equal coefficient of determination of 77.3 % for all four model specification. Figure 5 illustrates how the unexplained (unsystematic) time effects diminish after we include additional time dependent variables into the model. The time dummy coefficients of model I show a considerably positive sign over time. Moreover, the parabolic progression, indicates a time trend, which is accounted for by the use of monthly time dummies in the regression model. This parabolic progression can be also seen in the development of the NAV Spread, which increased after the individual closure dates for each fund to its maximum in Mid 2012 and significantly decrease until October 2014 of about 20-30%.

Moreover, the time dummies of model II, which include the industry-wide variables still exhibit a time trend.[16]

[14] Without overall economic uncertainty as a control variable, the VIX Europe shows a positive relationship with the NAV Spread.

[15] Both coefficients can be compared since the two uncertainty indices are normalized and exhibit the same variance.

[16] We conduct a Portmanteau test for white noise for the development of the time dummy coefficients, which indicate a Q statistic of 338.21 for model I and 143.34 for model II. Therefore, we detect a significant serial correlation in both time series. Lower Q statistics indicate less serial correlation. Hence, the consideration of industry-wide variables lead to a larger explanatory power. Nevertheless, these variables are not able to fully explain the progression of the NAV Spread.

Model III, which exhibit the uncertainty variables and the fund specifics shows no significant time trend. Moreover, the main model IV, which include all variables exhibit also no time trend. Model III and IV only differ in the consideration of the industry-wide variables. Figure 5 illustrates that the progression of the time dummies of model III and IV are almost equal. Although the use of industry-wide variables improve the fit of the model, the uncertainty indicators have a considerably larger effect.[17]

6. Conclusion

The event of a fund closure destroys up to 60 % of the value of the funds real estate portfolio. We analyze the major factors of influence on the NAV Spread. We categorize the potential factors into three groups, namely (I) fund specifics, (II) industry-wide and (III) uncertainty. We find that all three groups have a high explanatory power for the NAV Spread. Although there are notable differences between the individual funds (cross sectional heterogeneity), we find that the variance of the NAV Spread is mainly driven by time dependent influences, especially macroeconomic uncertainty.[18] Higher liquidity ratios and lower leverage ratios diminish the NAV Spread. A more conservative fund strategy by the fund‘s management help to decrease the NAV Spread. Moreover, the share of institutional investors has a significant influence on the NAV Spread. As expected, both, the closure and the liquidation of other funds lead to higher NAV Spreads of the particular fund. While higher overall economic uncertainty increases the NAV Spread, the stock market uncertainty (VIX) has an adverse effect on the NAV Spread. The fund managers have no control of the overall economic uncertainty or the closure or liquidation of other funds. Our results are in line with the Closed-End Fund Puzzle literature regarding the sign and the statistical significance of most influences. However, the environment for open-ended real estate funds is fundamentally

[17] The Q statistics of model III and IV diminish to 83.09 respectively 76.16. Although, model III and IV are not white noise the Q statistics indicate a significant increase in the explanatory power of our preferred model IV.

[18] The uncertainty indicators alone explain 43.1 % of the variance of the NAV Spread as Table 5 shows.

different since the assets alone are not traded on the public market. Eventually, the event of a fund closure is accompanied by the loss of "buy-back guarantee" for the fund. Naturally, this induces uncertainty which requires a risk premium (the NAV Spread). We find that the level of uncertainty is primarily driven by the overall macroeconomic uncertainty and not by the structure of the fund itself. Fund managers should prevent the event of a fund closure at any cost since they have little control over the NAV Spread once a fund has closed.

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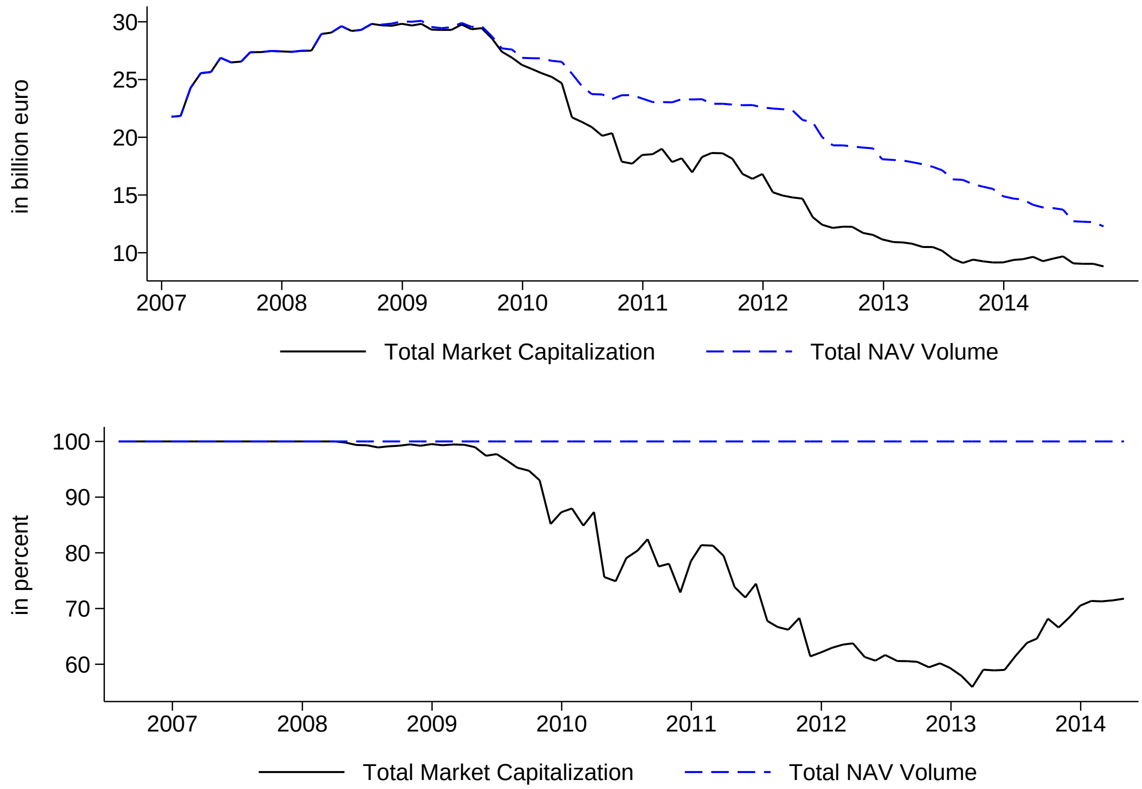
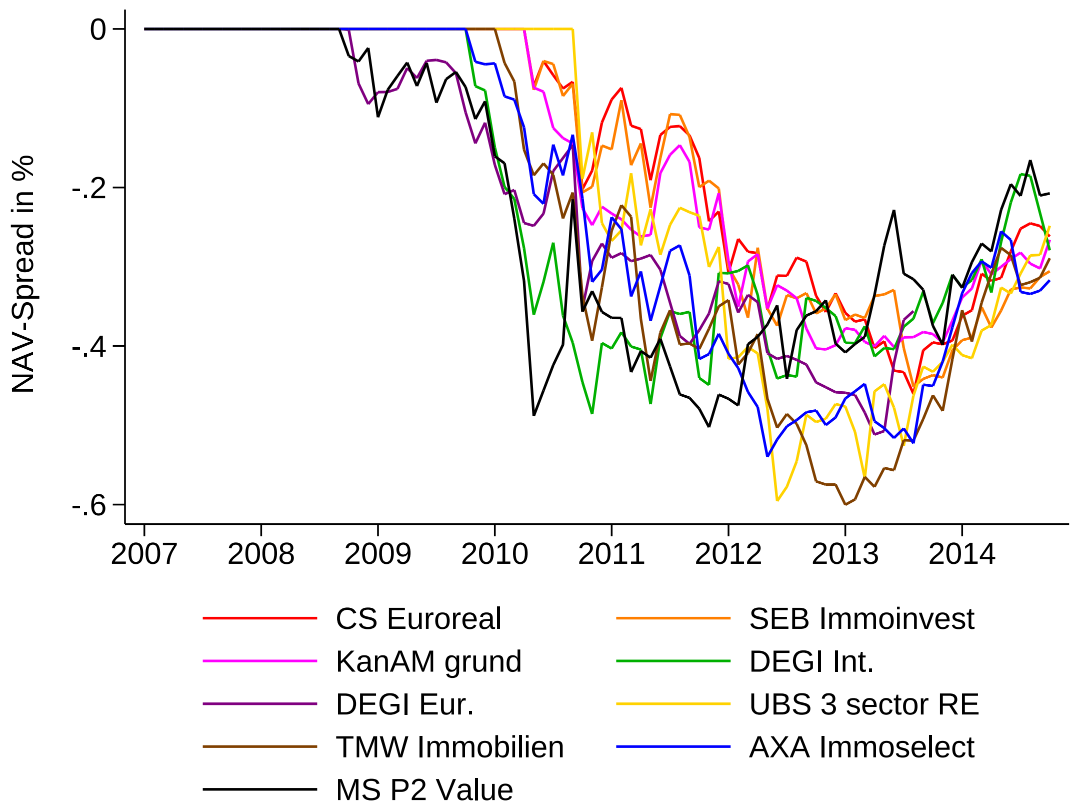
7. Figures

Figure 1. Total NAV Volume and Total Market Capitalization



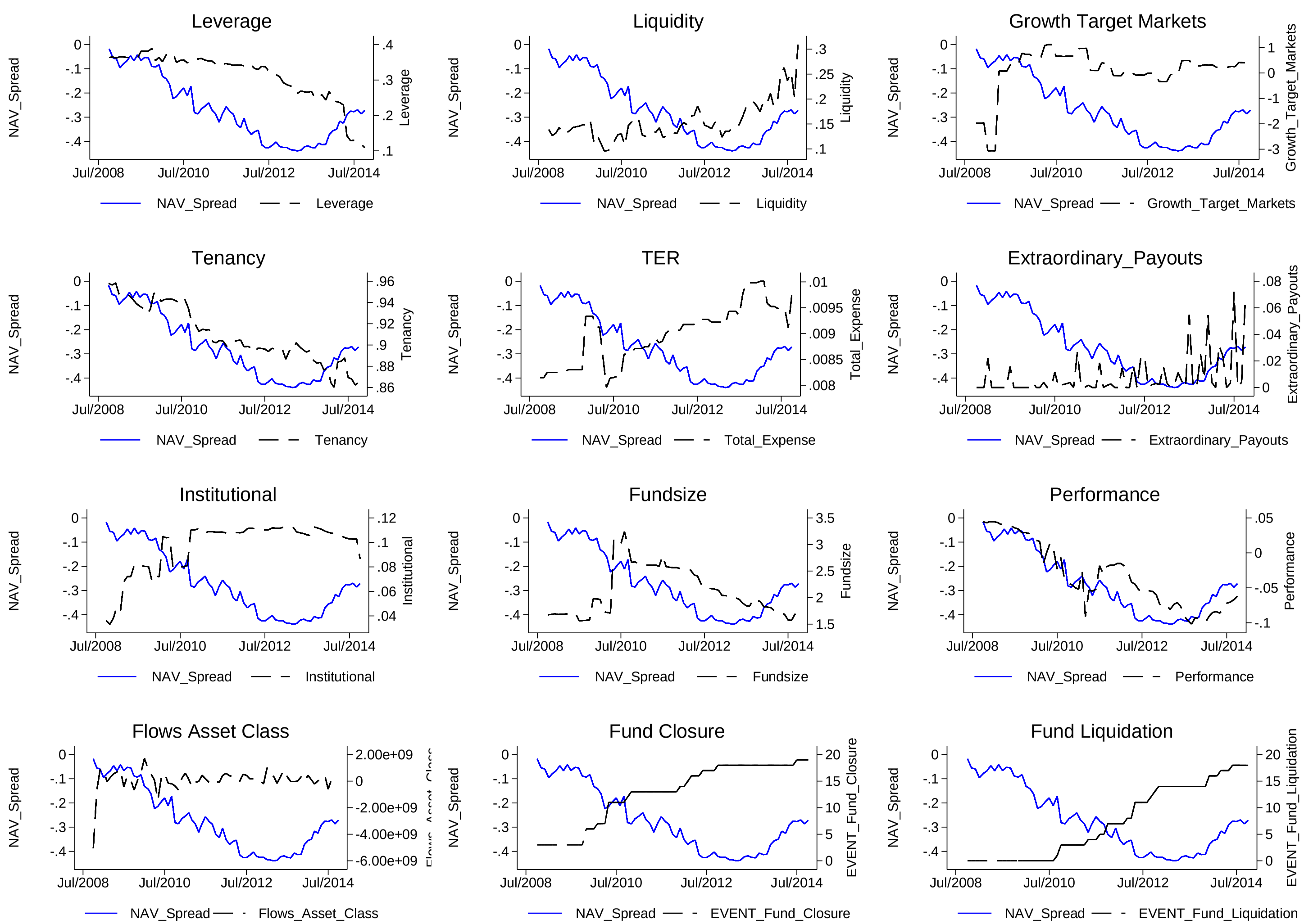
The figure shows the total NAV volume and the total market capitalization of all distressed open-ended real estate funds from 2007:1 to 2014:10. The above figure illustrates the absolute deviation between NAV and market prices, while the below figure displays the relative deviation. The total market capitalization is defined as the sum of the fund specific stock market prices weighted with the total number of shares of each fund. The total fund volume is calculated as the sum of the total number of fund shares multiplied with the NAV of each fund.

Figure 2. NAV Spread



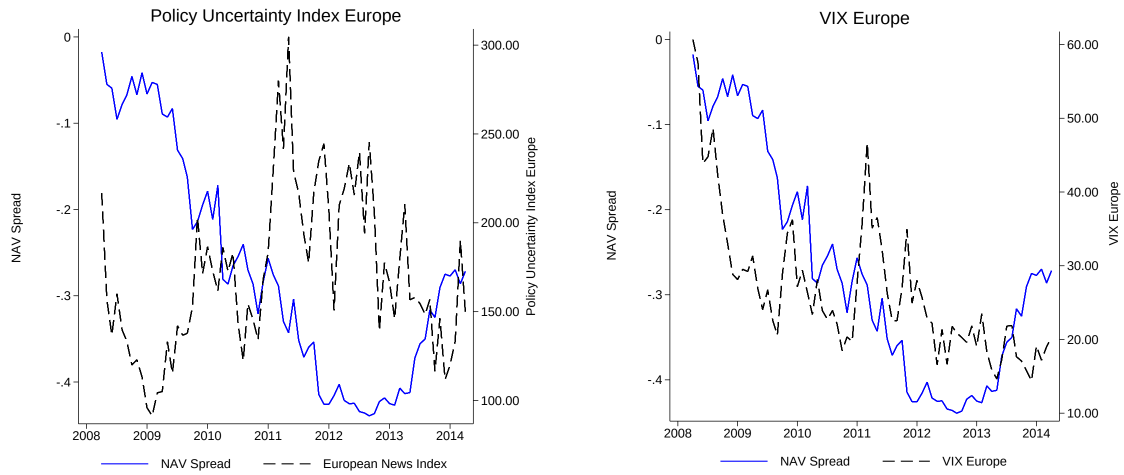
The figure shows the development of the NAV Spread for each fund from 2007:1 to 2014:10. The NAV Spread indicates the negative deviation between the funds NAV and the secondary market price in percent.

Figure 3. NAV Spread, Funds-Specifics and Industry-Wide Variables



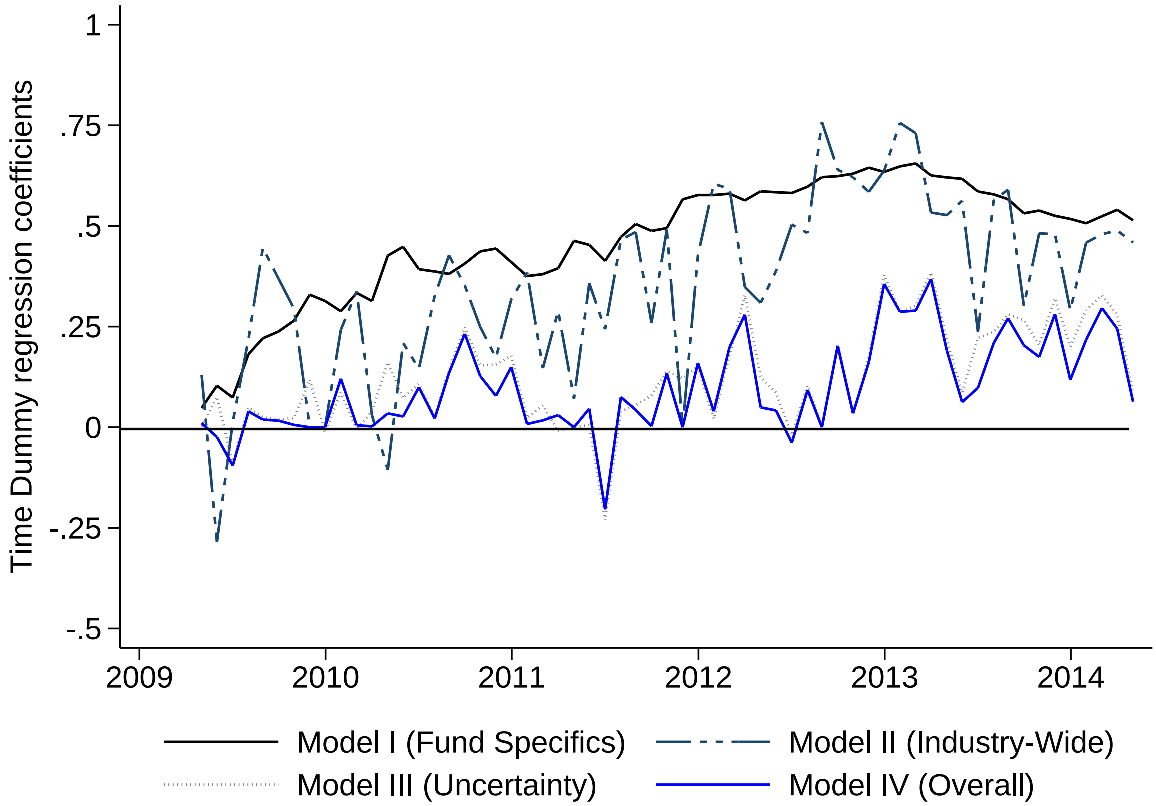
The figure illustrates the average progression of the fund specific and industry-wide variables for all distressed real estate funds in contrast to the average course of the NAV Spread from 2008:10 to 2014:10.

Figure 4. NAV Spread and Macroeconomic Uncertainty



The figure shows the average course of macroeconomic uncertainty variables in contrast to the average course of the NAV Spread from 2008:10 to 2014:10.

Figure 5. Development of Time Dummies



The figure illustrates the development of the time dummy coefficients over time for all four model specification.

8. Tables

Table 1. Overview Distressed Open Ended Real Estate Funds

fund	first closure	second closure	notice liquidation	depository bank
CS Euroreal A	10/30/08 - 06/29/09	05/20/10	05/21/12	04/30/17
SEB ImmoInvest	10/29/08 - 06/02/09	05/06/10	05/07/12	04/30/17
KanAm grundinvest	10/28/08 - 07/08/09	05/06/10	03/01/12	12/31/16
AXA Immoselect	10/28/08 - 08/28/09	11/19/09	10/20/11	10/20/14
DEGI International	10/31/08 - 01/31/09	11/17/09	10/25/11	10/15/14
DEGI Europa	-	10/31/08	10/01/10	09/30/13
UBS (D) 3 Sector RE	10/31/08 - 10/31/09	10/06/10	09/05/12	09/05/15
TMW Immobilien	10/28/08 - 10/31/09	02/08/10	05/31/11	05/31/14
Morgan Stanley P2 Value	-	10/30/08	10/26/10	09/30/13

The table shows an Overview of all distressed public open-ended real estate funds. In detail, the table displays the date of the first closing of each fund in October 2008. 7 of these funds reopened for a particular period of time. Therefore, these funds exhibit a second closing date. After 24 months of closing all 9 funds had to announce the liquidation. Column 4 displays the liquidation date. The BaFin determines an individual period for all funds to liquidate the real estate portfolio between 3 and 5 years. After this period a depository bank take over control of the fund‘s management. Column 5 exhibit the date of the take over. 9 of 10 distressed public open-ended real estate funds were comparable to each other and included in the present dataset. In contrast the HANSA Immobilia fund choose a different liquidation method without a 24 months closing period. Therefore, we exclude the HANSA Immobilia fund.

Table 2. Overview Summary Statistics

Variable	Mean	Std.Dev.	Min	Max	Obs
NAV SPREAD	0.314	0.130	0.001	0.600	517
Fund Specifics					
Leverage	0.299	0.120	0	0.690	496
Liquidity	0.159	0.105	0.005	0.625	505
Economic Growth Target Markets	0.002	0.006	-0.032	0.014	501
Tenancy	0.903	0.060	0.690	1	517
TER	0.009	0.002	0.006	0.013	511
Extraordinary Payouts	0.009	0.423	0	0.534	516
Institutional	0.103	0.099	0.001	0.368	520
Fund Size	2.217	1.890	.116	6.431	517
Perform	-0.051	0.074	-0.389	0.050	475
Industry-Wide					
Flows Asset Class	0.178	0.478	-4.359	1.693	520
Event Fund Liquidation	0.120	0.420	0	2	657
Event Fund Closure	0.231	1.136	0	9	657
Macroeconomic Uncertainty					
Policy Uncertainty Index Europe	170.625	44.784	91.379	304.603	657
VIX Europe	26.625	9.476	14.392	60.677	657

The table displays an Overview of the mean, standard deviation, minimum and maximum and the number of observations for all variables.

Table 3. Correlation Matrix: Funds-Specifics, Industry-Wide and Macroeconomic Uncertainty Variables

	NAV Spread	Leverage	Liquidity	Economic Growth	Tenancy	TER	Extra. payouts	Inst.	Fund Size	Perform	Flows Asset Class	Event Fund Liq.	Event Fund Closure	Policy Uncertainty	VIX Eur.
NAV Spread	1.00														
Leverage	0.00	1.00													
Liquidity	-0.20	-0.40	1.00												
Economic Growth	-0.42	0.08	0.02	1.00											
Tenancy	-0.25	0.25	0.04	0.14	1.00										
TER	0.23	0.21	-0.07	-0.04	0.21	1.00									
Extra. payouts	0.00	-0.19	0.20	0.00	-0.12	0.02	1.00								
Inst.	0.27	0.33	-0.25	-0.09	-0.08	0.33	-0.07	1.00							
Fund Size	-0.42	-0.13	0.14	0.10	0.07	-0.53	-0.08	-0.56	1.00						
Perform	-0.45	0.09	-0.04	0.03	0.44	-0.19	-0.09	-0.18	0.50	1.00					
Flows Asset Class	0.17	-0.08	0.04	-0.18	-0.04	0.08	0.03	-0.01	-0.06	-0.01	1.00				
Event Fund Liq.	0.53	-0.56	0.20	-0.34	-0.33	0.22	0.13	0.05	-0.15	-0.32	0.25	1.00			
Event Fund Closure	0.62	-0.48	0.18	-0.32	-0.32	0.19	0.11	0.09	-0.10	-0.34	0.18	0.92	1.00		
Policy Uncertainty	0.26	0.20	-0.04	-0.41	0.04	-0.03	-0.06	0.05	0.06	0.11	-0.03	-0.03	0.08	1.00	
VIX Eur.	-0.27	0.37	-0.09	0.01	0.19	-0.13	-0.08	-0.02	0.11	0.31	-0.26	-0.56	-0.53	0.50	1.00

Table 4. Results

	(I)	(II)	(III)	(IV)
VARIABLES	NAV SPREAD	NAV SPREAD	NAV SPREAD	NAV SPREAD
Fund Specifics				
Δ $Leverage_{i,t-1}$	0.290**	0.290**	0.290**	0.290**
	(0.105)	(0.105)	(0.105)	(0.105)
Δ $Liquidity_{i,t-1}$	-0.361***	-0.361***	-0.361***	-0.361***
	(0.0701)	(0.0701)	(0.0701)	(0.0701)
$Economic\ Growth\ Target\ Markets_{i,t-1}$	-4.179	-4.179	-4.179	-4.179
	(2.652)	(2.652)	(2.652)	(2.652)
Δ $Tenancy_{i,t-1}$	-0.192	-0.192	-0.192	-0.192
	(0.220)	(0.220)	(0.220)	(0.220)
Δ $TER_{i,t-1}$	-5.793	-5.793	-5.793	-5.793
	(6.958)	(6.958)	(6.958)	(6.958)
$Extraordinary\ Payouts_{i,t-1}$	-0.280**	-0.280**	-0.280**	-0.280**
	(0.0876)	(0.0876)	(0.0876)	(0.0876)
$Institutional_{i,t-1}$	-3.388*	-3.388*	-3.388*	-3.388*
	(1.671)	(1.671)	(1.671)	(1.671)
$Institutional\ sq_{i,t-1}$	6.815**	6.815**	6.815**	6.815**
	(2.490)	(2.490)	(2.490)	(2.490)
$Log\ Fund\ Size_{i,t-1}$	0.174***	0.174***	0.174***	0.174***
	(0.0431)	(0.0431)	(0.0431)	(0.0431)
Δ $Perform_{i,t-1}$	-0.0243	-0.0243	-0.0243	-0.0243
	(0.288)	(0.288)	(0.288)	(0.288)
Industry-Wide				
$Flows\ Asset\ Class_{i,t-1}$		-0.222***		-0.0182
		(0.0460)		(0.0282)
$Event\ Fund\ Liquidation_{i,t}$		0.167***		0.0445***
		(0.0189)		(0.0106)
$Event\ Fund\ Closure_{i,t}$		0.0645***		0.0306*
		(0.0165)		(0.0147)
Macroeconomic Uncertainty				
$Policy\ Uncertainty\ Index\ Europe_{i,t-1}$*			0.150***	0.140***
			(0.0169)	(0.0172)
$VIX\ Europe_{i,t-1}$*			-0.0923***	-0.123***
			(0.0183)	(0.0202)
Constant	-0.0251	0.0610	0.268**	0.268**
	(0.0949)	(0.105)	(0.108)	(0.116)
Observations	409	409	409	409
Number of funds	9	9	9	9

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
Table 4 displays the results of the panel model estimation with fixed effects and time dummies. Model (IV) exhibit the main results of the estimation including all significant variables. Model (I) - (III) displays the particular influence of fundamentals, industry-wide and macroeconomic uncertainty variables explaining the NAV Spread.
* Variables are standardized with zero mean and a standard deviation of one.

9. Appendix

Table 5. Results without time dummies

	(I)	(II)	(III)	(IV)
VARIABLES	NAV SPREAD	NAV SPREAD	NAV SPREAD	NAV SPREAD
Fund Specifics				
$\Delta\ Leverage_{i,t-1}$	0.208			0.252
	(0.169)			(0.225)
$\Delta\ Liquidity_{i,t-1}$	-0.446**			-0.435**
	(0.174)			(0.159)
$Economic\ Growth\ Target\ Markets_{i,t-1}$	-11.75***			-7.987***
	(2.246)			(2.010)
$\Delta\ Tenancy_{i,t-1}$	-0.512			-0.369
	(0.316)			(0.229)
$\Delta\ TER_{i,t-1}$	-2.462			3.966
	(11.16)			(13.82)
$Extraordinary\ Payouts_{i,t-1}$	-0.478**			-0.473**
	(0.170)			(0.168)
$Institutional_{i,t-1}$	1.938			1.005
	(1.345)			(1.494)
$Institutional\ sq_{i,t-1}$	-0.960			0.240
	(3.235)			(2.898)
$Log\ Fund\ Size_{i,t-1}$	-0.114*			-0.0781
	(0.0521)			(0.0444)
$\Delta\ Perform_{i,t-1}$	-0.982***			-0.749**
	(0.229)			(0.256)
Industry-Wide				
$Flows\ Asset\ Class_{i,t-1}$		0.0387*		0.0213
		(0.0170)		(0.0202)
$Event\ Fund\ Liquidation_{i,t}$		0.0227***		0.00646*
		(0.00593)		(0.00280)
$Event\ Fund\ Closure_{i,t}$		-0.00211		0.00268
		(0.00723)		(0.00669)
Macroeconomic Uncertainty				
$Policy\ Uncertainty\ Index\ Europe_{i,t-1}$*			0.0773***	0.0318***
			(0.00732)	(0.00822)
$VIX\ Europe_{i,t-1}$*			-0.0865***	-0.0434***
			(0.0107)	(0.00515)
Constant	0.242*	0.304***	0.282***	0.257*
	(0.117)	(0.00249)	(0.00247)	(0.127)
R-squared	0.379	0.037	0.431	0.434
Observations	409	409	409	409
Number of funds	9	9	9	9

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
The table displays the results of the panel model estimation without time dummies. Model (IV) exhibit the main results of the estimation including all significant variables. Model (I) - (III) displays the particular influence of fundamentals, industry-wide and macroeconomic uncertainty variables explaining the NAV Spread.
* Variables are standardized with zero mean and a standard deviation of one.

Regulatory Policy

Additionally, we consider the passed time to liquidate the entire real estate portfolio. Moreover, we use dummy variables to detect if the legal environment for distressed funds regarding the selling process affects the NAV Spread. The law regime in Germany authorises the fund‘s management to sell real estate assets in the first year of closing only deduction free. Afterwards the fund management can sell assets with a deduction of 10 % of the last appraisal value in the second year. Subsequently, a deduction of 20 % up to 30 % is authorised. After the determined liquidation date, the fund‘s management is assigned to a depository bank, which can sell the assets without any restrictions. Moreover, this event causes an extraordinary tax burden for all investors, since land transfer tax applies.

Table 6 shows the results of a further specification of the final model (IV). Model (V) includes the passed time until the liquidation date. The variable is calculated as the percentage of passed time from 0 % at the start of the liquidation process up to 100 % (Transfer of the fund management to a depository bank). The regression coefficient shows a significant negative sign. With a larger percentage of passed time, the NAV Spread diminishes considerable. This results surprises and is not in line with the theory. Closer to the liquidation process, investors face a tax burden and the fund‘s management is also exposed to larger selling pressure. The negative sign can be explained by the overall development of the NAV Spread. The Time to Liquidation variable increases constantly over time for each fund. The NAV Spread diminishes over time for all funds. Controlling for the passed time in the liquidation process lead to no reasonable results.

Moreover, model (VI) expand the final model by adding dummy variables for the respective regulatory policy. We use four different dummy variables to control for the legal environment of distressed open-ended real estate funds in Germany. All dummy variables are statistically not significant. Most likely funds sell their best assets deduction free at first. The fund‘s management needs time to sell the less profitable assets later with considerable sales deductions. In contrast, the fund‘s management could wait for a sellers market to sell their best and less profitable assets together. Hence, we do not know, when the particular funds sold their assets to the market. The legal environment seems to play no role in the course of the NAV Spread.

Table 6. Regulatory Policy

	(V)	(VI)
VARIABLES	NAV SPREAD	NAV SPREAD
Δ $Leverage_{i,t-1}$	0.204*	0.297**
	(0.102)	(0.105)
Δ $Liquidity_{i,t-1}$	-0.294***	-0.365***
	(0.0718)	(0.0677)
$Economic\ Growth\ Target\ Markets_{i,t-1}$	-4.614	-3.470
	(2.530)	(2.884)
Δ $Tenancy_{i,t-1}$	-0.115	-0.192
	(0.184)	(0.225)
Δ $TER_{i,t-1}$	-6.120	-5.410
	(7.478)	(6.965)
$Extraordinary\ Payouts_{i,t-1}$	-0.297**	-0.286***
	(0.0910)	(0.0831)
$Institutional_{i,t-1}$	-2.701	-3.387*
	(1.601)	(1.599)
$Institutional\ sq_{i,t-1}$	4.522*	7.164**
	(2.248)	(2.496)
$Log\ Fund\ Size_{i,t-1}$	0.0601	0.165***
	(0.0590)	(0.0379)
Δ $Perform_{i,t-1}$	-0.0647	-0.0654
	(0.278)	(0.271)
$Flows\ Asset\ Class_{i,t-1}$	0.0196	-0.0204
	(0.0129)	(0.0272)
$Event\ Fund\ Liquidation_{i,t}$	0.0690***	0.0441***
	(0.0103)	(0.0121)
$Event\ Fund\ Closure_{i,t}$	0.0285*	0.0289*
	(0.0133)	(0.0130)
$Policy\ Uncertainty\ Index\ Europe_{i,t-1}$	0.204***	0.131***
	(0.0354)	(0.0177)
$VIX\ Europe_{i,t-1}$	-0.180***	-0.118***
	(0.0272)	(0.0238)
Regulatory Policy		
Time To Liquidation	-0.651**	
	(0.267)	
10 % *Sale Decline*		0.0190
		(0.0217)
20 % *Sale Decline*		0.00533
		(0.0352)
$20-30$ % *Sale Decline*		0.0307
		(0.0397)
Depository Bank		0.0397
		(0.0505)
Constant	0.522**	0.258**
	(0.190)	(0.111)
R-squared	0.792	0.776

Robust standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1.
The table displays two extensions of the main regression model (IV). Model (V) consider the time constraint of the liquidation process. Model (VI) shows the influence of the German regulatory policy restricting the fund‘s management ability to sell assets.

Obsolescence – understanding the underlying processes

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Abstract

Obsolescence, defined as the process of declining performance of buildings, is a serious threat for the value, the usefulness and the life span of built properties. Thomsen and van der Flier (2011) developed a model in which obsolescence is categorised on the basis of two distinctions, i.e. between endogenous and exogenous cause-effect relationships and between physical and behavioural cause-effect relationships. In this way, the model presents a classification of underlying factors of obsolescence. However, these underlying factors, more specifically the underlying cause-effect relations, are still a black box. In this paper, the box is further disclosed by tracking back the underlying processes, resulting in a series of prototypes of detailed hypothetic cause-effect mechanisms. Applied to the adapted model, the results are initially tested on an iconic chocolate factory. Conclusions are drawn about the results and more generally about the usability and the further development of the model.

Keywords: life cycle analysis, obsolescence, conversion non-residential, feasibility.

1. Introduction

What is the potential lifespan of buildings, and how can the useful service life be extended?
Buildings do age. But unlike living creatures, the effects of the ageing of buildings can and must be counteracted by maintenance, improvement or adaption, on pain of obsolescence and decay. In particular obsolescence is a serious threat for built property and the physical, economic and societal investments incorporated in buildings. Insight in obsolescence is also important because of the on-going paradigm shift from new construction to maintenance and improvement of the existing housing stock. Depending on the researcher's discipline, the answer was sought in the physical condition of the building, the market value of the property, the behaviour of the proprietor, the prosperity of the neighbourhood, the quality of the environment etcetera; but despite some earlier attempts, a broad applicable integrated approach was not available. To close this gap, Thomsen and Van der Flier (2011) developed a holistic analytical model of obsolescence, meanwhile further developed and elaborated for residential buildings. In previous stages of the research we have reported about the further development of the model, the search for indicators and instruments to trace and measure different types of obsolescence and the testing of the model (Thomsen and Van der Flier, 2013; Nieboer et.al. 2014). The results showed that the model is useable and further development is feasible and promising, but a number of difficulties should be resolved, missing information gained and complexities tackled, all related to a better understanding of the core dynamics of obsolescence and the underlying cause-effect processes resulting in declining performance of buildings, the 'black box' of obsolescence (Thomsen et.al. 2015). This paper is dedicated to that task. The further development of the model as reported in this paper consisted of the elaboration of a series of hypothetic interrelated cause-effect mechanisms and prototypes. The paper describes the way this was done, the results and the adaption of the model, as well as a first application in a case study (Thomsen and Carels 2016).

1.1. Approach

To approach the black box and more specifically the underlying cause-effect relations, three directions are conceivable: an extended search for findings from sources in a wider domain, in particular similar

and/or related models concerning the process of declining performance and a laborious time and resources consuming search by means of systematic cause-effect analyses in a detailed series of case studies. In between these two it may also be worth to search for logic relations by hypothetic reasoning (Thomsen et.al. 2015).
The hypothetic prototypes described in this paper are mainly the result of the latter. For practical reasons the scope is narrowed to residential buildings.

1.2. Problem definition and research questions

The problem definition in this stage of the research was: What are, starting from the analytical model of Thomsen & Van der Flier, the determining cause-effect processes underlying obsolescence and decay of buildings, how are they interrelated, how do they work and what is their significance for the life cycle and life span expectancy?

This problem definition is divided in the following research questions that structure this paper:

1) What are the major cause-effect processes determining the life cycle and life span expectancy of buildings?
2) What is their character, how can they be determined, how are they interrelated and how do they work?
3) What can - by using a system of cause-effect prototypes - be learned from the life cycle and the process of obsolescence of the building and its functional and structural potencies and weakness in view of reuse?
4) What can be learned of the applicability of the prototypes?

These questions will be successively answered in the next sections. Question 1 will be answered in section 2, question 2 in section 3, question 3 in section 4, and question 4 in the concluding section 5.

2. Understanding obsolescence, the analytical model of Thomsen & Van der Flier

Buildings do age. But unlike living creatures, the effects of the ageing of buildings can and must be counteracted by maintenance, improvement or adaption, on pain of obsolescence and decay. In particular obsolescence is a serious threat for built property and the physical, economic and societal investments incorporated in buildings. Insight in obsolescence is also important because of the on-going paradigm shift from new construction to maintenance and improvement of the existing housing stock.
This section answers research question 1.

2.1. Obsolescence: definition and knowledge sources

Obsolescence can be defined in various ways: by causes, by effects or by elements (Markus et al., 1972; Nutt et al., 1976; Iselin and Lemer, 1993; Golton, 1997). In this paper obsolescence is broadly approached from both the technical and the behavioural domain. Following Miles et al. (2007) obsolescence is defined as the process of declining performance resulting in the end of what Awano (2006) calls the service life of buildings. Performance is defined as the extent to which buildings meet requirements, the formulation of which depending on the interests of the involved stakeholders. Despite the complex, multifactor and interrelated character of obsolescence, many studies only focus on one side of the phenomenon: on the technical, spatial or the economic side, or on the behaviour of the main actors, and the scope varies from single objects to stocks of different scale and tenure. There is only a small stream of studies that combine the various ways to look at the performance of buildings in a comprehensive approach. Examples are Prak and Priemus (1986) on the level of estates and Grigsby et al. (1987) on the level of neighbourhoods. More recently, Thomsen (2012) proposed a holistic approach inspired by the diagnosis-treatment model that is used in the field of pathology and elaborated for the building sector in the so-called building pathology (Harris, 2001; Watt, 2007).

2.2. The Thomsen & Van der Flier model

An earlier literature survey conducted by the authors (Thomsen & Van der Flier, 2011) showed the variety of science domains and viewpoints from which obsolescence of buildings can be approached: technical, including architecture, construction and planning; and behavioural, including economy, sociology and management. The literature survey concluded that obsolescence basically consists of interrelated cause-effect processes on two dimensions that emerged as most distinguishing:

(1) the character of the cause-effect relation: physical (related to the built artefact) or behavioural (related to the behaviour and actions of the main stakeholders, i.e. owners, residents and other users); and
(2) the origin of the cause-effect relation: endogenous (i.e. from the building itself), or exogenous (i.e. from the environment)[1].

Combined in a quadrant matrix the two dimensions result in a model with four types of obsolescence (see Figure 1):

(A) endogenous physical obsolescence: decline of the performance of the building by physical cause-effect processes within or directly related to the building itself, e.g. poor or substandard initial quality, physical decay, insufficient strength, leakage;
(B) exogenous physical obsolescence: decline of the performance of the building by physical cause-effect processes from outside the building, e.g. air pollution, acid rain, poor infrastructure, traffic noise and earthquakes;
(C) endogenous behavioural obsolescence: decline of the performance of the building by behavioural cause-effect processes within or directly related to the building itself, e.g. behaviour of the main stakeholders, (ab)use and (mis)management; and
(D) exogenous behavioural obsolescence: decline of the performance of the building by behavioural cause-effect processes from outside the building, e.g. poor liveability, declining market appreciation, adverse or failing government policies.

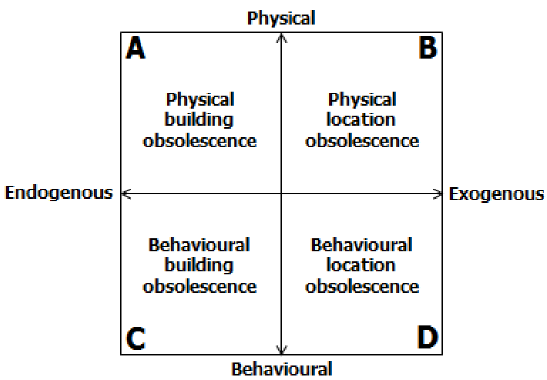

Figure 1. Analytical model Thomsen & Van der Flier (2011)

Combined the two distinctions result in a model with four quadrants that typify various ageing processes c.q. types of obsolescence (Figure 1). The quadrants are characterized by the underlying cause-effect mechanisms and not by their physical appearance. E.g. quadrant 'A' regards decline of performance of buildings by physical cause-effect processes within the building, e.g. poor or substandard initial quality resulting in defects. These mechanisms can be complex and also interrelated. Due to this, it is sometimes difficult to identify the type of obsolescence, for example in a

[1] This denotation of the terms endogenous and exogenous is different from the usage in economic models. The latter could possibly be used for the behavioural, but not for the physical dimension.

case where present decay is caused by a deliberate choice (a behavioural aspect) of substandard materials (a physical aspect) in the past. Nevertheless, it can be argued that complexity and interrelationship and related "wicked problem" difficulties as such are no valid reasons to refrain from a classification for analytic purposes.
The model was further developed as a broad tool to detect and analyse obsolescence. To identify and assess the impact of the various cause-effect processes, a range of existing instruments and approaches were inventoried (Figure 2).

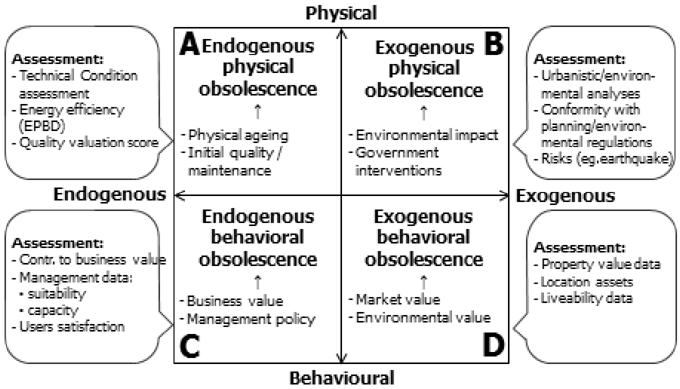

Figure 2. Extended Analytical model Thomsen et.al. (2015)

After a series of case studies, tests, analyses and discussions (Thomsen and Van der Flier, 2013; Nieboer et.al. 2014), the conclusion was that with the results so far, the development and testing phase were sufficiently successful to be continued with the next step, being the further development of the model as a diagnostic tool (Thomsen et.al. 2015). A first requirement for this step is that a number of difficulties should be resolved, missing information gained and complexities tackled, all related to a better understanding of the core dynamics of obsolescence and the underlying cause-effect processes resulting in declining performance of buildings, the 'black box' of obsolescence.

3. Better understanding obsolescence: towards a diagnostic tool.

Knowledge about causes and cause-effect processes may not be necessary for diagnoses, it is essential to understand how obsolescence works and will eventually be indispensable for a diagnostic tool for possible treatment and prevention.
This section answers research question 2.

3.1. Cause-effect processes types and mechanisms

The model is based on the hypothesis that the core dynamics of obsolescence consists of a series of complex interrelated recurrent cause-effect processes within and in between the four quadrants of the model, resulting in the eventual performance decline of buildings. Though these cause-effect chains are fundamental for all kind of ageing and decay processes, systematic interdisciplinary research has been very limited up to now, to as far as we know specialized fields as aircraft and automotive manufacture and maintenance, but not in the built environment. The advance of these cause-effect in that field is still a black box. For that reason, the research in this section carries necessarily a tentative and preliminary character.

Table 1. Cause-effect process types

type	Cause		effect	
A→A	A	physical defects; design errors; poor hydrothermal quality	A	consequential damage; condensation, rot; functional defects;
A→B			B	environmental damage; shadow, wind, reflections; environmental effects;
A→C			C	loss of demand, nuisance; discomfort, energy waste; owner/ user disinvestment;
A→D			D	liveability effects; insecurity; loss of demand; depreciation
B→A	B	environmental defects; planning errors; climate/ earthquake impact	A	physical damage; material damage; functional defects;
B→B			B	consequential damage; spatial obsolescence; environmantal insecurity;
B→C			C	nuisance; discomfort; owner/ user disinvestment;
B→D			D	liveability losses; insecurity; loss of demand, nuisance; depreciation;
C→A	C	loss of demand; discomfort; misuse, neglecting; disinvestment	A	maintenance backlogs consequential damage; loss of condition
C→B			B	maintenance backlogs environmental damage; environmental effects;
C→C			C	(increased) discomfort; misuse, neglecting; disinvestment
C→D			D	liveability losses; insecurity; loss of demand, depreciation;
D→A	D	liveability defects, insecurity loss of demand depreciation	A	maintenance backlogs consequential damage; loss of condition
D→B			B	maintenance backlogs environmental damage; environmental effects;
D→C			C	(increased) discomfort; misuse, neglection; disinvestment
D→D			D	(increased) liveability losses; insecurity; loss of demand, depreciation;

An obvious further step to understand and analyse these processes is to systematically identify all possible cause-effect relations within and in between the for quadrants of the model and examine the most plausible causes and effects. As a result, a series of 16 interrelated cause-effect process prototypes can be distinguished (the characters refer to the four quadrants of the model: A□A, A□B etc.). Combined with the three most relevant cause and effect examples per prototype as derived from

the above-mentioned literature survey and case studies results in 48 detailed cause-effect process types as shown in Table 1.
The table leads to the following observations:

- Considered are only hypothetic single sided cause-effect processes. In practice, they may often be more complicated and intertwined. In what way and to what extent these processes occur in practice has to be further investigated.
- Cause-effect processes are by nature highly dynamic, interrelated, intertwined, and interaction and intervention dependent. Their character and effect can only be determined by systematically repeated examination covering at least the most relevant life cycle phases.
- Though characteristically negative, cause-effect processes can also have positive effects, whether or not intended and/or arranged by targeted interventions as e.g. maintenance, reinvestments or management measures.
- Not by chance the impact of different causes on the same quadrant results in similar effects. And, as effects will at their turn act as causes, cause-effect processes will in practice appear as prolonged recurrent interrelated cause-effect chains.

4. Case study: The Ringers Chocolate Factory

The adapted model as described above has been tested in a few case studies, residential, non-residential and mixed use. The case study as described below is a large non-residential building, the Ringers chocolate factory in the Dutch town of Alkmaar.
This section answers question 3.

4.1. The Ringers factory, building history and significance

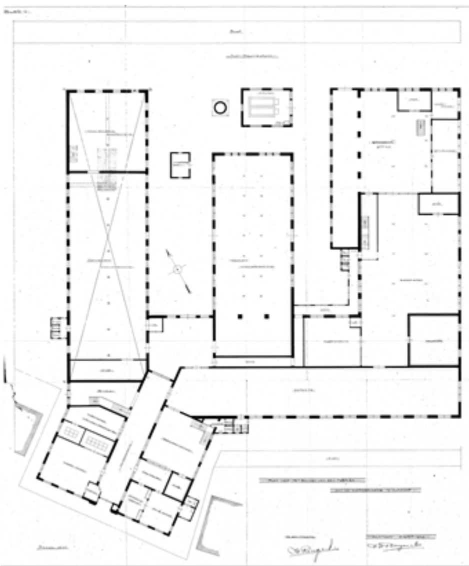

Figure 3. Masterplan 1920

Ringers was once a famous chocolate manufacturer. The Ringers factory building dates originally from the interbellum and was especially designed for the manufacture of chocolate. Situated opposite the historic city of Alkmaar as the first building on the north shore of the Noord Hollands canal and designed in a Frank Lloyd Wright inspired Amsterdam school of architecture style, it has been part of the mind-set of local peoples for ages. Following a masterplan, the building was steadily extended to its actual volume, being only half of the originally intended final state (Figure 1).

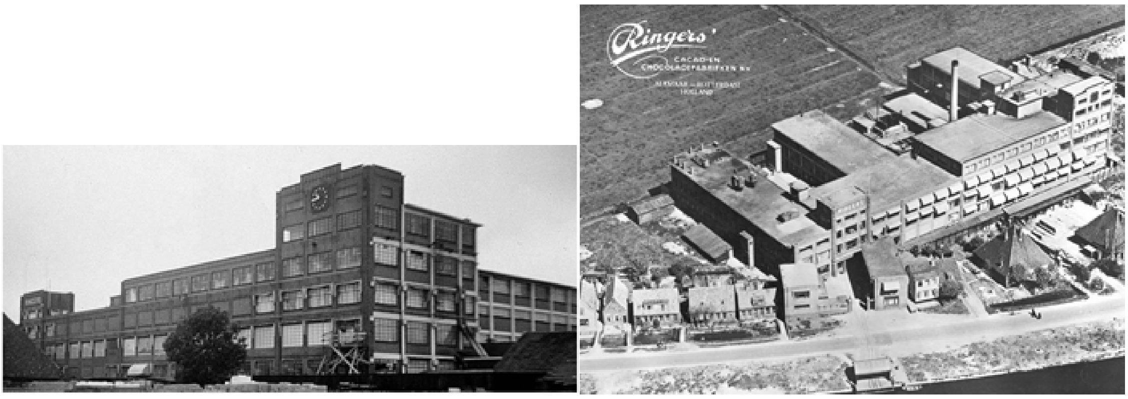

Figure 4. Façade 1937 and Aerial view 1940

Before the mirror symmetric east wing was realized, the factory closed and the building was sold to Klercq, a large home furniture company, whereupon the interior was converted into a furniture store, the courts were covered and converted into retail space and the monumental brick façade was covered with white synthetic cladding and the capital name on the façade was changed in Klercq as it is today (Figure 2). In everyday language though the name of the building remained Ringers.

Figure 5. Ringers as Klercq, 2007.

After the bankruptcy of Klercq in 2007, most floor space was vacant and at the end of the first decade of the 21st century most shops were closed and different plans were made for redevelopment with mixed functions (retail, education, offices, housing) but the new owner, the real estate developer MAB, part of the Rabobank, wanted demolition.

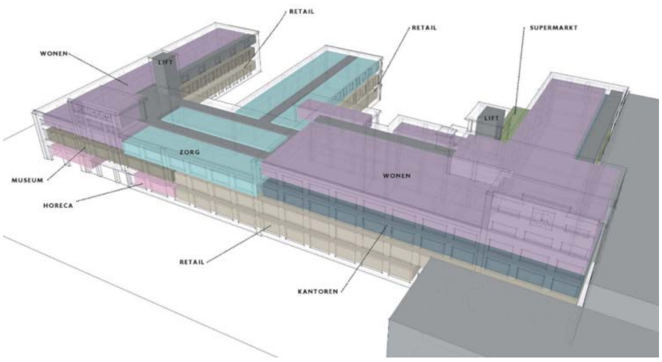

Figure 6. Reuse and transformation study (BOEI 2014)

After the local heritage association Alkmaar (HVA) started to mobilize public opinion to maintain and transform the Ringers building as important industrial heritage, and under pressure as a result of the real estate downturn following the subprime crisis, the property developer and the municipality slowly changed policy, giving way for redevelopment with conservation and reuse, for which BOEI - a ngo specialized in redevelopment of industrial heritage – made a feasibility study (Figure 3, BOEI 2014).

More recently Dobla Chocolate is willing to return a large part of Ringers to its original function (the past is the future!) and has succeeded in acquiring other participants for a balanced business case presented in July 2015. This new initiative and growing consensus about the importance of the building, is supported by the city council. Ringers was officially declared a monument on the 12th of April 2016.
Table 3 (Appendix) contains a concise overview of the different building stages, subdivided into proprietor/main function.

4.2. Relevant life cycle phases

Not all of the building phases as described in Table 3 are in the same way significant for the performance development of the Ringers building. Relevant are only development changes with a decisive effect on the life cycle. Overlooking the building history, the most decisive stages for the building's life span development were op to date (numbers refer to Railing 2012):
I. The main initial phase (1-10).
Resulting in the final E-shaped floorplan, this phase is determining for the initial building quality and performance capacity, specifically as a chocolate factory, but regarding building morphology, structure and spatial characteristics also for future change of use. The successive enlargements and additions did not change much of these characteristics. World war II and the preceding economic crisis had far-reaching effects, particularly on the economy, but the Ringers company stayed in business and effects on the Ringers building were hardly notable; during the war, there was even a substantial enlargement.
II. The heyday phase (11-18).
After the war the business revived rather soon and the increasing production was exported to 26 countries all over the world. Though the building was further extended and adapted a clear impact of this period on the life cycle is insignificant.
III. First decline (18-19).
(19-25). After the initial phases the company closure in 1973, followed by the acquisition by the Klercq furniture company and consecutive transformation as a home and furniture store was the first critical occurrence with decisive impact on the building, including - apart from adaptation of the interior- replacement and renewal of the main entrance.
IV. Extended use phase (19-26).
The transformation turn into success and resulted in several further alterations and additions, e.g. the complete cladding of the waterfront façade by rounded white synthetic sheets in 1982, intended to give the building a fresh contemporary facelift, addition of an external elevator and staircase, and adaptation of the N-facing courts and façades for i.a. consumer electronics retail.
V. Second decline (26-28).
The second critical and possibly fatal occurrence was the closure after bankruptcy of the Klercq company in 2008 leaving most of the floor space empty and making the future of the building part of the discussions about the revitalization of the ageing surrounding shopping area. The acquisition of the Ringers building by MAB to be removed and replaced by a new shopping mall would under unchanged circumstances have resulted in the end of the Ringers story. The worldwide economic crisis combined with the resistance of the local heritage association HVA and the retreating MAB made a game change and the demolition plans faded away.
VI. Redevelopment phase (28-34).
The participation of the redevelopment specialist BOEI made the municipality taking distance of their previous plans and convinced former opponents of the promising side of redevelopment of the building. A plan to establish a regional pop-music centre in Ringers was rejected though by the city council in favour for a new building. The entry of Dobla Chocolate Creations and its success in acquiring sufficient other participants for a balanced business case may open an unexpected second life for Ringers as chocolate factory.

4.3. Analysis

The analysis is based on the cause-effect process prototypes as described above and depicted in Table 1. Data for the indicators used are derived from the available sources and recent surveys by the author (2016). Where older qualitative data are absent they have been approximated by reasoned guesses. Applying the cause-effect types to the above described phases results in Table 2 (Appendix), showing the relative impact of identified cause-effect processes on the building performance over time. Due to the limited accuracy of the data, the scores are on a five-point scale, varying from very negative (--) to very positive (++).

4.4. Discussion

As Table 3 shows, the cause-effect prototypes enable an improved and objectified view on the determining mechanisms underlying the successive life cycle stages of the building. The answers on research question 2) what can be learned from the life cycle and the process of obsolescence of the building and its functional and structural potencies and weakness in view of reuse, are as follows.
The case clearly shows the interrelated multifaceted character of obsolescence. The determining cause-effect processes underlying the performance development of the building are found in all quadrants A, B, C and D. Noticeable are the relative positive impacts in the A- and also in the B- and D-quadrant, illustrating the strong influence of the initial building- and location quality. Against this stands the determinative impact of the decision making of the proprietor answering market and business circumstances. As is once again the fact, obsolescence is hardly a matter of physical decay but mainly the result of behaviour, either by the proprietor and/or due to property market dynamics; in the case of Ringers being the merger and resulting closure by the Ringers management and the bankruptcy of the Klercq management, but also the role of MAB and recently Dobla. The last phases show also the vulnerability of the building as an unprotected industrial heritage and the strong dependency on the municipal policy agenda, that varied from the market directed laissez-faire to finally the assignment of a heritage protected municipal monument. In the end the strong architectural, structural and multifunctional qualities of the building turn out to be still its basic strengths, giving solid opportunities for reuse.

5. Conclusions

Based on the answers to the research questions as concluded in the previous sections, the conclusions are as follows:
1) What is the architectural and structural building history and the resulting determining characteristics of the building?
The building history reveals the development of the Ringers building as a unique and consistent architectural piece of art, resulting from a unique family cooperation, with a strong basic quality that served and survived different functions and proprietors and has become part of the collective consciousness of the civil society in Alkmaar.
2) What can be learned from the life cycle and the process of obsolescence of the building and its functional and structural potencies and weakness in view of reuse?
Looking at the different phases of the building’s history, the life cycle analysis clearly shows the interrelated multidimensional character of the performance development, it’s strengths - being the initial building and location quality - and it’s vulnerabilities - being the dependence on proprietors, market developments and governmental and municipal policies and, in particular, the vulnerability of unprotected (industrial) heritage. As a consequence, solutions should in the same way be multidimensional, directed to as well the building as the behaviour of the key-actors.
3) What can be learned of the applicability of the cause-effect prototypes?

The application in this case enables an improved and objectified view on the determining mechanisms underlying the successive life cycle stages of the building. Transparency and rational reasoning and control of the decision making are the requirements necessary to prevent mistakes and to anticipate possible risks, for which purpose the analytical model is shown to be a valuable tool. The model itself does not directly point out the most appropriate approach for reuse, but enables a better analysis of the strengths, weaknesses, opportunities and threats on an ex-post basis and provides valuable input for ex-ante analyses.
Though the application in this case study is sufficiently promising, a broad series of applications in a wide range of building types, in particular in the residential stock, will be necessary to further develop, test and improve the model and the cause-effect prototypes. Thus: to be continued.

Acknowledgements

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Table 2. Impact analysis

Life cycle phase														
Phase	Stage		Type	Description	Impact	Type	Description	Impact	Type	Description	Impact	Type	Description	Impact
I.	1-10	Initial phase	AA	New, well built and maintained construction. Good energy efficiency (to that time standard) with partly double glazed windows. Fine architecture. Well dimensioned multi-purpose spatial structure.	++	BB	Open industrial area with accordingly infrastructure: road, waterway, nearby rail and station. Full conformity with (that time) regulations. Absence of environmental threats or conflicting neighbour interests.	++	CC	(No data). Well suited as purpose specific designed.	++	DD	Attractive valuable property; accommodate various functions. Well situated: waterfront, direct road and waterway connection, nearby rail, station and city centre. Ample extension space	++
			BA	-	o	AB	-	o	AC	Positive working environment	+	AD	Attractiveness	+
			CA	Positive	+	CB	Positive	+	BC	Positive working environment	+	BD	Attractiveness	+
			DA	Positive	+	DB	Positive	+	DC	Positive working environment	+	CD	Attractiveness	+
II.	11-18	Heyday phase	AA	As above. Well maintained.	+	BB	As above. Development mixed industrial and commercial area.	+	CC	As above. Former workers still testify love.	+	DD	As above.	+
			BA	-	o	AB	-	o	AC	As above	+	AD	As above	+
			CA	As above	+	CB	As above	+	BC	As above	+	BD	As above	+
			DA	As above	+	DB	As above	+	DC	As above	+	CD	As above	+
III.	18-19	First decline	AA	As above; emphasis on adaptability spatial structure. Energy efficiency stays behind.	+	BB	As above. Further development of adjacent shopping area.	++	CC	Closure due to negative profitability.	--	DD	Acquisition indicates acceptable market value.	+
			BA	-	o	AB	-	o	AC	-	o	AD	Attractiveness	+
			CA	Stop on investments	-	CB	Impact closure, no noted effect	o	BC	-	o	BD	-	o
			DA	As above	+	DB	As above	+	DC	Positive incentive	+	CD	Impact closure, no noted effect	o
IV.	19-26	Extended use phase	AA	Still as above, but alterations of lower quality, partly harming architecture (cladding façade); insufficient energy efficiency.	-	BB	Development of Overstad with changed urban plan: shopping centre, leisure, housing.	+	CC	Acquisition and investments indicate cost effective operation.	+	DD	As above.	+
			BA	-	o	AB	-	o	AC	-	o	AD	Impact cladding, no noted effect	o
			CA	Low maintenance investment	-	CB	-	o	BC	-	o	BD	-	o
			DA	-	o	DB	-	o	DC	No data		CD	-	o
V.	27-32	Second decline	AA	Increasing maintenance backlogs but still valuable architecture and solid structural condition	-/o	BB	Redevelopment of Overstad; changed urban plan enables demolition.	-	CC	Closure due to bankruptcy, followed by closures due to negative profitability	--	DD	Economic recession, bankruptcy of owner. Acquisition for removal likely negative for value.	-
			BA	-	o	AB	-	o	AC	-	o	AD	Impact maintenance backlog	-
			CA	No maintenance investment	--	CB	Impact vacancy, no noted effect	o	BC	-	o	BD	-	o
			DA	Some vandalism	-	DB	-	o	DC	Positive incentive, no effect	o	CD	Demolition plan of new owner	-
VI.	33-34	Redevelopment	AA	Consequential damages but still valuable architecture and solid structural condition	-/o	BB	Upgraded urban plan; formal monument status → heritage protection	++	CC	Policy change developer, willing to sell	+	DD	Ongoing negotiations/ retreat MAB/heritage protection → unknown effect on market value.	o/-
			BA	-	o	AB	Reconsideration urban planning	+	AC	Maintenance backlog	-	AD	Impact maintenance backlog vs. good reuse opportunities	o/+
			CA	No maintenance investment	--	CB	Impact vacancy, no noted effect	o	BC	-	o	BD	Positive value outlook	+
			DA	-	o	DB	Reinvestment opportunities	+	DC	Lower market value = chance	+	CD	Coalition for redevelopment	++

Table 3. Building history, stages and phases

Phase	Stage *)	Year	Owner	Main function	Intervention Physical	Process	Description
I.	0	1920	Ringers			X	Decision to return main production from Rotterdam to Alkmaar
	0	1920-21		Chocolate factory	X		Initial design and realisation NW-wing (3 floor)
	1	1922			X		Addition N-wing (3 floor)
	2	1925			X		Temporary connection shed
	3	1926			X		Addition main building SW-part (3/4 floor), addition gatehouse, boiler house
	4	1927			X		Addition NE-wing (1 floor)
	5	1928			X		Addition liquor distillery (1 floor) between stage 1 and 4
	6	1929			X		Addition boiler house
	7	1930			X		Roofing and extension canal quay
	8	1932			X		Build up gatehouse (2nd floor)
	9	1937			X		Final extension main building SE-part (4/5 floor)
		1940-45				X	WW-II; Rotterdam factory destroyed by German bombing
	10	1940			X		Build up NE-wing (stage 4, 4 floor), shedroof on interspace stage 1-4
II.		1945-65				X	Increasing production, export to 26 countries
	11	1948			X		Extension gatehouse with bath- and dressing room
	12	1949			X		Addition paper storage SE-corner
	13	1950			X		Addition shedroof and elevator interspace stage 0-1; renewal canal quay
	14	1951			X		Extension main building between stage 1-5 (4 floor)
	15	1956			X		Extension NW-part NW-wing (shedroof, 1 floor)
	16	1957			X		Extension warehouse, gate fire brigade
		1960			X		Free standing single floor building for car maintenance N of E- court
	17	1961			X		Extension N-wing (2 floor)
	18	1963			X		Minor additions: fire brigade facility, transformer room
		1964			X		Larger building for technical services NW-side.
		1965			X		Temporary lodge, NW-side; last Ringers construction.
III.		1969				X	Grave competition by cheap mass supply; merger with Cavenham Foods Ltd
		1970				X	Take-over by competitor Royal Droste
		1973				X	Closure, acquisition by Klercq home and furniture store
IV.	19	1974	Klercq	Furniture store	X		Conversion to furniture store, removal gatehouse etc, upgrade main entrance
	20	1982			X		White synthetic cladding on main S-façade
	21	1983			X		Addition of exterior elevator and staircase on main façade
	22	1987		+Store	X	X	Redesign with new roofing vault on NE-court for new retailer
	23	1988			X		White synthetic cladding on NW-façade
		1988		+Electronics store	X	X	Conversion NW-court and new entrance for electronics retail store De Block
	24	1993		+Bicycle store	X	X	Addition of shopping and repair space for bicycle store on NW corner.
		1993			X		Extension E-side main building for storage
	25	1996			X		Build up main building (stage 3) with 5th floor
	26	1997				X	Realisation adjoining shopping centre Noorder Arcade and Ringers bridge.
V.	27	2008				X	Closure after bankruptcy Klercq; acquisition by MAB property development
	28	2008	MAB	Redevelopment	X	X	Most floorspace vacant, increasing maintenance backlogs
	29	2011			X	X	HVA (Heritage Society Alkmaar) starts campaign for preservation
	30	2011				X	Municipality publishes urban plan Overstad enabling new development
		2011				X	MAB presents design replacing shopping mall with Ringers lookalike façade
	31	2012				X	Municipal initiative for expert team MAB-HVA; MAB to consider reuse
		2012				X	HVA submits request for formal heritage protection of Ringers
	32	2013				X	Bankruptcy De Block consumer electronics; almost complete vacancy.
VI.	33	2013	MAB/			X	MAB to terminate activities; BOEI (redeveloper industrial heritage) enters.
		2013	(BOEI)			X	Regional pop-music centre in Ringers? City council votes for new building.
		2013				X	Dobla Chocolate manufacturer wants to step in, looking for other investors
	34	2014				X	Refurbishment adjacent Noorder Arcade shopping centre after vacancies.
		2015				X	Continuing uncertainty and increasing maintenance backlogs

*) Source stages 0-25: Ralling (2012)

Residential Real Estate, Risk, Return and Home Characteristics: Evidence from Sydney 2002-14

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Abstract: While residential real estate is a key component of household wealth little is known about the investment characteristics of different types of properties. This paper outlines and applies a methodology for examining the variation in risk and return of individual homes. We use large data sets of home prices and rents for Sydney, Australia, from 2002-14, to estimate flexible spline hedonic models which incorporate spatial and characteristics smoothing. Using these models we construct unique home price and rental estimates for a large sample of properties for each time period. These imputations are used to examine the dynamics of risk and return for residential real estate by estimating a market model on total returns. We find that both the returns and their volatility are tied to certain home characteristics such as the region of the residence and whether the property is a house or apartment. Perhaps most surprisingly we find that there was a negative correlation between risk and return in the Sydney housing market over the period examined.

Keywords: house prices, residential real estate, hedonic regression, market model, smoothing spline.

JEL Classification Codes: C23, C43, G12, R30

*Please note, as this draft is preliminary, please do not quote from it or distribute it without the permission of the authors. We would like to thank Australian Property Monitors (APM) for providing the data used in this study.

1 Introduction

Globally residential real estate is a key store of wealth for households and investors. In the US for example, the Federal Reserve's Flow of Funds statistics estimate that households' holding of residential real estate is around $22 billion (Federal Reserve Board, 2015, Table B.101 Balance Sheet of Households and Nonprofit Organizations, p. 134). This is the largest asset class held by households by a significant margin. Work by Case and Shiller (1989, 1990), amongst others, has increasingly made available information on the returns to housing over extended periods of time. Integral here was the development of the S&P Case-Shiller House Price Index (Standard & Poor's, 2015) constructed for the US and certain metropolitan areas. Similar indexes have appeared in other countries. This has made information on historical housing price trends more readily available. This in turn has meant we can better understand the role of real estate in the household's investment portfolio and how it performs relative to other asset classes over the cycle (see for example, Flavin and Yamashita, 2002; Gelain and Lansing, 2014).

However, unlike other assets, such as stocks or bonds—where it is relatively easy to own a well diversified portfolio of such assets—it is usually the case that the vast majority of households own a single home. Moreover, each home is unique in its mix of locational and structural characteristics. This begs the question; what are the risk and return profiles of the various individual home-types that are actually owned by households? Just as certain stocks are likely to perform differently over time—perhaps as a result of their industry of operation, geographic footprint, the company's size and so forth—so potentially are different types of housing. In fact there is strong evidence for significant heterogeneity in price trends across homes. Case and Shiller (1989) found a weak correlation between the price movements of individual homes and those at the city-level. This implies that there are significant price dynamics which are occurring at a disaggregated level. Others have found significant levels of heterogeneity in housing dynamics. Bourassa, Hoesli and Peng (2003) found strong evidence of geographic housing submarkets within a city. McMillen (2003)—who estimated house price indexes at the census tract level for Chicago—found large differences in appreciation rates across the city. Melser and Lee (2014) looked at various market segments, not only those defined by geography, and also found evidence of distinct home price trends.

Disaggregated house price trends appear to be important. Yet they have not been the subject of rigorous analysis as to how they vary systematically as a function of housing characteristics. Do houses have higher returns than apartments and are they more volatile, how important is the regional component in risk and return and what is the impact of other characteristics—such as price level, momentum and dwelling size—in driving risk and returns? Such questions are obviously integral to homeowners but are also important for the banking industry. The credit risk of a mortgage will depend, along with other factors, on the dynamics of rental yields and particularly home prices. If these differ by property type then this implies that loans should be structured differently for different types of homes.

This paper outlines a methodology for examining the dynamics of the returns to housing at a disaggregated level and applies this approach to data for Sydney—Australia's largest city—from 2002-14. We make use of a large database of housing transactions prices and characteristics, from 2000-14, as well as a database of home rents starting in 2002. The data sets are comprehensive. The rental database includes 1,111,158 observations on 439,288 unique properties while the housing transaction data includes 528,518 observations on 418,611 unique properties over the respective periods. In order to analyse the drivers of individual home price movements we must first know what those movements are. This is a perennial problem with housing as each home is unique and they transact infrequently. Hence observed data will be insufficient. We show how the requisite indexes of residential real estate prices can be constructed for each house in our sales database, using transactions prices, characteristics data and flexible smoothing spline hedonic regression methods. These models are then used to impute individual home price indexes for a sample of 100,000 homes. We construct the total return for a given home—capital gain plus rental yield—and use this data to estimate a market model in order to understand the dynamics of risk and return over time.

The market model is a particularly useful device in this context—and a long-standing approach related to the Capital Asset Pricing Model (CAPM). It is used to examine an asset's risk and return (Markowitz, 1959; Sharpe, 1963; Fabozzi and Francis, 1978). Specifically, the market model provides a decomposition of the returns to individual homes into components due to; excess returns, the volatility of returns relative to similar assets, and an idiosyncratic component. Let y_{it} be the total return on house $i = 1, 2, \ldots, I$ between periods t and $t-1$. This is made up of a capital gain, $\ln(p_{it}/p_{it-1})$, and a rental yield, r_{it}/p_{it-1}. Denote y_{Mt} as the average market return across all property types in period t, then the market model is of the form,

$$y_{it} = \alpha_i + \beta_i y_{Mt} + e_{it}, \qquad i = 1, 2, ..., I,\ t = 1, 2, ..., T \tag{1}$$

The coefficient β_i reflects how the return on an individual asset matches the market return. A number greater (less) than one indicates that return is more (less) volatile than the market. The parameter α_i captures any systematic differences between the market return and the individual asset's return. These two parameters provide a succinct summary of the investment characteristics of each particular asset, identifying those assets which are higher and lower risk and which yield higher and lower returns. Understanding whether the α and β are systematically different across property types is likely to be highly relevant to many homeowners who can then choose homes which best suit their financial needs.

In the next section we discuss the data that is available to us for the empirical identification of disaggregated housing return dynamics. Integral to our ability to estimate the market model for housing is the existence of a price and rent series for each dwelling. Section 3 develops a flexible hedonic smoothing spline model which gives us the ability to impute prices and rents for homes in our sample. Section 4 implements the market model. We find that both the returns to certain property types and their volatility are closely related to the nature of the dwelling. In particular houses, as opposed to apartments, are associated with lower returns and greater volatility in these returns. Larger homes—those with more bedrooms—tend to have slightly higher returns and be somewhat less volatile. But more expensive homes have had lower returns and higher variability in these returns. Interestingly, there appears to be mean reversion in returns as homes with higher returns a year earlier tend to have lower returns in the future. Also, one of the key drivers of the dispersion in returns, and their volatility, is the region of the home. Perhaps most surprisingly, and in contrast with our of expectations, we find that overall there is *negative* correlation between the risk and return across homes. In an efficient market a positive relationship would be expected. Our results imply that there may be some exploitable opportunities across homes where owners could lower their risk and at the same time increase their returns. Section 5 concludes.

2 The Sydney Housing Data

The approach outlined in this article is applied to large datasets for Sydney, Australia. Sydney is the country's largest city with a population of more than 4.5 million. Our first dataset is for housing transaction prices and includes 528,518 observations on 418,611 unique homes from first quarter of 2000 to the final quarter of 2014. In addition we have 1,111,158 observations on asking rents in Sydney for 439,288 different properties from 2002 to the end of 2014. The rental data is from a major Australian listing website. While they are not necessarily the actual rent paid they are likely to closely approximate it given that there is limited negotiation over rents in Australia. Mostly the rent asked at the time of advertising is the rent received when the property is let.

Our data comes from a private provider of housing transaction data, Australian Property Monitors (APM).[1] They source a large amount of the data from the state Valuer General, a government agency which records property transactions. However, they supplement this information with extensive searches through real estate advertising websites and newspapers for property characteristics. The characteristics data we have available to us to estimate the hedonic equation for both selling prices and rents includes; number of bedrooms, number

[1]We thank APM and in particular Yvonne Chan and Odi Reuveni for assisting with access to the data.

of bathrooms, dwelling structure—whether the property is an apartment or a house—land area for houses (apartments do not involve the individual ownership of land by definition) and the latitude and longitude of the home.[2] Together these characteristics provide a solid basis upon which to model dwelling prices and rents.

We also have information on the length of time most of the properties were on the market—that is the time between when they were initially advertised and eventually sold. This data was used to produce a model and imputation for the illiquidity of a house. This will be used later as an explanator of housing risk and return.

The data we use in our estimation and imputation was drawn from a larger data set which was filtered somewhat to ensure that unusual transactions, or transactions with incomplete information, were not included. Any homes selling for more than \$5 million or less than \$50,000 were removed. As were properties that rented for less than \$100 or more than \$2,000 per week. We also dropped any dwellings with more than 7 bedrooms or more bathrooms than bedrooms. Given the hedonic approach taken to the estimation of house prices and rents we also removed any properties for where any of the characteristics listed above were missing. This limited the set of usable observations, particularly early in the sample when the availability of characteristics information was more limited. However, the sample of home sales, and particularly rents, is significant and encompasses a large number of observations across the regions of Sydney and a wide range of property types.

⟨⟨ *Insert Table 1 and Figure 1 here* ⟩⟩

Table 1 presents some summary statistics for the sample by structure-type, year and some key regions for both selling prices and rents. The regions listed are statistical subdivisions from the Australian Bureau of Statistics (see for example, ABS, 2006) and represent meaningful sub-city regions—similar segmentations are used on real estate listing websites for example. The location of these regions can be seen in Figure 1. The Inner Sydney region includes the CBD area and surrounds while regions such as Central Northern Sydney, Blacktown, Fairfield-Liverpool and St George-Sutherland represent outlying areas.

Both the sale price and rent datasets are large and reflect significant variation across time and regions. This makes them useful for estimating price and rental trends. However, there are some clear differences in the composition of the data sets which influences the way we proceed. For the home sales data, 331,668 (62.75%) of the observations are for houses while apartments make up the remaining 37.25% with 196,850 observations. This is significantly different from rental data set which has 60.85% apartments. The two data sets also differ along other dimensions. The rental data has a much higher proportion of

[2] Note here that our definition of a house is somewhat broader than a single family freestanding dwelling. We also include; terrace or row houses, villas, duplexes, semis or townhouses. These property are in most cases more similar to freestanding dwelling than an apartment hence we include them together.

observations in the central areas of Sydney, particularly Inner Sydney and Lower Northern Sydney. These compositional differences primarily reflect differences between the rental and owner-occupied stock of houses. Rental units tend to be smaller and more centrally located compared with owner occupied units.

Our objective in this paper is to understand the return dynamics for the stock of housing. Hence, in order to best represent the stock of homes in Sydney we focus on those dwellings in the sales data set. It is more likely that the sold homes represent an unbiased sample of the housing stock than do those homes which are rented. Hence, in the hedonic estimation which follows we use the rental data to estimate the rental hedonic function but only impute rents for a sample of properties observed in the sales data set. We first turn to the hedonic estimation.

3 Hedonic Estimation of Disaggregated House Price and Rent Trends

There are two key difficulties in constructing real estate sale price and rent indexes. The first is the underlying heterogeneity of residential real estate; no two homes are quite the same. The second is that homes sell only infrequently. This makes the construction of constant quality price indexes very difficult. To overcome this problem, and derive indexes for specific properties, we use hedonic regression methods. This relates the price and rent of homes to their characteristics and to time. This function can then be used to impute values for homes which did not transact in a given period.

However, a key issue with using hedonic methods in this context is that most standard hedonic techniques are not flexible enough to estimate unique prices, and hence price trends, for individual homes. In many hedonic studies strong assumptions are made regarding the pricing function and how it evolves over time and across space and dwelling characteristics. Consider the following general additive hedonic function for home prices,

$$\ln p_{it} = \tau_{i[r]t} + \sum_{c=1}^{C} f(z_{i[r]tc}) + \epsilon_{it}, \qquad t = 1, 2, ..., T,\ i = 1, 2, ..., I \tag{2}$$

Here there are $c = 1, 2, \ldots, C$ characteristics which take on the value $z_{i[r]tc}$ in time t for property i lying in geographic region r. Consider the function which mediates the impact of the characteristic on price. Most standard hedonic models pre-suppose rather simple relations. The time-dummy method (see for example; de Haan and Diewert, 2013) supposes that $\tau_{i[r]t} = \tau_t$ and $f(z_{i[r]tc}) = \delta_c z_{i[r]tc}$. That is, the impact of the characteristics is fixed across time and across homes and any difference in price is reflected in a time-varying intercept. More flexible hedonic methods have been used which allow for temporal flexibility in the quality characteristics, $f(z_{i[r]tc}) = \delta_{ct} z_{i[r]tc}$ or variability across discrete regions where they can be identified, e.g. $f(z_{i[r]tc}) = \delta_{crt} z_{i[r]tc}$ and $\tau_{i[r]t} = \tau_{rt}$ (for a fuller discussion see Hill and Melser, 2008). For our purposes, it is vital that the hedonic function accurately represents any differences in prices trends in individual homes. This requires a hedonic function which is flexible both in terms of the temporal dimension but also in the way that location and dwelling characteristics relate to price.

3.1 Smoothing Spline Hedonic Models

Our approach is to estimate a generalized additive model (GAM) with smoothing spline effects for each of the variables in terms of how they change over time. This builds on earlier work, such as Bao and Wan (2004), and reflects growing interest in the hedonic housing literature on the use of spline methods (see for example, Hill and Scholz, 2014). Each of the variables—land area, bedrooms, bathrooms and each of the dwelling types (apartment or house)—are included using a multi-dimensional smoother interacted with time and latitude and longitude. For bedrooms, for example, we denote the effect as, $s_1(bedrooms, t, lat., long.)$. What this means is that the effect of the number of bedrooms on price can be non-linear and, furthermore, can evolve both over time and across space (latitude and longitude). For the structure variables we include a separate spline for each but estimate a common smoothing parameter and denote this $s_3([apartment][house], t, lat., long.)$. The effect of location on price is modelled by a trivariate spline between latitude, longitude and time.

Smoothing spline models require estimates of the smoothing parameters—that is, the relative weight given to the smooth evolution of the parameters compared with the fit of the data. In our application the smoothing parameters are endogenously selected in conjunction with the data using the Generalized Cross Validation (GCV) approach.[3] The model is shown below,

$$\begin{aligned} \ln p_{it} = s_1(bedrooms, t, lat., long.) + s_2(bathrooms, t, lat., long.) \\ + s_3([apartment][house], t, lat., long.) + s_4(land\ area, t, lat., long.) \\ + s_5(t, lat., long.) + \epsilon_{it}, \quad t = 1, 2, ..., T,\ i = 1, 2, ..., I \end{aligned} \tag{3}$$

The smoothing spline price and rent models fit the data very well when compared with standard hedonic methods and other potential smoothing spline models. With regard to the latter point; we explored whether the spatial spline interactions with bedrooms, bathrooms, dwelling type and land area were required—that is we removed latitude and longitude from $s_1(.) - -s_4(.)$. This gives what we call the Time Smooth model, as opposed to the model

[3] The GAM smoothing spline estimation is implemented using the approach of Wood (2004, 2011) reflected in the `mgcv` package in R.

in (3) which is both temporally and spatially smooth. The results are more supportive of the full smoothing model. This model has a statistically significantly higher R^2 and a lower AIC for both prices and rents as shown in Table 2.

⟨⟨ *Insert Table 2 here* ⟩⟩

We also fit several different more standard hedonic formulations and compared the in-sample model fit. The results are shown in Table 2. The time-dummy method—in equation (2) $f(z_{itc}) = \delta_c z_{itc} \; \forall c = 1, 2, \ldots, C$—has an R^2 of 0.6789 compared with 0.8060 for our preferred Time-Spatial Smooth spline model for prices and 0.6641 compared with 0.7758 for rents. There are comparable differences in RMSE and MAE. The time-region dummy model, where the intercept in (2) changes every time period in each of the eleven regions listed in Table 1, has a marginally higher R^2 of 0.6820 for prices and 0.6671 for rents. We consider three further models; the time flexible model—which allows shadow prices to vary across time as well as including time-region dummy variables—the region flexible model—which allows parameters to change across regions—and finally the time-region flexible model which estimates separate parameters for each time and region. The R^2 for each of these models respectively is well below that for our preferred spline model for both prices and rents. This gives us some confidence that the more sophisticated Time-Spatial Smooth spline model is providing the best possible imputations of temporal price and rent trends for a diverse range of homes.

3.2 Hedonic Imputation Results

We used the estimated Time-Spatial Smooth spline hedonic model to impute sales and rental prices. This was done for a random sample of 100,000 properties drawn from the homes that are observed to sell over our sample. The complexity of the models and size of the data meant that it was infeasible to impute prices for all 418,611 unique properties which were observed to sell. Our sample of 100,000 is significant however. Prices were imputed from 2000Q1, rents from 2002Q1, up until 2014Q4.

We construct aggregate city-wide indexes by taking the mean of imputed log price and rent changes each period. We also construct total returns—the sum of the quarterly price gain and the rental yield. This gives us the y_{Mt} which is required in the market model (1). Note that unlike shares or bonds there are running costs (e.g. maintenance and repairs, insurance and taxes) associated with home ownership. Harding, Rosenthal and Sirmans (2007) estimate these at around 2.5% per annum. However, we do not have information on this in our data and we do not try to include them here. This means our estimates of total returns are likely to be somewhat overstated. But it is unlikely to significantly distort the relativities of total returns as the running costs for different homes are likely to be quite similar.

The quarterly log price and rent changes, and the total returns each quarter, are shown in Figure 2 and also in index form. We explored various methods of averaging these values across homes—such as the median or the trimmed mean—but it made very little difference to the resulting numbers.

⟨⟨ *Insert Figure 2 here* ⟩⟩

It can be seen that over the period, from 2000Q1 to 2014Q4, Sydney exhibited some significant house price dynamics. There was a boom in prices in the early 2000s followed by a modest decline from 2004 through to 2007. There was a small rise in prices in late 2007 and then a dip as a result of uncertainty around the global financial crisis (GFC) in 2008. Australia fared quite well during the GFC and house prices jumped as this became apparent. Prices were relatively stable from 2010 but rose strongly starting in 2012.[4] The cycles in housing prices are echoed in rents though they grow at a much steadier rate than do prices. Overall, rents and housing prices increased by broadly similar amounts from 2002Q1 to 2014Q4—prices rose by 89.87% while rents increased 78.40%. But this masked significant deviations at different points as a result of the more haphazard growth in prices. The index of total returns rose by 223.28% over the period or an impressive 9.45% per year.

Now turning to the disaggregated price trends. The estimated spline model provides unique imputations for price and rent trends, and hence total returns, for each of the 100,000 sampled homes. These imputations do vary, often quite significantly, based on the characteristics of the home. We can illustrate the diversity of price trends across property types by considering the cross-sectional distribution of price changes at different points in time. Figure 3 plots histograms of price change for two quarters; 2008Q3 and 2010Q3. It can be seen that there is significant dispersion in the imputations and moreover the distribution of price and rental changes, as well as total returns, shifts over time.

⟨⟨ *Insert Figures 3 here* ⟩⟩

We can also consider the diversity of price trends by looking at average price changes, rental yields and returns for specific types of dwellings. Figure 4 plots changes for four regions for houses with 3 bedrooms, 2 bathrooms and land area between $400m^2$ and $1000m^2$. It can be seen that while the overall dynamics are quite similar there are some quite large differences in certain quarters and overall. For example, price growth lagged in St George-Sutherland, rental growth was strong in Canterbury-Bankstown and average returns were highest in the Eastern Suburbs and St George-Sutherland.[5]

[4]Note, our index of Sydney prices is consistent with other publicly available indexes of the city's real estate prices. For example, the ABS (2015) index of house prices is quite similar in terms of trends to the index we have constructed.

[5]It is worth noting here that a close inspection of the Figure 4 reveals that St George-Sutherland had

⟨⟨ *Insert Figures 4, 5 and 6 here* ⟩⟩

Figure 5 illustrates price trends for 2- and 5-bedroom houses in the Eastern Suburbs. The overall appreciation rate is broadly similar—at least until the last couple of years. However, it can be seen that prices for smaller homes appear to be more volatile than for larger houses, particularly early in the sample. Figure 6 considers the price trends for houses and apartments in the Lower Northern Sydney region. Houses appear to have had a considerably higher appreciation rate compared with apartments but they also look to be significantly more volatile. There is also a large difference in the yield for houses compared with apartments—the latter has a considerably higher rental yield.

In Table 3 we provide summary statistics for the price and rent changes as well as the total return and rental yield across various dimensions from 2002Q1. We can see here that the dynamics of the total return is mainly driven by the capital gain. The majority of the total return comes from price change, which is relatively volatile. The rental yield contributes a smaller amount to total returns but is an order of magnitude more stable. Rents themselves are actually quite volatile, with a standard deviation which is only slightly smaller in magnitude than price changes, but interestingly these changes are fairly weakly correlated with house price changes. We constructed a correlation matrix of these four variables, which is shown in Table 4. It is perhaps surprising that contemporaneous rent changes are so weekly related to house price changes. This seems to reflect the lagging nature of rents as seen somewhat in Figure 2a. The correlation table illustrates the very strong link between total returns and the change in log prices and the weaker influence of rental yields.

⟨⟨ *Insert Table 3 and 4 here* ⟩⟩

These aggregate statistics also provide more general evidence for a significant difference between the rental yields on houses compared with apartments. For houses the rental yield averages 4.01% per year whereas for apartments it is 4.86%. Both Bracke (2013), for a matched sample of London, and Hill and Syed (2012), for Sydney, also find lower yields for houses. Bracke (2013) finds that the rental yield for houses is around half a percent lower than for apartments. This is similar, though a bit smaller, than our estimate of 0.85%. However, the capital appreciation has been lower for apartments than housing. This means we find that the average total return over the entire period was about the same for houses and apartments.

high mean returns but low price growth and only a moderately high rental yield. These results are consistent because for each chart we are averaging the returns for each property rather than using the average price growth and rental yield to calculate average returns. While in some cases this will give similar numbers for St George-Sutherland these two approaches give quite different numbers. This is as a result of the high degree of heterogeneity of returns at the property-level and the fact that this distribution need not be symmetric.

There are very significant differences in returns over time. In 2002 returns averaged 20.17%—2013 and 2014 were also very good years. But the worst year saw total returns of -1.27%. The regional aggregates are also interesting because they illustrate non-trivial differences in total returns. Fairfield-Liverpool had the highest return over the period of 10.78% per year followed closely by Blacktown.

Overall these results are strongly suggestive of housing return dynamics which are driven systematically by the nature of the property. It is the underlying drivers of the dispersion in real estate returns to which we now turn.

4 Risk, Return and Home Characteristics: Empirical Results for Sydney 2002-14

We use the imputed total returns for each of the homes in our data set to estimate the market model. Our objectives are two-fold. First, to examine the drivers of risk and return in the housing market. Second, to consider the relationship between risk and return for real estate. To do this we estimate the standard market model such as that outlined in equation (1) above—this yields an estimate of α and β for each home. However, in addition—in order to get at the first question and isolate the drivers of risk and return—we propose a modification of the standard market model. This allows the estimated α and β to vary by property characteristics (as opposed to by property). This reduces the dimension of the α_i and β_i parameters. It also enables us to more easily identify the characteristics driving the risk-return profile of housing. Our modified market model is shown below where, as before, z_{itc} denotes the home's characteristics,

$$y_{it} = \alpha_0 + \beta_0 y_t^* + \sum_{c=1}^{C} (\alpha_c z_{itc} + \beta_c z_{itc} y_t^*) + \eta_{it}, \quad i = 1, 2, \dots, I, \;\; t = 1, 2, \dots, T \qquad (4)$$

There is an issue related to inference in this market model. Much of the input data in (4) is estimated, e.g. the y_{it} and y_{Mt} are derived from the hedonic regression (3). This means that the standard errors in the regression (4) will be too low as they will not account for the first round estimation uncertainty. To address this we use a bootstrap approach to obtaining standard errors for the market model coefficients. That is, we use the estimated variance for each y_{it} from the hedonic model to simulate different values for the data, recalculate y_{Mt} and any other independent variables, and re-estimate (4). After doing this many times the resulting distribution of coefficient estimates enables us to derive standard errors which better reflect the true coefficient uncertainty. Let us now turn to the results from the characteristics-market model.

4.1 The Characteristics Driving Risk and Return

The results of the estimation of a number of different versions of (4) is shown in Table 5. Here we have estimated the market model outlined in (4) using various regressors and across different samples. We consider two general types of regressors; physical characteristics and financial characteristics. Included in the former grouping are structural and locational characteristics—house or apartment, property size (reflected in the number of bedrooms) and region. While the financial characteristics are the lagged values of; the log price level and total return.

Models A and B include just the structural characteristics while models C–G use both the structural and financial characteristics. Models A, C, D, E and G are estimated on all the available data while models B and F test the robustness of these result and only use data from 2006Q1 to 2014Q4. In a further robustness check, model G is the same as E but estimated using robust regression methods. The results illustrate the impact of a range of factors on the risk and return to real estate.

⟨⟨ *Insert Table 5 here* ⟩⟩

One of the key factors driving residential real estate prices is the structure type; whether the property is a house or an apartment. We find, in all models, that houses actually had weaker returns than did apartments over the period examined. The size of this effect is very large. In model B the annual difference in return between houses and apartments is as big as -3.88%. Though it falls somewhat when the lagged log price level is added to the model as houses tend to have higher prices. In our preferred model, model E, the difference in returns is -2.18%.

This is surprising. The conventional wisdom is that houses tend to appreciate more than do apartments because of their greater endowment of land compared with that for apartments. Researchers such as Davis and Heathcote (2007) have found that land price trends are responsible for much of real estate dynamics.

In terms of volatility the results show that houses tend to add to the variability of returns. In our preferred model E, houses are 23.22% more volatile than are apartments. This figure is as high as 32.29% in model B. The finding of weak returns and high variance of these returns for houses compared with apartments throws up a somewhat perplexing feature of our results; that risk (β) and return (α) appear to be negatively correlated for the homes in our data. We explore this further in the next section.

The size of the home is proxied by the number of bedrooms in our market model. In models A and B the effect of bedrooms is negative. But when the lagged log price level is included—which is positively correlated with the number of bedrooms—the coefficient switches to be positive in models C–G. The impact of this effect is significant but not as large as that for structure type. In model E an extra bedroom boosts returns by around 0.72% per annum. Interestingly, larger homes tend to be less volatile according to our calculations. An extra bedroom lowers the β of a home by 4.90% in model E.

Importantly, there is significant measured differences in risk and return across regions. In model A the highest returns are for Fairfield-Liverpool with a coefficient of 0.0024 while the Eastern Suburbs with a coefficient of -0.0084 does worst. This amounts to a spread in returns of 4.41% per annum. This is clearly large. The spread is even larger for model B, which is estimated over the truncated sampled, but falls somewhat in the models as the regional effect is absorbed by the additional regressors. Our best estimate, from model E, is that the spread in retuns is around 2.47% per annum across regions. The inclusion of the financial characteristics, in models C–G, changes the returns ordering from that observed in models A and B reflecting the fact that each region has a particular mix of homes. However, in each of the two sets of models the region ordering is fairly stable indicating that systematic patterns are being picked up here. The region in which the home is located is also an important component of volatility. The most volatile region in model E has a β-effect which is 29.46% higher than the least volatile region.

We also consider the financial factors which could potentially drive housing returns. Model's C–G include the log price level of the home in the prior quarter. This is a priori a potentially relevant explanator of returns if more expensive homes are less easily tradeable because of the larger amount of capital required to do so. This would point to pricier homes having higher returns. In fact we find the opposite. The coefficient on lagged log price level is negative and significant in models C–E. A home which is twice as expensive as another will have returns which are around -3.34% lower over the year. This is likely to reflect thinner markets at the upper end of the price distribution which reduces appreciation in strong markets but leads to poor growth in weaker markets. This is reinforced by the results on volatility of returns and price. In models C–E there is clearer evidence that more expensive homes have higher volatility in returns than less expensive properties.

Another factor which has been linked with excess returns is momentum (see for example, Jegadeesh and Titman, 1993). We investigate this by including the lag of total returns in the market model. In model D we include the 1-quarter lag. This leads to a model with a very high R^2 and a very significant coefficient on lagged returns indicating strong persistence. However, we are somewhat cautious about this result because the spline smoothing method used to estimate prices may have introduced a degree of spurious correlation in prices changes across nearby periods. The spline method penalizes rapid change in prices hence there will be inherent smoothing of this over time. Because of this we also investigate and prefer a 4-quarter lag in total returns, which will help remove the spline smoothing effect and still represents a reasonable test of momentum. Interestingly, in contrast to Case and

Shiller (1989, 1990) and others, we find a negative effect for momentum on housing returns. That is, high returns a year ago do not foreshadow high returns today. In fact the negative coefficient implies some degree of mean reversion in returns. This is the case in models *E–G*. High lagged returns tend to have a dampening effect on β.

4.2 The Relationship of Risk and Return

The previous results illustrated the links between property characteristics, risk and return—that is, what drives α and β. Another key question is; what is the relationship between the α and β for real estate?

It is of course expected that returns and risk will be positively correlated, as is found in studies of the share market. But this issue has recieved limited attention in the housing literature. It is an interesting question because housing markets perform very differently from share and bond markets. Cannon, Miller and Pandher (2006) are one of the few to examine this question. They looked at the relationship between returns and risk (the standard deviation of returns) for housing in a cross section of US zip codes. Mostly they found a positive relationship but for certain periods they found that a higher-β zip code—where the β was measured relative to share market returns—had lower returns and vice versa. Hence, there is some evidence of complexity in the risk-return tradeoff in housing markets.

We begin by focusing on the standard market model in (1) where we derive an α and β for each of the 100,000 homes for which we estimate returns. The resulting α ($\times$100) and β are plotted against each other in Figure 7. This illustrates the surprising result that there is a *negative* correlation between risk and return. The existence of a negative tradeoff between risk and return implies that risk averse households would be unambiguously better off, at least in terms of an investment strategy, purchasing certain types of homes. Those homes at the top-left of the scatter plot had both higher returns and lower variance than did those in the bottom-right.

⟨⟨ *Insert Figure 7 and 8 here* ⟩⟩

The existence of a negative tradeoff between risk and return in our data is fairly robust. We impute the values for α and β for each property using the characteristics-market model for model *E*—the results are similar for the other models. This is illustrated in Figure 8. The negative correlation is qualitatively similar though the dispersion in values of the α and β is much diminished given that we have imposed greater structure on the market model in (4) compared with (1). Furthermore, when we estimate unique α and β for each property, but use data only after 2006Q1, the negative correlation shown in Figure 7 is essentially unchanged.

The negative correlation between risk and return for real estate is surprising. On the face of it this phenomenon represents an opportunity for many households to be improve their financial circumstances by buying properties of a certain type. Given our data it is hard to pinpoint the cause of this phenomenon and are likely to reflect the complex nature of the housing market. However, there are a few possible explanations.

Property owners are made up of owner-occupiers and investors. It is likely to be the latter group which are evaluating housing investment on a purely financial basis. Owner-occupiers on the otherhand, which make up the majority of homeowners, are likely to take a broader perspective. The apparent disequilibrium between risk and return may in fact reflect some unobservable utility received by owner-occupiers from owning certain types properties. The payoffs to living in a particular property should mostly be capitalized into the market rent for the property. This has been included in our calculation. However, it is possible that the value of living in a certain property is different for owners from renters. For example, owners may value more highly having a backyard because they can put in a swimming pool, make a vegetable garden or put in an aviary. Renters cannot do this. Hence one explanation for this unusual finding of a negative correlation between risk and return is the heterogeneity of preferences across owners and renters...

5 Conclusion

The emergence of housing bubbles around the world—and their subsequent crashes—has shown just how important an asset class is residential real estate and just how poor is our understanding of it. The purpose of this paper has been to show that it is possible to construct real estate price indexes at a disaggregated level—in fact at the level of the individual home—and hence we can apply standard financial models to understand returns to home ownership. This enables us to answer some of the most basic questions around residential real estate; what is the risk and return for different types of housing investments.

Our empirical application, to residential property prices for Sydney from 2002-14, showed that returns are closely tied to the nature of dwelling, in particular whether the property is an apartment or house and the region of the property. This provides some useful insights to prospective homebuyers and investors who must decide what property to buy and hence what risk and return profile to enjoy. What was perhaps most surprising in our results was the *negative* tradeoff we recorded between risk and return. Rather than real estate owners having to accept higher risk to achieve higher returns, we found that in many cases no such tradeoff existed. This emphasises just how different housing assets are from other asset classes and the need for further research on this topic.

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Table 1: Summary Statistics

By	Dimension	No. of Obs.	House ($)		Price ($)[†]		Land Area (1000m^2)		Bedrooms		Bathrooms	
			Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
					Home Sale Prices							
Structure	Apartment	196,850	1.00	0.00	543,373.60	363,474.30	0.00	0.00	1.99	0.62	1.35	0.51
	House	331,668	2.00	0.00	879,270.00	570,506.60	0.72	0.60	3.41	0.91	1.81	0.80
Years	2000	4,779	1.80	0.40	750,532.70	516,162.90	0.55	0.52	3.43	0.99	2.12	0.72
	2001	8,676	1.78	0.41	760,099.40	514,015.10	0.52	0.52	3.34	1.01	2.06	0.72
	2002	9,458	1.75	0.43	886,430.70	592,460.80	0.49	0.52	3.27	1.05	2.00	0.75
	2003	11,752	1.73	0.44	900,251.20	595,136.80	0.48	0.52	3.21	1.05	1.94	0.74
	2004	13,327	1.71	0.45	849,640.00	573,924.30	0.48	0.53	3.13	1.04	1.85	0.75
	2005	30,498	1.66	0.47	678,812.40	493,272.80	0.45	0.54	2.90	1.04	1.61	0.74
	2006	38,251	1.65	0.48	664,496.20	503,068.20	0.44	0.55	2.87	1.04	1.59	0.73
	2007	48,316	1.64	0.48	688,510.30	532,765.30	0.44	0.56	2.85	1.04	1.58	0.72
	2008	42,201	1.61	0.49	652,246.60	498,135.40	0.44	0.58	2.80	1.05	1.56	0.71
	2009	56,977	1.59	0.49	654,689.30	479,166.10	0.44	0.61	2.77	1.05	1.56	0.70
	2010	53,446	1.61	0.49	755,849.90	532,162.80	0.45	0.60	2.84	1.06	1.60	0.72
	2011	56,465	1.57	0.49	722,751.50	490,028.60	0.44	0.63	2.77	1.06	1.58	0.71
	2012	46,078	1.63	0.48	768,121.30	491,990.70	0.47	0.61	2.89	1.08	1.65	0.74
	2013	54,715	1.61	0.49	839,270.10	533,086.00	0.47	0.63	2.90	1.10	1.67	0.75
	2014	53,579	1.62	0.49	959,057.80	575,664.50	0.46	0.61	2.90	1.11	1.67	0.75
Region	Blacktown	11,809	1.91	0.29	404,795.20	122,452.50	0.67	0.57	3.16	0.80	1.39	0.57
	Canterbury-Bankstown	36,256	1.73	0.44	513,015.40	222,740.80	0.53	0.61	2.95	0.92	1.46	0.66
	Central Northern Sydney	71,326	1.85	0.36	842,515.30	461,228.30	0.81	0.64	3.59	0.98	2.09	0.78
	Central Western Sydney	47,089	1.62	0.49	461,852.60	194,068.70	0.53	0.73	2.78	0.91	1.49	0.62
	Eastern Suburbs	51,809	1.46	0.50	1,087,357.00	786,230.80	0.19	0.33	2.64	1.05	1.59	0.76
	Fairfield-Liverpool	32,497	1.85	0.36	427,267.70	166,375.60	0.60	0.60	3.26	0.89	1.55	0.68
	Inner Sydney	65,068	1.47	0.50	734,051.30	449,719.10	0.14	0.32	2.21	0.93	1.42	0.58
	Inner Western Sydney	29,788	1.52	0.50	790,435.40	484,317.50	0.33	0.48	2.73	1.02	1.62	0.70
	Lower Northern Sydney	63,873	1.51	0.50	950,157.00	676,430.60	0.37	0.56	2.70	1.07	1.63	0.73
	Northern Beaches	48,506	1.61	0.49	920,425.40	567,622.40	0.45	0.53	2.97	1.14	1.77	0.79
	St George-Sutherland	70,497	1.65	0.48	659,648.60	361,311.30	0.51	0.61	2.95	1.03	1.63	0.74
Total		528,518	1.63	0.48	754,163.20	528,988.60	0.45	0.59	2.88	1.07	1.64	0.74
					Home Rents							
Structure	Apartment	676,177	1.00	0.00	470.51	212.51	0.00	0.01	1.82	0.61	1.25	0.45
	House	434,981	2.00	0.00	595.90	304.94	0.75	0.72	3.04	0.88	1.54	0.69
Years	2002	10,366	1.39	0.49	417.04	236.97	0.28	0.58	2.27	0.92	1.34	0.56
	2003	25,799	1.41	0.49	402.37	230.87	0.30	0.57	2.29	0.92	1.34	0.55
	2004	39,327	1.42	0.49	386.16	218.19	0.33	0.61	2.33	0.92	1.34	0.56
	2005	79,097	1.40	0.49	396.30	223.48	0.30	0.59	2.30	0.92	1.34	0.56
	2006	86,762	1.39	0.49	414.13	238.58	0.30	0.59	2.29	0.93	1.34	0.56
	2007	80,816	1.42	0.49	459.95	255.09	0.32	0.60	2.33	0.95	1.37	0.58
	2008	82,384	1.44	0.50	524.55	277.04	0.32	0.59	2.36	0.97	1.39	0.59
	2009	102,704	1.39	0.49	523.25	256.64	0.29	0.57	2.30	0.95	1.37	0.59
	2010	102,794	1.39	0.49	538.30	251.01	0.29	0.57	2.29	0.94	1.35	0.57
	2011	122,935	1.38	0.48	563.26	257.50	0.29	0.59	2.28	0.94	1.37	0.57
	2012	122,636	1.39	0.49	575.60	256.44	0.29	0.58	2.30	0.95	1.37	0.58
	2013	124,821	1.37	0.48	584.69	251.95	0.28	0.57	2.28	0.94	1.37	0.57
	2014	130,717	1.36	0.48	596.05	245.78	0.27	0.56	2.25	0.95	1.37	0.56
Region	Blacktown	16,996	1.81	0.39	350.86	85.77	0.64	0.63	2.80	0.77	1.25	0.47
	Canterbury-Bankstown	61,539	1.54	0.50	383.21	126.83	0.41	0.61	2.53	0.82	1.24	0.49
	Central Northern Sydney	91,598	1.70	0.46	579.75	277.79	0.71	0.77	3.11	1.03	1.79	0.72
	Central Western Sydney	105,334	1.47	0.50	378.65	117.95	0.45	0.76	2.43	0.79	1.36	0.53
	Eastern Suburbs	147,227	1.23	0.42	628.55	318.97	0.10	0.30	2.10	0.84	1.28	0.53
	Fairfield-Liverpool	49,259	1.74	0.44	364.07	109.06	0.57	0.69	2.89	0.86	1.32	0.54
	Inner Sydney	213,459	1.29	0.45	547.34	249.62	0.10	0.33	1.84	0.81	1.27	0.48
	Inner Western Sydney	75,346	1.32	0.47	488.68	198.03	0.24	0.52	2.26	0.82	1.38	0.55
	Lower Northern Sydney	175,505	1.26	0.44	557.89	288.29	0.22	0.54	2.12	0.89	1.34	0.55
	Northern Beaches	74,127	1.36	0.48	635.04	316.66	0.28	0.51	2.35	1.04	1.45	0.66
	St George-Sutherland	100,768	1.45	0.50	453.58	165.05	0.39	0.63	2.46	0.87	1.36	0.57
Total		1,111,158	1.39	0.49	519.60	260.05	0.29	0.58	2.30	0.94	1.36	0.57

[†] For rents the price is measured as dollars per week.

Table 2: Hedonic Model Fit Statistics

	Time Smooth	Time-Spatial Smooth	Time-Dummy (τ_t,δ_c)	Time-Region Dummy (τ_{rt},δ_c)	Time Flexible (τ_{rt},δ_{tc})	Region Flexible (τ_{rt},δ_{rc})	Time-Region Flexible (τ_{rt},δ_{rtc})
				Home Sale Prices			
No. Obs.	528,518	528,518	528,518	528,518	528,518	528,518	528,492
No. Parms.	1,124	1,332	74	660	896	700	3,209
AIC	45,701	-591	263,390	259,273	245,626	186,487	175,872
R^2	0.7881	0.8060	0.6789	0.6820	0.6852	0.7000	0.7052
RMSE	0.2521	0.2412	0.3104	0.3089	0.3073	0.3000	0.2974
MAE	0.1809	0.1711	0.2271	0.2256	0.2244	0.2178	0.2160
% of Absolute Errors: <0.15	54.43	57.39	44.54	44.89	45.18	46.54	46.85
<0.30	83.07	84.72	73.77	74.11	74.34	75.96	76.28
<0.50	94.89	95.35	90.97	91.07	91.13	91.59	91.77
				Home Rents			
No. Obs	1,111,158	1,111,158	1,111,158	1,111,158	1,111,158	1,111,158	1,111,153
No. Parms.	1,106	1,779	65	562	552	602	2,773
AIC	-339,922	-394,892	50,969	42,003	12,457	-104,189	-131,334
R^2	0.7641	0.7758	0.6641	0.6671	0.6695	0.6818	0.6850
RMSE	0.2074	0.2023	0.2476	0.2465	0.2456	0.2410	0.2397
MAE	0.1515	0.1466	0.1813	0.1803	0.1796	0.1756	0.1746
% of Absolute Errors: <0.15	61.25	63.09	53.70	54.09	54.29	55.40	55.72
<0.30	88.46	89.08	82.37	82.55	82.59	83.42	83.54
<0.50	97.12	97.33	94.98	95.01	95.04	95.30	95.35

Note: No. Obs.=number of observations used in the estimation, No. Parms.=number of parameters in the model (or equivalent in the smoothing splines), R^2= the squared correlation coefficient between estimated and actual log prices, RMSE=Root Mean Squared Error, MAE=Mean Absolute Error, AIC=Akaike Information Criterion.

Table 3: Housing Returns Summary Statistics (Annual Rates†)

By	Dimension	No. of Obs.	Price Change (%) Mean	Price Change (%) Std. Dev.	Total Return (%) Mean	Total Return (%) Std. Dev.	Rental Yield (%) Mean	Rental Yield (%) Std. Dev.	Rent Change (%) Mean	Rent Change (%) Std. Dev.
Structure	Apartment	1,632,918	4.48	8.76	9.56	8.98	4.86	0.73	4.62	6.38
	House	3,467,082	5.41	11.76	9.64	11.87	4.01	0.72	4.55	10.09
Years	2002	300,000	15.59	14.07	20.17	14.05	3.96	0.67	4.02	26.46
	2003	400,000	9.95	11.94	13.93	11.92	3.63	0.62	1.29	12.93
	2004	400,000	-4.64	10.33	-1.27	10.60	3.53	0.62	2.61	9.35
	2005	400,000	-3.40	8.02	0.32	8.10	3.86	0.57	3.80	6.06
	2006	400,000	0.00	6.30	4.11	6.29	4.11	0.63	6.39	5.33
	2007	400,000	7.97	6.09	12.70	5.88	4.38	0.73	10.49	5.62
	2008	400,000	-3.13	6.20	1.48	6.77	4.76	0.87	10.16	7.49
	2009	400,000	11.80	7.69	17.21	7.77	4.84	0.80	2.08	5.46
	2010	400,000	7.21	7.84	12.09	8.02	4.56	0.79	7.15	4.20
	2011	400,000	-0.37	4.23	4.26	4.64	4.65	0.73	4.13	4.06
	2012	400,000	2.58	4.17	7.44	4.35	4.74	0.69	1.74	3.17
	2013	400,000	14.52	5.39	19.74	5.25	4.56	0.69	3.29	3.52
	2014	400,000	14.00	5.73	18.64	5.79	4.07	0.66	2.74	4.42
Regions	Blacktown	121,176	5.74	12.14	10.76	12.26	4.75	0.82	3.20	12.06
	Canterbury-Bankstown	378,726	4.81	12.35	9.38	12.57	4.36	0.93	6.29	12.21
	Central Northern Sydney	753,882	5.73	10.45	10.21	10.48	4.23	0.62	4.19	8.52
	Central Western Sydney	452,472	5.46	11.22	10.39	11.42	4.68	0.98	5.03	6.52
	Eastern Suburbs	427,431	4.78	10.59	9.01	10.69	4.03	0.74	3.81	9.37
	Fairfield-Liverpool	345,525	5.79	13.60	10.78	13.74	4.72	0.92	6.80	9.79
	Inner Sydney	548,811	5.63	8.46	10.39	8.53	4.51	0.72	4.93	5.74
	Inner Western Sydney	282,030	4.99	10.48	9.06	10.58	3.87	0.81	4.66	8.22
	Lower Northern Sydney	555,390	5.02	9.31	9.12	9.37	3.91	0.69	3.67	7.24
	Northern Beaches	467,925	4.32	10.86	8.91	10.98	4.40	0.70	3.40	12.11
	St George-Sutherland	766,632	4.48	11.64	8.79	11.80	4.13	0.77	4.61	8.97
Total		5,100,000	5.11	10.88	9.62	11.01	4.29	0.82	4.58	9.03

†Note: These statistics have been annualized by multiplying the quarterly rates by 4.

Table 4: Contemporaneous Correlation Coefficients†

	Log Price Change	Total Return	Rental Yield	Log Rent Change
Log Price Change	1			
Total Return	0.9967	1		
Rental Yield	0.0886	0.1692	1	
Log Rent Change	0.0046	0.0106	0.0738	1

†Note: All correlation coefficients are significant except that between Log Rent Change and Total Return.

Table 5: Market Model Results

Model:†		A	B	C	D	E	F	G
No. of Obs.		5,019,552	3,764,664	5,019,552	5,019,552	5,019,552	3,764,664	5,019,552
No. of Parms.		26	26	28	30	30	30	30
R^2		0.7127	0.7293	0.7196	0.8473	0.7252	0.7419	0.5444
α	Intercept	0.0109***	0.0171***	0.1257***	0.1066***	0.1118***	0.1465***	0.1071***
		(0.0001)	(0.0001)	(0.0003)	(0.0004)	(0.0003)	(0.0006)	(0.0004)
	Apartment	0	0	0	0	0	0	0
		—	—	—	—	—	—	—
	House	-0.0077***	-0.0099***	-0.0052***	-0.0016***	-0.0055***	-0.0071***	-0.0055***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Bedrooms	-0.0006***	-0.0014***	0.0021***	0.0019***	0.0018***	0.0016***	0.0016***
		(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Blacktown	0	0	0	0	0	0	0
		—	—	—	—	—	—	—
	Canterbury-Bankstown	-0.0019***	-0.0013***	0.0010***	0.0015***	0.0008***	0.0023***	0.0005***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Central Northern Sydney	-0.0020***	-0.0055***	0.0038***	0.0031***	0.0034***	0.0016***	0.0027***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Central Western Sydney	0.0006***	0.0003***	0.0031***	0.0024***	0.0029***	0.0034***	0.0029***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Eastern Suburbs	-0.0084***	-0.0131***	0.0024***	0.0046***	0.0015***	-0.0001	0.0004***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Fairfield-Liverpool	0.0024***	0.0031***	0.0024***	0.0017***	0.0023***	0.0031***	0.0027***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Inner Sydney	-0.0023***	-0.0069***	0.0065***	0.0051***	0.0061***	0.0041***	0.0053***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Inner Western Sydney	-0.0068***	-0.0084***	0.0007***	0.0024***	0.0002**	0.0009***	-0.0003***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Lower Northern Sydney	-0.0059***	-0.0109***	0.0037***	0.0046***	0.0029***	0.0008***	0.0025***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Northern Beaches	-0.0035***	-0.0096***	0.0052***	0.0051***	0.0046***	0.0011***	0.0043***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	St George-Sutherland	-0.0044***	-0.0055***	0.0009***	0.0023***	0.0005***	0.0010***	-0.0006***
		(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Log Price Level, L1	—	—	-0.0098***	-0.0087***	-0.0085***	-0.0110***	-0.0081***
				(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
	Return, L1	—	—	—	0.5789***	—	—	
					(0.0005)			
	Return, L4	—	—	—	—	-0.0650***	-0.0252***	-0.0692***
						(0.0005)	(0.0006)	(0.0005)
β	y_M × Intercept	0.8143***	0.6491***	-0.6088***	-0.2832***	-0.7185***	-1.5343***	-0.7447***
		(0.0022)	(0.0036)	(0.0120)	(0.0128)	(0.0121)	(0.0184)	(0.0140)
	y_M × Apartment	0	0	0	0	0	0	0
		—	—	—	—	—	—	—
	y_M × House	0.2721***	0.3229***	0.2428***	0.1296***	0.2322***	0.2663***	0.2296***
		(0.0007)	(0.0012)	(0.0008)	(0.0008)	(0.0008)	(0.0013)	(0.0010)
	y_M × Bedrooms	-0.0068***	0.0162***	-0.0423***	-0.0166***	-0.0490***	-0.0413***	-0.0481***
		(0.0004)	(0.0006)	(0.0004)	(0.0004)	(0.0004)	(0.0007)	(0.0004)
	y_M × Blacktown	0	0	0	0	0	0	0
		—	—	—	—	—	—	—
	y_M × Canterbury-Bankstown	0.0505***	0.0372***	0.0127***	0.0080***	0.0018	-0.0339***	-0.0076***
		(0.0022)	(0.0037)	(0.0022)	(0.0022)	(0.0022)	(0.0037)	(0.0026)
	y_M × Central Northern Sydney	0.0062***	0.1127***	-0.0665***	-0.0021	-0.0932***	-0.0287***	-0.0922***
		(0.0020)	(0.0035)	(0.0021)	(0.0021)	(0.0022)	(0.0036)	(0.0025)
	y_M × Central Western Sydney	-0.0388***	-0.0297***	-0.0713***	-0.0307***	-0.0796***	-0.0908***	-0.1005***
		(0.0022)	(0.0037)	(0.0023)	(0.0023)	(0.0023)	(0.0037)	(0.0025)
	y_M × Eastern Suburbs	0.1447***	0.2699***	0.0079***	0.0234***	-0.0372***	0.0091**	-0.0418***
		(0.0021)	(0.0036)	(0.0024)	(0.0024)	(0.0025)	(0.0039)	(0.0031)
	y_M × Fairfield-Liverpool	-0.1034***	-0.1213***	-0.1031***	-0.0718***	-0.0997***	-0.1216***	-0.1181***
		(0.0021)	(0.0037)	(0.0021)	(0.0021)	(0.0021)	(0.0037)	(0.0024)
	y_M × Inner Sydney	0.0087***	0.1442***	-0.1012***	-0.0024	-0.1472***	-0.0758***	-0.1592***
		(0.0021)	(0.0035)	(0.0023)	(0.0023)	(0.0024)	(0.0037)	(0.0027)
	y_M × Inner Western Sydney	0.1553***	0.2022***	0.0602***	0.0702***	0.0248***	0.0128***	0.0143***
		(0.0020)	(0.0036)	(0.0022)	(0.0022)	(0.0023)	(0.0038)	(0.0026)
	y_M × Lower Northern Sydney	0.0604***	0.2051***	-0.0619***	-0.0026	-0.1030***	-0.0256***	-0.1027***
		(0.0021)	(0.0034)	(0.0023)	(0.0023)	(0.0024)	(0.0037)	(0.0028)
	y_M × Northern Beaches	-0.0771***	0.0918***	-0.1904***	-0.0748***	-0.2334***	-0.1287***	-0.2505***
		(0.0022)	(0.0035)	(0.0023)	(0.0023)	(0.0025)	(0.0037)	(0.0029)
	y_M × St George-Sutherland	0.0359***	0.0630***	-0.0331***	-0.0152***	-0.0580***	-0.0702***	-0.0582***
		(0.0022)	(0.0035)	(0.0022)	(0.0022)	(0.0023)	(0.0036)	(0.0025)
	y_M × Log Price Level, L1	—	—	0.1233***	0.0614***	0.1363***	0.1935***	0.1380***
				(0.0010)	(0.0011)	(0.0010)	(0.0015)	(0.0012)
	y_M × Return, L1	—	—	—	-1.4644***	—	—	
					(0.0208)			
	y_M × Return, L4	—	—	—	—	-0.4755***	-1.3540***	-0.1210***
						(0.0185)	(0.0239)	(0.0181)

† Models A and D include all possible observations given the regressors. Models B and E use the same data set while models C and F are estimated on data after and including 2006Q1. Significance levels: ***=1%, **=5%, *=10%.

Table 6: Characteristics of High and Low α and β

Variable	α below median	α above median	β below median	β above median
Bedrooms	3.43	2.64	2.70	3.38
Structure:				
Apartment	0.05 (8.12)	0.58 (91.88)	0.63 (99.98)	0.00 (0.02)
House	0.95 (69.34)	0.42 (30.66)	0.37 (26.92)	1.00 (73.08)
Region:				
Blacktown	0.02 (40.78)	0.03 (59.22)	0.01 (12.90)	0.04 (87.10)
Canterbury-Bankstown	0.08 (51.77)	0.07 (48.23)	0.04 (24.41)	0.11 (75.59)
Central Northern Sydney	0.16 (55.90)	0.13 (44.10)	0.10 (34.18)	0.19 (65.82)
Central Western Sydney	0.04 (21.63)	0.14 (78.37)	0.10 (57.76)	0.07 (42.24)
Eastern Suburbs	0.12 (67.95)	0.06 (32.05)	0.08 (47.89)	0.09 (52.11)
Fairfield-Liverpool	0.02 (16.18)	0.11 (83.82)	0.13 (95.17)	0.01 (4.83)
Inner Sydney	0.06 (29.26)	0.16 (70.74)	0.14 (61.46)	0.08 (38.54)
Inner Western Sydney	0.07 (62.80)	0.04 (37.20)	0.05 (42.45)	0.06 (57.55)
Lower Northern Sydney	0.13 (60.23)	0.09 (39.77)	0.09 (42.58)	0.13 (57.42)
Northern Beaches	0.10 (56.93)	0.08 (43.07)	0.17 (94.48)	0.01 (5.52)
St George-Sutherland	0.19 (64.47)	0.11 (35.53)	0.10 (33.29)	0.20 (66.71)
Log Price Level, L1	13.71	13.06	13.16	13.61
Return, L1	0.02	0.02	0.02	0.02
Return, L4	0.03	0.02	0.02	0.02

Figure 1: Sydney's Regions

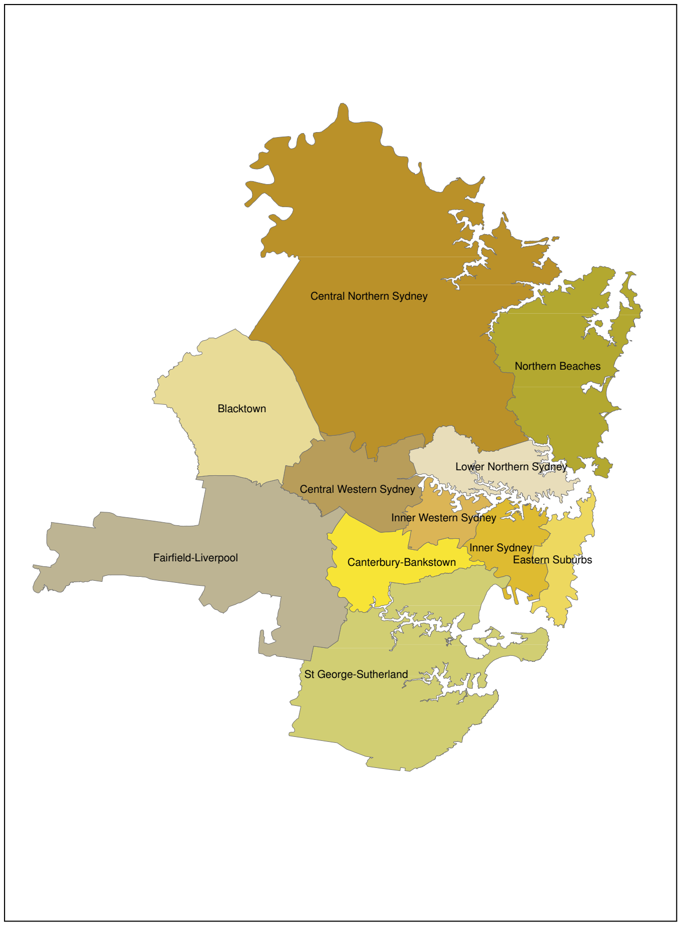
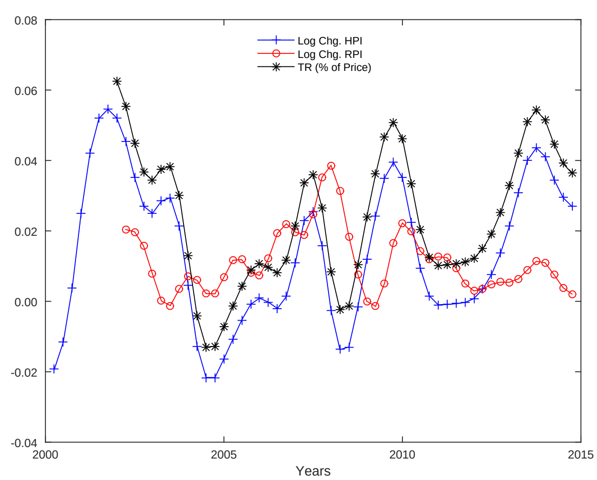


Figure 2: Aggregate Indexes for Sydney (2002Q1=1)

(a) Changes



(b) Indexes

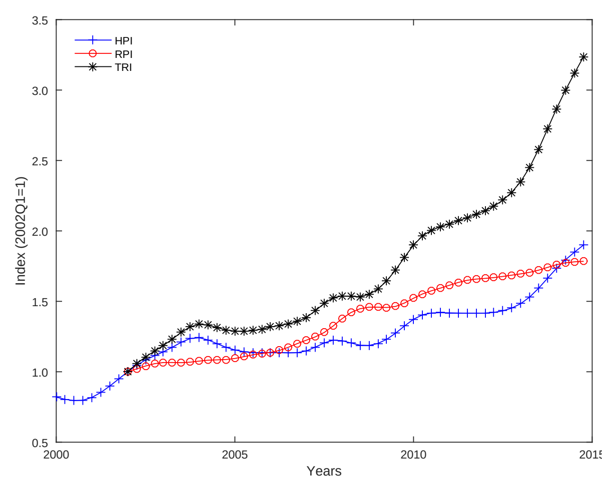


Figure 3: Histogram of Price and Rent Changes and Total Returns

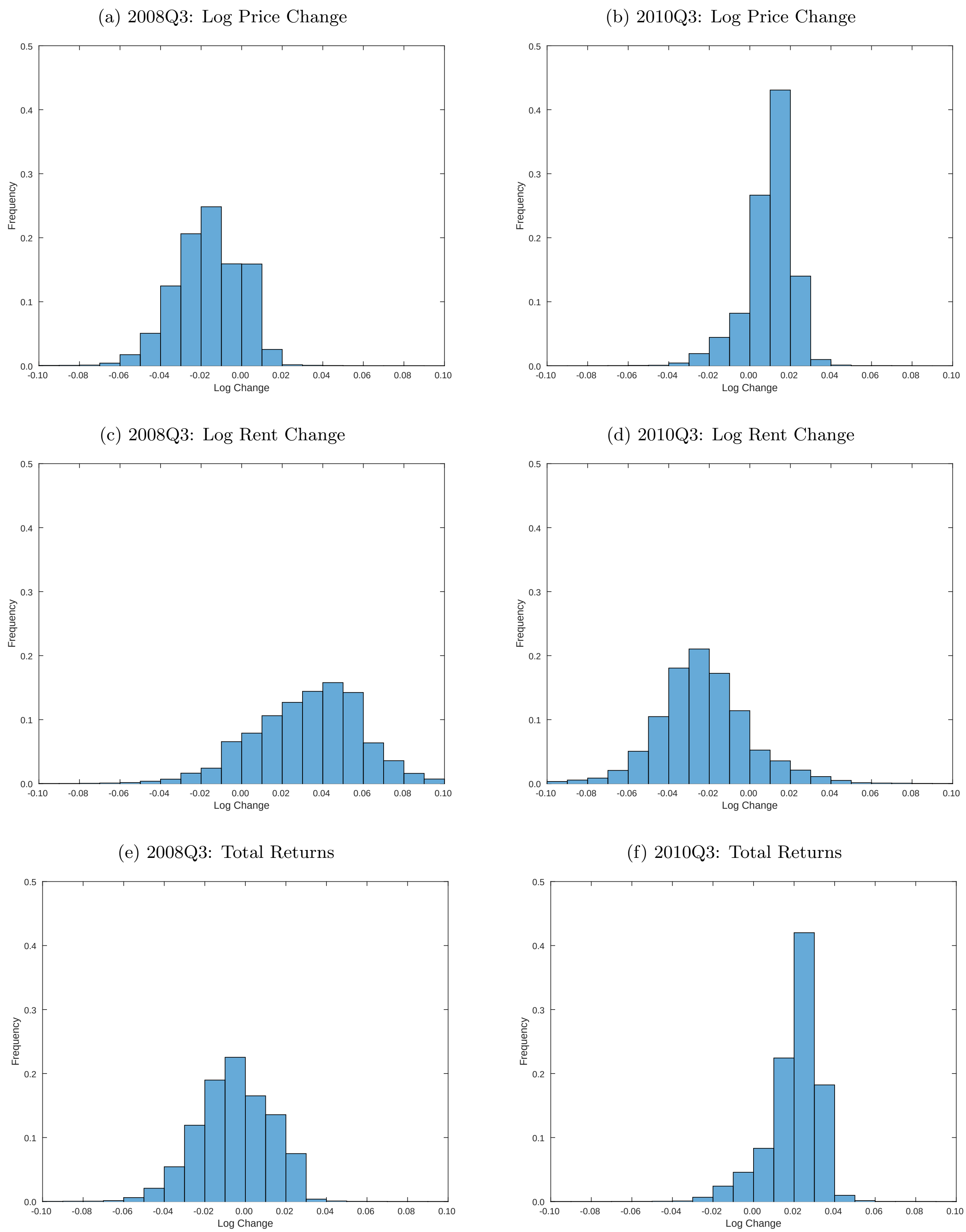
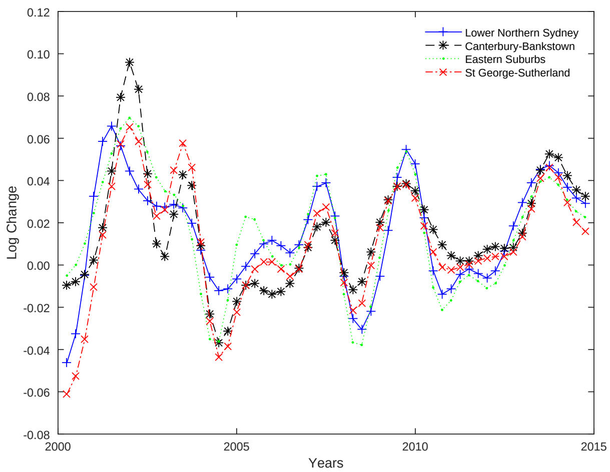
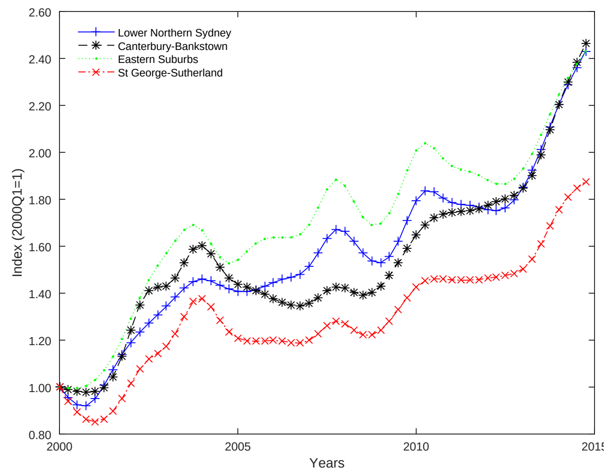


Figure 4: Comparing Houses Across Regions
(Mean for: House=1, Bedrooms=3, Bathrooms=2, Land Area $\in$ [400,1000])

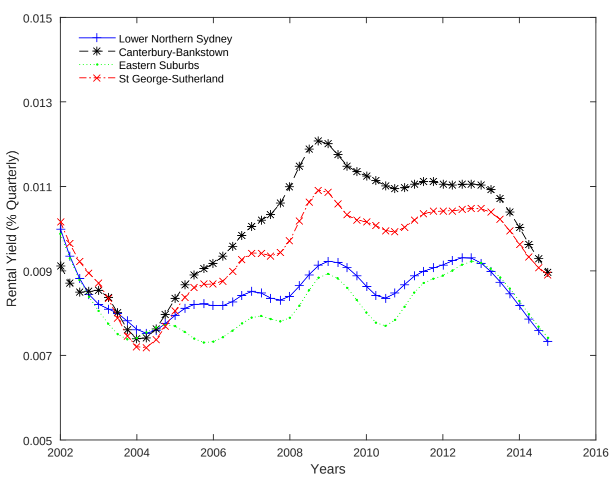
(a) Price Change



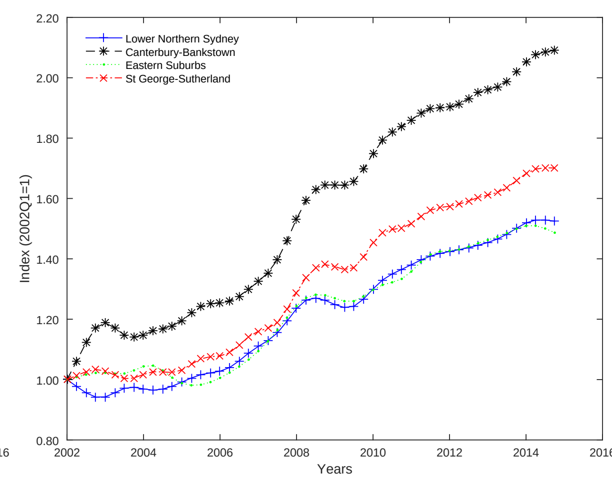
(b) Price Index



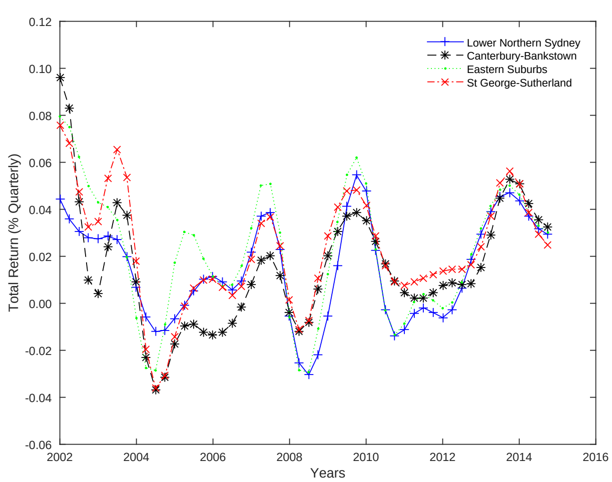
(c) Rental Yield



(d) Rental Index



(e) Total Return (%)



(f) Total Return Index

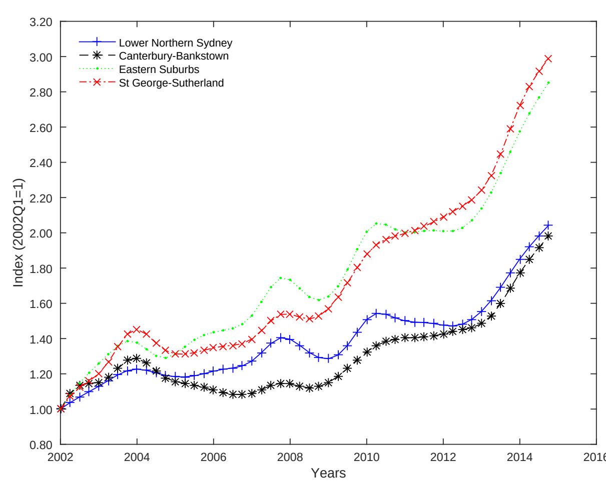
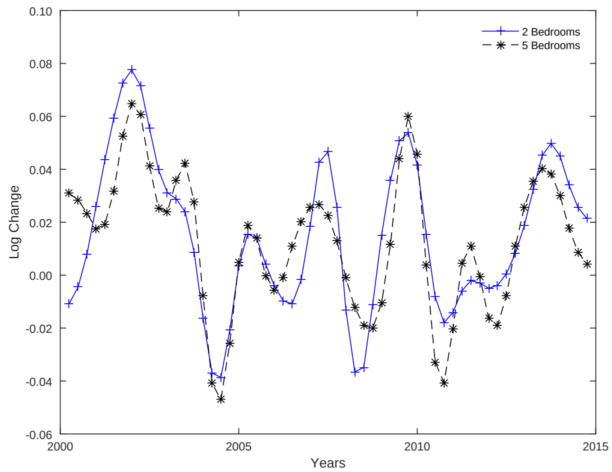
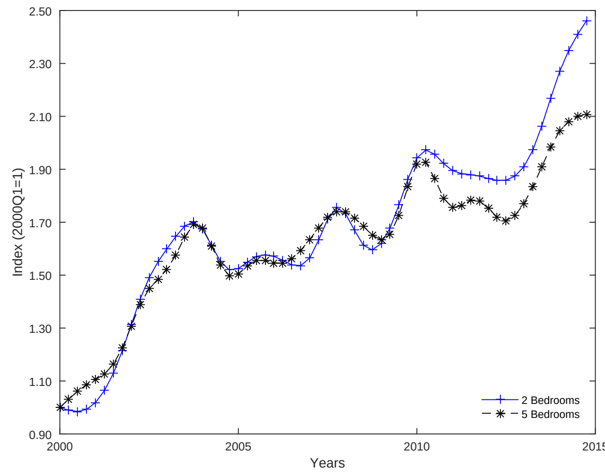


Figure 5: Comparing 2- and 5-Bedroom Houses
(Mean for: House=1, Land Area ∈ [400,1000], Region=Eastern Suburbs)

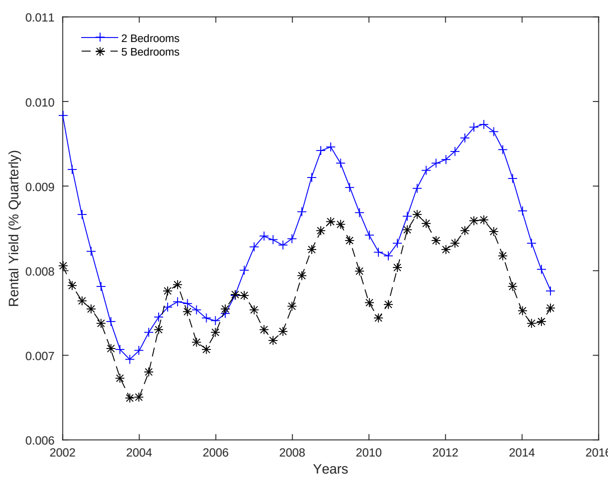
(a) Price Change



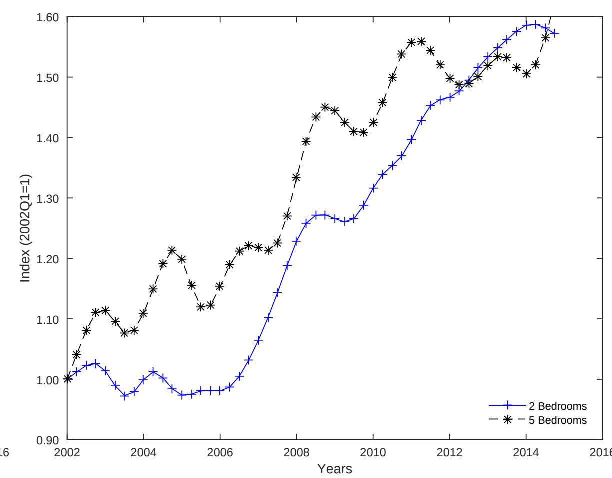
(b) Price Index



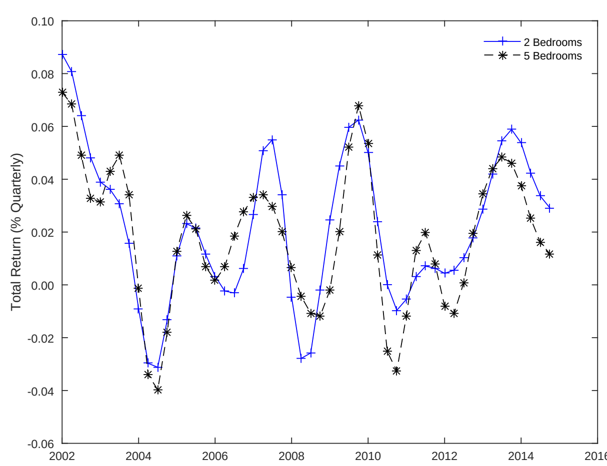
(c) Rental Yield



(d) Rental Index



(e) Total Return



(f) Total Return Index

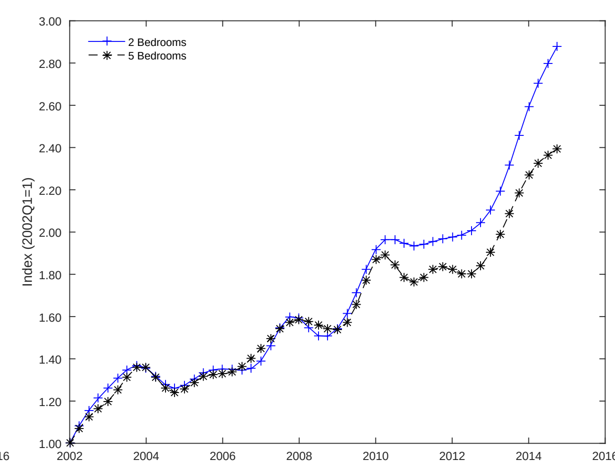
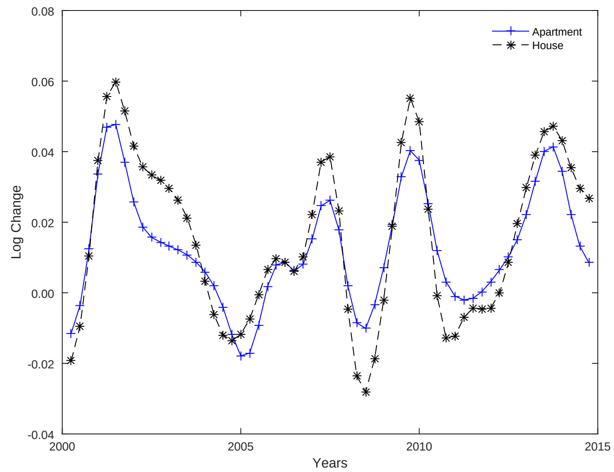
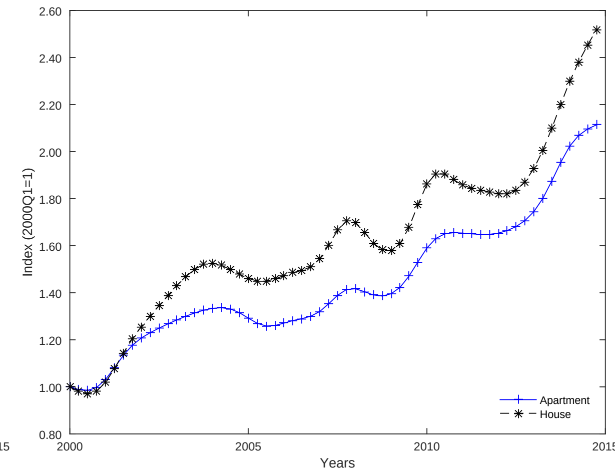


Figure 6: Comparing Houses and Apartments
(Mean for: Bedrooms $\in$ [1,4], Bathrooms $\in$ [1,2], Region=Lower Northern Sydney)

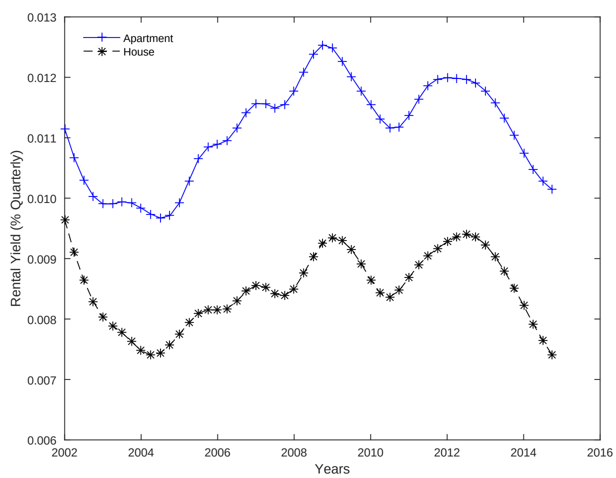
(a) Price Change



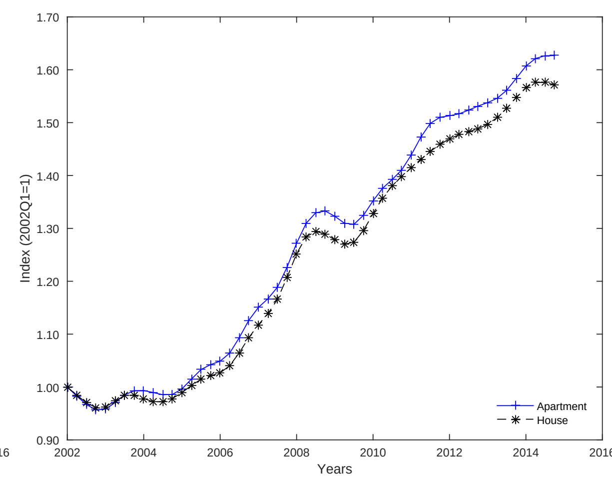
(b) Price Index



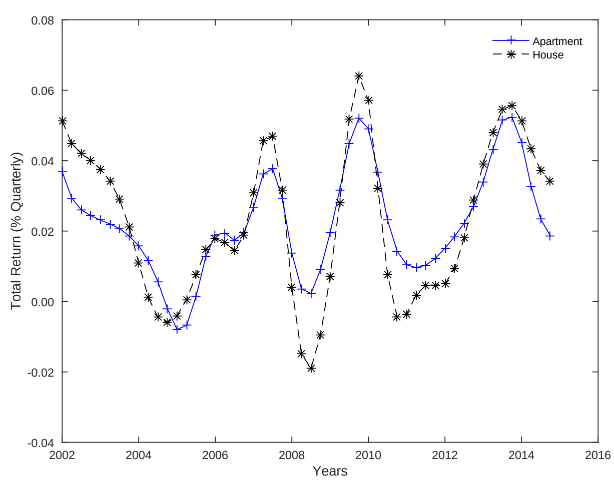
(c) Rental Yield



(d) Rental Index



(e) Total Return



(f) Total Return Index

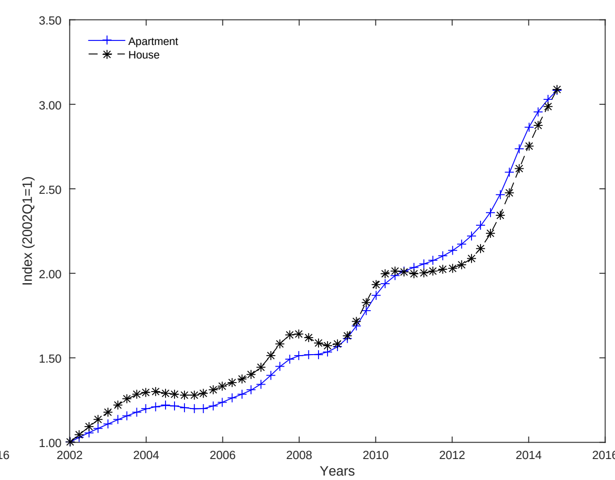


Figure 7: Correlation of α and β for All Homes (Individual Market Model for each Property)

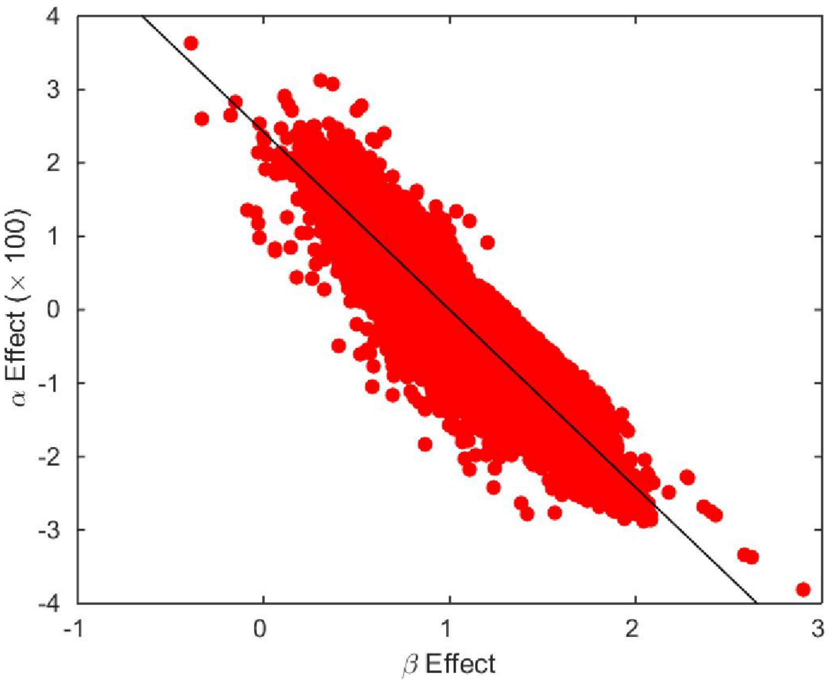
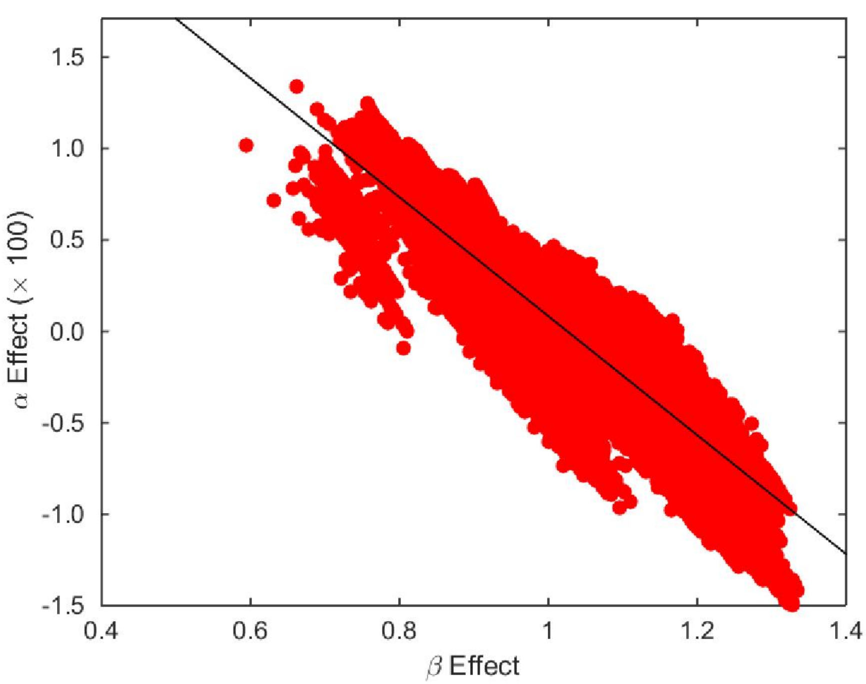


Figure 8: Correlation of α and β for All Homes (Model D)



Public vs. Private Market Arbitrage – Can Growth REITs Benefit from their High Valuation?

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Public vs. Private Market Arbitrage – Can Growth REITs Benefit from their High Valuation?

Abstract

This paper examines the impact of the ratio of price-to-fundamental value on the stock market performance of real estate securities following seasoned equity offerings and senior debt issuances. Using a global sample of real estate securities, we distinguish between growth stocks, i.e. those with the highest stock prices relative to the private market value of their properties, and value stocks, which tend to trade at substantial discounts to their net asset value (NAV). Consistent with the notion that newly issued equity is ultimately priced similar to pre-SEO levels, we find that growth stocks perform significantly better than value stocks in the 36 months following the SOE. We also examine the long run performance following senior debt issuances and document a substantial outperformance (underperformance) for growth (value) real estate securities in the 36 months following the offering. Overall, our findings are consistent with the hypothesis that growth REITs can benefit from "public vs. private market arbitrage".

Key words: public vs. private market arbitrage, cost of capital, net asset value, value vs. growth, seasoned equity offerings, debt offerings

Public vs. Private Market Arbitrage – Can Growth REITs Benefit from their High Valuation?

1. Introduction

Valuations of public and private market real estate can diverge substantially from each other when considering Net Asset Value (NAV) estimates. This observation holds for the evolution of average NAV-spreads over time and for cross-sectional comparisons. Figure 1 shows that value stocks tend to trade at significant discounts to their NAV, while growth stocks trade at a premium relative to the private market values of their properties.

When the price of an undervalued stock reverts to its fundamental value, investors may be rewarded with superior returns without being exposed to higher risk, as suggested by Ooi et al. (2007). On the other hand, the same authors find no evidence that growth REITs – i.e. those trading at a high ratio of price relative to fundamental value – are overpriced. This suggests that some real estate stocks may trade at a premium relative to fundamental value over extended periods of time. In other words, their public market stock prices are constantly higher than the private market value of their underlying properties.

This leads to our research question of whether real estate securities that trade at a premium relative to their fundamental value can capitalize on their public market valuations. In particular, can these firms raise capital in order to acquire private market real estate and ultimately enjoy the same premium valuation on the new capital? We refer to this value creation strategy as "public vs. private market arbitrage". In this paper, we define public vs. private market arbitrage as an attempt to increase the value of a company without any actual operational improvements. In the case of real estate securities, it means arbitraging the multiples at which private market real estate is traded relative to public market stock prices. In essence, multiple arbitrage hinges on asset valuations varying widely for different investors (i.e., public versus private).[1]

[1] In general, the academic literature on "multiple arbitrage" is relatively sparse, although the term has been associated as a type of value creation strategy of private equity firms. See for example the citation of a McKinsey Study by Matthews et al. (2009).

For example, if a REIT which trades at a significant premium to NAV raises new capital in order to acquire properties of the same type compared to the existing property portfolio, it seems reasonable to expect that, after transaction costs and completed integration, the REIT ultimately trades at its pre-SEO multiple.

A numerical example is as follows: assume the market capitalization of a REIT is 150 and its NAV is 100, which results in an NAV premium of 50% or a price-to-book ratio of 1. If that REIT raises equity of 10 (and a proportional amount of debt to keep it's leverage constant) and employs the whole amount to acquire private-market property, the NAV would increase to 110. Assuming a constant multiple of 1.5, the market capitalization would (eventually) increase to 165. This implies a market capitalization gain of 15, although only 10 has been raised in equity. The abnormal return of that REIT compared to all other REITs, which either did not or could not apply this strategy over the same period, would be 3.33% (5/150).

Such an extension of the premium valuation to new capital would result in shareholder value gains or outperformance compared to the REIT's peers. In contrast, capital raised by a REIT trading at a discount to NAV would be value-destroying for shareholders in case the new equity is ultimately priced at the pre-SEO discount to NAV. This leads us to our first hypothesis.

H1: Growth REITs outperform value REITs following capital issuances (SEOs + debt offerings).

When REITs raise new capital via debt offerings, a similar effect may occur, though through a different mechanism. Consider the example of two REITs, which are assumed to have the same amount of earnings and the same financial leverage. All else being equal, the growth REIT, i.e. the one with the higher price-to-book ratio, also trades at a higher price-to-earnings ratio. In case both REITs issue new debt to acquire private market real estate, the earnings of both REITs will increase by the same amount as long as the unlevered property return exceeds the cost of debt. However, under the assumption of constant PE multiples, the market capitalization of the growth REIT will increase more due to its higher PE-ratio, which would ultimately result in a outperformance of the growth REIT relative to the value REIT.

In addition to the PE-multiple effect, growth REITs may also benefit from a cost of capital advantage. According to Fama and French (1995), value stocks tend to obtain a higher probability of suffering from financial distress. In contrast, a premium to NAV may be interpreted as a signal that the capital market considers a growth REIT to be of superior quality compared to its peers. For this reason, it seems reasonable to assume that growth REITs also benefit from lower interest rates compared to value REITs when they issue new debt. Compared to value stocks, which issue debt at higher interest rates, this cost of capital advantage would also result in an outperformance of growth stocks in the periods following the debt offering compared to value stocks. The PE-multiple effect and the cost of capital advantage combined lead us to our second hypothesis.

H2: Growth REITs outperform value REITs following debt offerings.

The impact different cost of capital on the relative returns of value and growth stocks can also be explained by the formula for the leverage effect:

$$R_E = R_U + \frac{D}{E}(R_U - R_D) \qquad (1)$$

When the unlevered return on the property R_U exceeds the cost of debt R_D, the company benefits from a higher levered return on equity R_E. Lower cost of debt do not only increase the probability that the leverage effect is positive, but the magnitude of a (positive) leverage effect also increases with falling cost of debt. Even with a negative leverage effect (i.e., cost of debt is higher than the unlevered return on capital), low-cost-of-debt firms would outperform high-cost-of-debt firms, because the leverage effect is less negative.

For the purpose of our empirical tests, we follow the literature on the long-run performance of SEOs and debt issuances. Interestingly, our hypotheses regarding the outperformance of growth stocks are in contrast to prior studies on the long run performance following capital offerings. Spiess and Affleck-Graves (1995) document a substantial long-run underperformance of stocks following an SEO, and Spiess and Affleck-Graves (1999) document an underperformance following debt offerings.

Our empirical analysis is divided in two parts. First, we examine the long run performance of value and growth stocks by calculating buy-and-hold abnormal returns (BHARs) over the 36 months following the capital offerings. Next, we build value and growth portfolios consisting of stocks which had an SEO or debt issuance over the previous 36 months and use time series regressions to benchmark the portfolio returns against the four-factor model of Carhart (1997). Here, we distinguish between portfolio combinations of issuers and non-issuers, as well as value and growth stocks. Finally, we run panel regressions using of all types of portfolio combinations simultaneously in order to estimate the marginal impact of SEOs and debt issuances on the performance of growth stocks.

We empirically test our hypotheses using the historical constituents of the FTSE/EPRA NAREIT Global Real Estate Index. Our sample includes 502 REITs and REOCs from 11 countries over the 2000 to 2014 period. In total, we observe 249 SEOs and 90 senior debt issuances with the stated use of proceeds “investment” or “acquisition”.

Our analysis of BHARs provides support in favor of the public vs. private market arbitrage hypothesis (H1). On average, growth REITs outperform their benchmark, defined as the listed real estate index of their home country, by 9.45% (t-Statistic: 2.04) over the 36 months following the SEO. In contrast, value REITs on average underperform their peers. These results suggest that growth REITs benefit from public vs. private market arbitrage, as their premium valuation, at least in parts, extends to the newly raised capital. Further support for H1 is provided by our panel regression results, where we document a positive and significant marginal impact of SEOs on the abnormal performance of growth stocks.

Our results for debt issuances are similar to our findings for SEOs. The average BHAR of growth REITs over the 36 months following the debt issuance is 24.09% (t-Statistic: 2.33), while value REITs with debt issuances underperform their benchmark by 20.77% (t-Statistic: -1.52). Our portfolio regression results reveal that the risk-adjusted abnormal performance of growth REITs following debt issuances is positive as well (0,7% per month). Furthermore, our panel regression results document that the marginal effect of debt issuances on abnormal returns is positive in the case of growth stocks. Together, the results provide strong evidence in favor of H2.

To the best of our knowledge, ours is the first study which explicitly distinguishes between the long-run performances of value and growth stocks following capital offerings. Our results suggest this differentiation is an important factor, which has been neglected thus far.

The remainder of this paper is organized as follows. Section 2 discusses the related literature and hypotheses. Section 3 describes the data. Section 4 contains the empirical results, and Section 5 concludes.

2. Related Literature and Hypotheses

SEOs

The long-run underperformance following SEOs is a well-established result. Spiess and Affleck-Graves (1995) find that firms with SEOs underperform their benchmark by 22.84% for the three-year post-offering period. Howton et al. (2000) find that REITs, too, tend to underperform following SEOs.

The negative long-run performance following SEOs is often attributed to firms issuing equity when their shares are overvalued (Myers and Majluf, 1984), or to deteriorating firm operational performance following the issuance (Loughran and Ritter, 1995). Ghosh et al. (2011) document that REITs, too, tend to suffer from deteriorating operational performance following SEOs.

A recent strand of the SEO literature differentiates by the stated use of proceeds. Walker and Yost (2008) find that the market reacts more favorably to SEOs if the firm provides specific plans for the use of the soon-to-be-raised capital. Autore et al. (2009) categorize the stated use of proceeds into investment, recapitalization, and general corporate purposes. The authors find that issuers stating investment display little or no subsequent underperformance, whereas recapitalization or general corporate purposes experience abnormally poor performance in the subsequent three years. Silva and Bilinski (2015) find that firms citing investment needs show no abnormal performance after the offering. The authors attribute the lack of underperformance to issuers disclosing investment needs signaling positive NPV projects that require financing.

A strand of the REIT literature focuses on the announcement effects of acquisitions. Allen and Sirmans (1987), examine the gains to shareholders of acquiring REITs and detect a significant increase in stock price. The authors state that the primary source of the value gain seems to be improved management of the acquired trust’s assets. Ooi et al. (2007) study the wealth effects of property acquisitions, for Japanese and Singaporean REITs, and find a positive announcement effect. The authors state that economies of scale and better management by acquiring firms are the likely sources of acquisition-related economic gains. Ooi et al. (2011) study seasoned equity issuances by Japan and Singapore REITs. Here, too, the authors find a positive announcement effect.

In summary, the extant literature suggests that the long run performance following SEOs is negative in general. However, there tends to be less underperformance or even no abnormal performance if the stated use of proceeds is acquisitions or investments. In the case of REITs, this has even been associated with positive (short-term) announcement effects.

Since we are interested in potential arbitrage opportunities between public and private real estate markets, we focus on SEOs with the stated use of proceeds acquisitions or investments. We contribute to the literature by distinguishing between the ratio of price-to-fundamental value of issuing firms at time of the SEO. Assuming the pre-SEO multiple extends to the new capital as well, we predict that growth stocks will outperform value stocks. Here, it is important to note that the public vs. private market arbitrage strategies we attempt to examine would produce abnormal returns even without any efficiency gains, though transaction or integration costs may reduce potential excess returns of growth stocks and increase abnormal negative returns of value stocks.

Debt Issuances

The literature on the long-run performance following debt offerings is not as extensive as the SEO literature, and the findings are mixed. Spiess and Affleck-Graves (1999) document an underperformance following debt offerings. The REIT literature, however, finds no evidence for negative abnormal returns following debt offerings (Huerta-Sanchez, et al, 2012). In contrast, the authors find that during periods of increased debt issuance activity, even issuing REITs tends to earn positive abnormal returns.

Again, we aim to contribute to the literature by differentiating between the predicted long run performance effects for value and growth stocks. As in the case of SEOs, we focus on debt issuances with the stated use of proceeds "acquisitions" or "investments". It seems reasonable to expect that the financed property acquisition leads to an increase in earnings. All else being equal, growth stocks do not only have a higher price-to-book ratio than value stocks, but also a higher price-to-earnings ratio (or ratios of price to cash flow, or FFO). Assuming a constant post-debt offering multiple, the share price of growth stocks should increase more than the share price of value stocks.

Another argument why growth stocks may perform better following debt issuances is provided by Fama and French (1995) and Chen and Zhang (1998). The authors show that firms with a high price-to-book ratio have higher financial leverage, more earnings uncertainty, and are more likely to cut dividends compared to their low price-to-book counterparts. Given these characteristics, it seems reasonable to assume that growth stocks also benefit from lower cost of debt at the time of the issuance. From the equation (2) it can easily be seen that lower cost of debt results in superior operational performance.

Asset Growth in General

Our paper is also related to Ling, Ooi and Xu (2016), which considers a different question with another methodology and a focus on US-only REITs. Specifically, the authors examine the impact of asset growth on future returns. The authors find that fast-growing REITs tend to underperform slow-growing REITs. However, the authors also find that the (negative) asset growth effect is less pronounced for firms selling at a premium to NAV. The second finding is similar to our results, although we observe a *positive* effect for the tercile of REITs and REOCs that trade at the highest price-to-book ratios (or equivalently the highest NAV-premiums). Apart from the implications, our paper also differs from Ling, et al., (2016) with regard to the methodology. Our dataset enables us to identify the month of the capital offering, as well as the stated use of proceeds. Thus, we can identify the price-to-book tercile of a REIT or REOC at the time of issuance and more precisely measure the returns over the following 36 months. In contrast, Ling, et al. (2016), sort all REITs in June based on balance sheet asset growth over the previous year, which can be argued is a less precise approach, since by June the effect may already have occurred. Furthermore, our data enables us to disentangle whether asset growth was financed using equity (SEOs) or debt (debt issuances). Importantly, our results suggest asset growth can be beneficial for relative performance whether it is financed through SEOs or debt offerings, as long as the REIT or REOC enjoys a relatively high stock market valuation.

3. Data

Our sample is based on the historical constituents of the FTSE EPRA/NAREIT Global Real Estate Index over the 2000:01 to 2014:05 period. The index is comprised of listed equities with “relevant real estate activities." Relevant real estate activities are defined as the ownership, trading and development of income-producing real estate."

In our empirical analysis we benchmark the performance of real estate stocks against country-specific returns indices. To ensure the number of real estate stocks per country is sufficiently high, we exclude observations from countries with less than five real estate companies. Our final sample consists of 502 stocks from 11. [2]

Returns and balance sheet data are obtained from Datastream. Information on SEOs and debt issuances are collected from SNL. Overall, our sample period spans 249 SEOs and 90 debt issuances with the stated use of proceeds “acquisitions”, or “investments”. Table 1 contains some descriptive statistics on key variables.

Since our key differentiation by the time of the capital offering is the firm’s price-to-book ratio, we place a special emphasis on separating value and growth stocks in an accurate manner.

The majority of asset pricing studies separates value and growth stocks only once per year based on end of June data for the book-to-market ratio of equity (e.g. Fama and French, 1993). The rationale behind this procedure is to ensure that financial reporting data for the previous year are actually published and available to all investors. We use a monthly sorting procedure, based on Datastream's “Earnings per share report date (EPS)." We can thus ensure that financial reporting data are actually published as new portfolios are formed. For example, if the annual report for calendar year 2014 is published in April 2015, Datastream will report a new book value of equity from December 2014 onward, but we can shift this information by four months using the “Earnings per share report date."

[2] For a large part of our sample, the book equity per share may even be a good proxy for the firm’s fundamental value, or net asset value (NAV). This definition is sufficient if the home countries accounting regime requires fair value reporting. Then, the book value of equity can be understood as a sum of the valuation components of the company, assuming that cash and other assets, and liabilities are also reported at their market values. This condition is fulfilled for companies that report according to the International Financial Reporting Standards (IFRS), which was introduced in Europe and many other countries in 2005. In fact, only US stocks do not fulfill this condition, because historical cost-based US-GAAP accounting system. Hence, for all non US stocks from 2005 on, the price-to-book ratio can also be interpreted as a ratio of price-to-fundamental value.

Financial reporting frequency is generally semiannual and may even be quarterly. Thus, NAVs may only change semiannually, but we observe monthly changes in the book-to-market ratios due to share price fluctuations.

Finally, it is important to note that we classify value and growth stocks based on the price-to-book ratio of a stock relative to the average price to book ratio that stock's country. Value stocks are defined as those within the lowest tercile of the price-to-book ratio in their county, while growth stocks are defined as those within the highest tercile of the price to book ratio in a country.

4. Empirical Analysis

Buy-and-hold Abnormal Returns

We measure SEO post-issue performance as the stock's buy-and-hold return (BHR):

$$BHR_i = \prod_{t=1}^{T}\left(1 + R_{i,t}\right) - 1 \qquad (3)$$

where $R_{i,t}$ is the return of firm i in month t, and T is the earlier of the 3-year issue anniversary or the delisting date.

SEO abnormal returns after the offering are calculated as the buy-and-hold abnormal return (BHAR). Specifically, *BHAR* for issuing firm i is calculated as the difference between the *BHR* of the issuing firm and the *BHR* of the benchmark firm:

$$BHAR_i = \prod_{t=1}^{T}\left(1 + R_{i,t}\right) - \prod_{t=1}^{T}\left(1 + R_{benchmark,t}\right) \qquad (4)$$

where $R_{benchmark,t}$ is the EPRA/NAREIT index of the home country of firm i.

We use BHARs rather than cumulative abnormal returns (CARs) since this method more closely reflects investor experience when buying SEO stocks and holding them for 3 years after the issue. BHARs also avoid the unrealistic rebalancing assumption implicit in CARs that leads to high transaction costs (Barber and Lyon, 1997). Kothari and Warner (1997) do not recommend using CARs since the method leads to positively biased abnormal returns.

Figure 2 shows the cumulative BHARs of value (blue line) and growth (red line) stocks over the 36 months following an SEO with the stated use of proceeds "investments" or "acquisitions". While growth stocks continuously outperform their national EPRA index benchmark, value stocks substantially underperform.

Table 2 contains the average 36 month BHARs and their respective t-statistics. Panel A of Table 2 reveals that growth stocks on average outperform their benchmark by 9.45% (t-statistic: 2.04), whereas value stocks underperform their benchmark with -10.52% (t-statistic: -1.01). These results are consistent with H1, though the underperformance of value stocks is not statistically different from zero.

Figure 3 shows the BHARs following debt issuances where the stated use of proceeds is to finance investments or acquisitions. The long run performance following the debt issuance is similar to debt offerings. Panel B of Table 2 reveals that the average 36 months BHAR for growth stocks following debt offerings is 24.09% (t-statistic: 2.33). Again, the underperformance of value stocks is substantial (-20.77%), though not statistically different from zero (t-statistic: -1.52). These results are also consistent with H2.

Portfolio Regressions

Fama (1998) and Mitchell and Stafford (2000) advocate the use of the calendar-time approach since the method is less susceptible to the "bad model" problem and it does not compound spurious abnormal returns. The disadvantage of using the calendar-time method is that the approach has lower power to detect abnormal performance compared to event-time analysis. Loughran and Ritter (2000) show that using the Fama and French (1993) model captures only 50% of true abnormal returns, compared with 80% captured by BHARs with size and-book-to-market matched firms as benchmarks.

To test for abnormal performance after the issue, we use the Carhart (1997) four factor model, which controls for the market premium (MKT), the size effect (SMB), the book-to-market effect (HML), and the momentum factor (WML):[3]

$$R_{p,t} - r_{f,t} = \propto_p + \beta_1 \left(R_{M,t} - r_{f,t}\right) + \beta_2 SMB_t + \beta_3 HML_t + \beta_3 WML_t \qquad (5)$$

[3] The monthly SMB, HML and WML factors are obtained from Kenneth French's website (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/datalibrary.html). French's data library provides regional factors in USD for Asia Pacific ex Japan, Europe, Japan, and North America, so we convert the regional USD returns into local currency returns for the respective countries.

We apply the four-factor model to non-overlapping portfolios of growth stocks and value stocks, as well as issuing firms and non-issuing firms. Furthermore, we differentiate between SEOs and debt issuances. As our baseline model, we also apply the four factor model to value stocks and growth stocks. In total, we thus estimate 10 portfolio regressions.

We use equally-weighted portfolio returns as opposed to value-weighted returns to avoid our results are driven by outliers. Consequently, we also use the equally-weighted return of all real estate stocks of a country as the benchmark portfolio. Note that in the preceding analysis of BHARs, we had the (value-weighted) national Epra indices as a benchmark, which was consistent as BHAR imply no rebalancing, and so does the EPRA index. In the portfolio analysis however, we must take care of outliers, consequently, the benchmark should also be equally weighted.

Table 3 contains the four factor regression results for 10 portfolios. Models (1) and (2) contain the base case results for value and growth stocks, respectively. The coefficients on the Alpha represent the portfolio's monthly abnormal risk-adjusted return. Consistent with Woltering et al. (2015), value stocks in general outperform the benchmark, whereas growth stocks underperform. The annualized risk-adjusted outperformance of value stocks is about 3,6%, whereas the annualized underperformance of growth stocks is about 4,8%. These base case suggests that portfolios consisting of value stocks start with an advantage, whereas portfolios of growth stocks start with a disadvantage, i.e. it is harder for the portfolio consisting of growth stocks with SEOs to outperform given that growth stocks in general tend to underperform.

Models (3) to (7) contain the portfolio regression results for SEOs. Neither the coefficient on the risk-adjusted performance of value stocks with SEOs in the previous 36 months (Model 3), nor the portfolio of growth stocks with SEOs (Model 4) is statistically different from zero. Thus, the results provide no evidence in favor of H1. However, keeping the baseline results from Models 1 and 2 in mind, it is remarkable that any outperformance of value stocks disappears, while the underperformance of growth stocks also disappears.

Models (5) and (6) contain the regression results of value and growth stocks without SEOs in the previous 36 months. The results are very similar to Models (1) and (2).

Models (7) to (10) contain the regression results for debt issuances. The portfolio of value stocks with debt issuances in the previous 36 months does no longer outperform the benchmark (Model 7).

Model (8) provides evidence in favor of H2, since the risk-adjusted performance of value stocks with debt issuances in the previous 36 months is positive and statistically different from zero.

The results for non-issuers in models (9) and (10) are similar to the base case results.

In summary, the base case results, in particular the hurdle for growth stocks to outperform their benchmark, limit the statistical power of our tests in this section.

Panel Regressions

In order to overcome to hurdle that value stocks tend to outperform the benchmark, whereas growth stocks tend to underperform, we estimate a panel regression model which includes six portfolios – the portfolios of the three terciles based on the price-to-book ratio, each split up into firms with and without capital issuances in the previous 36 months. We then introduce indicator variables for value and growth, as well as issuing and non-issuing firms. In order to directly test our hypotheses 1 and 2, we then use interaction terms between these variables:

$$R_{p,t} - r_{f,t} = \propto_p + \beta_1 (R_{M,t} - r_{f,t}) + \beta_2 SMB_t + \beta_3 HML_t + \beta_3 WML_t + Value + Growth + Issuer + Value * Issuer + Growth * Issuer \qquad (5)$$

Table 4 contains the panel regressions results for the analysis of SEOs. Each of the three models contains a dummy variable, indicating whether the portfolio is a value portfolio, a growth portfolio, or a portfolio consisting of stocks which had an SEO in the previous 36 months. Model (1) also includes an interaction term between Value*Issuer to test whether the portfolio of value stocks with issuances significantly underperforms. Model (2) includes an interaction term between Growth*Issuer to test whether the portfolio of growth stocks with issuances significantly outperforms, and model (3) includes both interaction terms simultaneously.

In all three models, the coefficients on value are positive (but not significant), while the coefficients on growth are negative (and significant). That way we control for the general outperformance (underperformance) of value (growth) stocks. The coefficient on Issuer is negative in all models, though only significant in model (2). This indicates that portfolios with SEOs in the previous 36 months tend to underperform.

Our primary interest is on the interaction terms. The interaction term between Value*Issuer in model (1) is negative, but not statistically different from zero. Hence we find no evidence that value stocks with SEOs underperform their benchmark. In contrast, the coefficient on Growth*Issuer in model (2) is positive and significant, which is consistent with H1. However, the effect is no longer significant in model (3), which may include too many variables given the small number of cross-sectional units.

Table 5 contains the same approach as in Table 4, but focuses on debt issuances instead of SEOs. While there is no evidence in favor of underperformance for value stocks with debt issuances, the coefficients on the interaction term between Growth*Issuer in models (2) and (3) are both positive and statistically significant. This finding provides evidence in favor of H2.

Conclusion

This study examines the impact of the price-to-book ratio at the time of capital issuances on the long run performance following the event. Using different methods, we find strong evidence in favor of the public vs. private market arbitrage hypothesis. Real estate stocks with high price-to-book ratios tend to outperform their benchmark following both, SEOs and debt issuances. This suggests that their premium valuation extends to the newly raised capital, as well. While our evidence regarding the underperformance of value stocks is considerably weaker, value stocks tend to have negative returns following capital issuances. The spread between both groups is particularly large, which is consistent with H1 and H2.

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Figures

Figure 1: Average Premiums/Discounts to NAV from 2005-2014. This figure shows average NAV-Spreads for a global sample of REITs and real estate operating companies (REOCs). The calculations are based on REITs and REOCs from IFRS-countries, which require fair value accounting of properties and thus allow for a parsimonious definition of NAV. In each month, we rank a given country real estate firms by their price-to-book ratio. The red (blue) line represents the average NAV-spread for the tercile of REITs and REOCs with the highest (lowest) price-to-book ratio in a given country.

Figure 2: BHAR Returns following SEO with the intended use of proceeds "acquisitions". This figure show the cumulative BHAR returns of value (blue line) and growth (red line) stocks over the 36 months following an SEO with the stated use of proceeds "investments" or "acquisitions".

Figure 3: BHAR Returns following debt offerings with the stated use of proceeds: acquisitions This figure show the cumulative BHAR returns of value (blue line) and growth (red line) stocks over the 36 months following a debt issuance with the stated use of proceeds "investments" or "acquisitions".

Tables

Table 1: Descriptive Statistics

	SEOs	Debt Offerings	Price-to-Book	N (Total)	N(Average)
Australia	22	2	1.17	43	17.08
Belgium	1	0	1.08	7	5.39
Canada	39	7	1.88	35	17.33
France	0	0	1.45	14	8.24
Germany	11	4	1.23	18	8.06
Hong Kong	12	13	1.18	34	18.52
Japan	21	16	1.67	41	22.05
Netherlands	6	0	0.94	12	7.44
Singapore	13	7	1.13	21	12.31
Sweden	2	2	1.19	13	6.37
USA	110	35	2.38	195	103.38
Total	249	90	1.72	502	240.16

Table 2: BHAR returns following SEOs and debt offerings.

	N	Mean BHAR	t-statistic
Panel A: SEOs (acquisitions)			
All issuers	227	0.0655	1.40
Value	59	-0.1052	-1.01
Growth	69	0.0945	2.04
Panel B: Senior Debt Issuances (acquisitions)			
All issuers	76	0.0572	0.93
Value	21	-0.2077	-1.52
Growth	30	0.2409	2.33

This table reports buy-and-hold abnormal returns (mean BHAR) and t-Statistics of firms with capital issuances over the 36 months following the event. The benchmark is the EPRA/NAREIT index of the firm's country of origin. Panel A reports BHARs following SEOs with the stated use of proceeds "acquisitions". Panel B reports BHARs following debt issuances with the stated use of proceeds "acquisitions". The second (third) row reports the BHARs for the subsample of value (growth) stocks. Value and Growth stocks are identified by ranking all stocks in a given period according to their price-to-book ratio of equity. Following a capital offering, the categorization as a value or growth stock is held constant for the following 36 months.

Table 3: Portfolio Regression Results

	General		SEOs (acquisitions only)				Debt Issuances (acquisitions only)			
			Issuer		Non-Issuer		Issuer		Non-Issuer	
	Value (1)	Growth (2)	Value (3)	Growth (4)	Value (5)	Growth (6)	Value (7)	Growth (8)	Value (9)	Growth (10)
MKT	1.136***	0.960***	1.064***	1.268***	1.151***	0.923***	1.100***	1.209***	1.181***	0.893***
	(40.14)	(44.94)	(20.20)	(25.18)	(37.47)	(39.03)	(12.56)	(14.08)	(36.41)	(38.34)
SMB	0.111**	-0.046	0.214*	0.113	0.122**	-0.072	0.186	-0.386**	0.138**	-0.048
	(2.17)	(-1.11)	(1.93)	(1.05)	(2.18)	(-1.58)	(1.01)	(-2.06)	(2.36)	(-1.06)
HML	0.026	-0.052	0.006	-0.465***	0.043	-0.035	-0.393*	-0.780***	0.056	-0.062
	(0.49)	(-1.31)	(0.04)	(-3.54)	(0.75)	(-0.80)	(-1.77)	(-3.16)	(0.94)	(-1.43)
WML	-0.167***	0.170***	0.135**	0.071	-0.197***	0.185***	-0.112	-0.087	-0.186***	0.176***
	(-5.02)	(6.81)	(2.05)	(1.11)	(-5.48)	(6.66)	(-1.01)	(-0.78)	(-4.89)	(6.45)
Alpha	0.003**	-0.004***	-0.003	-0.002	0.003**	-0.004***	0.002	0.007*	0.002	-0.003***
	(2.02)	(-3.74)	(-1.11)	(-0.66)	(2.01)	(-3.29)	(0.44)	(1.70)	(1.38)	(-2.83)
Observations	173	172	151	148	173	172	150	142	173	172
R^2	0.943	0.939	0.803	0.864	0.937	0.920	0.642	0.688	0.933	0.917

This table reports the portfolio-level regression results. In Model 1 (Model 2), the dependent variable is the equally-weighted return on the portfolio of value (growth) stocks, identified as the tercile of stocks with the lowest (highest) price-to-book ratio relative to the average price-to-book ratio in the stocks home country at the end of the previous month. In Models 3-6, value and growth portfolios are separated into portfolios which had an SEO in the previous 36 months and those who didn´t. Likewise, Models 7-10 separates value and growth portfolios into debt issuing and non-issuing firms. Control Variables include the market return (MKT), the size factor (SMB), the value factor (HML), and the momentum factor (WML). T-statistics are in parentheses, and parameters marked ***,**, and * are significant at the 1%, 5%, and 10% levels, respectively.

Table 4: Panel Regression Results: SEOs

	(1)	(2)	(3)
MKT	0.996***	0.996***	0.996***
	(65.23)	(65.29)	(65.26)
SMB	0.041	0.040	0.040
	(1.41)	(1.38)	(1.38)
HML	-0.002	-0.001	-0.001
	(-0.06)	(-0.03)	(-0.03)
WML	0.008	0.008	0.008
	(0.43)	(0.44)	(0.44)
Value	0.003	0.002	0.002
	(1.37)	(1.06)	(0.96)
Growth	-0.003*	-0.006**	-0.006**
	(-1.75)	(-2.52)	(-2.39)
Issuer	-0.001	-0.003*	-0.003
	(-0.54)	(-1.86)	(-1.37)
Value*Issuer	-0.003		-0.001
	(-0.85)		(-0.27)
Growth*Issuer		0.006*	0.006
		(1.82)	(1.63)
Constant	0.001	0.002*	0.002
	(0.96)	(1.77)	(1.52)
Observations	1325	1325	1325
R^2	0.826	0.826	0.826

This table reports the panel regression results for 6 portfolios which are formed based on the three of the price-to-book ratio, each split up into firms with and without SEOs in the previous 36 months. Control variables are the same as in Table 3, but additionally include indicators for value and growth portfolios, as well a dummy which indicates the portfolio consists of firms with an SEO in the previous 36 months, and interaction terms between these variables. T-statistics are in parentheses, and parameters marked ***,**, and * are significant at the 1%, 5%, and 10% levels, respectively.

Table 5: Panel Regression Results: Debt Issuances

	(1)	(2)	(3)
MKT	0.949***	0.948***	0.948***
	(52.75)	(52.94)	(52.90)
SMB	0.012	0.008	0.008
	(0.32)	(0.23)	(0.21)
HML	0.034	0.036	0.036
	(0.87)	(0.92)	(0.92)
WML	-0.018	-0.017	-0.017
	(-0.77)	(-0.77)	(-0.77)
Value	0.005	0.003	0.002
	(1.57)	(1.56)	(0.79)
Growth	0.001	-0.005*	-0.006*
	(0.52)	(-1.78)	(-1.85)
Issuer	-0.001	-0.006***	-0.007**
	(-0.69)	(-2.73)	(-2.52)
Value*Issuer	-0.003		0.002
	(-0.66)		(0.54)
Growth*Issuer		0.014***	0.015***
		(3.37)	(3.35)
Constant	-0.001	0.001	0.002
	(-0.40)	(0.74)	(0.89)
Observations	1248	1248	1248
R^2	0.754	0.756	0.756

This table reports the panel regression results for 6 portfolios which are formed based on the three of the price-to-book ratio, each split up into firms with and without debt issuances in the previous 36 months. Control variables are the same as in Table 3, but additionally include indicators for value and growth portfolios, as well a dummy which indicates the portfolio consists of firms with an SEO in the previous 36 months, and interaction terms between these variables. T-statistics are in parentheses, and parameters marked ***,**, and * are significant at the 1%, 5%, and 10% levels, respectively.

User-focused design factors of workspace for nearly zero energy office renovation: findings from literature review

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Abstract

This paper highlights the importance of considering user satisfaction in office renovation. User-focused design approach in nearly zero energy office (nZEO) renovation is a way to increase user satisfaction and the value of office quality while meeting energy efficiency goal. The purpose of this paper is to investigate considerable measurement factors affecting user satisfaction. It is also to help better understating about user/occupants' preferences. Measurement factors are studied through literature reviews in relation to user satisfaction of workspaces. The approach aims to give a guide for analysis and evaluation of user satisfaction and to strengthen their importance in an office renovation. The findings present that main measurement factors to increase user satisfaction are not only associated with indoor environmental quality but also with psychological issues such as a feasibility of collaboration, social contact, etc. Additionally, the relationship between measurement factors and hierarchy of user requirements are described.

Keywords: *User values, occupant well-being, user satisfaction, office renovation, work environment*

1. Introduction

An awareness of healthy life has led to a concept of office design aimed to provide comfortable work environment and to make high quality workspaces. Management-oriented researches have addressed work environment by focusing on organisational structure and employee's performance (Danielsson and Bodin, 2008). This is because employees are likely to be motivated in better work environment.

Many studies have proven the correlation between better work environment and user satisfaction (Rothe et al., 2011a, Leifer, 1998, Wilkinson et al., 2011, Ornetzeder et al., 2016). At the same time, we all know we need to save energy and renovation of existing buildings is a potential solution to reduce energy consumption. In the European Union, around 85% of the 160 million buildings are showing thermally uneconomic conditions (SwedishScienceNet, 2010). According to EED (EU energy efficiency directive), the existing buildings have to be renovated within 30-40 years. Nearly zero energy office (nZEO) renovation can offer many opportunities in relation to reducing global energy use, reducing carbon footprint and, on a smaller scale, the energy bill. SHC (Solar Heating and Cooling) project reports state that building renovation can contribute to a 50-70% reduction in the overall energy demand (IEA, 2016).

However, does nearly Zero Energy Buildings (nZEB) provide a comfortable working environment to end-users? Nearly zero energy office renovation requires motivators other than energy saving benefits. In a functional perspective, nZEO renovations also have to provide a high level of comfortable work environment for employees' well-being and satisfaction besides realising a high energy reduction goal. A research addressed that indoor conditions may be connected to employees' mental health (Houtman et al., 2008). Although recent researches have investigated the correlation between user satisfaction and Indoor Environmental Quality (IEQ), there are more measurement factors which need to be taken into account during a renovation plan. Existing satisfaction measurement methods pay less attention to the functional relationship between work patterns and user satisfaction in energy efficient buildings. Thereby there is a lack of user-focused design approaches or guidelines for office renovation.

User satisfaction can be determined by physical comfort and psychological comfort levels. For example, concentration, privacy, social contact with colleagues and work space responding to a collaborative work environment are more related to cognitive experience and psychological comfort. From this point of view, user satisfaction needs to be measured by psychological condition as well as physical condition.

Therefore, the aim of this paper is to identify measurement factors which have to be considered during the pre-design phase of nZEO renovation. The main research question that will be answered in this paper are: what are the initial factors to maximise user satisfaction of nZEO renovation? How can the user satisfaction level be measured and evaluated?

2. Literature review

2.1 An overview of the occupant satisfaction for workplace

2.1.1 Definition of the occupant satisfaction in workplaces

Occupants satisfaction is a quite intangible aspect. Van der Voordt (2003) defined that employee satisfaction is to meet the employees' preferences and needs in their working environment, and the increase of employee satisfaction level is caused by their physical and psychological comfort degree. The user needs are important elements for employees to perform well. On the other hand, the preferences are not a fundamental element for user satisfaction. However, if the workplace would be according to the preferences, occupants would show higher user satisfaction (Rothe et al., 2012). The majority of researches have investigated the relationship between environmental influences and occupants' well-being by focusing on the range from physical-related well-being such as indoor environmental quality (IEQ) (Levin, 2003, Humphreys, 2005, Mofidi and Akbari, 2016, Wargocki et al., 2012, Newsham et al., 2009) to psychological-related well-being. These factors are controlled by organizational management, employees' way of work described by work pattern, flexibility of workspaces and social interaction (Ekstrand and Hansen, 2016, Haynes, 2007, Ruostela et al., 2015, Harris, 2016). The influence of the office layout, ceiling height and openness (Vartanian et al., 2015, Danielsson and Bodin, 2008) also have been studied as a part of psychological parameters.

2.1.2 The importance of occupant satisfaction for user-focused design approach in workplaces

The level of user satisfaction has been emphasised by several researchers as a significant factor for successful sustainable buildings as well as conventional office buildings (Brown and Cole, 2009, Wilkinson et al., 2011). The traditional real estate supplier-driven business has been changed to a demand-driven business (Niemi and Lindholm, 2010). Thus, understanding users' needs and preferences is necessary to manage the demand side in office markets.

Furthermore, occupiers work environment satisfaction can reduce vacancy rates The real estate market has put an effort into attracting current and new tenants. Appel-Meulenbroek (2008) argued that real estate management needs to focus more on the current tenants' needs than on potential new tenants' needs with several reasons:

- Keeping the current tenants' costs less than appealing to new tenants;
- The reduction of vacancy rate;
- The reduction of marketing cost;
- The reduction of operating cost.

As mentioned above, considering occupant satisfaction has a great impact on the organisational management of workspace.

2.1.3 Occupant preferences and expectations about workplace

Understanding occupants' preferences and their requirements for the work environment is a key driver to increase their satisfaction level and thereby adding value. IEQ and office design are the main elements which have an effect on the degree of user satisfaction. A preliminary study (Wilkinson et al., 2011) analysed parameters influencing user satisfaction in office buildings from various perspectives.
Table 1 summarises key categories from different studies influencing on the user satisfaction level.

From the employee's perspective, the interesting issues of nZEO buildings is well-being and health. The tenant is not interested in how much energy the building consumes and how much energy is saved. The employer or owner of a company rents an office because of its function and performance, supplying high quality work environment to employees. According to a survey (Rothe et al., 2011b), the most important attributes of the workplace are: functionality, comfort of the workspace, opportunities to concentrate and indoor climate. End-users want to work in a hygienic, comfortable and user controllable workplace where they can feel at home.

Another study about the user value of office buildings distinguished the meaning of well-being into psychological well-being and physical well-being. The concept of functional quality of buildings is divided into nine aspects: accessibility, parking facilities, efficiency, flexibility, safety, spatial orientation, privacy, territoriality and social contact, health and physical well-being, and sustainability (Van der Voordt and Wegen, 2005).

Besides the indoor quality of sustainable offices, building owners or tenants are also interested in the economical perspective. Building owners invest money for energy renovation, yet in the end the tenant pays the energy bill. Increased energy efficiency through nZEO renovation brings energy cost saving and provides financial benefits to users/tenants. Therefore, the prior requirements of office space for occupants define the physically and psychologically comfort, flexibility of workspace and efficiency.

References	User preferences/requirements factors																		
	Thermal comfort	Air quality	Noise control	Light /Daylight	User control	Spatial comfort	Privacy	Ability to do work	Concentration	Communication /Collaboration	Social contact /breakout space	Work location/ Flexibility	Ambiance	Aesthetic	Dimension work desk	ergonomics	Building location and amenities	View/ Scenery	Well-equipped facility
(Al Horr et al., 2016)	+	+	+	+			+					+		+			+		
(Ekstrand and Hansen, 2016)										+		+							+
(Harris, 2016)									+	+		+	+						
(Techau et al., 2016)		+	+	+	+								+					+	
(Ornetzeder et al., 2016)	+	+	+	+		+	+	+			+	+							
(Appel-Meulenbroek et al., 2011)	+				+	+	+				+	+	+	+	+	+			+
(Wilkinson et al., 2011)	+	+	+	+	+							+							+
(Rothe et al., 2011)	+	+	+	+		+	+	+	+	+		+	+				+		+
(Niemi and Lindholm, 2010)	+	+	+	+						+		+							+
(Oseland, 2009)							+		+	+	+	+						+	
(Danielsson and Bodin, 2008)					+		+		+	+	+	+							
(Haynes, 2007)	+		+	+			+		+	+	+	+		+					
(van der Voordt, 2004)	+		+	+					+	+	+	+	+					+	+
(Levin, 2003)	+	+		+	+														
(Leifer, 1998)	+	+	+	+		+	+	+				+							

Table 1 Criteria influencing user satisfaction in office buildings

2.2 The relationship between office layout and work pattern

Office layout has a strong interconnection with user satisfaction in a work environment. Modern office spaces are organised according to occupants' ways of working. This is the same for conventional offices layouts (Table 2), however the work pattern is getting divers.

In detail, organisations are changing and evolving. There are more team-based work and employees are physically more independent from their workspace than according to traditional workstyles. These changes brought the results of various strategies for workspace uses. The strategies basically stress that workspace should respond to workers' mobility (Table 3).

(Vos et al., 2000),(Dobbelsteen, 2004)		(Danielsson and Bodin, 2008)	
Cellular office	1-3 workplaces	Cell office	Single room office
Group office	4-12 workplaces	Shared room office	2-3 persons
Open-plan office	+13 workplaces	Small open plan	4-9 persons
		Medium-sized open plan	10–24 persons
		Large open-plan	+ 24 persons
Combi Office	Group work based	Combi office	Employees spend >20% of their time at workstations other than their own team-based work
Free office	Any place can turn into workspace	Flex office	No individual workstation The flex office includes backup spaces. Dimensioned for <70% of the workforce to be present simultaneously.

Table 2 Classification of office spatial concepts

Alternative workspace use strategy	Concept	Opportunities	Reference
NewWow (Multi-space use layout)	Comprehensive redesigning of work settings and practices (including physical, virtual and social working environment)	Space usage efficiency and costs dropped by 50%	(Ruostela et al., 2015)
Space-sharing structure	A workplace assigned to two or more employees, who use the workplace on a rotating basis	People always use the same space, giving employees sense of private territory	(Vos et al., 2000)
Non-territorial setting	A number of workplaces assigned to two or more employees Employees do not have their own territory	Provides opportunities for spontaneous interaction among employees Workgroups or departments are mobile, higher flexibility.	(Vos et al., 2000)
Activity-based setting	Workplaces are dedicated to specific tasks Employees move from one workplace to another depending on work activity Emphasizing mobility of employees	A more active approach to work, increased freedom and flexibility, better collaboration and cost savings due to less workplaces	(Vos et al., 2000)
Agile working	Workplaces emphasize mobility of workers within the office and outside of office.	Responding to flexibility, the choice of workers. Strengthening collaborative work and mobility.	(Harris, 2016)

Table 3 Alternative workspace use strategies

2.3 Measuring user satisfaction and measurement factors

2.3.1 User satisfaction measurement

Although measuring user satisfaction is complicated, it is imperative to develop a measurement method that can be applied to building design. Higher users' satisfaction can strengthen renovation design solutions and its total value (Shafaghat et al., 2016). Existing measurement tools mainly focusing on indoor environment of an office. It is considered as a healthy indoor environment when 80% of end-users are satisfied with the environmental settings (ASHRAEStandard, 2004).

Study	Title	Results	Tools
(Candido et al., 2016)	BOSSA: A multidimensional post-occupancy evaluation tool	Evaluation tool for nine indoor environmental quality dimensions and occupants' satisfaction	Building Occupants Survey System Australia (BOSSA)
(Kim and de Dear, 2013)	Workspace satisfaction: The privacy-communication trade-off in open-plan offices	Satisfaction level with workspace environment was the highest for those in enclosed private offices	indoor environmental quality (IEQ) dimensions
(Wargocki et al., 2012)	Satisfaction and self-estimated performance in relation to indoor environmental parameters and building features	Occupants in green buildings are on average more satisfied with their air quality and thermal comfort. Green offices prefer the spatial layout of open or partitioned floor plans to enclosed private offices.	LEED-rated/green buildings for indoor environmental quality (IEQ)
(Bluyssen et al., 2011)	Comfort of workers in office buildings: The European HOPE project	Perceived comfort is more than the indoor air quality, noise, lighting and thermal comfort responses. it also includes emotional state	Sir Karl Popper's theory model, Principal component analysis (PCA),
(Schakib-Ekbatan et al., 2010)	Occupant satisfaction as an indicator for the socio-cultural dimension of sustainable office buildings development of an overall building index	User satisfaction for comfort parameters at workplaces was affected by temperature, lighting conditions, air quality, acoustics, spatial condition and office layout	Principal component analysis (PCA), Post occupancy evaluation (POE)
(Veitch et al., 2007)	A model of satisfaction with open-plan office conditions: COPE field findings	18-item environmental satisfaction measure formed a three-factor structure reflecting satisfaction with: privacy/acoustics, lighting, and ventilation/temperature	Satisfaction with environmental features (SEF) measure
(Humphreys, 2005)	Quantifying occupant comfort: are combined indices of the indoor environment practicable?	Balanced occupants' satisfaction and overall assessments about indoor environment.	ASHRAE scale
(Leifer, 1998)	Evaluating user satisfaction: case studies in Australasia	User survey instrument based on nine parameters five grade scales regarding to user satisfaction	User satisfaction evaluation tool developed by Works Canada

Table 4 Summary of studies investigating parameters affecting user satisfaction and analysing tools

2.3.2 Physical factors

Thermal comfort

Thermal comfort is subjective and depends on dynamic factors made up of three variables: air temperature, relative humidity and relative air velocity (Hong et al., 2015). Although providing a place where every occupant can be satisfied is impossible, it is important to define the thermal comfort level of occupants. Thermal comfort in an office can be measured by the number of discomfort complaints from occupants (Al-Horr et al., 2016). A laboratory study (Lan et al., 2012) examining the effect of operative temperature on relative work performance shows that in summer, the indoor temperature for optimum performance can be increased from 23.9 to 25.4°C. In winter the indoor air temperature for optimum performance can be decreased from 21.9 to 19.7°C. Another laboratory study of (Tham and Willem, 2010) tested thermal comfort level and time exposure of occupants in three different room conditions. The result is thermal comfort is the highest at the 23°C condition. Two studies (Lan et al., 2012, Tham and Willem, 2010) proved that the preferred indoor air temperature level for occupants' comfort is regardless of energy efficiency considerations.

Air quality

A work place with good air quality has an impact on occupants' health condition and their satisfaction rate. IAQ studies have found these issues by conducting questionnaire about irritation, headaches, fatigue and illness, which are related to Sick Building Syndrome (SBS) symptoms (Seppänen et al., 2006, Wargocki et al., 2000). Better indoor air quality also reduces the health risks of occupants and increases productivity (Lan et al., 2011). Indoor air quality can be controlled by the ventilation rate and high ventilation rates result in a good indoor air quality. It means that Indoor Air Quality (IAQ) rate is assessed by the ventilation rate.

A ventilation system for a building should be selected based on building types and occupant behaviour patterns and expectations (Kim and De Dear, 2012). There are different ventilation systems which include a natural ventilation system or a hybrid/mixed mode HVAC system. The mixed mode HVAC system has a higher satisfaction rate and energy savings than other mechanical systems (Ezzeldin and Rees, 2013). In order to investigate the interrelation of air quality and satisfaction level, occupants' perception survey should include illnesses and SBS symptoms in their work place. These results will lead to better understanding IAQ condition and influence of user satisfaction.

Noise control

Noise has a high relevance in office building design. The effect of noise can lead to distraction and interruptions in workability of occupants. Noise in the office normally comes from colleagues and it often occurs in the open-plan office (Ornetzeder et al., 2016). Noise performance is also related to privacy in this case. A recommended minimum background noise level for open-plan offices is 45 dB, for cellular offices 40 dB (Field, 2008). In European standards, the level for the cellular office is from 30 to 40 dB and for the open-plan office is from 35 to 45 dB.

Light and daylight

The light condition is one of the factors that gives an influence on user satisfaction in their work place. The reason is that daylight has an impact on human visual comfort. The majority number of office employees prefers natural light over artificial light (Galasiu and Veitch, 2006) because of physical and psychological reasons. A research (Villa and Labayrade, 2016) aiming for energy-efficient luminous environment identified the optimal solution to be suitable for different users' requirements. The solution is to supply an individual task lamp which does not have a high-power demand (11W each) in shared office spaces.

The choice of window and shades system, in this point of view, is an important factor. It is not only because of providing outdoor views but also serving natural light. Preferred window size varies for different office conditions; however, a survey (Galasiu and Veitch, 2006) stated that the optimal window size on average needs to be in the range of 1.8 to 2.4 m in height to provide a wide lateral view.

2.3.3 Psychological factors

User control
Personal control for indoor environment is highly likely to improve user satisfaction level. A research stated that when office workers can control their own indoor environment comfort, health are improved (Raw et al., 1990). On the other hand, from an economic perspective, user control can result in a waste of energy due to inefficient thermal control (Shahzad et al., 2016). There are different employee groups in an office according to their various tasks and they have different work patterns. These conditions affect different building operational patterns. In other words, it is necessary to find out what are the optimal points of IEQ level for various occupant types and the optimal operational strategy will be the key to catch two goals.

Privacy
Privacy has a close relationship with office layout. The privacy of office workers is better protected in an individual space than in an open plan office. Privacy is distinguished by physical and cognitive aspects; sound privacy, visual privacy and perceived privacy, experienced by uncontrolled social contact and interruptions (Kim and de Dear, 2013). Specifically, the open-plan office has poor privacy conditions. However, it cannot be said that the open-plan office is highly likely to have privacy problems: it depends on the density of workstations. A larger workstation in open-plan office increases the satisfaction rate with acoustics and privacy (Leder et al., 2016) because the distance between colleagues is much greater. In terms of job satisfaction, privacy is related to more psychological demand which can lead to a higher level of cognitive satisfaction.

Spatial comfort
Spatial comfort is one of the key factors that determines to which extent workers would be satisfied and motivated in their workplace (Chandrasekar, 2011). Although this is a quite subjective factor, it is worthy to note for office design. Reasons for this is that several studies have revealed that office workers who feel comfortable with their work environment tend to show better work result and have relatively high self-esteem (Leder et al., 2016, Lee and Brand, 2005, Salama and Courtney, 2013). The awareness of spatial comfort is also associated with the organisation of workspace. One of the significances of office functionality is flexibility. With going along the lines of the view, a survey has revealed almost 90% of the respondents answered that better workplace layout and functional support result higher overall workers' performance (El-Zeiny, 2012, Gensler, 2006). Through other studies, it is identified that spatial comfort is determined not only by thermal conditions, light and acoustics but also by workplace design and layout.

Concentration
Concentration level is one of the major requirements for improving user satisfaction (Rothe et al., 2011b) and it is emphasised for the impact on users' task performance. Concentration is disturbed by different elements: air quality, loud noise, conversation and glare. These are physical elements. In the work environment, concentration is a significant factor for a worker who has more single-oriented work task.

Communication/collaboration
Improvement of the communication level is likely connected to productivity. It is because of better information exchange between colleagues and having more contact provides more understanding of each other (Van der Voordt, 2003). This factor is decided by the office layout and operational conditions.

Social contact
Establishing social contact is one of the factors to satisfy user demands. The definition of social contact here means interacting with other people to take a break or to have a chat. This parameter is highly linked to office layout and workspace operation.

2.3.4 The relationship between measurement factors and user requirements

Many studies mixed physical quality and psychological or cognitive quality of user satisfaction. In order to assess the level of user satisfaction, the measurement factors will be divided into three categories; basic human needs/must-be requirements, psychological needs/one-dimensional requirements and self-fulfilment needs/attractive requirements (Maslow, 1943, Witell et al., 2013, Shafaghat et al., 2016).

Maslow's Hierarchy of Needs (Maslow, 1943) depicts the user needs in three categories: basic needs, psychological needs and self-fulfilment. In overview of Maslow's model, the user needs can be divided into two parts: physical basic needs and psychological needs. Other studies demonstrated that satisfaction levels can be divided into three levels: necessity (basic satisfaction), performance (moderate satisfaction), and happiness (superior satisfaction) (Mbachu and Nkado, 2006, Wilkinson et al., 2011). These ways of grouping are quite similar to the Kano method (Witell et al., 2013). These humanistic concerns can be applied in conceptual design process and should not be ignored in the earliest design stage (Zhao et al., 2015).

3. Reflection and conclusion

3.1 Conclusions/findings

The findings from this paper highlight the importance of user satisfaction in office renovation, and functional requirement of nZEO renovation. The relationship between physical and psychological functionality of offices and 10 factors of user satisfaction have been analysed as shown in Figure1.

Physical conditions in workspaces such as heating, cooling, ventilation, light and noise are fundamental requirements for users. The parameters also have a strong connection with energy consumption. Besides the fundamental human needs, office occupants tend to seek to have cognitive/psychological comfort for better work environment. These factors lead to a higher-level of user satisfaction.

The level of user satisfaction is highly connected to the following ten parameters, and overall satisfaction is added to prevent missing indicators in case:

- Thermal comfort
- Air quality
- Noise control
- Light
- User control
- Privacy
- Spatial comfort (open space design and flexibility)
- Concentration (ability to do your work)
- Communication with their colleagues/work groups
- Social contact
- Overall satisfaction

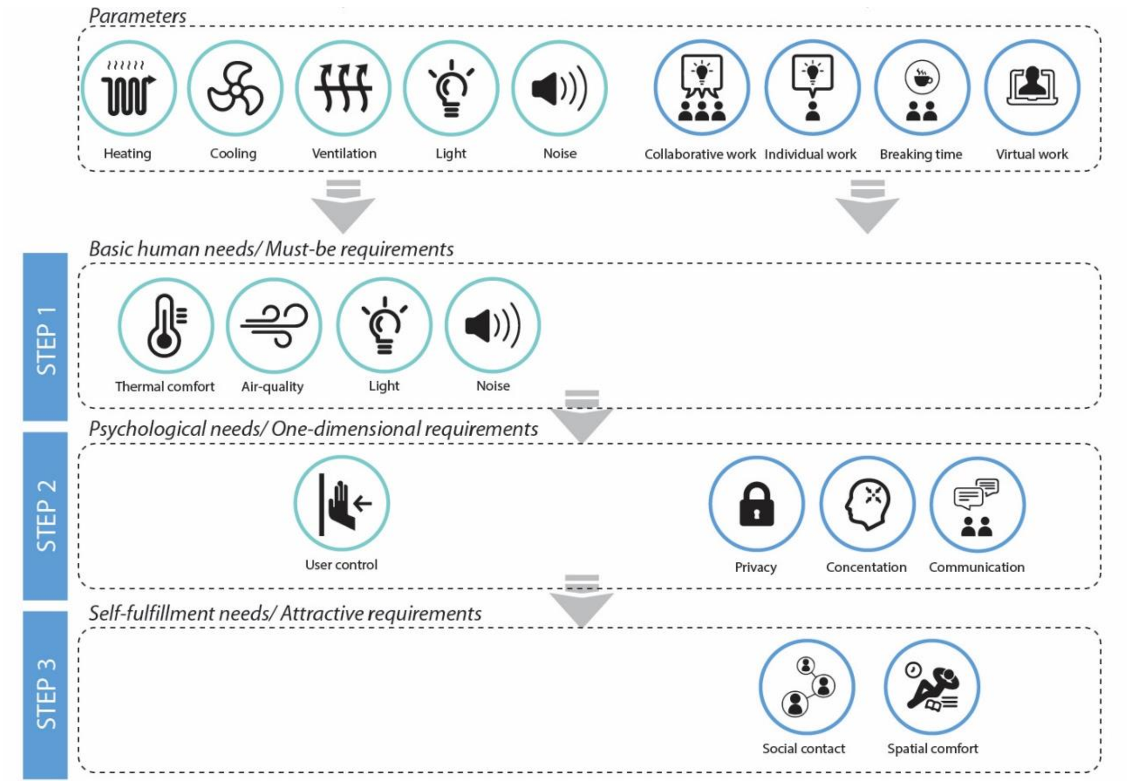

Figure 1 Classification of parameters for user-focused design

3.2 Discussion

In this paper, the measurement factors, used in other studies, to increase user value and satisfaction have been classified and analysed. In terms of indoor quality of offices, thermal comfort, air quality, light and noise are the most important factors. In addition, user control is also concerned as one of the important factor in relation to cognitive aspect. Although many researches deal with flexibility of workplace, in detail, the flexibility is highly related to communication/ collaboration. The factors such as privacy, concentration and social contact are also essential factors to achieve higher user satisfaction. It is important to consider how to measure the factors and how to evaluate user satisfaction. Particularly, cognitive-related factors such as social contact and spatial comfort are subjective so that the result might only rely on the user opinion. One possible method to study these cognitive related factors, is by using a questionnaire to conduct a survey. However, the quantitative data still need to be investigated, in order to find out whether they are essential factors for office renovation or not.

The definition of user satisfaction in this paper is different from job satisfaction of employees. Job satisfaction often include emotional aspects from having good working relationship with a boss or a leader or colleagues. This job satisfaction, however, is not part of the user-focused renovation design approach.

3.3 Recommendations and outlook

Some limitations may be related to evaluating user satisfaction and interpreting the results of collected data. For the further quantitative research, a questionnaire should be strongly connected to each measurement factor. As a result, the questionnaire needs to show each factor can potentially support users' requirements. The results of this paper provide important parameters for user-focused office renovation and strengthen the cogency of user requirements associated with office renovation.

The correlation between measurement factors and user-focused design strategies has to be studied. Likewise, the strategies to increase user satisfaction should be studied more in-depth. The next step in this research will be to look at the direct and indirect influences of user-focused design factors on nZEO renovation design strategies.

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Promises and lures of open creative space for innovative teams

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ABSTRACT

Like activity-based workspaces, innovative spaces are deemed to be efficient and flexible, but they are most often called upon to support collaborative and creative team work instead of individual whom sometime will work in a team. Our research objective is to further explore the links between the project team and its space to identify advantages as well as drawbacks and to determine if the company benefits from the adoption of open creative space with diverse collaborative areas. A case study of one world class company with several teams and diverse spaces is in progress.

Our results suggest that communication and coordination are well served by open creative spaces without negative impact on employees autonomy but intimacy is jeopardized which, paired with background noise that never stop, can lead to stress at work. This research shows that several elements of open spaces are felt in the same way by a team or by department employees. But a team requires proximity that is essential to the exchange of information and coordination among the members while the lateral and hierarchical relationships are slightly redefined.

Building managers needs to understand the percieved message that the individual receives from his organization through the design and allocation of spaces devoted to him and his team: freedom of action, empowerment to innovate or alienation to an environment that he does not control and which reduces him to a means of production until he leaves exhausted? The relationships between the feeling evoked by ambient conditions and their impacts on the individual, his tasks, his colleagues and his team is stronger than we could think. The temperature, the lighting as well as the variety of meeting rooms and their equipment's form a complex whole of which we do not yet know all the impacts on the worker and the teams. Indeed, the diversity of spaces and their equipment fits perfectly into the teams' activities, resulting in a positive synergy in terms of coordination, communication and creativity. Creative spaces deserve their name when it comes to teamwork.

Keywords : workplace creativity; innovation; team-based workspace; corporate property management; open space

INTRODUCTION

Real estate is often the second most important item of expenditure in an organization's budget (Hills & Levy, 2014; Haynes & Nunnington, 2010) and as such should be subject to strategic decision. Like activity-based workspaces, innovative spaces are deemed to be efficient and flexible, but they are most often called upon to support collaborative and creative team work instead of individual whom sometime will work in a team. Their purpose is to provide a high-performance workspace that maximizes employee productivity and reduces long-term operating costs (GSA, 2006). Interest in the study of these spaces has been sustained for several years but the results are still few (Morrow et al., 2012; Appel-Meulenbroek, 2016). Currently, neither the academic research nor the consultants work makes it possible to affirm that a tangible gain is acquired. Our research objective is to further explore the links between the project team and its space to identify advantages as well as drawbacks and to determine if the company benefits from the adoption of open creative space with multiple diverse collaborative areas : « As leaders consider their workspace needs, they should be informed of workspace fads versus workspace intent » (Blakey, 2015, p. 107).

The article begins with a review of the literature on collaborative spaces as well as the development of new products by project teams. We present the methodology based on a case study with interviews and survey and then analysis of the preliminary results.

LITERATURE REVIEW

The concept of space is often associated with architecture and design. However, the design of workspaces and the optimization that can arise from the ways of organizing workstations are of particular interest to management sciences and even more to real estate management. The organization of large workspaces in office towers has followed the development of vertical displacement technologies and the increasing demand for work to be carried out by "white-collar" or office workers (Blakey, 2015). During the last years, bureaucratic work has undergone a new evolution, increasingly including a part of work considered creative and collaborative. Work spaces have consequently followed this change with the new development of collaborative and creative spaces.

Flexible and open spaces appeared in the 1970s (Cohen, 2007); they have evolved to contain fewer individual spaces, a greater density and more common spaces (Hills & Levy, 2014). There are three main lines of management research that focus on space: 1) in support of innovation performed by new product/service development team 2) the more general one that focuses on office workplaces in support of performance and well-Being of employees; 3e) and a new trend that focuses on collaborative spaces outside the organization, whether they be originating from social economy or from business incubators. It is mainly space in support of innovation activities of an organization that this article focuses on.

McElroy and Morrow (2010) argue that several benefits can arise from changes in workplace layout, such as promoting lateral relationships between individuals of the same or of different teams, which in turn benefit innovation and raise creativity. It also makes it possible to crystallize a fierce will for change and to diminish the hierarchical culture that inhibits innovation. Other impacts are felt at the level of culture, tasks formalization, control given of the professional, flexibility, altruism, collaboration, satisfaction with employment and colleagues, emotional commitment to its organization, and the perception of organizational support (Waters & Roach, 1979). To sum up research has determined that productivity is linked to individual workspace preferences being met within the physical work environment (De Croon et al., 2005) whereas worker satisfaction reduce absenteeism and staff turnover (Waters & Roach, 1979) also reduce stress and health care costs meanwhile reinforces employee commitment (Haworth, 2015).

Today, teams need to be creative and innovative. In fact, creativity is seen as a source of innovation (Woodman et al, 1993; Amabile, 1996). “Creativity is the individual’s use of knowledge and practical experience, and willingness to work with others – within the constraints of the environment and its resources – to solve problems” (Slocombe, 2000, p.167). Innovation can be seen as the translation of ideas into new products, services or processes that can be marketed or used by the organization (Mumford et al., 2002). For a company that is competitive in terms of new products, real property management and architectural design should imperatively support creativity, generating innovation and a fortiori potential benefits. This suggests that the innovative design of workspaces has the potential to positively or negatively influence organizational culture and creative processes (Kallio et al., 2015). The transdisciplinary and collaborative nature of the work of new products and services development teams requires spaces that support both dynamic interactions or intense and focused individual work (Hua et al., 2011) and the work in a community of practice mediated by the TICs that characterize the project teams (Harvey, 2014). The connectivity and the intelligence of the place have their source in the technological environment of which the emerging part can consist of systems with visual and auditory sensors which react to the persons by restoring from their computer memory the requirements and data of the last working session of the team (Oksanen & Ståhle, 2013).

Some characteristics stand out: the manoeuvrability or modularity of the elements constituting the meeting and individual workplace, the possibility of transforming the space according to the needs and the work style as well as its connectivity and intelligence. Indeed, the possibility of being able to move its space gives the feeling of empowerment, of autonomy in the accomplishment of the work (McElroy & Morrow, 2010). The density of the place and the proximity of the team colleagues, the intimacy and the control on its environment are other elements perceived by the employees in front of their place of work. Finally, we can also add the aesthetic, attractiveness and emotional, artistic or intellectual stimulation of the place (Oksanen & Ståhle, 2013). The place itself can generate a feeling of identification. Kristensen (2004) concludes that space affects the well-being of individuals, channels of communication, availability of knowledge tools and enhances coherence and continuity. Emotional commitment, professional and social interaction are highly positive, while distraction is their negative counterpart (Haynes, 2008). Recognition of the person by the organization translated into physical signs, psychological security and the comfort of recognizing oneself in a familiar place express other important elements of the physical environment. In this context, the question of the impact of workspaces on satisfaction, efficiency and well-being has long been of interest to companies and researchers (Moles, 1972; 1977; Fischer, 2004; Vischer 2008). At the level of comfort, one finds the ambient conditions and the spatial conditions at the level of the work station. Ambient conditions include brightness, noise, air quality, air movement, temperature and humidity (Sundstrom & Sundstrom, 1986). The spatial conditions of the workstation include the size of the individual workstation, furnishings and equipment, privacy, the degree of partitioning and personalization of the workstation. However, perceived comfort is a complex phenomenon whose components can vary according to dimensions such as culture (Bluyssen et al., 2011) and whose interaction between components is not simply linear (Vischer, 2008). Vischer (2007) divides comfort into three categories: physical comfort, which includes safety, hygiene and accessibility; functional comfort, which refers to ergonomics in support of the performance of tasks and activities at work and; finally, psychological comfort which includes the sense of belonging, ownership and control over the workspace.

To remain competitive and ensure the realization of their strategy, the organizations must often manage several projects simultaneously (Morris & Jamieson, 2005; Bredillet, 2008). To manage the innovation effectively means to juggle with knowledge and resources (Hurmelinna-Laukkanen, 2011). For this purpose, the organizations adopt information technologies more and more, including the social media with an aim of supporting the innovation (Marion et al., 2014).

One of the challenges of developing new products is to manage interdependencies while sharing the specialized resources (Pavlak, 2004; Yaghootkar & Gil, 2012). To this end, coordination is a process of managing interdependencies (Barni, 2003) embedded in project management processes and both are particularly well served by the use of management information systems. For example, project management software such as MsProject or Primavera are used to split the project into its thousands of tasks, to estimate, schedule, assign and follow them. These series of activities can be made shown to team members on the walls of their "war room", a dedicated room to a project team. In addition, communication is one of the most important factors in the success of projects (Södelund, 2011) and in this sense the project manager must master the art. It is also a dialogue tool with the stakeholders, which allows the «project scope» to be redefined on a regular basis in relationship with the objectives (Ziek & Anderson, 2015). Another relevant element in this issue is the variability of size in the projects according to their different phases in their life cycle. Coupled with the issue of proximity, this reality requires flexibility, planning and creativity on the part of managers of the real property function in order to create the appropriate spaces for each team.

All the aspects of the working environment can be decomposed according to the level of observation: the individual, the team or the organization and according to the three levels of comfort target: physical, functional or psychological. Table 1 shows this tentative framework with examples.

Table 1. Elements of space strategy & some influential factors

Analysis level	Output comfort target		
	Physical	Functional	Psychological
Individual	*Basic health and safety; HACV; hygiene*	*Ambient conditions supporting work tasks (e.g. lighting near computer screen)*	*Feedback through workspace; participation in workspace decisions. Intimacy, commitment, stress*
	Ambient conditions (noise, temperature, air quality, etc.) Workstation (equipment, size, location, etc.) Support environment (facilities, work area)		Sundstrom & Sundstrom (1986); Veitch et al. (2003); Mulville et al. (2016) Sundstrom & Sundstrom (1986); Hua et al. (2010) Sundstrom & Sundstrom (1986)
Interpersonal relationship	*Basic health and safety; HACV; hygiene.*	*Open space, varied meeting-space with collaborative tools , informal areas; team customized space*	*Team control of furnishing and tools layout in its workspace; territorial definition; team customized space.*
	Workstation environment (density, colleague proximity; location) Room layout (location relative to colleagues) Floor layout (open space, distance between workstation & facilities)		Hua et al. (2010); Sundstrom et al. (1980) Sundstrom & Sundstrom (1986) Hua (2007)
Organization	*Basic health and safety; HACV; hygiene*	*Corporate values integrated in space; decisions about the workspace viewed as investment not cost.*	*Workspace is linked to organizational effectiveness; environmental design of workspace responsive to operating procedures and business processes.*
	Building (work unit differentiation, general layout, aesthetics)		Sundstrom & Sundstrom (1986); Kallio et al. (2015)

Analysis level from Vischer (2007); input/output adapted from Sundstrom & Sundstrom (1986); examples adapted from Vischer (2007) and this study.

METHOD

We privileged the case study of a large innovative hi-tech company with a mixed strategy of data collection (semi-structured interview, observation, secondary data analysis and survey) mainly for the potential wealth of data and the opportunity of a quasi-experimental design because of teams installed in different environments. At the submission moment, the case is still undergoing.

RESULTS & INTERPRETATION

The data come from several sources within the case study, we will present them in sequence in this section to regroup then some notable results in the discussion.

THE CASE

The analyzed site of a big company comprises three buildings with teams divided on floors renovated in "open creative space", or not. Each team size varies according to the project phase in progress. The industry of the company is worldwide and the competition is fierce. The industry being of high technology, the technological developments and the diversity of the platforms require a workforce at the cutting edge of technologies and being able to count on the most recent tools and work processes. The organization pressing challenges relate to innovation and productivity as well as the capacity to attract and keep top talent. In both cases, the organization' response largely depends on the environment it places at the disposal of these workers and teams. Because indeed, a diktat in force in this endeavour is that the members of a team must be in close proximity to each other. The methodology imposed on all development teams is the stage-gate. At a finer level, each team is free to use what it deems appropriate or even follow no type of project management.

Since the company foundation until the 2000s, the real property management aims at providing healthy basic working space mainly open since teams were asking for proximity. But the internal pressure coupled with trend setting Internet communication about creative space with Google as an exemplary leader push the real property director toward the concept of space flexibility as a measure of performance which leads him to hire a small team of designers and project managers to improve effectiveness of new workspace layouts when acquiring new spaces or during renovations. The team has begun transforming the spaces based on its knowledge and experience. They took the initiative of gathering the opinion of team members and leads and directors to improve their understanding of the requirements and increase the efficiency of the new spaces but after some years they decide to validate the results with external specialists from university.

What can be seen at first glance is the efficiency of the workstation installations that are done "overnight": for example a new employee coming from another division boxed his few personal effects including his keyboard and his mouse and finds it all at his new place up and running. The movement of the equipment or its replacement is a decision of the service which is specifically in charge of this function. This efficiency is supported by an adapted infrastructure that was installed as renovations took place. Another very visible element is that each floor is divided to give the largest areas to the teams as well as a variety of meeting rooms (large or small, equipped or not, decorated or not, etc.), relaxation areas or testing spaces (closed or semi-open laboratories as appropriate). Plants, islands of service, personalization elements are arranged in such a way as to create a certain intimacy. Most desks, chairs, filing cabinets are on wheels to allow teams to redeploy space according to a new working configuration.

There are still a few areas that are not renovated and the teams who find themselves there know that it is based on rational choices but cannot help thinking that they are "in punishment". It appears that the impact of new spaces is positive in terms of occupant satisfaction. However, management is wondering what could be the optimum threshold for investment in these spaces.

SURVEYS FROM INTERIOR DESIGN DEPARTMENT

For several years now, the Interior design department has been collecting the opinions of occupants and users of spaces and equipment installation. These are questionnaires distributed either (1) on the Intranet, (2) on tablets left in the areas, and (3) by e-mails after an equipment loan. There were also attendance surveys of the different spaces coupled with the reservations of the meeting rooms.

Overall the reviews of the various in-house surveys show that occupants respond willingly and directly - response rate at about 40% -. The elements considered non-functional or unpleasant are reported clearly. It shows that the building's basic performance (air quality, cleanliness, temperature and brightness) and equipment are satisfactory but could be improved. Individuals complain of excessive density and lack of privacy but require that all team members must reside in the same open area. They protest for the lack of free rooms (unavailable, too few or reserved) when they need them while rooms are sometime unoccupied. Some type of meeting room like small ones for 10-14 persons seems overbooked and rarely free. Next are the big ones that are regularly reserved. Regardless of size, those who do not have big screens and white board are more often than not unoccupied. War rooms that are dedicated to a single team, vibrate with activities and the walls are covered with information. According to the respondents, there are no meeting rooms for 1 to 3 people and this is a big shortage. Another issue is the reservation system which is not convenient but also people don't make the necessary to cancel a room when it is no longer needed. This appears to be widespread behavior (myseat, 2017).

INTERVIEW DATA & ANALYSIS

The first interviewed people were from the property management department and Interior design (5 persons). On the administrative side, we also saw a person from the communications department, a staffing person at strategic level, the IT director as well as his assistant responsible for the IT equipment installed in the different spaces. On the team side, the eleven interviews so far concern two multi-projects programs that well represent the decision-making levels and functions: technology, ideation/design and management.

The main results are presented in the same format as table 1 which allows to organize the conceptualization of the influences of spaces on the individuals, the teams and the organization.

Table 2. Influential factors as perceived by the interviewees

Analysis level	Output comfort target		
	Physical	Functional	Psychological
individual	Cleanliness is associated with respect by management, this sensitivity is exacerbated by other initiatives that promote health such as baskets of fruit placed in work areas and available for all as well as access to the gym created especially for employees. The brightness conditions are variable but mostly adequate to the needs of the various team trades almost everywhere.	Ergonomics is not optimal but most workstations can be moved and file folders "seat" are present almost everywhere to allow a colleague to sit next to a worker. IT environment & space equipment's are tailored to each trades and team but there is no personalization accepted. Some people say they do not have everything they need to do their job well.	Despite frequent surveys and suggestion boxes, employees do not feel they are being consulted/listened to. The space design reinforces the company culture which allows freedom to the individuals and the teams. Indeed, the floor layout allows a lot of different way to work alone or on various team size. Employees believe that this freedom very positively influences their creativity. No control on any ambient conditions like temperature. There are not enough places to isolate themselves when they have to phone or think. Some feel neglected and affected while they notice the level of housekeeping and maintenance.
Interpersonal relationship	Open spaces reinforce the behavior of directors to participate in all formal and informal meetings, so they must work before and after the usual hours to complete their tasks. Long hours have become the norm for all those who supervise teams.	Employees appreciate the fact that whiteboards and writable walls are everywhere. This enables them to improvise a discussion anywhere. Moreover, these devices promote the clarity of the communication and the ease of memorization. Guerillas sometimes burst between team leads around the allocation of spaces: everyone believe proximity is paramount. Yet they also complain about the lack of privacy and the impossibility of pondering for productive individual work.	Team are free to personalize their space but du to so frequent relocations few do it. Employees often make small improvised meetings of 2-3 around a workstation but they feel disrespectful of others around du to noise and distraction they generate.
Organization	The employees isolate themselves from the ambient noise with headphones. It is a behavior adopted by all. There are not enough locker rooms to leave boots and coats which can amplify the problem of moisture and odor in areas as well as spread of colds. Healthy behaviors are promoted by fruit baskets and the gym created for employees.	Since supervisors are always on the side, each employee is free to carry out his duties as he sees fit, provided he quickly reports problems. Communication and coordination are well served without negative impact on employees autonomy but intimacy is greatly jeopardized. Proximity makes conversations very easy, but not only those that are useful. Directors and managers, who are also in open spaces, lack privacy for certain tasks such as staff assessment.	The arrangement of spaces reinforces the feeling of belonging to his team and that the company is an important player in the industry. Trust is thus increased. Plants are placed everywhere and fruit baskets are added almost every morning, which contributes to well-being and the feeling of being well-treated. The dress code is simple: you do what you want. The sense of freedom and control is reinforced.

At the physical and individual levels, layout improvements can lead to expectations of comfort and well-being. Indeed if management looks at things that appears essential but less fundamental than those that affect health, it is normal to assume that the basic functions, in parallel, are mastered. The studied company leases the buildings, which can complicate its control. Nonetheless, a small proportion of employees interviewed noted and were offended by the lack of cleanliness or air quality deficiencies in their areas: they feel neglected and affected. Few people complain that brightness hinders work on the screen but some lack energy in areas without much natural light and the majority work with earphones to mitigate ambient noise and be able to concentrate. On the other hand, when it is necessary to call for personal reasons, employees look for isolated places, which is rather rare. The need could be filled by a few small rooms for individual work, which would also allow managers to withdraw from the team area from time to time.

At the functional level, the ergonomics of workstation and workplace is also discussed by some. They ask to improve comfort for lightening the constraint of the sitting position for long hours. They would like also a more open design allowing for impromptu meetings of 2 or 5 people with spare stools left in reserve without disturbing neighbors whom are very close. Informal areas that are still within sight or cafeteria are considered a less attractive choice. The proximity of the entire team is truly integrated into thinking patterns and reflexes. This paradigm seems characteristic of teamwork on complex and highly integrated projects. At the same time, filling this need for proximity seems to be sufficiently worth for the company that this is not questioned.

A difficulty that is not present for the teams concerns the appropriation of a place and the tendency to make it its own despite the policy of vagrancy - take the first place available, they are all similar (Hoendervanger et al., 2016). This is not the norm for teams for two reasons: 1) inside the team most workstations are highly customized to the occupant tasks and sub-teams are intentionally placed for better communication within and between sub-teams (McElroy and Morrow, 2010) and 2) different teams don't mix since their project have different objectives and sometime fight for the same resources (Hurmelinna-Laukkanen, 2011). The battle for space climbs one or two steps in the hierarchy and is settled far from team members. It is present in this company in part because space is seen as an encrypted message from the management according to its appreciation of the work of the team or the individual (Waters & Roach, 1979). In addition, as the size of the team is subject to variability during the project, project management tries to continually optimize the space based on the addition of resources that need to be briefed on progress and issues, and what better way to do this than to have them all together.

> *"The space in which we are is scrap. We have delivered an excellent product in the latest project and we are still here without planning for any renovations. Everyone perceives it as a punishment even if it is just a rational decision." Creative project director*

People in charge of the teams or of critical aspects such as quality monitoring are affected. Indeed, the close proximity of all allows them to remain constantly on the lookout for problems but it disrupts their ability to cut off the flow of activity to concentrate on tasks that are not of an interacting nature. The result is that they all work long hours. For example, two of them mentioned taking long voluntarily walks between their homes and the office to take advantage of these moments of reflection. Others say they get back to work once the children are in bed - the remote connection being much appreciated. Some arrived very early but are often surprised by colleagues. Many work at least one weekend day. Some burden could be relieved by several small rooms as discussed earlier.

> *"A workspace well situated for me? Right in the middle of my team's area, I have to be accessible. My people must not make any effort to join me. I moved myself from the last place - too far from my people." Project manager*

Another paradox concerns the perception of not being consulted when there are several means actively implemented to get their opinion. The history of in-house surveys and interviews lead us to argue that employees do not always associate changes in their environment with the responsive action of the layout design department. The results of the consultations could be communicated. It is likely that an internal marketing effort would pay off.

The personalization of the spaces of each team is not very widespread mainly because of the fear of being relocated soon. On the other hand, most affirm that it would be a good thing even if, already, the feeling of belonging to the team is very strong (Brown & Zhu, 2016). In fact, it is more perceived as a reward from top management and a way to stand out from other teams. To this end, the teams want the workspace design department to offer its services and tools to make this customization easier and partially standardized in the spirit of the company. Already the space design is perceived as a nice proof of the company support toward freedom to explore personal and team own track which confort the findings of Kallio et al. (2015).

The interior design department took the initiative to set up a gym, add plants and provide fresh fruit baskets regularly. The main result is to relax the atmosphere by allowing people to believe themselves a little "like home". One can notice, moreover, they are several to wear a t-shirt bearing the effigy of the company (McElroy & Morrow, 2010).

CONCLUSION

The objective of this study was to trace the impact of creative spaces on the dynamics of new product development teams. To do so, we conducted a case study with observations and secondary data. We also studied two large teams of the high-tech company using data obtained by the department of interior desing in a few surveys as well as interviews that we conducted with sixteen people.

Most physical components of open creative spaces influence teams in the same way as individuals in "activity-based" spaces. Everyone appreciates conditions favorable to physical and mental health (Veitch et al., 2007) and large open spaces that often allow greater brightness and more direct access to colleagues. However when the target is functional, we can put forward that team members are no longer satisfied with a few spaces but require a wide range of choices. With the possible exception of supervisors who tend to stay closer to their team to prevent problems (as they have the opportunity), team members do not change so much their behavior. They change a lot of emails for live discussions above their desktop. A paradox can be seen that is difficult to solve: one that opposes proximity to intimacy which can then lessen the positive influence of these "tools" yet well suited to teamwork. We have observed that they are satisfied with the level of communication and coordination due to proximity to all. They also consider that freedom and autonomy are widely granted which allows for greater creativity as Kallio et al. (2015) find it. But they all report that privacy is diminished, which leads certain to feel stress and eventually leave even when they feel close to the values of the company. When the message is well adapted to the functional and psychological level, this leads in our view to greater appropriation of space.

Building managers needs to understand the percieved message that the individual receives from his organization through the design and allocation of spaces devoted to him and his team: freedom of action, empowerment to innovate or alienation to an environment that he does not control and which reduces him to a means of production until he leaves exhausted? The relationships between the feeling evoked by ambient conditions and their impacts on the individual, his tasks, his colleagues and his team is stronger than we could think. The temperature, the lighting as well as the variety of meeting rooms and their equipment's form a complex whole of which we do not yet know all the impacts on the worker and the teams. Indeed, the diversity of spaces and their equipment fits perfectly into the teams' activities, resulting in a positive synergy in terms of coordination, communication and creativity. Creative spaces deserve their name when it comes to teamwork.

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Does Adversity Affect Long-Term Consumption and Financial Behaviour? Evidence from China's Rustication Programme*

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Abstract

In this paper I examine the long-term consequences of adversity on consumption and financial behaviour, using the largest forced migration experiment in history. From 1966 to 1978, 17 million urban youths in China, mostly junior or senior high school graduates, were sent to the countryside to do farm work for an average of three to four years under a rustication policy. Using data from the mini-census in 2005, I find that the rusticated generation behaves more conservatively than the non-rusticated generations over the long term, as they consume less housing and purchase more insurance and pension. In addition to the cross-generational influence, I investigate the intra-generational effects of rustication with data from the Chinese Household Income Project and the Chinese Twins Survey in 2002. A similar conservative behavioural pattern is revealed. Individuals with rustication experience spend less on housing, accumulate more saving and insurance, and invest less in risky assets, compared to their age-eligible but non-rusticated peers. Applying a habit-forming model, I suggest that one interpretation for the conservative behaviour lies in the habits formed during adversity. The results shed light on how a policy, especially in the early stage of life, influences one generation over the long term.

Key words: adversity, long-term effects, housing consumption, financial behaviour.
JEL Codes: J6, R23, D01.

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1 Introduction

Does adversity affect long-term consumption and financial behaviour? How does a policy influence one generation over the long term? I aim to address these two questions in this paper. Literature in economics, sociology, and psychology demonstrates evidence to support the correlation between early life experience and later economic behaviour. In the literature for the Great Depression, Malmendier & Nagel (2011) find that macroeconomic experiences influence individuals' risk taking behaviour. The generation which experienced the Great Depression tends to take fewer financial risks throughout their lives. They also have a markedly lower consumption of durable goods, as shown in Romer (1990) and Crafts & Fearon (2010). Schoar & Zuo (2013) examine the managerial styles of CEOs, and find that those entering the labour market during recession periods behave in a more conservative way.

Similar evidence is revealed among studies on the median- or long- term effects of military service or wars. Benmelech & Frydman (2014) study the behaviour of CEOs with military experience, and find that they are associated with conservative corporate policies and ethical behaviour. Blattman (2009) and Bellows & Miguel (2009) indicate that war violence changes individuals' political attitudes. They are more likely to join local political groups and vote after wars. With respect to other life adversities, Alesina & La Ferrara (2002) and Castillo & Carter (2007) present empirical evidence that people with traumatic experiences, such as disease or divorce, have less trust in others but show more altruism.

In this paper, I use a new quasi-natural experiment, China's rustication policy (programme), to investigate the long-term effects of adversity on economic behaviour. From 1966 to 1978, 17 million urban youths, mostly junior or senior high school graduates (born between 1946 and 1961), were sent to the countryside to do manual work for three to four years on average. With a shift from privileged urban status to an unprivileged rural one during adolescence, their behaviour on consumption and finance is expected to change. Previous studies have intensively investigated the long-term influence of rustication on education and income (Deng & Treiman, 1997; Giles *et al.*, 2008; Xie *et al.*, 2008; Yang & Li, 2011). Several papers investigate its impacts on mentality or consumption, focusing on the dimension of home appliances and beliefs (Zhang *et al.*, 2007; Zhou, 2013; Gong *et al.*, 2014). Kinnan *et al.* (2015) link the rustication programme with the later reforms to the household registration system, and demonstrate that improved access to migration induces higher levels of consumption and lower volatility in rural China. Nevertheless, as a big change in identity during adolescence when one's belief toward the world is first established (Ghitza & Gelman, 2014), the influence of rustication on later economic behaviour is worth investigating. In this paper, I concentrate on examining its impacts on consumption and financial behaviour, as well as demonstrating auxiliary findings on labour input, education, income and belief, which echo the literature (Deng & Treiman, 1997; Xie *et al.*, 2008; Yang & Li, 2011; Gong *et al.*, 2014).

I apply difference-in-difference, ordinary least squares (OLS), and fixed-effects estimations to the mini-census in 2005, the Chinese Household Income Project in 2002, and the Chinese Twins Survey in 2002 respectively, to examine the cross- and intra- generational impacts of rustication. To start with, I apply difference-in-difference strategy to the mini-census in 2005 to depict the general behavioural pattern of the rusticated versus non-rusticated generations. Rustication varies across cohort and region. The generation of 1946-1961 were subject to the policy, with almost half of the population rusticated in practice. Cohorts born before 1946 or after 1961 were rarely sent to the countryside. In addition, rustication was more severe in large cities than small ones as the revolutionary propaganda was much stronger and coercion was enforced (Deng & Treiman, 1997). I find that the rusticated generation behaves more conservatively in consumption and finance than the non-rusticated cohorts. They live in smaller houses, spend less on housing purchase, and buy more insurance and pension even after three to four decades. These findings are consistent with the literature that individuals experiencing economic recession tend to spend less on durable goods (Romer, 1990; Crafts & Fearon, 2010), and have a lower willingness to take financial risk (Malmendier & Nagel, 2011; Schoar & Zuo, 2013; Benmelech & Frydman, 2014).

Rustication was announced as compulsory for all age-eligible high-school graduates at the start. However, the quotas of rustication varied according to economic situation and policy changes. When the quota was less than 100% (not all high-school graduates were required to be rusticated), some selection occurred (Li *et al.*, 2010). There are two types of selection in the rustication. First, there exists cross-household selection, as the previously privileged families (such as the rich and/or educated) lost power in the social re-shuffle and were less able to help their children acquire exemptions from rustication (Zhou & Hou, 1999; Li *et al.*, 2010). Second, there is within-household selection. In the case of a binding quota, the parents had to choose which child(ren) to be rusticated. To overcome the potential endogeneity, I specify two empirical strategies. On the one hand, I explicitly control fathers' socioeconomic traits as proxies for the family background in the OLS estimation, with data from the 2002 Chinese Household Income Project in absence of the co-residency bias.[1] On the other hand, I apply twin and sibling fixed-effects estimations to the 2002 Chinese Twins Survey, which is the first dataset on twins in China. Bias from common family background is eliminated. In addition, the within-household selection is largely reduced in the specification for identical twins, as they are genetically the same, and have far less difference than non-identical twins or siblings that are further apart (Li *et al.*, 2010). Moreover, I specify a robustness check controlling the difference between identical twins using birth weight as a proxy for initial endowment following the literature (Rosenzweig & Wolpin, 1995; Behrman & Rosenzweig, 2004).

Just as with the difference-in-difference estimation, I find that individuals with rustication experience behave more conservatively than their age-eligible but non-rusticated peers. They spend less on housing consumption, save more, purchase more insurance, and invest less in risky assets such as stocks and bonds. Consistently across the three empirical strategies, I find that rustication decreases lifetime schooling, but does not have a significant influence on long-term income, as shown in previous studies (Meng & Gregory, 2002, 2007; Xie *et al.*, 2008; Yang & Li, 2011). The results remain robust if the potential influence from initial endowment, occupational choice, and spousal traits is taken into account.

Why do the rusticated individuals behave conservatively? With a simple habit-forming model, I consider one interpretation lies in the habits shaped during adversity (Becker & Murphy, 1988; Or-

[1] The 2002 Chinese Household Income Project collects socioeconomic information on parents, despite their living separately or being deceased. Thus it overcomes the co-residency bias in conventional household surveys.

phanides & Zervos, 1994; Crawford, 2010; Costa, 2013). Take housing for instance: given that the past and current consumption of habit-forming goods are complementary, the habit of depressed housing consumption formed during the rustication leads the later consumption to converge to a low steady state.[2] Empirical evidence examining the influence from the incidence versus the intensity of rustication supports the habit explanation. I find that it is mainly the rusticated years (the intensity) rather than the participation in the programme itself (the incidence) that contributes to the findings. The longer the rusticated period, the more likely is the convergence to a steady state of housing consumption. Interview evidence also supports this interpretation. The sent-down youths self-reported that they learned about the toughness of life from the adverse experience in rural areas (Zhou, 2013; Gong *et al.*, 2014). It is consistent as well with the evidence on the role of habits and values as determinants for behaviour and socioeconomic changes, such as the rise of the middle class during the Industrial Revolution and modern capitalism (Doepke & Zilibotti, 2008; Weber, 2013). What is worth mentioning is that the habit explanation does not exclude other possible interpretations. Various channels could co-exist, interact with each other, and influence long-term economic behaviour together.

Forced migration to rural areas happened in countries other than China, though none is comparable to its huge population and age concentration in adolescence. Indonesia had a Transmigration programme through the 20^{th} century, moving landless people from densely populated areas to less populous areas. The total population influenced was around five million (Fearnside, 1997). The Soviet campaign, *Dekulakization*, deported better-off peasants and their families to distant parts of the Soviet Union and other parts of the provinces between 1929 and 1932. More than 1.8 million rich peasants were deported during the peak time of 1930-1931 (Conquest, 1987; Viola, 2007). Russia's Virgin Lands Campaign between 1954 and 1963 was considered the predecessor for China's rustication programme. Advertised as a socialist adventure, 300,000 youths travelled to the Virgin Lands in the summer of 1954 (Taubman, 2004). Another parallel can be drawn with

[2]During the rustication, the sent-down youths lived in small shabby houses, called *"collective units"* that were shared with many others. Even by the end of 1976, about 1 million rusticated youths still had no proper dwellings to live in, especially for those who were married (Bonnin, 2013).

the U.S.'s Indian Removal in the 19^{th} century. About 70 thousand Indians were forcibly relocated to designated territories, because of population density concerns and the availability of arable land. Nonetheless, China's rustication programme affects a huge population of 17 million, and has a demographic concentration on adolescence when the attitude towards the world is first established (Ghitza & Gelman, 2014).

To the best of my knowledge, this is among the first to systematically investigate the long-term impacts of this biggest inner-country migration on economic behaviour. Previous studies focused on its impacts on education and income (Meng & Gregory, 2002, 2007; Xie *et al.*, 2008; Yang & Li, 2011). Literature investigates its influence on mentality or consumption, though focusing on the outcome of household appliances or beliefs (Zhang *et al.*, 2007; Zhou, 2013; Gong *et al.*, 2014). My finding is consistent with Gong *et al.* (2014) that the rusticated individuals are less likely to believe in luck, as they invest less in the risky assets and show more self reliance. Given that rustication shifts urban youths' privileged status into an unprivileged rural one during their adolescence when values are established, its impacts on behaviour are expected to be profound and worthy of investigation. In this study, I try to provide empirical evidence and explanation to locate the heterogeneity in economic behaviour. The study also sheds light on how a policy, pertaining to those in the early stage of life, exerts long-term impacts on a generation through changing their behaviour. The policy implication lies in the importance of later policy interventions if the policy makers take the long-term influence of one policy on economic behaviour into account.

The remainder of the paper is organised as follows. Section 2 specifies the theoretical framework. Section 3 provides institutional background on China's rustication programme. Section 4 describes three data sets followed by Section 5 which specifies corresponding empirical specifications. Section 6 presents and discusses empirical results. Section 7 draws conclusion.

2 Theoretical Framework

2.1 Set-Up

I adopt a habit-forming model to elaborate the long-term effects of rustication (Becker & Murphy, 1988; Abel, 1990; Orphanides & Zervos, 1994, 1995; Crawford, 2010). Suppose an individual has two consumption goods at period t: an ordinary good c_t with price 1, and a habit-forming good h_t (*eg.*, housing consumption) with price p. Her current utility, $u(c_t, h_t, s_t)$, depends on c_t, h_t, and a measure of stock of past consumption s_t, which depends on h_t but not c_t. The individual accumulates her future stock from previous consumption s_t and h_t. The evolution of stock is described below:

$$s_{t+1} = \delta s_t + h_t,$$

where δ is the depreciation rate of the past consumption stock. Through s_t and h_t, s_{t+1} enters the current utility $u(c_t, h_t, s_t)$. Her income y, is set constant following the literature (Becker & Murphy, 1988; Orphanides & Zervos, 1994, 1995). The maximisation problem is:

$$V(s_0) = max \sum_{t=0}^{\infty} \beta^t u(c_t, h_t, s_t) \quad (1)$$

$$s.t. \quad c_t + ph_t \leq y, \quad (2)$$

$$s_{t+1} = \delta s_t + h_t. \quad (3)$$

Following Orphanides & Zervos (1994), the utility function $u(c_t, h_t, s_t)$ follows the complementarity assumption that the current consumption h_t and the past consumption s_t are complements ($u_{hs} > 0$). In addition, this complementarity is stronger than that between c and $s (u_{hs} \geq u_{cs})$.[3]

Along an optimal path, the budget constraint (2) binds. By substituting $c_t = y - ph_t$ into the utility function, the objective function can be redefined as $x(h_t, s_t) \equiv u(y - ph_t, h_t, s_t)$, which is

[3] The other three assumptions of the utility function are: Assumption 1. the function $u(c, h, s)$ is second-order continuous for $c, h, s \geq 0$. Assumption 2. the function u is increasing and strongly concave in c and h. Assumption 3. $u_c(c, h, s) > 0$ for all $c, h, s \geq 0$ (Orphanides & Zervos, 1994).

a function of h_t and s_t only. Rewrite the maximization problem (1) in a dynamic programming framework:

$$V(s) = \max_h [x(h, s) + \beta V(\delta s + h)]. \tag{4}$$

The correspondence describing the optimal consumption path is: $\phi^*(s) \equiv \{s' | V(s) = x(s' - \delta s, s) + \beta V(s')\}$. $\bar{s}$ is a steady state if $\bar{s} \in \phi^*(\bar{s})$. Define s^c as a critical level if the optimal local dynamic diverges around it. Following Proposition 1 in Orphanides & Zervos (1994), the optimal paths are described as below:

Proposition: The optimal paths converge to a steady state monotonically from any initial stock; if the initial stock lies between two consecutive steady states, the optimal paths converge to either one or the other; exactly one critical level exists between any two consecutive stable steady states (Orphanides & Zervos, 1994).

2.2 Modelling the Impact of Rustication

I take the long-term impact of rustication on housing consumption as one instance to illustrate the incorporation of rustication into this model. Housing is habit-adjusted as discussed in the literature (Huang, 2012). Denote s_0 the initial individual stock of consumption at the start of rustication, and τ the duration of rustication. Define $h^*(s)$ the optimal unconstrained housing consumption, where s is the stock of past consumption. During the rustication, the housing consumption is depressed, as the sent-down youths lived in small shabby houses called *"collective units"*, which were shared with many others.[4] Thus I impose a cap on the housing consumption during the rustication, consistent with previous research (Costa, 2013). Set:

$$h_t = \bar{h} < h^*(s_0), \forall t \in [0, \tau]. \tag{5}$$

[4]Even by the end of 1976, about 1 million rusticated youth still did not lived in proper dwellings, especially for those married couples (Bonnin, 2013).

From the budget constraint (2), $c_t = \bar{c} = y - p\bar{h}, \forall t \in [0, \tau]$. Inserting $\bar{h}$ into eq.(3) and iterating, I obtain the stock of consumption at the end of rustication:

$$s_\tau(s_0) = \delta^\tau s_0 + \frac{1 - \delta^\tau}{1 - \delta}\bar{h}, \quad s_0 \ \ given. \tag{6}$$

If at the end of the rustication, the stock of consumption $s_\tau(s_0)$ is less than the critical level s^c, the housing consumption h_t will converge to a low steady state. Figure 1 illustrates the dynamics, with housing consumption on the vertical axis and the stock of consumption on the horizontal axis. The graphing follows Orphanides & Zervos (1995) and Costa (2013). Assume an individual is at the steady state $s_0 = s_h$ initially. During the rustication, she is forced to consume below $\bar{h}$, reducing her stock of consumption over the rustication period, τ. If by the end of the rustication, the stock of consumption $s_\tau(s_0)$ is less than a critical point s^c ($s^c < s_0$), she will enter a new optimal path converging to a new stable steady state with lower housing consumption. Alternatively, if the stock of consumption after the rustication does not drop below any critical value, the housing consumption will converge back to the original level. To summarise:

Prediction: After the rustication, if an individual's stock of housing consumption drops below a critical level, she will enter a new optimal path converging to a steady state with lower utilization of housing consumption.

From the conventional budget constraint with saving, an increase in the financial assets is expected from the decreasing consumption as demonstrated in the prediction above.

What is worth mentioning is that the habit channel could co-exist with other channels, such as the changing risk aversion or discount rate.[5] However, those mechanisms are not mutually exclusive. Moreover, they interact with each other, and shape the long-term economic behaviour together.[6]

[5]For instance, when the rusticated youths returned to cities, they were subject to fewer resources compared to their non-rusticated peers because of the lost years in the countryside. Poor economic status is associated with high risk aversion (Binswanger, 1981; Guiso & Paiella, 2008). To prepare for future rainy days, the rusticated youngsters are expected to consume less, save and insure more, and invest less in the risky assets. In addition, it is also plausible that the discount rate alters among the rusticated youths. They discount the future less and save more.

[6]For instance, the wealth effect after returning to cities could interact with the habit-forming channel, and aggravate the negative effect of rustication on housing consumption.

3 Institutional Background

From 1966 to 1978 during China's Cultural Revolution, approximately 17 million urban youths (1/10 of the urban population), most of whom were junior or senior high school graduates, were sent to the countryside (Li *et al.*, 2010; Gong *et al.*, 2014; Kinnan *et al.*, 2015). With no access to formal education, they spent 3-4 years on average in the rural area. They did heavy manual farm work for 12 hours per day and 7 days per week, as documented in Bernstein *et al.* (1977) and Zhou (2013). More than 90% returned to the cities by 1980, two years after the official end of the Cultural Revolution (Bonnin, 2013). About 5% never returned having married local peasants or found employment in non-agricultural jobs in rural areas (Zhou & Hou, 1999).

3.1 Origins and Rules of the Rustication

The earliest documented rustication was in 1955. It was small scale with less than 8,000 individuals affected (Bonnin, 2013). Large-scale rustication was initiated in 1966, with the start of the Cultural Revolution. In the first two years of the Cultural Revolution, primary schools, high schools, and universities were shut down. Many urban youths participated in the revolutionary activities. The rustication was made official in 1968, as Mao urged the urban youths to go to the rural areas to be re-educated by the farmers (Zhang *et al.*, 2007; Li *et al.*, 2010). Most were unwilling to be separated from families, and thus coercive techniques such as threatening parents with job loss were used (Deng & Treiman, 1997).

In addition to the revolutionary propaganda, rustication was motivated by deep economic concerns. The rising urban unemployment was an important cause for the large-scale rustication. Interrupted by the Cultural Revolution, senior high schools and universities closed and did not admit new students until 1971/1972. When they reopened, senior high schools did not recruit old students who missed the chance in previous years (Meng & Gregory, 2002). Universities did not admit senior high school graduates directly (Li *et al.*, 2010). The recruiting criterion was not academic merit, but performance in the Cultural Revolution (*e.g.,* participation in the rustication), political attitude, or family background.[7] The dysfunction of senior high schools and universities in absorbing graduates served to increase youth unemployment. In addition, shortly after the foundation of the People's Republic of China in 1949, the baby boom enhanced the employment pressure among urban youths (Banerjee *et al.*, 2010; Zhou, 2013). The red line in Figure 2 circles the first baby boom shortly after 1949. Those children were of high-school age when the Cultural Revolution started, and would enter the labour market if there was no rustication.

The local government had yearly send-down quotas to meet. The quota varied according to the economic situation and policy changes. Figure 3 depicts the number of rusticated youths migrating into rural areas (Kojima, 1996). From 1967 to 1968, approximately 2 million people were sent to the rural areas. This number peaked at 2.67 million in 1969 (Kojima, 1996; Bonnin, 2013). With the economic recovery and increasing supply of urban jobs, the number of rusticated youths dropped in the following years. A second peak appeared around 1975 when the four leaders of the Revolution, called the *"Gang of Four"*, seized power and strongly advocated rustication using patriotic propaganda (Bai, 2014).

3.2 Variation Across Cohort and Region

The majority of the rusticated youths were junior or senior high school graduates. I focus on the cohorts born between 1946 and 1961 following the literature (Li *et al.*, 2010). The earliest birth cohort of 1946 contains the senior high school graduates in 1966 when large-scale rustication began.[8] The latest birth cohort of 1961 includes the junior high school graduates in 1978 when the rustication programme was officially ended. Figure 4 graphs the rustication rate in each cohort. It validates the specification on the treated generation between 1946 and 1961. For cohorts out of this range, the rustication rate is less than 10%.

The destination of rustication also varies, depending on the home cities and time of rustication. Bonnin (2013) documents that most rustication was within the province and students were sent

[7] Section 3.3 discusses the role of family background on rustication in detail.

[8] During that period, children were admitted into primary school around the age of 8. Primary-school education lasted for six years, followed by three years of junior- and senior- high school education, respectively (Li *et al.*, 2010).

to the nearby countryside. However, there was about 8% cross-province migration, mostly from big municipalities to the remote frontiers. Figure 5 demonstrates the direction of cross-province migration. It was concentrated in the three biggest municipalities (Beijing, Tianjin, and Shanghai), but also included other provincial capitals such as Wuhan and Chengdu. The destinations were the remote frontiers, such as Heilongjiang in the northeast, Xinjiang in the northwest, and Yunnan in the southwest. Because of the variation of rustication across cohort and region, I adopt a difference-in-difference estimation to capture the generation effect of rustication. Details are displayed in Section 5.1.

3.3 Potential Endogeneity

Rustication was announced as compulsory for almost all age-eligible high school graduates at the beginning. Nevertheless, when the sent-down quota was binding (not all high school graduates were requested to be rusticated), some selection occurred. There was cross- and within- household selection during the rustication (Zhou & Hou, 1999; Li *et al.*, 2010). On the one hand, the possibility of being sent to the countryside varied across households. This is because the previously privileged families (*eg.,* the rich and/or the educated) lost power in the social re-shuffling of the Cultural Revolution. Thus they are less able to help their children acquire exemptions from rustication. One the other hand, children from previously unprivileged families with parents who were workers, farmers, or soldiers during that time period, were more likely to be able to inherit their parents' jobs or join the army. Thus they were able to return to cities earlier, or even be exempted from rustication. In the 1970s, the rustication policy was relaxed. A small proportion of junior high school graduates, most with favoured family backgrounds, were directly admitted into senior high schools.

Figure 6 displays one instance of how the possibility of rustication varies with family background. The bar indicates the possibility of being rusticated. Numbers in brackets indicate observations in each category with percentages in the parentheses. A majority of the fathers have educational level at elementary school level (35.6%), followed by those who with no schooling

(29.3%), with junior high school level (18.3%), and with senior high school level or above (16.8%). Clearly, children from previously privileged family backgrounds, such as those with fathers who were intellectuals, had a higher probability of being sent to the countryside. This is because intellectuals were considered elites before the Cultural Revolution, and were against in the programme. A similar scenario applies to children of enterprise owners, as shown in Figure A.1. However, the magnitude of selection is small, with less than 5% conditional on fathers' educational level, or less than 10% on their social status.

In contrast, there is within-household selection in addition to the cross-household selection (Li *et al.*, 2010). Parents had to choose the child(ren) to go to the countryside if not all children were requested for rustication. Different empirical strategies are applied to address the cross- and within- household endogeneity, and will be described in Section 5.

4 Data

I use three data sets, each of which is associated with one empirical specification, to examine the long-term effects of rustication on housing consumption and financial behaviour. The three data sets supplement each other and are described as below.

4.1 Mini-Census 2005

I first use the 2005 mini-census to describe the behaviour of the rusticated generation versus non-rusticated generations. The generation experiencing rustication is expected to behave in a different way from their earlier or later counterparts, as almost half of them were rusticated, and the effect could spill over to other age-eligible but non-rusticated individuals. Figure 7 illustrates examples of the spill-over effects. For instance, the surge of population returning to cities after the programme may generate a demand shock on urban housing.[9] Importantly, the cross-generation investigation is not subject to the cross- or within- household selection as described in Section 3.3.

[9] The rustication programme was ended officially in 1978. In the following year, 3.95 million rusticated youths returned to cities (Kojima, 1996).

The mini-census was implemented from November 1 to November 10 in 2005 by the National Bureau of Statistics of China and the office of the 1% population sampling investigation in the State Council of the People's Republic of China. It covered 1% of the national population, or approximately 13,000,000 observations. The data I use covers 20% of the mini-census. My sample focuses on the urban areas, since the target of the large-scale rustication policy was urban educated youths. Rural residents and urban-to-rural migrants are excluded.[10]

The merits of using this data set are two-fold: first, the sample covers all provinces and is representative of the general population. My sample contains approximately 1 million observations with intact information on education and income. The sampling is according to the population in each province, autonomous region, and municipality, and thus representative of the general population. Second, unlike the population census, the mini-census asks detailed questions on housing size, purchasing price, insurance, and working time, in addition to education and income. It provides a rare opportunity to investigate the overall pattern of consumption and financial behaviour across China.

The summary statistics are presented in Column (1) of Table 1. Individuals are in their late 40s in 2005 and are sex balanced (52% are male). Almost half (45%) of the sample has at least a senior high school level of education in 2005, but only 5% achieves university level. The annual income is 1,630 U.S. dollars (USD) in 2002 values. The average housing size is 59 square metres, with an estimated market housing price of 7,645 USD in 2002 values. The average working hours are 46 hours per week, or approximately 9 hours per day.[11] Concerning insurance purchase, 30% of the population have unemployment insurance. The proportion of pension and health insurance almost doubles, possibly because of the average age being in the late 40s, when old-age support and medical care become increasingly important.

One possible caveat lies in no direct measurement on rustication being available in the mini-census. However, as I am interested in the cross-generational influence, this information is not

[10]Migrants from rural to urban areas still hold rural registration (*Hukou*), and do not have equal access to the same educational and occupational opportunities as urban citizens.

[11]The official working days per week in China are five after 1995.

necessarily needed. The following two datasets provide detailed rustication information at the individual level, which examines the intra-generational effects of rustication.

4.2 Chinese Household Income Project 2002

I apply the 2002 Chinese Household Income Project (CHIP 2002) to examine the intra-generational effect of rustication. CHIP 2002 is a joint research study sponsored by the Institute of Economics at the Chinese Academy of Sciences, the Asian Development Bank, the Ford Foundation, and the East Asian Institute at Columbia University. Consistent with the previous strategy, I focus on urban residents only. The data covers 54 cities or municipalities from 11 provinces in China, as marked in dark grey in Figure 8.

The advantages of using CHIP 2002 data to analyse the long-term impacts of rustication lie in the following features. First, the CHIP project provides rich data on rustication and outcome variables. The survey asks each individual above 35 years old about the experience of rustication and the length of time one was sent to the countryside. In addition, it records the individual's housing consumption (housing size and market price), saving, investment portfolio, expenditure on insurance, as well as working time, occupation, education and income. It provides a rare opportunity to investigate the consequences of rustication from various perspectives. Secondly, it collects information on family background in the absence of co-residency bias. The survey reports socioeconomic status on the parents of household heads and spouses, regardless of whether they live together or are alive. The information contains parental educational levels, social status classified before the Cultural Revolution, and political party affiliation. To the best of my knowledge, this is the only household survey in China that provides such detailed information on family background and overcomes co-residency bias. Last but not least, the area under this survey is geographically and economically representative, which provides an opportunity to yield nationally representative estimates.[12]

[12]CHIP is considered geographically representative as the areas under survey cover the northeast (Liaoning), the south (Guangdong), the southwest (Yunnan), and the west (Gansu). It is considered to be economically representative as the surveyed areas include the richest parts in China such as Beijing and Guangdong, as well as the least developed parts such as Gansu.

Column (2) in Table 1 presents the summary statistics. They are generally the same as those found in the mini-census, with no statistically significant differences reported. Among those age-eligible youths born between 1946 and 1961, 42% have been rusticated. Conditional on being rusticated, the average length of being sent to the countryside is 3.89 years (detailed tabulation of the rusticated years is shown in Table A.1). By the end of 2002, they have saved 4,342 USD, which is about three years' income.[13] In addition, they have invested 828 USD in stocks and bonds by the end of that year, which is almost half of their annual income. They also spend 195 USD on insurance, which is about 1/10 of annual income.

4.3 Chinese Twins Survey 2002

The third data set I apply is that of the Chinese Twins Survey in 2002, which is the first twins data set in China, designed by Professors Mark Rosenzweig and Junsen Zhang.[14] The survey was carried out by the National Bureau of Statistics in 2002 in five cities in China, depicted in yellow triangles in Figure 8.[15] It includes 1,838 identical twins, 1,152 non-identical twins, and 1,672 singletons (as control group) aged between 18 and 65. The survey collects information on each twin's housing consumption, working time, schooling, income, emotional control, and other demographic details, such as age, gender, and number of household members. Similar questions are also asked to their non-twin siblings and singletons in the control group.

My sample contains 602 identical twins and 4,866 siblings born between 1946 and 1961 with intact information on rustication, education, and income.[16] In addition to providing a rich set of outcome variables, I consider the following advantages of using the Twins Survey for this study. First, it contains detailed information on rustication, such as whether individuals were rusticated and for how many years. Second, it facilitates the elimination of bias from cross- and within-

[13]Saving is defined as the summation of fixed and current deposits, stocks and bonds, and others. Other sources contain money lent, self-owned funds for family business, investment in enterprises/business (except stocks and bonds), and monetary value of commercial insurance as a deposit.

[14]Professor Mark Rosenzweig is Frank Altschul professor of Economics at the Yale University. Professor Junsen Zhang is Wei Lun Professor of Economics at the Chinese University of Hong Kong.

[15]The five cities are Chengdu, Chongqing, Harbin, Hefei, and Wuhan.

[16]The sibling sample includes siblings of all twins and singletons.

household selection, as discussed in Section 3.3. This is because identical twins share similar genetics and have same family background. By adopting a twin fixed-effects strategy, I can eliminate influence from the unobserved family background. In addition, the differences between identical twins are much less than those between the non-identical twins and among further apart siblings. Thus the within-household bias on rustication is much reduced under this strategy. Similarly, siblings share the same family background although with various genetic traits. The sibling fixed-effects estimation supplements the results from the twin fixed-effects strategy.

Summary statistics on identical twins and siblings are displayed in Columns (3) and (4) of Table 1, respectively. They are roughly the same as those presented in the previous two data sets. No statistically significant differences are found for the variables. Specifically, for identical twins born between 1946 and 1961, more than half (54.2%) were rusticated. Almost 30% (180 twins from 90 pairs) of them have within-twin difference in rustication, which generates the variation in the twin fixed-effects estimation. The variation of rustication within identical twins is demonstrated in Table A.2.

5 Empirical Specification

5.1 Difference-in-Difference Estimation

Rustication varies across cohort and region, as discussed in Section 3.2. Therefore I apply difference-in-difference estimation to the mini-census in 2005 to investigate the generational effect of rustication. The outcome variables contain housing consumption, insurance and pension purchase, as well as working time, education, and income.

The treated generation includes individuals born between 1946 and 1961. The comparison group contains individuals born between 1940 and 1966 but not in the treated generation. I also specify a complementary strategy as comparing balanced rusticated cohorts of 1946-1950 and 1954-1958 *versus* non-rusticated cohorts of 1941-1945 and 1962-1966. They are the earliest (1946-1950) and latest (1954-1958) rusticated cohorts *versus* the non-rusticated cohorts ahead

(1941-1945) and afterwards (1962-1966). Specifically, the 1959-1961 birth cohort is excluded as individuals in that cohort were born during the Great Famine, and may otherwise contaminate the results.

In addition to birth cohort, rustication also varies across region. As documented in Bonnin (2013), the rustication was more severe in big cities, as the revolutionary propaganda was stronger and coercion was applied more heavily. To test this argument, I plot the city rustication rate against the logarithm of the city population using the census data in 1953, and present the result in Figure 9. A positive and statistically significant coefficient is revealed. With a 1% increase in the city population, the rustication rate is raised by 0.03 percentage points, and is statistically significant at the 5% level. As the average city rustication rate is 0.31 revealed from the Chinese Household Income Project 2002, the 1% rise in the city population indeed increases the city rustication rate by almost 10%. Consistent with the classification in the City Statistical Yearbook, I define cities with population above 1 million as big cities (NBS, 1985, 2002).[17]

The empirical specification is as follows:

$$y_{ict} = \alpha_1 big_c + \alpha_2 cohort_t + \alpha_3 big_c * cohort_t + X_{ict}\alpha_x + \mu_{ict} \tag{7}$$

where i stands for individual, c represents city, and t identifies time. *big* equals 1 if an individual lives in a big city. Otherwise, it equals 0. The dummy of *cohort* equals 1 if an individual was born between 1946 and 1961. It equals 0 if he/she was born between 1940 and 1966 but not in the treated generation. In the complementary specification, *cohort* equals 1 if an individual was born in 1946-1950 or 1954-1958 cohort. It equals 0 if in either the 1941-1945 or 1962-1966 cohort.

y_{ict} is the outcome variable. It includes housing consumption (housing size and price), pension and insurance purchase (unemployment and health insurance), as well as education (dummies of having education at senior high school/above or university/above), income (logarithm of income in the last month), and working time (working hours last week). X_{ict} is a vector of control variables,

[17] The cut-off points of city size are 2 million, 1 million, 0.5 million, and 0.2 million according to the City Statistical Yearbook. The range of the population in big cities in 1953 was from 1,091,600 to 6,204,417. The range for small cities was from 26,200 to 916,800.

which contain age, ethnicity, gender, and regional dummies. ϵ_{ict} is the disturbance term. Standard errors are clustered at the city level.

α_3 identifies the effect of rustication. One assumption for α_3 picking up the influence of rustication is that there is a parallel trend in outcome variables between big and small cities before the programme. Otherwise, the change may be because of events other than the rustication. Figures 10 - 12 check those trends. For instance, the senior high school rates in big cities (blue solid line) and small cities (red dashed line) are roughly parallel for cohorts prior to 1946 (Figure 10). With the start of the rustication, the senior high school rate remains stagnant in small cities but drops sharply in big cities. The deviation from the preceding parallel trend identifies the effect of rustication. Similar parallel trends are displayed in income (Figure 11) and housing consumption (Figure 12), which validate my method of difference-in-difference.

A similar specification as that in Eq. (7) is carried out, except the dummy of big_c is replaced with a continuous variable of city population in 1953:

$$y_{ict} = \beta_1 pop53_c + \beta_2 cohort_t + \beta_3 pop53_c * cohort_t + X_{ict}\beta_x + \xi_{ict} \tag{8}$$

where $pop53_c$ is the logarithm of city population in 1953. Others variables remain the same as in Eq. (7).

5.2 OLS Estimation Controlling Family Background Explicitly

With application to the Chinese Household Income Project in 2002 as described in Section 4.2, I specify OLS regression controlling family background explicitly as follows:

$$y_i = \gamma_1 rus_i + \gamma_2 family_i + X_i\gamma_x + \epsilon_i \tag{9}$$

The sample is restricted to individuals born between 1946 and 1961. Standard errors are clustered at the city level and y_i is the outcome variable. It includes housing consumption (housing size and price), and a set of measures on financial behaviour such as saving, share of investment out of income on risky assets (stocks and bonds), and expenditure on insurance, which examines individual allocation of net consumption wealth. It also contains education (senior high school/above or university/above), income (logarithm of annual income), and working time (monthly working days and daily working hours).

rus_i is the interested independent variable. It is either a dummy for being rusticated, or the total rusticated years. $family_i$ is a vector indicating family background, which includes dummies for fathers' social status, educational level, and political status. X_i is a vector of control variables, including age, ethnicity, gender, and provincial dummies in all specifications. Additional controls vary slightly in different regressions. In the specification for housing consumption, I control education, income, and number of household members. In the specification for financial behaviour, education and income are additional controls. In the specification for income, I follow the literature (Mincer, 1974; Li *et al.*, 2010) by controlling for schooling, working years, and the squared form. Schooling is included as one additional control in the equation for working time.

5.3 Twin and Sibling Fixed-Effects Estimation

Regressions under twin fixed-effects follow conventional specification in the literature (Li *et al.*, 2007, 2010). Conditional on the data availability, my empirical work focuses on estimating the effects of rustication on housing consumption, working time, education and income, with data from the Chinese Twins Survey. The econometric specifications are as below:

$$y_{1j} = \lambda_1 rus_{1j} + Z_j\lambda_Z + X_{1j}\lambda_X + \mu_j + e_{1j} + \varepsilon_{1j} \tag{10}$$

$$y_{2j} = \lambda_1 rus_{2j} + Z_j\lambda_Z + X_{2j}\lambda_X + \mu_j + e_{2j} + \varepsilon_{2j} \tag{11}$$

where the subscript j indicates family. The subscripts 1 and 2 refer to twin orders. All identical twins born between 1946 and 1961 were age-eligible for the rustication. y_{ij} ($i = 1, 2$) is the outcome variable, which includes housing consumption (housing size and property rights), working time (monthly working days and weekly working hours), education (dummies for having education at senior high school/above or university/above), and income (logarithm of income in the last month). rus_{ij} $(i = 1, 2)$ is the interested independent variable. Similar to that in the OLS estimation, it indicates a dummy for being rusticated or the total rusticated years.

Z_j is a vector of observed family variables, such as regions, which are the same for identical twins. X_{ij} $(i = 1, 2)$ is a set of twin-specific control variables, which differ slightly in the regressions for different outcome variables. Specifically, in the specification for housing consumption, X_{ij} contains age, gender, schooling, number of household members and logarithm of monthly income. In the specification for working time, X_{ij} contains schooling years, in addition to the common controls of age and gender. In the regression for logarithm income, X_{ij} includes additional controls of schooling years, experience, and square form of experience, as under the OLS estimation. μ_j stands for unobserved family effect, such as parents' social, educational, or political status. e_{ij} $(i = 1, 2)$ indicates unobserved twin-specific endowment, such as ability, and ε_{ij} is the disturbance term. Standard errors are clustered at the household level.

Estimate of λ_1 under OLS estimation is biased because children from previously privileged families are more likely to be sent to the countryside, as discussed in Section 3.3. However, it is difficult to find proxies to identify unobserved family effect μ_j and twin-specific endowment e_{ij}, which are possibly correlated with rus_{ij}. To address the bias in OLS estimates, I apply fixed-effects estimation to identical twins. By taking difference between Eqs. (10) and (11), the fixed-effects estimator λ_1 below is obtained:

$$y_{1j} - y_{2j} = \lambda_1(rus_{1j} - rus_{2j}) + (X_{1j} - X_{2j})\lambda_X + \varepsilon_{1j} - \varepsilon_{2j} \tag{12}$$

The unobserved family effects μ_j are eliminated as twins share the same family background. Because identical twins are genetically the same, the influence from twin-specific endowment e_{ij} is reduced. One potential remaining concern is about within-twin selection. Parents may select one twin rather than the other to be sent down, depending on their unobserved endowment.[18]

[18] In the later stage of rustication, if a child was an only child or the only one staying at home, he/she could be exempted from the rustication (Liu *et al.*, 1995; Zhou & Hou, 1999).

Nonetheless, this difference is far less between identical twins than that between non-identical twins or spaced siblings (Li *et al.*, 2010). I also implement sensitivity analyses to control for the twins' birth weight as measure for initial endowment in Section 6.6.

In addition, I apply sibling fixed-effects estimation to siblings of all twins and singletons. The specification is as follow:

$$y_j = \lambda_1 rus_j + Z_j\lambda_Z + X_j\lambda_X + \mu_j + \varepsilon_j \qquad (13)$$

where μ_j stands for the unobserved family-specific heterogeneity, which can be eliminated by the fixed-effects estimation. Other variables are defined the same as in Eqs. (10) and (11).

6 Empirical Results

Literature has intensively investigated the influence of rustication since the 1990s, although most focuses on education and income, or on household appliance in recent work (Zhou & Hou, 1999; Xie *et al.*, 2008; Li *et al.*, 2010; Yang & Li, 2011; Zhou, 2013). In this section, I present my new findings on the long-term consequence of rustication on consumption and financial behaviour. I also display the similar results on education and income as shown in the literature, and the auxiliary finding on working time.[19]

6.1 The Long-Term Effect of Rustication on Housing Consumption

Table 2 presents the long-term effect of rustication on housing consumption. Panel A displays the cross-generational effects of rustication from difference-in-difference strategy. Columns (1) and (3) demonstrate the estimates from Eq. (7), while Columns (2) and (4) show the corresponding estimates from Eq. (8). The first row presents results comparing generation 1946-1961 *versus* other cohorts born between 1940 and 1966. The second row displays the estimates for cohorts 1946-1950 and 1954-1958 *versus* 1941-1945 and 1962-1966. Panels B-D present the intra-generational effects

[19] Additional findings on self control and self reliance are shown in Table A.5 in the appendix.

of rustication. Specifically, Panel B presents the OLS estimates controlling family background explicitly. Panels C and D display the results from twin and sibling fixed-effects estimations, separately. The effects of being rusticated and the length of rustication are demonstrated in different rows.

I find that the rusticated generation spends significantly less on housing consumption even in the 2000s, compared to their non-rusticated counterparts as shown in Panel A. Rustication has negative and statistically significant impacts on both housing size and purchase price, consistently across various specifications. As expected, the magnitudes of estimates in Columns (1) and (3) are consistently larger than those in Columns (2) and (4), as the former aggregates the effect from all big cities.

Controlling family background explicitly, the OLS estimates in Panel B reveal a similar pattern. The sent-down youths live in smaller dwellings by 1.8 square metres on average, compared to non-rusticated individuals with education and income controlled (Column (1) of Panel B). It is statistically significant at the 10% level of significance. One additional year of rustication reduces housing size by 0.5 square metres with statistical significance at the high 1% level (Column (2) in Panel B). With respect to the housing price, sent-down individuals spend 796 USD less than their non-rusticated counterparts. One more year of rustication is associated with 187 USD less in housing expenditure. The two estimates are at the 5% and 1% levels of statistical significance respectively. The magnitudes are similar to or within reasonable variation compared to those of estimates presented in Panels A.

Similar results are revealed under twin and sibling fixed-effects strategies. With one more year of rustication, the housing size decreases by 0.8 and 0.5 square metres among identical twins (Column (2) of Panel C) and siblings (Column (2) of Panel D) separately. The magnitude is similar to the one found under OLS specification. The two estimates are statistically significant at conventional levels. The rate of private home ownership drops as well, although with no statistical significance.

The negative impact of rustication on housing consumption is consistent with studies on the influence of the Great Depression. Romer (1990) and Crafts & Fearon (2010) find that the generation experiencing the economic crisis has a markedly lower consumption of durable goods. Similar to the economic recession, rustication induces individuals to forgo the pursuit of the largest household durable goods of housing.

6.2 The Long-Term Effect of Rustication on Saving and Investment

Table 3 presents the OLS estimates on the long-run influence of rustication on saving and investment, controlling family background explicitly. Columns (1) and (2) present the effects of rustication on the logarithm of household savings, which contains fixed and current deposits, stocks and bonds, and the monetary value of commercial insurance as a deposit. The last two columns display the corresponding results on the ratio of stocks and bonds relative to annual income. It aims to estimate the influence of rustication on the behaviour of investing in risky assets.

I find that rustication increases saving and decreases the investment in risky assets. Specifically, the rusticated youths accumulate 6.5% more saving compared with their non-rusticated counterparts, with statistical significance at the 10% level (Column (1)). In addition, with one more year of rustication, the ratio of stocks and bonds relative to the total income declines by approximately 0.03 percentage points (Column (4)). The estimate is statistically significant at the 10% level. Considering stocks only, the share of stocks out of income is decreased by 0.025 percentage points (Column (6)) with one more year of rustication. The estimate is with statistical significance at the 10% level.

This financial behaviour is consistent with that of the depression babies (Malmendier & Nagel, 2011). The generation which experiences low stock/bond returns is less likely to participate in the stock/bond market throughout their life. Even if they participate, they invest a lower proportion of their income in such risky assets. Schoar & Zuo (2013) show that CEOs who enter the labour market during recession periods accumulate more long-term assets but have less asset turnover. Evidence on rustication agrees with the literature in the sense that the rusticated individuals accumulate more saving. However, contrast to the effect of the Great Depression, no stocks or bonds existed during the rustication period. Nonetheless, the rustication still changes their investment behaviour. This finding echoes Gong *et al.* (2014) that the rusticated individuals believe less in luck, and thus they spend less in risky assets.

6.3 The Long-Term Effect of Rustication on Insurance and Pension

Table 4 presents the long-term impacts of rustication on insurance and pension purchase. Panel A presents the difference-in-difference estimates from the 2005 mini-census. The outcome variables are dummies if an individual purchases unemployment or health insurance, or a pension. Panel B displays the OLS estimates of the effect of rustication on annual insurance expenditure from CHIP 2002.

I find that the sent-down generation purchases more insurance than the non-rusticated generations as shown under the difference-in-difference strategy in Panel A. Rustication increases the possibility of purchasing a pension by 0.9%-4.1% (Columns (2) and (5) in Panel A). The probability of buying health insurance is also increased by 1.2%-5% (Columns (3) and (6) in Panel A). All the coefficients are statistically significant at a high 1% level of significance.

Similar evidence is found under the OLS strategy controlling family background explicitly. The sent-down experience increases annual insurance expenditure by 51 USD (Column (1) in Panel B). This estimate is statistically significant at the 10% level of significance. Given the average insurance expenditure is 195 USD (Column (2) in Table 1), rustication raises the insurance purchase by almost 25%.

This finding is consistent with the literature that individuals born during the Great Depression are less willing to take financial risks in later life (Malmendier & Nagel, 2011). It is also in accord with the mass media report that Millennials experiencing the economic recession in late-2000s behave in a more risk-averse manner (Groth & Giang, 2012). As shown in the literature, more risk aversion is associated with more insurance purchases (Cicchetti & Dubin, 1994; Rabin & Thaler, 2001). Although no insurance or pension existed during the rustication, the adverse experience still influences the treated population in that they purchase more health insurance and pension in the long run. Nevertheless, rustication does not have a statistically significant impact on the purchase of unemployment insurance. A possible explanation is that the rusticated youths were at the late stage of their working life cycle (44-59 years old) in 2005. The risk of unemployment is low and replaced by the approaching retirement.

6.4 Auxiliary Findings: The Long-Term Effect of Rustication on Education, Income, and Working Time

The Long-Term Effect of Rustication on Education and Income The effects of rustication on education and income are first-order results and are studied intensively (Deng & Treiman, 1997; Zhang *et al.*, 2007; Giles *et al.*, 2008; Xie *et al.*, 2008; Yang & Li, 2011). In this section I display similar findings in Tables 5 and 6 to those in the literature. The table structure is the same as that of Table 2.

Lifetime education is decreased, as shown graphically in Figure 10 and empirically in Table 5. The rusticated generation has lower educational stock than the earlier or later generations, as shown in Panel A of Table 5. The finding is robust under various specifications of the difference-in-difference estimation. The intra-generational effect of rustication, as shown in Panels B-D, is consistent with the cross-generational evidence. Controlling for family background explicitly, one more rustication year reduces senior high school and university rates by 0.9% and 0.3% respectively, at a high 1% level of significance (Columns (2) and (4) in Panel B). Similar results are repeated under fixed-effects estimation. Compared to non-rusticated twins, the rusticated twins are 4.4% less likely to reach university level (Column (3) in Panel C). This coefficient is statistically significant at the 10% level of significance.

Although rustication reduces lifetime schooling, it has no statistically significant impact on income across various empirical specifications as shown in Table 6. The literature demonstrates similar results (Zhang *et al.*, 2007; Xie *et al.*, 2008; Yang & Li, 2011). Zhang *et al.* (2007) suggest that the insignificant change in income can be ascribed to the improved interpersonal skills and resilience generated by hardship. Detailed discussion is provided in Section 6.5.

The Long-Term Effect of Rustication on Working Time A consumer's utility is formed through consumption and leisure, as described in conventional microeconomic settings (MaCurdy, 1981; Seckin, 2001; Arrow & Dasgupta, 2009). Thus in addition to investigating the effect of rustication on housing consumption, I examine its impact on working time, which is a complement for leisure given the total time fixed. Table 7 reports the estimates under the four empirical specifications.

I find that there is no statistically significant cross-generational effect of rustication, as presented in Panel A of Table 7. In other words, the working pattern does not differ significantly between rusticated and non-rusticated generations. One explanation is the squeezing effect. As the rusticated youths work longer, they squeeze the working time for their peers. Therefore on average, the rustication does not have statistically significant influence on working time for the overall treated generation.

In comparison to the insignificant cross-generational effect of rustication, the intra-generational effect of rustication on working time is positive and statistically significant as presented in Panels B-D. Specifically, rusticated youths spend around five more hours per week working (Columns (3) in Panels C and D), compared to non-rusticated individuals. The two estimates are statistically significant at 1% or 5% levels respectively. Similar results are revealed for the impact from the total length of rustication. With one additional year of being sent down, working time is raised by 0.2-0.3 days per month (Columns (2) in Panels C and D), and 1.7-1.9 hours per week (Columns (4) in Panels C-D), with statistical significance at conventional levels.[20]

These findings are consistent with mass media reports on the changing work ethic of generation Y who experienced the late-2000s recession.[21] They are "twice as keen to work" (Keogh, 2012), and "work incredibly hard" to protect their jobs (Groth & Giang, 2012), as they start to consider a good job as a "privilege" rather than a "given" (Levit, 2010). However, to the best of my knowledge, all of these claims are from employers' reports or interviews. No empirical studies have

[20]The measurement on working time from the Chinese Household Income Project (Panel B) is considered less precise than that from the Twins Survey (Panels C and D). In the former survey, average working time in the previous year is collected rather than that in the previous week as in the Twins Survey. Thus it introduces more memory errors.

[21]Generation Y, also known as Millennials, refers to those born between the early 1980s and early 2000s, who are the descendants of the Generation X.

been done in this area. This research attempts to provide evidence from survey data to examine the impact of adverse experience on work ethic.

6.5 Incidence *Versus* Intensity of Rustication

Does the incidence or the intensity of rustication shape long-term economic behaviour? In this section, I examine the effects of being rusticated and the length of rustication simultaneously, under a twin fixed-effects estimation. Supporting evidence for the habit channel is revealed in Table 8.

With the rustication dummy (the incidence) and the total years (the intensity) entering the equations simultaneously, I discover that it is the intensity, rather than the incidence of rustication, that drives the behaviour pattern. Specifically, with one more year of rustication, housing size is reduced by 0.63 square metres, with statistical significance at the 10% level (Column (1)). One additional rusticated year is also associated with 1.8 more hours of work per week, as demonstrated in Column (2). The estimate is statistically significant at the 5% level. The incidence of rustication, however, is not statistically significant in either of the specifications.

Consistent with previous findings, neither the incidence nor the intensity of rustication affects long-term income, as shown in Column (3). In addition, neither of them has a statistically significant influence on education (Columns (4) and (5)), possibly because of the dispersed effects when putting the rustication dummy and length of time simultaneously into the regression.

The finding that the intensity rather than the incidence of rustication drives the results supports the explanation of habit formation. It is because the longer the rusticated years, the more stable the habit is. In this scenario, an individual is more likely to converge to the steady state in the long term.

6.6 Robustness Checks

Tables A.3 - A.4 show the robustness checks. To address the potential endogeneity from cross- and within- household selection, I use a twin fixed-effects strategy with an application to identical twins.

The first concern is that individuals' initial endowment may be correlated with their exposure to rustication and the later outcome simultaneously. In such a case, the estimates are contaminated. Although identical twins, for instance, are genetically similar to each other, their slight difference may still bias parental choice in making the rustication decision as discussed in Section 3.3. Following the literature, I choose weight at birth as one measure for initial endowment, and include it as an additional control in Eq. (12) (Rosenzweig & Wolpin, 1995; Behrman & Rosenzweig, 2004). Results are presented in Panel A of Table A.3. A similar pattern as that in the baseline results is revealed. The magnitudes and levels of significance of the robustness estimates are similar or within reasonable variation.

The second concern is that rustication may alter individuals' occupational choice and thus affect their long-term working behaviour. Taking the endogenous occupational choice into account, I control explicitly for the working sector and occupational type in the main regressions. Results are displayed in Panel B of Table A.3. Similar to the findings in the baseline results, the rusticated individuals decrease their housing consumption but work for longer hours. Moreover, I test directly the effects of rustication on participating in the state-owned sector, being a white-collar worker, or the possibility of self-employment. Results are presented in Table A.4. No statistically significant influence is revealed from rustication on the sectoral or occupational choice.

Third, as housing consumption and time allocation are jointly decided between married couples, the traits of the spouse may also affect the results. To address this concern, I include the schooling and working sector of the spouses of twins into the estimation. Again, the baseline results remain robust after controlling for spousal information, as shown in Panel C of Table A.3.

Last but not least, the cohort effect is also likely to influence the long-term outcome. As shown in Figure 3, the intensity of rustication varies across years. Individuals sent to the rural areas during peak time may be affected more by the rustication over the long term, than their counterparts rusticated during the mild period. Thus I include the initial year of rustication into

Eq. (12).[22] Results are presented in Panel D of Table A.3. Again, the baseline outcome keeps robust after this sensitivity test.

7 Conclusion

In this paper, I investigate the long-term consequence of adverse experience on economic behaviour. Using the largest forced migration experiment of China's rustication programme between 1966 and 1978, I estimate its influence on housing consumption and financial behaviour in the 2000s.

By applying a difference-in-difference estimation to the mini-census in 2005, I first examine the cross-generational effect of the rustication. I find that the rusticated generation behave more conservatively than the non-rusticated cohorts. They live in smaller houses, spend less on housing purchases, and buy more insurance and pension in the long term. Second, I investigate the intra-generational impact of rustication, applying OLS and fixed-effects estimations to the Chinese Household Income Project and the Chinese Twins Survey in 2002 respectively. A similar behavioural pattern was demonstrated. The rusticated individuals behave more conservatively than their non-rusticated counterparts. They reduce housing consumption, increase saving and insurance, and decrease investment in risky assets even three to four decades after the programme. The findings are consistent with the literature that consumer behaviour changes following economically hard times. Romer (1990) and Crafts & Fearon (2010) find that consumption on durable goods dropped sharply during the Great Depression. In addition, the depression babies who experienced low returns from stocks and bonds invest less in risky assets throughout their lifetime.

How to explain the long-term conservative behaviour after experiencing an adversity? I suggest that one interpretation lies in the habits formed during adversity. In the scenario of rustication, the sent-down individuals experienced depressed housing consumption during the rustication (Bonnin, 2013). Following the habit-forming model (Becker & Murphy, 1988; Abel, 1990; Orphanides &

[22] For individuals (in this case, the identical twins) never sent to the rural areas, I assign their initial years of rustication to 0 and add dummies equal 1 if the values are imputed. Thus the regression is a variation from Eq. (12): $y_{1j} - y_{2j} = \lambda_1(rus_{1j} - rus_{2j}) + \lambda_2(sentyear_{1j} - sentyear_{2j}) + \lambda_3(impute_{1j} - impute_{2j}) + (X_{1j} - X_{2j})\lambda_X + \varepsilon_{1j} - \varepsilon_{2j}$.

Zervos, 1994, 1995; Crawford, 2010), if their stock of housing consumption drops below a critical level at the end of the rustication, their lifetime consumption is expected to converge to a low steady state. Empirical evidence that the effects of rustication mainly derive from the intensity rather than the incidence supports this interpretation. The longer the rusticated years, the more likely it is that the housing consumption converges to a steady state. Consequently, saving can be expected to increase. What is worth mentioning is that, the habit interpretation does not exclude other possibly co-existing mechanisms.

This research fits with the literature on how adversity, such as economic recession, wars, or other traumatic life experiences, influences long-term economic behaviour (Bellows & Miguel, 2009; Blattman, 2009; Malmendier & Nagel, 2011; Schoar & Zuo, 2013; Benmelech & Frydman, 2014). It also contributes to studies on migration (Conquest, 1987; Mitchneck & Plane, 1995; Fearnside, 1997; Viola, 2007), and stands out as an analysis of the largest inner-country migration. Furthermore, it provides evidence on how a policy, and especially one applied in the early stage of life, influences long-term socioeconomic development. The future research agenda includes a general equilibrium analysis on the effects of rustication on cross-sectional inequality and inter-generational investment, its long-term effects on the connection between urban and rural areas, and on rural development.

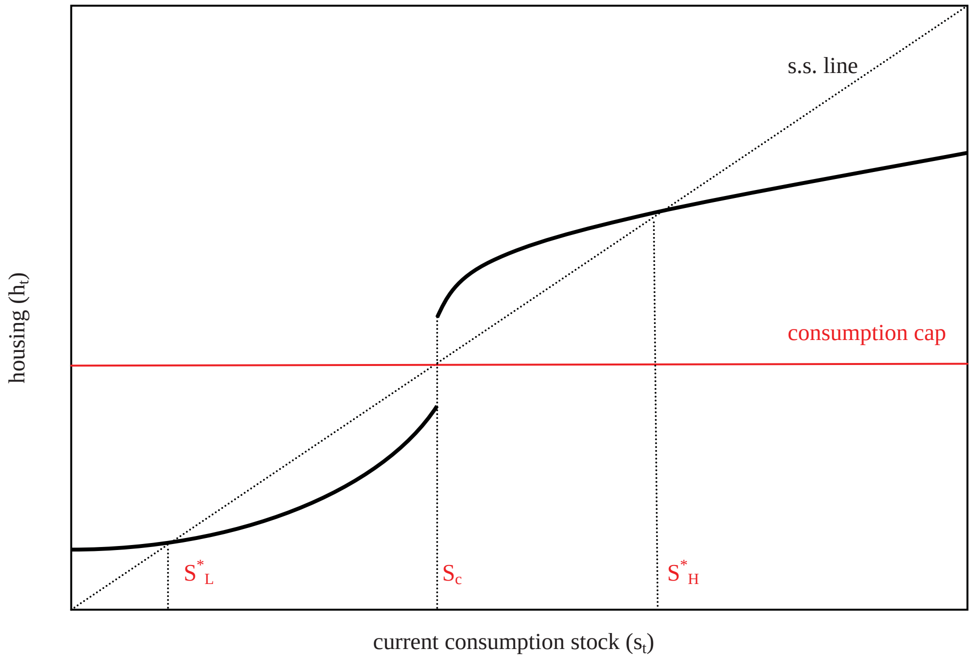
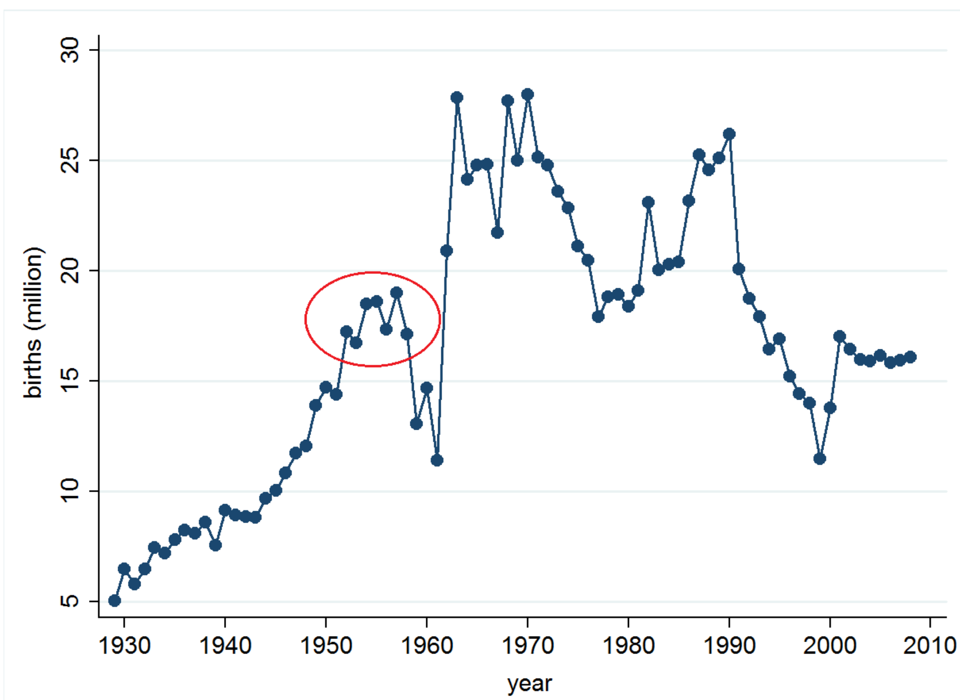
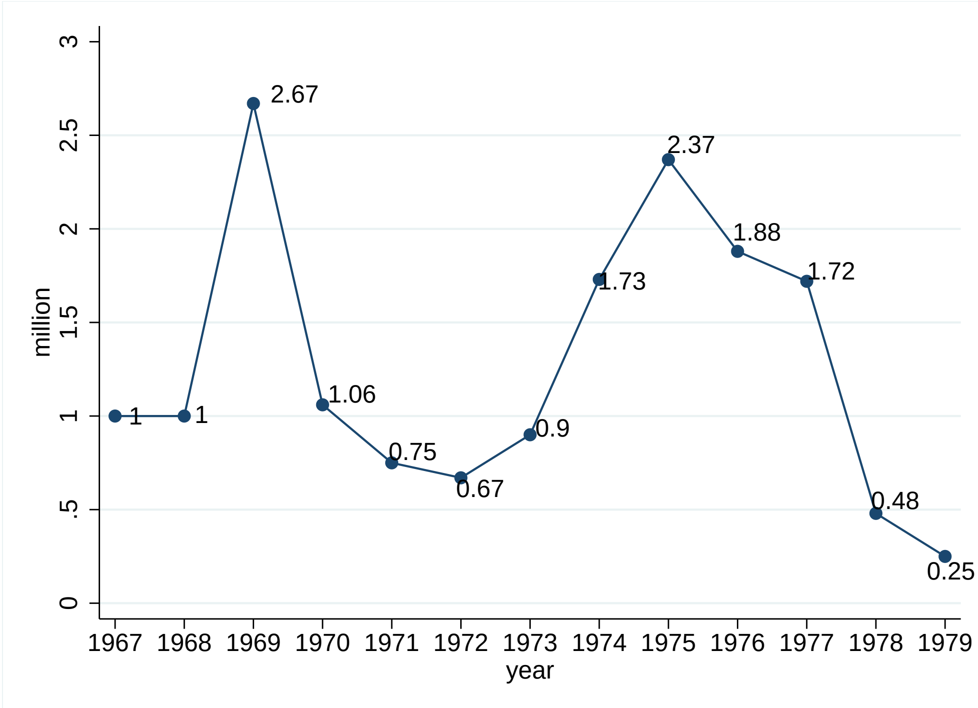


Figure 1: Illustration of Rustication Dynamics in an Optimisation Problem with Multiple Steady States



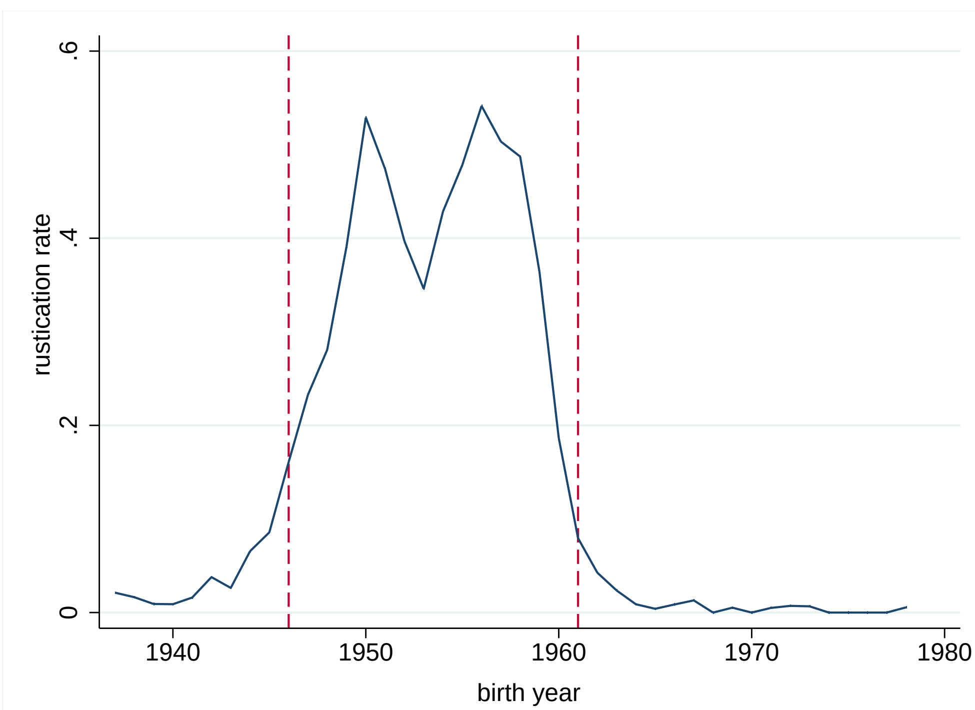
Data source: National Bureau of Statistics of China.
The red line circles the first baby boom after the foundation of P.R.China in 1949.

Figure 2: Number of Births in China (1930 - 2010)



Data source: Kojima (1996).

Figure 3: Number of Rusticated Youths

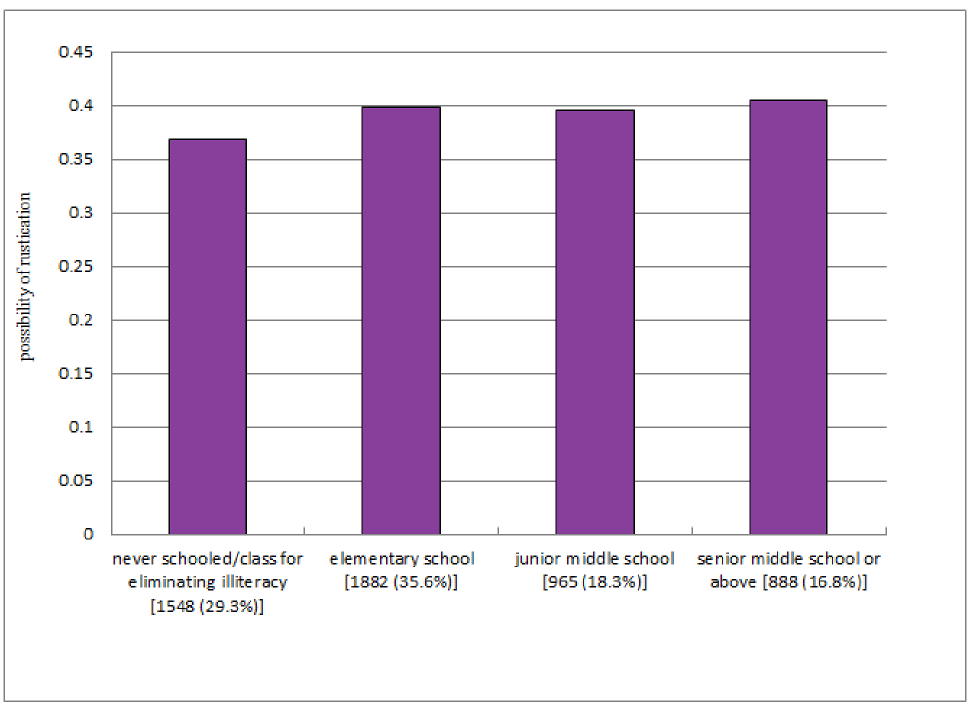


Data source: Chinese Household Income Project 2002.

Figure 4: Rustication Rate in Each Cohort

Data source: Bonnin (2013).

Figure 5: Migration in the Rustication



Data source: Chinese Household Income Project 2002.

Figure 6: Variation in the Possibility of Rustication by Father's Educational Status

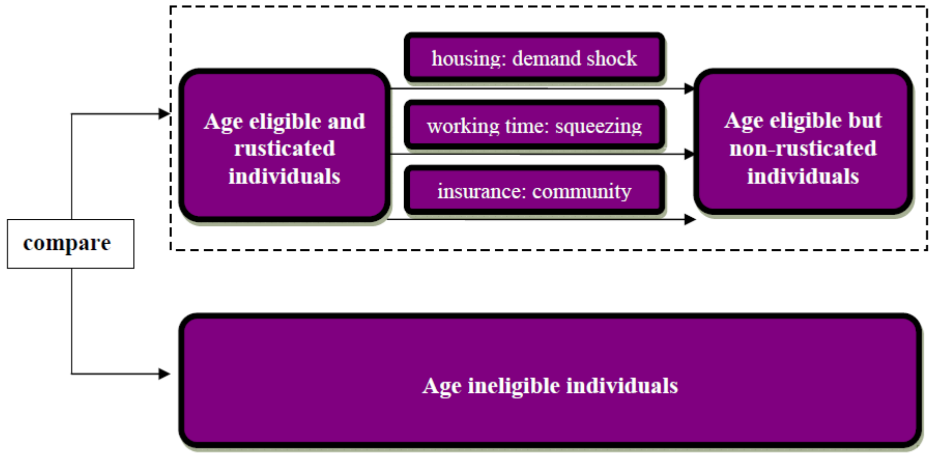


Figure 7: An Illustration on the Spill-over Effect of Rustication

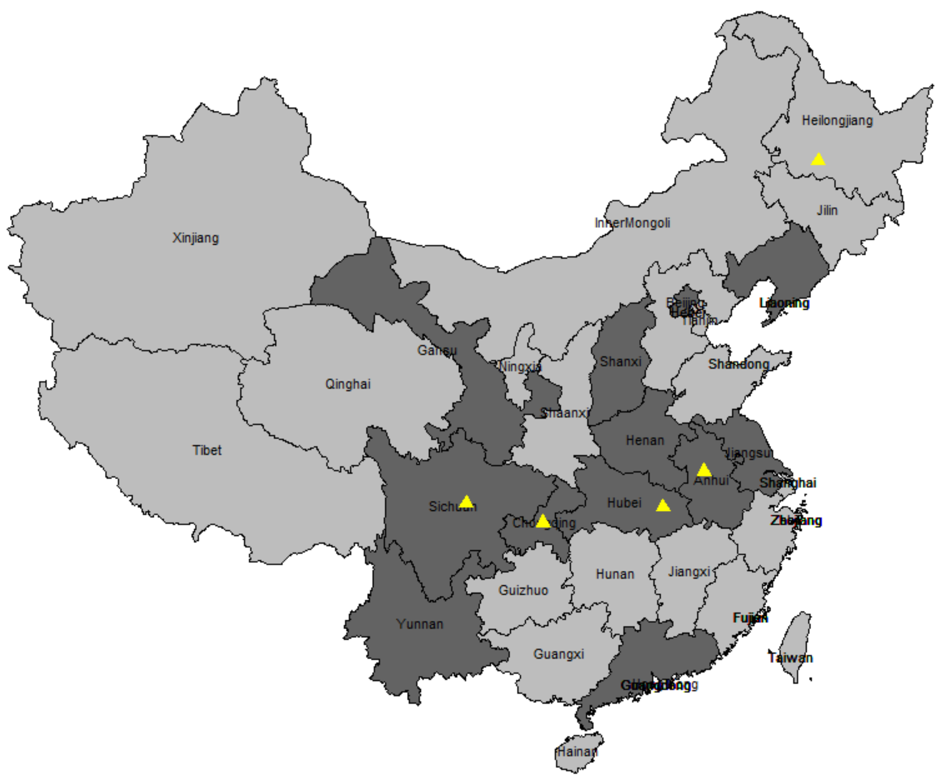
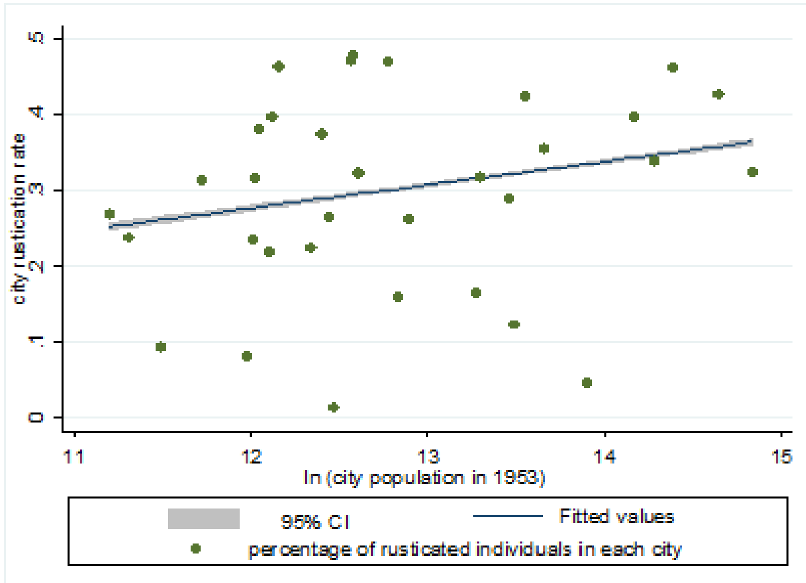


Figure 8: Data Coverage in the Chinese Household Income Project 2002, Chinese Twins Survey 2002, and mini-census 2005



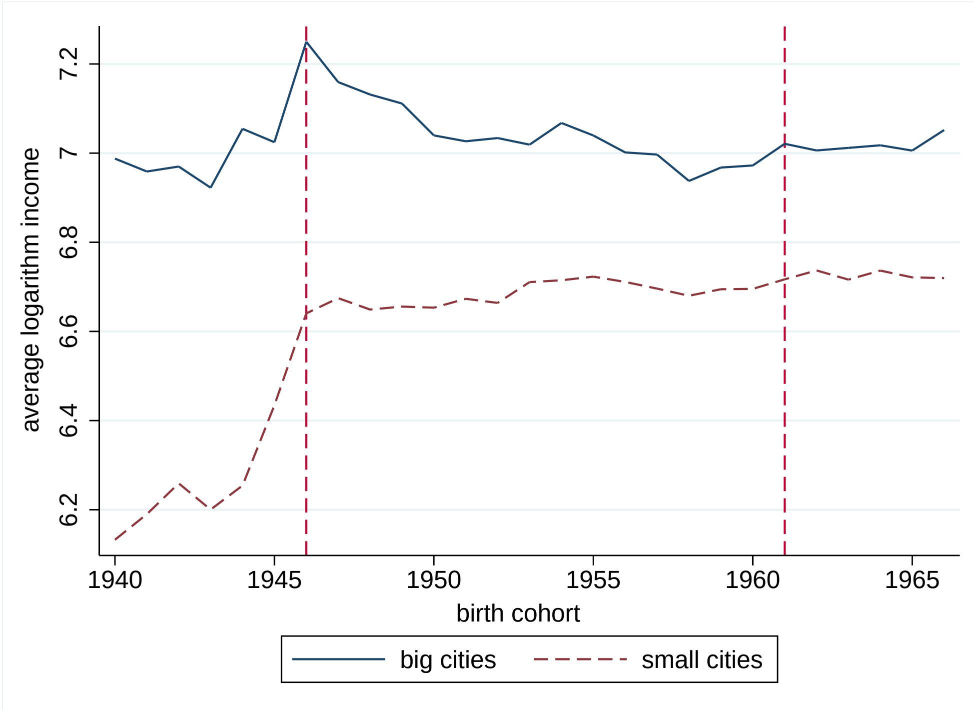
$$\text{rustication rate} = \underset{(0.197)}{-0.088} + \underset{(0.015)}{0.03}\ \ln(\text{city population in 1953})$$

Data source: Chinese Household Income Project 2002 and Census 1953.

Figure 9: Rustication Rate and City Population in 1953

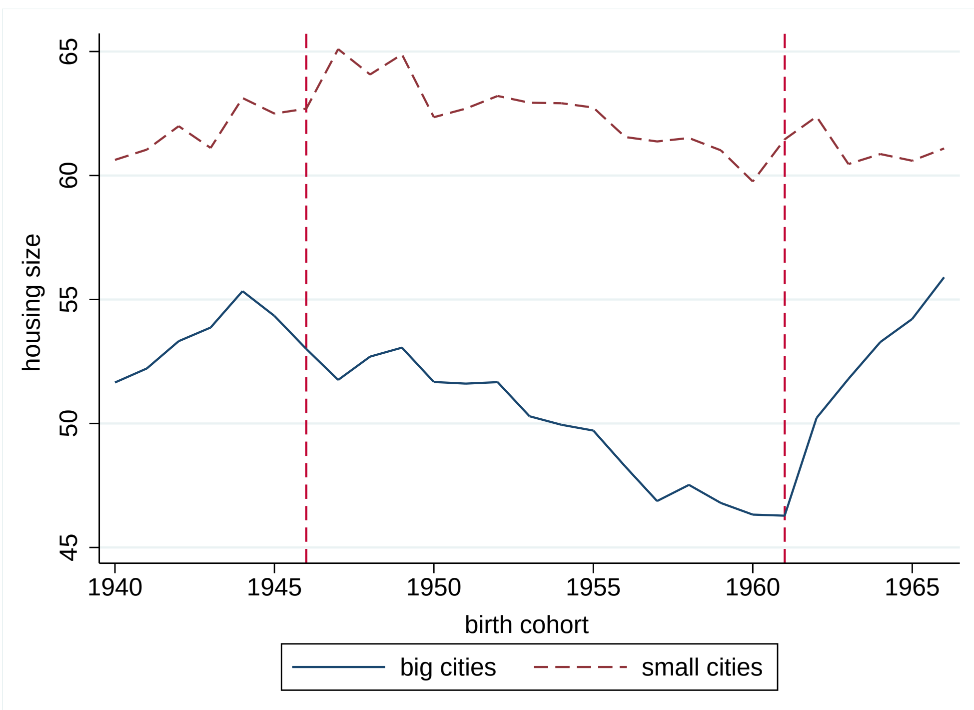
Data source: Mini-census 2005.

Figure 10: Senior High School Rate in Each Cohort



Data source: Mini-census 2005.

Figure 11: Average Logarithm of Monthly Income in Each Cohort



Data source: Mini-census 2005.

Figure 12: Housing Size (square metres) in Each Cohort

Table 1: Summary Statistics for the Rusticated Generation (Birth Cohort 1946-1961)

	Mean (Standard deviation)			
	Mini census 2005	CHIP 2002	Identical twins 2002	All siblings 2002
	(1)	(2)	(3)	(4)
Age	49.75	48.02	47.19	47.81
	(7.39)	(4.13)	(3.93)	(4.04)
Gender (male = 1)	0.52	0.49	0.48	0.48
	(0.50)	(0.50)	(0.50)	(0.50)
Being rusticated	-	0.42	0.54	0.45
(yes = 1)	-	(0.49)	(0.50)	(0.50)
Rusticated years	-	3.89	3.40	4.02
(conditional on rustication)	-	(2.66)	(3.46)	(3.29)
Senior high school	0.45	0.59	0.54	0.50
or above	(0.50)	(0.49)	(0.50)	(0.50)
University or above	0.05	0.05	0.05	0.05
	(0.22)	(0.21)	(0.21)	(0.22)
Annual income (USD)[a]	1,630.07	1,447.50	1,391.79	1,242.76
	(1,507.98)	(1,066.13)	(2,153.70)	(1,898.29)
Housing size (m^2)	58.92	50.13	60.35	58.66
	(41.14)	(22.76)	(40.81)	(38.55)
Private housing (=1)	-	-	0.77	0.78
	-	-	(0.42)	(0.41)
Housing value (USD)[b]	7,645.06	10,135.41	-	-
	(14,623.06)	(11,798.46)	-	-
Saving (USD)	-	4,341.84	-	-
	-	(5,162.82)	-	-
Investment on stocks	-	828.14	-	-
And bonds (USD)	-	(2,679.77)	-	-
Annual insurance	-	194.96	-	-
expenditure (USD)	-	(756.40)	-	-
Unemployment insurance	0.30	-	-	-
(purchased = 1)	(0.46)	-	-	-
Pension	0.62	-	-	-
(purchased = 1)	(0.49)	-	-	-
Health insurance	0.61	-	-	-
(purchased = 1)	(0.49)	-	-	-
Monthly working days	-	22.86	22.27	22.38
	-	(3.89)	(5.76)	(5.59)
Weekly working hours[c]	45.56	40.25	42.88	42.87
	(10.96)	(6.73)	(15.14)	(15.71)
Observations[d]	223,722	4,469	602	4,866

Notes: [a] Annual income in Columns (1) and (2) is transferred from monthly income.
[b] Housing price in Columns (1) and (2) is purchasing price and estimated market price respectively.
[c] The weekly working hours in Column (2) is transferred by daily working hours*5, as the legal weekly working days are five in China in 2002.
[d] Number of observations varies slightly in the specifications for income, housing consumption, working time, saving, investment, and insurance, due to missing values.

Table 2: The Long-Term Effects of Rustication on Housing Consumption

	Housing Consumption			
	(1)	(2)	(3)	(4)
Panel A. Difference-in-Difference Estimates - Mini Census				
	Housing size (m^2)		Purchasing price	
	big city * cohort	population * cohort	big city * cohort	population * cohort
1946-1961 vs.	-4.663***	-1.347***	-621.0**	-231.4**
others in 1940-1966	(1.134)	(0.324)	(315.1)	(101.8)
Observations	223,625	147,908	187,538	120,033
1946-1950 & 1954-1958 vs.	-4.584***	-1.357***	-594.8*	-231.5***
1941-1945 &1962-1966	(1.115)	(0.320)	(309.6)	(83.1)
Observations	169,159	110,930	142,369	90,615
Panel B. OLS Estimates - Control Family Background Explicitly (CHIP)				
	Housing size (m^2)		Purchasing price	
Being rusticated (=1)	-1.760*		-796.2**	
	(0.994)		(324.0)	
Rusticated years		-0.516***		-186.8***
		(0.154)		(61.5)
Observations	4,289	4,289	4,338	4,338
Panel C. Twin Fixed-Effects Estimates - Identical Twins				
	Housing size (m^2)		Property rights (private=1)	
Being rusticated (=1)	-3.653		-0.006	
	(2.714)		(0.058)	
Rusticated years		-0.806**		-0.005
		(0.362)		(0.009)
Observations	584	584	570	570
Panel D. Family Fixed-Effects Estimates - All Siblings				
	Housing size (m^2)		Property rights (private=1)	
Being rusticated (=1)	-2.976		-0.019	
	(2.393)		(0.046)	
Rusticated years		-0.535*		-0.0061
		(0.319)		(0.006)
Observations	826	826	788	788

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies. In addition, schooling years, number of household members, and income are controlled in Panels B-D. Father's social, educational, and political status are also controlled in Panel B.

Table 3: The Long-Term Effects of Rustication on Saving and Investment

	Saving and Investment (CHIP 2002)					
	Ln (saving)[a]		**Stocks & bonds/income**		**Stocks / income**	
	(1)	(2)	(3)	(4)	(5)	(6)
Being rusticated (=1)	0.065*		-0.111		-0.095	
	(0.037)		(0.122)		(0.097)	
Rusticated years		0.003		-0.032*		-0.025*
		(0.006)		(0.018)		(0.014)
Observations	3,968	3,968	4,338	4,338	4,338	4,338

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, age, schooling, regional dummies, father's social, educational, and political status. In the specifications for saving, income is also controlled.

[a] Savings contain fixed and current deposits, stocks and bonds, and monetary value of commercial insurance as a deposit.

Table 4: The Long-Term Effects of Rustication on Insurance and Pension

Insurance Purchase						
Panel A. Difference-in-Difference Estimates - Mini Census 2005						
	Purchase=1					
	big city * cohort			population * cohort		
	unemployment	pension	health	unemployment	pension	health
	(1)	(2)	(3)	(4)	(5)	(6)
1946-1961 vs.	0.031	0.031***	0.043***	0.009	0.009***	0.012***
others in 1940-1966	(0.019)	(0.008)	(0.008)	(0.006)	(0.003)	(0.003)
Observations	223,705	223,705	223,705	147,944	147,944	147,944
1946-1950 & 1954-1958 vs.	0.006	0.041***	0.050***	-0.0006	0.012***	0.013***
1941-1945 &1962-1966	(0.020)	(0.009)	(0.009)	(0.006)	(0.003)	(0.003)
Observations	169,225	169,225	169,225	110,959	110,959	110,959
Panel B. OLS Estimates -Control Family Background Explicitly (CHIP 2002)						
	Insurance expenditure					
	(1)			(2)		
Being rusticated (=1)	51.27*					
	(30.24)					
Rusticated years				7.14		
				(5.32)		
Observations	4,338			4,338		

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies. In addition, schooling years, income, and father's social, educational, and political status are controlled in Panel B.

Table 5: The Long-Term Effects of Rustication on Education

	Education			
	Senior high school or above		University or above	
	(1)	(2)	(3)	(4)
Panel A. Difference-in-Difference Estimates - Mini Census				
	big city * cohort	population * cohort	big city * cohort	population * cohort
1946-1961 vs.	-0.052***	-0.017***	-0.027***	-0.010***
others in 1940-1966	(0.015)	(0.004)	(0.005)	(0.001)
Observations	223,722	147,951	223,722	147,951
1946-1950 & 1954-1958 vs.	-0.047***	-0.014***	-0.025***	-0.010***
1941-1945 &1962-1966	(0.015)	(0.004)	(0.004)	(0.001)
Observations	169,238	110,963	169,238	110,963
Panel B. Probit/OLS Estimates - Control Family Background Explicitly (CHIP)				
Being rusticated (=1)	0.009		0.003	
	(0.019)		(0.007)	
Rusticated years		-0.009***		-0.003***
		(0.003)		(0.001)
Observations	4,465	4,465	4,465	4,465
Panel C. Twin Fixed-Effects Estimates - Identical Twins				
Being rusticated (=1)	-0.011		-0.044*	
	(0.485)		(0.027)	
Rusticated years		-0.007		-0.005
		(0.007)		(0.003)
Observations	602	602	602	602
Panel D. Family Fixed-Effects Estimates - All Siblings				
Being rusticated (=1)	0.011		0.005	
	(0.017)		(0.008)	
Rusticated years		-0.002		0.0002
		(0.003)		(0.002)
Observations	4,866	4,866	4,866	4,866

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies. Father's social, educational, and political status are also controlled in Panel B.

Table 6: The Long-Term Effects of Rustication on Income

	Ln (income)	
	(1)	(2)
Panel A. Difference-in-Difference Estimates - Mini Census		
	big city * cohort	population * cohort
1946-1961 vs.	-0.004	-0.005
others in 1940-1966	(0.016)	(0.005)
Observations	117,128	75,504
1946-1950 & 1954-1958 vs.	0.013	0.0003
1941-1945 &1962-1966	(0.018)	(0.006)
Observations	88,563	56,399
Panel B. OLS Estimates - Control Family Background Explicitly (CHIP)		
Being rusticated (=1)	0.017	
	(0.023)	
Rusticated years		0.002
		(0.004)
Observations	4,338	4,338
Panel C. Twin Fixed-Effects Estimates - Identical Twins		
Being rusticated (=1)	0.075	
	(0.089)	
Rusticated years		0.017
		(0.013)
Observations	600	600
Panel D. Family Fixed-Effects Estimates - All Siblings		
Being rusticated (=1)	0.023	
	(0.026)	
Rusticated years		-0.003
		(0.006)
Observations	4,435	4,435

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies. In addition, schooling years, working years and the square form are controlled in Panels B-D. Father's social, educational, and political status are also controlled in Panel B.

Table 7: The Long-Term Effects of Rustication on Working Time

	Working Time			
	Monthly working days		Weekly working hours	
	(1)	(2)	(3)	(4)
Panel A. Difference-in-Difference Estimates - Mini Census				
	big city * cohort	population * cohort	big city * cohort	population * cohort
1946-1961 vs.	–	–	-0.091	0.009
others in 1940-1966	–	–	(0.206)	(0.067)
Observations	–	–	116,141	74,880
1946-1950 & 1954-1958 vs.	–	–	0.051	0.049
1941-1945 &1962-1966	–	–	(0.218)	(0.076)
Observations	–	–	87,850	55,954
Panel B. OLS Estimates - Control Family Background Explicitly (CHIP)				
Being rusticated (=1)	0.033		0.286	
	(0.149)		(0.212)	
Rusticated years		0.024		0.119**
		(0.023)		(0.056)
Observations	3,152	3,152	3,139	3,139
Panel C. Twin Fixed-Effects Estimates - Identical Twins				
Being rusticated (=1)	1.395		5.528***	
	(0.887)		(2.430)	
Rusticated years		0.295*		1.886***
		(0.170)		(0.517)
Observations	282	282	282	282
Panel D. Family Fixed-Effects Estimates - All Siblings				
Being rusticated (=1)	1.192		5.231**	
	(0.755)		(2.239)	
Rusticated years		0.199*		1.668***
		(0.103)		(0.341)
Observations	374	374	374	374

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies. In addition, schooling years are controlled in Panels B-D. Father's social, educational, and political status are also controlled in Panel B.

Table 8: The Long-Term Effects from Being Rusticated versus Rusticated Length

	Twin Fixed-Effects Estimates				
	Housing size	Weekly working hours	Ln (income)	Senior high school/above	University/ above
	(1)	(2)	(3)	(4)	(5)
Being rusticated (=1)	-1.841	0.265	0.035	0.012	-0.042
	(2.924)	(3.557)	(0.096)	(0.052)	(0.028)
Rusticated years	-0.628*	1.849**	0.014	-0.008	-0.001
	(0.338)	(0.756)	(0.013)	(0.008)	(0.002)
Schooling	-0.431	0.387	0.040*		
	(1.027)	(0.586)	(0.023)		
Ln (income)	9.867***				
	(2.480)				
Number of household members	6.260***				
	(1.523)				
Observations	584	282	600	602	602

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, ethnics, age, and regional dummies.

Appendix

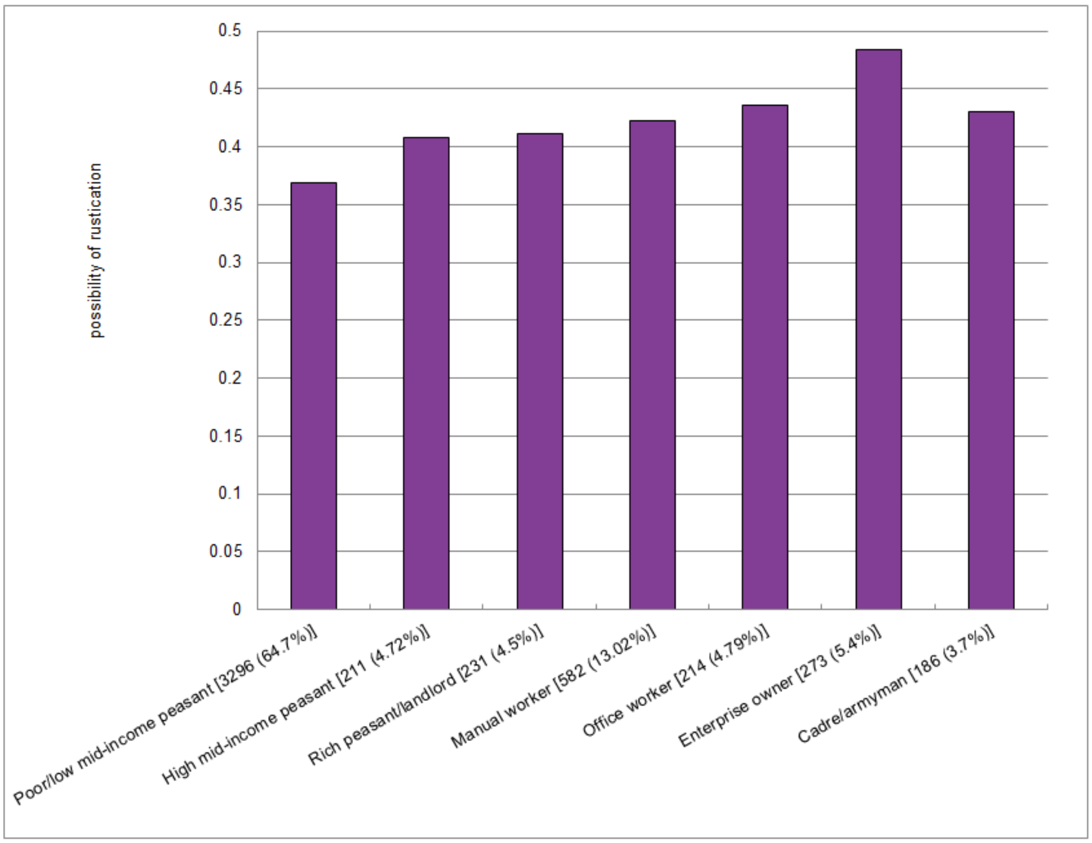
The Long-Term Effect of Rustication on Self Control and Self Reliance

As an exogenous shock, rustication transformed the youngsters' privileged urban status into an unprivileged rural one, and exposed them to unfamiliar environment. It is therefore expected to change their attitude toward others and control over themselves. Table A.5 presents my findings on the long-term effects of rustication on self control and self reliance.

Panel A presents the impact of rustication on self control ability, specifically on the capacity of controlling negative emotions, from the data of identical twins. The outcome variable is a dummy equal to 1 if an individual self-reports that he/she can always control anger or disgust. Otherwise it equals 0. Under twin fixed-effect estimation, I discover that individuals experiencing rustication are 17.5% and 18.1% more able to control anger and disgust respectively than their non-rusticated counterparts (Columns (1) and (3)). Both of the two estimates are at the 5% level of statistical significance. Similarly, with one more year of rustication, their capacity to inhibit negative emotion increases by 3%-4% (Columns (2) and (4)). Although the result is potentially subject to the self-report bias, it sheds light on the influence of rustication on non-cognitive skills (Zhang *et al.*, 2007).

Panel B shows the influence of rustication on self reliance. The outcome variable is a dummy of borrowing money from family or friends in emergency rather than from financial institutes with data from CHIP 2002. Columns (1) and (2) display the OLS estimates, while Columns (3) - (4) show the corresponding probit estimates, with family background controlled explicitly. With one additional sent-down year, an individual is about 0.4% less likely to borrow money from family members or friends in emergency, under both OLS and probit estimations (Columns (2) and (4)). Both of the two estimates are statistically significant at the 10% level of significance. In other words, they are more inclined to rely on themselves in the case of a financial crisis. The finding is consistent with Gong *et al.* (2014) that the rusticated individuals are less likely to believe in luck. Instead, they show more self reliance.

These findings are consistent with the literature that individual experiences affect psychosocial outcomes and shape attitude toward others. Blattman & Annan (2010) find that people exposed to severe war violence have higher psychological distress afterwards than those experiencing little war violence. Individuals with life traumatic experience, such as disease or divorce, are less likely to trust others (Alesina & La Ferrara, 2002). It is also coherent with the way that economic recession in the 2000s alters the Generation Y. They are reported to behave more modestly and hate conflicts (Groth & Giang, 2012).



Data source: Chinese Household and Income Project 2002.

Figure A.1: Variation in the Possibility of Rustication by Father's Social Status

Table A.1: Tabulation of Rustication Years

Years of rustication (conditional on being rusticated)	
	count (percent)
1 year	114 (5.89)
2 year	482 (24.88)
3 year	538 (27.77)
4 year	262 (13.53)
5 year	201 (10.38)
6 year	90 (4.65)
7 year and above	250 (12.91)
Mean	3.89 years
Observations	1,937

Notes: The data is from the Chinese Household Income Project 2002. The sample is restricted to individuals born between 1946 and 1961.

Table A.2: Variation in Rustication within Identical Twins

Variation in rustication within twins	
Neither rusticated	186 (30.90)
One rusticated	180 (29.90)
Both rusticated	236 (39.20)
Observations	602

Notes: The data is from the Chinese Twins Survey in 2002.
The sample is restricted to identical twins born between 1946 and 1961.

Table A.3: Robustness Checks (Twin Fixed-Effect Estimates)

	Twin Fixed-Effect Estimates - Identical Twins		
	Housing size (1)	working days/month (2)	working hours/week (3)
	Panel A. Control for initial endowment (birth weight)		
Being rusticated (=1)	-3.068	0.752	3.532*
	(2.824)	(0.759)	(2.038)
Rusticated years	-0.767**	0.262	1.745***
	(0.366)	(0.177)	(0.535)
Observations	572	272	272
	Panel B. Control for working sector and occupational type[a]		
Being rusticated (=1)	-5.524	1.388*	5.550**
	(3.488)	(0.802)	(2.265)
Rusticated years	-1.492**	0.246	1.833***
	(0.606)	(0.162)	(0.440)
Observations	270	282	282
	Panel C. Control for spouse's traits[b]		
Being rusticated (=1)	-9.366**	0.646	4.230
	(4.625)	(1.327)	(3.747)
Rusticated years	-1.880	0.174	2.236**
	(1.223)	(0.244)	(0.871)
Observations	192	134	134
	Panel D. Control for the initial year of being rusticated		
Being rusticated (=1)	-0.073	2.591***	0.967
	(2.485)	(0.328)	(1.045)
Rusticated years	-0.610*	0.168	1.830**
	(0.336)	(0.280)	(0.764)
Observations	584	282	282

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Schooling years, income, and number of household members are controlled in the specification for housing size. Schooling years are controlled in the specification for working time.

[a] Working sector equals 1 if an individual is in the state-owned sector. Otherwise it equals 0. Occupational type equals 1 if an individual works with white-collar job. Otherwise it equals 0.

[b] Spousal traits include schooling and working sector.

Table A.4: The Long-Term Effects of Rustication on Occupational Choice

	Twin Fixed-Effect Estimates - Identical Twins					
	State-owned sector (=1)		White collar (=1)		Self-employment (=1)	
	(1)	(2)	(3)	(4)	(5)	(6)
Being rusticated (=1)	0.018		0.004		0.018	
	(0.087)		(0.078)		(0.034)	
Rusticated years		-0.011		0.011		0.013
		(0.018)		(0.020)		(0.013)
Observations	292	292	286	286	292	292

Notes: The sample is restricted to identical twins born between 1946 and 1961.
Schooling years are controlled in all specification.

Table A.5: The Long-Term Effects of Rustication on Self Control and Self Reliance

Self Control and Self Reliance				
	(1)	(2)	(3)	(4)
Panel A. Emotional control (identical twins)				
	anger control		disgust control	
Being rusticated (=1)	0.175**		0.181**	
	(0.079)		(0.079)	
Rusticated years		0.042***		0.030**
		(0.015)		(0.014)
Observations	272	272	270	270
Panel B. Borrow money from family/friends (CHIP)				
	OLS		Probit	
Being rusticated (=1)	-0.017		-0.017	
	(0.017)		(0.017)	
Rusticated years		-0.004*		-0.004*
		(0.003)		(0.002)
Observations	4,357	4,357	4,357	4,357

Notes: robust standard errors are displayed in the parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%. Additional regressors in all specifications include gender, age, schooling, and regional dummies. Father's social, educational, and political status are controlled in Panel B.

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Spatial and Temporal House Price Diffusion in the Netherlands: A Bayesian Network Approach

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Abstract

Following the 2007-08 Global Financial Crisis, there have been a growing research interest on the spatial interrelationships between house prices in many countries. This paper examines the spatio-temporal relationship between house prices in the twelve provinces of the Netherlands using a recently proposed econometric modelling technique called Bayesian graphical vector autoregression (BG-VAR). This network approach enables a data driven identification of the most dominant provinces where house price shocks may largely diffuse through the housing market and it is suitable for analysing the complex spatial interactions between house prices. Using temporal house price volatilities for owner-occupied dwellings, the results show evidence of house price diffusion pattern in distinct sub-periods from different provincial housing sub-markets in the Netherlands. We observed particularly prior to the crisis, diffusion of temporal house price volatilities from Noord-Holland.

Keywords: Graphical models, House price diffusion, Spatial dependence, Spillover effect

JEL classification: C11; C15; C32; C52; R20; R32

1. Introduction

The collapse of house prices during the 2007-08 Global Financial Crisis (GFC) slowed down economic growth in many countries. After the GFC, researchers and governments alike have been seeking to understand the dynamics of house price development in order to resuscitate the stagnating housing market and the general economy. This has consequently led to a new research agenda that specifically seeks insights into spatial interactions and diffusion between the regional housing markets. House prices vary over space and time, but developments of house prices across regions may not be entirely independent of each other. As explained by Gong et al. (2016), there is significant variations in regional house prices, however, they interrelate spatially over time, and it is therefore paramount for governments to understand this interrelationship in formulating policies to regulate the overall functioning of the housing market.

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Spatial interrelationship between regional house prices may take the form of a long-run convergence or a temporal diffusion mechanism. Long-run convergent property markets equilibrate and remain integrated over long period of time (Holmes and Grimes, 2008; Cook, 2005; Cotter et al., 2011). Temporal house price diffusion is also sometimes known in the literature as ripple or spillover effect (see Meen, 1999). This market phenomenon depicts the situation where temporal house price volatility in one region is believed to propagate to house prices in other regions with a transitory or permanent effect (Balcilar et al., 2013; Canarella et al., 2012; Pollakowski and Ray, 1997). Empirical evidence in support of this temporal house price diffusion mechanism exists in the context of the US (Canarella et al., 2012; Holly et al., 2010; Pollakowski and Ray, 1997) and the UK (Meen, 1999, 1996; Holly et al., 2011). More recent results from China and other developing countries also learn support to the house price diffusion hypothesis (see Gong et al., 2016; Lee and Chien, 2011; Nanda and Yeh, 2014; Balcilar et al., 2013). However, in most of these previous studies, the hypothesis is tested for a lead-lag relationship where it is assumed a priori that the diffusion will start from some economically "superior region".

In this paper, we shed light on the spatial and temporal house price diffusion for the case of the Netherlands. The focus is specifically as follows: First, we investigate if there is a spatial dependence of temporal house price volatilities and a diffusion pattern between provinces in the Netherlands. Secondly, we are interested in identifying from the data the province where temporal house price volatilities may predominantly diffuse. Lastly, we investigate if these spatio-temporal relationships vary over time, particularly, if they are unchanged before and after the GFC.

We employ a graphical network approach for studying these spatio-temporal house price dynamics. Graphical modelling is a class of multivariate analysis that uses graphs consisting of nodes and edges to study the interaction and path dependence between variables. The nodes in this graph represent the variables while the edges denote their interactions and dependence structure (see Lauritzen, 1996; Eichler, 2007). The graphical modelling approach has become popular as a more natural way to discover hidden and complex interactions among multiple variables. It is applied mostly in the study of contagion and systemic risk analysis in the financial sector where there is complicated and non-linear relationships between variables (see Ahelegbey, 2016, for a more comprehensive review). Like most financial variables, one indeed expects a complex interrelationships between regional house prices which can easily be handled by the graphical network approach.

In essence, our paper makes four main contributions to the literature. First, we analyse the spatio-temporal house price dynamics in Netherlands which has an entirely different market settings from those studied in the previous papers. The housing market in the Netherlands is unique in many respects. It is a highly regulated market where central and local authorities play an active role. The market is extremely inefficient because of high transaction costs and regulated use of building plots (see Vermeulen and Rouwendal, 2007). In general, demand and supply factors in the Dutch owner-occupied housing sector are outcomes of the government housing policies besides income and population growth (see Boelhouwer et al., 2004; Toussaint and Elsinga, 2007). This paper is first to study the spatio-temporal house price dynamics in this unique market setting of the Netherlands and hence adds an interesting dimension to the subject. The second contribution of the paper is that it demonstrates the usefulness of graphical techniques in analysing the spatio-temporal house price dynamics. To the best of our knowledge, this is the first empirical paper that puts forward the graphical framework as an alternative for analysing the house price diffusion mechanism.

The paper specifically uses the recent Bayesian graphical vector autoregression (BG-VAR) model proposed by Ahelegbey et al. (2016a). The BG-VAR is a data driven approach where the directed edges of the network represent causal relationships. This connects to the third contribution of our paper. We estimate spatial interactions that have causal interpretations rather than mere lagged correlations (see details in Ahelegbey et al., 2016a). Fourth, we deduce the central regional market where house price volatilities possibly diffuse from the data. This is contrary to previous studies which assume a priori some "bigger cities" as central in investigating the house price volatility diffusion process (e.g. Holly et al., 2011). This potential selection bias is avoided in our approach because such central region can be easily inferred from the network using statistical measures for the centrality. Moreover, we can learn the diffusion pattern of the temporal house price fluctuations from the network structure without resort to impulse response analysis.[1] The specific statistical measures for analysing the centrality and diffusion mechanism are made precise in subsequent sections.

Using quarterly data on temporal house price volatilities (1995:Q1-2016:Q1) for existing owner-occupied dwellings from the twelve provinces of the Netherlands, our results support a temporal dependence and diffusion dynamics between the provincial housing markets. These interrelationships however varied over the study period in terms of the degree of dependence and the centrally dominant sub-markets. Noord-Holland in particular was most predominant region where temporal house price volatilities likely diffused to other provinces prior to the crisis. In application, the results of this paper are relevant for policy makers who wish to direct regulations aimed at avoiding temporal regional house price volatilities from cascading systemically to other regions. Likewise, investors may find the results applicable in diversifying and managing risks of their housing portfolios.

We organised the remaining sections of the paper as follows: A brief overview of the related literature is provided in Section 2. Section 3 describes the BG-VAR model. The description of our data is presented in Section 4 while Section 5 discusses the empirical results. The entire paper is concluded in Section 6.

[1] The BG-VAR nevertheless also has an underlying variable selection mechanism that will yield a parsimonious VAR model for performing impulse response analysis.

2. Extant Literature

Many scholars have been working on the spatio-temporal house price diffusion or the so-called ripple effect and a vast literature now exist. An extensive review of the literature is provided by Balcilar et al. (2013) and most recently by Nanda and Yeh (2014) and Gong et al. (2016). We only provide a brief summary here. The study of this ripple effect hypothesis actually began from the UK when English researchers observed that house prices rise, during an upswing, first from the South-East (mostly London) and then spread out to other parts of the country (Giussani and Hadjimatheou, 1991; Meen, 1996, 1999). According to Pollakowski and Ray (1997) house price diffusion will not necessarily occur between neighbouring housing markets, but may require some form of economic interrelationship. Meen (1999) likewise shared the view of Pollakowski and Ray (1997), and noted that spatial dependence may not be necessary for explaining the ripple effect. Meen (1999) then suggested four probable mechanisms through which rising house prices from one region may later manifest in other parts of the UK. These channels according to the author include: migration, equity transfer, spatial arbitrage and spatial patterns in house price determinants. As also noted later by Canarella et al. (2012), migration particularly may lead to house price ripple effect if households relocate in response to changes in the spatial distribution in house prices.

Meen (1999) methodologically assumed that regional house prices will react to shocks at different rates, and then went on to provide an empirical framework for testing the ripple effects. This was effectively equivalent to testing the stationarity of the regional to national house price ratios. Although Meen (1999) was unsuccessful in confirming the ripple effect with the augmented Dickey-Fuller test of Dickey and Fuller (1979), the author's empirical framework became the basis for other scholars who later found empirical evidence using more sophisticated stationarity test procedures. Cook (2003), for instance adopted the threshold and momentum threshold autoregressive test procedures while Holmes and Grimes (2008) used a combination of unit root test and principal component analysis to confirm the spillover effect in the UK. Canarella et al. (2012) similarly studied the house price diffusion effect in the US by using a combination of the generalised least squares (GLS) version of the Dickey-Fuller, non-linear unit root tests and other test procedures that control for structure breaks. Balcilar et al. (2013) also adopted a Bayesian and non-linear unit root tests, with and without structure breaks to investigate the ripple effect in the South African housing market. The panel seemingly unrelated regressions augmented Dickey-Fuller (SURADF) has equally been employed by other scholars (e.g. Lee and Chien, 2011; Holmes, 2007).

Recently, tremendous effort has also been channelled, relying on the advancement in the econometric literature, in refining the methodology for testing the ripple effect hypothesis beside the "Meen framework". Holly et al. (2011), for example proposed a dynamic modelling approach where they allow shocks from the dominant region to propagate to other regions and then echo back. The authors found support for the ripple effect using this approach for the UK with London as the dominant region. Gong et al. (2016) also adopted similar method in their study of ripple effect for 10 regions in the Pan-Pearl river of China. Nanda and Yeh (2014), in a related study also suggested using a dynamic panel-spatial model. Some researches equally advocated formulating a vector autoregressive (VAR) model and subsequently testing for Granger Causality (GC) and/or performing (generalised) impulse response analysis (IRA) to examine the ripple effect hypothesis. Brady (2014), for example captured the spatial diffusion of regional housing prices in the US with impulse response functions estimated directly from a single equation spatial autoregressive model. Vansteenkiste and Hiebert (2011) used a global VAR model to study if there are house price spillovers across the euro area countries. Gupta and Miller (2012a) and Gupta and Miller (2012b), similarly formulated different VAR models after which they tested for GC and performed IRA to verify the spatial diffusion phenomenon for various Metropolitan Statistical Areas (MSA) in the US.

The approach in this paper also starts with a baseline VAR model. It follows Ahelegbey et al. (2016a) which converts a VAR model to a Bayesian graphical network (BG-VAR). The BG-VAR identifies temporal and directional dependency between variables and it is somewhat related to the concept of GC. The GC, however adopts a pairwise (or conditional pairwise) analysis to identify the dependence patterns without accounting for the structural uncertainties. On the other hand, the BG-VAR employs a Bayesian technique which incorporates necessary prior information to explore the structure and to apply model averaging. Ahelegbey (2016) provided an empirical evidence that support the superior efficiency of the BG-VAR over the GC in producing dependence patterns that are more suitable to capture complex interdependencies. Investigating the dependence structure between multiple time series with the BG-VAR model is generally more convenient for researchers and policy makers to understand directional or causal relationships. The graphical component especially aids a visual understanding of the interactions between the time series.

3. The Bayesian Graphical Vector Autoregressive (BG-VAR) Model

This section presents the formulation of the BG-VAR model adopted in this paper. Assume for a moment that temporal house price volatilities in one region is a result of earlier shock to house prices in other regions. We can formulate a vector autoregressive process of order p (VAR(p)) to capture these interdependencies. As mentioned earlier, some authors study the spatial and temporal house price dynamics by testing for Granger causality (GC) and performing impulse response analysis from this underlying VAR model.

Let Y_t denote the vector of house price volatilities at the time t from n regions. We can write the VAR(p) process for Y_t following the equation

$$Y_t = \sum_{i=1}^{p} B_i Y_{t-i} + u_t = BX_t + u_t, \quad u_t \sim \mathcal{N}(\mathbf{0}, \Sigma_u) \tag{1}$$

where $t = p+1, \dots, T$; p is the maximum lag order; B_i, $1 \leq i \leq p$ is $n \times n$ matrix of coefficients; $B = (B_1, \dots, B_p)$ is $n \times np$ and $X_t = (Y'_{t-1}, \dots, Y'_{t-p})'$ is $np \times 1$ stacked autoregressive coefficient matrices and lags of the house price volatilities respectively. The set of equations in (1) captures the structure of the interactions between the regional house price volatilities and Ahelegbey et al. (2016a) show that the temporal dependencies between them could be inferred from B. For example when the volatility of house prices in one region depends only on a subset but not on earlier shock to house prices in all the regions, there are components of B that become zero. In general, B_{ij} measures the anticipated effect of changes in the j-th predictor ($X_{j,t}$) on the house price development in the i-th region ($Y_{i,t}$).

Ahelegbey et al. (2016a) show that the VAR model (1) can be operationalised as a graphical model using the relation $B = (G \circ \Phi)$, where G is a binary (0/1) matrix, Φ is a coefficients matrix, both of dimension $n \times np$, and ($\circ$) is the element-by-element product. The elements of G represent the presence or absence of an edge (interaction) between volatility of house prices in pairs of regions. A one-to-one correspondence between B and Φ conditional on G can be identified. That is, $B_{ij} = \Phi_{ij} \neq 0$, if $G_{ij} = 1$; and $B_{ij} = 0$, if $G_{ij} = 0$.

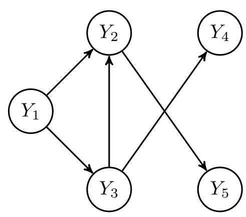
As an example, consider an arbitrary five-dimensional VAR(1) with coefficients matrix

$$B = \begin{pmatrix} \beta_{11} & 0 & 0 & 0 & 0 \\ \beta_{21} & 0 & \beta_{23} & 0 & 0 \\ \beta_{31} & 0 & \beta_{33} & 0 & 0 \\ 0 & 0 & \beta_{43} & \beta_{44} & 0 \\ 0 & \beta_{52} & 0 & 0 & \beta_{55} \end{pmatrix} \tag{2}$$

where the non-zero elements of B are real numbers. The network that depicts the temporal dependence among the variables associated with (2) can be visualised in Figure 1. The links in the network indicate lagged dependencies between the variables without self lag effects (self-loops). Since $\beta_{21} \neq 0$, $Y_{1,t-1}$ has a significant impact on $Y_{2,t}$, which we denote as $Y_1 \to Y_2$.

$$\begin{array}{c} \\ Y_{1,t} \\ Y_{2,t} \\ Y_{3,t} \\ Y_{4,t} \\ Y_{5,t} \end{array} \begin{array}{c} \begin{array}{ccccc} Y_{1,t-1} & Y_{2,t-1} & Y_{3,t-1} & Y_{4,t-1} & Y_{5,t-1} \end{array} \\ \begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 \end{pmatrix} \end{array}$$

(a)



(b)

Figure 1: Network matrix and diagram associated with the temporal dependence in the five-dimensional VAR(1) process in (2). Note: links are lagged effects without self-loops.

For the analysis in this paper, it suffices to estimate only the network structure captured by G. Let $D_t = (X'_t, Y'_t)'$ be a $d \times 1$ vector, where $d = n + np$ and assume $D_t \sim \mathcal{N}(\mathbf{0}, \Omega^{-1})$, where Ω is a $d \times d$ precision matrix. The joint distribution for all the variables in D_t can be summarised with a graphical model and represented by the pair $(G, \Omega) \in (\mathcal{G} \times \Theta)$. Here, G is a directed acyclic graph (DAG) of the relationships among the variables in D_t, Ω consists of the VAR model parameters, $\mathcal{G}$ and Θ are the graph and parameter space respectively. The triple (Ω, Σ_u, B) are mathematical related. Suppose $X_t \sim \mathcal{N}(0, \Sigma_{xx})$ and $Y_t|X_t \sim \mathcal{N}(BX_t, \Sigma_u)$, B and Σ_u can be obtained from the covariance matrix of D_t (i.e. $\Sigma = \Omega^{-1}$) by

$$B = \Sigma_{yx}\Sigma_{xx}^{-1}, \qquad\qquad \Sigma_u = \Sigma_{yy} - \Sigma_{yx}\Sigma_{xx}^{-1}\Sigma_{xy} \tag{3}$$

where Σ_{yx} is $n \times np$ covariances between Y_t and X_t, Σ_{xx} is $np \times np$ covariances among X_t and Σ_{yy} is $n \times n$ covariances among Y_t. Given B, Σ_u and Σ_{xx}, Ω can equally be obtained using the well-known Sherman-Morrison-Woodbury formula (Woodbury, 1950),

$$\Omega = \Sigma^{-1} = \begin{pmatrix} \Sigma_{xx}^{-1} + B'\Sigma_u^{-1}B & -B'\Sigma_u^{-1} \\ -\Sigma_u^{-1}B & \Sigma_u^{-1} \end{pmatrix}, \qquad \text{where} \quad \Sigma = \begin{pmatrix} \Sigma_{xx} & \Sigma_{xy} \\ \Sigma_{yx} & \Sigma_{yy} \end{pmatrix} \tag{4}$$

By defining $B = (G \circ \Phi)$, equation (4) shows how Ω relates to G through B. The specification of the BG-VAR model is completed with the choice of a hierarchical prior on the lag order p, the graph structure G and the parameter Ω.

We now focus on the estimation procedure for the graph structure (G) associated with the temporal dependence between the regional house prices. In the Bayesian framework, the joint prior distribution of (p, G, Ω) is given by $Pr(p, G, \Omega) = Pr(p)Pr(G|p)Pr(\Omega|p, G)$. It is important to first select the optimal lag order for the VAR model. Following Ahelegbey et al. (2016b), we choose p in the range $0 < p_{\min} < p_{\max} < \infty$, for some lower bound $p_{\min}$ and upper bound $p_{\max}$. More specifically, we assume p follows a discrete uniform prior on $\{p_{\min}, \ldots, p_{\max}\}$ with a distribution

$$Pr(p) = \frac{1}{p_{\max} - p_{\min} + 1} \tag{5}$$

Since we seek to estimate the regional market that is central in the spread of house price volatility from the data, it is more reasonable to assume a priori that any region is equally likely to play this role. This implies that the graph structure can be represented as a product of local sub-graphs of each equation of the model and may be written as

$$Pr(G|p) = \prod_{i=1}^{n} Pr(\pi_i|p) \tag{6}$$

where $\pi_i = \{j = 1, \ldots, np : G_{ij} = 1\}$ is the set of price volatilities of the i-th equation predictors.

We formulate in what follows, the standard techniques for estimating G also described by Ahelegbey et al. (2016a,b). We assume for each edge G_{ij}, an independent Bernoulli trial with conditional prior probability

$$Pr(\pi_i|p,\gamma) = \gamma^{|\pi_i|}(1-\gamma)^{np-|\pi_i|} \tag{7}$$

where $|\pi_i|$ is the cardinality of π_i and $\gamma \in (0,1)$ is the Bernoulli parameter. We use a uniform graph prior by choosing $\gamma = 0.5$ so that $Pr(\pi_i|p,\gamma=0.5) = 2^{-np}$ and $Pr(G|p) \propto 1$.

Following standard Bayesian paradigm, we also assume that Ω conditional on p and a complete graph G is Wishart distributed, $\Omega \sim \mathcal{W}(\nu, \underline{S}^{-1})$, with density

$$Pr(\Omega|p,G) = \frac{1}{K_d(\nu,\underline{S})}|\Omega|^{\frac{(\nu-d-1)}{2}} \exp\Big\{-\frac{1}{2}\langle\Omega,\underline{S}\rangle\Big\} \tag{8}$$

where $\langle A,B\rangle = tr(A'B)$ is the trace inner product, ν is the degree of freedom, $\underline{S}$ is the prior sum of squared matrix and $K_d(\nu,\underline{S})$ is the normalizing constant. The likelihood of a random sample $\mathcal{D} = (D_1,\ldots,D_T)$ is multivariate Gaussian with density

$$Pr(\mathcal{D}|p,\Omega,G) = (2\pi)^{-\frac{1}{2}dT}|\Omega|^{\frac{1}{2}T} \exp\Big\{-\frac{1}{2}\langle\Omega,\hat{S}\rangle\Big\} \tag{9}$$

where $\hat{S} = \sum_{t=1}^{T} D_t D_t'$ is a $d \times d$ sample sum of squared matrix.

Given that G is unknown, a standard Bayesian approach for determining the graph structure is to integrate out Ω from (9) with respect to its prior given by

$$Pr(\mathcal{D}|p,G) = \int Pr(\mathcal{D}|p,\Omega,G)\ Pr(\Omega|p,G)d\Omega = \frac{K_d(\nu+T,\underline{S}+\hat{S})}{(2\pi)^{\frac{1}{2}dT}K_d(\nu,\underline{S})} \tag{10}$$

where $\underline{S}+\hat{S}$ is the posterior sum of squared matrix. The expression (10) is the marginal likelihood function expressed as ratio of the normalising constants of the Wishart posterior and prior. Following standard application, the marginal likelihood factorises into the product of local terms, each involving $Y_{i,t}$ and its set of selected predictors, $X_{\pi_i,t}$, given by

$$Pr(\mathcal{D}|p,G) = \prod_{i=1}^{n} Pr(\mathcal{D}|p,G_{i,\pi_i}) = \prod_{i=1}^{n} \frac{Pr(\mathcal{D}^{(i,\pi_i)}|p,G)}{Pr(\mathcal{D}^{(\pi_i)}|p,G)} \tag{11}$$

where $\mathcal{D}^{(i,\pi_i)}$ and $\mathcal{D}^{(\pi_i)}$ are sub-matrices of $\mathcal{D}$ consisting of $(Y_{i,t}, X_{\pi_i,t})$ and $X_{\pi_i,t}$ respectively. Let $w_i \in (\{i\} \cup \pi_i)$. The closed-form expression for the left-hand side of (11) is given by

$$Pr(\mathcal{D}^{w_i}|p,G) = \frac{\pi^{-\frac{1}{2}T|w_i|}\nu^{\frac{1}{2}\nu|w_i|}}{(\nu+T)^{\frac{1}{2}(\nu+T)|w_i|}} \frac{|\underline{\Sigma}_{w_i}|^{\frac{1}{2}\nu}}{|\bar{\Sigma}_{w_i}|^{\frac{1}{2}(\nu+T)}} \prod_{s=1}^{|w_i|} \frac{\Gamma\big(\frac{\nu+T+1-s}{2}\big)}{\Gamma\big(\frac{\nu+1-s}{2}\big)} \tag{12}$$

where $|w_i|$ is the cardinality of w_i, $\underline{\Sigma}_{w_i}$ and $\bar{\Sigma}_{w_i}$ are the prior and posterior covariance matrices of $\mathcal{D}^{w_i}$. Again, we follow standard practice and set $\underline{\Sigma}_{w_i} = I_{|w_i|}$, where $I_{|w_i|}$ is a $|w_i|$ dimensional identity matrix.[2] By definition, (12) consists of a component that is independent of $\bar{\Sigma}_{w_i}$. We can reduce the computational time by expressing this independent component as a function $Q_\nu(|w_i|, p, T)$ given by

$$Q_\nu(|w_i|, p, T) = \frac{\pi^{-\frac{1}{2}T|w_i|}\nu^{\frac{1}{2}\nu|w_i|}}{(\nu+T)^{\frac{1}{2}(\nu+T)|w_i|}} \prod_{s=1}^{|w_i|} \frac{\Gamma\left(\frac{\nu+T+1-s}{2}\right)}{\Gamma\left(\frac{\nu+1-s}{2}\right)} \tag{13}$$

Since for each equation, we have np number of explanatory variables, $|w_i|$ will be bounded below by 1 and above by $np+1$. Thus, we can set $\nu = np+2$. Given ν, T and p, $Q_\nu(|w_i|, p, T)$ does not directly depend on the variables in w_i but on $|w_i| \in \{1, \ldots, np+1\}$. Hence, (12) may be expressed as

$$Pr(\mathcal{D}^{w_i}|p, G) = Q_\nu(|w_i|, p, T) \quad |\bar{\Sigma}_{w_i}|^{-\frac{1}{2}(\nu+T)} \tag{14}$$

The posterior covariance matrix of $\mathcal{D}$ is also given by

$$\bar{\Sigma} = \frac{1}{\nu+T}\left(\nu I_d + \sum_{t=1}^{T} D_t D_t'\right) \tag{15}$$

Thus, $\bar{\Sigma}_{w_i}$ in (14) can be obtained as a sub-matrix of $\bar{\Sigma}$ which corresponds to the elements in w_i. Pre-computing $\bar{\Sigma}$ and $Q_\nu(|w_i|, p, T)$ for $|w_i|$ given ν, T and p, before sampling the network matrix reduces the computational complexity and makes the algorithm efficient. The details of sampling the network structure is provided in Appendix A.

4. Description of Data

This paper studies the temporal spatial dependence and diffusion pattern of house prices in the Netherlands. In this section, we give a brief background to the regional housing market in the Netherlands and describe the data. The spatial units for our analysis are the twelve official Dutch provinces[3] and these include: Drenthe, Flevoland, Friesland, Gelderland, Groningen, Limburg, Noord-Brabant, Noord-Holland, Overijssel, Zuid-Holland, Utrecht and Zeeland (see map in Figure 2). Zuid-Holland is the largest in terms of GDP (141.758 billion Euros in 2014), followed by Noord-Holland (133.358 billion Euros in 2014). Zeeland is the smallest with estimated GDP of 11.429 billion Euros in 2014 according to Statistic Netherlands. The capital Amsterdam is hosted by Noord-Holland while the government seat (The Hague) is located in Zuid-Holland.

Following result in the extant literature that house price shocks from the "mega economic districts" diffuse through to the peripheral regions (see Gong et al., 2016; Holly et al., 2011),

[2] For any $n \times n$ identity matrix A, we have $|A| = 1$.
[3] In this paper, we use region and province interchangeably.

our initial expectation is that Noord-Holland or Zuid-Holland at certain periods may be found central in the house price diffusion mechanism in the Netherlands.

Figure 2: The twelve provinces of the Netherlands. *Source:* d-maps.com

We defined the temporal volatilities from quarterly house price indexes between 1995Q1 and 2016Q1 for owner-occupied dwellings in the analysis of this paper. The original house price indexes were obtained from the Centraal Bureau voor de Statistiek (CBS). CBS is the Dutch official statistical agency which publishes, among others, housing statistics online. A simple plot of the house price indexes (Figure 3) shows a common trend in the growth of house prices in all the twelve regional markets before and after the GFC. The periods prior to 2009 show relatively volatile and faster house price appreciation which may be attributed to many factors. Most importantly, however, the Dutch government had forcefully promoted home ownership during these periods with the National Mortgage Guarantee scheme and through an income tax structure that offered generous rebates on the payment of mortgage interest (see, Boelhouwer et al., 2004; Boelhouwer, 2002; Elsinga, 2003; Toussaint and Elsinga, 2007). These incentive packages generally made it cheaper for individual households to purchase their own dwellings. Consequently, there was an increase demand which also led to an upward and more volatile house prices before the crisis.

As in other countries, financial institutions in the Netherlands were also hit by the 2007-08 GFC. The impact of the crisis on house prices however started in the last quarter of 2008 as seen in Figure 3. Following the GFC, average house prices in the Netherlands declined by

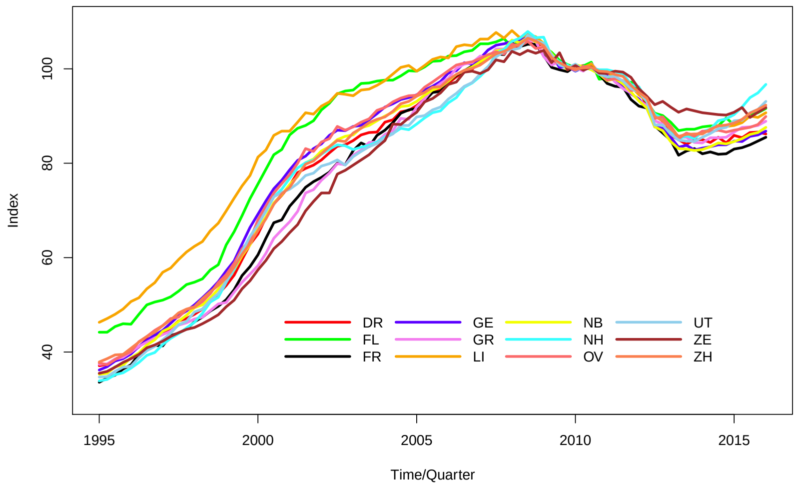


Figure 3: CBS' house price index for the 12 Dutch provinces. Note: DR = Drenthe, FL = Flevoland, FR = Friesland, GE = Gelderland, GR = Groningen, LI = Limburg, NB = Noord-Brabant, NH = Noord-Holland, OV = Overijssel, UT = Utrecht, ZE = Zeeland, ZH = Zuid-Holland.

almost 25% between 2009 and 2013. Teulings (2014), attributed the collapse in the Dutch property values with the higher unemployment and redundancy rates during the meltdown. Other scholars however blamed the collapse on the Dutch financial institutions who tightened up mortgage accessibility and impeded new home buyers from the market (Boelhouwer, 2014; Bardhan et al., 2011). Since the beginning of 2014, there have been gradual recovery of Dutch house prices, somewhat faster in Zuid-Holland and Noord-Holland.

5. Spatial and temporal house price dynamics

In studying temporal house price diffusion, we are interested here in understanding if temporal house price volatilities in one region of the Netherlands is a result of earlier shock(s) to house prices in other regions. Our methodology adopts the the network approach. We followed Martens and Van Dijk (2007) to define the house price volatilities for each region as the squared returns given by

$$SR_t = [100(\log I_t - \log I_{t-1})]^2 \tag{16}$$

where I_t is the house price index at the time t. Figure 4 summarises the temporal regional house price volatilities.

We began by estimating the temporal interdependencies between the regional house price volatilities from the network structure using a twenty-quarter rolling window. This was to examine the degree of temporal interdependencies in the regional house prices and to discern the patterns over time. Figure 5 presents the network density associated with the volatility interdependencies. The network density is a crude measure which indicates the proportion

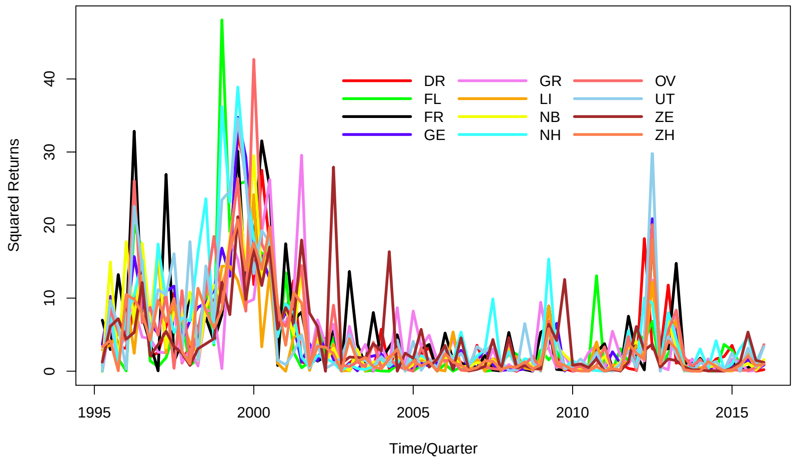


Figure 4: Regional house price volatilities. Note: DR = Drenthe, FL = Flevoland, FR = Friesland, GE = Gelderland, GR = Groningen, LI = Limburg, NB = Noord-Brabant, NH = Noord-Holland, OV = Overijssel, UT = Utrecht, ZE = Zeeland, ZH = Zuid-Holland.

of regions whose temporal house price volatilities influence (or are caused by earlier) price movements in other regions. Over the study period, the figure shows that the network density increased from 1995 to 2003, then decreased until 2008, after which it began to increase again.

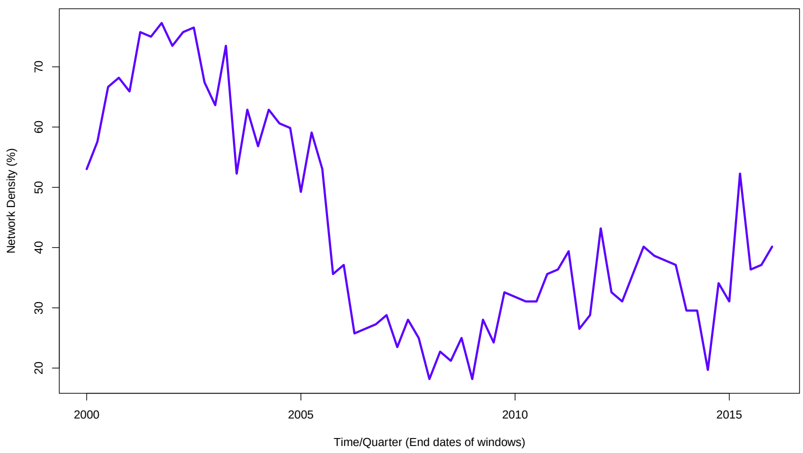


Figure 5: Density of networks of house price volatility in the 12 Dutch regional housing markets estimated over the period 1995Q2 – 2016Q1 using a rolling window of 20 quarters.

Interestingly, the above sub-periods somehow coincide with recognisable stages in the development of house prices in the Netherlands. For instance, most Dutch researchers recognise the period 1995–2003 as one during which house prices increased legitimately because of rise in disposable income and government stimulation of the housing market (Boelhouwer

	Links	Density	Average Degree	Average Path Length
1995-2003	106.00	0.80	17.67	1.20
2003-2008	30.00	0.23	5.00	2.23
2008-2016	43.00	0.33	7.17	1.65

Table 1: The network statistics for the three graphs. Connected nodes have graph distance 1.

Period	DR	FL	FR	GE	GR	LI	NB	NH	OV	UT	ZE	ZH
1995-2003	4	2	4	4	3	1	1	2	2	4	4	2
2003-2008	4	1	1	1	1	1	1	1	1	1	1	1
2008-2016	1	1	1	1	1	1	1	1	1	1	1	1

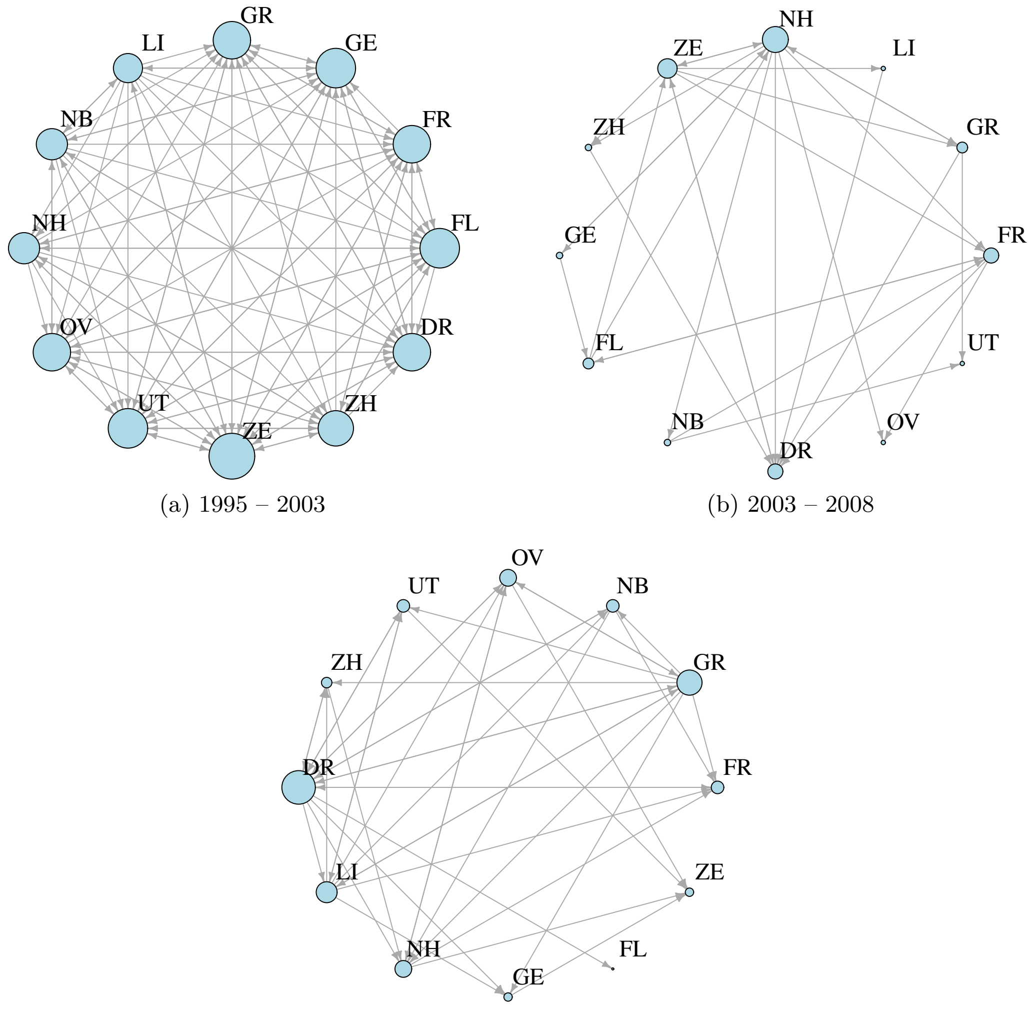
Table 2: Equation-specific lag order of each equation for the sub-periods. Note: DR = Drenthe, FL = Flevoland, FR = Friesland, GE = Gelderland, GR = Groningen, LI = Limburg, NB = Noord-Brabant, NH = Noord-Holland, OV = Overijssel, UT = Utrecht, ZE = Zeeland, ZH = Zuid-Holland.

et al., 2004; Boelhouwer, 2002; De Vries, 2010; Toussaint and Elsinga, 2007). Moreover, some analysts argue that the Dutch house price development from 2003–2008 was mostly due to over-valuation and speculative investment activities which also precipitated the crisis that started from the last quarter of 2008 (Xu-Doeve, 2010; Aalbers, 2009a,b).

By reasoning from the perspective of Meen (1999), it is conceivable that the higher regional house price volatility interdependencies from 1995 to 2003 might be, among other things, due to some common shocks or the correlated fundamentals. As pointed out earlier, the Dutch home ownership sector underwent reforms from the mid-1990s to early part of the 2000s where the government policy regulations and consequently mortgage interest rates became somewhat determinate fundamentals of house price development throughout the Netherlands. The varied response rate of house prices to these fundamentals in the different regions as explained by (Meen, 1996, 1999), may play a role in the network volatility interdependencies displayed from 1995 to 2003. On the other hand, the period after 2003 when it is also widely believed that there were speculative investment activities, it is more likely that the temporal house price dependence then, might be due to spatial arbitrage or equity transfer. This is in line with the arguments put forward by Meen (1999).

We turned the focus on the three sub-periods: 1995Q1–2003Q4, 2003Q1–2008Q4 and 2008Q1–2016Q1 to throw more light on the interdependence between the regional house price volatilities. The summary statistics and optimal lag order associated with the network structure for each specific sub-period are presented in Tables 1 and 2. The average path length for example, represents the average graph-distance between all pair of nodes, where interconnected nodes have graph distance of 1. In general, the higher the graph distance the slower it takes house price shocks in one region to cascade systemically. Table 1 also indicates the total links and average degree which are important for the network analysis.

The interest here is to identify the regions with temporal house price volatilities that are predominately causal and their specific interconnection with the others. These regions are important because they play key role in the transmission of house price shocks. If identified, it helps policy makers to monitor the housing market and to direct regulations that prevent systemic failure. In the network terminology, these regions are the hub-centralities (see, Benzi et al., 2013). The network structures for the three sub-periods are presented in Figure 6. As in in Figure 5, these network structures show the degree to which the regional house price volatilities are interdependent or connected to one another in each sub-period.



(a) 1995 – 2003

(b) 2003 – 2008

(c) 2008 – 2016

Figure 6: Network diagrams of temporal volatility connectedness in the regional market among the 12 Dutch provinces during (6a) 1995 – 2003, (6b) 2003 – 2008, and (6c) 2008 – 2016. The size of the nodes is proportional to their degree (in-degree + out-degree). Note: DR = Drenthe, FL = Flevoland, FR = Friesland, GE = Gelderland, GR = Groningen, LI = Limburg, NB = Noord-Brabant, NH = Noord-Holland, OV = Overijssel, UT = Utrecht, ZE = Zeeland, ZH = Zuid-Holland.

We determined the hub-centrality for each sub-period using the Katz measure (Katz, 1953). Table 3 presents the Katz centrality measure and the ranks associated with the network structure in Figure 6 for each region. The table show that Limburg ranked the most central in

	1995 – 2003			2003 – 2008			2008 – 2016		
	Cent.	Rank	Dist.	Cent.	Rank	Dist.	Cent.	Rank	Dist
Drenthe	284.68	12	1	1.66	10	1	**28.02**	1	0
Flevoland	481.32	6	1	3.78	3	2	1.00	11	1
Friesland	387.45	9	1	3.55	5	1	1.89	9	1
Gelderland	310.65	10	1	2.42	7	1	1.71	10	1
Groningen	302.52	11	1	3.70	4	1	25.67	2	1
Limburg	**656.80**	1	0	1.86	8	2	17.77	3	1
Noord-Brabant	559.68	3	1	2.45	6	1	5.35	5	1
Noord-Holland	524.50	4	1	**11.06**	1	0	4.58	6	1
Overijssel	478.83	7	1	1.00	12	1	6.06	4	1
Utrecht	408.87	8	1	1.00	11	2	4.11	7	1
Zeeland	563.77	2	1	8.24	2	1	1.00	12	2
Zuid-Holland	499.19	5	1	1.86	9	1	3.38	8	1

Table 3: Hub centrality among the Dutch major provinces during the sub-periods. Note: *Cent.* means hub centrality, *Dist.* measures distance from hub to other markets. Connected nodes have graph distance 1. Bold values indicate hubs.

the network of regional house price volatility for the Netherlands in the sub-period, 1995-2003. Between 2003-2008, Noord-Holland is ranked the most central while Drenthe is ranked the most central for the sub-period 2008-2016. The Table 3 also indicates the network distance which may also be used to capture the diffusion dynamics of temporal house price volatilities from these central regions.

The network distance is by definition the length of the shortest path between two nodes in the network. A network distance of 1 denotes a direct interconnection while a distance of 2 indicates the interdependence between two nodes, mediated by another node. In tandem with this description, the results of Table 3 may be interpreted to mean that, temporal house price volatility from Limburg in the period 1995-2003 had a causal influence on the volatility of house prices in the other regions. Similarly, we find that temporal house price volatility in Noord-Holland had directly affected other regions between 2003-2008, except for Flevoland, Limburg and Utrecht where this was mediated. Also for the period 2008-2016, the table shows volatility of house prices from Drenthe directly impacted house price movements in all regions apart from Zeeland where it was mediated. Furthermore, the optimal lag order of 1 selected as in Table 2 reveals that temporal house price volatilities from these central regions in any quarter caused a temporal house price volatility in other regions in the following quarter.

6. Discussion and concluding remarks

In an effort to revive the housing markets that have collapsed in many countries following the 2007-2008 Global Financial Crisis (GFC), there is an ongoing research agenda that seeks understanding into the spatio-temporal dynamics of house prices. This paper makes three main contributions to this new research area. Firstly, the paper studied the spatio-temporal house price dynamics in the unique context of the Netherlands, which is first of its kind. Here, the paper specifically asked if there is temporal spatial dependence of house prices in the Netherlands. It then investigated the diffusion pattern and identified the specific regions where temporal house price volatilities are likely to spread.

For the second contribution, the paper demonstrated the usefulness of graphical and network techniques in analysing the spatio-temporal house price dynamics. Particularly the paper adopted the newly proposed Bayesian graphical vector autoregression (BG-VAR) model which is in general more efficient in identifying dependence patterns between multiple variables than the traditional concept of Granger causality. As a third contribution, the paper proposed a simple data driven techniques to identify the regional housing sub-market where diffusion of temporal house price volatilities may predominately start.

In the empirical analysis, the paper used temporal volatilities constructed from quarterly house price indexes for owner-occupied dwelling between 1995Q1 and 2016Q1. The results, based on the BG-VAR model and various network statistics, support a temporal dependence of the regional house prices in the Netherlands. Nonetheless, we observed a varying degree of this temporal interdependence over the study period. We found that the Dutch regional house prices were highly interdependent between 1995 and 2003. After 2003, the degree of interdependence weakened until 2008 and again increase from 2008 to 2016. Recognising that this periods coincide with historic stages in the development of house prices in the Netherlands, we studied in details the spatio-temporal dynamics in the sub-periods: 1995-2003, 2003-2008 and 2008-2016.

During these sub-periods: 1995-2003, 2003-2008 and 2008-2016, we identified Limburg, Noord-Holland and Drethe as the respective regional housing markets that are most central in the diffusion of temporal house price volatility. One lesson from this finding is that contrary to the extant literature (e.g. Meen, 1999; Holly et al., 2011; Gong et al., 2016) which posit that temporal house price volatility spread from some economically “mega city”, there is also the possibility that the diffusion may equally start from an “economically smaller” region (like Drenthe in the Dutch case under study here). Moreover, the results of the paper suggest that the central region where the house price diffusion may predominantly starts is not constant, instead it changes over time depending on the economic conditions. For instance, while many Dutch researchers recognise the sub-period 1995-2003 as an era when house prices increased proportionately to the fundamentals, the sub-period 2003-2008 is identified with the era preceding the GFC when its also believed that residential properties were over-valued and there were speculative investment activities. In each of these sub-periods, we found different central regions for the house price diffusion.

Previous literature also suggest that temporal house price volatility diffuse from the central region and slowly through to the remote peripheral areas. We analyse this diffusion pattern in this paper with the network distance. The network distance yields literally the number of regions to which temporal house price volatilities may diffuse having started from the central region. This however augments the graphical aids provided by the results of the BG-VAR detailed in the main text. For the Netherlands, we identified that the diffusion trajectory is limited to at most 2 regions, following a maximum network distance of 1, 2,2 in the respective sub-periods studied.

In application, the results in this paper are relevant for policy makers who wish to stimulate segments of the housing market or to direct regulations that is aimed at avoiding temporal regional house price volatilities from cascading systemically to other regions. In particular, because house prices are temporally interdependent, stimulating a segment of the market may lead to a ripple effect on the other sub-markets. Hence, policy makers may be guided by results of this paper to formulate bundle of regulations aimed at reviving the housing market in a collective manner. On the other hand, by identifying in a current period one region where temporal house price volatilities may largely diffuse, policy makers may carefully examine the house price developments in that sub-market and address any abnormal price increases before the spillover effect becomes widespread. Investors may equally find the results of this paper applicable in diversifying and managing risks of their housing portfolios.

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Appendix A. Sampling Network Structure

The sampling of the graph structure in this paper follows the procedure described by Ahelegbey et al. (2016b). The method is summarised here for completeness. First, for a given lag order p, the initialisation of the Markov chain Monte Carlo (MCMC) is ran in two steps.

(i) Set G^0 to $n \times np$ null matrix. This is the case when each equation has no predictor(s).
(ii) For each equation $i = 1, \dots, n$; test each $X_{j,t} \in X_t$, $j = 1, \dots, np$ as a potential predictor of $Y_{i,t}$. If $Pr(Y_{i,t}|X_{j,t}, p) > Pr(Y_{i,t}|p)$, then set $G^0_{i,j} = 1$, otherwise $G^0_{i,j} = 0$.

These steps provide a good starting point for implementing the algorithm for sampling the network structure. The authors suggest to use the Gibbs sampling algorithm which proceeds at each m-th iteration as follows:

(i) Denote with $G^{(m-1)}$, the current network matrix and find $\pi_i^{(m-1)}$, the set of indexes of the non-zero elements of the i-th row of $G^{(m-1)}$.
(ii) Find $X^{(m-1)}_{\pi_i,t}$, the vector of elements in X_t whose indexes corresponds to $\pi_i^{(m-1)}$.
(iii) Draw an index k from the set of indexes of possible predictors, say $X_{k,t} \in X_t$.
(iv) Set $G^* = G^{(m-1)}$ and add/remove edge between $Y_{i,t}$ and $X_{k,t}$, i.e., $G^{(*)}_{ik} = 1 - G^{(m-1)}_{ik}$.
(v) Find $\pi_i^{(*)}$, the set of indexes of the non-zero elements of the i-th row of $G^{(*)}$ and $X^{(*)}_{\pi_i,t}$, the vector of elements in X_t whose indexes corresponds to $\pi_i^{(*)}$.
(vi) Compute $Pr(Y_{i,t}|X^{(m-1)}_{\pi_i,t}, p)$ and $Pr(Y_{i,t}|X^{(*)}_{\pi_i,t}|p)$, and $R_\alpha = \dfrac{Pr(Y_{i,t}|X^{(*)}_{\pi_i,t}, p)}{Pr(Y_{i,t}|X^{(m-1)}_{\pi_i,t}, p)}$.
(vii) Sample $u \sim \mathcal{U}_{[0,1]}$ from a uniform distribution. If $u < \min\{1, R_\alpha\}$, set $G^{(m)} = G^{(*)}$, otherwise set $G^{(m)} = G^{(m-1)}$.

The above steps are implemented for a total of M iterations and averaged over the sampled graphs. The posterior probability of an edge is then estimated by $\hat{e}_{ij} = \frac{1}{M}\sum_{m=1}^{M} G^{(m)}_{ij}$, where $G^{(m)}_{ij}$ is the edge from $X_{j,t}$ to $Y_{i,t}$ in the network matrix G at the m-th iteration. See Ahelegbey et al. (2016a) for details on the convergence diagnostics of the MCMC chain. For simplicity, we estimate $\hat{G}_{ij}$ such that $\hat{G}_{ij} = 1$, if $\hat{e}_{ij} > 0.5$, and zero otherwise.

We construct a temporal network structure by transforming the estimate matrix $\hat{G}$ to an adjacency (square binary) matrx of a directed graph. Following the labeling of our network matrix as shown in Figure 1, the edges in the adjacency matrix indicate a direct link from a column label to a row label. For example $A_{ij} = 1$ means $Y_j \to Y_i$. Let A be an $n \times n$ null matrix. We construct the adjacency matrix following the steps below.

(i) For $i \neq j = 1, \dots, n$, denote with y_j, the set of indexes of $Y_{j,t-1}, \dots, Y_{j,t-p} \in X_t$
(ii) Find $V_{i,y_j} = \hat{G}_{i,v_j}$, the vector of edges on the i-th row and the y_j columns of $\hat{G}$
(iii) If $\sum V_{i,y_j} \neq 0$ then set $A_{ij} = 1$, otherwise $A_{ij} = 0$

The main diagonal of A are therefore represented by zeros. The above is similar to testing, $H_0 : B_{1,ij} = \ldots = B_{p,ij} = 0$ against H_A : Not H_0, $\forall i, j = \{1, \dots, n\}, i \neq j$.

The German Real Estate Transfer Tax: Evidence for Single-Family Home Transactions

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Abstract

This paper uses recent data for single-family home purchases to study the effects of the German real estate transfer tax. We aim to separate the tax's short-term anticipatory effects from its long-term effects on real estate transactions. The data indicate that an increase in the transfer tax is negatively correlated with the number of transactions that take place in the market for single-family homes. We estimate that a one percentage point higher transfer tax produces enormous anticipation effects and yields approximately 6% fewer transactions over the long run.

JEL Code: H20, H71, R30.
Keywords: Real estate transfer tax, housing markets, property taxation, anticipation effects.

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1. Introduction

The impact of real estate transfer taxes[1] on the residential housing market is a controversial subject in both political debates and scholarly research. On the one hand, some authors consider the positive effects of transfer taxes that result from less volatility and speculation in the real estate market (see Catte et al. 2004). However, these findings are empirically ambiguous (see Crowe et al. 2011 and Aregger et al. 2013) and must be placed in the context of potentially larger economic distortions. On the other hand, higher transaction costs might discourage sales and purchases and may lead to a less active market and thus to welfare losses for both buyers and sellers (European Commission 2015, Deutscher Bundestag 2016, Büttner 2016). High real estate transfer taxes might also decrease worker mobility, thus adding imperfections into the labor market when owners remain in their home although it might be more efficient to move to a different place (Andrews et al. 2011). Exploiting a unique new dataset, this paper aims to show that real estate transfer taxes have a substantial negative long-term effect on real estate transactions.

Our data on single-family home transactions provide a powerful method for assessing the adverse effects of the real estate transfer tax by investigating tax increases in different German states for the 2005–2015 period. We include dummy variables before and after the tax increase that capture when transactions are pushed ahead of the tax increase. By excluding from our sample this bunching around the tax increase, we can measure the tax increase's long-term effects on transactions. To our knowledge, this long-term effect has not been isolated and measured in previous econometric analyses. The results of our study indicate that an increase in the transfer tax is negatively correlated with the number of transactions that occur on the market for single-family homes. We find significant evidence that transfer tax increases lead to massive bunching of transactions just before an increase and a nearly equally large drop in transactions immediately following a tax increase. In addition, market activities decrease by 6% over the long run following the increase.

Despite its economic relevance, there is only a small body of literature that focuses on the effects of real estate transfer taxes on the real estate market.[2] One of the first studies addressing the effects of an in-

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[1] The literature uses several different terms for real estate transfer taxes, i.e., land transfer taxes, property transfer taxes, housing transfer taxes, or real property transfer taxes. To simplify, we henceforth refer to all of those as real estate transfer taxes.

[2] The effects of higher transaction costs in general (including those due to higher real estate transfer taxes) are a recurring theme in the literature. For example, van Ommeren and van Leuvensteijn (2005) examine the effects of transaction costs on residential mobility in the Netherlands. However, it is useful to focus on one specific type of transaction cost as we do here. When summarizing transaction costs empirical examinations are hampered because different costs are often due at different points in time and the incidence of the cost falls upon different market

crease in the transfer tax was undertaken by Benjamin et al. (1993) and involved sales of land in Philadelphia. The authors find that the sales prices of properties inside of Philadelphia decreased relative to properties outside of the metropolitan area as a result of higher tax rates. In a more recent study, the impact of Toronto's transfer tax, which was imposed on single-family home sales in early 2008, has been studied by Dachis et al. (2012). These authors estimate that the 1.1% tax led to a 15% decline in transaction volumes. Kopczuk and Munroe (2013) examine the effects on house prices of the 1% real estate transfer tax on residential transactions over $1 million in New York and New Jersey. The authors explore bunching at the tax notch on a theoretical basis by means of an equilibrium bargaining model and conclude that market participants are incentivized not to pursue a transaction close to the threshold. Empirically, Kopczuk and Munroe (2013) find evidence of significant bunching just below the price notch. Quite similarly, Slemrod et al. (2016) analyze different policy reforms of real estate transfer taxes in Washington D.C. and find evidence of manipulative sorting around the price notch but not around the time notch. With regard to studies of European real estate transfer taxes, there are only studies considering the effects of transfer taxes in the U.K. Best and Kleven (2013) study the impact of a tax holiday between 2008 and 2009 and show that there is bunching just below the price notches, in addition to distortions involving the volume and timing of transactions. The same unanticipated stamp duty tax holiday was also studied by Besley et al. (2014), who find it led to significant decreases in sales prices and an increase in transactions.

Whereas previous studies measure short-term transaction bunching, there are no empirical studies to our knowledge on the long-term adverse effects of real estate transfer taxes. This paper is most closely related to Dachis et al. (2012), as we are also concerned with the effects of a higher real estate transfer tax on the number of transactions in the market for single-family homes. Our analysis, however, is distinguished from previous studies because we do not focus on transactions in North American metropolitan areas but on transactions in both urban and rural areas in Germany. We thus conduct the first analysis for a continental European housing market in which bank lending practices are more conservative, homeownership rates are lower, housing supply tends to be more rigid and tenant-landlord regulation is comparatively strict (Andrews et al. 2011).

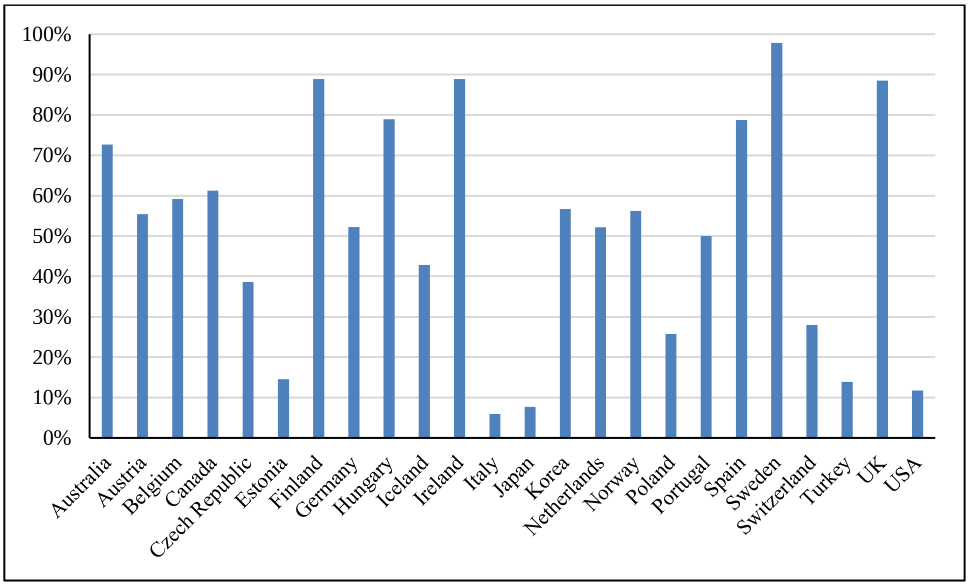
participants. Further, the definition of transaction costs varies greatly in previous studies, which further muddles the results, particularly in terms of comparisons. To distinguish our study from this strand of the literature, we discuss only those studies that directly measure the effects of a change in the real estate transfer tax in this section.

2. Institutional Background in Germany

To highlight the economic relevance of real estate transfer taxes and to provide supporting information for our empirical strategy, we now present the relevant institutional background facts on real estate transfer taxes in Germany.

Real estate transfer taxes are commonplace and an important source of government revenues in many OECD countries (Andrews et al. 2011).[3] Nonetheless, tax rates reveal significant variation across different countries; for example, at 10%, Belgium imposes one of the highest tax rates on real estate transactions in Europe (although some exceptions apply) (European Commission 2015). In some countries, such as the U.K. and Portugal, progressive rate structures are utilized. Notably, almost half of the EU member states have transfer tax rates below 5%, and Germany fits right in the middle with a current median rate of approximately 5%. As a consequence, the share of real estate transfer taxes out of total transaction costs[4] varies substantially among countries (see Figure 1). With regard to Germany, the real estate transfer tax amounted to nearly 52% of the average transaction cost in 2011.[5]

FIGURE 1. AVERAGE SHARE OF REAL ESTATE TRANSFER TAXES ON TRANSACTIONS COSTS OF PROPERTY TRANSACTIONS IN OECD COUNTRIES, 2011



Notes: The figure shows the average share of real estate transfer taxes on total transaction costs of property transactions in OECD countries in 2011 where data are available. Transaction costs include notary and legal fees, real estate agent (broker's) fees and real estate transfer taxes. *Data*: Andrews et al. (2011).

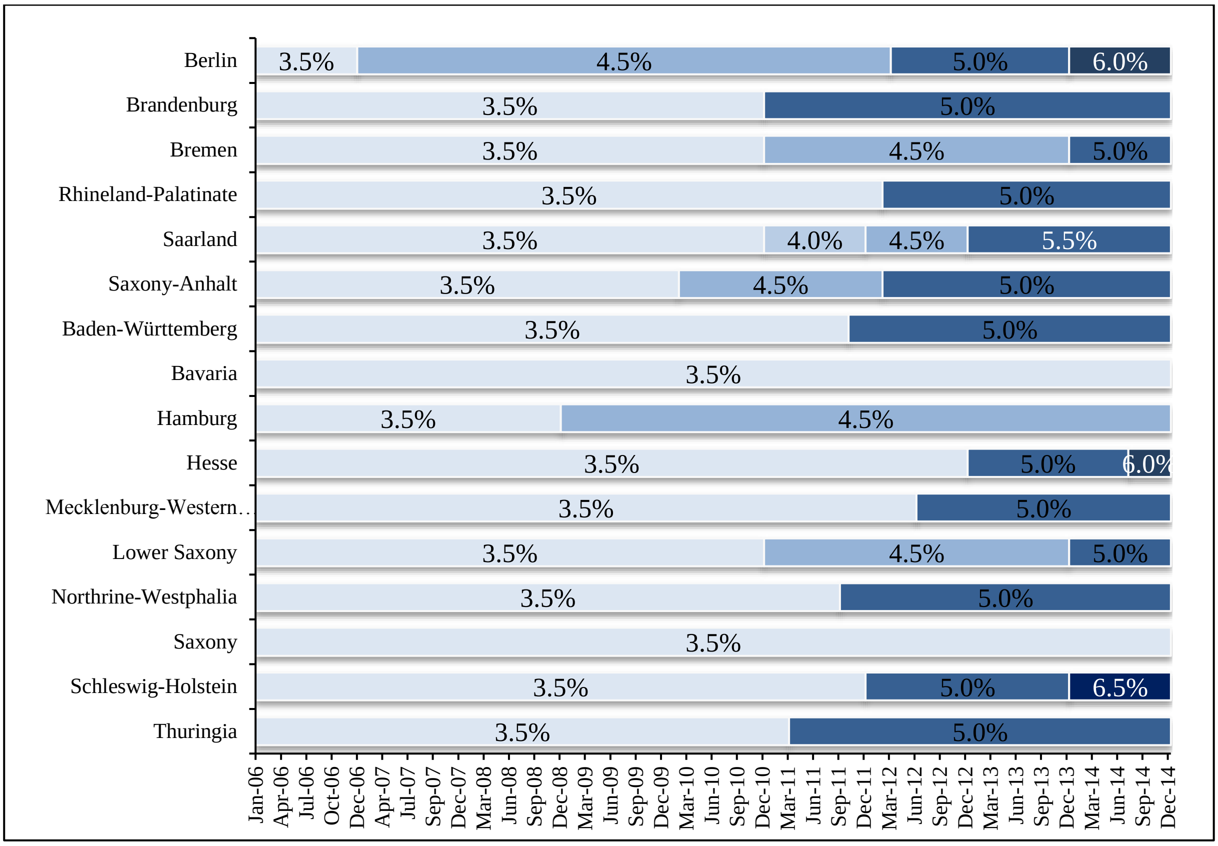
[3] In 2012, the tax revenue from real estate transfer taxes was equal to 0.8% of GDP in the European Union (European Commission 2015).
[4] Following Andrews et al. (2011), transaction costs include notary and legal fees, real estate agent (broker's) fees and real estate transfer taxes.
[5] For more details on transaction costs in Germany, see Figure 9 and the explanations in the appendix.

Generally, real estate transfer tax regimes differ greatly among countries with regard to the tax base, tax schedule, exemptions and the tax incidence (for a comparison of housing taxation systems in different countries, see Oxley and Haffner 2010). In Germany, after the buyer and seller agree upon a price and the buyer ensures appropriate funding, a notary must draft the official contract for the purchase of the property. Next, a date for the certification must be set, which can take place as quickly as a couple of days later and as long as several weeks later. After executing the contract, the attesting notary requests the registration in the land register. The original certificate of the contract remains with the notary; copies are sent to the buyer and the seller, the land registry, the relevant property valuation committee and, where appointed, the real estate agent. An additional copy is transmitted to the responsible tax office of the district in which the transaction is taking place. The tax office draws the real estate transfer tax assessment on the buyer, the party formally responsible for paying the tax. Everything that must be spent to purchase a property is subject to the transfer tax, including the purchase price, encumbrances on the property, usage rights, abatement costs and broker fees. The term 'property' also includes fractional shares of the property, land rights (such as leaseholds) and condominiums. Next to the land itself, everything that is inherently a part of the property is taxable, such as a house built on the land (including newly built houses). Although most countries apply progressive tax rates, German states impose a flat tax on real-estate transactions. Further, there are only a few exemptions from taxation in Germany: Notably, transactions valued at less than € 2,500, inheritances and transfers within families are exempt from the transfer tax.

The German real estate transfer tax system has historically been subject to substantial revisions: In 1983, the tax rate was standardized at 2% for all German states.[6] This rate was raised to 3.5% in 1997. However, following a 2006 constitutional reform of the German federation aimed at strengthening state competencies, German states can set their real estate transfer tax rates themselves (similar to US states), and almost all German states (with the exception of Bavaria and Saxony) have increased their rates since that time. In particular, rightwing governments were less active in increasing the real estate transfer tax rates than leftwing and center governments (Krause and Potrafke 2016). Figure 2 provides an overview of the effective dates of each increase. As of the present date, no German state has decreased the tax rate. As of 2016, the real estate transfer tax rate ranges between 3.5% and 6.5% (see Figure 11 in the appendix), resulting in an increase of the average tax rate across all German states since 2007 of approximately 51%.

[6] The German states constitute the second layer of government beneath the federal level.

FIGURE 2: REAL ESTATE TRANSFER TAX RATES IN GERMAN STATES FROM 2006 TO 2014



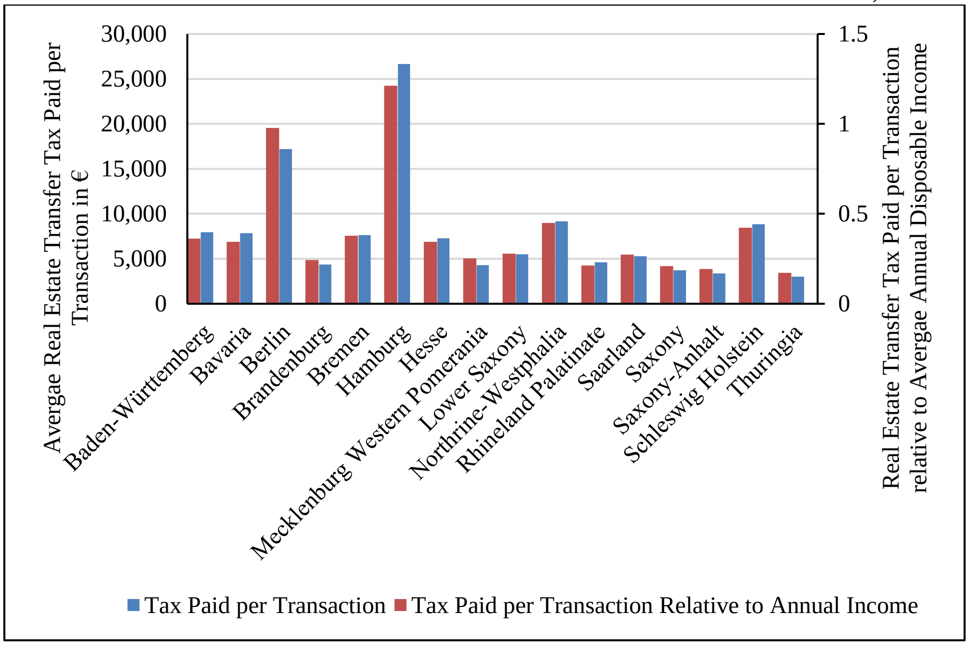
Notes: The figure presents the levels of the real estate transfer tax in the German states from January 2006 to December 2014. Changes in the tax typically take place at the beginning of a month, although the first increase in Saxony-Anhalt took place on the 2nd of March in 2010. *Data*: Official announcements of German state governments.

Typically, increased taxation rates are justified by the consolidation of budgets due to high public debt and the 'debt brake' anchored in Germany's Basic Law that will become effective in 2020 (RWI 2012, IW Köln 2015). Tax changes primarily come into effect in January – presumably for practical reasons and not because real estate transactions are particularly high in this month.[7] Therefore, it is assumed that a change in the tax rate occurs independently of the number of real estate transactions.

[7] In fact, our analysis shows that the number of single-family home transactions is particularly low in January (see section 3).

Although the tax rates do not seem to be particularly high, the real estate transfer tax results in a relatively high tax amount to be paid because of the substantial taxable base (i.e., the property). Therefore, even small changes in the tax rate may cause buyers to accelerate a planned transaction to fall under a lower tax rate. Figure 3 shows the average transfer tax paid per transaction and its share of average annual per capita disposable income in 2012 for each German state.

FIGURE 3. AVERAGE REAL ESTATE TRANSFER TAX PAID PER TRANSACTION AND REAL ESTATE TRANSFER TAX PAID PER TRANSACTION RELATIVE TO AVERAGE ANNUAL DISPOSABLE INCOME, 2012

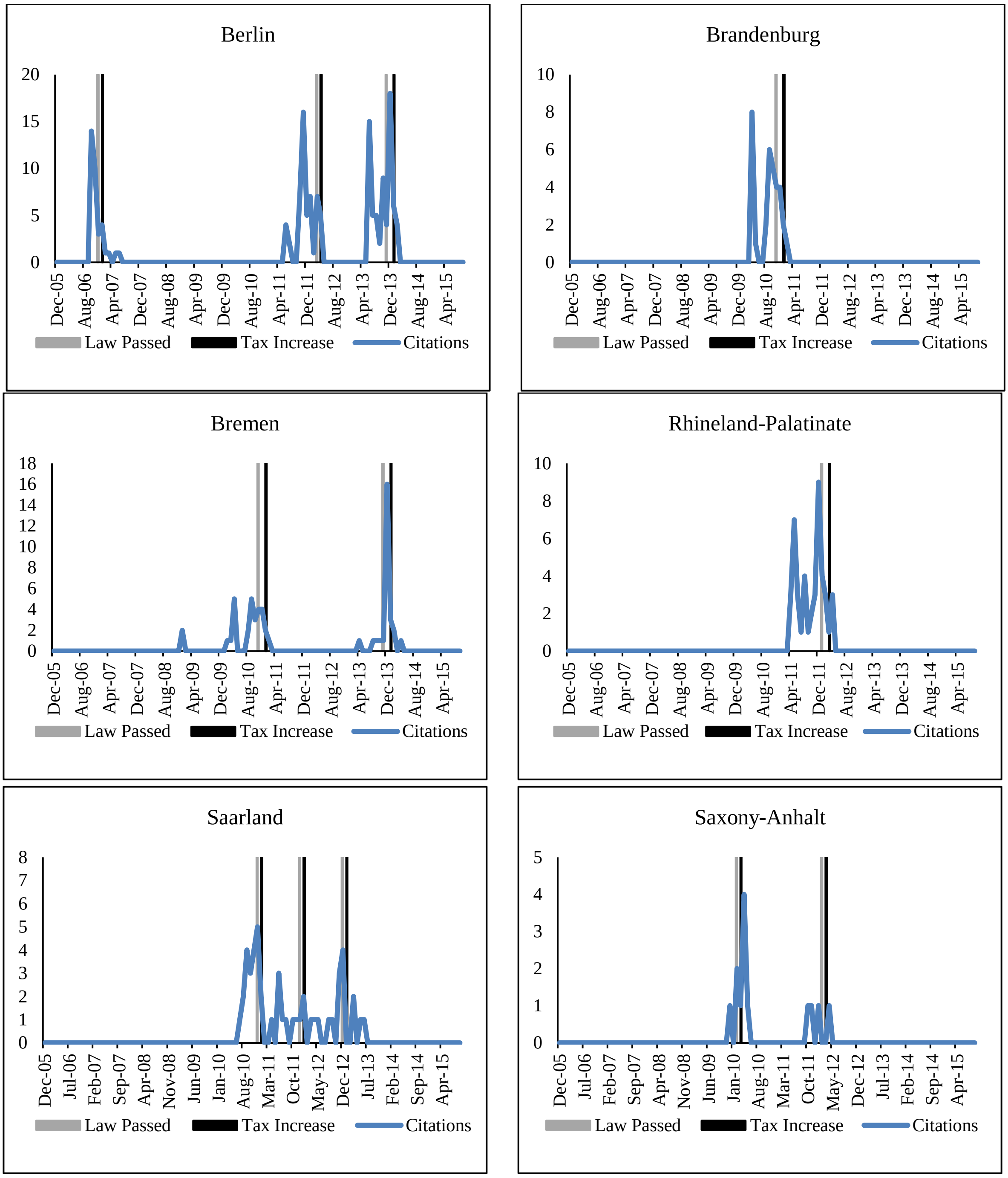


Notes: The figure shows the average real estate transfer tax paid per transaction in 2012 (left hand side, blue columns) and the real estate transfer tax paid per transaction relative to average annual disposable income in Germany in 2012 (right hand side, red columns). *Data*: Bundesministerium der Finanzen (2015a), Bundesinstitut für Bau-, Stadt- und Raumforschung (2015) and Arbeitskreis der Gutachterausschüsse und Oberen Gutachterausschüsse der Bundesrepublik Deutschland (2014).

Changes to the real estate transfer tax rates are typically announced several months in advance, as they must be passed by the state parliament. Figure 4 charts the media coverage on the topic and the respective tax increases for the states included in our empirical analysis. Media citations are particularly high when tax changes are announced or discussed by the state parliaments. With regard to the actual date of the tax increase, media coverage is less active. The data indicate that it can be assumed that the timing of the tax changes in most cases is largely anticipated.[8] In the next section, we illustrate a theoretical framework to investigate this anticipation effect.

[8] The only exceptions here seem to be Saarland and Saxony-Anhalt where media coverage has been relatively low. In Saarland, a stepwise increase of the real estate transfer tax on a yearly basis was announced in 2009, which might explain this issue.

FIGURE 4. MEDIA CITATIONS OF REAL ESTATE TRANSFER TAX INCREASES IN VARIOUS GERMAN STATES



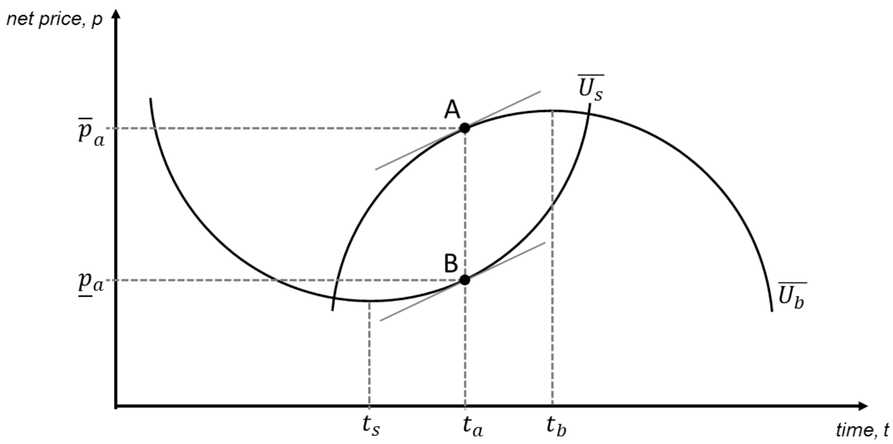
Notes: The figure provides the media citations of '*Grunderwerbsteuer Erhöhung*' ('Real Estate Transfer Tax increase') plus the respective state name. Media coverage has been particularly intense at the end of the legal year, as many newspapers present special issues that cover major tax changes in the upcoming year. If there have been simultaneous tax increases in different states, media coverage has generally been higher. Further, media speculation on further tax increases can be observed after elections, in particular. Media citations are from The Financial Times, Frankfurter Allgemeine Zeitung, Frankfurter Allgemeine Sonntagszeitung, Handelsblatt, Die Welt, Die Welt am Sonntag, Die Zeit, Süddeutsche, Spiegel Online, Wirtschaftswoche, Focus, Focus-Money, Immobilien Zeitung, Immobilienwirtschaft, dapd Nachrichtenagentur, news aktuell, vdi Nachrichten, Börse Online, Euro am Sonntag, die tageszeitung, Der Tagesspiegel, Berliner Morgenpost, Berliner Zeitung, Berliner Kurier, Frankfurter Rundschau, Westfalen-Blatt, Rhein-Zeitung, General-Anzeiger, Sonntag Aktuell, Münchner Abendzeitung, Stuttgarter Zeitung, Stuttgarter Nachrichten, Kölner Stadtanzeiger, Kölnische Rundschau, Nürnberger Nachrichten, Saarbrücker Zeitung, Meininger Tageblatt, Aachener Nachrichten, Märkische Allgemeine, Schweriner Volkszeitung, Mitteldeutsche Zeitung, Potsdamer Neuste Nachrichten, Leipziger Volkszeitung, Lampertheimer Zeitung, and Darmstädter Echo. *Data*: http://www.genios.de.

3. Conceptual Framework

In this section, we refer to the theoretical framework proposed by Slemrod et al. (2016) to distinguish among the various economic effects of increases in the real estate transfer tax. Slemrod et al. (2016) address both a price and a time discontinuity (or notch) for when new taxes take effect. As there is no price notch in Germany, we limit our analysis to the time notch (see Slemrod et al. 2016, pp. 14 ff.).

Potential buyers and sellers in the housing market are matched exogenously. Both the buyer's and the seller's valuation of a house are determined by exogenous outside options. Both parties have preferences regarding the transaction date. Moving the transaction away from the preferred sale or buy date reduces the utility of either party based on convex cost functions. Thus, utility is a combination of the transaction price and the transaction date, where the preferred transaction date yields the highest utility for a given price. Figure 5 depicts the price/date combinations (indifference curves) for both seller and buyer that yield the lowest acceptable utility levels in a scenario without transfer taxes. The seller would gain higher utility from higher prices at a given transaction date. Thus, higher indifference curves represent higher utility levels for the seller, whereas lower indifference curves represent higher utility levels for the buyer.

FIGURE 5: BARGAINING SOLUTION IN A SCENARIO WITHOUT TAXES



Notes: The figure depicts the bargaining solution of a matched buyer and seller pair. t_s (t_b) is the seller's (buyer's) preferred transaction date. The indifference curves, $\overline{U_s}$ and $\overline{U_b}$, show the seller's reservation price and the buyer's willingness to pay as functions of the transaction date. The distance [AB] depicts the highest possible bargaining surplus. Thus, the transaction will take place on t_a. $\underline{p}_a$ and $\overline{p}_a$ represent the lower and upper bounds for the transaction price.

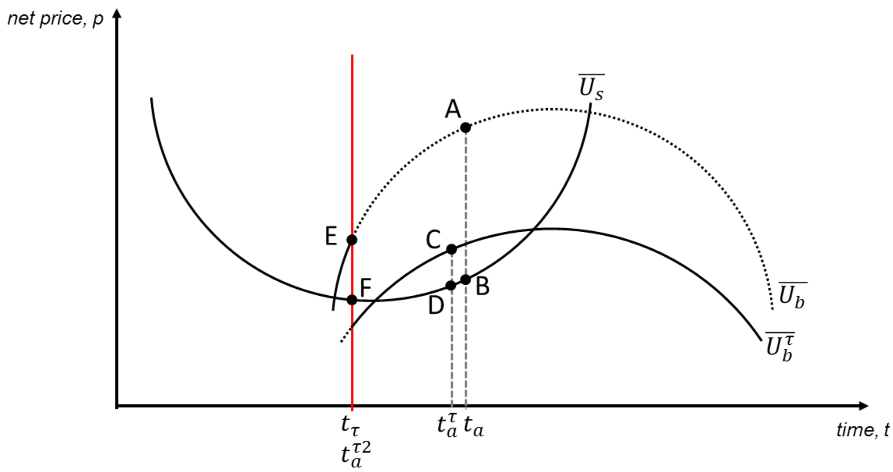
Buyer and seller engage in a Nash bargaining situation well in advance of the actual transaction, and the transaction date is uniquely defined by the Pareto-optimality condition. In the interior solution, the indifference curves are tangent, thus maximizing the bargaining surplus. Subsequently, the price is determined based on the individual bargaining power of both parties.

Figure 6 illustrates a scenario with the introduction of real estate transfer taxes. The red line reports the date that the new tax takes effect. The dotted line marks the highest price that the buyer is willing to pay at each transaction date. Since the transaction tax is imposed on the buyer, it measures his gross willingness to pay. Consequently, the buyer's net willingness to pay is lowered by the amount of the appropriate tax liability.

Because the tax is assessed on the basis of the sales price, with a lower price, the buyer thus profits not only from paying less to the seller but also from having to pay a lower tax amount. To a certain extent, the buyer profits more from a lower price than the seller suffers. In the bargaining solution, the party might pick a lower transaction price, while compensating the seller by moving the transaction date slightly toward his preference. The same argumentation holds for postponing the transaction if the buyer prefers to transact before the seller.

However, if the time period between the effective date of the new tax and the bargaining solution with taxes is sufficiently short, the amount of taxes saved compensates for the rather strong deviation in the time preferences. As a result, transactions become bunched just before the effective date of the new tax (the notch), which is followed by a steep drop in transaction numbers for the period after the notch.

FIGURE 6: BARGAINING SOLUTION IN A SCENARIO WITH A NEW TAX – ANTICIPATION EFFECT WITH RESPECT TO THE EFFECTIVE DATE

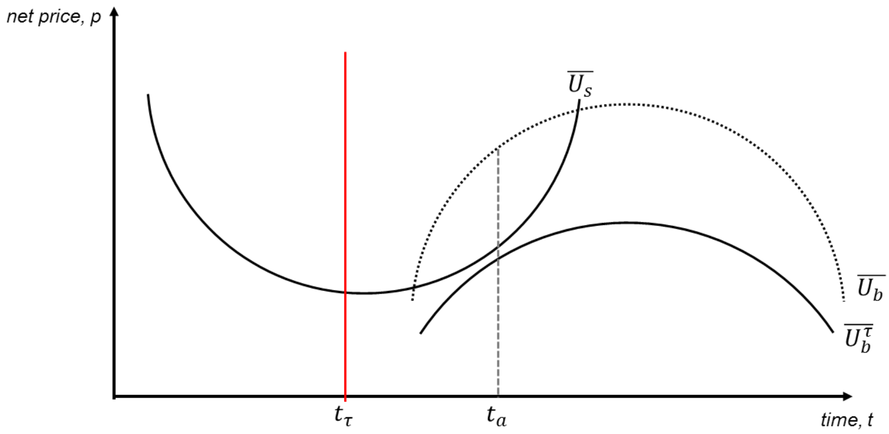


Notes: The new real estate transfer tax rate is introduced at t_τ. Here, the buyer's indifference curve shows a discontinuity. Because he must pay a higher price after the effective date of the new tax rate, his net willingness to pay drops on that date. The bargaining surplus absent taxes ($[AB]$) can no longer be obtained. The highest possible outcome with the new tax in place is located at t_a^τ with a bargaining surplus of $[CD]$.[9] However, in the depicted scenario, buyer and seller will choose to transact marginally before the effective date of the new tax. In $t_a^{\tau 2}$, they achieve a bargaining surplus of $[EF] > [CD]$.

[9] More precisely, $[CD]$ represents the bargaining surplus if the seller holds all bargaining power. If the buyer holds all bargaining power, the surplus would be $(1+\tau)[CD]$ because of the lower tax liability.

A second effect is that transactions might not take place at all due to transfer taxes, which is the case if the bargaining surplus in a situation without taxes is smaller than the tax liability at all times. The reason for this effect is either that the price spread in the willingness to pay and the reservation price is fairly small, the transaction date preferences are wide apart (see Figure 7), or a combination of the two. If so, a transfer tax might lead to a negative maximal bargaining surplus. Thus, in such a case, not transacting at all results in the highest utility for both parties.

FIGURE 7: BARGAINING SOLUTION IN A SCENARIO WITH A NEW TAX – THE LONG-TERM EFFECT



Notes: The figure depicts a scenario in which no transaction takes place due to the real estate transfer tax. The buyer's willingness to pay does not exceed the seller's reservation price at any given time. Thus, no surplus can be generated by transacting.

For an announced but not yet implemented transfer tax increase, we expect temporal substitutions. To maximize the bargaining surplus, accelerating transactions is profitable if the tax saved compensates for the utility loss resulting from the time deviation. All transactions that would have taken place sufficiently close after the tax increase are moved to a transaction date marginally before the tax increase.

Hypothesis 1: More transactions take place just before the tax increase (bunching).

On the other hand, those transactions that are brought forward do not take place after implementation of the higher real estate transfer tax.

Hypothesis 2: Fewer transactions take place immediately after the tax increase (lagging).

With real estate transfer taxes in place, the sale of a property yields less utility as lower prices can be obtained. Concurrently, buying a property also yields less utility as higher prices must be paid. Therefore, the number of transactions should drop after the tax increase.

Hypothesis 3: The higher the real estate transfer tax, the fewer transactions take place (liquidity).

4. Data

In this section, we empirically investigate the conceptual framework we described above. Unfortunately, figures on real estate transactions in Germany are scarce. However, we can rely on a unique dataset provided by the Property Valuation Committees of Berlin, Brandenburg, Bremen, Rhineland-Palatinate, Saarland and Saxony-Anhalt. Our data cover only transactions involving single-family homes for several reasons.[10] First, these dwellings have a high rate of owner-occupation and are used for private housing (see Table 7 in the appendix); therefore, our sample consists almost exclusively of private transactions. Commercial transactions might bias our results as commercial buyers can set the real estate transfer tax off against the tax liability. The data cover the number of single-family home transactions since 2005 on a monthly basis for each German state. Our sample spans the period from January 2005 to December 2014[11] for almost all states, which allows us to include all tax increases that took effect during the sample period.[12] We included two years prior to the actual possibility that states might change the tax rate; by examining transactions in which no tax increases could have taken place, we can control for seasonal and common factors that might affect transactions on a range of relatively similar properties.

The sample is restricted to observations that are considered 'suitable' by the Property Valuation Committees, i.e., the sales price and the property size must lie within specific thresholds.[13] As a result, the impact of outliers is minimized. Overall, 12 tax increases are covered by our sample (see also Figure 2). Altogether, these restrictions produce a sample size of 655 observations, which are summarized in Table 1. In addition to data on the level of the real estate transfer tax, we aggregate economic and fiscal controls that may drive the number of transactions of single-family homes. The dataset also contains information regarding the introduction or abolition of public funding instruments on the housing market (see Table 9 in the appendix).

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[10] For more details on the market-share and average price of single-family homes in the states included in the sample, see Table 8 in the appendix.

[11] As a result, our time frame includes the recent global financial and economic crisis. However, it is reasonable to assume that the crisis does not skew our results, as the German real-estate market was mostly unaffected by the crisis because interest rates for real estate finance are traditionally fixed for long periods of time in Germany and the average equity component is higher than in other countries (BMVBS 2012).

[12] The only exception is Saarland, where data were available only between 2010 and 2013, and therefore the latest real estate transfer tax increase is not included.

[13] For example, in Rhineland-Palatinate, the sales price of the property must be between € 40,000 and € 2,000,000 and the property size must be greater than 300 m² but less than 2,000 m².

TABLE 1. DESCRIPTIVES: NUMBER OF TRANSACTIONS PER MONTH FOR DIFFERENT GERMAN STATES, THE LEVEL OF THE REAL ESTATE TRANSFER TAX AND THE LEVEL OF THE TAX INCREASE

Variable	*Time Frame*	*Mean*	*Std. Dev.*	*Min*	*Max*	*Obs.*
Number of transactions per month[a]	01/2005-08/2015	317	185	20	1,157	665
... in Berlin	01/2005-08/2015	255	73	85	711	128
... in Brandenburg	01/2005-12/2014	480	112	168	1,128	120
... in Bremen	01/2005-12/2014	98	33	20	214	120
... in Rhineland-Palatinate	01/2005-03/2015	545	157	120	1,157	123
... in Saarland	01/2010-12/2013	210	48	99	329	48
... in Saxony-Anhalt	01/2005-06/2015	253	56	84	417	126
Level of Real Estate Transfer Tax	01/2005-08/2015	4.17	0.74	3.50	6.00	665
Level of Tax Increase	01/2007-01/2014	0.875	0.361	0.5	1.5	12

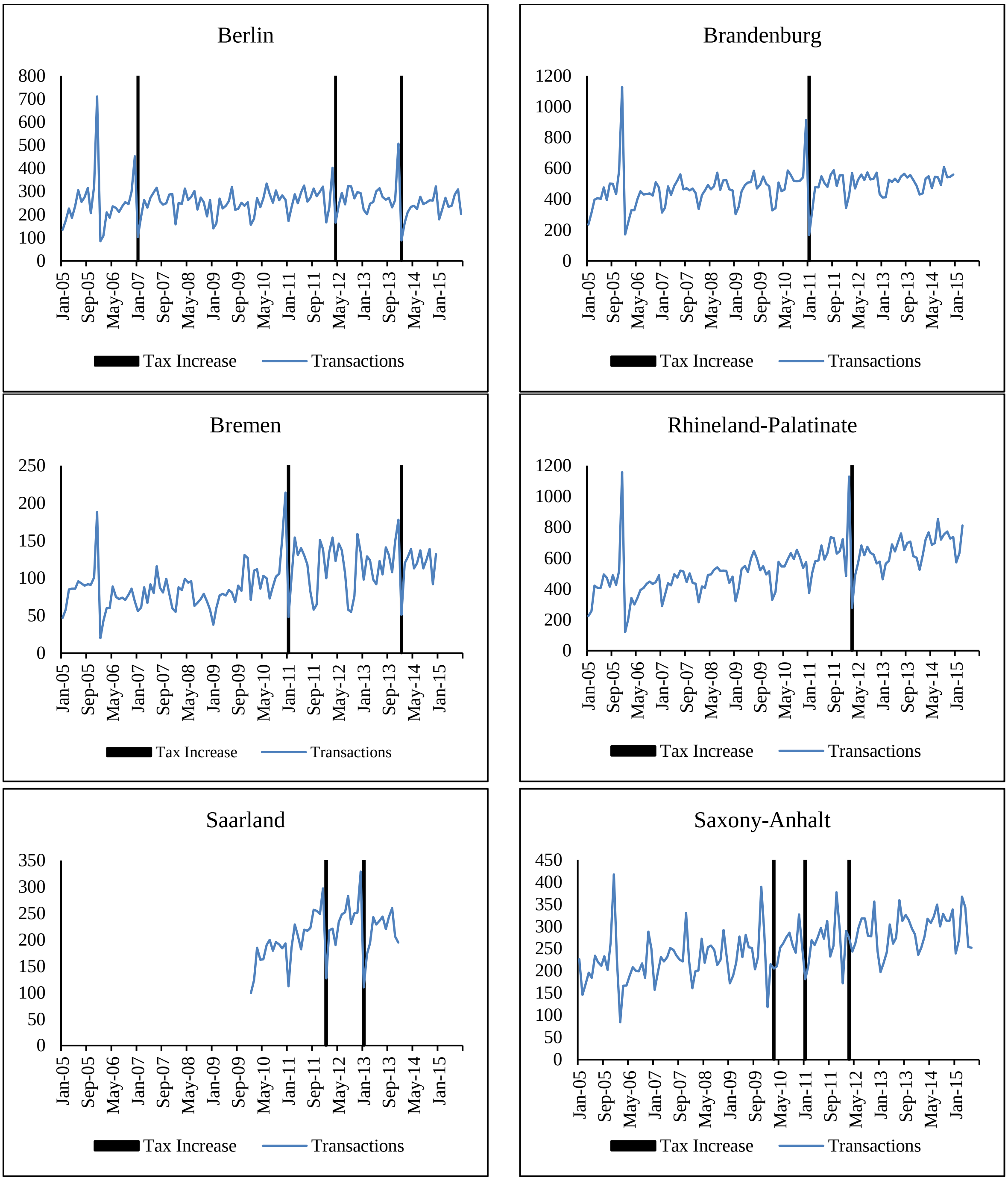
Notes: The table reports the descriptives of the data set. The data provided by Rhineland-Palatinate do not cover transactions in the cities of Kaiserslautern, Koblenz, Ludwigshafen am Rhein, Mainz, Trier and Worms.

Certain interesting features emerge from the descriptive statistics: The number of transactions per month varies greatly among states, which indicates that we included both rural and urban (i.e., city-states) areas in Germany. We have months with as few as 20 observations in one state and months with more than 1,000 transactions. The real estate transfer tax rate is equally distributed in the sample and averages approximately 4.2%.

Figure 8 plots the number of transactions per month for each included German state over time and suggests that some transactions have been accelerated and rescheduled to take place just before the tax increases. There clearly seems to be a bunching around the dates of tax increases. Apart from bunching at the tax increase notches, we notice bunching on an even grander scale at the end of 2005. This observation can be explained by the abolition of a large public funding instrument, the '*Eigenheimzulage*'.[14]

[14] The '*Eigenheimzulage*' funding instrument was one of the largest public funding instruments in Germany. It was introduced in 1996 to support the acquisition of owner-occupied residential property for low-income households (Heitel et al. 2011). The financial burden for the federal budget associated with the '*Eigenheimzulage'* was relatively high while the number of new homes completed was not as high as expected (Dorffmeister et al. 2011). As a result, the federal government considered abolishing the funding instrument, which led to massive anticipation effects for three years until the *'Eigenheimzulage'* was actually abolished in January 2006 (Dorffmeister et al. 2011).

FIGURE 8. NUMBER OF SINGLE-FAMILY HOME TRANSACTIONS IN VARIOUS GERMAN STATES



Notes: The figure gives the number of transactions for each German state included in the sample over time. *Data*: Property Valuation Committees in Berlin, Brandenburg, Bremen, Rhineland-Palatinate, Saarland and Saxony Anhalt.

Compared to the bunching effects around the tax increases, a decrease in overall real estate market activity is less obvious in Figure 8. The strong bunching effects and the high degree of seasonality make it difficult to identify a level shift in the number of transactions after tax increases. However, in the following econometric analysis, we isolate this long-term effect.

5. Estimating the Effects of a Tax Increase

5.1 Empirical Strategy

All German states began with the same real estate transfer tax levels at the outset of our observed time frame. However, state governments have been authorized to independently set their own tax rates since September 2006. Whenever a state changes its tax rate, the remaining states function as control groups. In our sample, many states have raised their tax rates by different amounts and at different times. Since state governments justify tax changes with household consolidation, we can assume that the changes do not depend on the number of single-family home transactions and thus rule out possible reversed causality (see Section 2). However, there might yet be interdependencies between states: When one state increases its transfer tax rates, households might choose not to move to this state but might instead migrate to another state. We are not able to control for this particular increase in transactions in that other state. However, there are only a few urban areas of different states that are sufficiently close to be considered geographical substitutes for migration decisions.[15] Moreover, state-specific characteristics (e.g., administrative divisions, educational systems or availability of nurseries) can be assumed to be more important to migration decisions than transfer taxes.[16] Altogether, we are provided with a setting that is suitable to identify the causal effects of real estate transfer taxes on the number of transactions.

Our regression design is a two-way least squares dummy variable estimation. The fixed effects panel regression is important to control for state-specific characteristics in our panel. We control for time-variant specifics affecting all states by including a date dummy for every month in our sample. The baseline estimation takes the following form:

$$
\begin{aligned}
T_{i,t} = \alpha_i + \beta R_{i,t} &+ \sum_{h=1}^{2} y_h before_{h,i,t} + \sum_{j=1}^{2} \delta_j after_{j,i,t} \\
&+ \sum_{k=1}^{2} \eta_k (before_{k,i,t} * \ raiselevel_{k,i,t}) + \sum_{l=1}^{2} \theta_l (after_{l,i,t} * \ raiselevel_{l,i,t}) \\
&+ \sum_{m=1}^{128} \lambda_m date_{m,t} + controls_{i,t} + \varepsilon_{i,t} \ .
\end{aligned}
$$

$T_{i,t}$ denotes the log number of transactions in state i at time t as the dependent variable. On the right-hand side, we include the level of the real estate transfer tax, $R_{i,t}$. Furthermore, we add dummy variables

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[15] This issue might be particularly relevant for so-called twin metropolitan areas like Mannheim and Ludwigshafen am Rhein, Ulm and Neu-Ulm and Mainz and Wiesbaden. Those cities are not included in our sample.

[16] However, we do conduct a robustness check in which we omit observations that might be influenced by border effects (see Section 65.3).

for h months before a particular state tax changes, $before_{h,i,t}$, and for j months after the tax changes, $after_{j,i,t}$. We further multiply these dummies by the level of the corresponding tax increase in percentage points and report the results. In this manner, we can test whether the anticipation effect depends on the extent of the increase. To control for any effects that affect all states simultaneously, we include m dummy variables, $date_{m,t}$, for each month of our panel. In another specification, we substitute the date dummies with dummies for the twelve months of the year to control for seasonal effects and dummies for each year to control for the time trend. The equation comprises group-specific constants α_i and the error term $\varepsilon_{i,t}$. To allow heteroskedasticity, we employ Huber-White sandwich standard errors (see Huber 1967, White 1980).

To control for changes in other transaction costs, we include dummy variables for the changes in notary fees.[17] To capture possible bunching for this change as well as for the drop in transaction numbers, we use two dummies: July and August 2013. We do the same for the implementation or abolition of public funding instruments that affect the housing market (see Figure 8 in the appendix). We thereby only control for the bunching effects of further public funding instruments, not the level of funding. However, those instruments consist mostly of loans, which should have a rather small impact on housing decisions in times of low interest rates. The '*Eigenheimrente'* and particularly the '*Eigenheimzulage'* presumably have a greater influence on the number of transactions.[18] However, those two funding instruments and also the change in notary fees apply to all states concurrently. Thus, they have no effect on the regressions including date dummies and need only be included in the specification using dummies for years and months. We have no reason to believe that any further variables systematically distort the number of transactions. In conclusion, we expect the estimated relationship between the real estate transfer tax and the number of transactions to be of causal nature.

5.2 Results

Table 2 reports the regression output. In line with the primary stream of the previous literature, we find a significant negative correlation of the number of single-family home transactions and the level of the real estate transfer tax in all specifications. An increase in the transfer tax of one percentage point results in approximately 6% fewer transactions over the long run. On top of the long-run effects, we observe

[17] For more details on why other transaction costs are not included in the model, see Figure 9 and the respective explanations in the appendix.
[18] Since the effects for the *'Eigenheimzulage'* are quite large (see Figure 8), we use two months prior to and after its abolition. The *'Eigenheimrente'* has no significant effect on the number of transactions, which may be because this public funding instrument remained little-known (BMVBS 2013).

massive anticipation effects for the months just before and just after a tax is raised. This ‘bunching around the time notch’ has also been observed in previous studies.

The first regression (1) suggests that the anticipation effect depends on the level of the tax increase. Aggregating the coefficients of the interaction terms with the plain anticipation coefficients results in approximately 43% more transactions just before the tax notch for a tax rate increase of one percentage point. Consistently, the results aggregate to a drop of 47% fewer transactions immediately following an increase. We observe similar results in the second specification (2) in which we omit the interaction terms. Here, we measure the pure anticipation dummies without controlling for the level of tax increases. The coefficients thus represent the anticipation effects for an average tax increase, which is 0.875 percentage points. The slightly lower coefficients of approximately 41% more transactions and 46% fewer transactions on either side of the time notch are thus consistent with previous findings.[19]

In specification (3), we use monthly and yearly dummies instead of date dummies. Compared to the first results, the coefficients seem quite robust, although the significance levels change. Column (4) omits all anticipation effects and reports a higher effect of the transfer tax level as a result. This result stems from the fact that for each state, the time frame with the lowest transfer tax includes a bunching of transactions due to the approaching increase but with no drop in transactions. Additionally, the time frame with the highest transfer tax for each state includes the period with a precipitous drop in the number of transactions immediately after a tax increase without including possible bunching for future tax increases. We measure 12.5% fewer transactions for a one percentage point higher transfer tax. When we control for the bunching effects, however, 6% fewer transactions remain as a long-run effect.

[19] Although the anticipation effect before and after the tax increase is of similar magnitude, the drop in transactions after the tax increase is slightly larger. As the real estate transfer tax already controls for accelerating transactions and the long-term sales disincentive, we can only speculate about the underlying causal mechanism. A possible channel might be psychological in nature (in the sense of loss aversion; Thaler, 1985): In the absence of psychological factors, the bargaining solution might be to transact in the month immediately following a tax increase. However, the newly higher tax liability might be more present psychologically and might thus have a higher impact on utility than for transactions taking place even later. As a result, more people might be reluctant to transact. Evidence for overreactions to housing policy changes can be found for the case of Shanghai (Zhou, 2016).

TABLE 2. BASELINE RESULTS

	Dependent Variable: Log Number of Single-Family Home Transactions			
Specification	(1)	(2)	(3)	(4)
Real Estate Transfer Tax	-0.0552*	-0.0647*	-0.0637**	-0.1248***
	(0.0228)	(0.0258)	(0.0193)	(0.0286)
Months Before the Tax Change				
2	-0.0391	-0.0161	-0.0089	
	(0.2111)	(0.0712)	(0.1480)	
1	0.1020	0.4115***	0.1164	
	(0.1696)	(0.0830)	(0.1239)	
Months After the Tax Change				
1	-0.1855	-0.4597***	-0.1444	
	(0.1163)	(0.0740)	(0.1934)	
2	0.2054	-0.0420	0.2383	
	(0.2619)	(0.0547)	(0.2436)	
*Level of Tax Increase * Months Before Tax Change*				
2	0.0295		0.0385	
	(0.1741)		(0.0914)	
1	0.3267*		0.3325**	
	(0.1355)		(0.0988)	
*Level of Tax Increase * Months After Tax Change*				
1	-0.2839*		-0.2827	
	(0.0945)		(0.1538)	
2	-0.2466		-0.2612	
	(0.2206)		(0.1879)	
Constant	5.1789***	5.2120***	5.2376***	5.4212***
	(0.1655)	(0.1699)	(0.0556)	(0.1369)
Controls	YES	YES	YES	YES
Date	YES	YES	NO	YES
Years	NO	NO	YES	NO
Months	NO	NO	YES	NO
Obs.	665	665	665	665
Adj. R-squared	0.7606	0.6179	0.7004	0.7673

Notes: Significance levels (robust standard errors in brackets): *** 0.01, ** 0.05, and * 0.10. Column (1) shows the results for the specification of the equation in section 5.1. The regression of column (2) omits the interaction terms. In column (3), we replace the date dummies with seasonal and year dummies. Column (4) presents the results of the regression without controlling for the anticipation effects around the increase notches.

6. Robustness Checks

For robustness exercises, we apply a number of different specifications to our model. First, we consider different lengths for the anticipation period by comparing the baseline regressions with two dummy variables before and after tax increases with the case of one and three dummy variables. In section 6.2 below, we control for the possible effects of a temporary suspension of the real estate transfer tax for housing companies and cooperatives. Because this policy measure only affects Brandenburg in our data, our robustness regressions omit Brandenburg from the sample. Section 6.3 omits both Brandenburg and Berlin to control for housing markets in our sample which might exceed state borders. In section 6.4, we show further subsample regressions by omitting each state, one at a time.

6.1 Different Lengths of Anticipation

In the baseline setting, we generated dummy variables for the two months before and after tax increases. However, transactions might be accelerated over even longer time periods. Table 3 shows the regression results for different amounts of anticipation dummies.

In the first column of each specification, we use only one month before and after a tax increase. Transactions that are shifted in time outside of those two months are now calculated into the time frame before the tax increase. Thus, lower taxes are associated with even more transactions. A steep drop in transactions immediately following a tax increase stretching out farther than one month is calculated into the time period of a higher tax rate. Both effects lead to overestimating the long-term effects of transfer taxes on transactions. Using more dummy variables reduces the coefficient. However, the difference in coefficients for using one and two dummies is greater than for the setting with two and three month dummies. As expected, fewer transactions are accelerated when the transaction date absent the tax raise would have been further away from the time notch.

The specification with two month dummies before and two month dummies after the time notch is the one we trust most. Using even more dummies shows us that a slight overestimation of the long-term effect persists. However, when we stretch the anticipation period, we trim the time frame under which we estimate the long-term effects and thus increase uncertainty.

TABLE 3: RESULTS FOR DIFFERENT LENGTHS OF ANTICIPATION

	Dependent Variable: Log Number of Single-Family Home Transactions								
	(1)			(2)			(3)		
#month dummies	1	2	3	1	2	3	1	2	3
Real Estate Transfer Tax	-0.0606**	-0.0552*	-0.0521*	-0.0663**	-0.0647*	-0.0654*	-0.0711**	-0.0637**	-0.0618**
	(0.0229)	(0.0228)	(0.0252)	(0.0253)	(0.0258)	(0.0279)	(0.0216)	(0.0193)	(0.0205)
Months Before the Tax Change									
3			-0.1811			0.0007			-0.1174
			(0.1106)			(0.0731)			(0.0732)
2		-0.0391	-0.0418		-0.0161	-0.0163		-0.0089	-0.0092
		(0.2111)	(0.2197)		(0.0712)	(0.0717)		(0.1480)	(0.1493)
1	0.1014	0.1020	0.1015	0.4134***	0.4115***	0.4115***	0.1135	0.1164	0.1184
	(0.1548)	(0.1696)	(0.1740)	(0.0788)	(0.0830)	(0.0808)	(0.1169)	(0.1239)	(0.1238)
Months After the Tax Change									
1	-0.1634	-0.1855	-0.1877	-0.4567***	-0.4597***	-0.4589***	-0.1500	-0.1444	-0.1452
	(0.1155)	(0.1163)	(0.1184)	(0.0715)	(0.0740)	(0.0742)	(0.1894)	(0.1934)	(0.1957)
2		0.2054	0.2056		-0.0420	-0.0411		0.2383	0.2397
		(0.2619)	(0.2723)		(0.0547)	(0.0550)		(0.2436)	(0.2480)
3			0.0793			0.0105			0.0612
			(0.1406)			(0.0282)			(0.1051)
*Level of Tax Increase * Months Before Tax Change*									
3			0.1984						0.1504*
			(0.1094)						(0.0647)
2		0.0295	0.0301					0.0385	0.0400
		(0.1741)	(0.1762)					(0.0914)	(0.0926)
1	0.3272*	0.3267*	0.3290*				0.3323**	0.3325**	0.3340**
	(0.1321)	(0.1355)	(0.1376)				(0.0959)	(0.0988)	(0.1005)
*Level of Tax Increase * Months After Tax Change*									
1	-0.2985**	-0.2839**	-0.2854**				-0.2753	-0.2827	-0.2824
	(0.1040)	(0.0945)	(0.0920)				(0.1504)	(0.1538)	(0.1539)
2		-0.2466	-0.2484					-0.2612	-0.2626
		(0.2206)	(0.2293)					(0.1879)	(0.1898)
3			-0.0806						-0.0432
			(0.1344)						(0.0748)
Constant	5.1977***	5.1789***	5.1680***	5.2176***	5.2120***	5.2144***	5.2649***	5.2376***	5.2326***
	(0.1455)	(0.1655)	(0.1712)	(0.1507)	(0.1699)	(0.1741)	(0.0641)	(0.0556)	(0.0633)
Controls	YES	YES	YES	YES	YES	YES	YES	YES	YES
Date	YES	YES	YES	YES	YES	YES	NO	NO	NO
Years	NO	NO	NO	NO	NO	NO	YES	YES	YES
Months	NO	NO	NO	NO	NO	NO	YES	YES	YES
Obs.	665	665	665	665	665	665	665	665	665
Adj. R-squared	0.7690	0.7701	0.7710	0.7657	0.7660	0.7660	0.7085	0.7099	0.7106

Notes: Significance levels (robust standard errors in brackets): *** 0.01, ** 0.05, and * 0.10. Column (1) shows the results for the specification of the equation in section 25.1. The regression of column (2) omits the interaction terms. In column (3), we replace the date dummies with seasonal and year dummies. Column (4) presents the result of the regression without controlling for the anticipation effects around the increase notches.

6.2 Temporary Suspension of the Real Estate Transfer Tax for Housing Companies and Cooperatives

In 2004, the German government approved a law that allowed for a temporary suspension of the real estate transfer tax for mergers of housing companies and housing cooperatives in eastern German states (*Gesetz zur Grunderwerbsteuerbefreiung bei Fusionen von Wohnungsunternehmen und Wohnungsgenossenschaften in den neuen Ländern, Drucksache 51/04*). This regulation lasted from December 2003 until December 2006 and aimed at incentivizing housing companies and cooperatives to undertake new investments and therefore to help them grow their businesses (see Bundesrat 2004).

As we included three eastern German states in our sample (Berlin, Brandenburg and Saxony-Anhalt) and as our chosen time frame overlaps with the temporary suspension of the real estate transfer tax, we must consider whether the suspension had an effect on the number of transactions. For the case of Saxony-Anhalt, mergers were excluded in the original data set. In Berlin, no mergers of housing companies and housing cooperatives took place between 2004 and 2006. Thus, we must only remove those mergers that took place in Brandenburg from our dataset. According to the Federation of German Housing and Real Estate Companies (*Bundesverband deutscher Wohnungs- und Immobilienunternehmen e. V., GdW*),[20] 15 mergers took place between 2004 and 2006. Unfortunately, no detailed information on these mergers is available; therefore, we omit Brandenburg as a whole from our sample to ensure that the distortive effects of that regulation are excluded.

Table 4 reports the regression results with and without Brandenburg. While the anticipation coefficients are very robust towards the omission of Brandenburg, the real estate transfer tax coefficient is slightly lower in all specifications. The reaction towards higher tax levels is thus higher in Brandenburg and possible mergers for single-family homes do not seem to cause an underestimation of the regression coefficients.

[20] In Brandenburg, almost all housing and real estate companies are members of the Federation of German Housing and Real Estate Companies (see BBU 2015 and Statistische Ämter des Bundes und der Länder 2014).

TABLE 4: RESULTS WITH AND WITHOUT BRANDENBURG

	Dependent Variable: Log Number of Single-Family Home Transactions							
Specification	(1)		(2)		(3)		(4)	
Brandenburg included?	YES	NO	YES	NO	YES	NO	YES	NO
Real Estate Transfer Tax	-0.0552*	-0.0419	-0.0647*	-0.0507	-0.0637**	-0.0555*	-0.1248***	-0.1125**
	(0.0228)	(0.0282)	(0.0258)	(0.0327)	(0.0193)	(0.0228)	(0.0286)	(0.0326)
Months Before the Tax Change								
2	-0.0391	-0.1086	-0.0161	-0.0204	-0.0089	-0.0595		
	(0.2111)	(0.1922)	(0.0712)	(0.0775)	(0.1480)	(0.1117)		
1	0.1020	0.0419	0.4115***	0.3955**	0.1164	0.0643		
	(0.1696)	(0.1624)	(0.0830)	(0.0970)	(0.1239)	(0.0939)		
Months After the Tax Change								
1	-0.1855	-0.1780	-0.4597***	-0.4474***	-0.1444	-0.2331		
	(0.1163)	(0.1371)	(0.0740)	(0.0754)	(0.1934)	(0.1976)		
2	0.2054	0.1000	-0.0420	-0.0424	0.2383	0.1600		
	(0.2619)	(0.2521)	(0.0547)	(0.0503)	(0.2436)	(0.2162)		
*Level of Tax Increase * Months Before Tax Change*								
2	0.0295	0.1023			0.0385	0.0932		
	(0.1741)	(0.1471)			(0.0914)	(0.0628)		
1	0.3267*	0.3861**			0.3325**	0.3891**		
	(0.1355)	(0.1267)			(0.0988)	(0.0977)		
*Level of Tax Increase * Months After Tax Change*								
1	-0.2839**	-0.2929			-0.2827	-0.1845		
	(0.0945)	(0.1525)			(0.1538)	(0.2137)		
2	-0.2466	-0.1465			-0.2612	-0.1859		
	(0.2206)	(0.2352)			(0.1879)	(0.1743)		
Constant	5.1789***	5.0297***	5.2120***	5.0607***	5.2376***	5.0763***	5.4212***	5.2754***
	(0.1655)	(0.2362)	(0.1699)	(0.2425)	(0.0556)	(0.0641)	(0.1369)	(0.1806)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Date	YES	YES	YES	YES	NO	NO	YES	YES
Years	NO	NO	NO	NO	YES	YES	NO	NO
Months	NO	NO	NO	NO	YES	YES	NO	NO
Obs.	665	545	665	545	665	545	665	545
Adj. R-squared	0.7701	0.7553	0.7660	0.7516	0.7099	0.6893	0.7153	0.7033

Notes: Significance levels (robust standard errors in brackets): *** 0.01, ** 0.05, and * 0.10. Column (1) shows the results for the specification of the equation in section 25.1. The regression of column (2) omits the interaction terms. In column (3), we replace the date dummies with seasonal and year dummies. Column (4) shows the results of the regression without controlling for the anticipation effects around the increase notches.

6.3 Regional Border Effects

When people just marginally prefer one state over another in a migrating scenario, an increase in real estate transfer taxes might have a decisive influence on the decision of where to move. Thus, we might see market activity that has nothing to do with the transfer taxes in that particular state but with raised taxes in a neighboring state.

As stated in section 5.1, people should seldom be on the verge of indifference when it comes to migrating to one state or another. Germany has scarcely any pairs of areas that are located in different states that qualify as regional substitutes. In addition, area-specific differences other than geographical differences should have an impact on the housing decision. After all, two areas of different federal states are also located in different districts and different municipalities. The area-specific characteristics therefore also comprise all specific characteristics at different federal levels.

Nonetheless, we cannot fully exclude that the real estate transfer tax in one area affects market activity in another geographically close area of a different state. To a great extent, this concern can be eliminated by taking a closer look at our dataset. Affected areas might be so-called twin-metropolitan areas in which urban areas of two different states are located on opposite sides of the border, such as in some areas in Rhineland-Palatinate. Fortunately, our dataset does not include those particular areas.[21] In addition, the housing market in city-states like Bremen and Berlin, which are embedded in Lower Saxony and Brandenburg respectively, might be interdependent with the surrounding state. To the benefit of our analysis, Lower Saxony implements the exact same tax increases as Bremen, thus not distorting the interdependence of these two states and not causing any bias in our data for Bremen. However, since Berlin and Brandenburg differ in their transfer tax measures, our baseline results might be biased by border effects between these two states.

Table 5 compares the results of our baseline regressions with the omission of Berlin and Brandenburg from our dataset. Notably, in the remaining states, the bunching before a tax increase to a large extent stems from the second month after a tax increase. For the long-term effects, the coefficients are only slightly lower and thus confirm our previous findings.

[21] Ludwigshafen am Rhein and Mannheim in Baden-Wuerttemberg, in addition to Mainz and Wiesbaden in Hesse, qualify as twin-metropolitan areas. However, none of these cities are included in our data (see section 4).

TABLE 5: RESULTS WITH AND WITHOUT BERLIN & BRANDENBURG

	Dependent Variable: Log Number of Single-Family Home Transactions							
Specification	(1)		(2)		(3)		(4)	
Brandenburg or Berlin included?	YES	NO	YES	NO	YES	NO	YES	NO
Real Estate Transfer Tax	-0.0552*	-0.0504	-0.0647*	-0.0596	-0.0637**	-0.0630**	-0.1248***	-0.1221***
	(0.0228)	(0.0274)	(0.0258)	(0.0350)	(0.0193)	(0.0119)	(0.0286)	(0.0178)
Months Before the Tax Change								
2	-0.0391	-0.0306	-0.0161	-0.0305	-0.0089	-0.0671		
	(0.2111)	(0.3581)	(0.0712)	(0.1223)	(0.1480)	(0.2039)		
1	0.1020	0.0256	0.4115***	0.3252**	0.1164	0.0031		
	(0.1696)	(0.2945)	(0.0830)	(0.0945)	(0.1239)	(0.1478)		
Months After the Tax Change								
1	-0.1855	-0.0372	-0.4597***	-0.4212**	-0.1444	-0.0071		
	(0.1163)	(0.2562)	(0.0740)	(0.1230)	(0.1934)	(0.4371)		
2	0.2054	0.3773*	-0.0420	-0.0039	0.2383	0.4461**		
	(0.2619)	(0.1424)	(0.0547)	(0.0806)	(0.2436)	(0.1053)		
*Level of Tax Increase * Months Before Tax Change*								
2	0.0295	0.0046			0.0385	0.0834		
	(0.1741)	(0.2589)			(0.0914)	(0.0652)		
1	0.3267*	0.3301			0.3325**	0.3953*		
	(0.1355)	(0.2414)			(0.0988)	(0.1455)		
*Level of Tax Increase * Months After Tax Change*								
1	-0.2839**	-0.3874			-0.2827	-0.3422		
	(0.0945)	(0.2645)			(0.1538)	(0.3984)		
2	-0.2466	-0.3816*			-0.2612	-0.4075**		
	(0.2206)	(0.1294)			(0.1879)	(0.0898)		
Constant	5.1789***	5.0521***	5.2120***	5.0848***	5.2376***	5.0505***	5.4212***	5.3020***
	(0.1655)	(0.3506)	(0.1699)	(0.3642)	(0.0556)	(0.0655)	(0.1369)	(0.2236)
Controls	YES	YES	YES	YES	YES	YES	YES	YES
Date	YES	YES	YES	YES	NO	NO	YES	YES
Years	NO	NO	NO	NO	YES	YES	NO	NO
Months	NO	NO	NO	NO	YES	YES	NO	NO
Obs.	665	417	665	417	665	417	665	417
Adj. R-squared	0.7701	0.7799	0.7660	0.7755	0.7099	0.7092	0.7153	0.7450

Notes: Significance levels (robust standard errors in brackets): *** 0.01, ** 0.05, and * 0.10. Column (1) shows the results for the specification of the equation in section 25.1. The regression of column (2) omits the interaction terms. In column (3), we replace the date dummies with seasonal and year dummies. Column (4) shows the result of the regression without controlling for the anticipation effects around the increase notches.

6.4 Further Subsamples

In addition to excluding Berlin and Brandenburg from our regression, we now regress specification (1) of the baseline results in Table 2 while omitting one state at a time. In this manner, we can analyze whether our coefficients are determined by observations in individual states.

The results are shown in Table 6. The coefficient for the real estate transfer tax level ranges from 4.2 to 7.5% and is insignificant for most of the specifications. However, the large drop in transaction numbers over the long run remains the same. Even more so, our results show lower standard errors for larger (negative) coefficients. In addition, although the anticipation dummies and the interaction dummies vary strongly for different settings, aggregating these coefficients reduces most of that variance. The results suggest that the level of tax increase is differentially important throughout the German states.

TABLE 6: RESULTS FOR SUBSAMPLES

	Dependent Variable: Log Number of Single-Family Home Transactions					
State omitted	Brandenburg	Bremen	Saarland	Saxony-Anhalt	Berlin	Rhineland-Palatinate
Real Estate Transfer Tax	-0.0419	-0.0593	-0.0688**	-0.0449	-0.0748**	-0.0429
	(0.0282)	(0.0284)	(0.0187)	(0.0326)	(0.0215)	(0.0310)
Months Before the Tax Change						
2	-0.1086	-0.2551**	-0.0096	0.1338	0.0369	0.0289
	(0.1922)	(0.0747)	(0.1987)	(0.3170)	(0.3266)	(0.2010)
1	0.0419	-0.0289	0.1039	0.2907	0.0932	0.1225
	(0.1624)	(0.1418)	(0.1793)	(0.1590)	(0.2841)	(0.1857)
Months After the Tax Change						
1	-0.1780	-0.1145	-0.2620**	-0.2042	-0.0181	-0.2789**
	(0.1371)	(0.2524)	(0.0890)	(0.0984)	(0.2226)	(0.0864)
2	0.1000	-0.0712	0.1957	0.2185	0.5050**	0.2944
	(0.2521)	(0.1933)	(0.2774)	(0.2761)	(0.1528)	(0.2659)
*Level of Tax Increase * Months Before Tax Change*						
2	0.1023	0.2073*	-0.0052	-0.0623	-0.0548	-0.0694
	(0.1471)	(0.0832)	(0.1809)	(0.2738)	(0.2428)	(0.1998)
1	0.3861**	0.4333***	0.3481*	0.2050	0.2780	0.2909
	(0.1267)	(0.0805)	(0.1408)	(0.1667)	(0.2419)	(0.1823)
*Level of Tax Increase * Months After Tax Change*						
1	-0.2929	-0.3354	-0.2861**	-0.2924**	-0.3853*	-0.1426
	(0.1525)	(0.1707)	(0.0752)	(0.0761)	(0.1793)	(0.1242)
2	-0.1465	-0.0057	-0.2630	-0.2692	-0.4705**	-0.3356
	(0.2352)	(0.1671)	(0.2130)	(0.2429)	(0.1260)	(0.2201)
Constant	5.0297***	5.4476***	5.2536***	5.0326***	5.2653***	5.0448***
	(0.2362)	(0.1653)	(0.1787)	(0.0903)	(0.1987)	(0.2139)
Controls	YES	YES	YES	YES	YES	YES
Date	YES	YES	YES	YES	YES	YES
Years	NO	NO	NO	NO	NO	NO
Months	NO	NO	NO	NO	NO	NO
Obs.	665	665	665	665	665	665
Adj. R-squared	0.7690	0.7701	0.7710	0.7657	0.7660	0.7660

Notes: Significance levels (robust standard errors in brackets): *** 0.01, ** 0.05, and * 0.10.

7. Conclusion

The real estate transfer tax in Germany is a major part of all transaction costs in land purchases. An increase in the tax rate makes real estate acquisitions significantly more expensive. We conclude that the announcement of an increase in the real estate transfer tax leads to significant reaction of the housing market: Many market participants accelerate their planned transactions to take advantage of the lower tax rate. On top of that, a drastic drop in transactions can be observed after the tax increase.

However, the tax change also leads to long-run effects: Due to the higher tax rate, transactions become less attractive for buyers and sellers and therefore market activity decreases. The increase in the tax rate might be particularly relevant for so-called 'threshold households' which were *just* able to buy a house and for which even slight changes in the tax rate can cause greater financial burdens that they may not be able or willing to carry. Our results show that a one percentage point higher tax rate is accompanied by 6% fewer transactions. This finding questions the wisdom of real estate transfer tax increases when other political measures that attempt to support home-ownership creation are in place.

Increasing the tax leads to massive distortions around the time notch, whereas the long-run drop in transactions also curbs the tax revenue increase. Büttner (2016) shows that increases in the real estate transfer tax in Germany result in a less than proportional increase in tax revenues.

Transfer Taxes increase moving costs which can cause further distortions (see Kawata et al. 2016). These effects on the economy as a whole require further research. We were able to show that in many cases, the former first-best option – to buy or sell a single-family home – no longer constitutes the optimal choice for a household. Thus, we expect households to rent rather than to buy or sell, to choose cheaper houses and to stay longer in their home rather than to move. As a result, longer commutes might be possible which can have negative consequences on the urban labor market (see for example Ross and Zenou, 2008).

Additionally, future research efforts should be undertaken to develop a better understanding of the effects of the tax change on real estate transactions. Thus far, we have only been able to study tax increases, as no German state has yet decreased their real estate transfer tax. It would be interesting to learn whether the market would react similarly to a tax change in the opposite direction. Real estate transactions in other countries in which there have been both a tax increase and a tax decrease (or holiday) might provide valuable frameworks and insights to investigate this interrelation in more detail.

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Appendix

TABLE 7. SHARES OF DIFFERENT TYPES OF HOME USAGE (OWNER-OCCUPIED VS. RENTED-OUT) IN GERMANY, 2011

	Total Number of Dwellings	*Share of Owner Occupied*	*Share of Rented Out*
Single-Family Homes[a]	18,681,375	74%	22%
Multi-Family Homes	21,863,942	16%	78%
Total	40,545,317	100%	100%

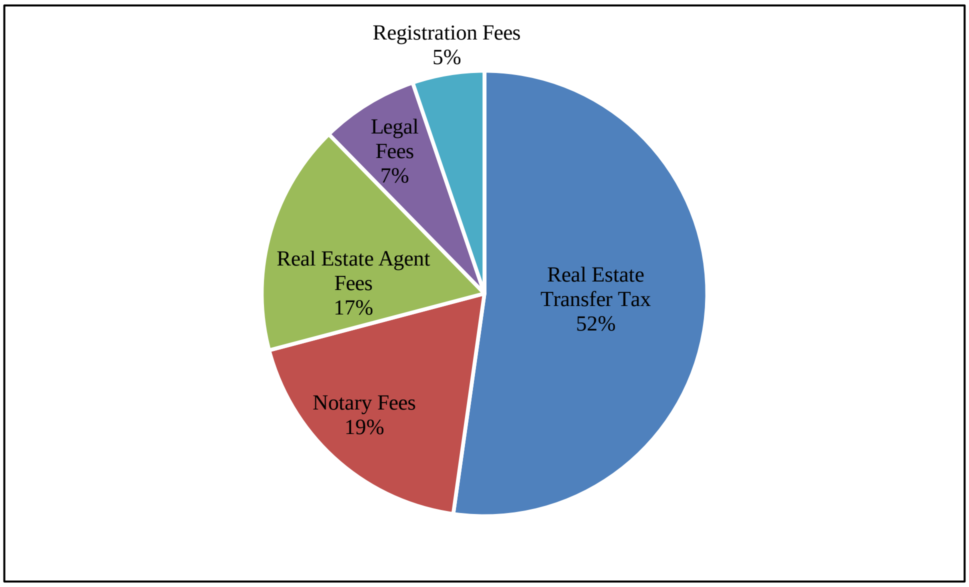
Notes: The table presents the share of owner-occupied homes and the share of rented-out homes for single-family homes and multi-family homes. If a dwelling is neither owner-occupied nor rented-out it is vacant or used as a holiday home. a) Single-Family Homes are defined as dwellings with one or two apartments. *Data*: Statistische Ämter des Bundes und der Länder (2014).

TABLE 8. MARKET SHARE OF AVERAGE PRICE OF SINGLE-FAMILY HOMES IN DIFFERENT GERMAN STATES, 2011

	Share of People living in Single-Family Homes[a]	*Share of Single-Family Homes on all Residential Buildings*	*Average Transaction Price of Single-Family Homes*
Berlin	14%	54%	€ 294,261.91
Brandenburg	57%	84%	€ 124,355.66
Bremen	42%	75%	€ 174,307.93
Rhineland-Palatinate	66%	84%	€ 169,826.03
Saarland	72%	87%	€ 156,352.87
Saxony-Anhalt	51%	79%	€ 75,386.19

Notes: The table presents the share of people living in single-family homes in the total population and the share of single-family homes out of all residential buildings in different German states in 2011. a) Single-Family Homes are defined as dwellings with one or two apartments. *Data*: Statistische Ämter des Bundes und der Länder (2014) and Property Valuation Committee of Berlin, Brandenburg, Bremen, Rhineland-Palatinate, Saarland and Saxony-Anhalt (2015).

FIGURE 9. AVERAGE SHARE OF DIFFERENT TYPES OF COSTS ON TRANSACTION COSTS OF PROPERTY TRANSACTIONS IN GERMANY, 2011



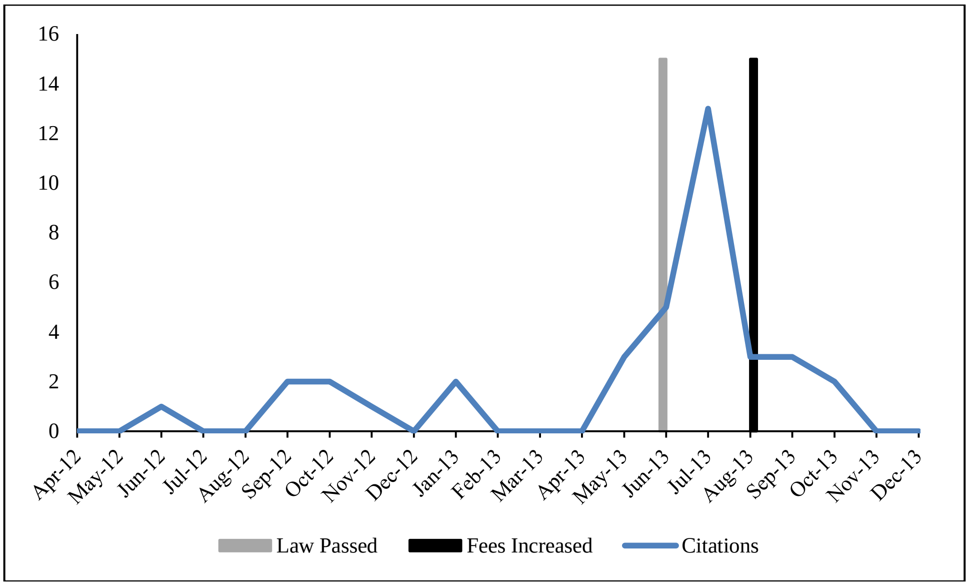
Notes: The figure shows the average share of different types of costs on the total transaction costs of property transactions in Germany for 2011. Transaction costs include notary and legal fees, real estate agent (broker's) fees and real estate transfer taxes. *Data*: Andrews et al. (2011).

Following transfer taxes, real estate agent and notary fees also play a significant part in the total transaction costs. As all other fees are relatively small, it can be assumed that they have little to no impact on the number of real estate transactions.

With regard to real estate agent fees, there is no legislative basis stipulating a certain fee level. Thus, real estate agents can theoretically ask for individual fees. However, agents typically align themselves to the fees suggested by the umbrella organization in their respective German state. During the time frame of our analysis, there has been no change in this suggested fee level recommended by these umbrella organizations. As a result, we do not include changes in real estate agent fees in our analysis.

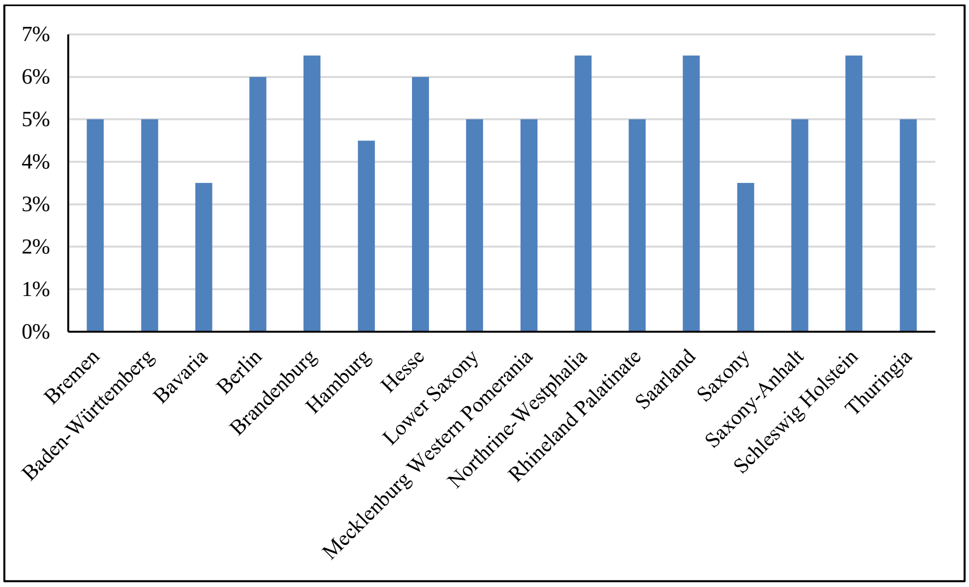
Notary fees are legally fixed; as of August 2013, a new law concerning legal and notary fees has been introduced (*Gerichts- und Notarkostengesetz*, former *Kostenordnung für Verfahren der freiwilligen Gerichtsbarkeit*). As a result, legal and notary fees increased on average by 0.5 percentage points for all German states. Figure 10 charts the media coverage on this topic and the date the increase in fees took effect. The data suggest that the timing of the change in the fees has not been much anticipated as most media coverage only took place in the month preceding the increase of the fees. We control for the change in notary fees in our baseline setting.

FIGURE 10. MEDIA CITATIONS OF THE INCREASE IN LEGAL AND NOTARY FEES IN GERMANY



Notes: The figure presents the media citations of '*Gerichts- und Notarkostengesetz*' ('Law on Court and Notary Fees'). Media coverage was particularly heavy immediately before the fee increase. Further, all citations in the months before the law passed can be considered as from rather professional journals, which leads us to the assumption that people have not been particularly aware of the increase in legal and notary fees. Media citations from Der Betrieb, Betriebsberater, Bundesrat Parlamentsdrucksachen, Bundestag Parlamentsdrucksachen, Gesetzgebungskalender, Haufe, Bundesanzeiger, Immobilienzeitung, Tierischer Volksfreund, NotBZ, Gießener Anzeiger, Coburger Tageblatt, Die Kitzinger, Saale Zeitung, Fränkischer Tag, Bayrische Rundschau, Bonner Generalanzeiger, Kölnische Rundschau, Welt am Sonntag, Handelsblatt, Sächsische Zeitung, Berliner Morgenpost, Freue Presse, Badische Zeitung, Euro, Nürnberger Nachrichten, news aktuell, Brauwelt, and Miet-Rechts-Berater. *Data*: http://www.genios.de.

FIGURE 11. TAX RATE OF THE REAL ESTATE TRANSFER TAX IN GERMAN STATES AS OF 2016



Notes: The figure shows the tax rate of the real estate transfer tax for all German states as of 2016. Apart from Bavaria and Saxony, all German states have increased their real estate transfer tax rates since 2007.

TABLE 9. OVERVIEW OF PUBLIC FUNDING INSTRUMENTS ENCOURAGING HOME OWNERSHIP IN GERMANY

Name	*Funding Type*	*Geographical Coverage*	*Funding Amount*	*Funding Period*
Eigenheimzulage	tax allowance	Germany	1% of purchase price	until 12/2005
Eigenheimrente	loan/tax allowance	Germany	154-454 € annually	since 01/2008
IBB Familienbaudarlehen	loan	Berlin	max. 60% of collateral value	since 03/2015
ILB Brandenburg Kredit	loan/grant	Brandenburg	max. 50,000 €	since 01/2013
ISB Darlehen Wohneigentum	loan	Rhineland-Palatinate	max. 150,000 €	since 04/2013
Saarländische Wohnraumföderung	loan	Saarland	max. 400 €/m²	since 04/2008

Notes: The table presents all public funding instruments encouraging home ownership in Germany that were introduced or abolished during the time period of our sample. Funding instruments at the municipal level have been excluded due to their limited impact on transactions at the state level. *Data*: http://www.genios.de and http://www.baufoerderer.de.

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The macroeconomic forces that drive REIT returns in Australia

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Abstract: Real Estate Investment Trusts (REITs) represent a viable alternative to direct property investments. They offer enhanced liquidity and risk diversification. In addition, the securitisation process provides a level of governance not typically offered in direct property markets. However, as an openly traded security, it experiences risk exposures inherent to equities such as interest rate risk, default risk, inflation and so on. This study explores the nature and magnitude of various macroeconomic risk factors that drive REIT performance.

Utilising data from the Australian market over a 20 year period spanning multiple economic cycles, REITs were found to have an adverse relationship to unexpected inflation and default risk suggesting that REITs are not an effective hedge against inflation. On the other hand, increasing spreads in the yield curve and changes to expected inflation and were found to correlate positively with fund performance. The latter effect possibly being due to higher expected rents. These effects are greater for highly leveraged funds and those that adopt a stapled trust structure. This is expected given their greater reliance on debt and the wider set of operating activities which compound exposures to market and financial risk. These funds also exhibited a greater overall exposure to market risk. Size risk was also considered with small cap funds exhibiting greater exposure to the risk factors than medium and large funds.

The practical implications for asset allocation strategies is that portfolio managers and other investors seeking to take a long position may select highly leveraged funds with a stapled trust structure operating in a low interest environmental with higher expected inflation; whole those wishing to adopt a more defensive stance may consider less heavily geared funds with external management.

Keywords: REITs, securitised property, listed property trusts, capital asset pricing, multifactor asset pricing models, financial risk factors, inflation risk, credit spreads, default risk, property investment

1 Introduction

Real Estate Investment Trusts (REITs) offer investors a range of benefits that distinguish themselves from other asset classes. As an alternative to direct (unsecuritised) investment in property, REITs confer at least two advantages. The first is liquidity. The securitised nature of REITs allow investors to take positions in the sector without cumbersome transaction costs and lengthy delays in execution. The second is diversification. The relatively low unit cost enables the allocation of funds across the sector resulting in diverse portfolio holdings. Furthermore, as REITs are openly traded on securities exchanges, they operate in well established regulatory environments providing a level of governance that is typically not offered in the direct property market.

As a security, it offers the potential for capital appreciation and high rates of dividend yield. The latter occurs by virtue of the regulatory environment. In the United States for example, REITs are exempt from corporate income taxes if they distribute at least 95% of net income in the form of dividends to shareholders (Chen and Tzang, 1988). In Australia, no formal distribution requirements exist however, undistributed income is taxed at the highest marginal rate (46.5%) thus creating an incentive for full distribution (EPRA 2013).

These benefits however come at a cost. As an openly traded security, it faces exposure to risk factors inherent to equities such as market exposure, interest rate risk, default risk, inflation and so on. Chan, Hendershott & Sanders (1990) found that REITs typically experience lower exposure to market risk as opposed to common equities but greater sensitivity to interest rates, which is especially true for highly leveraged firms. Furthermore as REITs primarily derive their revenue from rents, higher inflationary expectations tend to improve rental yields, flowing through as higher distributions to investors. However, the same cannot be said for unexpected increases in inflation, which reduce performance. More recent studies confirm some of these findings. Peterson and Hsieh (1990) concluded that unexpected changes in interest rates and the probability of default significantly affected mortgage REIT performance but not equity REITs. Likewise, Cheong et al (2006) find evidence of a cointegrative relationship between performance and the stock market and long run interest rates.

Other studies have investigated the impact of firm characteristics on REIT performance. Common risk factors such as size and value (as measured by book to market equity) have been found to affect REIT performance. Other determinants have included leverage, liquidity and the value of underlying real estate owned by the fund (Chan, Hendershott & Sanders 1990; Conover, Friday & Howton 2000; Clayton & MacKinnon 2000; McIntosh, Liang & Tompkins 1991; Patel & Olsen 1984).

While there is a considerable volume of research on US based REITs, less attention has been devoted to the Australian market. Tan (2004) examined the effect of management structure and found evidence of outperformance by internally versus externally managed funds, which was consistent with the findings of Newell and Tan (2005) from an earlier study period. Lee, Robinson and Reed (2008) found a strong relationship between downside systematic risk and leverage, management structure and market capitalisation, though the explanatory power of the latter has diminished in recent years. Yong and Singh (2015) who investigated the impact of leverage and management structure determined that highly leveraged funds experienced greater sensitivity to adverse movements in long term interest rates; while internally managed REITs performed better during favourable economic conditions as such funds are permitted to engage in property development and/or fund management activities. Their findings were broadly consistent with earlier work by Stevenson et al. (2007), Ratcliffe and Dimovski (2007) and Newell and Peng (2009).

The objective of this study is to evaluate the exposure of REITs to common macroeconomic factors in the Australian market. The effects of management structure and gearing levels will be tested as well. Lastly, the impact of size on REIT performance is also considered. The next section provides an outline of methodology. Section 3 addresses data sources and collection methods. Results are presented in Section 4 and Section 5 concludes.

2 Methodology

The pricing of risky assets is an important theoretical and empirical issue in finance. The relationship between risk and return is most commonly articulated in the form of *asset pricing models*, which express returns as linear combination(s) of identifiable risk factors. The exact number, effect and persistence of these factors however vary across time and region making the identification of these factors and the estimation of their effects largely empirical in nature.

Merton (1973) argued that market exposure alone, while undeniably significant was an incomplete representation of the returns generating process suggesting that investors receive a premium not only for bearing market risk but also unfavourable shifts in the investment opportunity set. This was later tested by Gibbons (1980; 1982) through the incorporation of a set of changing state variables giving rise to *multi-factor models*.

Ross (1976) demonstrated how such models could be used to identify mispricing of assets thereby allowing profit via arbitrage. This led to the development of the Arbitrage Pricing Theory[1]. The 'theory' however was silent on the identity and nature of the relevant risk factors. This "rather embarrassing gap" was eventually addressed by Chen, Roll and Ross (1986) who determined that unexpected changes in inflation, national production, investor confidence and the yield curve were significant in explaining security returns. It is from these modern class of asset pricing models that this study draws its inspiration.

In principle, stock prices can be written as a function of discounted dividends:

$$p = f\left(\frac{E(c)}{r}\right)$$

where *c* represents a dividend stream and *r* is the discount rate. Therefore, systematic forces which affect either expected cash flows and/or the discount rate will influence returns. The discount rate takes into account the time value of money and is affected by changes in the level of interest and term structure spreads across different maturities. Therefore, unanticipated changes in the risk free rate will influence the time value of future cash flows and hence returns. The discount rate is also affected by the uncertainty of future cash flows. Unanticipated changes in the risk premium affects the stability of future cash flows which in turn influence prices and returns.

The effects of inflation on stock returns are not immediately clear. Inflation itself develops for a number of reasons and its effects vary across asset type. Unexpected changes in inflation can exert an effect on returns. Perhaps one of the more obvious explanations is that higher inflation leads to higher input costs[2] and lower levels of consumer spending resulting in declining profits. Returns may also be affected if inflation exceeds dividend growth resulting in reductions to income streams. This may be particularly true for income generating securities such as REITs.

[1] In fact, the CAPM may be thought of as a special case of the APT for which only one factor – market exposure is identified. For an excellent description, please see Elton, Gruber, Brown and Goetzmann (2016).

[2] via 'sticky' wages and/or prices

Other theories suggest that the link between inflation and returns depends on whether an asset is perceived to be a value or growth stock. Value stocks have strong current cash flows that diminish over time while growth stocks are characterised by the opposite. If an increase in inflation leads to a commensurate rise in interest rates[3] then growth stocks would experience greater discounted cash flows than value stocks as cash flows are generated further into the future. Therefore, growth stocks would be more negatively affected by periods of high inflation.

Lastly, the timing of inflation may also have a varying impact on asset prices. Inflation may correlate positively with stock returns during economic contractions. This stems from the notion that unexpected inflation may contain new information about forthcoming economic recovery.

However, if changes to inflation are expected, returns may improve to the extent that the security is able to act as a partial hedge against rising prices. REITs in particular may fulfil this role. Studies by Brueggaman, Chen and Thibodeau (1984); Ibbotson and Siegel (1984) and Hartzell, Hekman and Miles (1987) support this notion. Chan, Hendershott and Sanders (1990) however argue that these studies employed returns data based on market appraisals rather than actual transaction prices. Such data may be smoothed which understates the true volatility of real estate returns and overstates risk adjusted returns.

[3] A valid assumption given nominal interest rates and inflation are theoretically linked according to the Fisher equation

Economic factors

The economic factors employed in this study are based on the work of Chen, Roll and Ross (1986). These include: unexpected inflation, changes to expected inflation, changes to risk premia and the term structure of interest rates.

Inflation

Unexpected inflation is defined as the difference between actual and expected inflation:

$$UI(t) = I(t) - E[I(t)|t-1]$$

Where $I(t)$ is the natural logarithm of the ratio between $CPI(t)$ and $CPI(t-1)$. The series of expected inflation $E[I(t)|t-1]$ is derived using the methodology of Fama and Gibbons (1984). In principle, it is obtained via application of the Fisher equation:

$$TB(t-1) = E[RIR(t)|t-1] - E[I(t)|t-1]$$

Where $TB(t-1)$ represents the Treasury Bill rate at the end of period, *t – 1*. $RIR(t)$ represents the real interest rate at period t which is calculated as the difference between $TB(t-1)$ and $I(t)$. $E[RIR(t)|t-1]$ is the expected real interest rate and is obtained using the methodology of Fama and Gibbons (1984). Expected inflation, $E[I(t)|t-1]$ is therefore calculated as the difference between $E[RIR(t)|t-1]$ and $TB(t-1)$.

Changes to expected inflation is defined as the difference between one period ahead expected inflation and expected inflation in the current period:

$$DEI(t) = E[I(t+1)|t] - E[I(t)|t-1]$$

Risk premia

Unexpected changes to the risk premium is defined as the difference in return between a portfolio of long term corporate bonds and long term government bonds:

$$URP(t) = BBB(t) - LGB(t)$$

Where $BBB(t)$ represents the return on BBB rated low-grade bonds and $LGB(t)$ represents the return on long term government bonds. $URP(t)$ would be zero in a default-free economy. Therefore, changes to $URP(t)$ can be interpreted as shifts in the probability of default.

Term structure

The term structure of interest rates is defined as the difference between long and short term government bonds:

$$TERM(t) = LGB(t) - TB(t-1)$$

Under the assumption of risk neutrality, TERM can be interpreted as reflecting the unexpected return on long term government bonds.

The following table provides a summary of the aforementioned variables:

Symbol	Variable	Description
I	Inflation	Log ratio in CPI between consecutive periods.
TB	Treasury Bill	Return on short term Government Securities represented by the 90 day bank accepted bill rate.
LGB	Long term Government Bond	Return on long term Government Securities represented by the 10 year treasury bond rate.
BBB	BBB rated Corporate bonds	Return on BBB rated Corporate bonds. This is used to calculate unexpected changes to the risk premium, URP
UI	Unexpected Inflation	Difference between actual and expected inflation. Expected inflation is further calculated as the difference between the Treasury bill rate and Expected Real Interest Rate.
RIR	Real Interest Rate	Difference between nominal interest and inflation represented by the Treasury bill rate and Inflation rate respectively.
DEI	Changes to Expected Inflation	Difference between one period ahead expected inflation and expected inflation in the current period.
URP	Unexpected change in Risk Premium	Difference between returns on a portfolio consisting of BBB rated low grade corporate bonds and Long Term Government Bonds.
TERM	Term structure	Difference between Long and Short term Government Securities.

Asset pricing tests

To test the sensitivities of returns to the aforementioned risk factors, the following factor model was used:

$$R = \beta_0 + \beta_1 STOCK + \beta_2 UI + \beta_3 DEI + \beta_4 URP + \beta_5 TERM + \varepsilon \qquad (1)$$

where *R* is a vector of expected returns, STOCK represents the monthly logarithmic returns for the ASX200 stock market index; and the beta's are the loadings on the state variables. The effect of fund characteristics such as leverage, management structure, size and industry of operation was evaluated by dividing observations into portfolios based on the relevant criteria and estimating the factor model.

Leverage: To evaluate the effect of leverage, funds were divided into high and low debt groups based on gearing levels as measured by debt to capital ratios. Funds were considered as high debt (HD) if their debt to capital ratio exceeded the cross sectional average in the prevailing time period and low debt (LD) otherwise.

Management structure: Funds were divided into two portfolios: internally managed (stapled) and externally managed (traditional). Under a traditional trust, external parties perform many of the management functions such as tenant management, asset acquisition and disposal and negotiation of debt contracts. From 2005 onwards many A-REITs began internalising the asset management function and increasingly began to engage in property development activities resulting in stronger performance while simultaneously increasing risk exposure.

Size: A common risk factor not only among REITs but for equities in general, size risk measures the premium attached to small cap stocks. Funds with less than AUD$1bn in market capitalisation were considered *small*, while funds with a market capitalisation between AUD$1 – 3bn were considered *medium* and funds with a market capitalisation in excess of AUD$3bn were considered *large*.

3 Data

This study includes REITs listed on the Australian Stock Exchange (ASX) between 1995 and 2015. All financial variables including: adjusted closing prices[4], number of shares outstanding, debt to capital ratios[5], market capitalisation and market price indices were obtained from Datastream. Returns were calculated as the natural logarithm of price ratios in sequential periods. All financial variables were available at monthly frequency. Macroeconomic variables such as GDP, inflation, 90 day bank accepted bill rates and 10 year treasury bond rates are widely available from official public sources. BBB rated bond rates however were only available from 2005 onwards.

In total, there were 55 A-REIT entities available on Datastream. To be included in the sample, REITs must satisfy size and data availability requirements. Funds with less than 24 months of available data were removed from the sample. Also, funds with less than AUD$100m in market capitalisation were not considered. Annualised summary statistics are presented in Table 1:

	A-REITs	ASX200	UI	DEI	URP	TERM
Arithmetic mean	5.66%	5.31%	0.97%	-0.12%	23.01%	5.03%
Geometric mean	3.12%	3.86%	0.74%	-0.17%	22.81%	4.42%
Median	9.53%	7.23%	0.56%	-0.04%	19.85%	5.32%
Standard Deviation	18.95%	15.11%	7.10%	1.41%	15.57%	9.19%
Skewness	-1.6026	-1.0797	0.4250	-0.4597	1.2358	-0.1072
Kurtosis	3.1446	1.8618	0.0188	-0.1824	1.0580	-0.7545
Number obs.	229	229	229	229	128	229

Table 1 Summary statistics for annualised rates of return for A-REITs and the ASX200 index. Unexpected Inflation (UI), Changes to Expected Inflation (DEI), Unexpected changes to the Risk Premium (URP) and Term structure of interest rates (TERM) have also been annualised.

[4] Adjusted for dividend payments, stock splits and so forth

[5] Defined as (Long Term Debt + Short Term Debt & Current Portion of Long Term Debt) / (Total Capital + Short Term Debt & Current Portion of Long Term Debt)

A-REITs outperformed the general stock market over the sample period but exhibited greater volatility. Mean returns however were substantially lower than median rates indicating negative skewness. This effect was stronger in A-REITs and can largely be attributed to the effects of the GFC which had a substantial impact on securitised property funds. Summary statistics during the pre-GFC, GFC and post-GFC periods are further presented in Table 2:

		A-REITs	ASX200	UI	DEI	URP	TERM
Pre-GFC	Arithmetic mean	11.89%	9.11%	0.29%	-0.06%	9.23%	6.33%
	Geometric mean	11.08%	9.52%	-0.14%	-0.09%	2.76%	5.23%
	Median	11.23%	9.40%	-1.09%	-0.09%	9.49%	6.08%
	Standard Deviation	9.24%	10.15%	7.54%	1.47%	4.09%	7.55%
	Skewness	0.0660	-0.4719	0.7533	-0.5649	-0.4077	-0.0304
	Kurtosis	0.5378	-0.0924	0.5203	0.1916	-0.4756	-1.2681
	Number obs.	133	133	133	133	32	133
GFC	Arithmetic mean	-34.00%	-18.23%	2.99%	-0.98%	39.54%	-8.79%
	Geometric mean	-35.83%	-17.94%	7.59%	-0.72%	47.73%	-3.60%
	Median	-35.77%	-19.88%	6.63%	-0.92%	33.74%	-9.37%
	Standard Deviation	23.26%	22.67%	9.16%	1.45%	18.47%	5.96%
	Skewness	0.7440	0.5479	-0.5446	0.0412	0.2760	1.1912
	Kurtosis	-0.2082	-0.5238	-1.3198	-1.4026	-1.6085	1.6336
	Number obs.	24	24	24	24	24	24
Post-GFC	Arithmetic mean	7.38%	6.13%	1.54%	0.05%	23.62%	7.23%
	Geometric mean	5.28%	1.85%	0.17%	-0.13%	20.30%	5.71%
	Median	6.39%	6.57%	0.86%	0.27%	21.49%	6.49%
	Standard Deviation	14.55%	12.64%	5.16%	1.20%	11.72%	9.02%
	Skewness	-0.0560	0.3250	0.1418	-0.2557	1.2293	0.1214
	Kurtosis	-0.2647	-0.3192	-0.7005	-0.8954	2.0413	-0.8941
	Number obs.	72	72	72	72	72	72

Table 2 Summary statistics divided into pre-GFC, GFC and post-GFC periods. Observations prior to August 2007 belonged to the pre-GFC phase. Observations between September 2007 and August 2009 were considered as the GFC phase while observations from September 2009 onwards were considered post-GFC.

When viewed from this perspective, it becomes apparent that A-REITs outperformed the general stock market during the pre-GFC era with higher returns and lower overall risk. During the GFC however, this pattern was reversed with A-REITs suffering heavy losses. Over the post-GFC recovery period, A-REIT performance improved (as did the general equities market) though not returning to pre-GFC levels. Another noteworthy observation is the effect of the GFC on average default risk premiums which roughly quadrupled during the crisis.

4 Results

Leverage and management structure

Results of the factor model regressions for portfolios consisting of ALL funds, HD vs. LD funds and internally (stapled) vs. externally (unit) managed funds are reproduced in Table 3.

	ALL Funds	***LD***	***HD***	***Stapled***	***Unit***
Constant	-0.0049	-0.0044	-0.004	-0.0053	-0.0038
STOCK	0.764***	0.8892***	0.6926***	0.7984***	0.6575***
UI	-1.4243***	-1.6415***	-1.6603***	-1.5475***	-1.1004***
DEI	4.7393***	3.9073**	5.5084***	4.8876***	4.0036**
TERM	1.0813***	0.4009	0.9438**	1.0723***	1.0171***
Adjusted R^2	0.400	0.402	0.402	0.396	0.377

Table 3 Results are based on estimations of Equation (1). *, ** and *** denotes statistical significance at the 10%, 5% and 1% levels of significance respectively. Results indicate the varying levels of exposure to risk factors based on leverage and management structure.

All portfolios exhibited less than unitary market betas suggesting that REITs have relatively lower market exposure in general. Market risk is more prevalent in Low Debt funds and Internally managed funds as opposed to High Debt and Externally managed funds. Unexpected changes to inflation had a strongly significantly negative impact on REIT performance suggesting that securitised property may not be an effective hedge against inflation. Higher inflationary expectations however improved fund performance possibly due to higher expected rents. Lastly, wider spreads in the yield curve had a positive impact on fund performance. Conversely, narrowing spreads would have a negative impact. One possible explanation is that a narrow spread might be an indication of impending economic stress. During crisis episodes such as recessions, central banks are expected to lower interest rates. In such an environment, investors may prefer a steady income stream such as those offered by long term bonds. The resultant increase in demand for long term bonds bids up their prices and reduces yield flattening the yield curve.

Note that the default risk variable, URP was not included in this analysis. As previously mentioned, data for this variable was only available from 2005 onwards. Therefore, inclusion of this variable would have resulted in the loss of approximately half the observations. This variable was subsequently included in a separate set of regressions and the results are presented in Table 4.

	ALL Funds	***LD***	***HD***	***Stapled***	***Unit***
Constant	0.0067	0.0071	0.0093	0.0073	0.0039
STOCK	1.0197***	1.1319***	0.8645***	1.0719***	0.8918***
UI	-1.4146**	-0.9429	-1.6477**	-1.5138**	-1.1834
DEI	2.6304	2.2971	4.585*	2.2728	3.5587
TERM	1.1228**	0.5597	1.1749**	1.092**	1.2007**
URP	-0.7693*	-0.6362	-0.9768**	-0.8422**	-0.5451
Adjusted R^2	0.648	0.613	0.553	0.642	0.537

Table 4 Results are based on estimations of Equation (1). *, ** and *** denotes statistical significance at the 10%, 5% and 1% levels of significance respectively. This model includes the URP variable which was only available from 2005 onwards. Therefore, results are only based on observations between 2005 and 2015

The impact of default risk is only evident in High Debt funds and Stapled trusts. This is to be expected given their added propensity for risk taking and the commensurate premia that must be paid to investors. HD funds for example borrowed aggressively to fund expansion; while stapled trusts are permitted to undertake development activities. Note the estimated effects may have been overstated as data for URP was not available prior to 2005 restricting the modelling period to 2005 onwards during which the GFC featured prominently.

Size

To estimate the impact of size, funds were divided into three categories: small, medium and large. Small funds were defined as having less than AUD$1bn in market capitalisation. Medium funds were defined as having between AUD$1 – 3bn in market capitalisation and Large funds were those in excess of AUD$3bn in market capitalisation. The results are presented in Table 5.

	Small	***Medium***	***Large***	***Small***	***Medium***	***Large***
Constant	-0.0064	-0.0068	0.0002	0.0085	0.007	0.0074
STOCK	0.7017***	0.8333***	0.8333***	1.003***	1.017***	0.9236***
UI	-1.6614***	-0.8412	-0.7635**	-1.6591**	-0.6053	-0.7369
DEI	5.7376***	3.8782*	0.0982	2.7598	3.4393	-0.7306
TERM	1.3046***	0.9483*	0.3661	1.4599***	0.8976	0.4339
URP				-0.8822*	-1.0204	-0.587
Adjusted R^2	0.305	0.239	0.463	0.605	0.281	0.529

Table 5 Results indicate the varying levels of exposure to risk factors based on size. Note the second half of the results include the URP variable which was only available from 2005 onwards, restricting the sample period accordingly.

All portfolios exhibited some degree of exposure to market risk with larger funds having marginally greater exposure. Small and Large funds were inversely related to unexpected increases in inflation while changes to expected inflation had a positive impact for small and medium sized funds. Small funds also exhibited a greater exposure to term structure changes while medium and large funds were less sensitive. Lastly, default risk was only significant for small funds. Overall, small funds had a greater exposure to the various risk factors than larger funds, which were driven predominantly by market exposure.

5 Conclusions

The arbitrage pricing model of Chen, Roll and Ross (1986) explored the relationship between returns and a set of risk factors including industrial production, unexpected inflation, changes to expected inflation, default risk premiums and the term structure of interest rates. These risk factors have been shown to have a direct relationship to returns in the REIT sector and common equities in general. This study has examined the impact of these risk factors on Australian REITs and most of its conclusions are broadly consistent with findings from well established studies of the US market.

In general, A-REITs exhibited lower levels of market exposure. Inflation on the other hand had a dual effect. Unexpected increases in inflation had a negative impact on performance suggesting that REITs are not an effective hedge against inflation. Changes to expected inflation however had a positive effect, possibly due to higher expected rents. Higher spreads in the yield curve correlated positively to returns while unexpected increases in default risk had a negative impact.

In terms of gearing levels, highly leveraged funds exhibited less exposure to market risk but greater exposure to unexpected inflation. Changes to expected inflation however were of greater benefit to highly leveraged funds as were wider interest spreads. These funds however performed poorly during unexpected increases in the risk premium suggesting that higher gearing levels increased exposure to default risk.

With regard to management structure, internally managed funds were found to have greater exposure to market risk and unexpected inflation. However, they exhibited superior performance when inflation was expected to rise. Not surprisingly, given their additional involvement in development activities, stapled funds also experienced greater exposure to default risk.

Regarding size effects, small cap funds displayed a higher degree of exposure to market risk, unexpected inflation, changes to the term structure and default risk while medium and large funds were driven predominantly by market risk alone.

The implications for asset allocation strategies is that portfolio managers and other investors seeking to take a long position may select highly leveraged funds with a stapled trust structure operating in a low interest environmental with higher expected inflation; whole those wishing to adopt a more defensive stance may consider less heavily geared funds with external management.

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Loss Given Default for residential real estate banks: Evidence from the Euro area

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Loss Given Default for Residential Real Estate Banks:

Evidence from the Euro area

Abstract

Loss given default (LGD) for residential real estate loans is affected by real estate market trends due to the impact on the value of debtors' main collateral. Banks specialized in real estate lending are expected to be better at selecting lending opportunities, properly evaluating real estate collaterals, and managing the recovery process. The recovery process is expected to differ for specialized lenders but there is no consensus about their differences from other market players.

The paper examines LGD for a representative sample of European banks to underline the key differences related to real estate specialization. Results show that real estate banks, on average, perform a better recovery process. Moreover, real estate banks not fully specialized in real estate can better manage the real estate market cycle effect, reducing the pro-cyclicality of LGD.

Keywords: Loss Given Default, Real estate banks, Real Estate market, Lending

1. Introduction

Banks' loss given default (LGD) is affected by systemic risk and the recovery process in normally less effective in a market downturn than in stable markets (e.g. Dullmann and Trupp, 2004). The last financial crisis demonstrates that real estate mortgages could be one of the main drivers of loss in the event of default if the value of collateral decreases and the recovery process duration increases (Andersson and Mayock, 2014).

The literature on residential mortgages underlines the unique features of exposure related to mortgages and different degrees of sensitivity to changes in market scenario (e.g. Agarwal et al., 2006). Lenders' capital requirements are set without considering the specific risk that can characterize the real estate mortgage (e.g. pre-payment risk) or the diversification strategy adopted by the bank in selecting counterparties (e.g. geographical diversification; Calem and Lacour-Little, 2004). Empirical evidence on the risk assumed by banks specialized in real estate lending is still ambiguous, with some authors supporting the hypothesis that increasing exposure in the sector drives risk taking (Blasko and Sinkey, 2006) and others demonstrating that specialization in real estate lending allows return maximization and minimization of the risk of the lending portfolio, especially for banks that already have expertise in the sector (Eisenbais and Kwast,1991).

This paper aims to evaluate differences in LGD risk between banks specialized in real estate lending (REBs) and other lenders, as well as in the sensitivity of the effectiveness of their recovery processes to real estate market trends. The results show that, normally, REBs have a lower average LGD than other banks (an yearly average gap of 1%-2%) and their risk proxy distribution is less concentrated in the tails. Analysis of the main LGD risk drivers shows that specialization in real estate does not per se increase the recovery risk, but a lack of diversification in the lending portfolio composition (too concentrated on residential mortgages) leads to an increase in the lender's risk.

The remainder of the paper is organized as follows. Section 2 presents a detailed literature review of the measurement issues for LGD and its main drivers, focusing on the main distinctive features of residential mortgages. Section 3 describes the empirical analysis, presenting the sample (Section 3.1), the methodology

(Section 3.2), the main results (Section 3.3), and the results of robustness tests (Section 3.4). Section 4 concludes the paper, summarizing the results and presenting their implications.

2. Literature Review

LGD is the amount of losses sustained by the lender in the event of default of a borrower (e.g. Fesovalyi and Hurt, 1998) and it can be measure using the following alternative approaches:

- Implied market premium;
- Workout process;
- Accounting proxy.

The first category of models uses information on defaulted corporate bonds to forecast the value of LGD, assuming financial market efficiency. The approach uses the current price of the defaulted loans to identify the expected LGD on the basis of a no-arbitrage strategy, comparing the return on the defaulted loans with that of other corporate bonds (Maclachlan, 2005).

The workout LGD is obtained as the ratio between the actual value of cash flows related to the recovery process and the exposure at default. Although this approach is more complex, its greater accuracy and flexibility allow it to be applied to many kinds of debt (Calabrese and Zenga, 2010).

Accounting LGD is based on charge-off amounts in terms of non-performing facilities and computes the LGD proxy based on the banks' annual information disclosure in the balance sheets. The charge-off amounts are affected by lending product types, average past due amounts, collateral used, and accounting standards that could affect the degree of prudence adopted by the lenders in their risk management policies (Lehutova, 2011).

Independent of the approach used to measure recovery risk, the literature identifies different drivers that could affect banks' exposure independently of the country and time period. The main factors that may affect the LGD are the following (Schuermann, 2004):

- Capital structure;
- Presence and quality of collateral;
- Type of contract;
- Business cycle;
- Relationship lending.

Firms normally adapt their optimal/target capital structure to macroeconomic dynamics to maximize the benefits and minimize the costs related to the debt–equity structure. In the event of default, borrowers who have adjusted their capital structure dynamically are normally able to significantly reduce lenders' losses (Hackbarth et al., 2006).

The type of collateral could be a personal guarantee and real collateral and the value of the LGD is normally significantly higher in the case of personal guarantees with respect to real collateral (Dermine and Carvalho, 2006). While collateral reduces the expected LGD for any type of exposure, the current value of the guarantee provided does not affect the impact on the recovery rate: In fact, the collateral value could decline before the bank gains ownership of the asset and supervisors normally require the value of the covenant to be adjusted on the basis of the expected value in the event of default (Frye, 2000). The value and recovery rates of defaulted bank loans could be analysed by considering both secondary market loan pricing and actual payments to defaulted loan holders (Carty and Lieberman, 1996).

The main aspect of the contract that can affect the recovery process results is the loan's seniority and the LGD is normally lower for more senior and secured exposures (Renault and Scaillet, 2004) and even more so for market financing solutions (Mora, 2012). Riskier financial contracts are revolving loans, where, near default, borrowers normally tend to increase their usage ratio and the lender's exposure (Zaniboni et al., 2013). The LGD can be also affected by the borrower's relative size (with respect to the bank's other debtors) and, normally, above-average exposure implies a lower recovery rate due to the excessive concentration of the lending portfolio and the lower independence of the lender with respect to the borrower (Grunert and Weber, 2008**).**

The business cycle affects the efficiency and effectiveness of the recovery process and, normally, better economy conditions have a positive impact on the recovered value (Lowe and Segoviano, 2002). The role of the business cycle depends on the firm's sector and, normally, sectors characterized by a greater share of immaterial assets suffer higher losses in a market downturn (Dermine and Carvalho, 2006). The literature finds an economic downturn has a negative impact on the recovery rate, considering all counterparties' rating grades, even if a difference in sensitivity exists (Bade et al., 2011).

Variables such as the length of the relationship, income, the number of esisting baking relationships, the type of employment, borrower credit or behavioural scores, debit balance, and the region of residence may influence the LGD od a specific contract(Crook and Bellotti, 2012). Banks that establish long-term relationships with customers suffer less from information asymmetry and they are better able to properly evaluate debtors and (especially if the debtor has no multiple banking relatioships) they can easily renegotiate the debt before an increase of the probability of default and/or LGD risk exposure(Gupton et al., 2000).

The literature on residential mortgages demonstrates that LGD behaviour may differ with respect to other types of lending solutions offered by the same bank and the main issues are related to foreclosure law, loan to value dynamics, and risk sharing agreements.

The efficiency of foreclosure law can affect recovery value due to the increase in time necessary for recovery and the additional costs related to the judicial procedure (Clauretie and Herzog, 1990). The probability of no recovery of the lender's exposure can increase in countries characterized by inefficient civil courts and can create an incentive for out-of-court procedures and debt renegotiation.

The loan-to-value ratio is the main proxy of the LGD risk assumed by the bank; however, the mortgage loss severity in distressed housing markets is significantly higher than under normal housing market conditions due to the decreasing appraisal value of the collateral provided (Qi and Yang, 2009).

In the residential mortgage loan industry, senior mortgages generate very low loss rates, while losses for subordinated claims are higher (Park and Won Bang, 2014). However, the use of simple risk sharing arrangements can greatly mitigate expected losses and reduce the variability of losses and these results are confirmed even for sub-prime loans (Pennington-Cross, 2003).

3. Empirical analysis

3.1 Sample

The sample considers all banks in the euro area for which Bankscope has detailed information about the amount of residential mortgages outstanding between 2006 and 2015. Of the starting sample of all 6871 banks in the euro area for the time horizon analysed, only around 27% disclose in their balance sheets the amount of exposure to residential mortgages and the level of disclosure differs across countries (Table 1).

Table 1: Sample composition by Country and year

Country	Number	%	Year	Number	%
Germany	1873	43.45%	2005	2939	68.17%
Italy	654	15.17%	2006	3073	71.28%
France	439	10.18%	2007	3132	72.65%
Austria	359	8.33%	2008	3167	73.46%
Spain	196	4.55%	2009	3231	74.95%
Portugal	148	3.43%	2010	3349	77.68%
Luxemburg	129	2.99%	2011	3538	82.07%
Netherlands	100	2.32%	2012	3581	83.07%
Belgium	88	2.04%	2013	3591	83.30%
Ireland	82	1.90%	2014	3516	81.56%
Finland	67	1.55%	2015	2564	59.48%
Cyprus	39	0.90%			
Slovenia	26	0.60%			
Switzerland	25	0.58%			
Malta	25	0.58%			
Latvia	21	0.49%			
Greece	17	0.39%			
Estonia	12	0.28%			
Lithuania	11	0.26%			

Source: Bankscope data processed by the authors

Table 1 shows that the most represented country in the sample is Germany (43.45%), followed by Italy (15.17%), France (10.18%), and Austria (8.33%). The remaining countries represent less than 4.55% of the banks in the sample.

The sample is quite stable over time because, apart from 2015, when less than 60% of the sample shows data, almost 70% of the banks have information available for the full time horizon and the sample does not have a survivorship bias problem.

3.2 Methodology

The study uses the accounting LGD, measured as the net charge-off rate computed at the bank level for each year, following the approach proposed by Sironi and Zazzara (2003). The dependent variable *LGD* is the percentage of the charge-off over the outstanding balance at default in the previous time period (e.g. Siddiqi and Zhang, 2004):

$$LGD_{it} = \frac{Charge - off_{it}}{Defaulted\ Loans_{it-1}} \times 100 \qquad (1)$$

where

LGD_{it} = estimated value of the LGD

$Charge - off_{it}$ = value of passage into loss for bank *i* at time *t*

$Defaulted\ Loans_{it-1}$ = amount of bad and doubtful debts for bank *i* at time t - 1

The proxy considers all types of possible defaulted loans that are classified in the balance sheet as doubtful loans, restructured loans, past due 90 days, loss loans, or substandard loans.

In order to consider that the role of real estate exposure could differ on the basis of the bank's degree of specialization in real estate lending, a new proxy for real estate exposure is constructed for each bank in each year as the ratio between the residential mortgages' exposures and the overall amount of loans for each bank:

$$REexposure_{it} = \frac{Residential\ Mortgages_{it}}{Loans_{it}} \tag{2}$$

where higher values indicate the bank's increasing exposure at time t to residential real estate lending and potentially greater specialization in mortgages. Following the standard approaches proposed in the literature, a bank is classified as a real estate bank if its exposure to residential mortgages is greater than 30% (Eisenbeis and Kwast, 1991).[1]

The analysis of the impact of real estate lending on banks' LGD is conducted using the following formulas (Castro 2013) in a random effect panel regression model:

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \varepsilon_{it} \tag{3}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 ReExposure_{it-1} + \varepsilon_{it} \tag{4}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb30_{it-1} + \delta_3 Reb30ReExposure_{it-1} \\ + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \tag{5}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \varepsilon_{it} \tag{6}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 ReExposure_{it-1} + \varepsilon_{it} \tag{7}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta IR_{it-1} + \gamma_4 \Delta Cred_{it-1} + \gamma_5 \Delta Shares_{it-1} \\ + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb30_{it-1} + \delta_3 Reb30ReExposure_{it-1} \\ + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \tag{8}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \varepsilon_{it} \tag{9}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 ReExposure_{it-1} + \varepsilon_{it} \tag{10}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb30_{it-1} \tag{11}$$

[1] Thresholds other than 30% are considered in the robustness tests presented in Section 3.4.

$$+\delta_3 Reb30ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it}$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1}$$
$$+\gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \varepsilon_{it} \quad (12)$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1}$$
$$+\gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 ReExposure_{it-1} + \varepsilon_{it} \quad (13)$$

$$LGD = \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1}$$
$$+\gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb30_{it-1} \quad (14)$$
$$+\delta_3 Reb30ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it}$$

where the independent variables are specified as
LGD_{it-1} = one-year-lagged value of the LGD
ΔUR_{it-1} = unemployment rate
ΔGDP_{it-1} = growth rate of the real gross domestic product (GDP)
ΔIR_{it-1} = spread between the long-term (10-year) and short-term (three-month) interest rates
$\Delta Cred_{it-1}$= yearly credit growth
$\Delta Shares_{it-1}$ = yearly growth rate of a share price index (Eurostock)
HPI_{it-1} = housing price trend measured by Eurostat (country-level data)
$REER_{it-1}$ = real effective exchange rate (to control for external competitiveness)
$\Delta Indebtness_{it-1}$ = yearly growth rate of the ratio of total private loans to the GDP
$\Delta PublicDebt_{it-1}$ = yearly growth rate of the government's public debt as a percentage of the GDP
$FinCrisis_{it}$ = dummy variable to control for the financial crisis period that assumes the value of one from the fourth quarter of 2008 onwards and zero otherwise (Reinhart and Rogoff, 2009)
$Reb30_{it-1}$ = control dummy that indicates real banks i has a real estate exposure at least equal to 30% at time t-1
$ReExposure_{it-1}$ = ratio between residential mortgage and gross loans for the bank i at time t-1
$Reb30ReExposure_{it-1}$ = interaction term between *Reb* and *ReExposure*

All the panel regressions consider fixed effects on the basis of the results of a Hausman specification test. Standard statistical fitness measures are presented to evaluate the contribution of the real estate proxies to the LGD proxy's forecasting accuracy.

3.3 Results

A preliminary analysis of the sample considers summary statistics of the LGD proxy for the full-time horizons to evaluate if there is any time trend in the risk proxy (Table 2).

Table 2: Summary statistics on LGD values and determinants by year

	LGD_t	$Charge\text{-}offs_t$ / Gross $Loans_t$	Defaulted $loans_t$ / Gross $Loans_t$
2007	55.86%	0.47%	0.21%
2008	22.97%	0.34%	0.70%
2009	20.90%	0.41%	0.67%
2010	21.29%	0.45%	0.80%
2011	28.70%	0.43%	1.05%
2012	63.61%	0.61%	1.81%
2013	68.34%	1.07%	2.93%
2014	62.64%	1.21%	3.35%
2015	55.15%	2.91%	2.83%

Source: Bankscope data processed by the authors

Table 2 shows the LGD values starting in 2007 at 55.86% and reaching 55.15% in 2015. The maximum value was recorded in 2013 (68.34%) but the risk proxy value is abnormally low in 2008–2011, probably due to conservative policies in the write-off policy adopted by the banks. In fact, with the charge-off and defaulted loans dynamics considered separately, the percentage of defaulted loans over gross loans is increasing over time. The percentage of charge-offs to gross loans during 2008–2011 does not increase linearly but it is, at the end of the time horizon, in 2015, comparable to the defaulted loans ratio (with growth of +2.44% for the former and +2.62% for the latter). The slow growth of the charge-off rate in the first years of the crisis is consistent with the assumption that the write-off policy adopted by banks is normally backward looking (e.g. Beck and Narayanamoorthy, 2013) and less representative of the real losses expected in an extraordinary economic downturn scenario.

The analysis of the LGD values for banks classified on the basis of real estate exposure allows the identification of interesting differences with respect to the average (Table 3).

Table 3: Average LGD on the basis of the Real Estate exposure

	Overall	RE1Q	RE2Q	RE3Q	RE4Q
2007	55.86%	56.90%	67.44%	52.31%	47.18%
2008	22.97%	23.47%	24.70%	21.98%	21.52%
2009	20.90%	19.60%	23.24%	17.25%	22.43%
2010	21.29%	22.07%	22.60%	19.99%	20.67%
2011	28.70%	25.34%	31.07%	31.22%	26.51%
2012	63.61%	65.71%	65.96%	61.56%	61.52%
2013	68.34%	71.73%	68.17%	67.42%	66.17%
2014	62.64%	64.88%	63.52%	61.56%	60.76%
2015	55.15%	54.43%	53.78%	56.81%	55.40%
Overall	54.23%	56.18%	54.93%	53.93%	52.09%
	Overall	RE1Q	RE2Q	RE3Q	RE4Q
LGD<10%	42.85%	42.03%	42.20%	41.89%	45.19%
10%≤LGD<20%	2.74%	1.88%	2.39%	3.81%	2.77%
20%≤LGD<30%	0.89%	0.28%	0.99%	1.08%	1.14%
30%≤LGD<40%	0.38%	0.47%	0.50%	0.50%	0.08%
40%≤LGD<50%	0.28%	0.28%	0.33%	0.33%	0.16%
50%≤LGD<60%	0.11%	0.19%	0.08%	0.17%	0.00%
60%≤LGD<70%	0.08%	0.09%	0.08%	0.08%	0.08%
70%≤LGD<80%	0.17%	0.00%	0.33%	0.17%	0.16%
80%≤LGD<90%	0.06%	0.00%	0.00%	0.08%	0.16%
LGD≥90%	52.44%	54.78%	53.10%	51.90%	50.24%
LGD<10% & LGD≥90%	95.29%	96.81%	95.29%	93.79%	95.43%

Source: Bankscope data processed by the authors

The analysis of the average LGD value shows a negative linkage between the risk proxy and residential real estate loan exposure (from a maximum of 56.16% for banks with minimum real estate exposure to a minimum of 52.09% for those with maximum exposure). The difference is driven by the years 2007 and 2008 and 2012–2015, when, on average, the LGD for banks with maximum exposure to real estate (RE4Q) was lower than that of all the other groups of banks (RE1Q, RE2Q, and RE3Q).

The LGD distribution for the full sample is not normal and is characterized by a bimodal distribution with modal values equal to 0% and 100%. The results are consistent with existing literature (e.g. Asarnow and Edwards, 1995) that justifies this type of anomaly due to prevalent recovery process characteristics that could totally fail if bankruptcy is declared (*LGD* = 100%) or could allow for full recovery from the exposure in the event that the defaulted entity become again able to pay (*LGD* = 0%) (Chalupka and Kopecsni, 2009). Banks with above-average exposure to real estate (RE3Q and RE4Q) are characterized by a lower incidence of bimodal values (93.8% for RE3Q and 95.4% for RE4Q), even if the difference from the other types of banks is limited to one to two percentage points (96.81% for RE1Q and 95.29% for RE2Q).

Table 4: LGD macro-determinants and the role of real estate exposure – Panel fixed effect

The table presents a panel regression analysis of the current value of the LGD for the bank i at time t with respect to a set controlling variables related to macro-economic conditions (ΔUR_{it-1} and ΔGDP_{it-1}), financial market conditions ($\Delta IR_{it-1}, \Delta Cred_{it-1}$, $\Delta Share_{it-1}$), housing market trend (HPI_{it-1}), exchange rate dynamics ($REER_{it-1}$), a financial crisis dummy ($FinCrisis_{it}$), and a set of bank's real estate exposure proxies ($Reb30$, $Reb30ReExposure$ and $ReExposure$). All indepedent variables (excluding the *FinCrisis* dummy) are lagged of one year in order to avoid endogeneity problems. For more details about the variables construction see section 3.2.

	(3)	(4)	(5)	(6)	(7)	(8)
LGD_{it-1}	0.277***	0.278***	0.277***	0.280***	0.280***	0.280***
ΔUR_{it-1}	0.233***	0.233***	0.230***			
ΔGDP_{it-1}				-0.408***	-0.408***	-0.405***
ΔIR_{it-1}	-0.172	-0.191	-0.197	-0.537	-0.553*	-0.557*
$\Delta Cred_{it-1}$	0.299***	0.305***	0.306***	0.338***	0.342***	0.344***
$\Delta Share_{it-1}$	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
HPI_{it-1}	-0.038	-0.042	-0.047	-0.377	-0.381**	-0.381**
$REER_{it-1}$	0.084	0.087	0.087	0.104	0.106	0.105
$FinCrisis_{it}$	-0.005	-0.056	-0.006	-0.006	-0.006	-0.007
$Reb30_{it-1}$			-0.054			-0.058
$Reb30ReExposure_{it-1}$			0.271**			0.292*
$ReExposure_{it-1}$		0.038	-0.204		0.334	-0.226*
α_t	0.344***	0.328***	0.366***	0.343***	0.328***	0.369***
N° banks	1071	1071	1071	1071	1071	1071
N° obs	3293	3293	3293	3293	3293	3293
R^2	0.882	0.877	0.872	0.8818	0.880	0.874

Notes: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.
Source: Bankscope data processed by the authors

The analysis shows a high degree of autoregressive persistence for the LGD value, independent of the model selected, and the results are consistent with international evidence of the low (near-zero) variability over time of the recovery risk proxy (Camba-Méndez and Serwa, 2016). As expected, better (worse) economic conditions, proxied by the GDP growth or unemployment rate, have a positive (negative) impact on the LGD. An increase in the credit available to both private and public entities has a negative (positive) impact on the recovery rate (LGD) because the collateral provided is unable to ensure full recovery of the initial exposure. In an upward (downward) real estate market, proxied by the housing market trend, the value of collateral increases (decreases) and LGD exposure therefore decreases (increases). None of the other macrovariables (long-term interest rate, stock market trends, and exchange rates) or the crisis dummy is statistically significant in explaining LGD dynamics.

The introduction of real estate lending proxies has an impact on the LGD estimation, but the result is not only driven simply by the amount of residential mortgages offered, which is positively linked with the LGD but not statistically significant. Analysis of the REBs shows more interesting results: Specialization in real estate does not imply an increase of the LGD, while excessive exposure to real estate for specialized lenders has a positive impact on the LGD. The results support the hypothesis presented in literature that real estate specialization does not imply a higher risk (Eisenbeis and Kwast, 1991) but the lack of diversification in the lending portfolio increases the recovery risk for lenders (Winton, 1999)

Due to the significant differences in public debt policies adopted by the countries in the sample, the analysis is replicated by considering separately the growth in public and private debt to test if the effectiveness of the recovery policy is affected by the main type of debtor raising funds in the market (Table 5).

Table 5: LGD macro-determinants and the role of real estate exposure – Panel fixed effect with extended model

The table presents a panel regression analysis of the current value of the LGD for the bank i at time t with respect to a set controlling variables related to macro-economic conditions (ΔUR_{it-1} and ΔGDP_{it-1}), financial market conditions $\Delta Indebtness_{it-1}$, $\Delta PubDebt_{it-1} \Delta Share_{it-1}$), housing market trend (HPI_{it-1}), exchange rate dynamics ($REER_{it-1}$), a financial crisis dummy ($FinCrisis_{it}$), and a set of bank's real estate exposure proxies ($Reb30$, $Reb30ReExposure$ and $ReExposure$). All indepedent variables (excluding the *FinCrisis* dummy) are lagged of one year in order to avoid endogeneity problems. For more details about the variables construction see section 3.2.

	(9)	(10)	(11)	(12)	(13)	(14)
LGD_{it-1}	0.275***	0.275***	0.275***	0.275***	0.275***	0.275***
ΔUR_{it-1}	0.118**	0.119**	0.114*			
ΔGDP_{it-1}				-0.533**	-0.536**	-0.542**
$\Delta Indebtness_{it-1}$	0.051	0.052	0.055	0.367**	0.369**	0.372*
$\Delta PubDebt_{it-1}$	0.255***	0.253***	0.254***	0.372***	0.372***	0.371***
$\Delta Share_{it-1}$	-0.001**	-0.001**	-0.001**	-0.000	-0.000	-0.000
HPI_{it-1}	0.220	0.221	0.218	0.111	0.112	0.112
$REER_{it-1}$	0.094	0.093	0.092	0.315**	0.314**	0.313*
$FinCrisis_{it}$	-0.005	-0.005	-0.006	-0.007	-0.007	-0.009
$Reb30_{it-1}$			-0.059			-0.069
$Reb30ReExposure_{it-1}$			0.279*			0.308*
$ReExposure_{it-1}$		0.012	-0.231*		0.015	-0.245*
α_t	0.327***	0.322***	0.361***	0.317***	0.310***	0.353***
N° Banks	1072	1072	1072	1072	1072	1072
N° obs	3296	3296	3296	3296	3296	3296
R^2	0.8773	0.8766	0.8695	0.8755	0.8744	0.8646

Notes: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.
Source: Bankscope data processed by the authors

Considering public and private debt separately, the results show that the increase of the LGD is mainly driven by an increase in public debt, demonstrating that the recovery process is longer and less effective for this type of customer compared to private ones. The results are consistent with international evidence, because sectors in Europe that are prevalently public or offered by publicly owned firms (e.g. healthcare, public transportation, and communication) normally exhibit low recovery rates (e.g. Altman and Kishore, 1996).

The new model shows that, as before, real estate banks with excessive exposure to real estate loans are characterized by a higher LGD, but now an increase in real estate exposure also has a negative and statistically significant effect on the LGD of all the other banks.

3.4 Robustness test

As robustness tests, the analysis considers different thresholds for discriminating between REBs and non-REBs. A preliminary analysis of the summary stastitics allow evaluating the thresholds that can be used in order to discriminate among banks in the sample (Table 6).

Table 6. Percentage of REBs description on the basis of the threshold selected

	2007	2008	2009	2010	2011	2012	2013	2014	2015
REB 10	89.76%	89.20%	88.25%	88.36%	88.06%	88.24%	87.95%	88.74%	89.43%
REB 20	83.13%	80.62%	79.30%	80.04%	80.04%	80.49%	80.69%	81.98%	82.51%
REB 30	71.69%	70.69%	70.60%	72.07%	70.57%	70.30%	70.03%	72.31%	72.98%
REB 40	54.22%	57.81%	59.54%	60.62%	57.29%	56.91%	57.07%	59.45%	59.14%
REB 50	42.17%	41.31%	39.90%	40.23%	35.37%	34.85%	35.36%	37.36%	36.95%
REB 60	28.92%	22.00%	20.88%	20.57%	19.06%	18.48%	17.92%	18.74%	19.39%
REB 70	18.07%	6.84%	6.96%	6.88%	6.78%	6.99%	6.93%	7.25%	7.25%
REB 80	10.24%	1.88%	1.86%	1.99%	2.24%	2.33%	2.56%	3.02%	2.74%
REB 90	4.82%	0.54%	0.68%	0.72%	0.95%	0.98%	0.91%	1.10%	1.17%
REB 100	2.41%	0.00%	0.06%	0.06%	0.06%	0.11%	0.16%	0.22%	0.13%

Source: Bankscope data processed by the authors

Data show that the sample composition could be similar(on the basis of the number of banks) if the analysis considers alteratively the threshold of 30%, 40% and 50% while for other thresholds the sample will be too concentrated only on type of bank (REB vs NoREB).

On the basis of the sample features previously discussed, the panel regression analysis is tested using 40% and 50% as alternative thresholds with respect to the 30%. In formulas:

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb40_{it-1} \\ & + \delta_3 Reb40ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \end{aligned} \tag{11a}$$

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb50_{it-1} \\ & + \delta_3 Reb50ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \end{aligned} \tag{11b}$$

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb40_{it-1} \\ & + \delta_3 Reb40ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \end{aligned} \tag{14a}$$

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 Reb50_{it-1} \\ & + \delta_3 Reb50ReExposure_{it-1} + \delta_4 ReExposure_{it-1} + \varepsilon_{it} \end{aligned} \tag{14b}$$

where, in addition to the variables in formulas (9) and (12), the new independent variables are:

$Reb40_{it-1}$ = dummy variable that assumes a value of one if the bank i at time t has real estate exposure at least equal to 40%
$Reb50_{it-1}$ = dummy variable that assumes a value of one if the bank i at time t has real estate exposure at least equal to 50%
$Reb40ReExposure_{it-1}$ = interaction term between *Reb40* and *ReExposure*
$Reb50ReExposure_{it-1}$ = interaction term between *Reb 50* and *ReExposure*

The results of the panel regression model for the two alternative thresholds are presented in Table 7.

Table 7: LGD macro-determinants and the role of real estate exposure with alternative REB proxies

The table present a panel regression analysis of the current value of the LGD for the bank i at time t with respect to a set controlling variables related to macro-economic conditions (ΔUR_{it-1} and ΔGDP_{it-1}), financial market conditions ($\Delta Indebtness_{it-1}$, $\Delta PubDebt_{it-1}\Delta Share_{it-1}$), housing market trend (HPI_{it-1}), exchange rate dynamics ($REER_{it-1}$), a financial crisis dummy ($FinCrisis_{it}$), and a set of banks real estate exposure proxies ($Reb40, Reb50, Reb40ReExposure, Reb50ReExposure$ and $ReExposure$). All indepedent variables (excluding the *FinCrisis* dummy) are lagged of one year in order to avoid endogeneity problems. For more details about the variables construction see section 3.2.

	(10a)	(13a)	(10b)	(13b)
LGD_{it-1}	0.276***	0.276***	0.275***	0.275***
ΔUR_{it-1}	0.112*		0.107*	
ΔGDP_{it-1}		0.558***		0.540**
$\Delta Indebtness_{it-1}$	0.051	0.373**	0.051	0.364**
$\Delta PubDebt_{it-1}$	0.257***	0.375***	0.260***	0.374***
$\Delta Share_{it-1}$	-0.001**	-0.000	-0.001**	-0.000
HPI_{it-1}	0.213	0.109	0.190	0.091
$REER_{it-1}$	0.103	0.327**	0.102	0.319**
$FinCrisis_{it}$	-0.005	-0.008	-0.006	-0.009
$Reb40_{it-1}$	-0.106**	-0.118**		
$Reb40ReExposure_{it-1}$	0.233*	0.263**		
$Reb50_{it-1}$			-0.027	-0.045
$Reb50ReExposure_{it-1}$			0.148	0.184
$ReExposure_{it-1}$	-0.092	-0.105	-0.148**	-0.155**
α_t	0.351***	0.343***	0.365***	0.357***
N° Banks	3296	3296	3296	3296
N° obs	1072	1072	1072	1072
R^2	0.8661	0.8605	0.8605	0.8554

Notes: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.

Source: Bankscope data processed by the authors

Results for the 40% threshold are consistent with the base case scenario presented in Table 4 while results for the 50% threshold do not show a statistically significant linkage between real estate specialization and real estate exposure due to the lower number of banks classified as specialized lenders in the sample.

An alternative approach for evaluating the impact of real estate lending exposure on the LGD could be constructed without any assumption about REB status, classifying banks into quartiles on the basis of their real estate exposure. The new regression models are as follows:

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta UR_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 RE1Q_{it-1} \\ & + \delta_3 RE2Q_{it-1} + \delta_4 RE3Q_{it-1} + \delta_5 RE4Q_{it-1} + \varepsilon_{it} \end{aligned} \tag{15}$$

$$\begin{aligned} LGD = {} & \alpha_t + \gamma_1 LGD_{it-1} + \gamma_2 \Delta GDP_{it-1} + \gamma_3 \Delta Indebtness_{it-1} + \gamma_4 \Delta Pubdebt_{it-1} \\ & + \gamma_5 \Delta Shares_{it-1} + \gamma_6 HPI_{it-1} + \gamma_7 REER_{it-1} + \delta_1 FinCrisis_{it} + \delta_2 RE1Q_{it-1} \\ & + \delta_3 RE2Q_{it-1} + \delta_4 RE3Q_{it-1} + \delta_5 RE4Q_{it-1} + \varepsilon_{it} \end{aligned} \tag{16}$$

where, in addition to the variables in formulas (9) and (12), the new independent variables are:

$RE1Q_{it-1}$ = product of *ReExposure* and a dummy variable that assumes the value of one for banks with real estate exposure in the first quartile
$RE2Q_{it-1}$ = product of *ReExposure* and a dummy variable that assumes the value of one for banks with real estate exposure in the second quartile
$RE3Q_{it-1}$ = product of *ReExposure* and a dummy variable that assumes the value of one for banks with real estate exposure in the third quartile
$RE4Q_{it-1}$ = product of *ReExposure* and a dummy variable that assumes the value of one for banks with real estate exposure in the fourth quartile

The results of the analysis are presented in Table 8 and confirm that there is no linear relation between real estate exposure and the LGD, because the estimated coefficients do not increase with the degree of real estate exposure and are never statistically significant.

Table 8: LGD macro-determinants and the role of real estate exposure by quartile

The table present a panel regression analysis of the current value of the LGD for the bank i at time t with respect to a set controlling variables related to macro-economic conditions (ΔUR_{it-1} and ΔGDP_{it-1}), financial market conditions ($\Delta Indebtness_{it-1}$, $\Delta PubDebt_{it-1} \Delta Share_{it-1}$), housing market trend (HPI_{it-1}), exchange rate dynamics ($REER_{it-1}$), a financial crisis dummy ($FinCrisis_{it}$), and a set of banks real estate exposure proxies ($RE1Q$, $RE2Q$, $RE3Q$ and $RE4Q$). All indepedent variables (excluding the *FinCrisis* dummy) are lagged of one year in order to avoid endogeneity problems. For more details about the variables construction see section 3.2.

	(14)	(15)
LGD_{it-1}	0.275***	0.275***
ΔUR_{it-1}	0.115**	
ΔGDP_{it-1}		0.541**
$\Delta Indebtness_{it-1}$	0.053	0.371**
$\Delta PubDebt_{it-1}$	0.258***	0.376***
$\Delta Share_{it-1}$	-0.001**	-0.000
HPI_{it-1}	0.21	0.103
$REER_{it-1}$	0.093	0.313**
$FinCrisis_{it}$	-0.005	-0.008
$RE1Q_{it-1}$	0.103	0.088
$RE2Q_{it-1}$	0.019	0.012
$RE3Q_{it-1}$	0.008	0.003
$RE4Q_{it-1}$	0.023	0.018
α_t	0.307***	0.320***
N° Banks	3296	3296
N° observations	1072	1072
R^2	0.8738	0.8760

Notes: *** statistically significant at 1%, ** statistically significant at 5%, * statistically significant at 10%.
Source: Bankscope data processed by the authors

4. Conclusion

REBs are characterized by a lower LGD than that of banks with limited exposure to mortgages and are also less affected by extreme events that drive the LGD to extreme values (zero or one). The increase in real estate exposure is not linearly related with LGD risk and specialization in real estate loans does not imply an increase of the LGD, while excessive exposure to real estate has a positive impact on LGD.

The real estate cycle could affect the availably of lending due to changes in collateral value and especially rduring eal estate bubbles banks may offer an excessive amount lending assuming the vaue of the collateral provided will continue to grow over time. Empirical evidence on the recovery process shows that supervisors have a higher incentive to control because, in the event of debtor default, they will be less able to recover their exposure (Herring and Watcher, 2005).

LGD dynamics are normally affected not only by bank characteristics but also by contract (e.g. the LTV) and borrower characteristics, with supervisory authorities currently performing stress tests to evaluate how much of the risk assumed by financial systems can be ascribed to specific contract or debtor features (Greve and Hahnenstein, 2014). The empirical analysis proposed in the paper considers the full portfolio of loans and distressed loans without distinguishing them on the basis of contract features or customer type. This approach does not allow evaluating whether REBs are better at managing the recovery process, independent of the type of contract and exposure. The availability of internal data about banks' portfolios of distressed loans could allow the evaluation of which types of loans or customer REBs implement a more efficient recovery process.

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Do homeowners save more? – Evidence from the Panel on Household Finances (PHF)

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Abstract:

In this paper we analyse the impact of property ownership on the saving behaviour of households. We are particularly interested in investigating whether homeowners save more than renters or not. A related question is whether mortgage payments and other regular savings are substitutes or complements for German households. To answer these questions we use a large cross-sectional dataset on individual households' finances and employ a matching estimator. We find that households owning property and repaying mortgages do save more than renters, if contractual savings and mortgage payments are summed up. However, the difference between regular savings flows of renters and owners is small and insignificant. Owners do not seem to substitute contractual savings with mortgage payments.

Keywords: household saving, homeownership, survey data

JEL-Classification: D14, R21, D31, D91

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1. Introduction

Different homeownership rates have been identified as one of the main explanatory factors for the differences observed in net median wealth of households across Euro Area countries. Recent evidence based on household surveys with detailed wealth information not only confirmed that homeownership rates vary considerably across countries, but also that homeowners are on average and in the median considerably richer than renters in all countries (HFCN (2013), Christelis et al. (2013)). In Germany, for example, the mean net wealth of owners is about 8 times higher than the mean net wealth of renters. Why is this the case? And how are homeowners different from renters in Germany? In principle, buying a home is simply an exchange of financial assets (and debts) for real assets. If this line of reasoning is correct, there is no a priori reason why owning a home is a good predictor for high wealth, as renters should just hold their wealth in investments other than property. Why differences between homeowners and renters exist nonetheless, can have many reasons, e.g. differences in the distribution of inheritances/gifts, income differentials, different asset price developments of real versus financial assets, different propensities to save and different levels of savings of homeowners versus renters.

In this paper we investigate the saving behaviour of renters and owners. Our main research question is whether renters (all other things equal) save less and consume more than owners. There are good reasons to assume that this is indeed the case. Usually buying a home is linked to transaction costs as well as considerable debt burden and repayment obligations vis-à-vis a financial institution. The repayment obligations require the owner households to save a fixed amount each month, whereas renters do not accumulate wealth by paying rent. In theory, the rent should only be as high as the interest payments of the owner plus some compensation for depreciation, for the same level of housing services. In this situation renters should (everything else equal) have income left for consumption or savings that is not spent on mortgage repayments. In other words, differences in the wealth of renters and owners can only manifest if renters consume a large fraction of their income that they would otherwise have to spend on mortgage payments had they bought a house. A second research question concerns the link between mortgage payments and other (regular) savings. If owner households reduce their savings in financial assets because they have to repay mortgages, the effect on net wealth would be smaller than if the mortgage repayments are complementary to other savings. If full substitution took place, owner households would only become relatively richer if house prices outperformed the return on other investments.

We use the new Bundesbank survey on household finances in Germany ("Panel on Household Finances" – PHF[1]) to analyse these questions. This survey presents an excellent data source to analyse both the saving behaviour of German households and the differences between rent payments and repayments on mortgage loans. In particular, the dataset includes monetary stocks and saving flows of households' regular and discretionary savings into a variety of investment vehicles and detailed information on mortgage payments as well as rental payments. To answer our research questions we use matching techniques to match renter and owner households with similar characteristics.

We find that homeowners save substantially more than renters when we compare otherwise equal households. This difference can mainly be attributed to the fact that homeowners and renters exhibit comparable flows for regular savings as renters, and in addition save on top by repaying their mortgages.

The rest of the paper is organized as follows: section 2 outlines the theoretical framework for our study. In section 3 we present a description of the dataset and variables, before we move on to explain our empirical strategy, i.e. the matching procedure, in section 4. We outline the results of our empirical analysis in section 5, before we conclude in section 6.

2. Literature Review and Theoretical Framework

There is ample evidence that homeownership is correlated with higher levels of wealth accumulation than renting (see e.g. Di et al. (2007), Dietz and Haurin (2003)), and various reasons have been put forward in the literature why homeowners are richer than renters. Classical arguments include house price developments, different returns from housing versus financial assets or differential savings behaviour of owners and renters.

Campbell and Cocco (2007) find that rising house prices in the UK have large positive effects on (older) homeowners' consumption while there is no effect on (young) renter households which they attribute to a wealth effect of homeownership. On the other hand, a large literature has argued that simultaneous increases in house prices and consumption may be driven by common factors contradicting the wealth channel from house price growth to consumption (see Attanasio and Weber (1994), Attanasio et al. (2009) and Attanasio et al. (2011)). For the US, Engelhardt (1996) finds an asymmetry in the saving behaviour of households with total and unanticipated real housing capital gains. Households experiencing a real gain in housing

[1] For more information see v. Kalckreuth et al. (2012) and www.bundesbank.de/phf

do not reduce their saving while households with real housing capital losses increased their saving in response to a real house price appreciation.

While house price increases in other countries in the Euro Area might be one main determinant of the high net wealth of households in these countries with respect to German households (see HFCN 2013, Christelis et al 2013), the German housing market has displayed virtually stagnating prices in the last decade. Additionally, the mostly required large down payments and high transaction costs for buying a house[2], a long waiting time to convert the traditional contractual savings for housing ("Bausparverträge") into a mortgage credit and a large and well-functioning rental market have characterised the German housing market as one traditionally without notable price increases until 2010.[3] These institutional features make the German market a good example to analyse differences between owners and renters as there is a good alternative for owning a house.

Apart from offering a service stream, buying a house is also an investment in a risky asset, and naturally the expectation of the house price development will also determine the decision to buy a home. A large literature has used simulated returns from owning a house relative to renting under various model assumptions about financing, mortgage plans and alternative investments, which renters could have undertaken with their down payment (see, for example, Goodman (1997), Goetzman and Spiegel (2002) and Belsky et al (2007)). When comparing the user cost of capital of home owners to the cost of renting, most of these studies find that for the U.S. home returns are higher than inflation but below financial market returns. Important determinants are the holding period that is analysed as well as the quality of the house and the location of the building.

A related question is whether homeowners have different portfolio profiles than renters and how their asset portfolio interacts with their housing stock. Flavin and Yamashita (2002) estimate the risk and return to financial assets and real estate and calculate optimal portfolios of homeowners. They show that young households which are typically highly leveraged and have high housing to net worth ratios prefer to reduce the risk of their portfolio by either paying down mortgage or by holding bonds instead of stocks while older households have a

2 See Chiuri and Jappelli (2000) for an overview of credit market imperfections in an international context.

3 A reversal of this trend is only notable after the Great Recession (see Deutsche Bundesbank, 2013).

higher optimal portfolio share of stocks as their housing to net worth ratio is lower.. Hurst (1998) finds that better balanced portfolios of homeowners lead to higher levels of wealth than portfolios that only hinge on homeownership. Several other papers have studied the optimal evolution of housing and non-housing consumption over the life cycle (Yang (2009), Cocco (2004), Yao, Zhang (2004)).

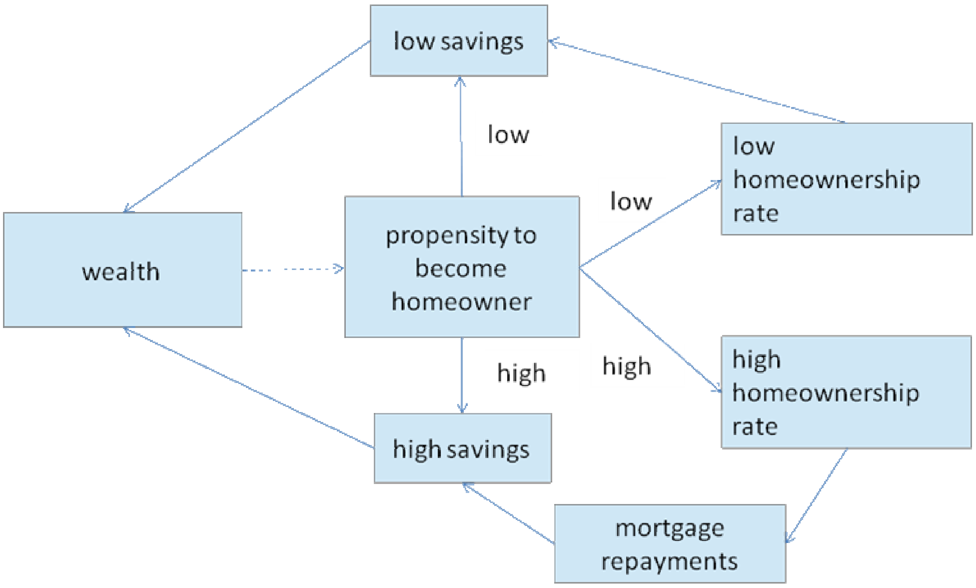
Another channel towards the higher wealth accumulation may be that home owners have a higher propensity to save than renters, both before and after buying their main residence and are also different from renters as they prefer to commit to save. Therefore, an interesting group to study are renters who plan to purchase a house in the future and whose ability to make a down payment may be affected by a house price increase. They can respond to house price increases either by an increase in savings or by a reduction if they decide to postpone buying a house. Sheiner (1995) finds that renters living in high house price areas accumulate significantly more net worth than those living in less expensive areas. She concludes that young people are indeed liquidity constrained as they save more in order to be able to make a higher down payment.

Once renters become owners, making mortgage payments is a form of forced savings, and hence owners may save more than renters after achieving homeownership simply because they have to. Di et al. (2007) use the PSID to examine how actual tenure choices made by households have affected wealth accumulation over long periods. They find that homeownership itself is strongly correlated with greater future net wealth rather than the propensity to save prior to acquiring a home. Using the same data set, Skinner (1989, 1994) finds mixed evidence of owning a house on saving rates by home owners. Krumm and Kelly (1989) argue that overall savings do not seem to differ between renters and owners but that owners substantially increase their non-housing savings beyond that of renters. For Germany, Grunert (2003) documents that the average savings rate of homeowners is more than double the average savings rate of renters. She attributes the higher savings rate to the forced savings due to mortgage redemption and to a habituation effect after the full mortgage repayment.

Our study differs from previous empirical work as we use matching techniques to compare homeowners with a mortgage and renters employing a new cross-sectional data base comprising savings flows and wealth levels at a very detailed level.

The following graph depicts the relationships we propose between wealth, saving and homeownership[4]. We argue that households with a low propensity (or willingness) to become a homeowner have only little or no reason to accumulate substantial amounts of financial assets. They will not have to finance a down payment and other savings motives are less relevant in Germany than in other countries. The household with a high propensity and maybe even concrete plans to buy property on the contrary, will save for the down payment, transaction costs and probably also build up buffer stocks for future mortgage repayments or renovations. This would lead to different savings levels even before the actual purchase of a property takes place. What is more, if those households then actually buy properties, they commit to mortgage repayments. If these mortgage repayments do not fully substitute other (contractual) savings, the owner households will continue to have higher savings rates compared to the renter households. It is likely that no substitution takes place if the households choose debt burden levels (repayment + interest) that are comparable to the rent they used to pay before they bought a house. In theory rents should represent the user costs of capital, i.e. the interest payments on the mortgage plus a compensation for depreciations. Thus, owner households should not be able to simply substitute rent and debt payments. If this equality does not hold, however, and rents also cover (parts of the) mortgage repayments, then some reduction in savings other than mortgage repayments can be expected for owners.

Figure 1 Schematic overview of theoretical framework



[4] For the sake of simplicity it shows just one reason why a household may have a low propensity to become a homeowner, his level of wealth. Of course there are other reasons like household size, preferences, etc.

Taking these mechanisms and arguments together may explain the higher wealth of owner households compared to renter households.

We will test the following hypotheses below:

H1: Households which own their main residence and repay a mortgage are saving more than renter households, if saving is defined as the sum of contractual savings, discretionary savings and mortgage repayments.

H2: Households owning their main residence do not fully substitute contractual savings with mortgage repayments.

3. Data, Key Variables and Descriptive Statistics

In this section we describe the dataset, the key variables of our empirical analysis and provide some descriptive statistics.

The PHF survey

We use data from the "Panel of Household Finances" (PHF) , a new household survey on wealth in Germany. The PHF was conducted between September 2010 and June 2011 by infas on behalf of the Deutsche Bundesbank[5]. It is part of a larger effort to collect harmonized wealth data in the Euro Area, the so called "Household Finance and Consumption Survey" (HFCS). In contrast to most other studies in the Euro Area, the PHF has a special focus on savings. It collects for all asset types, not only the value of the asset but also the amount invested in the asset on a regular basis. The questions on regular savings are supplemented with questions on discretionary savings and savings motives in the PHF. The survey also collects detailed information on homeownership and mortgages. The unit of observation for the survey is the household. Most information is therefore available on the level of the household, with the exception of income and pension questions which were asked to individual household members older than 16 years which can be aggregated to the household level. The random sample is representative for households German. It was designed to oversample households living in wealthy areas. In total 20,100 households were sampled of which 3,565 households were successfully interviewed. Due to item non response, a pervasive phenomenon in survey data, the data set was multiply imputed.[6]

[5] See Von Kalckreuth et al. (2012) for details on the methodology.
[6] Referenz ecb and Junyi

Key variables

At the core of our analysis is the saving behaviour of households in Germany. The PHF was designed to collect qualitative and quantitative data on regular savings attached to financial assets. It also collects information on all private pensions and has a summary question on discretionary savings. Furthermore, interest payments and mortgage repayments are collected for every secured and unsecured loan. This comprehensive coverage of savings allows us to differentiate between gross savings and net savings. Gross savings is the sum of all investments in assets (savings and repayments) by households; to arrive at the net savings we subtract all savings that have been dissolved in a given year as well as new consumer loans taken on. We further differentiate within each of these two broad categories, by calculating savings rates, including all loan repayments (excluding mortgages on secondary property), only mortgage repayments for mortgages secured with the household main residence and no loan repayments at all[7].

A key ingredient of our analysis is the identification of homeowners (with a mortgage) and renters in our sample. This is straight forward as the PHF contains direct questions on the homeownership status and on whether the household is servicing a mortgage loan. We put a household in the "homeowner with mortgage" group if the household owns its main residence at least partially and has a mortgage attached to this property.

Descriptive Statistics

The unweighted sample sizes for our analysis are as follows: of the 3,565 households about 56% or 2,013 households own their main residence, 1,552 are renters. Only 40% (812 households) of those owners still have to pay back a mortgage. After dropping cases with missing values on the degree of urbanization and the observations of common support (7 owner households) as well as households with negative gross savings rates, we end up with 768 treated households, i.e. owning their main residence and paying back a mortgage on the residence, and 1,510 renter households in the control group.

[7] Please note that we analyze differences in the actual savings amounts and not the savings rate in our matching procedure below. Our propensity score estimation includes the net household income as a regressor. As a result, we will compare households with the same or a very similar net income after the matching is done.

Table 1 Net wealth holdings of households by type of homeownership, weighted, in euro, implicate 1

Net wealth in euro	Mean	P25	Median	P75
Renters	53,464	1,320	11,300	38,600
Owners with mortgage	283,222	71,200	167,200	319,650
Owners without mortgage	464,169	140,380	257,100	455,100
Total	202,353	7,250	53,420	218,300

Source: PHF 2010/11 – Implicate 1

The data confirms other studies, in that it shows substantial differences in both mean and median net wealth between owners and renters. One may argue that this is only an effect of including real estate in the net wealth concept. But the differences are also there for financial wealth (Table 2), indicating that owners are wealthier on average than renters.[8]

Table 2 Financial wealth holdings of households by type of homeownership, weighted, in euro, implicate 1

Financial wealth in euro	Mean	P25	Median	P75
Renters	31,622	1,880	8,330	31,100
Owners with mortgage	64,501	14,800	36,500	84,058
Owners without mortgage	89,975	14,000	44,000	103,200
Total	52,889	4,000	19,200	56,600

Source: PHF 2010/11 – Implicate 1

The variable we are most interested in is the savings behaviour of owners and renters. The descriptive statistics show that homeowners do on average save more than renters. Obviously this would be the case if mortgage repayments are included in the savings concept, but the difference between the two groups remains if one focuses on all regular savings – excluding mortgage repayments - only (see Table 3).

[8] Further differentiating households by the age cohort of the main income earner shows, that substantial difference in wealth between owners and renters can be observed for all age cohorts. Results are available upon request.

Table 3 Net annual savings of households by type of homeownership (excl. mortgage repayments), weighted, in euro, implicate 1

Annual net savings (excl. mortgage repayments) in euro	Mean	P25	Median	P75
Renters	958	0	300	2400
Owners with mortgage	3,184	240	2,400	6,656
Owners without mortgage	3,467	0	1,229	5,880
Total	2,016	0	720	4,066

Source: PHF 2010/11 – Implicate 1

The comparisons presented above do not take into account, however, that owners and renters do not only differ in terms of their housing situation, but along several other dimensions as well. Therefore, the observed difference in savings levels cannot be attributed to the ownership status (alone). If the two groups differ along income levels, these differences could be responsible to the observed savings levels.

The two groups – renters and owners with a mortgage - differ significantly with respect to several standard socio-demographics and other characteristics in the expected manner (see table 5 in the appendix – line “unmatched”). The most marked differences between owners and renters show up for the household size, income, and regional indicators. Homeowners with mortgages are on average larger, richer, and more likely to be found in rural areas and suburbs than renters.

4. Empirical Strategy – The Matching Procedure

As the descriptive analysis above has shown, homeowners and renters do not only differ in terms of wealth, but also along several other dimensions, like income, household size or employment status. As these variables are influencing the savings behavior of households they need to be controlled for in order to estimate the effect of housing alone on savings levels. In order to test our hypotheses we will therefore look at the savings behavior of renter and owner households with similar characteristics. The characteristics we want to equate can be classified as follows: household demographics, characteristics of the main income earner, region and an indicator for mobility: Household demographics are the household-size (head count) and the logarithm of household's net income together with an indicator variable of whether the household has received a substantial gift or inheritance in the past. The main income earner's characteristics are the age (also included as a square term), the marital status and the level of education. To account for regional factors we include the degree of urbanization (city centre, suburb, rural area) of the municipality the household lives in. Mobility is represented by a dummy variable indicating that the household has lived in the dwelling he is currently in for several years as opposed to moving in the year of the interview.

One possible standard approach to address this issue would be to estimate a simple OLS regression that controls for various household characteristics and includes a dummy variable for homeowners. With this approach we would have faced the problem of endogeneity of the ownership variable. Furthermore we would have to assume that homeownership and saving levels are related in a linear fashion. In the absence of a good exclusion restriction to alleviate the endogeneity problem (through IV estimation) and no clear guidance on why the effect should be linear, we opted for the matching procedure. The matching approach allows us to compare the savings behavior of renters and homeowners with similar characteristics, without the problems the standard approaches are faced with. The matching approach has its roots in labour market research (Heckman et al. (1998); Heckman et al. (1999); Lechner (1998)), but has been applied in many other fields as well.

The basic idea of the matching methods is to re-establish the conditions of an experiment where a number of households are randomly assigned to a "treatment" group or a control group of similar households which do not receive the "treatment" (Dehejia and Wahba (2002)). If no experimental data is available it is difficult to answer the question, how a household would have behaved if it had not received the treatment ("counterfactual situation"). Simply comparing statistics of the treated and control group, leads to biased results, because the two groups vary along several dimensions other than the treatment status. It is therefore essential to make sure that similar households are included in the comparison. The matching procedure does just that, it is an algorithm to match each treated household to an untreated "twin" household, which shows the same characteristics except the treatment status. By comparing the outcome for the treated households in the hypothetical state (counterfactual) with the actual outcome, the impact of the treatment on savings ("average treatment effect on the treated (ATT)") can be isolated from other influences while keeping the heterogeneity of the households intact. This is an advantage over regression analysis, where the mean impact would be evaluated. Another advantage of the matching over conventional regression type analysis is that it does not require any assumption about the functional form of the link between treatment and outcome.

The matching method in our case works as follows: We start by splitting the households into two groups, those owning the main residence and those that do not. Note, our theoretical framework implies that owner households with repayment obligations exhibit a different savings behavior than renter households. Instead of matching homeowners and renters we will therefore match only homeowners with a mortgage to renter households. In the classic matching the second step would be to assign each homeowner household with a mortgage one similar "twin" household from the renter households. We use kernel matching, however, which means that not a single household from the control group of renters is linked to each owner with a mortgage, but rather a weighted average of the control group (cf. Lechner (1999); Lechner (2002); Smith and Todd (2001))[9]. The weighting is based on a so called "propensity score" (Rosenbaum and Rubin (1983); Rosenbaum and Rubin (1985)) and in our application an Epanechnikov kernel. The propensity score is estimated from a probit model regressing a "homeownership with mortgage" dummy on several household characteristics. The propensity score indicates the probability for each household to be a homeowner with a mortgage. To improve the quality of the matches we reduce the sample to households with "common support", i.e. we eliminate households that have a propensity score higher than the maximum or smaller than the minimum in the potential control group (Czarnitzki et al. (2007))[10]. We do not use sampling weights to obtain the propensity score. As Fröhlich (2007) argues, weights can be neglected in the estimation of the propensity score if the same sampling methods is used for the source and the target sample, i.e. both the treated and control group are from the same survey, which is the case here.

In order for the matching procedure to yield valid results, the conditional independence assumption (CIA) as described by Rubin (1977)) has to hold. It states that conditional on the propensity score treatment participation (owning the main residence) is statistically independent from treatment outcome (savings behaviour). This CIA helps to overcome the problem that the owner household cannot be observed as a renter household as well, i.e. the counterfactual outcome is unobservable. If the CIA is fulfilled, we can obtain the average outcome of owner households in the absence of ownership from the sample of twin renter

[9] We also did a classic propensity score matching. The matches were not as good as with the kernel matching. However, the results only changed little.

[10] Only two households owning their main residence and paying back a mortgage had to be deleted from the sample because of lack of "common support".

households. It implies that all variables that influence the savings behaviour and the ownership status of a household are known and available in the data set (see Aerts and Schmidt (2008)). Unfortunately the CIA cannot be validated empirically (Almus et al. (1999)).

5. Results

At the beginning of the matching process we need to estimate the probability of households to own property. We refer to this likelihood as the propensity score. In order to estimate this likelihood, we specify a probit regression model with a latent independent dummy variable, which is one if the household owns its main residence and is paying back a mortgage, and the above mentioned control variables. The results are presented in table 6 in the appendix. As the descriptive statistics already implied all control variables are significant. The coefficients also exhibit the correct signs, homeownership increases with household size, income and education. Being located in a rural area also increases the propensity to buy a house, whereas being very mobile reduces it. The only surprising result from the probit is the dummy variable of whether the household has received a substantial gift or inheritance in the past. It has a positive sign, one might have expected that receiving an inheritance may reduce the probability of being a owner with a mortgage. The comparison between the control and treatment group after the matching shows, that the matching worked and we are now really comparing similar groups of households, which do not significantly differ on any of our control variables, but on their ownership status (cf. Table 5 in the appendix). The results presented in table 4 below show that ownership is indeed accompanied by higher savings, regardless of whether we look at gross or net savings. Renter households save approximately 4,800 Euros a year or 400 Euros per month less in net terms than similar households that own their main residence, if mortgage repayments on the household main residence (HMR) are taken into account. The differences are highly significant confirming hypothesis one. If one looks at the narrower savings concept and excludes mortgage repayments, the renters save slightly more on average than the owners. The differences are not significant, however. What this finding indicates is that owner households seem to substitute only a small part of their contractual and discretionary savings for mortgage payments. In the absence of mortgage payments owner households would have spent only between 20 and 40 Euro more on other savings.

This result shows that households do not really change their savings behaviour in general but change their consumption behaviour. Hence, the long term commitment of households for redemption payment can be interpreted as some kind of forced saving. Our second hypothesis is therefore also confirmed. One reason for the observed behaviour may be that the mortgage rate or debt burden for the mortgage is chosen such that it substitutes the rent payments. This is not the case, however. Table 4 clearly shows that the debt burden is significantly higher (about 200 Euros per month) than the rent payments of comparable households[11]. Owner households do save something in addition to the interest payments required for the loan, because interest payments only account for approx. 4,400 euros of the annual debt burden of 9,616. The remaining 5,200 Euros are saved.

Table 4 Matching Results – Comparison of means between treated and control group

	Variable	Mean: Treated	Mean: Control	Difference (ATT)	Significance Level
Gross Savings	All repayments1)	12080	6724	5356	***
	Only hmr mortgage repayments	11507	5975	5532	***
	Only consumer loan repayments	6887	6726	161	
	Without any repayments	6314	5977	337	
Net Savings	All repayments1)	9406	4618	4788	***
	Only mortgage repayments	8834	3869	4965	***
	Only consumer loan repayments	4213	4620	-407	
	Without any repayments	3641	3871	-230	
Rents and debt service	Rent vs. Mortgage debt service	9616	6887	2729	***
	Rent vs. Mortgage interest rate	4412	6887	-2475	***
	Rent vs. Mortgage repayment	5204	6887	-1683	***

Source: PHF survey 2010-11, implicate 1.

[11] Note, for this comparison to be valid we have to assume that owner households bought properties that are similar to those of the renter group we compare them to. This is not controlled for in our analysis.

Notes: All values are annual amounts in Euro. Bootstraped standard errors (50 replications) used in the calculation of significance tests. *** 99% significance level [1)] excl. mortgages on other properties

6. Conclusions and Future Research

In this paper we analyze the differences in savings behavior of households in Germany. We use the PHF and its large number of questions on savings in the PHF to shed light on the differences in savings behavior between households owning their main residence and renter households. This is an essential topic if one wants to understand the different wealth levels observed for these groups. What is more, cross-country evidence on household wealth suggests that increasing homeownership rates as seen recently may alter total savings by the household sector in Germany.

We show that households which own their main residence do save more than comparable households that do not. The main reason for this seems to be the fact that owner households do not substitute contractual savings with mortgage repayments, but save on top. This is plausible for two reasons: first, a large parts of the savings of households in Germany is usually saved in long term contracts (e.g. pension contracts, whole-life insurance), which are costly to terminate prematurely. If the household can afford to pay the mortgage rates and interest, without dissolving long term contracts, it has every incentive to do so. Second, banks in Germany usually require their borrowers to pay back at least some part of the mortgage loan each month, i.e. households have virtually no option to just pay interest. This system can be seen as inducing some forced savings for owner households.

Appendix

Table 5: Control variables for propensity score model – matched vs. unmatched

		Mean		t-test	
Variable		Treated	Control	t-value	p>t
Propensity Score	Unmatched	0.571	0.221	35.11	0.000
	Matched	0.570	0.566	0.35	0.725
HH-Size:	Unmatched	0.409	0.368	1.94	0.052
2 members	Matched	0.409	0.397	0.56	0.579
HH-Size:	Unmatched	0.195	0.126	5.43	0.000
3 members	Matched	0.195	0.206	0.33	0.738
HH-Size:	Unmatched	0.191	0.074	9.41	0.000
4 members	Matched	0.191	0.231	-1.14	0.256
HH-Size:	Unmatched	0.085	0.033	6.27	0.000
5+ members	Matched	0.085	0.080	0.93	0.352
Log. of annual net	Unmatched	8.111	7.476	23.40	0.000
hh income	Matched	8.105	8.090	0.57	0.566
Inheritance or Gift	Unmatched	0.420	0.203	11.25	0.000
received (dummy)	Matched	0.420	0.411	0.36	0.719
Age of	Unmatched	50.589	49.749	1.16	0.247
Referenzperson	Matched	50.627	50.828	-0.34	0.737
Refpers. is married	Unmatched	0.824	0.457	17.99	0.000
(dummy)	Matched	0.825	0.823	0.10	0.924
Edu. RP:	Unmatched	0.514	0.562	-2.16	0.031
ISCED-Level 2	Matched	0.513	0.494	0.74	0.461
Edu. RP:	Unmatched	0.432	0.308	5.89	0.000
ISCED-Level 3	Matched	0.433	0.426	0.27	0.784
Loc. of dwelling:	Unmatched	0.255	0.357	-4.96	0.000
close to city centre	Matched	0.255	0.225	1.40	0.163
Loc. of dwelling:	Unmatched	0.355	0.291	3.15	0.002
suburb	Matched	0.356	0.374	-0.72	0.473
Loc. of dwelling:	Unmatched	0.329	0.187	7.71	0.000
rural area	Matched	0.328	0.340	-0.53	0.596
Moved in 2010/11	Unmatched	0.067	0.234	-10.08	0.000
	Matched	0.067	0.067	0.06	0.950

Source: PHF survey 2010-11, implicate 1

Table 6: Probit Estimation for probability to own household main residence and repay mortgage

Variable	**Coefficients and standard errors**
HH-Size: 2 members	0.282** (0.116)
HH-Size: 3 members	0.465*** (0.136)
HH-Size: 4 members	0.662*** (0.149)
HH-Size: 5 members	0.720*** (0.178)
Log. of annual net hh income	0.711*** (0.068)
Substantial Gift received	0.428*** (0.070)
Age of Referenceperson	0.128*** (0.015)
Age of Referenceperson squared	-0.001*** (0.0001)
Referenceperson is married	0.276*** (0.092)
Edu. RP: ISCED-Level 2	0.300*** (0.125)
Edu. RP: ISCED-Level 3	0.261*** (0.132)
Loc. of dwelling: close to city centre	0.328*** (0.120)
Loc. of dwelling: suburb	0.571*** (0.118)
Loc. of dwelling: rural area	0.916*** (0.122)
Moved in 2010/11	-0.646*** (0.107)
constant	-10.419*** (0.629)
Number of Observations	2,280
Log Likelihood	-1006.214
Correctly classified observation (Pr(D)>0.5 => dependent variable=1)	78.5%
Pseudo – R2	0.311

Source: PHF survey 2010-11, implicate 1.

Table 7: Matching Results – extended

	Variable		Mean in Euro		t-tests	
			Treated	Control	t-value	p>t
Gross savings	All repayments[1)]	Unmatched	12091	3654	27.37	0.000
		Matched	12080	6724	9.07	0.000
	Only mortgage repayments	Unmatched	11520	3187	27.75	0.000
		Matched	11507	5975	9.08	0.000
	Only consumer loan repayments	Unmatched	6904	3647	11.89	0.000
		Matched	6887	6726	0.37	0.714
	Without any repayments	Unmatched	6333	3180	11.87	0.000
		Matched	6314	5977	0.79	0.428
Net savings	All repayments[1)]	Unmatched	9425	2123	19.27	0.000
		Matched	9406	4618	10.58	0.000
	Only mortgage repayments	Unmatched	8854	1656	18.68	0.000
		Matched	8834	3869	8.27	0.000
	Only consumer loan repayments	Unmatched	4238	2116	6.03	0.000
		Matched	4213	4620	-0.74	0.462
	Without any repayments	Unmatched	3667	1649	5.62	0.000
		Matched	3641	3871	-0.31	0.755
Rents and debt service	Rent vs. Mortgage debt service	Unmatched	9622	4768	22.09	0.000
		Matched	9616	6887	7.86	0.000
	Rent vs. Mortgage interest rate	Unmatched	4424	4768	-2.09	0.000
		Matched	4412	6887	-11.14	0.000
	Rent vs. Mortgage repayment	Unmatched	5198	4768	2.42	0.000
		Matched	5204	6887	-19.79	0.000

Source: PHF survey 2010-11, implicate 1.

Notes: All values are annual amounts in Euro. Bootstraped standard errors (50 replications) used in the calculation of t-tests. [1)] excl. mortgages on other properties

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The sources and effects of rental market underdevelopment in Central Europe. The results of a survey and DSGE model simulations.☆

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Abstract

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1. Introduction

The role of housing for macroeconomic stability can not be overstated. According to Leamer (2007) fluctuations in the housing market activity are the core cause of the business cycle, whereas the data on residential investment can be successfully used as an early warning sign of an oncoming recession. In the context of European monetary integration, the high importance of the housing market, which was well described before the launching the euro by Maclennan et al. (1998), has manifested in the form of substantial imbalances and painful adjustment in Spain and Ireland (Conefrey and Gerald, 2010). There are also numerous analyses on the importance of the housing market structure and its dynamics for the transmission of macroeconomic disturbances to the economy, which follow the seminar paper of Iacoviello (2005).

Even though the literature on the role of the housing market in the economy is extensive, the number of studies analyzing the role of the rental market for macroeconomic stability is relatively scarce. Only a handful of papers focus on the relationship between rental market characteristics and the dynamics of the housing sector. Arce and Lopez-Salido (2011) build a theoretical model to show that the availability of rental housing reduces the risk of a house price bubble. In the same vain Rubio (2014) builds a theoretical DSGE model to explore the interaction between housing tenure and monetary policy and shows that a larger size of the rental market makes the monetary policy more stabilizing. This result is confirmed by an empirical study by Cuerpo et al. (2014), who indicate that private rental market regulations, in particular different aspects of rent controls and tenant-landlord regulations, influence the response of house prices to economic and demographic disturbances. Similarly, Czerniak and Rubaszek (2016) find that the size of the rental market has a significant impact on house prices fluctuations and the variability in the construction sector activity in the euro area economies. Finally, a number of studies find that an increase in the availability of rental housing leads to higher population mobility, hence to more efficient allocation of the labor force (Barcelo, 2006; Caldera-Sanchez and Andrews, 2011).

In this context a low share of the private rental market observed in most Central European countries, including Poland, might be considered as a serious structural weakness, and raises two important questions. The first one relates to reasons behind rental market underdevelopment. The literature provides some answers. At a macro level, it has been already shown that the different homeownership rates across European countries can be attributed to the efficiency of institutions, fiscal policies as well as cultural or educational factors (Earley, 2004; Mora-Sanguinetti, 2010).

At a micro level, it has been found that households' tenure choices in European countries are significantly affected by marital status, income, age as well as nationality, where the latter factor can be attributed to cultural or institutional differences (Bazyl, 2009). As for the relative importance of various reasons to own or rent, it is worthy to mention about the study of Ben-Shahar (2007), who indicates that psychological factors are often more important in explaining tenure choices than the economic ones. The second question is what can be done to increase the size of the rental market? This kind of analyses are usually conducted with the help of a theoretical, general equilibrium models. For instance, Gervais (2002) uses a life-cycle model to how changes in taxation affects the housing tenure decision. Contrary, Ortega et al. (2011) build a DSGE model with the rental market to analyze the effects of housing market reforms in Spain. The main finding is that eliminating a subsidy to house purchases or introducing subsidies to rental payments as well as increasing the efficiency in the production of housing rental services raise the share of the rental market.

The contribution of this article is twofold. First, we conduct an original survey among a representative group of 1005 Poles, which allows us to better understand the attitudes of Poles towards various housing tenure choices. In particular, we are able to estimate to what extend the reluctance of Poles towards renting is of economic or psychological nature, similarly to what was done by Ben-Shahar (2007) for ISraeli student. Second, we modify the DSGE model with the rental market proposed by Ortega et al. (2011) and calibrate it to the Polish data. This allows us to conduct several simulations, which are helpful in assessing the effects of potential reforms aimed at developing the rental market. We complement the description of survey results and model simulations with discussion on how to improve the functioning of the rental market in Poland.

The rest of the paper is organized as follows. In Section 2 we describe the history of rental market development in Poland. Section 3 presents the results of the survey. In Section 4 we present the DSGE model and the result of simulations. The last section concludes and provides some interpretation of the results in the form of policy recommendations.

2. Rental market development in Poland

The size of the private rental market in Poland is relatively small compared to other EU countries. According to Eurostat data, in 2014 the share of owners without and with mortgage stood at 72.7% and 10.8%, respectively, which gives the homeownership rate at 83.5%. The share of public and private rental amounted to 12.2% and merely 4.3%, respectively. This points to a serious underdevelopment of the private rental market compared to the Western EU countries, such as Germany (39.6 %), France (19.3 %) or Italy (14.3 %). At the same time, the size of the private rental market was comparable to other countries in Central and Eastern Europe, except the Czech Republic (Figure 1). Figure 1 also shows that the share of the private rental market is much more developed in the German-speaking countries than in the Anglo-Saxon or Southern European ones. According Elsinga and Hoekstra (2005) this can be explained by institutional and cultural factors. For example, in the Anglo-Saxon countries possessing a house is usually associated with a sense of security, autonomy, personal identity and is considered to be a sign of economic success. As a result a subjective utility from living in a dwelling that is owned is much higher than from living in the same dwelling that is rented. This individual preference is explained by Saunders (1990) in terms of people's possessive instinct and the desire to mark out own territory. The individual preference for homeownership in many countries is reinforced by the housing policy that is based on the assumption that a high proportion of owners has a positive impact on economic and social development. This kind of policy, in the form of fiscal incentives for owners combined with strong protection of tenants at the expense of landlords, stands behind relatively high homeownership rates in the Southern European countries (Mora-Sanguinetti, 2010). In the case of the German-speaking countries the situation is different. The preference for ownership, both at individual and country level, is not so strong as in other places in Europe. At an individual level, a sense of security is provided by a developed social system and high protection of tenants, under which evictions or excessive rents increases are limited. At a country level, fiscal support and good legislation encourage institutional investors to locate funds in the rental housing. As a result, the private rental market is relatively well developed and rent prices are affordable, which allows people to choose more freely on the timing of entering the ownership.

In the case of Poland, as well as other Central European countries, a high proportion of owners and a marginal share of the rental market can be justified by a number of factors. As indicated by Augustyniak et al. (2013) for Poland and Lux and Sunega (2014) for the countries of the region, a very important factor was the transfer of public rental housing into private hands, which took the form of a massive sale to sitting tenants. They could buy occupied apartments at a very discounted price. For Poland this is well illustrated by the Eurostat data, according to which the share of public rental decreased from 34.9% in 2007 to just 12.3% in 2014 (Figure 2). The second factor is related to changes in the mortgage market, in particular a steady decrease of inflation and nominal interest rates, which in the 1990s often stood at two digit levels, combined with better access to FX denominated loans, especially in Swiss franks. The changes in the financial sector, but also a variety of programs promoting house purchase on credit[1] led to an increase in the proportion of owners with a mortgage (from 2.9% in 2007 to 10.8% in 2014, Figure 2). Third, ineffective regulations are another factor behind the low rental share in Poland and other countries of the region. For example, the excessive protection of "bad" tenants combined with no support for the landlords is increasing the risk of investment in rental housing. This, in turn, is reflected in higher rents and lower supply of houses to let. Another example is the lack of clear regulations related to rent control, which increases the risk of rent increases, hence theoretically should reduce the demand of households for long-term rent in line with the theoretical model of Sinai and Souleles (2005). The lack of consistent housing policy to develop the rental market is nicely summarised by Priemus and Mandic (2000), who claim that in the countries of the region both private and public rental market at the beginning of the twenty-first century was "no man's land". In the case of the private rental market, one could observe the lack of institutional investors specializing in professional rental services. The authors indicate that the private rental market was *de facto* the extension of the ownership, in which the offer is dominated by dwellings uninhabited by the owner (ie. inherited), not "buy-to-let" dwellings.

An open question is about the individual reasons behind low share of the rental market in Poland, as well as in other countries of the region. It is possible that solely financial factors are important, namely that owning is just cheaper option to satisfy housing needs than renting. The alternative is that badly regulated relations between the landlord and the tenant might lead to a situation in which living in a dwelling that is rented is providing much lower utility than living in the same dwelling that is owned. It is also possible that there are strong cultural and psychological factors, which causes that only owning can provide true satisfaction from housing services. The discussion on individual motives that stand behind owning and renting, which is crucial to understand the root causes of rental market underdevelopment, is the subject of the next section of this article.

[1]In Poland there were two such programs. Within the first program, *Rodzina na Swoim* (Family on its Own), the government was subsidising up to 50% of mortgage interest payments for the first eight years after the purchase of an apartment. In 2014 *Rodzina na Swoim* was modified into *Mieszkanie dla Młodych* (Apartment for the Young), in which the government was subsidising downpayment for young families, where the subsidy amounted up to 30% of an apartment value.

3. The survey

In this section we present the results of the unique survey among a representative group of 1,005 Poles. The survey was conducted between 9 and 13 June 2016 within a regular Omnibus CAPI survey by IPSOS Sp. z o.o. The exact content of the survey, which consists of 31 questions, as well as the distributions of answers are discussed in details in Rubaszek and Czerniak (2017). The individual data as well as the survey in online version is available at the webpage of the author.[2] Here we present the selected results, which we consider to be crucial in the context of discussion on the individual reasons behind rental market underdevelopment.

We start with the answers to the question about the tenure status of the occupied dwelling. They indicate that the distribution of households in the survey is broadly comparable to the Eurostat data. In particular, the share of tenants at market price amounts to 5.2%, for tenants at reduced price it is 14.2%, whereas the respective figures for ownership with and without mortgage are 7.8% and 61.6%, respectively. The remaining 11.2% are usually young respondents that live with their parents. An analysis of private market tenants indicates that they are usually unmarried and young (up to 30 years), don't have children, inhabit relatively small dwellings (for over half of respondents the surface was smaller than 45 sq. meters) that are located in one of the biggest cities in Poland. The duration of their residence in the currently occupied dwelling is rather short (for almost three quarters of respondents it is less than 5 years) and they plan to change the address in the short-term horizon (almost half of respondents plan to move within five years). This description fits well students or people who just started their professional careers, for whom renting is a temporary form of satisfying housing needs. It is worth noting that only 11 private market tenants declared that they live with a partner and have at least one child. Out of these respondents, six persons rent because they cannot afford to buy a property, three persons do not want to take a mortgage, one person found an attractive offer and only one person rents because his job requires high mobility. The above characteristics indicate that the private rental market is not treated as a serious alternative to ownership.

To check whether Poles really prefer ownership to renting we have asked three direct questions about potential tenure choice. The distribution of answers is presented in Table 1. The first question was about the preferred tenure choice in case of moving ($TenPref1$). The answers for

[2] The survey was conducted in Polish. The translation into English is available upon request from the authors.

homeowners without mortgage were very skewed towards owning: only 9.0% them indicated renting and 66.9% ownership. Interestingly, among owners with a mortgage the preference for renting was nearly twice larger and amounted to 16.6%, which may be explained by higher awareness about financial disadvantages of servicing a mortgage. The largest percentage of respondents indicating renting as the preferred choice was among the tenants, both private (44.2%) and pubic (42.0%). For all respondents, however, the fraction of people choosing renting (17.3%) was three times lower than those that pointed to owning (58.5%). This result is important in the context of discussions on the policies aimed at the development of the rental market, which should take into account both increasing the supply of as well as stimulating demand for rental housing. As indicated by Coolen et al. (2002), for the latter it is important to create conditions in which property owners are considering renting as an acceptable alternative in case of moving.

In the next question respondents could choose between renting and buying a dwelling on credit ($TenPref2$). Since buying a dwelling on credit is more expensive than if its purchase is financed from savings, it was expected that the percentage of people who would choose owning will be lower than in the case of question $TenPref1$. And indeed, for the entire sample 52.6% of respondents indicated purchasing with a mortgage against 29.7% of people pointing to renting. What is more important, for people aged up to 35 years, i.e. in the age of forming a household, the respective shares were very close to the total sample and amounted to 54.1% and 31.6%. These results indicate that there is a non-negligible group of people who would potentially be interested in renting a dwelling rather than taking a mortgage. In other words, there exists sizeable demand for rental housing.

In the last question we have asked the respondents to answer whether they agree with the following statement ($TenPref3$): *Buying a dwelling is financially better than renting it because after repaying the mortgage you are left with a dwelling and after paying rents you are left with nothing.* After Ben-Shahar (2007) we call this statement as *flawed economic reasoning* because the evaluation of relative financial attractiveness of the two tenure forms should be based on the comparison of the present value of rent payments to the present value of the payments on mortgage loan instalments less the value of the property after the repayment of the loan. It turns out that as many as 78.0% of respondents agree with this statement, while only 10.9% respondents are of different opinion. For tenants the respective shares are less tilted towards ownership, but still amount to 63.5% (agree) and 13.5% (don't agree). It should be pointed out that similar results were obtained by Ben-Shahar (2007) in a survey among Israeli students (85% of respondents agreed with the statement). Our interpretation is that financial considerations about the relative advantages of both housing tenure options are strongly affected by non-financial factors.

Given that the tenure choice is strongly affected by non-financial factors, it can be claimed that households derive greater utility from living in owned rather than rented dwellings. This hypothesis for selected EU countries is confirmed by two empirical studies based on individual data from Eurostat's European Community Household Survey (Elsinga and Hoekstra, 2005; Diaz-Serrano, 2009). Both articles show that the tenure status significantly affect the answers to the question: *How satisfied are you with your housing situation?*. To explore the relative importance of financial and non-financial factors on tenure choices by Poles, in the survey we have asked a series of questions related to economic and psychological reasons to own or rent. As regards the former, basing on the literature, we have focused on the four following factors (Henderson and Ioannides, 1983; Bourassa, 1995; Sinai and Souleles, 2005):

E1. The relative cost of renting and servicing mortgage

E2. The risk of house prices or rents fluctuations

E3. Transaction costs

E4. Taxes and fiscal incentives

Then, taking into account the results of Coolen et al. (2002) and, above all, Ben-Shahar (2007), we selected the following psychological factors:

P1. Social status

P2. A sense of freedom and independence

P3. Comfort

P4. Peace of mind

P5. The well-being

P6. Attachment to the housing unit

P7. Family

P8. Happiness

The results in Table 2 clearly show that Poles prefer owning to renting both due to psychological and economic reasons. The distribution of answers to question $E1$ shows that 64.0% of respondents think that servicing a mortgage is cheaper than paying a rent, whereas 12.6% is of the opposite opinion. Moreover, answers to $E@$ demonstrate that for a dominant part of respondents (65.6%) the risk of rent changes is higher that the risk of house prices fluctuations. This means that for most Poles renting is considered to be less attractive financially than owning. As regards the eight psychological factors, the distribution of answers is broadly similar for all of them: about 70% of respondents prefer owning and about 10% of them indicate renting, whereas about 20% has no opinion. These shares would indicate that psychological factors are even more important for tenure decision than the economic ones. The result that is worthy to emphasise is that for question $P7$ the shares are the most tilted towards owning, which indicates that Poles do not consider rented dwellings to be a good place for a family.

To assess the relative strength of economic and psychological factors on tenure preferences among Poles we have conducted a series of logit regressions in which the dependent variable was a dummy indicating that a given household would choose renting rather than owning. The classification was done on the basis of answers to questions $TenPref1$, $TenPref2$ and $TenPref3$. For convenience, below we describe when we assign the unity value for the dependent variable:

TenPref1: A person prefers renting in case of moving.

TenPref2: A person prefers renting to mortgage in case of no funds to buy a dwelling.

TenPref3: A person do not agree with the *flawed economic reasoning* sentence.

The explanatory variables of our interest are the answers to economic and psychological questions, which have described above. Given that the answers were highly correlated, to avoid multicollinearity problem, we applied the principal component analysis. In particular, we took the first factor for $E1$-$E4$ ($EconFact$) and $P1$-$P8$ questions ($PsychFact$). Next, taking into account the discussion by Ben-Shahar (2007), who states that our economic beliefs are strongly influenced by psychological ones, to measure the true impact of economic beliefs on tenure preferences, we took the residuals from the regression of $EconFact$ on $PsychFact$. Finally, the both factors were standardised so that the estimates of the parameters could be compared. As regards control variables, following the studies by Bourassa (1995); Coolen et al. (2002); Andrews and Sanchez (2011), we have included demographic characteristics (age, marital status, a variable that indicates whether an individual arrived from another city), income (given the low quality of income data in our database, we used the level of education to describe the financial position of a household), the size of the town of a household's residence as well as the current tenure status.

The results of the three logit regressions are presented in Table 3. They show that both economic and psychological factors are significant for tenure preferences in all regressions. As regards their relative importance, the results vary with the choice of the dependent variable. For $TenPref1$ the estimates for $EconFact$ and $PsychFact$ parameters are broadly comparable and amount to 0.522 and 0.596, respectively. This means that the intended housing tenure choice in case of moving is to the same extent determined by economic and psychological considerations. If the question is changed into whether to rent or buy with a mortgage ($TenPref2$), financial considerations become more important. The estimate of the parameter standing at $EconFact$ doubles and amounts to 1.122, whereas the parameter at $PsychFactor$ is almost unchanged and stand to 0.664. This should not be surprising as buying a dwelling on credit is more expensive than if the purchase is financed from owned funds, hence economic advantage of owning becomes less pronounced. Contrary, in the third regression psychological factors clearly dominate the economic ones: the estimates of the respective parameters are 1.333 and 0.589, respectively. This confirms that the *economic wisdom* we often believe in are not based on thorough calculations but rather on our psychological beliefs. This also applies to the housing tenure choices in Poland. Finally, while describing the results of the logit models, it can be noted that their fit, as measured by pseudo R^2, count R^2 or AUROC, is satisfactory.

At the end, we have asked a series questions that could help to assess which factors are the main hindrance to the rental market development. The upper panel of Table 4 analyses the barriers to demand for rental housing. It shows that among factors that are considered to decrease the comfort of being a tenant the most important ones are related to how the rental market is organised and regulated. In the former case, more than half of respondents agrees that tenants are excessively constrained in arranging the interior of the rented apartment and landlords are inspecting housing units too often. This lack of professionalism among individual landlords obviously decreases satisfaction from living in a rented apartment as compared to owning it. In the latter case, also more than half of Poles agrees that inefficient regulations related to rent control and tenant protection are decreasing the comfort of renting. It should be noted that regulations protecting tenants against the risk of rent increase or unexpected eviction are of crucial importance for developing the market for households that plan long-term rental. Finally, the level of rents and the offer of dwellings for rental also turned out to be important, albeit to a lower extent than the previous factors. The lower panel of Table 4 analyses the barriers to the supply of rental housing. It demonstrates that the main factor that decrease the attractiveness of investment in houses to let is related to the low culture of tenants. This, combined with high protection of "bad" tenants against eviction, causes that the risk of investing in rental housing in Poland is high. This, in turn, leads to lower supply and higher level of rents on the private market.

To sum up, the results of the survey lead to the following conclusions. Poles strongly prefer owning to renting. This can be explained by both, economic and psychological factors. As regards the former, the level of rents is high in comparison to the cost of owning. This is due to the "bad tenant" risk of investing in rental housing as well as fiscal policy that is tilted towards owning (this will be discussed in the next section). On top of that, the financial attractiveness of renting is further diminished by false economic reasoning, for instance that paying rent is a waste of money. In the case of psychological factors, many Poles do not consider rental housing as a serious alternative to owning in case of a long-term stay, especially if the household is a family with children. This might be partly explained by inefficient regulations as well as low professionalism of landlords, which decrease satisfaction from living in rented dwellings.

4. A model

In this section we propose a model that will be used in the next section to asses the effects of changes in the organisation of the housing rental market. To be more precise, we evaluate the impact of three reforms:

i. Decreasing the impact of "bad tenant" risk on the level of rents.
ii. Removing fiscal incentives to own.
iii. Increasing the professionalism of landlords, hence eliminating psychological disadvantages of renting.

on the size of the rental market as well as the dynamics of key macrovaraibles, including those that describe the dynamics of the housing sector.

The proposed model is based on the framework of Iacoviello (2005), whereas the description of the rental market is closely related to the recent works by Ortega et al. (2011) and Rubio (2014). The main structure of the model is as follows.

1. There are two types of consumers: savers and borrowers, which differ in their discount factors.
2. Borrowers face collateral constraints when applying for a mortgage.
3. There are two production sectors: the construction and the consumption goods sector.
4. Housing can be purchased or rented.
5. Savers are the landlords in the economy and provide rental services to borrowers.
6. There are fiscal incentives to house purchases and to rentals, in the form of subsidies and taxes.

A more elaborated description, with optimisation problems is presented below.

4.1. Savers

Savers maximize their utility from consumption $C_{s,t}$, housing services $H_{s,t}$ and working hours $N_{s,t}$:

$$\max E_0 \sum_{t=0}^{\infty} \beta_s^t \left(\log C_{s,t} + j \log H_{s,t} - \frac{(N_{s,t})^{1+\eta}}{1+\eta} \right), \tag{1}$$

where $\beta_s \in (0,1)$ is the discount factor and E_0 the expectation operator. $1/\eta > 0$ is the labor supply elasticity and $j > 0$ constitutes the relative weight of housing in the utility function. $N_{s,t}$ is a composite of labor supply to the consumption $(N_{cs,t})$ and housing sector $(N_{hs,t})$,

$$N_{s,t} = \left[\omega_l^{1/\varepsilon_l} (N_{cs,t})^{(1+\varepsilon_l)/\varepsilon_l} + (1-\omega_l)^{1/\varepsilon_l} (N_{hs,t})^{(1+\varepsilon_l)/\varepsilon_l} \right]^{\varepsilon_l/(1+\varepsilon_l)}, \tag{2}$$

where ω_l is a weight parameter and ε_l the elasticity of substitution between both labor types.

The budget constraint is:

$$\begin{aligned} C_{s,t} + b_{s,t} + q_{h,t} \left[(1-\tau_h)(H_{s,t} - (1-\delta_h) H_{s,t-1}) + (H_{z,t} - (1-\delta_z) H_{z,t-1}) \right] \leq \\ \frac{R_{t-1} b_{s,t-1}}{\pi_t} + w_{cs,t} N_{cs,t} + w_{hs,t} N_{hs,t} + q_{z,t} H_{z,t} + S_t + T_t, \end{aligned} \tag{3}$$

where $q_{h,t}$ is the real housing price, $w_{cs,t}$ and $w_{hs,t}$ denote real wages, whereas $N_{cs,t}$ and $N_{hs,t}$ are labor supply in the consumption and the housing sectors, respectively. Savers can purchase or sell houses either to live in $(H_{s,t})$ or to rent it $H_{z,t}$ at price $q_{z,t}$. δ_h and δ_z are the depreciation rates for owner-occupied and rented dwellings, respectively. They might differ due to the "bad tenant" risk, which was discussed in the previous section. We allow for the existence of tax incentives to own, in particular a subsidy τ_h. Next, the level of savings is given by $b_{s,t}$ and the risk free interest rate by R_{t-1}. π_t is the inflation rate at period t. Finally, S_t are the profits of firms and T_t a lump-sum government transfer.

The first-order conditions for this optimization problem are as follows.

$$\frac{1}{C_{s,t}} = \beta_s E_t \left(\frac{R_t}{C_{s,t+1}\pi_{t+1}} \right) \tag{4}$$

$$\frac{j}{H_{s,t}} = (1-\tau_h) \left[\frac{q_{h,t}}{C_{s,t}} - \beta_s (1-\delta_h) E_t \left(\frac{q_{t+1}}{C_{s,t+1}} \right) \right] \tag{5}$$

$$\frac{q_{h,t}}{C_{s,t}} = \frac{q_{z,t}}{C_{s,t}} + \beta_s (1-\delta_z) E_t \frac{q_{h,t+1}}{C_{s,t+1}} \tag{6}$$

$$\frac{w_{cs,t}}{C_{s,t}} = (N_{s,t})^{\eta} \omega_l^{1/\varepsilon_l} \left(\frac{N_{cs,t}}{N_{s,t}} \right)^{1/\varepsilon_l} \tag{7}$$

$$\frac{w_{hs,t}}{C_{s,t}} = (N_{s,t})^{\eta} (1-\omega_l)^{1/\varepsilon_l} \left(\frac{N_{hs,t}}{N_{s,t}} \right)^{1/\varepsilon_l} \tag{8}$$

Equation (4) is the standard Euler equation for consumption. Equations (5) and (6) represents the intertemporal condition for housing purchased to own and let, respectively. In these equations benefits of purchasing a housing unit equate the alternative costs of forgone consumption. Finally, equations (7) and (8) describe the labor-supply conditions for consumption goods and housing sector.

4.2. Borrowers

Borrowers solve a similar optimisation problem as savers:

$$\max E_0 \sum_{t=0}^{\infty} \beta_b^t \left(\log C_{b,t} + j \log \widetilde{H}_{b,t} - \frac{(N_{b,t})^{1+\eta}}{1+\eta} \right), \tag{9}$$

where $\beta_b < \beta_s$ is the discount factor, and

$$N_{b,t} = \left[\omega_l^{1/\varepsilon_l} (N_{cb,t})^{(1+\varepsilon_l)/\varepsilon_l} + (1-\omega_l)^{1/\varepsilon_l} (N_{hb,t})^{(1+\varepsilon_l)/\varepsilon_l} \right]^{\varepsilon_l/(1+\varepsilon_l)}. \tag{10}$$

The key in the optimisation problems of savers and borrowers is that $\tilde{H}_{b,t}$ is a composite of owned housing purchased with a mortgage ($H_{b,t}$) and rental housing ($H_{z,t}$):

$$\tilde{H}_{b,t} = \left[\omega_h^{1/\varepsilon_h} \left(H_{b,t}\right)^{(\varepsilon_h - 1)/\varepsilon_h} + \left(1-\omega_h\right)^{1/\varepsilon_h} \left(H_{z,t}\right)^{(\varepsilon_h - 1)/\varepsilon_h}\right]^{\varepsilon_h/(\varepsilon_h - 1)}, \tag{11}$$

The parameter ω_h is very important in our analysis, as it approximates the preference for owning a house (purchased on credit) versus the rental housing. In turn, ε_h describes the elasticity of substitution between preferences for owner-occupied housing and rental. In this way, borrowers derive utility from the two types of housing. It should be emphasized that that this does not literally mean that each borrower lives simultaneously in their own house and in a rented house. Instead, the interpretation is that there exists a large representative borrower-type household with a continuum of members, some of whom live in owner-occupied houses, the rest of whom live in rented houses. This composite index in the equation thus represents the aggregate preferences of all household members with respect to each kind of housing service.

The budget constraint and the collateral constraint for the borrowers are as follows:

$$\begin{aligned} C_{b,t} + \frac{R_{t-1} b_{b,t-1}}{\pi_t} + q_{h,t}\left(1-\tau_h\right)\left(H_{b,t} - \left(1-\delta_h\right) H_{b,t-1}\right) + q_{z,t}\left(1-\tau_z\right) H_{z,t} = \\ = b_{b,t} + w_{cb,t} N_{cb,t} + w_{hb,t} N_{hb,t} \end{aligned} \tag{12}$$

$$b_{b,t} \leq E_t\left(\frac{1}{R_t} k q_{h,t+1} H_{b,t} \pi_{t+1}\right) \tag{13}$$

where $b_{b,t}$ represents the level of debt and k is a maximum loan-to-value ratio. The first-order conditions of this maximization problem are:

$$\frac{1}{C_{b,t}} = \beta_b E_t\left(\frac{R_t}{C_{b,t+1}\pi_{t+1}}\right) + \lambda_t, \tag{14}$$

$$\frac{j}{\tilde{H}_{b,t}}\left(\frac{\omega_h \tilde{H}_{b,t}}{H_{b,t}}\right)^{1/\varepsilon_h} = \left(1-\tau_h\right)\left(\frac{q_{h,t}}{C_{b,t}} - \beta_b\left(1-\delta_h\right) E_t \frac{q_{h,t+1}}{C_{b,t+1}}\right) - \lambda_t k E_t q_{h,t+1}\frac{\pi_{t+1}}{R_t}, \tag{15}$$

$$\frac{j}{\tilde{H}_{b,t}}\left(\frac{(1-\omega_h)\,\tilde{H}_{b,t}}{H_{z,t}}\right)^{1/\varepsilon_h}=(1-\tau_z)\,\frac{q_{z,t}}{C_{b,t}} \tag{16}$$

$$\frac{w_{cb,t}}{C_{b,t}}=(N_{b,t})^{\eta}\,\omega_l^{1/\varepsilon_l}\left(\frac{N_{cb,t}}{N_{b,t}}\right)^{1/\varepsilon_l}, \tag{17}$$

$$\frac{w_{hb,t}}{C_{b,t}}=(N_{b,t})^{\eta}\,(1-\omega_l)^{1/\varepsilon_l}\left(\frac{N_{hb,t}}{N_{b,t}}\right)^{1/\varepsilon_l}, \tag{18}$$

where λ_t is the Lagrange multiplier of the collateral constraint. The above conditions can be interpreted analogously to those for the savers. The most important difference is in demand equation for owned and rented housing (15 and 16), which mow equates the marginal utility from housing services (and the marginal value of housing as collateral in the case of (15)) with the alternative cost of forgone consumption.

4.3. Firms

The intermediate,consumption goods market is monopolistically competitive. Individual firm production function is:

$$Y_t\,(z)=A_t\,(N_{cs,t}\,(z))^{\gamma}\,(N_{cb,t}\,(z))^{(1-\gamma)}, \tag{19}$$

with $\gamma\in[0,1]$ measuring the relative size of each group in terms of labor. A_t represents technology, which is an autoregressive process $\log A_t=\rho_A\log A_{t-1}+u_t$ with normally distributed shocks. The symmetry across firms allows avoiding index z and re-writing the above equation in the form of the aggregate production function for consumption goods.:

$$Y_t=A_tN_{cs,t}^{\gamma}N_{cb,t}^{(1-\gamma)},. \tag{20}$$

The intermediate housing investment goods market is also assumed to be monopolistically competitive and subject to the same technology shock A_t. The aggregate production function for housing investment is therefore:

$$IH_t=A_tN_{hs,t}^{\gamma}N_{hb,t}^{(1-\gamma)}, \tag{21}$$

Intermediate goods producers maximize profits:

$$\max_{N_{cs,t},N_{hs,t},N_{cb,t},N_{hb,t}} \frac{Y_t}{X_t} + q_{h,t}IH_t - w_{cs,t}N_{cs,t} - w_{hs,t}N_{hs,t} - w_{cb,t}N_{cb,t} - w_{hb,t}N_{hb,t}, \tag{22}$$

where X_t is the markup that is equal to the inverse of real marginal costs. The first-order conditions are the following:

$$w_{cs,t} = \frac{1}{X_t}\gamma\frac{Y_t}{N_{cs,t}}, \tag{23}$$

$$w_{cb,t} = \frac{1}{X_t}(1-\gamma)\frac{Y_t}{N_{cb,t}}, \tag{24}$$

$$w_{hs,t} = \gamma\frac{q_{h,t}IH_t}{N_{hs,t}}, \tag{25}$$

$$w_{hb,t} = (1-\gamma)\frac{q_{h,t}IH_t}{N_{hb,t}}, \tag{26}$$

The price-setting problem for the intermediate-goods producers is a standard Calvo-Yun case. They sell goods at price $P_t(z)$. They can re-optimize the price with $1-\theta$ probability in each period. The optimal reset price $P_t^{OPT}(z)$ solves:

$$\sum_{k=0}^{\infty}(\theta\beta)^k E_t\left\{\Lambda_{t,k}\left[\frac{P_t^{OPT}(z)}{P_{t+k}} - \frac{\varepsilon/(\varepsilon-1)}{X_{t+k}}\right]Y_{t+k}^{OPT}(z)\right\} = 0. \tag{27}$$

The aggregate price level is thereofre:

$$P_t = \left[\theta P_{t-1}^{1-\varepsilon} + (1-\theta)\left(P_t^{OPT}\right)^{1-\varepsilon}\right]^{1/(1-\varepsilon)}. \tag{28}$$

By combining (27) and (28) and log-linearizing, we can obtain the standard forward-looking Phillips curve.

4.4. Monetary authority and equilibrium conditions

The central bank sets interest rates according to a Taylor rule:

$$R_t = (R_{t-1})^{\rho} \left[\pi_t^{(1+\phi_\pi)} \left(\frac{Y_t}{Y_{t-1}} \right)^{\phi_y} R \right]^{(1-\rho)} \varepsilon_{R,t}, \tag{29}$$

where $0 \leq \rho \leq 1$ is the parameter associated with interest rate smoothing. $\phi_\pi > 0$, $\phi_y > 0$ measure the interest rate response to inflation and output, respectively. R is the steady-state value of the interest rate. $\varepsilon_{R,t}$ is a white noise shock with 0 average and σ_ε^2 variance.

The equilibrium condition for the consumption goods and housing investment markets are:

$$Y_t = C_{s,t} + C_{b,t} \tag{30}$$

$$IH_t \equiv (H_{s,t} - (1-\delta_h) H_{s,t-1}) + (H_{b,t} - (1-\delta_h) H_{b,t-1}) + (H_{z,t} - (1-\delta_z) H_{z,t-1}) . \tag{31}$$

Finally, the equilibrium government budget constraint is:

$$T_t = \tau_z q_{z,t} H_{z,t} + \tau_h q_{h,t} \left[(H_{s,t} - (1-\delta_h) H_{s,t-1}) + (H_{b,t} - (1-\delta_h) H_{b,t-1}) \right] . \tag{32}$$

5. Reforming the rental market

Calibrating the model

We calibrate a subset of parameters to match a number of features of the Polish economy. Firts of all, the weight parameters in the CES baskets of housing services ω_h is set 2/3 on the basis of answers to the $TenPref2$ question from the survey (Table 1). The parameters describing the labor market were fixed at $\omega_l = 0.14$ and $j = 0.06$ so that the share of labor in the construction sector stood at 7.6%. The value of j parameter, together with depreciation rates at $\delta_z = 1\%$ and $\delta_h = 0.75\%$ quarterly, were additionally fixing the residential investment to GDP ratio at 3.3%, close to the 2007-2015 avarage from the OECD data. The discount factor β_s was set to 0.995 so that, taking into account the value of δ_z, the ratio of quarterly rents q_z were equal to 1.5% of house value, in line with the National Bank of Poland data presented in quarterly reports "Information on home prices and the situation in the housing and commercial real estate market in Poland". As regards parameters describing regulation, we set the LTV parameter m to 0.8, in line with the current restrictions related to the maximum LTV, and took into account that landlords have to pay 8.5% turnover taxes ($\tau_z = -0.085$). Finally, give all the above parameters, we have set the share of savers to be $\gamma = 2/3$, so that the share of the rental market stood at 6.8%, in line with the survey data (if we exclude public rental). The above choice implies that the share of owners with a mortgage is 17.2%, much more than in the survey (10.4% if we exclude public rental). We have decided that this share share is higher than what is observed in the data as the mortgage markets in POland was almost non-existent before 2004, hence it is difficult to claim that the current share is the steady-state value.

The remaining parameters are set to standard values in the literature. For borrowers, we use a slightly lower discount factor than the one of the savers, in line with the literature on DSGE models with housing and financial frictions. Following Horvath (2000), we set the elasticity of substitution between labor types, ε_l, to one. For the elasticity of substitution between services from home ownership and renting, ε_h, we follows Ortega et al. (2011) and take the value of 2 in order to make households more sensitive to the relative price of houses and rents than would be the case under lower values. The value for the elasticity of substitution among final goods, $\varepsilon_p = 6$, implies a markup of 20% in the steady state, a value commonly found in the literature. The probability of not changing prices, θ, is set to 0.75, implying that prices change every four quarters on average. The coefficients in the Taylor Rule are set to 0.9 for the lagged interest rate and 0.5 for inflation and output, respectively, as proposed in the seminal paper by Taylor. The values for the above parameters are reported in Table 5. The resulting model steady-state ratios, compared to their data counterparts, are presented in Table 6. It shows that the model reproduces the average proportion of residential investment over GDP, 3.4% (3.3% in the data) , as well as the weight of employment in construction over total employment (7.7% in the model, 7.6% in the data). The rental share in the model is 6.9% (consistent with the 6.8 %, found in the survey), whereas the share of housing with mortgages is 17.2% in the model, above the number found in the data (10.4%) due to reasons discussed above.

Impulse-responses to a monetary shock

In order to assess some of the dynamic properties of the model, here we present figure 3, which shows impulse responses to a one standard deviation shock to the nominal interest rate.[3] Following the monetary policy tightening, GDP, inflation and real house prices all go down, as expected. The increase in the cost of mortgages leads borrowers to substitute away heavily from house purchases and increase their demand for rented houses. This is reinforced by two effects. First, rental rates go down, which in turn is due to the fact that landlords expect a quick recovery in real house prices following the shock. Second, the fall in real house prices reduces the collateral value of housing, thus limiting borrowers' access to credit and further reducing their demand for mortgaged housing. The increase in residential investment is driven by the strong increase in the demand for rented houses.

Steady state analysis

In this section, we use the DSGE model previously described to evaluate the effects on the main macroeconomic variables of interest of introducing some sets or reforms in the rental market. In particular, we focus on the quantitative effects on removing fiscal incentives to own, what we call the "neutral fiscal policy" scenario, increasing the protection of landlords, and lowering the disutility of renting. In terms of the model, this would correspond to setting taxes equal to zero, lowering the depreciation of rental services, and lowering the preference parameter of owner-occupied housing, respectively. We display the consequences of these reforms on steady-state values and on the dynamics of the model.

5.1. Effects on the Steady State

In order to assess the long-run impact of the proposed measures, we compute the steady state effects of the alternative policy scenarios. The results for the key variables and ratios are displayed in Table 7. Specifically, in the second column of the table we present the results for fiscal policy reform that removes all subsidies and taxes. The third column displays the steady-state values associated with better protecting the landlords against the "bad tenant" risk, which is proxied by a reduction of δ_z to the level of $delta_h$. In the fourth column, we present the effects of professionalizing

[3] In figure 3, the nominal interest rate and inflation are shown in absolute deviations from steady state and in annualized terms; all other variables are shown in percentage deviation from steady state.

rental services, which is represented by lowering the disutility of renting through shifting the weight ω_h in the housing CES aggregator. The fifth column presents the combined effect of the above three reforms.

We can observe that the first reform, moving to a neutral fiscal policy with no subsidies on housing markets has relatively small effects on the overall economic activity although it contributes to increasing the housing rental share. This measure implies a reallocation of the available housing stock from the ownership to the rental segment of the market. In particular, the rental share in the housing market increases to 7.7%. On the contrary, borrowers reduce their holdings of mortgaged houses, such that the share of mortgaged houses in the total housing stock falls. The effects of the second reform, which is increasing the protection of landlords against bad tenants, are quite similar, in the sense that the overall economic activity is not affected much and the largest effect is the reallocation of the housing stock from the ownership to the rental segment. Finally, an increase in the household preference for renting has also similar effects to the other two measures. It increases the size of the rental market and lowers the amount of houses that are purchased with a mortgage. This measure brings the strongest effects, although it is more difficult to implement because it implies changing preferences or cultural factors. The last column displays the combined effects of all three reforms. Since they have effects that go in the same direction, we see that the housing rental share would increase from a value of 6.8% to 15%, which is a sizable increase. These measures would contribute to enhance the size of the rental markets in Poland.

6. Conclusions and policy recommendations

The share of the rental housing market in Central European countries, including Poland, is very low. This might be explained by the fact that, as described by Priemus and Mandic (2000), the rental market is “no man’s land”. In this paper we have explored the reasons behind this state of affair using individual data from the unique survey that was conducted in June 2016 among the representative sample of 1005 Poles. We have found that private tenants are usually young, unmarried persons with low income, who can not afford to buy a dwelling. The rental market is treated a short-term, temporary solution, and not as a vital alternative to ownership for a longer stay. The results of the survey has also allowed us to confirm the thesis that the preferences of Poles are strongly tilted towards owning. The results of logit regressions, as well as the distribution of answers to selected questions, indicate that these preferences are strongly influenced by economic and psychological beliefs. Poles perceive ownership not only as a cheaper form of satisfying housing needs, but also as the only way to provide a safe place for the family and to really "fell at home". The survey also allows us to identify the most important barriers to demand for and supply of rental housing. Among the former, inefficient institutions and the lack of professional renting services turned out to be the most important. In the case of the latter, the low culture of tenants combined with their high protection seems to dominate.

Given the above diagnosis, in the second part of our study we have proposed a DSGE model with rental housing and collateral constraints and calibrated it to the Polish data. Next, we have used the model to quantify the effects of three reforms of the rental market: (i.) removing the "bad tenant effect" on the level of rents, (ii.) equalising fiscal incentives for different types of housing tenure, and (iii.) improving the standard of rental services leading to a shift in housing tenure preferences. All three reforms lead to an increase in the share of the rental market. Our computations indicate that introducing the three reforms would shift the rental share from 6.8% to 15.0%. Moreover, we show that reforming the rental market is also beneficial for macroeconomic stability [extend this part].

The above results justify why developing the rental market in Central European countries should be considered as a top priority for housing policy. Moreover, based on the results of the study we may formulate a number of recommendations for housing policy. First of all, lowering the relative cost of renting in comparison to owning seems to be one of the key factors. This could be achieved by introducing smart regulations protecting landlords against "bad" tenants, which would limit the risk associated with investing in rental housing that is included in the level of rents. Eliminating fiscal measures promoting ownership would also help. Second, stimulating the professionalization of renting services would contribute to changing psychological attitudes towards renting. This could be achieved by encouraging professional investors that specialise in managing and building rental housing, but also by supporting associations of individual landlords or rental management companies. Third, smart regulations that protect "good" tenants against the risk of large rent increases or unexpected eviction would increase the sense of security and stability of the rent contract. This would reduce one of the most important barrier to demand for rental houses: the belief that renting is not a stable form to meet housing needs. Finally, it is worth mentioning that the decision about buying a dwelling is often based on the "false economic reasoning". This might lead to the conclusion that education or information campaign about advantages and disadvantages of different forms of housing tenure could contribute to the increase in demand for rental as well as better housing choices of households.

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Table 1: Tenure preferences by tenure status
(% shares of answers for households with a given tenure status).

	tenant		**owner**		**total**
	private	public	mortgage	no mtg.	
TenPref1. Preferred tenure choice in case of moving to a new dwelling					
renting	44.2	42.0	16.6	9.0	17.3
buying	34.6	28.0	74.4	66.9	58.6
don't know	21.2	30.0	9.0	24.1	24.1
TenPref2. Preferred tenure choice in case of no own funds to buy a dwelling					
renting	50.0	61.5	19.2	21.6	29.7
buying with mortgage	38.5	25.2	78.2	55.6	52.6
don't know	11.5	13.3	2.6	22.8	17.7
TenPref3. Flawed economic reasoning					
agree	63.5	69.2	89.7	80.8	78.1
don't agree	13.5	18.9	7.7	8.2	10.9
no opinion	23.1	11.9	2.6	11.0	11.0

Note: The question that we call *flawed economic reasoning* is as follows: *Buying a dwelling is financially better than renting it because after repaying the mortgage you are left with a dwelling and after paying rents you are left with nothing.*
Source: The results of the survey.

Table 2: Economic and psychological factors influencing housing tenure preferences.

	owning	no opinion	renting
Economic factors			
E1. Mortgage / rental costs	64.0	23.4	12.6
E2. Risk of house price / rent fluctuations	65.6	22.8	11.6
E3. Transaction costs	62.1	26.1	11.8
E4. Taxes	61.0	25.3	13.7
Psychological factors			
P1. Social status	70.8	19.5	9.7
P2. Freedom and independence	71.1	16.5	12.3
P3. Comfort	71.6	17.0	11.3
P4. Peace of mind	70.9	17.8	11.2
P5. Well-being	71.5	17.9	10.5
P6. Attachment to dwelling	70.1	18.5	11.3
P7. Family	72.6	18.0	9.4
P8. Happiness	68.8	21.1	10.1

Source: The results of the survey.

Table 3: Determinants of tenure preferences in a logit model).

	TenPref1	TenPref2	TenPref3
Psychological and economic factors			
Psychological	0.522***	0.664***	1.333***
Economic	0.596***	1.122***	0.589***
Demographic factors			
age	-0.023***	0.004	0.006
kids	-0.070	0.084	0.060
migration	0.431***	-0.087	0.404
Town size			
large	-0.213	-0.345	-0.285
medium	-0.355	-0.270	-0.325
Marital status			
single	0.035	0.206	0.548
divorced	0.674*	0.123	-0.055
widow	0.774**	-0.100	0.519
Education			
medium	-0.047	-0.166	-0.072
high	-0.109	0.174	-0.162
Current tenure status			
private tenant	0.884**	0.493	-1.137**
public rental	1.140***	1.243***	-0.396
owner	-0.569*	-0.340	-0.715**
mortgage	0.163	-0.332	-0.741
Nobs	1005	1005	1005
Pseudo R^2	0.196	0.238	0.263
Count R^2 (Cramer method)	0.735	0.735	0.765
Count R^2(Threshold at 0.5)	0.85	0.802	0.896
AUROC	0.795	0.811	0.856

Source: Calculations on the basis of the results of the survey.

Table 4: The reasons of rental market underdevelopment in Poland

	Agree	No opinion	Don't Agree
Factors decreasing the comfort of being a tenant			
Tenants are too much constrained in arranging apartment	56.8	30.2	12.9
Landlords are inspecting the apartment too often	53.3	34.4	12.2
Tenants are not well protected against rent increases	56.2	31.0	12.7
Tenants are not well protected against eviction	56.7	31.1	12.1
Rents are too high in comparison to mortgage installment	53.9	33.3	12.7
The offer of dwellings to rent is too scarce to meet preferences	46.8	35.9	17.3
Factors decreasing the attractiveness of investing in rental housing			
Low culture tenants	62.6	28.9	8.6
Excessive rent control	50.3	37.2	12.4
Excessive protection of tenants against eviction	40.3	43.6	16.1
Low rate of return	39.4	47.3	13.3
Low demand	44.0	41.6	14.4

Source: Calculations on the basis of the results of the survey.

Table 5: Calibration of the DSGE model

Parameter	**Value**	**Description**
β_s	0.995	Discount factor of savers
β_b	0.985	Discount factor of borrowers
j	0.06	Relative weight on utility from housing services
ω_l	0.14	Weight parameter in labor services aggregator
ω_h	2/3	Weight parameter in housing services aggregator
ε_l	1	Elasticity of substitution between labor types
ε_h	2	Elasticity of subst btw. home ownership and rent
η	1	Inverse elasticity of labor supply
ε_p	6	Elasticity of substitution among final goods
γ	2/3	Savers labor-income share
δ_h	0.75%	Depreciation rate of the housing stock
δ_z	1.00%	Depreciation rate of the rental stock
m	0.8	Makimum LTV ratio
θ	0.75	Calvo parameter
τ_h	0	Subsidy rate house purchases for owner occupation
τ_z	-0.085	Subsidy rate on rent payments (here taxes)
ϕ_R	0.9	Coefficient on lagged nominal interest rate in Taylor rule
ϕ_Π	0.5	Coefficient on inflation in the Taylor rule
ϕ_Y	0.5	Coefficient on output in the Taylor rule

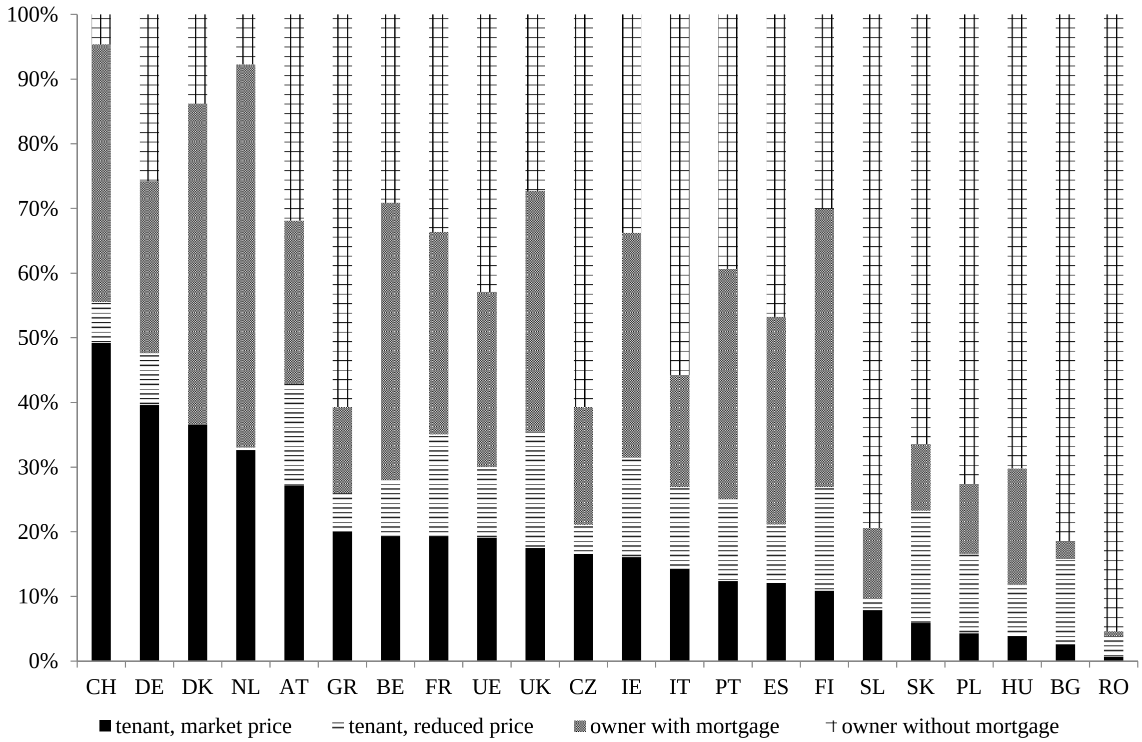
Table 6: Steady State Ratios

	Data	**Model**	**Data Sources**
Housing rental Share, H_z/H	0.069	0.068	Survey data
Share of housing w/ mortgage, H_b/H	0.104	0.172	Survey data
Rent over housing price, q_z/q_h	0.015	0.015	National Bank of Poland, 2007-2015
Residential investment / GDP, $q_h IH/GDP$	0.033	0.034	OECD, 2007-2015
Construction labor share, $L_{h/}(L_c + L_h)$	0.076	0.077	OECD, 2007-2015

Table 7: Steady-state effects of rental market reforms

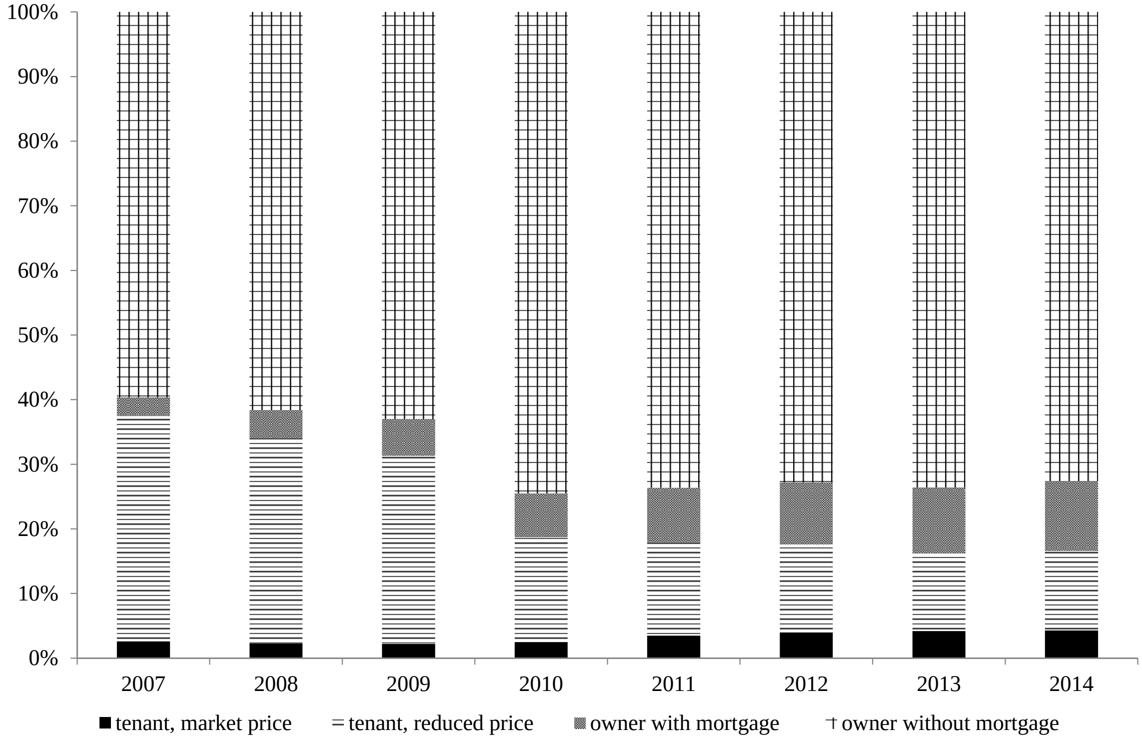
	Benchmark	Neutral taxes $\tau_z = 0$	Lower bad tenant risk $\delta_z = 0.75\%$	Professional rental services $\omega_h = 0.5$	Combined
Housing rental Share	0.068	0.077	0.091	0.104	0.150
Share of housing w/ mortgage	0.172	0.167	0.160	0.132	0.113
Rent over housing price	0.015	0.015	0.0125	0.015	0.0125
Residential investment / GDP	0.034	0.034	0.034	0.034	0.034
Construction labor share	0.077	0.077	0.076	0.077	0.077

Figure 1: The structure of housing tenure status in European countries in 2014.



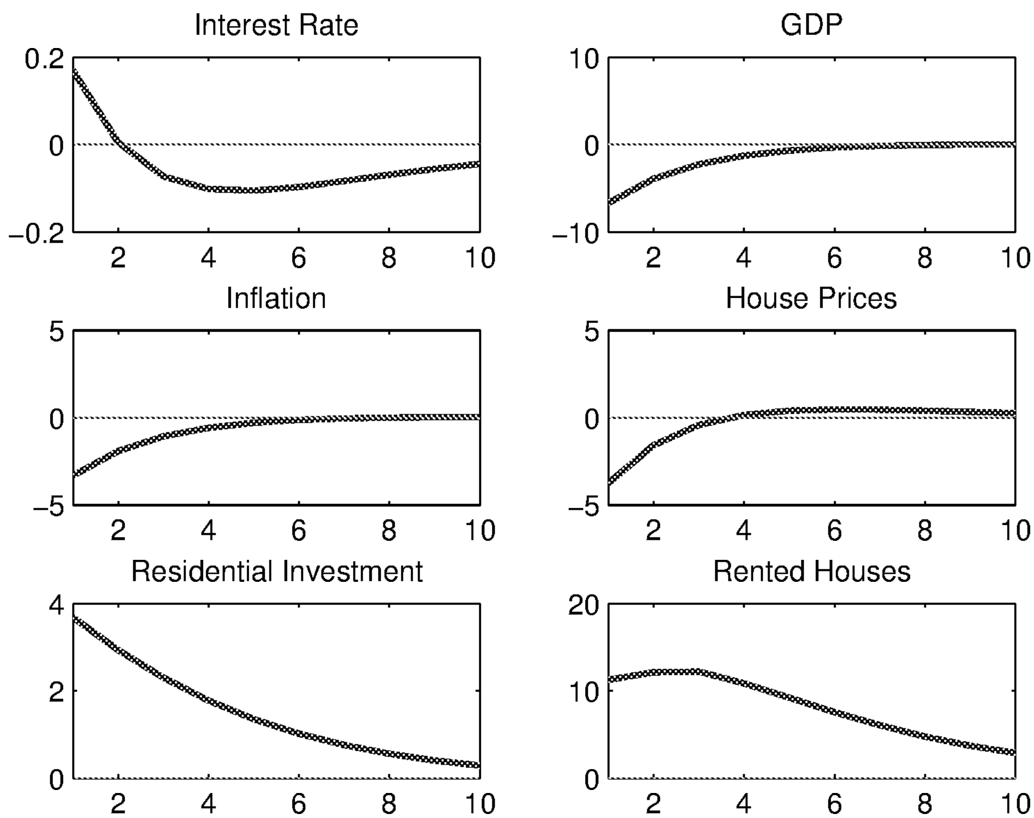
Source: Eurostat.

Figure 2: The structure of housing tenure status in Poland over 2007-2014.



Source: Eurostat.

Figure 3: Impulse responses to a monetary policy shock.



Individual Payoffs and the Effect of Homeownership on Social Capital Investment

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Abstract

Are all social capital investments equal in the eyes of homeowners and renters? Presumably, social capital investments that lead to increases in home values provide stronger incentives for homeowners than renters. In contrast, for social capital investments that do not directly impact home values, one would not expect homeowners and renters to differ in their investment rates. In this paper, we test this hypothesis using confidential and detailed individual-level panel data from Los Angeles county. We estimate the effect of homeownership on social capital investment, i.e., participation in social-capital creating activities, using a bivariate probit model and fixed effects models that control for individual-specific, time-constant heterogeneity that would otherwise cause omitted variable bias. Each model addresses the endogeneity of homeownership differently with identification arising from different sources. We find strong evidence that homeownership increases the rate of participation in block meetings, a social capital investment that should affect property values, and find no homeownership effect on three other social capital creating activities that likely do not: volunteerism, participation in a local political organization, and participation in a civic group. The results suggest that the effect of homeownership on social capital investment depends on whether the returns to such investments accrue solely to homeowners.

Keywords: Social Capital, Homeownership, Housing externalities
JEL Classifications: R20, R21, D62

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1. Introduction

A popular argument in support of widespread homeownership is that homeownership generates positive externalities. For example, homeownership is argued to increase participation in social-capital creating activities, or *investment in social capital*. Implicit in such an argument is that homeownership changes an individual's behavior by increasing the incentives to invest. That is, just as a homeowner chooses to improve her property if she reaps some individual benefit, a homeowner is more likely to invest in social capital that, say, improves her community when the returns to such investment is expected to be recouped through a higher home value. In contrast, a renter would lack this monetary incentive and would be relatively less likely to invest in such social capital since any pecuniary payoff from community-specific investments accrues only to landlords. Consequently, we expect participation rates in social capital activities to differ the most between homeowners and renters for those activities that have direct bearing on property values.[1]

A natural way to test whether homeowners invest more in a particular form of social capital than do renters is to compare the social capital investment rates of homeowners and renters. This approach, however, is plagued by a particular difficulty: homeownership is likely an endogenous variable since the qualities that make an individual invest in social capital may be

[1]Readers interested in the theoretical model of social capital investment and homeownership from which this intuition is derived should refer to DiPasquale and Glaeser (1999). A more general model of social capital investment can be found in Glaeser, Laibson, and Sacerdote (2002).

the same qualities that determine homeownership. Endogeneity could potentially be addressed using instrumental variable estimation or with access to panel data, either of which is a rare empirical luxury. Consequently, the causal effect homeownership has on social capital investment is still an open question.

In this paper we use a confidential dataset, the Los Angeles Family and Neighborhood Survey (L.A.FANS), to test the hypothesis that relative to renters, homeowners invest more in social capital when there are higher individual payoffs to homeowners. Because of the structure of our data, we can use both instrumental variable estimation and panel data methods. This allows us to identify the relationship between social capital investment and homeownership from two very different, and what we believe to be, credible sources of variation. We estimate a bivariate probit model that identifies the homeownership effect using the exogenous variation of anticipated changes in real wages. We then estimate two fixed effects models – the logit fixed effects model and the linear fixed effects model – to identify the homeownership effect by measuring how social capital investment changed over time in response to changes in homeownership status conditional on individual-specific time-constant unobserved heterogeneity.

The L.A. FANS dataset contains four different activities: participation in block or neighborhood meetings, volunteerism in a local organization, participation in a business or civic group, and participation in a local or state political organization. Of these, only participation in block or neighborhood meetings directly affects neighborhood and community quality and thus property values. Finding that homeownership encourages participation in block or neighborhood meetings but not these three other activities is therefore consistent with our hypothesis that social capital investment is like most economic activities in which payoffs matter.

We do in fact find strong evidence for a positive, large effect of homeownership on the rate of participation in block meetings in both the bivariate probit model and the fixed effects models. The bivariate probit model estimates that a homeowner is 32 percentage points more likely than a renter to participate in a block meeting, and the linear fixed effects model estimates the effect to be about 15 percentage points. The logit fixed effects model estimates the direction of the effect to be positive and significant. We find no significant homeownership effect on the three other participation variables. This suggests that, unlike participation in a block meeting, the payoffs to participating in these three social capital creating activities do not differ between owner and renter.

The paper is organized as follows. The next section discusses the relevant literature. Section 3 contains the model and estimation approach, Section 4 contains a description of the data, and Section 5 discusses the results. We conclude in Section 6.

2. Literature Review

The concept of social capital has its origin in sociology. Portes and Landolt (1996) attribute the genesis of the concept to the early sociological works in the nineteenth-century. The term social capital was first used by sociologist Bourdieu (1986) to refer to access to resources that accrue to people through membership in certain communities. Following Putnam (1993)'s finding of a positive correlation between civic engagement and government quality, there was a surge in empirical research estimating the *effects* of social capital on socio-economic outcomes. These early studies seemingly found a positive relationship between social capital and economic or labor outcomes (for example, see Furstenberg and Hughes (1995) and Knack and Keefer (1997)). However, many of these studies suffer from identification problems that arise due to endogeneity issues. Durlauf (2002), in his persuasive and insightful critique, discusses the identification pitfalls contained in many of these oft cited studies.

Another strand of literature apart from the empirical studies on the *effects* of social capital seeks to identify the *mechanisms* behind the creation of social capital. Some early papers include Rossi and Weber (1996) and Rohe and Stegman (1994). Rossi and Weber (1996), using data from the General Social Survey (GSS), find that homeowners are more "consistently engaged" in local politics and are more likely to vote in national elections.[2] Rohe and Stegman (1994) find that homeowners are more likely to participate in neighborhood and block associations but are not that different from renters in terms of church, school and political organizations involvement.

These papers suffer a similar identification problem; unobservables may determine homeownership and social capital investment simultaneously.[3] For instance, individuals who have a taste for homeownership may also have a predilection for being politically active or forming social ties within their

[2]For a review of voting behavior and homeownership, see Herbert and Belsky (2006).

[3]See Dietz and Haurin (2003) for a comprehensive review of this problem along with an extensive discussion of the social benefits and costs of homeownership.

communities. That is, homeownership is likely an endogenous variable which creates both an omitted variable problem and selection bias, rendering inconsistent estimates.

More recent studies on social capital and homeownership are more conscious of the problem of omitted variables bias and selection effects. However, their results, seen as a whole, are largely inconclusive. For example, DiPasquale and Glaeser (1999) find that in the United States homeownership has a positive effect on participation in *all* social capital activities in their data, perhaps because the identification of their model comes from using average homeownership rates within an income quartile, race and state – an instrument that they admit is "less than perfect."[4] Engelhardt et al. (2010) make use of exogenous variation arising from a program that subsidized saving for home purchases that was randomly made available to a group of low-income households in Tulsa, Oklahoma. For some activities, they find evidence of no effect or a negative effect of homeownership; for other activities, their results are not conclusive, perhaps because of their small sample size or their use of a weak instrument. Hilber (2010), exploring the link between housing supply and social capital, finds that homeowners in more built-up areas have a greater incentive to invest in social capital.

[4]DiPasquale and Glaeser (1999) also use a German panel dataset to test whether an individual become better citizens after he or she had become a homeowner. They find that the effect of homeownership is weak.

3. Models and Estimation

Our data comes from a confidential version of the Los Angeles Family and Neighborhood Survey (L.A.FANS) which contains household-level panel data from 65 census tracts in Los Angeles County. The panel data allows us to estimate two different types of models: a bivariate probit model and fixed effects models. Each model approaches the endogeneity of homeownership differently with identification arising from different sources. The benefit of taking two different approaches to estimation is credibility of the results. If the results share a similar interpretation, as ours do, the conclusions should be more convincing. We now discuss the details of the two types of model.

The bivariate probit model accounts for endogeneity of homeownership by specifying a second equation which models the relationship between homeownership and an exogenous source of variation. In other words, identification of the effect of homeownership on social capital investment arises from an exogenous instrument that affects social capital investment only through homeownership. The challenge, of course, is to find a believable source of exogenous variation, which in many cases proves challenging.

The second type of model we estimate are fixed effects models. The logit fixed effects model and the linear fixed effects model identify the effect of homeownership on social capital investment with an entirely different identification approach than the bivariate probit. Instead of using the exogenous variation of an instrument, fixed effects models control for endogeneity by removing person-specific, time-constant unobserved heterogeneity that is correlated with homeownership. Estimation and identification of the model arises from how the dependent variable changes in response to changes in explanatory variables. This approach relies on fewer parametric assumptions than the bivariate probit model, and allows for more general forms of endogeneity.

3.1. Bivariate Probit Model

The bivariate probit model allows instrumenting of the endogenous homeownership, a discrete variable, in a probit model by specifying an additional equation that is analogous to the first stage of the two stage least squares.

As such, the bivariate probit model comprises two components: a social capital equation and a homeownership equation. Formally, we specify the latent propensity to own, I^*, as

$$I^* = \gamma Z + \epsilon$$

where Z is a vector of observable variables, γ is a vector of parameters, and ϵ is an error term. A person is a homeowner ($I = 1$) if $I^* > 0$, and a renter ($I = 0$) otherwise.

Further, assume that a person's latent propensity to participate in a particular social capital creating activity is $y^* = \delta I + \beta X + \nu$, where I is the observed indicator variable of homeownership, X is a vector of observable variables, β is a vector of parameters, and ν is an error term. A homeowner participates in the activity if $y^* > 0$. We can write the model succinctly as:

$$\begin{aligned} I^* &= \gamma Z + \epsilon, \quad I = 1 \ \text{ iff } \ I^* > 0, \quad I = 0 \text{ otherwise} \\ y^* &= \delta I + \beta X + \nu, \quad y = 1 \ \text{ iff } \ y^* > 0, \quad y = 0 \text{ otherwise} \end{aligned} \tag{1}$$

The error terms ϵ and ν are normally distributed with means zero and variances normalized to 1, and the correlation between ϵ and ν is denoted as

ρ. Even though the model is identified by non-linearity, the results are more believable if an instrument for I is included in Z. We discuss our instrument, future change in real wages, below in the data section.

For each activity, the log-likelihood function is

$$
\begin{aligned}
\ln L = \sum_{i=1}^{N} \Big\{ & (1 - I_i) \cdot (1 - y_i) \cdot \ln \Phi \left(\gamma Z_i, \beta X_i, \rho\right) \\
& + (1 - y_i)\, I_i \cdot \ln \Phi \left(-\gamma Z_i, \delta + \beta X_i, -\rho\right) \\
& + y_i\, (1 - I_i) \cdot \ln \Phi \left(\gamma Z_i, -\beta X_i, -\rho\right) \\
& + I_i \cdot y_i \cdot \ln \Phi \left(-\gamma Z_i, -\delta - \beta X_i, \rho\right) \Big\}
\end{aligned}
\tag{2}
$$

The maximum likelihood estimators are consistent and asymptotically normally distributed.

The marginal effect of ownership is the effect ownership has on the probability of participation. For the bivariate probit model in (1), the marginal effect of homeownership for a person with characteristics X is the difference between the probability of participation of the person as an owner and as a renter:

$$
\begin{aligned}
\textit{marginal effect} \;&=\; \mathrm{P}\left(y = 1 \mid I = 1, X\right) - \mathrm{P}\left(y = 1 \mid I = 0, X\right) \\
&=\; \Phi\left(\delta + \beta X\right) - \Phi\left(\beta X\right).
\end{aligned}
\tag{3}
$$

3.2. Fixed Effects Models

We estimate two fixed effects models: the fixed effects logit model and the linear fixed effects model. Both models control for individual-specific, time-constant heterogeneity, eliminating common causes of omitted variable bias such as a time-constant predilection for social participation. We estimate both models as each have positive and negative aspects. However, as our discussion in the results section below will show, both models produce similar results.

Fixed effects logit is appealing because it explicitly accounts for the discreteness of homeownership. Though discreteness of the dependent variable does not violate the assumptions of the linear regression model, it does cause some well-known and undesirable properties such as prediction outside the unit interval. A strength of the fixed effects logit is also a limitation: allowing unobserved heterogeneity to be arbitrarily related to the explanatory variables means that only the sign of the homeownership effect is identified, and not the magnitude, in contrast to the linear model in which both are identified.

Fixed effects logit removes any time-constant heterogeneity with a clever transformation. Let the probability of individual i's participation in a particular activity be:

$$\mathrm{P}\left(y_{it}=1 \mid I_{it}, X_{it}, c_i\right)=\Lambda\left(\delta I_{it}+\beta X_{it}+c_i\right), \tag{4}$$

where $\Lambda(\cdot)$ is the logistic function and c_i is unobserved heterogeneity. The transformation to the model removes c_i and results in the likelihood function below. For $T=2$ periods of data:

$$\begin{aligned}\ln L=\sum_{i=1}^{N} \quad & n_i\Big\{w_i \cdot \ln \Lambda\left\{\delta\left(I_{i2}-I_{i1}\right)+\beta\left(X_{i2}-X_{i1}\right)\right\} \\ & +\left(1-w_i\right) \cdot\left(1-\ln \Lambda\left\{\delta\left(I_{i2}-I_{i1}\right)+\beta\left(X_{i2}-X_{i1}\right)\right\}\right)\Big\},\end{aligned} \tag{5}$$

where $w_i=1$ if $\Delta y_i=y_{i2}-y_{i1}=1$ and $w_i=0$ if $\Delta y_i=y_{i2}-y_{i1}=-1$. The term $n_i = 1$ if $\Delta y_i \neq 0$ and zero otherwise. That is, $n_i = 1$ if there was a change in participation from period 1 to 2.

By the presence of n_i and $I_{i2} - I_{i1}$ in (5) (and in the sum of squared residuals of the linear fixed effects model), one can see that δ is identified by whether and in which direction participation changes when the homeownership status changes. Consequently, only individuals who switch participation status - those that participated in the first period and did not participate in the second period, or, vice versa - contribute to the estimation. The intuition is straightforward. If participation changed when homeownership status did not, homeownership was not a contributing factor. If the change in participation was often in the same direction as the change in homeownership status, then the estimate of effect of homeownership on social capital investment is positive.

Maximum likelihood estimators of (5) are consistent and are asymptotically normally distributed. For further details of the transformation and estimation, see Wooldridge (2010).

4. Data

The Los Angeles Family and Neighborhood Survey (L.A.FANS) collected longitudinal data on neighborhoods, families, children, and on residential choice and neighborhood change from 65 census tracts in Los Angeles County. Wave 1 of the data was collected from April 2000 to January 2002. Wave 2 was collected from the fall of 2006 to November 2008.[5] The confidential

[5]See Peterson et al. (2004) for a full description of the survey.

version of the dataset that we use identifies each household's census tract, which allows us to include important neighborhood information such as median house values and population density. We include working adults between the age of 25 and 65 who were sampled in both waves. In total, our sample consists of 728 observations of 364 individuals.

Table 1 contains summary statistics for the full sample, for owners, and for renters. Our participation variables are in the first five rows: 21% of the sample volunteered in a local organization (*volunteer*), 14% participated in a neighborhood or block meeting (*block meeting*), 8% participated in a business or civic group (*civic group*), and 7% participated in a local or state political organization (*political organization*). About 50% of the sample are homeowners. Owners are more likely to be married, older, and have higher (real) wages and (real) non-housing wealth and education levels. Finally, in our sample, homeowners live in census tracts with a median house value about $19,000 higher than the median house value in the renters' census tracts and the tracts are 0.5% less dense.

The (unconditional) marginal effect of homeownership on the participation variables and the standard deviation are reported in Table 2. These values are the differences between the participation rates of owners and of renters in the sample. One can see that for each of the participation variables, homeowners are more likely to participate than renters, in some cases by a large margin, and all results are significant at the 1% level. For instance, the rate of volunteerism of homeowners is 19.9 percentage points higher than renters. Homeowners are more likely than renters to attend block meetings by 15.2 percentage points. We do not see as great a difference in the relative likelihood of participation in a civic group or in a political organization, though this is not too surprising since the aggregate participation rate of each of these activities is low. Relative to renters, owners are 7.7 percentage points more likely to participate in a civic group and 5.0 percentage points more likely to participate in a political organization. The models estimated below will determine whether these effects persist after including control variables and accounting for selection into ownership.

4.1. Instrumental Variable in the Bivariate Probit Model

To address the endogeneity of homeownership in the bivariate probit model, we instrument using *change in real wage* from wave 1 to wave 2 of the survey. This variable is meant to capture anticipated changes in earnings, which should in turn affect current homeownership. For example, consider two individuals with identical characteristics, including current wage, except that one anticipates an increase in wage in the future and the other expects no change in wage. The former individual is more likely to own today than the latter.[6] As long as anticipated future earnings does not affect the current decision to participate, the instrument is valid.

One possible mechanism that would void exogeneity is the following. Suppose that individuals work more hours currently with the hope of increasing wages in the future. If the extra work crowds out participation, then our instrument is not valid. In unreported regressions, we find that, in fact, the number of hours worked in the first wave has no relationship to change in real wages. Moreover, as a robustness check we included hours worked as an

[6] See Olsen (1987) which discusses the importance of future earnings on housing choices.

additional covariate in the bivariate probit model, and the results did not change.

Besides endogeneity of homeownership, one might also worry that a social-minded individual may choose to live in neighborhoods (or census tracts) conducive to social interaction and that also tend to have high homeownership rates such as suburban neighborhoods. Following Brueckner and Largey (2008), who find that lower population density encourages social participation, we include the natural log of population density of the census tract as a control variable to account for such sorting.

Finally, a concern discussed in DiPasquale and Kahn (1999) is that renters may choose neighborhoods with higher quality than owners. If this is the case, then our estimate of the homeownership effect can be treated as a lower bound under the reasonable assumption that social capital and unobserved neighborhood quality are positively correlated. Moreover, any bias should be relatively small since we have included neighborhood level explanatory variables, including median house value, that should control somewhat for unobserved neighborhood quality. (DiPasquale and Kahn (1999) find that house value is correlated with many of their measures of neighborhood quality.)

5. Results

In this section, we first provide descriptive results from a probit model with homeownership as the dependent variable and probit models of participation in various social capital activities, treating homeownership as an exogenous covariate. These models allow us to contrast the results with our preferred models, the bivariate probit model, which instruments for homeownership, and fixed effects models that control for individual-specific, time-constant heterogeneity that is correlated with homeownership. Even though the identification approach of these two types of models differ, we will see that they lead us to the same conclusion: homeownership has a significant effect only on participation in a block or neighborhood meeting, the social capital investment with the most direct impact on house values.

5.1. Homeownership and Participation Probit Regressions

Table 3 contains estimates of a probit model of ownership. The model is estimated using the first wave of the sample data to correspond with the wave used to estimate the bivariate probit. This model is analogous to the first stage of a two-stage least squares regression, and is a consistent quasi-maximum likelihood estimator of the homeownership equations of the bivariate probit models we estimate later (see Avery et al. (1983)).

The signs of the estimates are as expected, and most of the estimates are significant. Being married, being older, having more children, earning a higher wage, having greater wealth, and more education all have positive and significant effects on homeownership. Higher median house value and density are associated with decreased ownership. Our instrument, change in the real wage, has the expected positive sign and is statistically significant at the 5% level, indicating that, all else equal, individuals who expect an increase in wages in the future are more likely to own.[7]

[7]While there exists a clear rule of thumb to gauge whether an instrument is weak in a linear model (Stock and Yogo, 2005), we are not aware of any similar guide for non-linear

Table 4 contains estimates of participation probit models. We estimate univariate probits using wave 1 data as well as random effects probit. Since homeownership is the variable of interest here, we compute the marginal effect of ownership for all participation variables, presented in the last row. For all the participation variables, we see that adding control variables to the analysis reduces the estimated marginal effects below the unconditional estimates in Table 2. The marginal effect of homeownership on *volunteer* for both probit models is 0.11. For *block meeting*, the simple probit estimates a marginal effect of 0.15, slightly above the 0.13 estimate from the random effects probit model. All these marginal effects are statistically significant. The marginal effects of homeownership on the other two participation variables are positive but close to zero and not statistically significant. This is not completely unexpected since the overall rate of participation in *civic group* and *political organization* is small, and any homeownership effect is likely small, if not zero, and it may be difficult to accurately estimate the effect given the relatively small sample size.

Bearing in mind that we are not yet controlling for endogeneity of homeownership, the estimates in Table 4 nonetheless indicates some patterns. For example, having more education has a positive and significant effect on social capital investment. Older people are more likely to participative in block or neighborhood meetings, and wages have a positive effect on *volunteer* and *civic group*.

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models such as the bivariate probit.

5.2. Bivariate Probit

Table 5 contains the estimates of the bivariate probit model. The estimates of the homeownership equation are similar to those found in Table 3, as expected. The more interesting results are found in the participation equation. We see that for three of the participation variables, *volunteer*, *civic group*, and *political organization*, ownership has no effect. In contrast, the marginal effect of ownership on *block meeting* is positive, large, and statistically significant at the 5% level. The results indicate that an owner is 32 percentage points more likely to participate in a block or neighborhood meeting than a renter. Moreover, the results tell us that when selection into homeownership is accounted for, the positive effect of homeownership on *volunteer* goes away.

These results suggest that homeownership effects are only present for an activity that is most directly linked to a homeowner's self interest as renters are less likely to invest their time attending block meetings since any improvements of the community or neighborhood potentially results in higher property values and such appreciation only accrues to the landlords, the homeowners.

5.3. Fixed Effects Models

Tables 6 and 7 contain the estimates of the logit fixed effects models and the linear fixed effects model. For each participation variable, two specifications were estimated, one with ownership alone and one with additional time varying explanatory variables.[8] The linear fixed effects model is estimated with 728 observations. Due to the nature of the transformation, and the necessity for switches in participation across waves, there are many fewer observations for estimation of the logit fixed effects model (82 for *volunteer*, 72 for *block meeting*, 36 for *civic group*, and 42 for *political organization*). Nonetheless the estimated effect of homeownership in both models is similar to that found in the bivariate probit model. Ownership has a positive and significant effect on *block meeting*. Further, we see from the linear model that the magnitude of the homeownership effect on *block meeting* is estimated to be about 15 percentage points. That is, an owner is about 15 percentage points more likely to participate in a block or neighborhood meeting than a renter. The effect of homeownership on the other three participation variables is not statistically significant. Since the model is identified by the response of participation to switches in homeownership status, the estimates indicate that such switches in the data are positively correlated to switches in *block meeting*, while the other three participation variables are either not responsive to homeownership switches or move in opposing directions or both. Moreover, finding that *block meeting* responded to homeownership switches that the other participation variables did not respond to could indicate that, even if there is a positive effect of homeownership on these three activities that we are not able to tease out in this dataset, the effect must be less important than the effect we find on *block meeting*.

[8] Time-invariant explanatory variables are removed with the transformation to remove time-invariant heterogeneity. Further, we drop variables that change infrequently such as education level and age bins.

6. Conclusion

In this paper, we test the relationship between homeownership and social capital with two types of models, a bivariate probit and fixed effects models, using individual-level data on participation in social-capital creating activities within Los Angeles county. The advantage of using two types of models is that each deals with unobserved heterogeneity in a different way, providing different identification schemes of the the effect of homeownership on social capital investment. We find that both types of models tell a similar story. Homeownership encourages participation in block and neighborhood meetings, but there is no significant effect on three other participation variables: volunteering, participation in a civic group, and participation in a local political organization. These results are consistent with the hypothesis that homeowners are more incentivized to invest in social capital that directly affects neighborhood quality and, consequently, their property values, than renters are. The payoffs to participating in the three other social capital activities seemingly do not differ by owner and renter.

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	Full Sample		Owners		Renters	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Volunteer	0.212	0.409	0.311	0.464	0.112	0.316
Block meeting	0.136	0.343	0.212	0.409	0.060	0.238
Civic group	0.077	0.267	0.116	0.320	0.038	0.192
Political organization	0.071	0.258	0.096	0.296	0.047	0.211
Own	0.499	0.500	1.000	0.000	0.000	0.000
Education						
High school or less	0.427	0.495	0.298	0.457	0.556	0.497
Some college	0.295	0.457	0.350	0.478	0.241	0.428
College	0.169	0.375	0.196	0.397	0.142	0.350
Prof. School	0.109	0.311	0.157	0.364	0.060	0.238
Latino	0.538	0.499	0.408	0.492	0.668	0.471
Married	0.604	0.489	0.719	0.450	0.490	0.501
Number of children	1.415	1.215	1.413	1.248	1.416	1.182
Age						
25 - 30	0.095	0.293	0.036	0.186	0.153	0.361
30 - 40	0.353	0.478	0.287	0.453	0.419	0.494
40 - 50	0.367	0.482	0.441	0.497	0.293	0.456
50+	0.185	0.389	0.237	0.425	0.134	0.341
Real wage ($1000's)	31.85	25.66	40.65	28.13	23.09	19.33
Real non-housing wealth ($1000's)	114.49	248.46	186.22	304.90	43.15	143.56
Ln(Census-tract median house value)	12.20	0.45	12.25	0.47	12.16	0.41
Ln(Census-tract density)	9.09	1.08	8.71	1.13	9.46	0.87
Wave 2	0.500	0.500	0.562	0.497	0.438	0.497
Change in real wage	3.073	19.582	2.344	23.849	3.639	15.526
Number of observations	728		363		365	

Table 1: Summary Statistics

	Mean	Std. Dev.
Volunteer	0.199 ***	0.030
Block meeting	0.152 ***	0.025
Civic group	0.077 ***	0.020
Political organization	0.050 ***	0.019

Table 2: Unconditional Marginal Effect of Homeownership on Participation

	Ownership	
	Coef.	Std. Err.
Change in real wage	0.01 **	0.00
Some college	0.49 **	0.21
College	0.30	0.27
Prof. School	0.51	0.35
Latino	0.12	0.20
Married	0.29 *	0.17
Number of children	0.16 **	0.08
Age 30 - 40	0.36	0.25
Age 40 - 50	0.96 ***	0.25
Age 50+	1.48 ***	0.33
Real wage	0.03 ***	0.01
Real non-housing wealth	0.00 **	0.00
Ln(median house value)	-0.92 ***	0.27
Ln(density)	-0.38 ***	0.09
Constant	12.13 ***	3.34

Table 3: Ownership Probit Regressions

	Volunteer				Block meeting				Civic group				Political organization			
	Wave 1 Probit		Random Effects Probit		Wave 1 Probit		Random Effects Probit		Wave 1 Probit		Random Effects Probit		Wave 1 Probit		Random Effects Probit	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Own	0.50 **	0.20	0.56 ***	0.17	0.80 ***	0.22	0.86 ***	0.21	0.44	0.30	0.42	0.27	0.04	0.30	0.12	0.21
Some college	0.52 **	0.24	0.76 ***	0.21	0.44 *	0.26	0.27	0.22	0.48	0.35	0.26	0.32	0.96 **	0.47	0.72 ***	0.28
College	0.65 **	0.29	0.94 ***	0.26	0.66 **	0.30	0.62 **	0.27	0.61	0.40	0.65	0.40	1.16 **	0.51	0.77 **	0.33
Prof. School	1.25 ***	0.34	1.19 ***	0.29	0.36	0.37	0.16	0.32	0.54	0.47	0.37	0.45	1.47 ***	0.53	1.23 ***	0.35
Latino	-0.46 **	0.21	-0.45 **	0.19	-0.14	0.23	0.02	0.20	0.06	0.28	-0.26	0.28	0.15	0.31	0.02	0.22
Married	-0.07	0.19	-0.14	0.16	-0.29	0.20	-0.19	0.17	-0.23	0.27	-0.31	0.25	0.21	0.29	0.17	0.20
Number of children	0.03	0.08	0.10	0.07	0.08	0.08	0.02	0.07	0.15	0.10	0.16	0.10	0.04	0.12	-0.11	0.09
Age 30 - 40	0.16	0.28	0.36	0.26	0.75 *	0.44	0.73 **	0.35	0.13	0.52	-0.27	0.40	0.02	0.43	0.06	0.31
Age 40 - 50	0.08	0.29	0.32	0.27	1.03 **	0.44	0.87 **	0.35	0.79	0.50	0.12	0.39	0.02	0.45	-0.03	0.31
Age 50+	0.13	0.38	0.29	0.30	1.02 **	0.49	0.68 *	0.37	0.20	0.66	0.10	0.44	0.49	0.52	0.24	0.34
Real wage	0.01 *	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01 ***	0.00	0.01 ***	0.00	0.00	0.00	0.00	0.00
Real non-housing wealth	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ln(median house value)	-0.24	0.24	0.27	0.19	-0.06	0.25	-0.04	0.21	-0.22	0.32	-0.20	0.28	0.28	0.34	0.15	0.23
Ln(density)	0.11	0.09	0.13	0.08	0.11	0.10	0.10	0.08	0.08	0.13	-0.04	0.11	0.08	0.15	0.00	0.09
Wave 2			0.14	0.14			-0.31 **	0.15			-0.01	0.20			0.20	0.18
Constant	0.11	2.98	-6.77 ***	2.55	-2.97	3.13	-3.18	2.68	-1.31	3.90	-0.12	3.56	-7.22	4.59	-4.36	3.07
Own marginal effect	0.11 **	0.04	0.11 ***	0.03	0.15 ***	0.04	0.13 ***	0.03	0.04	0.03	0.02	0.02	0.00	0.03	0.01	0.02

Table 4: Participation Probit Regressions

	Volunteer				Block meeting				Civic group				Political organization			
	Participation		Own		Participation		Own		Participation		Own		Participation		Own	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Own	-0.22	0.80			1.63 **	0.75			0.84	0.74			0.11	0.73		
Change in real wage			0.01 **	0.00			0.01 *	0.00			0.01 **	0.00			0.01 **	0.00
Some college	0.60 **	0.24	0.50 **	0.21	0.31	0.29	0.52 **	0.21	0.41	0.37	0.49 **	0.21	0.95 **	0.48	0.49 **	0.21
College	0.69 **	0.28	0.32	0.27	0.54 *	0.33	0.32	0.27	0.56	0.41	0.29	0.27	1.15 **	0.51	0.30	0.27
Prof. School	1.30 ***	0.33	0.47	0.34	0.23	0.38	0.55	0.34	0.49	0.48	0.51	0.35	1.45 ***	0.54	0.50	0.35
Latino	-0.44 **	0.21	0.16	0.20	-0.12	0.22	0.13	0.20	0.06	0.28	0.10	0.20	0.15	0.31	0.12	0.20
Married	0.01	0.20	0.28	0.17	-0.35 *	0.20	0.30 *	0.17	-0.27	0.27	0.29 *	0.17	0.20	0.29	0.29 *	0.17
Number of children	0.06	0.08	0.15 *	0.08	0.06	0.09	0.16 **	0.08	0.14	0.10	0.17 **	0.08	0.04	0.12	0.16 **	0.08
Age 30 - 40	0.26	0.29	0.37	0.24	0.65	0.43	0.38	0.25	0.07	0.52	0.35	0.25	0.01	0.44	0.36	0.25
Age 40 - 50	0.29	0.36	0.94 ***	0.25	0.78	0.49	0.99 ***	0.25	0.66	0.55	0.95 ***	0.26	-0.01	0.50	0.96 ***	0.26
Age 50+	0.44	0.49	1.48 ***	0.33	0.68	0.57	1.49 ***	0.33	0.04	0.70	1.48 ***	0.33	0.46	0.60	1.48 ***	0.33
Real wage	0.01 **	0.01	0.03 ***	0.01	0.00	0.01	0.03 ***	0.01	0.01 *	0.01	0.03 ***	0.01	0.00	0.01	0.03 ***	0.01
Real non-housing wealth	0.00	0.00	0.00 **	0.00	0.00	0.00	0.00 **	0.00	0.00	0.00	0.00 **	0.00	0.00	0.00	0.00 **	0.00
Ln(median house value)	-0.35	0.26	-0.87 ***	0.27	0.08	0.27	-0.92 ***	0.27	-0.15	0.34	-0.90 ***	0.27	0.28	0.35	-0.92 ***	0.27
Ln(density)	0.03	0.12	-0.37 ***	0.09	0.18 *	0.11	-0.38 ***	0.09	0.11	0.14	-0.37 ***	0.09	0.09	0.16	-0.38 ***	0.09
Constant	2.14	3.62	11.45 ***	3.39	-5.20	3.58	12.15 ***	3.32	-2.40	4.33	11.89 ***	3.37	-7.32	4.90	12.12 ***	3.34
Rho	0.43	0.44			-0.55	0.44			-0.26	0.60			-0.05	0.91		
Own marginal effect	-0.05	0.18			0.32 **	0.16			0.09	0.10			0.01	0.07		

Table 5: Bivariate Probit Regressions

	Volunteer				Block meeting				Civic group				Political Organization			
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Own	0.37	0.58	0.40	0.65	1.95 ***	0.68	2.04 ***	0.80	0.81	0.85	-0.10	1.36	-0.14	0.82	-0.42	0.91
Married			-0.30	0.64			-0.09	0.77			-0.73	1.27			0.90	0.78
Number of children			0.32	0.25			0.24	0.26			1.39 ***	0.61			0.11	0.35
Real wage			0.01	0.01			0.03 *	0.02			0.00	0.03			0.00	0.01
Real non-housing wealth			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Ln(median house value)			-0.53	1.27			-1.70	1.74			-1.03	2.34			-0.54	1.73
Ln(density)			0.23	0.53			-0.57	0.52			0.65	0.65			-0.55	0.78
Constant	0.45 *	0.24	0.55 **	0.26	-0.55 **	0.27	-0.64 **	0.32	0.28	0.35	1.12 *	0.62	0.61 *	0.34	0.66 *	0.38

Table 6: Logit Fixed Effects Regressions

	Volunteer				Block meeting				Civic group				Political organization			
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Own	0.07	0.06	0.07	0.06	0.15 ***	0.05	0.14 ***	0.05	0.04	0.04	0.04	0.04	0.01	0.04	0.01	0.04
Married			-0.03	0.06			-0.03	0.06			-0.02	0.04			0.07	0.04
Number of children			0.02	0.02			0.02	0.02			0.03 **	0.01			-0.01	0.02
Real wage			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Real non-housing wealth			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00
Ln(median house value)			-0.10	0.11			-0.20 ***	0.10			-0.17 **	0.07			-0.01	0.08
Ln(density)			0.02	0.04			-0.01	0.04			0.02	0.03			0.00	0.03
Constant	0.18 ***	0.03	1.23	1.50	0.06 **	0.03	2.57 *	1.39	0.06 ***	0.02	1.80 *	0.98	0.06 ***	0.02	0.12	1.07

Table 7: Linear Fixed Effects Regressions

The Performance of REIT Acquirers in the Post-Merger Period

Chris Ratcliffe

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Monica Keneley

Executive Summary

Mergers and acquisitions are a feature of modern economies. However, research on conventional bidding firms in mergers and acquisitions (M&As) has shown, on average, shareholders are worse off in the long-run (Alexandridis, Mavrovitis and Travlos, 2012). This study examines the long-term post merger performance of US Equity Real Estate Investment Trusts (REITs) to see if this under-performance extends to the largest REIT sector in the world. In contrast to the earlier REIT data samples used by Campbell, Giambona and Sirmans (2009), we find, prior to the macroeconomic event of the financial crisis, that existing shareholders of bidding firms earn significant and positive abnormal returns. This outcome supports the synergy motive for M&As in the REIT sector. Results from announcements occurring after the onset of the financial crisis show signs of negative and significant abnormal returns, suggesting these M&As were driven by the agency and/or hubris motive.

Keywords REITs, Equity REITs, Mergers and Acquisitions, Post-merger abnormal returns

JEL Classifications G11; G14; G34

INTRODUCTION

Mergers and acquisitions are an ongoing process as markets respond to internal and external pressures. A key issue arising from this activity is the extent to which it promotes efficient market outcomes. From an economic perspective, mergers and acquisitions (M&As) should provide for the efficient management of companies, improved mobility of capital and an efficient allocation of scarce resources (Manne, 1965). However, there is growing evidence of underperformance of bidding firms shares in the years following the M&A announcement (Alexandridis, Mavrovitis and Travlos, 2012, Bessembinder and Zhang, 2013). Jensen and Ruback (1983, p.20) comment 'these post-outcome negative abnormal returns are unsettling because they are inconsistent with market efficiency and suggest that changes in stock prices overestimate the future efficient gains from mergers'. Such arguments are supported by Campbell, Giambona and Sirmans (2009) who argue that these types of results are troubling as they suggest the existence of weak form market efficiency. The ensuing informational problems translate into an inefficient allocation of resources.

Whilst the debate surrounding the issue of post merger performance continues, one issue that has received less attention is that of the motivations of acquiring firms. If acquiring firms do not reap the returns expected, why do they engage in such activities? Berkovitch and Narayanan (1993) identify several motives for M&As; namely the synergy motive, the hubris hypothesis and the agency motive. The post-announcement under-performance of acquirers suggests that the motivation for M&As may be a result of hubris and/or agency issues rather than efficiency considerations (Alexandridis, Mavrovitis and Travlos, 2012, Ang, Yingmei and Nagel, 2008, Conn, Cosh, Guest and Hughes, 2005). If the M&A is motivated by hubris and/or manager's self-interest, this may result in negative abnormal post-announcement performance (Ratcliffe, Dimovski and Keneley, 2015). Savor and Lu (2009) argue that manager's views may be influenced by prior performance and therefore overpay for an acquisition. If this were the case, then it would add support to the hypothesis that weak form market efficiency exists. To test this line of argument the current study explores the performance of the American Real Estate Investment (REIT) market.

The American REIT sector comprises a significant component of the US financial market. The 223 REITS listed on the FTSE in December 2015 had a market capitalisation of $US939 billion (https://www.reit.com/data-research/data/industry-snapshot accessed 28/1/2016). Globally these institutions represent 63.9% of the international REIT market (European Public Real Estate Association). Within the REIT sector, Equity REITs make up the majority of entities and accounted for 94% of market capitalisation of all US REITs (that also includes mortgage REITs) in 2015. Given the size of this market and its contribution to the American economy, analysis of the outcomes of M&As in this market can provide insights into broader performance issues that accompany industry consolidation. The purpose of this paper is twofold. First, to investigate if under-performance extends to the US REIT sector, in particular Equity REITs. Second to examine the motivation(s) of REIT M&As in the post-announcement period. Anderson, Medla, Rottke and Schiereck (2012) argue that the findings of previous studies are inconclusive and leave many questions unanswered. The current study aims to provide further insight into the drivers of M&A decisions.

This paper extends the body of research that has pointed to conflicting performance outcomes post-M&As by Sahin (2005) and Campbell, Giambona and Sirmans (2009). It also considers the impact of market disruption and regulatory change on post-performance results. It utilizes a later dataset that captures the impact of both the introduction of the *REIT Modernization Act* of 1999 and the global financial crisis. The Act paved way for REITs to own up to 100% of a taxable REIT subsidiary and included a reduction in the mandatory payout requirement to 90% of earnings (Howe and Jain, 2004). Howe and Jain (2004) argue that the changes in the regulatory environment as a result of the Act transformed REITs, impacting on their growth, risk and profitability. If such is the case, it could be expected that performance outcomes may have altered. The under performance issues noted in earlier studies may not be as apparent with the change in the market environment.

We examine 63 Equity REIT M&A announcements from 2000 to 2014 over the one, two and three-year event windows. To assess the post-announcement performance of bidders two methodologies are employed. The first is the buy-and-hold abnormal returns (BHAR) method, described by Barber and Lyon (1997). The second is based on the Fama and French (1993) three-factor model. As Gregory (1997) and Limmack (1997) have pointed out, the choice of event study methodology to assess long-term performance can have an important impact on the level of excess returns. Utilizing two different methods will enable the study to test the robustness of the post-announcement performance of bidders.

Prior US REIT research by Campbell, Giambona and Sirmans (2009) and Sahin (2005) has produced mixed results. Sahin (2005) examined REIT acquisitions from 1994 to 1998 and observed a positive and significant median BHAR over the three-year event window. While Campbell, Giambona and Sirmans (2009) detected BHARs over the five-year period to be negative and significant during their study period of 1994 to 2001. Our findings for the full Equity REIT sample from January 2000 to September 2014 suggest that the REIT M&A market is informationally efficient. We find no significant negative abnormal performance post announcement. Moreover, when the sample was separated to take into account the financial crisis we find support for the synergy motive in the pre-financial crisis period. Both BHARs and three-factor model abnormal returns are indeed positive and significant. Post-crisis results show signs of negative abnormal returns, suggesting such synergy motivations had altered It is hypothesised that this result is due to the high volatility and uncertainty in the sector during the crisis, making it difficult for bidders to integrate the assets of the targets and achieve synergistic benefits.

The remainder of this paper proceeds as follows. The literature section reviews the relevant literature in this area providing the context to the present study. Next we describe the data collection process and methodologies employed. The results and discussions are then presented and finally we provide our concluding comments.

LITERATURE REVIEW

This review examines the prior literature in respect to the motivation and performance of REITs following a M&A announcement. The three major motives for M&As collated previously by Berkovitch and Narayanan (1993) provide a useful start. The synergy motive suggests that M&As result in the realisation of economic gains with the merging of the resources of two firms, leading to positive wealth effects for the acquiring firms shareholders (Sudarsanam, Holl and Salami, 1996). The hubris hypothesis argues management make mistakes in evaluating targets and engage in M&As even where there is no synergy (Roll, 1986). If positive gains are observed around announcement it may be that the result is due to true synergies (Roll 1986). However, management may still make errors in valuation resulting in a decline in bidding firm value following the M&A announcement (Dodd, 1980, Kiymaz and Baker, 2008). The agency motive suggests M&As occur because managers pursue their own self-interest, sometimes at the expense of shareholders (Jensen, 1986, Malatesta, 1983, Morck, Shleifer and Vishny, 1990).

Agrawal and Jaffe (2000) provide an extensive review of the post-acquisition literature from 1974 to 1998. The majority of early studies employed either a market model or market adjusted model to calculate the cumulative average abnormal returns (CARs). Results of these early studies show evidence of the hubris and/or agency motive, with acquirers earning negative abnormal returns post-announcement. For example, Ellert (1976), Dodd and Ruback (1977) and Malatesta (1983) all found negative CARs over the post announcement period utilising the market model.

Langetieg (1978) pointed to the possible disadvantages of these early methodologies employed in estimating post merger performance.[1] The author estimated acquirer excess by calculating the difference between the bidding firm's performance and the performance of a non-bidding control portfolio. Results showed that acquiring firms earn insignificant abnormal returns over the one and two-year timeframes. Langetieg (1978) concluded that the control firm approach results are consistent with the efficient market hypothesis.

Buy-and-Hold Abnormal Returns

Kothari and Warner (1997), Barber and Lyon (1997) and Lyon, Barber and Tsai (1999) have criticised the methodologies employed in the early post-announcement studies and recommend the use of a buy-and-hold methodology. Kothari and Warner (1997) argue that the market model approach does not account for possible shifts in the parameters used to calculate expected returns. In addition, Barber and Lyon (1997) contend that the shift in the parameters impacts on excess returns and the variances used to estimate the test statistics. Early results employing BHAR methodology, returned insignificant excess returns over the three-year post announcement period (Higson and Elliott, 1998, Mitchell and Stafford, 2000).

Subsequent studies however, observed significant negative BHARs post-M&A announcement. In the UK, Cosh and Guest (2001), Sudarsanam and Mahate (2003) and Conn, Cosh, Guest and Hughes (2005) observed negative and significant BHARs over the three to four-year post announcement period, ranging from -7.50% to -16.30%. Betton, Eckbo and Thorburn (2007) examined US M&As and found significant negative BHARs of -21.90% over the five-year post-announcement period. Ang, Yingmei and Nagel (2008) also observed negative and significant BHARs of -5.02%. Following on from these US studies, Bouwman, Fuller and Nain (2009) detected negative and significant BHARs of

-7.22%. Finally, Bessembinder and Zhang (2013) found acquirers earn negative and significant BHARs of -7.90% over the five-year post announcement period.

Fama-French Three-Factor Model

Fama and French (1993) propose that the three-factor asset-pricing model be employed to examine long-term abnormal performance because the returns can be described by the size and book-to-market factors. Mitchell and Stafford (2000, p.288) argue 'the systematic errors that arise with imperfect expected return proxies – the bad model problem – are compounded with long-horizon returns'. Mitchell and Stafford (2000) also argue that the BHAR method ignores any cross-sectional dependence of the over-lapping excess returns of individual event firms.

Gregory (1997) examined UK M&As utilising the three-factor model. Results showed bidders earn negative and significant mean monthly abnormal returns (ARs) of -0.75%. This result was supported by later studies examining US acquirers (Gaspar, Massa and Matos, 2005, Mitchell and Stafford, 2000) and Canadian M&As (André, Kooli and L'Her, 2004). All three studies report negative and significant mean monthly ARs ranging from -0.20% to -0.75%.

However, Moeller, Schlingemann and Stulz (2004), observed insignificant non-negative monthly ARs. Similarly, Croci, Petmezas and Vagenas-Nanos (2010) study of UK M&As from 1990 to 2005 also reported insignificant mean monthly ARs. Subsequent studies employing the three-factor model display mixed results. For example, Bouwman, Fuller and Nain (2009), Dutta and Jog (2009) and Latorre, Herrero and Farinós (2014) all observed positive and significant mean monthly ARs, ranging from +0.52% to +0.70%, in their studies of the US, Canadian and Spanish M&A markets respectively. In contrast, Alexandridis, Antoniou and Zhao (2006) report significant negative excess returns of -1.02% in their UK study and Alexandridis, Mavrovitis and Travlos (2012) finds US bidders earn negative and significant mean ARs of -0.25%.

A number of researchers have adopted mixed methodologies to test the robustness of their results. These studies have employed both the BHAR and three-factor methods. Conn, Cosh, Guest and Hughes (2005) observed negative and significant post-announcement performance across both methods.[2] While Croci, Petmezas and Vagenas-Nanos (2010) and Datta, Kodwani and Viney (2013) detected insignificant excess returns in both methodologies. Dutta and Jog (2009) present positive and significant ARs from the three-factor model, but insignificant positive BHARs. Finally, Bouwman, Fuller and Nain (2009) produced completely contrasting results. Three-factor average monthly ARs were +0.66% and significant (equating to a cumulative average AR of +15.84% over the two-year event period), compared to a negative and significant BHAR of -7.22%. Unfortunately, the authors did not provide an explanation for the contrasting results. They did, however, cite Loughran and Ritter (2000) who state that ‘since different methods have different powers of detecting abnormal performance, there should be differences in abnormal return estimates across different methodologies’ (Bouwman, Fuller and Nain, 2009, p.654). This study acknowledges this and therefore employs both methods to provide robustness to the results.

REIT Post-announcement Performance

Research into REIT post announcement shareholder performance has been limited to three papers. Two of these investigated the US REIT market (Campbell, Giambona and Sirmans, 2009, Sahin, 2005) and the other examined the Australian REIT (A-REIT) sector (Ratcliffe, Dimovski and Keneley, 2015). Sahin (2005) investigated the long-term performance of acquiring REITs utilising both the BHAR and three-factor model methods over the three-year post announcement period. The study examined 30 REIT M&As from 1994 to 1998. BHARs results over the three-year event window were +3.56%, however the result was not significant. The median BHAR was significant at the 10% level and positive (+11.62%). These outcomes provide support for the synergy motive for REIT M&As. In contrast, three-factor model results showed acquirers earn mean monthly ARs of -0.50%, however, the result lacked statistical significance.[3]

Following on from Sahin (2005), Campbell, Giambona and Sirmans (2009) conducted the second investigation into the long-term wealth effects of M&As within the REIT sector. The study consisted of 85 equity REIT M&A announcements between 1994 and 2001. The study observed negative and significant BHARs of -9.9% over the five-year post acquisition period. The study also calculated BHARs of +0.3% for the 12 month period and -1.5% for 36 months, however neither result displayed statistical significance. Campbell, Giambona and Sirmans (2009) concluded that the results confirm that post-acquisition underperformance of REITs is consistent with those observed in more general corporate finance studies and provide support for the hubris and/or agency motive.

Ratcliffe, Dimovski and Keneley (2015) examined 65 A-REIT M&A announcements from 1996 to 2012. The study employed both BHAR and three-factor methodologies.[4] Results showed that bidders earn negative and significant abnormal returns across both models. The two and three-year post-announcement BHARs were -8.21% and -12.27% respectively and the two-year three-factor model observed a CAR of -12%. The results are consistent with Campbell, Giambona and Sirmans (2009) and further support the hubris and/or agency motive for REIT M&As.

However, Ratcliffe, Dimovski and Keneley (2015) identified a structural break in the data set due to the financial crisis. After partitioning the results, the authors observed that the negative excess returns for the full sample were being driven by the financial crisis. Pre-crisis BHAR and three-factor excess returns were positive and significant. While long-term excess returns extended across the financial crisis were negative and highly significant. Ratcliffe, Dimovski and Keneley (2015) concluded that acquirers may have unwittingly over-paid for the targets assets prior the financial crisis and subsequent revaluations compounded their under-performance.

Examination of the prior research makes it difficult to draw strong conclusions on the post-announcement performance. On average, the results across varying methods of measuring long-term returns suggest market inefficiency. However, Fama (1998) argues that market efficiency should not be discarded. He suggests that an efficient market produces different types of events that individually cause share prices to over or under-react. The under-reaction will be approximately as frequent as the over-reaction in an efficient market. If these anomalies are split randomly between each other, they are consistent with market efficiency.

Furthermore, it appears that the long-term return anomalies that suggest market inefficiency are sensitive to a number of factors. These include the different time periods studied and possibly the different datasets, the methodology employed (Bessembinder and Zhang, 2013, Martynova and Renneboog, 2008) and the different markets examined (e.g. US versus Europe).

The contribution this paper makes is to provide an analysis of post-announcement performance in the REIT sector, which takes into account significant periods of adjustments. The impacts of dramatic changes in the economic and regulatory environments have not been studied in depth. This paper provides a detailed study of these impacts in relation to the post-announcement period. The study employs both BHAR and three-factor methodologies and by examining the post-announcement performance within the same industry decreases possible ‘inaccuracies resulting from missing pricing factors that may have varying effects across industries’ (Campbell, Giambona and Sirmans, 2009).

DATA COLLECTION AND METHODOLOGY

Data Collection

Post-announcement excess returns for US equity REIT acquirers are calculated over the one, two and three-year event periods. The sample period for the study extends from January 2000 to September 2014. January 2000 was selected as the starting period due to the introduction of the *REIT Modernization Act 1999*. As discussed in the introduction, Howe and Jain (2004) argue that the Act transformed REITs, impacting on their profitability, growth and risk. We searched successful equity REIT M&A announcements where the deal value was in excess of $50 million within the *Bloomberg Database* and crosschecked the announcements with National Association of Real Estate Investments Trusts merger data. Share price data and book value data was collected via both the *Bloomberg* and *Thomson Reuters Databases*.

The initial data search identified 97 successful M&A announcements. The study then employed the following screening process to isolate the final sample:

- REIT monthly share prices must be available for a minimum period of twelve months after the announcement month, to a maximum of 36 months;
- accounting data available for acquirers on December 31 the year prior the announcement; and,
- there must be an absence of large-scale confounding events occurring during the post-announcement period.[5]

Insufficient price and accounting data resulted in the removal of 25 announcements and a further nine were removed due to the announcement overlapping with subsequent announcements. After screening we observe 63 M&A announcements for the one-year event window. The two-year window comprises 49 observations, while the three-year period contains 35 observations. The differences in the number of observations across the three periods are due to the final filtering requirement. More specifically, if a bidder makes an announcement in July 2001 and another in October 2002, the 2001 announcement would only be included in the one-year excess return calculations. The abnormal returns would not be calculated for the two and three-year periods because they overlap the October 2002 announcement. However, the October 2002 announcement has no overlapping post-announcement periods and therefore excess returns would be calculated for the one, two and three-year event windows.

In relation to the buy-and-hold methodology, the study also required the construction of a matching/control portfolio. The control firms are selected from the equity REIT sector and are subject to the same filtering processes described above, with the additional constraint that the control firm is not involved in a M&A during the sample period.

Table 1 presents the descriptive statistics for the acquiring sample. It can be seen that REIT bidders are, on average, larger than the acquisition value ($5.1 billion versus $2.4 billion). Campbell, Ghosh, Petrova and Sirmans (2011) and Eichholtz and Kok (2008) both observed REIT bidders were, on average, approximately twice the size of the acquisition value in their short-term studies on REIT M&As. Mean book-to-market ratio shows that REIT acquirers were, on average, trading at a premium to Net Tangible Assets (NTA) prior the announcement, suggesting that the bidders are in a healthy financial position. This outcome is consistent with Campbell, Giambona and Sirmans (2009) who also observed REIT bidders were trading at a premium to NTA prior the announcement.

<<INSERT TABLE 1 ABOUT HERE>>

Figure 1 shows the equity REIT M&A announcements by year employed in the study. It can be seen that consolidation activity within the sector peaked in 2006. However, from 2007 to 2009 there was a distinct slowdown in announcements and no M&A observations in 2009 as the impacts of the financial crisis took effect on REITs. Martynova and Renneboog (2008, p. 2419) suggest that M&A activity “is usually disrupted by a steep decline in stock markets and a sub-sequent recession”.

<<INSERT FIGURE 1 ABOUT HERE>>

Methodology

Two types of methodologies have been employed in this study, buy-and-hold abnormal returns and the three-factor model. Prior research indicates mixed results utilizing the various methods. As described in the literature review, Barber and Lyon (1997) and Lyon, Barber and Tsai (1999) document that the use of the BHAR method is superior to the CARs method when assessing long-term performance. On the other hand, Mitchell and Stafford (2000) and Bouwman, Fuller and Nain (2009) both advocate the use of the three-factor model. Mitchell and Stafford (2000) argue that there is cross-sectional correlation of individual event firms when estimating long-term abnormal returns. Bouwman, Fuller and Nain (2009) argue that employing the three-factor model automatically accounts for cross-sectional correlations in the portfolio variance at each point in time.

Given the discussions regarding the most appropriate methodology, this study employs both methodologies. This will enable the study to test the robustness of the post-announcement performance of REIT acquirers. Consistent with short-term event studies, we first have to identify the date of the M&A announcement. Following Campbell, Giambona and Sirmans (2009), the event month [$t = 0$] for the study is set as the month end in which the M&A is announced.

Buy-and-Hold Abnormal Returns

To calculate BHARs an appropriate benchmark (non-event) control portfolio is required. We follow the methodology presented by Campbell, Giambona and Sirmans (2009) to develop the non-event control portfolio. First, we identify all non-event REIT firms available for the study period. The non-event REITs are then ranked on market size and book-to-market value. Market size is calculated as the number of shares on issue times the closing share price one calendar month before the event occurrence. Book-to-market is calculated as the firm's book value, divided by the market value of the firm reported in their annual report prior to the M&A announcement.

Each REIT bidder is then matched to three non-event REITs that are closely equivalent to the bidding REIT in terms of size and book-to-market.[6] The control portfolio is then matched to the event firm for the full buy-and-hold period.

The BHARs are calculated as the difference between the compounded monthly returns over the event period of the event firm less the control portfolio:

$$BHAR_i = \prod_{t=1}^{T}\left(1 + R_{i,t}\right) - \left(BHR_{RP,i}\right) \qquad (1)$$

Where:

$$BHR_{RP,i} = \sum_{j=1}^{n} \frac{\left[\prod_{t=1}^{T}\left(1 + R_{j,t}\right)\right]}{n} \qquad (2)$$

$BHAR_i$ is the buy-and-hold abnormal return for event firm *i* over the time period *T*;

$R_{i,t}$ is the monthly total return for event firm *i* in month *t*;

$R_{j,t}$ is the monthly total return for non-event firm *j* in month *t*;

n is the number of non-event firms that make up the control portfolio; and

$BHR_{RP,i}$ is the arithmetic average compounded monthly return of the control portfolio.

The statistical significance of the BHARs is calculated for each event window. This study employs two statistical tests to assess the robustness of the BHARs significance. The first is a traditional test statistic:

$$t_{BHAR} = \frac{\overline{BHAR_T}}{\sigma(BHAR_T)/\sqrt{N}} \tag{3}$$

Where:

$\overline{BHAR_T}$ is the sample mean BHAR calculated over time period *T;*

σ(BHAR$_T$*)* is the cross-sectional sample standard deviation; and

N is the number of event observations.

Barber and Lyon (1997) provide evidence that long-term BHARs are positively skewed resulting in negatively biased *t*-statistics. To adjust for the potential skewness bias when BHARs are calculated using control portfolio, Lyon, Barber and Tsai (1999) advocate the use of a skewness-adjusted *t*-statistic:

$$t_{sa} = \sqrt{N}\left(S + \frac{1}{3}\hat{\gamma}S^2 + \frac{1}{6N}\hat{\gamma}\right) \tag{4}$$

Where:

$$S = \frac{\overline{BHAR_T}}{\sigma(BHAR_T)} \tag{5}$$

and,

$$\hat{\gamma} = \frac{\sum_{i=n}^{n}(BHAR_{it} - \overline{BHAR_T})^3}{N\sigma(BHAR_T)^3} \qquad (6)$$

The calculation of $\hat{\gamma}$ is an estimate of the coefficient of skewness and $\sqrt{N}S$ is the standard *t*-statistic of equation (3) (Lyon, Barber and Tsai, 1999).

Fama-French Three-Factor Model

The second methodology employed to identify post-announcement performance is the three-factor model developed by Fama and French (1993). Asset pricing research has shown that the three-factor model has strong empirical support in determining share price movements (Brailsford, Gaunt and O'Brien, 2012). The three-factor model is implemented by regressing the post-announcement monthly excess returns of the acquiring firm against a market factor, a size factor and a book-to-market factor:

$$R_{i,t} - R_{f,t} = \alpha_i + \beta_i RMRF_t + s_i SMB_t + h_i HML_t + \varepsilon_{i,t} \qquad (7)$$

Where:

$R_{i,t}$ is the return on security *i* in month *t*;

$R_{f,t}$ is the return on the 180-day Treasury Bill Rate in month *t*;

α_i is the intercept term;

$RMRF_t$ is the excess return on the value-weighted market index;

SMB_t is the return difference between the portfolios of small and large firms in month *t*;

HML_t is the return difference between the portfolios of high and low book-to-market firms in month *t*; and

$\varepsilon_{i,t}$ is the standard error term.

The intercept, α_i, is the variable of interest in the model and measures the mean monthly abnormal return of the event firm. A positive intercept indicates the sample firm has outperformed, after controlling for market, size and book-to-market factors (Barber and Lyon, 1997).

As the focus of this study is the equity REIT sector, the calculation of the factors is developed from the equity REIT universe. Excluding conventional firms from the estimation of the factors removes any possible noise within the factors that may not be relevant to the REIT sector. The market index employed is the FTSE NAREIT All Equity REITs Index. The calculation of the SMB and HML factors follows Fama and French (1993) and Brailsford, Gaunt and O'Brien (2012).

RESULTS AND DISCUSSION

BHAR Results

The BHAR results for REIT bidders are presented in Table 2. Panel A shows the excess returns for the full study period. Acquirers earn positive, but insignificant, BHARs across the three event windows. This outcome suggests that the anomaly of post-merger underperformance does not hold for REITs. In addition, the result supports the argument by Eichholtz and Kok (2008) that, due to their regulatory environment, REITs may be less vulnerable to agency problems. Our results are consistent with prior REIT research by Sahin (2005) who observed insignificant BHARs of +3.56% over the three-year event period.

<<INSERT TABLE 2 ABOUT HERE>>

The full sample period covers the financial crisis, to examine the impacts of the crisis on the long-term performance of REIT bidders, the sample was divided into pre- and post-crisis. Figure 2 displays the FTSE NAREIT All Equity REITs Index over the study period.[7] The index reached a month-end high of 10,526.96 in January 2007 before the onset of the crisis. The cut-off month is consistent with prior REIT studies examining the impacts of the crisis on REIT performance (Simon and Ng, 2009, Sun, Titman and Twite, 2015).

<<INSERT FIGURE 2 ABOUT HERE>>

Panels B and C of Table 2 present the BHARs for announcements occurring pre- and post-January 2007. Pre-crisis results show that REIT bidders earn positive and significant mean BHARs across all three-event windows. Ranging from +10.72% in the one-year period to +24.04% for the three-year window. In addition, the median BHARs are also positive and significant across all periods. This outcome suggest that prior to the structural break, due to the financial crisis, that REIT M&As were motivated by synergy.

The low interest rate environment post-2000 and rising commercial property prices may have contributed to acquirer excess returns (Barclays, 2012). In addition, Lee (2010) indicates that after the *Modernization Act*, larger REITs became more desirable to institutional investors. Ciochetti, Craft and Shilling (2002) argue that institutional investors prefer larger and more liquid REITs because it allows them to buy and sell large positions without affecting share prices. Campbell, Ghosh, Petrova and Sirmans (2011) suggests that mergers are a useful way to increase firm size, and improve market depth. Devos, Ong and Spieler (2007) observed a positive relationship between REIT value and analyst coverage. While Goebel, Harrison, Mercer and Whitby (2013) revealed a positive relationship between analyst coverage and institutional investors. It is hypothesized, given these factors, acquiring REITs were able to increase their property holdings (in a rising market) and at the same time attract institutional investment resulting in positive abnormal returns.

Panel C shows that acquirers earn negative BHARs across all three-event windows in the post-crisis period. However, only the two-year mean BHAR displays statistical significance (-9.45%, *p-value* < 5%). This result highlights the structural change in the REIT sector as a result of the financial crisis. Betton, Eckbo and Thorburn (2007) suggest that negative post-announcement excess returns may be due to a negative regulatory shock. However, it would be expected that a shock like the financial crisis would impact on non-merged firms as well. The post-crisis abnormal returns may be a result of the high volatility and uncertainty in the sector during the crisis period, making it difficult for acquirers to integrate the assets of the targets and achieve any possible synergistic benefits.

In addition, Kawaguchi, Sa-Aadu and Shilling (2012) indicate that REITs increased their risk levels, via increased leverage, before the crisis, taking advantage of the low interest rate environment of the mid-2000s. At the same time commercial property values increased greatly from 2004 to 2007 leading to “one of the largest commercial real estate bubbles in history” (Barclays, 2012, p. 25). The onset of the crisis saw a decline in commercial property values, resulting in REITs trading at a discount to NTA and an increase in vacancies (Block, 2012). It is hypothesised that, in addition to the problems with integrating targets assets, unintentional over-payment for property assets prior the crisis and the subsequent fall in property prices compounded acquirers underperformance.

Three-Factor Abnormal Returns Results

Table 3 presents the abnormal returns from the three-factor model methodology. Panel A reports the results for the full study period. Consistent with the BHAR results, we do not find significant excess returns over the full study period. Panel B shows the three-factor results for the pre-crisis period. The intercept for both the one- and two-year event windows are positive and significant. One-year monthly excess returns are 0.6%, equating to an annual abnormal return of 7.2% and the two-year excess return is 12% (0.5% monthly return). These results support the findings of the BHAR methodology and the synergy motive for REIT acquisitions, prior to the financial crisis and hence adding value to shareholders in the long-term.

<<INSERT TABLE 3 ABOUT HERE>>

Panel C shows the three-factor excess returns for post-January 2007. The intercept is negative across all three periods, consistent with the BHAR results. However, only the one-year model is statistically significant. Acquirers earn a mean monthly abnormal return of -0.8%, which equates to an annual abnormal return of -9.6%. This result further supports the hypothesis that REIT bidders experienced significant under-performance possibly due to over-payment for property assets, increased uncertainty in the sector during the crisis and integration of the targets assets. The results in the post-January 2007 sub-period across both methods imply that REIT M&As were driven by the hubris motives. The differing results across both sub-periods raises the issue of motivation in the REIT sector. It is hypothesized that REIT M&A motivation is not static and is influenced by external macro-economic events. The shift from synergy to hubris motivations is an example of how this may occur.

CONCLUSIONS

This study extends the prior US REIT post-announcement research by Sahin (2005) and Campbell, Giambona and Sirmans (2009) with a later dataset that incorporates the effects of the financial crisis. Both the BHARs and the three-factor model abnormal returns of REIT M&As from 2000 to 2014 are measured. Results over the full sample period show, in contrast to the majority of research on conventional firms, that REIT bidders do not underperform in the three-years post-announcement.

The study lends support to the hypothesis put forward by Fama (1998), that markets may experience anomalies in returns and still be regarded as informationally efficient. Within the study period, changes in regulation and the business environment altered longer-term outcomes. Whereas previous studies have suggested that the market tended towards weak form efficiency, the current study indicates that this is not necessarily a permanent feature of the REIT sector. Market adjustment to the changing economic landscape improved bidder returns suggesting greater levels of information efficiency. This result also supports the synergy motive for M&As in the REIT sector. The low interest rate environment of the period, the focus to increase size to attract institutional investors and rising commercial property prices may have contributed to the positive excess returns.

We accept that although this study has employed two methods to assess post-announcement performance, it can be difficult to isolate the pure M&A effect from other events that may have occurred in the event window and therefore impacted on the results. The pre-crisis results, however, from both methodologies are consistent with the synergy motive. The financial crisis had a significant impact on the REIT sector; the effects observed in this study have shown negative and significant excess returns. Further investigation in the post-crisis era may add more clarification to the Fama (1998) hypothesis and the impact of structural changes in the market. In addition, we feel further research into REIT regimes globally will also add to our understanding of the post-announcement performance of REITs.

ENDNOTES

1. Langetieg (1978) discusses that the assumption of stationary betas in the market model, biases in measurement errors, model specification errors and other common non-merger influences can impact the observed excess returns.
2. The three-year BHAR was -19.78%, compared to a cumulative average abnormal return of -14.4% for the three-factor model.
3. Sahin (2005) utilized the factors provided by Kenneth R. French that are derived for the market as a whole, which may have introduced distortion from other sectors into the modeling resulting in differences in the BHAR results and the three-factor model.
4. The market factors in the study were derived from the A-REIT universe and not the general market. The authors cited that the use of A-REIT factors removes possible noise within the factors that may not be relevant to A-REITs.
5. For example, a firm that is involved in multiple M&As that occur, at a minimum, within one-year of each other will require the removal of the earlier announcement, as the data collection period covers the later announcement. Lyon, Barber and Tsai (1999) claim a lack of independence is generated from overlapping returns, yielding mis-specified test statistics.
6. Barber and Lyon (1997) describe the parameters for matching the event firm to the portfolio should lie within the range of 70% to 130% of size and book-to-market value. Attempting to match bidding REITs by property type would have made it difficult for the control group to meet the parameters of 70% to 130%.
7. The Index was set to a base of 100 in January 2000.

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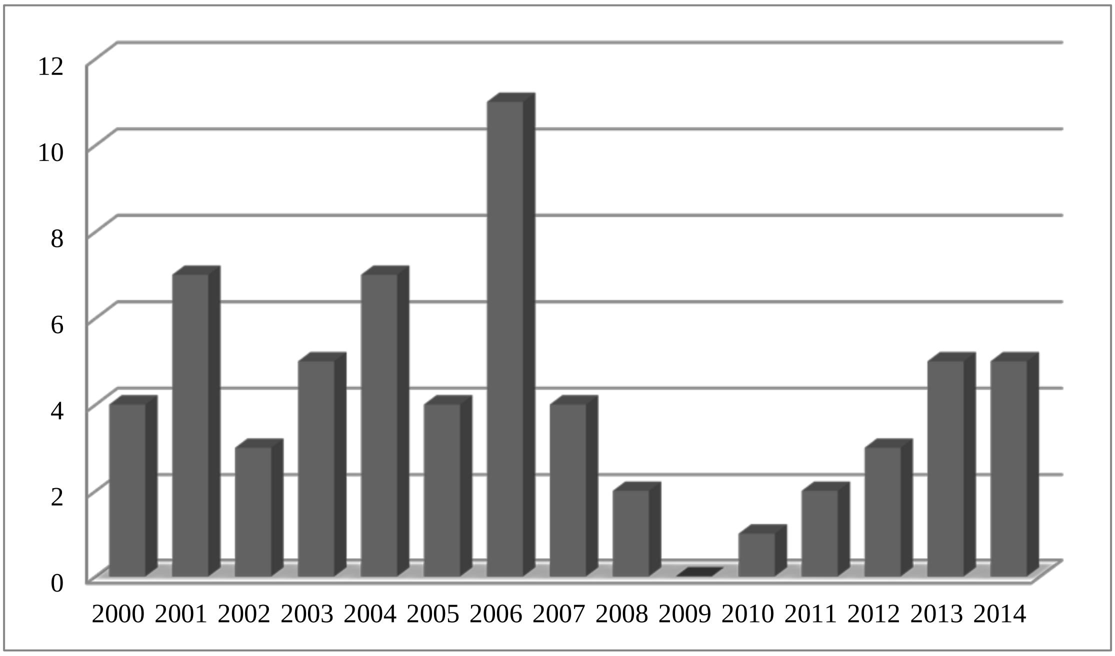
Exhibit 1 Descriptive statistics for equity REIT M&A announcements.

	M&A Characteristics ($M)	**Bidder Size ($M)**	**Bidder Book-to-Market**
Mean	2,430.68	5,082.60	0.5367
Median	1,097.00	3,449.40	0.4926
Min	58.80	70.10	0.0371
Max	16,517.00	24,343.38	1.2598
Skewness	2.4093	1.7375	0.6851
Kurtosis	8.3916	2.7184	0.5007
No. Obs	63		

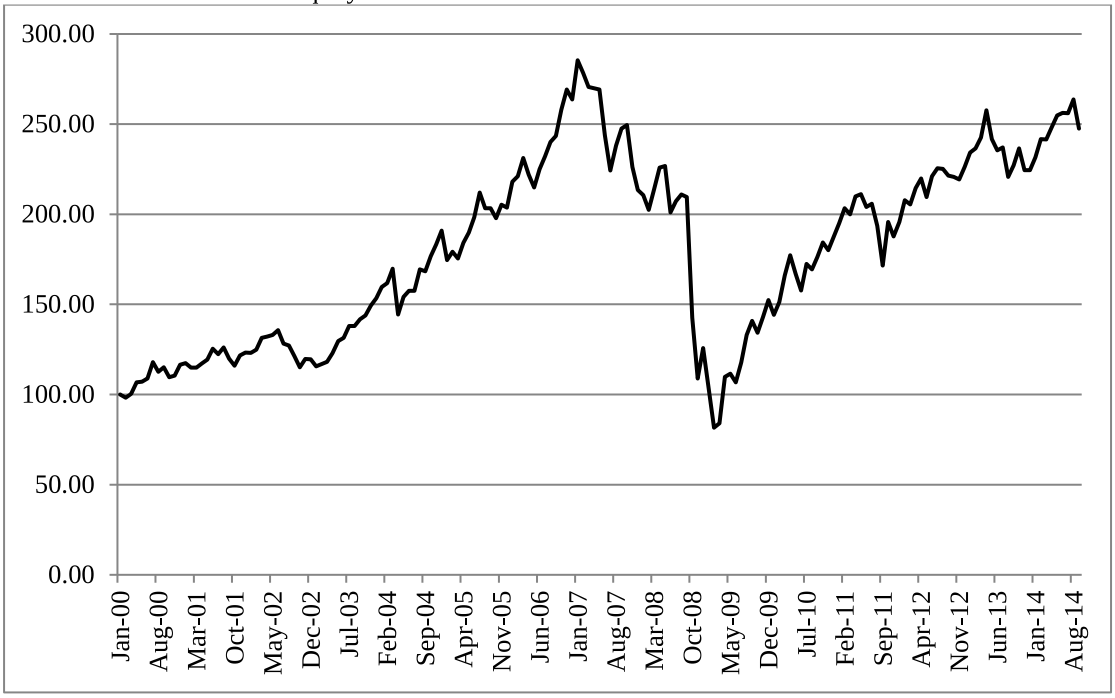
Notes: Descriptive statistics for M&A deal characteristics, acquirer size and book-to-market ratio for REIT announcements from January 2000 to September 2014.

Exhibit 2 REIT M&A announcements.



Graph of REIT M&A announcements employed in the study by year.

Exhibit 3 FTSE NAREIT Equity REIT Index.



Graph of the FTSE NAREIT Equity REIT Index, January 2000 to September 2014.
The index was set to a base value of 100 in January 2000. Source: NAREIT (https://www.reit.com/nareit).

Exhibit 4 REIT Acquirer Buy-and-Hold Abnormal Returns.

	One Year	**Two Year**	**Three Year**
Panel A: Full Sample			
Mean BHAR	+3.45%	+1.65%	+2.79%
(P-value)	(0.263)	(0.732)	(0.692)
(Skewness-adjusted p-value)	(0.231)	(0.710)	(0.684)
Median BHAR	+0.76%	-1.26%	-0.56%
(P-value)	(0.806)	(0.794)	(0.937)
(Skewness-adjusted p-value)	(0.781)	(0.820)	(0.949)
Number Observations	63	46	38
Panel B: Pre-Jan 2007			
Mean BHAR	+10.72%	+17.43%	+24.04%
(P-value)	(0.004)***	(0.036)**	(0.045)**
(Skewness-adjusted p-value)	(0.000)***	(0.003)***	(0.004)***
Median BHAR	+9.46%	+21.36%	+20.74%
(P-value)	(0.011)**	(0.010)**	(0.083)*
(Skewness-adjusted p-value)	(0.001)***	(0.000)***	(0.017)**
Number Observations	30	19	14
Panel C: Post-Jan 2007			
Mean BHAR	-3.17%	-9.45%	-9.59%
(P-value)	(0.486)	(0.049)**	(0.243)
(Skewness-adjusted p-value)	(0.516)	(0.002)***	(0.182)
Median BHAR	-2.11%	-6.26%	-5.75%
(P-value)	(0.642)	(0.193)	(0.484)
(Skewness-adjusted p-value)	(0.667)	(0.135)	(0.431)
Number Observations	22	20	18

Notes: This table shows the mean and median buy-and-hold abnormal returns (BHAR) for acquiring REITs over the study period of January 2000 to September 2014. BHARs are calculated over the one, two and three-year post-announcement periods. Panel A shows the BHARs calculations for full sample period. Panel B shows the BHARs calculations up to January 2007. Panel C shows all BHAR calculations that occurred after January 2007. BHARs are calculated using the size and market-to-book matching as described by Lyon, Barber and Tsai (1999). *P*-values are calculated using a standard *t*-statistic and a skewness-adjusted *t*-statistic. ***, **, * show statistical significance at the 1%, 5% and 10% level respectively.

Exhibit 5 REITs Three-Factor Model Abnormal Returns.

	One Year		**Two Year**		**Three Year**	
	Coef.	**(p-val)**	**Coef.**	**(p-val)**	**Coef.**	**(p-val)**
Panel A: Full Sample						
INTERCEPT	-0.002	(0.555)	-0.001	(0.850)	-0.001	(0.611)
RMRF	0.936	(0.000)***	0.965	(0.000)***	0.985	(0.000)***
SMB	0.284	(0.016)**	0.073	(0.453)	-0.064	(0.499)
HML	0.098	(0.375)	0.328	(0.000)***	0.390	(0.000)***
R^2	0.265		0.348		0.466	
Adj. R^2	0.262		0.346		0.465	
Number Observations	756		1104		1368	
Panel B: Pre-Jan 2007						
INTERCEPT	0.006	(0.013)**	0.005	(0.017)**	0.001	(0.743)
RMRF	0.901	(0.000)***	0.897	(0.000)***	0.870	(0.000)***
SMB	-0.088	(0.432)	-0.061	(0.566)	-0.064	(0.536)
HML	-0.111	(0.355)	-0.007	(0.947)	0.072	(0.504)
R^2	0.428		0.424		0.431	
Adj. R^2	0.423		0.421		0.427	
Number Observations	372		456		504	
Panel C: Post-Jan 2007						
INTERCEPT	-0.008	(0.073)*	-0.004	(0.331)	-0.006	(0.190)
RMRF	0.941	(0.000)***	0.989	(0.000)***	0.869	(0.000)***
SMB	0.506	(0.016)**	0.273	(0.147)	-0.109	(0.528)
HML	0.262	(0.119)	0.399	(0.008)***	0.468	(0.001)***
R^2	0.202		0.336		0.392	
Adj. R^2	0.196		0.332		0.390	
Number Observations	384		648		864	

Notes: This table presents the results of the three-factor model ordinary least squares regression using monthly data for REIT bidders over the sample period of 2000 to 2014. *RMRF* is the excess return on the All Equity REIT index, *SMB* is the return difference between a portfolio of small and large REITs, *HML* is return difference between the portfolios of high and low book-to-market REITs. The INTERCEPT measures the mean monthly abnormal return. The number of observations represents monthly bidder excess returns over the event windows. Panel A shows the calculations for the full study period. Panel B presents the results up to January 2007 (pre-crisis) and Panel C shows results for the post-January 2007 sub-period. ***, **, * show statistical significance at the 1%, 5% and 10% level respectively.

Information Asymmetry, Lease Incentives, and the Role of Advisors in the Market for Commercial Real Estate

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SUMMARY — Using a unique transactions dataset, this paper examines the determinants of lease incentives in the Amsterdam office market. The study focusses on the type of landlord involved (institutional/privately owned) and whether the tenant or landlord used an advisor to help them with the transaction. The results show that an institutional landlord, ceteris paribus, offers 11 percentage points more incentives than a private owner. In addition, a landlord who uses the services of an advisor pays 16 percentage points less incentives. An advisor at the side of the tenant increases incentives by 7 percentage points. If both parties use an advisor lease incentives are not statistically different from using no advisors at all. The results in this paper highlight the crucial role of market information, information asymmetry, and bargaining in the market for commercial real estate.

JEL–code — R30; D82; L85

Keywords — commercial real estate; office market; lease incentives; advisor; information asymmetry

I. Introduction

Especially in thinly traded, intransparant markets, bargaining plays a crucial role in the formation of prices (Harding et al, 2003). The market for commercial real estate is a typical example of such a market. If we look at the office market in the US alone, there has been 7.5 million square feet of new-to-market leases signed in 2015 and there is an expected new supply of 48.9 million square feet in 2016 (JLL, 2016). Taking into account that the average rent in 2015 is about 30 dollar per square foot (and in many cities much higher), it is safe to say that we are talking about a multi-billion dollar market. This implies that finding good (non-defaulting, long-term) tenants is an important business.

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A typical marketing strategy is that a landlord gives lease incentives to ensure that a tenant signs a long-term rental contract. This can be a rent-free period, cash to buy various types of equipment, up to a full renovation of the offered space. There is typically a lot of money involved with lease incentives and, to the extent it affects rental income, it also has a fundamental impact on the asset value of commercial real estate. Although incentives play a crucial role in the market for commercial real estate, there is typically not much known about the exact amount of incentives that are offered or what are the determinants of lease incentives. This paper aims to fill this gap.

In this paper, a unique dataset on lease incentives (rent-free periods/rent discounts) from the Amsterdam office market over the period 2002-2012 is used. Because office markets are intransparent — transactions data is not publically available — and the data is typically fragmented (there are usually several intermediaries involved, all with their own databases), it is difficult to get any kind of consistent data on commercial property transactions, let alone lease incentives. The data used in this paper was gathered by the Amsterdam taxing authority (DBGA) for taxation purposes. We also added transactions data from Cushman & Wakefield. A unique aspect of the dataset is that it also contains information about building characteristics, location characteristics, transaction-specific characteristics and the subjects involved in the transaction (type of landlord/advisors). In particular, the final dataset includes information about the exact location of the office building, number of tenants, length of the lease agreement, type of landlord, the number of square meters as mentioned in the lease contract, and several other location (e.g. office supply in the surrounding area, travel time to nearest highway ramp/station, google walk score) and building (i.e. construction year, whether the building is a high-rise building) characteristics. We use data from Strabo (research company specialized in real estate market information) on whether the landlord or tenant used the services of an advisor to help negotiate a transaction. Because there are some transactions without any lease incentives, we estimate several Tobit regression models to examine the determinants of lease incentives. Moreover, the dataset is far from perfect as we observe quite some missing values in some of the variables. Nevertheless, with a base sample of about 400 property transactions, we can find some interesting patterns in the data. We focus the discussion on the effect of the type of landlord (institutional/private) and whether there was an advisor on the side of the landlord/tenant involved in the transaction.

The results in this paper show that, ceteris paribus, an institutional landlord offers 11 percentage points more incentives than a private owner. This is sizeable effect relative to the average incentive of about 16 percent. A potential reason for this effect is that a private owner is more performance oriented and as such is less likely to give high incentives. An institutional landlord provides higher lease incentives as the incentives are typically given by an (external or internal) asset manager who is not financially dependent on the actual rent that is given, but just whether the office space is rented out or not. Furthermore, we find that a tenant who uses an advisor to help 'seal the deal' gets 7 percentage points more incentives when the landlord does not have an advisor. Information on market rents and incentives are typically not publically available, which creates an information asymmetry between buyers and sellers, in favor of the sellers. An advisor can provide help in getting the appropriate market information and can give advice when negotiating a lease contract. Apparently, this alleviates the information asymmetry. From this perspective, hiring an advisor seems to make sense. Interestingly, a landlord using the services of an advisor offers, on average, 16 percentage points less incentives, but only if a tenant does not have an advisor. This effect is much larger than the effect if a tenant uses an advisor. This difference, however, should be interpreted with caution. If high incentives are underreported the effect of an advisor at the side of the tenant is underestimated and the effect of an advisor at the side of the landlord is overestimated. Finally, if both the tenant and landlord use an advisor the effect on lease incentives is not statistically significantly different from not using an advisor at all. Apparently, if both the tenant and landlord hire an advisor there is, at least from the perspective of incentives, not much to gain.[1] This seems to be in line with a prisoners dilemma story in which both parties cannot afford *not* to hire an advisor and end up with incurring the cost of hiring an advisor.[2] Interestingly, the raw data shows that in about 61 percent of the transactions both parties use the services of an advisor.

The results in this paper highlight the crucial role of market information, information asymmetry, and bargaining in the market for commercial real estate. Market information, in a market where information is scarce and goods are heterogeneous, is very valuable to get a good deal. An advisor can provide relevant market information, which is a valuable resource as long as it leads to an informational advantage for the tenant or landlord. Moreover, the underlying financial incentives (type of landlord) determine the bargaining leeway of tenants. The findings in this paper increases our understanding about the functioning of a market that is typically deemed to be highly intransparent.

This paper relates to several strands of literature.

- <u>The value of information in real estate transactions.</u> Levitt and Syverson (2008) find that real estate agents sell their own homes for more than comparable houses of their clients. Greater information asymmetry leads to larger distortions. Similarly, see Rutherford et al. (2005).
- <u>Bargaining with private information.</u> Kennan and Wilson (1993) argue that bargaining, costly delays, and failure to agree can be valuable to convey private information (signaling).

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[1] Of course, an advisor may provide other valuable services (search for tenants, arranging contracts) decreasing search and transaction costs.

[2] The actual cost of hiring an advisor differs by transaction. It can easily be 10 percent of the yearly rent or a percentage of the negotiated lease incentive. It at least suggests that hiring an advisor is not a trivial decision.

- Bargaining in real estate. Merlo and Ortalo-Magné (2004) provide more insight in the strategic interaction between buyers and sellers by examining a rich source of data on list price revisions and actual offers made by buyers in England. Harding et al. (1993) extend the standard hedonic framework to include bargaining power. Colwell and Munneke (2006) examine bargaining in *commercial real estate markets*, but only focusing on sold properties (not on lease agreements).
- Marketing. Hendel et al. (2009) show that different real estate marketing platforms can lead to differences in time to sell. Multiple listing service sales sell faster in comparison with a no-service, For-Sale-By-Homeowner platform.
- (Financial) advisors. Howe and Shilling (1990) find that REIT performance is determined by the type of advisor that is used by the REIT. More general: top-tier advisors are more likely to complete mergers and acquisitions deals (Hunter and Jagtiani, 2003).
- Differences in commission structures affect the performance of real estate agents. Munneke and Yavas (2001) show that full-commission agents spend more effort and hence have better results when selling a house, but they also get more listings which crowds out this effect.
- Asymmetric information in commercial real estate. Garmaise and Moskowitz (2004) use the difference in property tax assessments of and market value of commercial real estate to create a measure of (asymmetric) information. Buyers reduce the asymmetric information by a variety of strategies including only buying properties that are nearby. Our paper looks at hiring advisors as strategy.
- Lease incentives. Bond (1994) discusses (theory) the variation (cycle) of lease incentives over time. After vacancy levels peak, incentive levels peak, and this eventually affects rental rates and vacancy rates.

Conclusion: Bargaining, information asymmetry, is a well-established fact in residential markets, but there is much less known about this issue in commercial real estate markets. As such, our paper contributes by providing more insight regarding this topic.

The remainder of this paper is organized as follows. Section II discusses the determinants of rents and lease incentives. Section III presents the data used in this study. Section IV covers the empirical methodology. In Section V, we present the results. Section VI concludes.

II. Determinants of office rents and lease incentives

There is quite some literature available about the determinants of rental prices of office space. A good overview is given by Slade (2000). This literature mainly focusses on contract rents. The research of Moll (2012) and Boots (2014) show that contract rents are not a good

TABLE 1 — DETERMINANTS OF OFFICE RENTS

Variable	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
Vacancy/supply		✓	✓	✓	✓	✓																		
Density							✓	✓																
Distance to center of city								✓	✓	✓	✓	✓	✓											
Accessibility										✓				✓										
Location															✓	✓	✓							
Floor space								✓		✓								✓	✓	✓				
Number of floors										✓								✓						
Building year								✓	✓			✓						✓	✓		✓			
Functional meters								✓												✓				
Amenities in building																						✓		
Parking norm																							✓	✓
Appearance					✓	✓																		
Lease term				✓		✓																		
Size Transaction				✓		✓																		
Multi tenant							✓																	
GDP						✓																		

I Mills (1992)
II Clapp (1993)
III Wheaton & Torto (1988)
IV Koppel & Keeris (2006)
V Boots (2014)
VI Moll (2012)
VII Wheaton (1984)
VIII Bollinger et al. (1998)
IX Sivitanidou (1995)
X Fuerst (2007)
XI Dunse en Jones (1988)
XII Hough & Kratz (1983)
XIII Brennan ea, (1984)
XIV Cervero & Duncan (2002)
XV Can & Megbolugbe (1997)
XVI Casetti (1997)
XVII Clapp (2003 & 2004)
XVIII Shilton & Zaccaria (1994)
XIX Colwell et al. (1998)
XX Slade (2000)
XXI Frew & Judd (1988)
XXII Ho et al. (2005)
XXIII Nitsch (2006)
XXIV Bentvelzen (2012)

reflection of the market situation because the actual (effective) rents are also determined by incentives. The determinants of the effective rental prices are related to the determinants of incentives because the effective rent is adjusted for incentives. To identify potential determinants of incentives, we look more closely at the determinants of the (effective) rental prices.

Table 1 shows an overview of several studies and the determinants that were included in those studies. It is evident that many studies include a combination of building, location, and transaction characteristics. Our study will also include a combination of such variables (for a detailed discussion, see Section III), but we will also include some subject-specific variables. It is evident that subject-specific variables, like the type of landlord and whether there are advisors involved, are typically not taken into consideration, let alone in relation to lease incentives. Notable exceptions, but only focusing on the residential market, are Gu & Colwell (1997) and Harding et al. (1993). Harding et al. (1993) use a hedonic framework including the differences and sums of buyer/seller characteristics. They show that factors such as the wealth of households, gender, and other demographic factors, determine bargaining power. Colwell and Munneke (2006) have also applied this approach to the commercial real estate market. Buyers and sellers are divided into five categories: individual, individual in cooperation with bank, corporate, corporate in cooperation with bank, and individual banks. They show that sellers who work together with a bank sell offices for a lower price and buyers buy for a higher price (symmetric bargaining) in comparison to corporate buyers and sellers. Moreover, the involvement of a trust increases bargaining power and decreases the price by 17 percent for buyers and increases the price by 20 percent for sellers. A crucial difference with regard to our study is that we do not focus on transaction prices (investors), but the behavior of the landlord and tenant (rental lease agreements). We use an approach which is much more in line with the 'markup' approach that Genesove and Mayer (1997) used for residential markets.

III. Lease incentives and the Amsterdam office market

A. The Amsterdam office market

Figure 1 shows the main office areas in Amsterdam:

1. Centrum
2. (Oud) Zuid (incl.Zuidas)
3. Zuidoost
4. Teleport-Sloterdijk
5. Westelijke tuinsteden (incl. Riekerpolder)
6. Overige gebieden

The first five areas capture more than 85% of the total stock of office space. The last category includes less important offices areas like Amstel Business Park, de Omval, and de Schinkel.

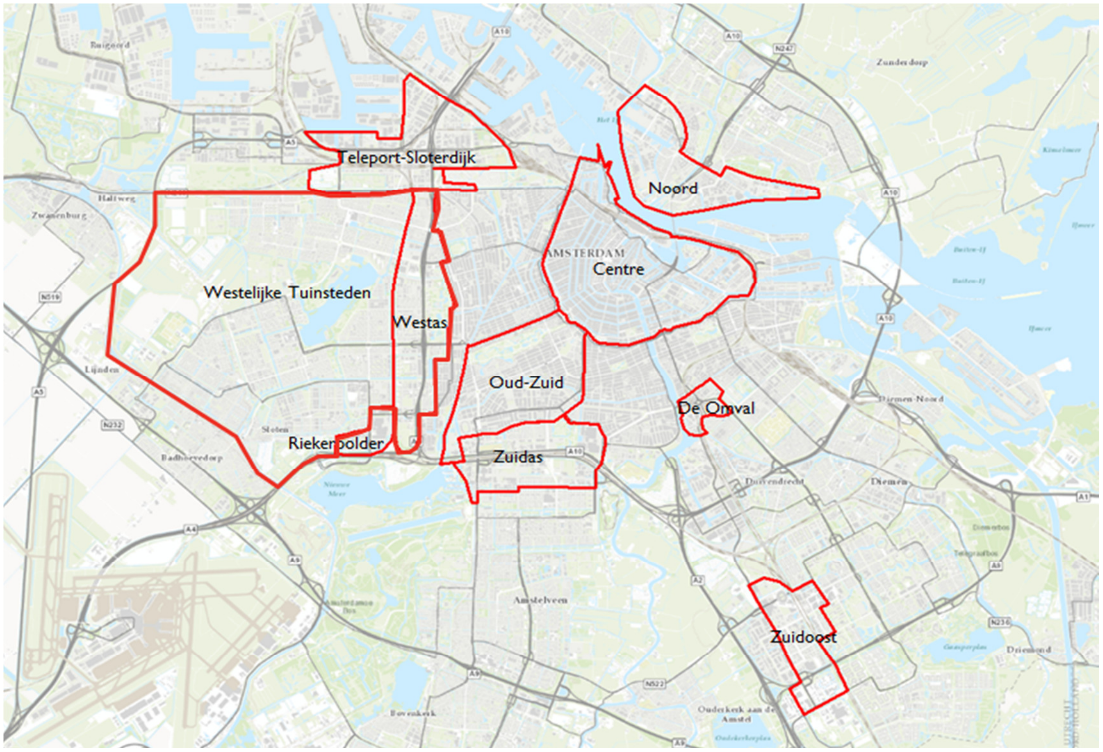
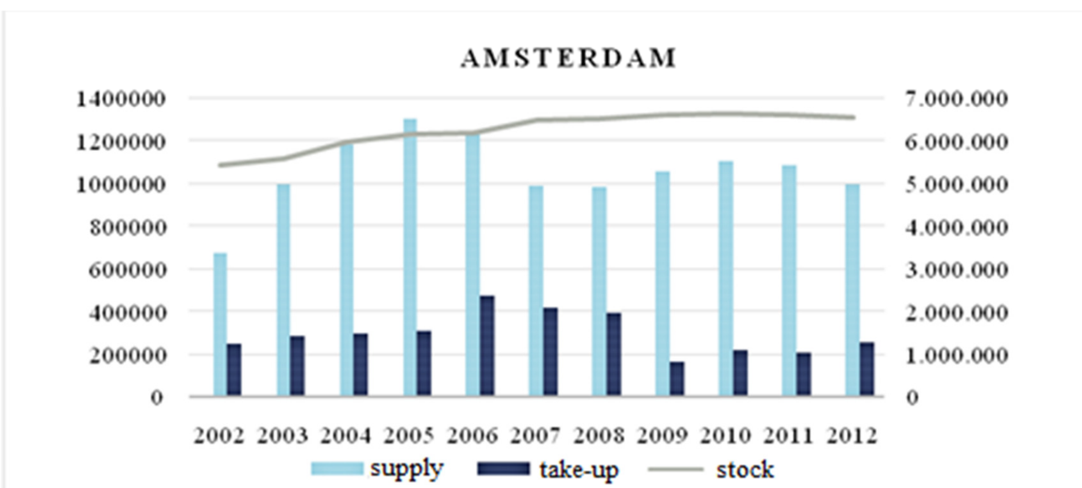


FIGURE 1 — MAIN OFFICE LOCATIONS IN AMSTERDAM



SOURCE: CUSHMAN & WAKEFIELD, OWN CALCULATIONS

FIGURE 2 — SUPPLY AND DEVELOPMENT OF OFFICE SPACE IN AMSTERDAM (SQUARE METERS)

Figure 2 shows the supply and development of office space in Amsterdam. Amsterdam is the largest office market in the Netherlands and provides office space to a variety of large national and international companies. The city has a strong concentration of companies from the ICT sector and financial sector. The European Cities Monitor[3] shows that Amsterdam, from a European perspective, is already for many years a prominent place for businesses to locate. Between 2002-2012 Amsterdam has always had a position in the top ten of most attractive cities to locate as a business. Cities such as London, Paris, Frankfurt, and Brussels are typically more highly ranked than Amsterdam. Amsterdam has a good location in Europe (a major airport and harbor are nearby), the is a stable political climate, and it has an attractive fiscal policy.

Although Amsterdam is an attractive city for businesses to locate, there is a structural oversupply of offices (as of the year 2000). In part, this is the results of excessive construction of new offices, and more recently, due to the financial crisis. Flexible working (working remotely) and ageing of the population has also resulted in a decrease in the number of persons employed. Between 2002 and 2006 office space take-up increased from 250000 m^2 to 478000 m^2 . The increase came after the recession due to the dot-com crisis and the attack on the world trade center in New York in 2001. The inelasticity of supply (pork cycle) is clearly visible in Figure 2 when comparing the take-up in 2006/2007 and the growth in office supply. In 2006, supply barely increased while take-up increased substantially. In 2007, take-up was less but the supply of office space increased a lot. Typically, supply increases with a delay because of the long production time to create new office space. The vacancy rates between 2002 and 2012 varied between 15.2% (2012) and 21.3% (2005). Given a necessary friction level of 5 to 8 percent (OGA, 2006), it is safe to say that the vacancy in the Amsterdam office market is well above the vacancy necessary to ensure a healthy functioning of the market.

B. Lease incentives

Table 2 contains the variables (and sources) used in this study (see the appendix for a detailed description of the sources). The main independent variable is the percentage incentives that is given to a tenant. Although there are many sources of incentives (see Table 3), we only have information on the rent-free period and rent discounts. This implies that the results in this paper only apply to those two types of incentives. Since we underestimate the total amount of incentives, the effects we estimate are most likely an underestimate of the effects we would find if we had a measure of total incentives.

[3] http://www.europeancitiesmonitor.eu/

TABLE 2 — VARIABLES, SOURCES, AND EXPECTED SIGN

Variable	Description	Source	Expected sign
Incentives	Percentage incentives	DBGA*	
Landlord	Private = 0, Institutional = 1.	DBGA*	+
Advisor landlord	no=0, yes=1.	Strabo	-
Advisor tenant	no=0, yes=1.	Strabo	+
Lomvtra	Logaritm of contracted meters of office space.	DBGA*	+
Transaction year	Year of Transaction	DBGA*	+/-
Lease term	Lease term in months	DBGA*	+
Single tenant	0= multitenant if < 90% space, 1= single tenant if ≥ 90% space	DBGA*	+
High building	< 6 floors =0, 6 or more =1	TU Delft	-
Near public transport	Walk distance to nearest station	Arcgis	-
Near highway	Travel time to nearest highway ramp	Arcgis	-
Amenities	Google walkscore	TU Delft/eigen onderzoek	-
Aanbod	Percentage office supply in area.	C&W	+
Centrum	I = specific locate, otherwise = 0	C&W	-
Zuidoost	I = specific locate, otherwise = 0	C&W	+
Zuid & Zuidas	I = specific locate, otherwise = 0	C&W	+
Teleport-Sloterdijk	I = specific locate, otherwise = 0	C&W	+
Westelijke tuinsteden	I = specific locate, otherwise = 0	C&W	+
Overige gebieden	I = specific locate, otherwise = 0	C&W	+/-

*Cushman & Wakefield data used to supplement the data.

The methodology section goes into more detail how incentives are exactly calculated, but basically a discounted cash flow method is used. The incentives are based on a survey done by the Amsterdam taxing authorities, DGBA (in the Netherlands owners need to pay property taxes, which is based on the assessed value of the properties), and covers transactions between 2002 and 2012. We only used transactions with a lettable floor area of 500 m2 or more that were extensively checked for correctness (and approved) by the Amsterdam taxing authorities and subsequently checked by the Technical University, Delft (TU Delft). In total there are 415 transactions available (including 29 transaction taken from Cushman and Wakefield), this is roughly 15 percent of the total number of accepted transactions, 33% were not accepted (for a discussion, see Boots, 2014). We excluded six observations as outliers, leaving a total of 409 observations available for the empirical analysis. The spatial distribution of the transactions are shown in Figure 3 and Table 4. There are transaction available from all major office locations in Amsterdam.

The data also contains information on the type of landlord, square meters in the contract, the year of transaction, lease term in months, and whether there are one or more tenants. The location is also known, but (also given the number of observations per area) we decided to use the more aggregated definition of office areas as used by Cushman & Wakefield. Whether an advisor was involved in the transaction was take from the research company Strabo. The google walkingscore (measure of amenities nearby) and whether the building is a high-rise building are from the database of TU Delft. Finally, the percentage office supply in a particular area was made available by Cushman & Wakefield. In sum, we include building-specific, location-specific, transaction-specific, but also subject-specific variables in the empirical analysis.

Table 3 — Types of incentives

• One or more rent free periods	(This study)
• Rent discount (typically the first few years)	(This study)
• Fit out contribution and/or 'turn key' completion [a]	
• No re-delivery obligation [b]	
• Relocation allowance	
• Physical adjustment of the property on request of the tenant	
• Signing bonus and/or other payments (money at free disposal)	
• Option on released vacant office space	
• Escape clauses	
• Limit/cap on service costs and/or rent indexation	
• Share in the development profits after sale by the developer to an investor	
• Pay for less square meters than the actual rented square meters	
• Other incentives [c]	

Source: Van Gool (2011). a) Completion including installation package (partitions, carpeting, etc.). b) The tenant does not have to remove the installed amenities and/or does not have to deliver the office space in shell condition. c) The landlord takes over a previous rental contract, extra flexibility in rental contracts, the provision of additional services (shuttle bus service, exclusive advertisement rights).

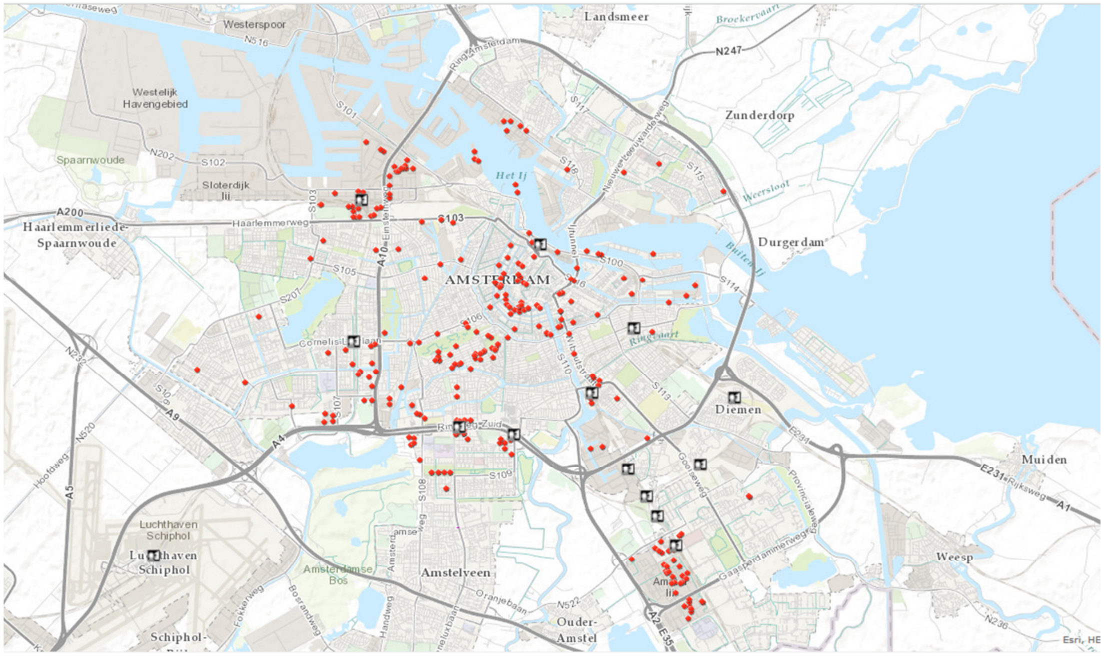


FIGURE 3 — OFFICE MARKET TRANSACTIONS IN AMSTERDAM

TABLE 4 — NUMBER OF TRANSACTIONS PER AREA

Contractjaar	Centrum	Zuid	Teleport-Sloterdijk	Westelijke tuinsteden	Overige gebieden	Totaal
2002	12	3	5	4	14	**46**
2003	12	9	3	3	6	**39**
2004	11	11	4	3	5	**39**
2005	10	4	4	7	5	**35**
2006	12	15	8	2	9	**50**
2007	8	19	3	4	15	**56**
2008	8	11	4	3	12	**43**
2009	8	5	4	2	4	**29**
2010	6	9	2	4	7	**33**
2011	3	15	2	4	8	**37**
2012	4	2	0	0	1	**8**
Totaal	**94**	**103**	**39**	**36**	**86**	**415**

Table 5 contains the descriptive statistics of the incentives dataset. The average incentives are about 8 percent. However, there are relatively a lot of transactions without any incentives (also see Figure 4), something we specifically need to take into account in the empirical methodology. Interestingly, the number of transaction without incentives has decreases over time, especially after the crisis. This seems to suggest that landlords might have adjusted for the economic cycle not by reducing contract rents, but by providing more incentives. Table 6 shows that also the amount of incentives has increased substantially after the crisis. The average incentives, excluding no incentives, is 15.6 percent.

TABLE 5 — DESCRIPTIVE STATISTICS

	Mean	Std. Dev.	Minimum	Maximum
Percentage incentives	0.08191	0.106848	0.000	0.414
Effective initial rent per m^2	169.8135	82.88135	30.32	519.79
Log size transaction (m^2)	7.0494	0.75667	6.21	10.00
Supply	0.16402	0.044619	.074	0.259
Log travel time	1.2023	0.72590	-1.33	2.51
Log distance station	7.1264	0.86827	1.42	8.70
Walkscores	75.67	16.300	27	100
Landlord (institutional/private)	0.60			
Advisor tenant	0.64			
Advisor landlord	0.86			
D2002	0.11			
D2003	0.09			
D2004	0.10			
D2005	0.08			
D2006	0.12			
D2007	0.14			
D2008	0.10			
D2009	0.07			
D2010	0.08			
D2011	0.09			
D2012	0.02			
Contract < 37 months	0.14			
Contract 37 to 84 months	0.68			
Contract >84 months	0.17			
Dummy Single tenant	0.28			
Dum. high building (>5 stories)	0.44			
Construction year until 1900	0.11			
Construction year 1900-1949	0.15			
Construction year 1950-1969	0.16			
Construction year 1970-1989	0.17			
Construction year 1990-1999	0.20			
Construction year 2000 or more	0.21			
Dummy Centrum	0.22			
Dummy zuidoost	0.14			
Dummy Westelijke Tuinsteden	0.09			
Dummy Teleport Sloterdijk	0.09			
Dummy Zuid	0.25			
Dummy Other areas	0.21			
Period		2002-2012		
Number of transactions		409		

TABLE 6 — INCENTIVES OVER TIME

Year	N	Mean	Median	Std. Deviation	Minimum	Maximum
2002	45	0.01799	0.00000	0.038576	0.000	0.209
2003	38	0.03562	0.00000	0.065271	0.000	0.230
2004	39	0.02099	0.00000	0.046028	0.000	0.207
2005	34	0.06721	0.02615	0.082550	0.000	0.233
2006	48	0.06632	0.00000	0.098900	0.000	0.410
2007	56	0.07883	0.01516	0.103562	0.000	0.342
2008	42	0.09551	0.08468	0.094836	0.000	0.352
2009	29	0.15753	0.12260	0.138697	0.000	0.414
2010	33	0.11982	0.06093	0.127426	0.000	0.379
2011	37	0.18798	0.19166	0.116065	0.000	0.362
2012	8	0.14359	0.19565	0.100406	0.000	0.241
Total	409	0.08191	0.01761	0.106848	0.000	0.414

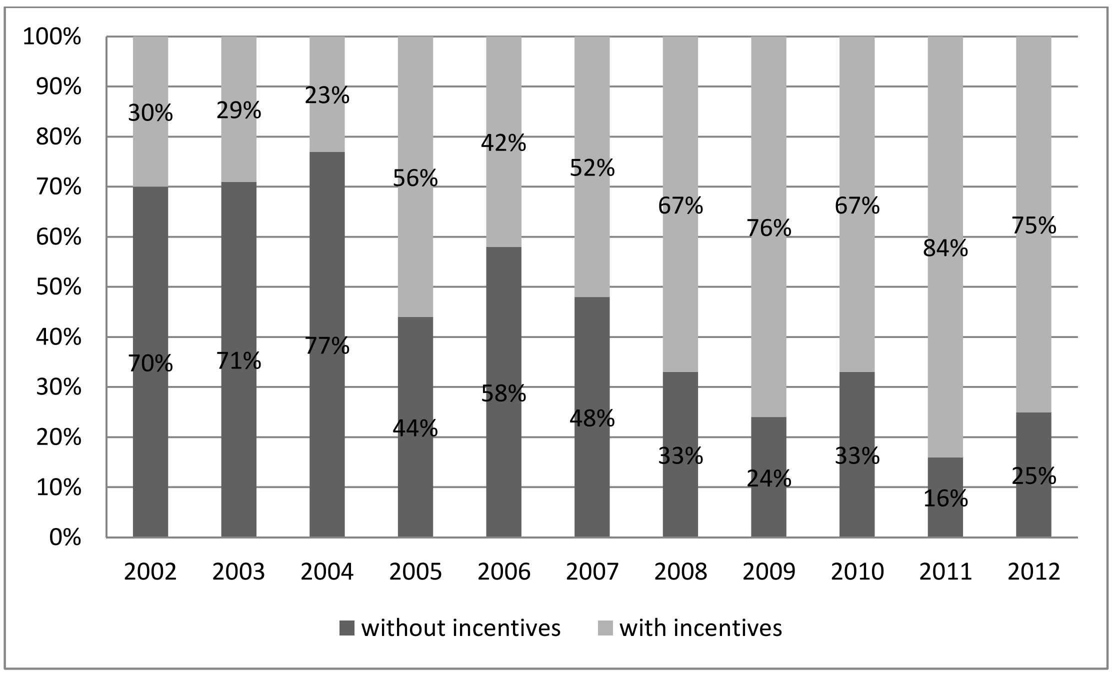


FIGURE 4 — TRANSACTIONS WITH AND WITHOUT INCENTIVES

C. Sample selection, the type of landlord, and the role of advisors

Although there are 409 observations about lease incentives, the type of landlord and the advisor indicators are, unfortunately, only available for a subsample of the data. As long as the sample selection is based on the independent variables (i.e. construction year, location) we would not expect our results to be biased as we will control for those variables. However, if high lease incentives are underreported (see Figure 5 for the distribution of observed lease incentives) it might lead to sample selection bias. For example, the institutional landlord/private landlord variable is only available for 318 observations. If higher lease incentives are given by institutional landlords (in comparison to private landlords) and these lease incentives are underreported the effect of institutional landlords on lease incentives is underestimated. The descriptive statistics in Table 5 shows that, for those cases were the type of landlord is not missing, about 60 percent of the rental agreements are by an institutional landlord.

Similarly, 64 percent of the tenants (203 total observations) used an advisor when negotiating a contract, and this percentage is 86 percent for the landlord (209 total observations). Again there are quite some missing observations. It is not strange that a lot of landlords use an advisor as we only have information about new tenants (not contract extension). In case of the 'tenant advisor' indicator we would again expect an underestimation (if high incentives are underreported). As an advisor for the landlord is expected to lead to lower incentives the effect of an advisor on lease incentives might be overestimated. Finally, in 61 percent of the transactions both landlord and tenant used an advisor (124 total observations) and in 8 percent of the (124) cases both the landlord and the tenant do not use the services of an advisor. Given the number of missing observations we start with a simple hedonic type of model before examining the effect of the type of landlord and the role of advisors. Even though the dataset has its limitations - it might be difficult to accurately and correctly estimate the effect of the type of landlord and the use of an advisor on lease incentives – it still provides us with an important perspective on a market that is highly intransparant.

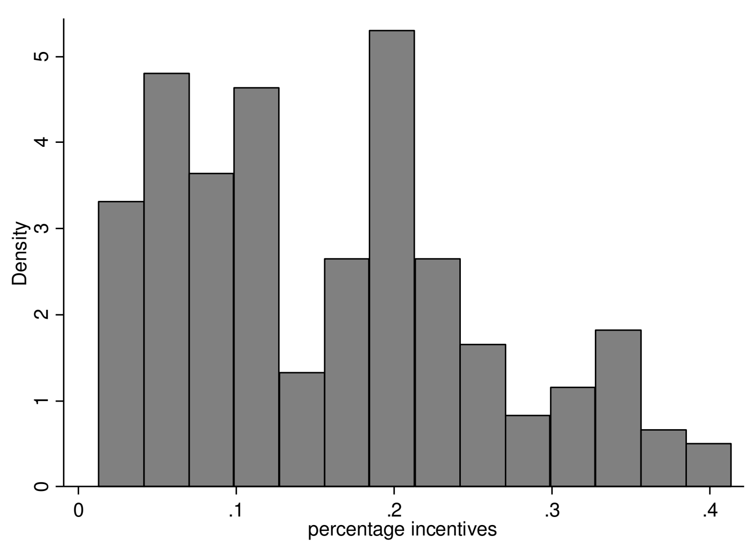


FIGURE 5 —DISTRIBUTION OF LEASE INCENTIVES

D. Other determinants of lease incentives

We also include a variety of other control variables. In particular, the size of the transaction is on average 1,000 m2. The average yearly supply of office space in Amsterdam is 16,4 percent of the total stock of office space in Amsterdam. The Google Walk score is on average 75 and is a measure of accessibility. Not surprisingly, in some transactions in the center of Amsterdam the Google Walk score is a perfect 100. The majority of office market transactions were done in 2007, the year before the crisis. The majority of rental contracts are between 37 months and 84 months. This is not surprising as it is common practice to have a 5 year rental agreement. We would expect that for a longer rental agreement more incentives are given. In 28 percent of the transactions a single tenant (more than 90 percent of the space rented by a single tenant) rented the office space. This seems like a lot, but in the center of Amsterdam there are relatively small office spaces which is relatively easily rented by a single tenant. About 44 percent of the transactions are done in a high rise building (a building more than 5 stories high) and 41 percent of the registered transactions were based on a building with construction year 1990 or later. The highest number of transactions was in Amsterdam Zuid and Amsterdam Center.

IV. Methodology

An incentive is a factor (financially or non-financially) that facilitates the location choice of companies. As mentioned, in this paper only the rent-free period or rent discount are measured. To calculate the relative incentive, the present value (discounted cash flow method) of the annual rent during (full contract duration) is calculated. Subsequently, the present value is calculated without incentives. The rents are indexed by inflation (i), in the rental agreement this is typically the consumer price index all households, and discounted using the discount rate (r):

$$CW = \sum_{t=1}^{T} * (HI_t\,(1+i)^t) / (1+r)^t \qquad (1)$$

Subsequently, the percentage incentives are calculated as :

$$(\Sigma \text{ CW HI total} - \Sigma \text{ CW HI corrected for incentives}) / \Sigma \text{ CW HI total} \qquad (2)$$

Consequently, the percentage incentives is a positive number. The discount rate is assumed to be equal to the risk free rate (rent on 10 year bonds) corrected for the average inflation in the preceding 5 years (CPI with basis year 2006). The average discount rate we used was 2.1 percent, with the highest discount rate in 2008 (2.4 percent) and lowest in 2006 (1.7

percent). A solvable landlord like the government or a stock market listed company might be more prepared to give higher incentives. The risk of a future cash flow for the landlord is incorporated in the discount rate. For a less solvable tenant the incentives may be spread over the rental term to reduce the risk. So, the incentives measure we use is basically a summary measure that already incorporates the potential differences in risk associated with the rental cash flows.

Based on our measure of lease incentives, the following (Tobit) regression model is estimated:

$$I_{i,t} = \alpha + \sum_{k=1}^{K} b_k X_{k,i,t} + \tau_t + \varepsilon_{i,t} \qquad (3)$$

where $I_{i,t}$ is the percentage incentive of transaction i in year t, $X_{k,i,t}$ are all of the independent variables (again see Table 4). The τ_t are time fixed effects and $\varepsilon_{i,t}$ is the error term. We are mainly interested in the parameter estimates of b_k for the dummy variable landlord (institutional/private) and the dummy variables advisor tenant/landlord. Because we use the percentage incentives, the interpretation of the coefficients is in percentage points. Note that by using incentives, we use a direct measure of bargaining outcomes. This is a clear benefit in comparison to a hedonic type method where we would adjust for buyer and seller characteristics and would need to assume symmetric bargaining (see Harding et al., 2003). Bargaining, in part, is based on the availability of relevant market information. This is what we try to measure with the advisor tenant/landlord indicators. In terms of empirical strategy, we built up the regression model one variable at a time starting with a base model that includes all of the standard hedonic variables (but without the main variables of interest).

V. Results

Table 7 reports the regression results.[4] In column 1, a hedonic type of regression is reported. In the subsequent columns we add the type of landlord, and whether the tenant and landlord have used the services of an advisor in the transaction. As is customary with this type of Tobit analysis, column 6 contains a recalculation of the results (marginal effects) based on the full model, conditional on positive incentives, and evaluated at the mean of the independent variables. The discussion is categorized by the different variable types: the subjects involved in the transaction, location characteristics, building characteristics, and transaction-specific characteristics.

[4] Note that the OLS results are similar to the Tobit estimates and leads to the same conclusions. Only the Tobit results are reported.

A. The type of landlord and the effect of advisors on lease incentives

The effect of the type of landlord on lease incentives is reported in columns 2 to 5. An institutional investor provides about 6.2 to 15.4 percentage points more (latent) incentives. This is basically the effect for the whole population of transactions and is typically interpreted as an increase in the incentive to provide lease incentives. In case the latent variable is positive it equals the amount of incentives. Conditional on providing positive incentives, however, this effect is 11.2 percentage points. This is the increase in the conditional expectation of the actual lease incentives in case those incentives are positive, which is commonly regarded as a more useful interpretation of the marginal effects. The effect is statistically significant at the one percent significance level. As mentioned, an institutional landlord (like the government) might care less about lease incentives as those incentives are typically given by asset managers who are not directly financially dependent on the amount of incentives that are given, but are hired to ensure that the building is actually rented out.

An advisor on the side of the tenant (without an advisor at the side of the landlord) has an effect on the latent incentives variable of about 9.2 to 12.3 percentage points. Conditional on positive incentives this effect is 6.7 percentage points. This effect is sizeable relative to the average incentive of 8.2 percent and average positive incentive of 15.6 percent. The effect is significant at the ten percent significance level and this result is in line with the idea that an advisor is valuable for a tenant from the perspective of increasing lease incentives. The effect of an advisor on the side of the landlord is a bit larger, -16.4 percentage points, and again statistically significant at the one percent significance level. The effect of an advisor is larger for landlord than for tenants. It is difficult to interpret this effect as it may be the results of higher incentives being underreported. A priori, we would have expected that the effect is higher for tenants. Tenants have less information about the market and building than a landlord who own the building and possibly also other similar buildings. It might be that an advisor is less willing to work for a tenant than for a landlord or that a tenant is less able to benefit from the knowledge of an advisor. Again, it is difficult to say.

If both the tenant and landlord use the help of an advisor then there is a negative -1.5 percentage point effect on incentives, but this effect is not statistically significantly different from zero. This result at least implies that the competitive forces in the market are such that the information given by advisors are equally valuable (in terms of bargaining power) for both landlords and tenants. We would have expected that tenants are more informationally disadvantaged (information asymmetry in favor of the landlord) and as such would gain the most from having an advisor. It might also be that tenants in the Amsterdam office markets have easy access to the same market information (or are professional enough to acquire such information) as landlords and, as such, are not as informationally disadvantaged as commonly asserted. However, the fact that the difference between both advisor indicators is relatively small (and there are substantial costs of hiring an advisor) suggests that hiring advisor is, although maybe rational, not necessarily the most beneficial outcome. The problem of this prisoners dilemma situation is that both the tenant and landlord cannot credibly promise not to use an advisor. As such, the majority of landlords and tenants end up hiring an advisor just to make sure that they have the relevant market information to close a transaction. Of course, an advisor may also make a transaction more smooth and as such may still be valuable.

B. The effect of location

Interestingly, we do not find much evidence of differences across office locations in Amsterdam. Only in the area 'westelijke tuinsteden' the lease incentives are disproportionally higher. Apparently, the location effect is captured by the other variables like the building characteristics, but also the accessibility measure, and office supply. For instance, we find that office supply has a positive effect on incentives, even though this effect is only statistically significant at the 10 percent significance level (only in specifications 5 and 6). A one percentage point more office supply in the area leads to an increase of incentives of 0.6 percentage points.

The effect of the travel time to a highway and walking distance to a train station has an unexpected negative effect on incentives especially in the baseline regressions. However, in later specification including the type of landlord and the advisor variables this effect is no longer statistically significantly different from zero. The Google Walkscore, a measure of nearby amenities, has a positive and statistically significant impact only in the final regression model. A standard deviation change in the Google Walkscore (16 out of a potential 100) increase the expected lease incentives, conditional on receiving a positive incentive, by 3.2 percentage points.

C. Building characteristics

A high-rise building has a positive effect on the latent lease incentives variable of 5.9 to 6.9 percentage points. The higher the number of floors the greater to probability of a panoramic view and the more likely the office building is perceived to be a landmark (prestige effect). Unfortunately, this effect is only 2.3 percentage points and not statistically significant based on our final estimates reported in column 6. A further building characteristic that we included, the construction year of the building (reference category before 1900), does not seem to have much of an effect on lease incentives. We only find a negative effect in case of some of the cohorts, but this effect does not seem to hold in our final regression model.

D. Transaction-specific variables

As expected, the results in Table 7 show that the rental term has a positive effect on lease incentives. A landlord is willing to provide more incentives in case the tenant shows a long-term commitment to rent a property. In column 6, a rental agreement of 37 months or more leads to about 7 percentage point more lease incentives. This effect is highly statistically significant.

Further results indicate that the size (in square meters) of the transaction does not have a discernable impact on lease incentives. Typically, we would expect to see more incentives in case of larger transactions. By contrast, if a tenant is willing to hire a majority of the office space within a building, they do get higher incentives. In column 6, this effect is about 5.4 percentage points and it is statistically significantly different from zero at the 5 percent significance level. Apparently, the positive commitment of a tenant to hire such a large part of the office space induces landlord to provide more incentives even though having a single tenant is risky from a cash flow perspective. If this tenant leaves, the majority of the office space in the building will be vacant. Finally, the results in Table 7 suggest that during the financial crisis (after 2008) higher lease incentives were given to compensate for higher vacancy rates in the office market. Especially in 2009, the lease incentives were 11.7 percentage points higher than in 2002. Relative to 2008, this difference was 6.4 percentage points.

TABLE 7 — REGRESSION RESULTS
(DEPENDENT VARIABLE: PERCENTAGE INCENTIVES)

	(1)	(2)	(3)	(4)	(5)[5]	(6)
	Basis	+Type landlord	+ Advisor tenant	+ Advisor landlord	+ adv. Tenant, adv. landlord	Conditional on pos. incentives
Landlord (institut.)		0.082***	0.062**	0.073**	0.154***	0.112***
		(0.022)	(0.026)	(0.032)	(0.034)	(0.025)
Advisor tenant			0.123***		0.092*	0.067*
			(0.024)		(0.052)	(0.038)
Advisor landlord				-0.097***	-0.225***	-0.164***
				(0.036)	(0.053)	(0.040)
Both advisor					-0.016	-0.012
					(0.047)	(0.034)
Log size trans.	-0.005	-0.007	-0.009	0.013	-0.010	-0.009
	(0.011)	(0.013)	(0.016)	(0.018)	(0.016)	(0.012)
Supply	-0.102	0.287	0.178	0.371	0.839**	0.574**
	(0.335)	(0.385)	(0.427)	(0.483)	(0.383)	(0.286)
Log time to highway	-0.035*	-0.020	-0.040	0.003	0.010	0.003
	(0.020)	(0.024)	(0.025)	(0.031)	(0.025)	(0.018)
Log dist. to trainst.	-0.026***	-0.022**	-0.012	-0.012	0.001	0.004
	(0.008)	(0.009)	(0.012)	(0.013)	(0.011)	(0.079)
Walkscore	-0.001	-0.001*	-0.001	0.001	0.003***	0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)
High building	0.069***	0.070***	0.094***	0.059**	0.039	0.023
	(0.019)	(0.022)	(0.025)	(0.029)	(0.028)	(0.021)
Single tenant	-0.026	-0.023	0.036	-0.037	0.067**	0.054**
	(0.021)	(0.026)	(0.027)	(0.033)	(0.031)	(0.023)

[5] Especially in this final model the number of observations decreases substantially, while we do estimate a substantial amount of parameters. As a result, we also estimate a regression without year and construction year dummies, but with the variables year, year squared, construction year, construction year squared. The results remain very similar.

Contract 37 to 84	0.073***	0.095***	0.093**	0.118***	0.102**	0.070**
	(0.028)	(0.029)	(0.041)	(0.039)	(0.043)	(0.031)
Contract >84	0.071**	0.094***	0.071	0.106**	0.097*	0.067*
	(0.032)	(0.035)	(0.047)	(0.047)	(0.048)	(0.035)
Centrum	0.032	0.048	0.037	-0.010	-0.015	-0.000
	(0.031)	(0.037)	(0.037)	(0.049)	(0.036)	(0.027)
Zuidoost	0.016	-0.004	0.013	0.001	0.016	0.001
	(0.039)	(0.043)	(0.047)	(0.051)	(0.047)	(0.036)
Westelijke Tuinst.	0.072**	0.102**	0.027	0.047	0.082**	0.076**
	(0.036)	(0.040)	(0.043)	(0.054)	(0.046)	(0.035)
Teleport Sloterdijk	-0.002	-0.025	0.013	-0.009	0.033	0.031
	(0.041)	(0.047)	(0.052)	(0.063)	(0.053)	(0.040)
Zuid	0.021	0.025	-0.023	-0.017	-0.021	-0.004
	(0.025)	(0.032)	(0.037)	(0.039)	(0.041)	(0.031)
Const.yr 1900-1949	0.014	0.005	0.053	-0.061	-0.051	-0.037
	(0.036)	(0.044)	(0.040)	(0.051)	(0.043)	(0.035)
Const.yr 1950-1969	-0.068*	-0.141***	-0.105**	-0.113*	-0.020	-0.015
	(0.040)	(0.051)	(0.050)	(0.068)	(0.046)	(0.038)
Const.yr 1970-1989	-0.045	-0.098*	-0.101**	-0.068	-0.019	-0.014
	(0.039)	(0.050)	(0.047)	(0.069)	(0.046)	(0.040)
Const.yr 1990-1999	-0.044	-0.107**	-0.114**	-0.112	-0.034	-0.025
	(0.039)	(0.051)	(0.049)	(0.069)	(0.045)	(0.042)
Const.yr $\geq$ 2000	0.011	-0.050	-0.053	-0.040	-0.004	-0.003
	(0.037)	(0.048)	(0.044)	(0.065)	(0.043)	(0.039)
2003	0.012	0.010	-0.001	0.104*	-0.053	-0.039
	(0.040)	(0.047)	(0.047)	(0.061)	(0.054)	(0.045)
2004	-0.022	-0.052	-0.061	-0.015	-0.130**	-0.095*
	(0.037)	(0.043)	(0.051)	(0.060)	(0.060)	(0.049)
2005	0.096***	0.075*	0.040	0.159***	-0.040	-0.029
	(0.036)	(0.041)	(0.051)	(0.049)	(0.060)	(0.047)
2006	0.083**	0.077*	0.075	0.095	-0.004	-0.003
	(0.035)	(0.041)	(0.049)	(0.058)	(0.060)	(0.046)
2007	0.098***	0.072*	0.071	0.091	-0.021	-0.016
	(0.035)	(0.039)	(0.044)	(0.058)	(0.050)	(0.043)
2008	0.133***	0.130***	0.090*	0.130**	0.073	0.053
	(0.034)	(0.039)	(0.053)	(0.054)	(0.053)	(0.042)
2009	0.209***	0.216***	0.172***	0.268***	0.160***	0.117***
	(0.036)	(0.044)	(0.047)	(0.061)	(0.048)	(0.045)
2010	0.145***	0.156***	0.183***	0.210***	0.109**	0.079*
	(0.038)	(0.046)	(0.045)	(0.059)	(0.047)	(0.043)
2011	0.218***	0.246***	0.187***	0.286***	0.079*	0.058
	(0.032)	(0.036)	(0.040)	(0.047)	(0.044)	(0.042)
2012	0.199***	0.190***	0.148***	0.299***	0.121***	0.089*
	(0.052)	(0.056)	(2.38)	(0.054)	(0.040)	(0.050)
Observations	409	318	181	168	112	112
Left-censored	198	159	71	73	35	35
Log Likelihood	9.16	8.87	50.79	25.81	65.58	65.58
Chi kw. Regr.	183.07***	173.79***	155.34***	120.62***	142.34***	142.34***

***,**,*, significance at 1%, 5% en 10%, respectively. Standard errors in parentheses. The coefficients in column 6 are the marginal effects (based on column 5) conditional on positive incentives and evaluated at the mean of the independent variables.

VI. Conclusion and discussion

More insight into the exact functioning of the office market is of fundamental importance for landlords, tenants, and (institutional) investors. This paper has examined the determinants of lease incentives in the Amsterdam office market. A unique dataset from the Amsterdam taxing authority between 2002-2012 has been used. The regression results show that the type of landlord (institutional versus private) has a statistically significant positive effect on the percentage incentives. An institutional landlord, ceteris paribus, offers 11.2 percent higher incentives than a private landlord. This is the effect on the expected percentage incentives conditional on having a positive incentive. A private landlord rents out office space at own account and risk, while an institutionally owned real estate is governed by asset managers who are allowed to rent out office space for the investor. This can be asset managers working for the investor or private asset managers. These managers typically have some leeway to act freely. A private landlord in which each month of free rent is directly visible in the financial results, might be less inclined to provide incentives. In addition, private landlords are, at least in part, typically financed by debt and may not be able to provide incentives because of bank covenants, but also because there may be substantial monthly costs (rent payments, operational costs). Finally, it may be that a private landlord has a longer investment horizon and, as such, is less affected by lower rents or a private landlord may simply not have enough liquid assets to pay for incentives.

The regression results have also showed that a commercial advisor at the side of the tenant increases incentives substantially. In particular, we find 6.7 percentage points higher incentives. This result seems to be in line with a story in which there is information asymmetry between the landlord and tenant. Negotiating a lease is typically not a core business of a tenant. Moreover, the landlord might be more aware of current market conditions (especially since a landlord typically owns multiple buildings). By contrast, when a landlord uses the services of an advisor it leads to lower incentives. In particular, we find a 16.4 percentage point lower incentive. Apparently, besides finding an appropriate tenant, the advisor might be much better aware of the actual market situation than the landlord. Again, given that higher incentives are likely not reported this may be an overestimate. Finally, an advisors do not seem to have an impact on incentives if hired by both the landlord and the tenant. This suggest that there is a prisoners dilemma story in which the tenant and landlord hire and advisor and pay its cost while from an incentives perspective it does not lead to much gain. A landlord and tenant, however, cannot credibly promise not to use an advisor, so a strategy were both use an advisor might be a Nash equilibrium. This result indicates that market forces are such that, even though we expected that a tenant stands most to gain, the information asymmetry between tenants and landlords are taken away when both hire an advisor.

In sum, the results in this paper suggest that better market information results in a better bargaining position for both tenant and landlord. However, our findings also indicate that, even though the coefficient on the indicator 'advisor tenant' is smaller than the effect of an advisor on lease incentives given by landlords, when both use an advisor there is not difference in incentives at all. Given the considerable costs of hiring an advisor, this result questions whether an advisor is worth hiring. However, besides potential other benefits of hiring an advisor, it seems that, in a market where information is key, market participants cannot afford not to hire an advisor. If the counterparty in a rental lease transaction has superior information, leading to an increase in information asymmetry, not hiring an advisor can have a negative impact on the acquired lease incentives.

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Appendix

A. Description of main data sources

1. Building database TU Delft

TU delft gathered the hedonic characteristics of office buildings in Amsterdam. These are mainly building-specific and location-specific variables like the google walkscore, construction and renovation year and the number of floors.

2. GIS data – Arcgis

We have used GIS program to calculate the walking distance to the nearest station and travel time to the ramp of the nearest highway. The walking distance is a better measure than the distance by car, which has been used in previous research (see Boots, 2014). Moreover, we did not use the distance to the ramp of the nearest highway, but the travel time as distance can be equal, but travel times can differ substantially.

3. Amsterdam tax authority (DBGA)

DBGA collects transactions data of rental agreements as part of the law WOZ (translated: 'valuing real estate'). To determine the value of a real estate object they send a questionnaire to new tenants of a building. This mains that extensions of existing rental agreements are not registered. In the questionnaire information is asked about incentives, square meters, number of parking places, and the lease term.

4. Basisregistratie Gebouwen en Adressen (BAG)

The BAG (Basis registration addresses and buildings) contains information about all adresses and buildings in a municipality. This information is publicly available and contains data on the size of the real estate object, the construction year, and whether the object is in use.

5. Cushman & Wakefield

Cushman & Wakefield is a real estate advisor that collects all of the relevant information about the Amsterdam (and other) office market and analyses that information (market reports). Market information about Amsterdam, including transactions data of transactions that were guided by Cushman & Wakefield, were made available for this study.

6. Strabo

Strabo is a research company that is specialized in market research and real estate information. They have a transactions information system (called VTIS) which contains, amongst others, all of the relevant information about transactions of offices in Amsterdam. This is also based, in part, on information from PropertyNL and de Vastgoedmarkt. The database also contains information whether an advisor was involved with the transaction for either the landlord, tenant, or both.

Situations Vacant: A Conceptual Framework for Commercial Real Estate Vacancy

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Abstract

Commercial real estate vacancy is a key indicator of property market efficiency, economic performance and urban resilience. However, there has been little conceptual reflection into the abstract notion of vacancy beyond binary distinctions of natural and structural vacancy. Although useful simplifying meta-concepts, neither accounts for the internal complexity and imperfection that permeates real commercial property markets. Consequently, the objective of this article is to outline a conceptual framework that describes vacancy across the commercial real estate building life-cycle – from initial construction to final demolition and redevelopment. The originality of the research rests in its utility as the first known holistic examination of commercial real estate vacancy beyond that of an abstract economic factor, while its value is explicit in the conceptual typology which can be used by researchers interested in market imperfections and consequent interventions.

Key words: Natural Vacancy, Structural Vacancy, Commercial Real Estate,

Introduction and justification for research

Albert Einstein allegedly quipped that,

> 'If a cluttered desk is a sign of a cluttered mind, of what, then, is an empty desk a sign of?'

In a slightly broader context, what do underperforming and empty commercial properties (taken to mean office, retail and leisure and industrial buildings) tell us about the cities in which they reside, the landlords who own them, the investors that trade them, and the institutions of the commercial real estate markets which govern them? One way of considering this situation, from the perspective of the commercial office market, is that empty offices provide,

> *'A window into the soul of our shifting economy'*
>
> *(Carter 2015, quoted in Sourcable.net 16 February 2015).*

This analytical aperture directs the primary aim for this article. In order for researchers to reflect on commercial real estate vacancy, they need to have a conceptual framework (introduced in Figure 1) that can be used to reflect on the material reality of vacant properties - one that moves beyond the binary distinction of natural and structural vacancy and the broad notions of positive and negative vacancy. In this article, *natural vacancy* is broadly taken to mean those properties that efficiently clear respective property markets while *structural vacancy* is taken to mean those vacant properties that no longer have a relationship with occupier demand in their present use. Consequently, the primary objective of this article is to develop a framework that can be used to examine vacancy throughout the building lifecycle – starting with the initial construction phase and ending with demolition and redevelopment. The article is based on research into the commercial office market, however, the resultant conceptual typology can be applied broadly to all of the major commercial real property types (for example retail and leisure and industrial markets) as long as the unique nature of each type of property is also considered.

Theoretical context

Various researchers have examined vacancy; those interested in obsolescence and depreciation (Baum, 1991, 1993; Baum & McElhinney, 1997; Dunse et al, 2002; Andrew & Pitt, 2006; Crosby & Devaney 2006; Crosby et al 2011); those interested in the adaptation of vacant properties (Barlow & Gann, 1996; Beauregard, 2006; Kincaid, 2002; Heath 2001; Geraedts & van der Voordt, 2003; Agre, 2005; Langston et al, 2008; Remoy, 2010; Remoy and Wilkinson, 2012; Wilkinson and Read, 2011) those who want to map the characteristics of vacancy (Myers & Wyatt, 2004; Katyoka & Wyatt, 2008; Remoy H & Koppels, 2009); those who model the cyclical behaviour of the economy and property (Ball 2003; Barras, 2009; Wheaton 1999); and those who reflect on the medium to long-term rental adjustment process (Blank & Winnick, 1953; Wincott, 1997; Voith & Crone, 1988; Crone, 1989; Grenadier, 1995; Pissarides, 2000, 2005; Sanderson, et al., 2006; Miceli & Sirmans, 2013). Concurrently, professional practices regularly also use relative vacancy levels (alongside absorption and take-up, rent and yield) to monitor the performance of local markets (see quarterly updates from international commercial real estate companies, CBRE, Colliers and Cushman and Wakefield, BNP Paribas, Jones Lang LaSalle).

Historically, it is the latter research into rental adjustment and professional practice that have given most attention to vacancy, although recognition is given to the more recent emphasis on understanding vacancy in order to assist adaptive re-use. Much of this traditional research has specifically focused on the natural rate of vacancy rate and the prime markets. Typically, this language has borrowed from neo-classical economics, particularly its cyclical nature, and surveys of the labour market. This is most clearly seen in the parallel utilisation of the natural rate of unemployment and property vacancy and the utilisation of initial, cyclical and frictional categories of unemployment and property vacancy (outlined by Kerris and Kopells, 2006).

In the study of employment, initial vacancy is taken to mean those potential employees who are recently qualified but yet to find employment. The parallel example in commercial real estate are those commercial properties that have just been constructed but have not been filled yet. Cyclical unemployment occurs in parallel with the economic cycle; for example, when the economy is in decline unemployment will rise and vice versa. A similar process takes place, although lagged, in commercial real estate as the property cycle oscillates over time. Furthermore, frictional unemployment is a result of the movement of employees between firms and the consequent time taken to hire and refill vacant positions. This same process takes place in commercial real estate as businesses expand and retract. While structural unemployment is the consequence of a permanent change in the composition of the economy which leads to mis-matches between the requirements of business and the available employee skills and training base to fill these positions (for a rare discussion of structural property vacancy see Remoy, 2010).

The central argument in this article is that while commercial real estate is most certainly linked into the economic cycle it deserves its own conceptual framework that recognises the unique nature and imperfections associated with property markets. It is work noting that initial, cyclical and frictional concepts of vacancy implicitly assume that the market process will correct itself over time as the market clears. It is only structural vacancy that considers the other side of this situation, those properties that do not clear the market. On a certain level, the existing set of terminology covers both sides of the commercial market, those properties that are temporarily vacant and those that are permanently vacant. However, under closer scrutiny this argument starts to fall apart when we consider that the natural rate of vacancy, which by most estimates only accounts for 4-10% of stock, has received the majority of academic attention. The rest of the vacant commercial stock, that considered structurally vacant, is relatively unexplored (Lausberg, 2008). This article responds to this situation by setting out a conceptual framework that delves under this situation, particularly, the transition from natural to structural vacancy and reveals the operation of sub-optimal variants of vacancy which have received less attention in academia and practice. It achieves this aim by introducing two other commercial property ingredients into the discussion, the commercial property descriptions ‘prime’ and secondary. In this paper prime property is taken to mean the most recent additions to, and most desirable segments of, commercial stock. In contrast, secondary property is taken to mean older stock in relation to the traditionally more desirable prime stock. The secondary focus is vindicated in the vacancy typology, when it becomes increasingly apparent that a simple bifurcation between natural and structural vacancy does not exist. Secondary vacancy transcends both positions, indicating the ambiguous and dynamic nature of commercial vacancy.

It is worth noting that it is not the aim of this article to criticise existing research into vacancy, indeed, it is the basis for many of the econometric pillars of commercial real estate thought. Rather, the article argues that the current nature of commercial real estate necessitates a more detailed engagement with vacancy which in turn will help those engaged with a more resilient built environment. This extended debate also has the potential to inform new econometric analysis into less efficient parts of commercial real estate. The conceptual output of this article, the vacancy typology, is informed by a 3-year research project into office market obsolescence, depreciation and vacancy in the UK. While conducting this research, primarily based on an on-going interview process with industry professionals, it quickly became apparent that the traditional language used in academia and practice to describe vacancy was not adequate to express or explain the various manifestations of vacancy present in the commercial office market, nor its variability and change. The typology builds upon the traditional concepts of initial, frictional, cyclical and structural vacancy, in order to better reflect the full extent, and process, of commercial vacancy.

Situations vacant

Some commercial vacancy is a ‘necessary’ attribute of property markets. The efficient operation of the commercial markets, reflected in churn and filtering of businesses (Greenhalgh et al., 2003; Greenhalgh, 2008) up and down the property ladder cannot happen without a certain degree of vacancy. This type of vacancy can be understood as that part of stock that efficiently clears in response to the needs of occupier demand. This process of vacancy is generally referred to as initial, frictional or cyclical in nature (Kerris and Kopells, 2006). However, this perspective does not tackle those properties that do not efficiently clear through the market mechanism. This type of vacancy is not just a problem for commercial property landlords; it is also a problem for every nearby small business owner who depends on workers for daily trade. Each empty desk or shop represents one less person spending money in town, city and regional centres (Carter, 2015).

Underperforming and vacant buildings offer a powerful mode of reflection in relation to societies most wasteful practices. Increasingly, commercial buildings engage consumer demand for relatively fleeting moments in time, yet, endure for long centuries in the built environment. Reflecting this situation, following the opening of the Frank Gehry designed Facebook headquarters in California, Marc Kushner (2015) heralded the potential end of the office, arguing that social media is changing the way we consume the built environment. This statement is not necessarily as hyperbolic as it may first appear, technology is increasingly pervasive. However, Lausberg (2008) indicates that this situation, the precarious nature of commercial property, is little known in contrast to traditional perspectives of market efficiency. Reflecting the importance of this omission, Wilkinson et al (2014) attest that the continuing use of existing commercial real estate stock is a universal concern.

They argue that,

> *'There is a need for greater knowledge and awareness of what happens to societies buildings over time and how we might adapt them sustainably. This action includes avoiding premature destruction through finding new uses for buildings that have become unwanted or obsolete. While new development must also be sustainable, there is insufficient time for us to act unless proactive intervention into the performance of existing building stock becomes a priority'*

(Wilkinson et al., 2014:5).

Summarising this situation, Lausberg (2008) indicates that it is relatively easy to estimate natural vacancy (associated with initial, cyclical and frictional vacancy) from available market data. However, he indicates that there is a knowledge deficit in relation to structural vacancies, which he generally equates with obsolescence and location. He argues that not understanding this situation places commercial property and associated locations at significant risk.

The implications of this situation are disquieting. Instead of focusing on what is not known and working to remedy this situation, market actors and academics focus on the comfortable reality of the 'prime' market which can be equated with the historical 'natural' rate of vacancy. Consequently, the narrative of vacancy is beset by what Pickety (2014:2) calls,

> *'An abundance of prejudice and paucity of fact.'*

Which results in a potential risk, where,

> *'We overestimate what we know and underestimate the value of the unknown'*

(Taleb, 2010:140).

A Typology of commercial vacancy

Orthodox thought suggests that commercial vacancy can be separated into two broadly distinct tiers, that of natural vacancy and that of structural vacancy. This then interacts with the realities of commercial property practice, which in itself, is separated into the prime market and the secondary market. However, these bifurcations do not run contiguously. Each vacancy tier, natural and structural, has its own characteristics, and although both part of the same commercial market, operate and manifest themselves quite differently.

Figure 1, the Typological Model of Vacancy, and the proceeding narrative explain this situation. Figure 1 should be read from left to right and top to bottom. The horizontal dimension describes the operational variation inherent in commercial property vacancy, running from the macro to the micro level. This is denoted by the horizontal arrows which pass through Column 3. The vertical dimension represents the property ladder, the filtering process of tenants as they move between buildings, and the building life cycle. The best properties are added to the top in a funnel like system and the worst ones eventually drop out of the bottom depending on their contingent circumstance (following the vertical arrows in Column 3).

Figure 1: Typological Model of Vacancy

Segmentation		The Market (towns, cities and regions)	Vacancy Processes
Natural Vacancy	Premium Vacancy	Prime	• Cyclical • Frictional • Initial
	Auxiliary Vacancy		• Churn • Hidden • Strategic
Structural Vacancy	Evolutionary Vacancy	Secondary	• Inefficient • Inertial • Transformational
	Final Vacancy		• Physical • Planning • Economic

The first column describes the respective tiers of vacancy, natural vacancy and structural vacancy. Natural vacancy describes those properties that efficiently clear through the classic supply and demand mechanism, while structural vacancy describes those properties that no longer clear through the supply and demand mechanism (Column 1 describes the macro level description of the vacancy process). This bifurcation can then be sub-divided in order to reflect real market segmentation. The natural rate can be sub-divided into premium and auxiliary vacancy. Premium vacancy, as the name suggests represents the very best buildings that are on the market and is associated with the familiar initial, frictional and cyclical vacancy (Kerris and Koppells, 2006; Lausberg, 2008). Auxiliary vacancy describes those vacant secondary properties that still have a role to play in the commercial real estate market. Auxiliary vacancy describes non-prime secondary properties that are held in reserve in order to 'fill in' prime supply shortages. The concept of 'filling in' is, by its very nature temporary. This is because it presumes that once new prime buildings are constructed, tenants will move to higher specification accommodation. Filling in is most likely to take place in buoyant areas with tight supply conditions and during and following times of recession when speculative construction has abated resulting in lagged development.

Auxiliary vacancy is more permanent in those areas with adverse economic conditions, where it is difficult to justify the cost of development. In these locations it is important to safeguard viable secondary space in order to fulfil the requirements of occupier demand and economic development (in such areas auxiliary vacancy is closer to premium vacancy).

In turn, structural vacancy can then be sub divided into evolutionary vacancy and final vacancy. Evolutionary vacancy describes those properties that could still have a future in alternative use if adapted. Final vacancy, as the name suggests describes those properties that no longer have a future either in their present or alternative use and should therefore be removed from property supply altogether. The first two columns can then be related to the overall commercial market (column 3), which, for simplicity, is divided into prime property and secondary property. The prime market only intersects with premium vacancy, while, secondary vacancy accounts for auxiliary, evolutionary and final vacancy.

It is this part of the model that lays out the disparity and non-alignment between natural and structural vacancy, and the prime and secondary market (they are not one and the same). Demonstrating the influence of the secondary market, this model indicates that it is, in part, included in both tiers of vacancy, natural and structural, as it also forms part of the auxiliary layer of vacancy. It is this non alignment that exposes the myth that all secondary vacancy is bad and that the natural rate of vacancy only contains prime property. The third column, representing the property market (and its contingent location), forms the spinal structure of the model. The left hand side (of which) considers the segmentation of vacancy in market locations, while the final column to the right, considers the processes of vacancy that take place in these locations. It is these processes that reflect and make sense of the dynamic change and movement that takes place within and between the respective segments of commercial vacancy.

This is because the final column describes the micro level vacancy interaction. 'Cyclical', 'frictional' and 'initial' vacancy are relatively well known in the international literature (Kerris and Koppells, 2006; Lausberg, 2008; Remoy, 2010). These concepts are typically associated with the 'natural' rate of vacancy, market clearing and concepts of equilibrium and premium vacancy. By themselves they are an efficient means of describing premium vacancy as its level oscillates around equilibrium (cyclical), as it facilitates the movement of firms (frictional) and as new property enters the market (initial). All three types of vacancy are helpful as they facilitate the efficient operation of the property market and are therefore presumed to be temporary in nature.

Moving down Column 4, churn, hidden and strategic vacancy describe those types of commercial vacancy that taken place within auxiliary vacancy. Churn vacancy is a variation of frictional vacancy, describing this concept after it has begun to filter down the property ladder. Churn vacancy takes place when the push and pull factors of new development at higher specification are constructed and cause existing tenants to filter up the property ladder through a 'flight to quality.' It is different to frictional vacancy because it leads to a downward revision in rent, capital value and yield (without significant property improvement) and takes place more regularly. In itself, it is not a negative attribute of vacancy, (this type of filtering and absorption is directly related to new start-ups and small businesses), however, it is a signal that such property is no longer a prime investment. Hidden vacancy describes that portion of vacancy that is difficult to detect, often consciously so. It includes those properties that are taking shelter from empty property taxation (but are vacant to all intents and purposes) and those properties considered grey space (those properties that are leased but are surplus to tenant requirements).

Strategic vacancy is a potentially negative attribute of the commercial market. It describes those instances when landlords forcibly evict or coerce tenants to leave their buildings in pursuit of higher values associated with alternative building use even though they are still relatively viable in their present use (hence why it sits in the auxiliary segment). Strategic vacancy is particularly prevalent in England, following planning changes which have incentivised landlords in certain locations to target more profitable use (the advent of relaxed planning regulation, through permitted development rights, has been seen to favour office to residential conversion due to the higher economic value of the latter). All three of these concepts are still part of natural vacancy but are also associated with degrading performance and an increase in void space.

Inefficient vacancy, transformational vacancy and inertial vacancy take place in the evolutionary vacancy layer. These types of vacancy can be considered on a progressive redevelopment spectrum and chart the transition of commercial property into potential new use. Inefficient vacancy describes those properties that are inefficient in terms of operational cost, holding cost and embodied carbon. These properties are functionally and economically obsolete and are ready to transition into alterative use (or potentially within use following major improvement). Inertial vacancy describes the regular impasse between operational use (in original form) and transformation (into new use). It does not happen in all cases but can be a consequence of restrictive tenancy covenants, planning negotiations and financial due diliegence. As the names suggests, transformational vacancy describes those properties going through new development, and details the final transition between inefficient use, and such properties leaving supply altogether (and entering another property market with additional attributes).

Physical, planning and economic (often interrelated rather than separate categories) vacancy processes make up final vacancy. Planning vacancy includes those properties that cannot be adapted into alternative use (but are no longer viable in their present use) because they are constrained by planning regulation that places restriction on alternative use. Physical vacancy describes those properties that have either depreciated beyond repair or have restrictive designs which do not lend themselves to re-use. Economic vacancy describes those properties that are not supported by viable local rental levels. In other words, the underlying rental levels that underpin such buildings do not cover existing running cost or the cost of development. The only way these buildings can be re-used is through the introduction of subsidy.

The segmentation is not a static model. There is a great deal of transference between the fuzzy boundaries of the four segments, especially between auxiliary and evolutionary vacancy (and increasingly between market segments as the boundaries between use dissolve). The model will also vary between locations depending on the prevailing market conditions in those locations.

Conclusion

This article has explicated a conceptual framework for commercial vacancy that moves beyond the positive facets of vacancy, such as initial, frictional and cyclical vacancy types (Kerris and Koppels, 2006) and the general approximation of structural vacancy. This thread of enquiry builds upon the initial work of Kerris and Koppels (2006) and sets out a conceptual framework that considers natural and structural types of vacancy, highlighting an additional set of vacancy concepts. The theoretical argument suggest that commercial vacancy can be separated into two distinct tiers, that of natural vacancy and that of structural vacancy.

Natural vacancy describes those properties that efficiently clear through the classic supply and demand mechanism, while structural vacancy describes those properties that no longer clear through this mechanism. This distinction then interacts with the commercial market, which in itself is separated into the prime market and the secondary market. However, these bifurcations do not run contiguously. Not all secondary vacancy is structural; for example, auxiliary vacancy captures those secondary properties that still clear the market and are held in reserve to support and fill-in for the prime market in certain locations.

Each vacancy tier has its own characteristics, and although part of the same commercial market, operate and manifest quite differently. To demonstrate this situation, the horizontal dimension of the vacancy typology describes the scale based variation inherent in vacancy, running from the macro to the micro level. The vertical dimension represents the property ladder and the temporal building life cycle. The best properties are added to the top in a funnel-like system and the worst ones eventually drop out of the bottom dependent on their contingent circumstance. The originality of the research rests in its utility as the first known holistic examination of commercial real estate vacancy beyond that of an abstract economic factor, while its value is explicit in the conceptual typology which can be used by researchers interested in market imperfections and consequent interventions.

However, in order to begin to understand commercial vacancy, it is necessary to qualify the research findings in this paper. First, the UK focus of the research reveals the need for some cautionary words in relation to the context and content of the findings and conclusions in this paper. We must be careful of over generalisation and simplification. Each location in the world contains a variety of comparable but highly specific real estate markets which are contingent and socially produced in each context. It is therefore likely that the operation of vacancy will be different in alternative market contexts. Therefore, it is hoped that the conceptual framework set out in this paper is used as a framework for discussion rather than rigid structure.

Similarly, in taking such a wide view of commercial vacancy, some of the finer details of the different types of property and vacancy been dealt with in cursory fashion. This paper has only provided general descriptions and drawn broad conclusions, a great deal more research will be needed to fully understand the specific nature of commercial vacancy. Finally, by focusing its research on the UK, the paper is Anglocentric in its conceptualisation and understanding of commercial real estate, which will most certainly add a degree of bias to the judgements contained within. Despite these caveats, we consider that the material within provides a conceptual framework through which a more comprehensive picture of commercial vacancy begins to emerge. Above all, the message is clear: we misunderstand contemporary commercial real estate, if we believe that commercial vacancy can be reduced to a simple bifurcation of natural and structural vacancy.

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Homeowner Effect and Strategic Interaction in Local Property Taxation*

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Abstract

This paper investigates whether and how strongly the share of households owning their homes in a community affects residential property taxation by local governments. Homeowners bear full property tax burdens irrespective of local market conditions, and the tax is more salient to them. "Home owner communities" may hence oppose high property taxes in local elections in order to protect their housing wealth. Using granular spatial data from a complete housing inventory in the 2011 German Census and war-related housing damages as a source of exogenous variation in local homeownership, we provide empirical evidence confirming that otherwise identical jurisdictions choose significantly lower property tax multipliers when the share of homeowners in their population is higher. This result appears to be independent of local housing market conditions, which suggests tax salience as the key mechanism for this effect. We find strong positive spatial dependence in tax multipliers, indicative of property tax mimicking by local governments.

Keywords: *Homeownership rate; public financing; residential property tax; spatial tax mimicking; yardstick competition.*

JEL-Classification: *D*72, *H*20, *H*71, *H*72, *H*77

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1 Introduction

Property taxes form a main source of tax revenue for local governments.[1] Due to the immobility of the tax base even in the long run, they are moreover associated with low excess burdens. The property tax hence is usually considered to score high from a tax efficiency perspective. Its true efficiency however hinges critically upon the political economy of property taxation, the decisions of how, whom and how much to tax within the local institutional context (Wilson 2006). While property taxes are technically levied on both owner-occupiers and renters the same way[2], the perception and economic burden of the tax can differ substantially among these two basic groups of voters.

According to the "home voter hypothesis" first coined by Fischel (2001), especially owner-occupiers are expected to oppose high local property tax rates. Homeowners have strong incentives to promote high market values for the typically biggest wealth items in their portfolios. The level and popularity of a property tax has also been argued to depend on the salience of the tax (Brunner et al. 2015, Cabral and Hoxby, 2016). In many countries, including Germany, property taxes tend to be much more salient for homeowners than for renters. German homeowners annually receive a discrete property tax note directly from their municipality. For renters, the property tax amount usually appears among many other cost positions in the annual utilities statement, which they receive from their landlords.[3] As a consequence of differences in salience, renters have been documented to underlie the illusion of not paying property taxes at all, even if they do (Oates 2005). According to a political economy argumentation, "homeowner communities", i.e. municipalities with a dominant

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[1] Total revenue of German property tax type B (which is levied on non-agricultural property including improvements to land) amounted to 12.8 billion EUR in 2015. This corresponds to approximately 330 euros per housing unit and to about one-sixth of total municipal tax revenue. The relative importance of property taxes is even much higher in Anglo-Saxon and also many European countries.

[2] In Germany, landlords are statutorily allowed to completely shift the property tax to their tenants on a pro-rata basis. Of course, local market conditions may preclude that property taxes are fully shifted forward onto renters in many locations in economic terms.

[3] Other positions typically include insurance, waste collection, housekeeping, street-cleaning etc.

share of households owning their homes, should therefore be likely to tax property more lightly than otherwise comparable communities.

In this paper, we make us of a previously untapped detailed data set which enables us to investigate whether the share of owner-occupiers in local housing markets indeed affects the intensity of property taxation by local governments. The core of our analysis is exclusive data from the 2011 German Census, which included a complete inventory of all German residential real estate for the first time since 1987. The housing inventory collected information on the type of owner and the current state of use for each individual dwelling. We aggregate this data to the level of municipalities, which typically rank between U.S. Census Tracts and U.S. Census Block Groups in terms of population. We merge this data with local property tax multipliers and detailed information from fiscal accounts, income tax statistics, labor statistics, and federal elections. Our final data set covers more than 8,000 Western German municipalities and contains rich information on local fiscal conditions, socio-demographic structures, economic prosperity, and political tastes.[4]

In order to identify causality running from local homeownership rates to tax levels, our empirical analysis exploits two unique circumstances of the German housing market: the missing link between actual property market values and the size of the tax base in the German property tax system, and the extensive destruction of the German housing stock during the Second World War. The missing link between the size of the tax base and actual home market values ensures that the local tax multiplier is the one and only factor in the computation of the German property tax that can truly be influenced by local governments. The war-related destruction of residential buildings in German towns and villages, which led to large-scale provision of rental housing in areas heavily affected by warfare (Wolf and Galicia 2015), provides us with exogenous spatial variation in homeownership rates which

[4] We do not include Eastern German municipalities in the analysis due to data constraints on several important variables.

we exploit for causal inference about the homeowner effect. By controlling for spatial interdependence based on spatial autoregressive models, we simultaneously account for the possibility of strategic tax rate choice behavior among municipalities.

The potential role of property rights in local housing stocks in driving local tax rates has been subject to a very limited number of studies. These have moreover been plagued by issues of identification and statistical control (see, e.g., Roche, 1986; Oates, 2005; Brunner et al. 2015). We contribute to this strand of literature by asking whether and how the local rate of homeownership causally affects property taxation in a very large sample of local jurisdictions. By yielding evidence supportive of spatial dependence in municipal property tax multipliers, our study also contributes to the literature on spatial interaction in property tax setting. Germany is a prime field to study how homeownership affects local property tax setting because homeowners are not always the most numerous shareholders in local communities, which helps creating a counterfactual experiment. Different from the U.S. and many other industrialized countries, municipal homeownership rates are often below 50 per cent.[5]

We approach the questions of a homeowner effect in the presence of strategic interaction in property tax rates between jurisdictions along two dimensions: We first develop a yardstick competition model of local property taxation, which serves as basis for the formulation of three key research hypotheses. We subsequently test these hypotheses in an integrated spatial framework by linking local property tax multipliers to local proportions in owner-occupied housing units. Simultaneously, we use an extensive set of confounding variables to control for local fiscal conditions, political tastes, and neighbourhood tax rates. In our identification strategy, we explicitly account for the endogeneity problem between property tax and the share of homeowners by using alternative instrumental variables.

[5] The aggregate homeownership rate in Germany is 43 per cent. For a discussion of reasons for this low rate, see Voigtländer (2009).

Our empirical evidence suggests that homeowner communities are indeed taxed differently compared to otherwise identical communities. Depending on specification, a rise in the municipal homeownership rate by ten percentage points decreases the local property tax multiplier by 2-3 points. For a standard home of 80,000 euros tax value evaluated at the mean multiplier of 340 points, this is equivalent to a roughly one per cent decrease in the annual tax burden. This key result withstands several robustness tests, in particular controlling for spatial dependence and endogeneity arising among homeownership and property taxes.

Our results have practical implications to local policy makers in providing an evidence-based possibility to judge their actual tax rate choices against a benchmark. The findings also indicate that actual levels of property taxation may not be efficient in terms of social welfare. If homeowners manage to successfully oppose high property taxation relative to other sources of local fiscal revenue, property taxation will tend to be too low in homeowner communities, while other local fees and taxes will tend to be too high. The latter effect could unfold adverse repercussions on the access to local public and quasi-public goods.

The remainder of the paper is organized as follows: Section 2 provides a review of previous research concerning the political economy of property taxation as well as spatial property tax dependence, including a discussion the concepts of home voting and tax illusion. Section 3 links this review to a yardstick competition model of local property taxation, which serves to derive our key hypotheses to be tested. Section 4 serves to introduce the data set, discuss our identification strategy, and present the empirical results. Section 5 concludes.

2 Home-Voting, Renting, and Spatial Property Tax Interaction

The understanding that local voters are the key underlying agents that ultimately influence residential property and other taxes goes back to Tiebout (1956). Tiebout's "vote with your feet" model still dispensed completely with political behaviour in local government. Fischel (2001) was among the first to articulate the idea that among local voters, owner-occupiers (homeowners) may differ substantially with respect to their attitudes towards desired levels of local public spending and the structure of financing by local governments. The core reading of his “home-voter hypothesis” goes that taxation (and other) decisions by local governments are driven by the desire of resident homeowners to maximize the values of their houses. Local governments are viewed within this concept as municipal corporations whose shareholders are homeowners, who in turn are motivated to control their governments because its services and taxes directly affect the values of their largest assets (Fischel 2001). Fischel’s hypothesis has now been investigated in the context of numerous local public referenda, usually with corroborating results (see, e.g., Dehring et al. 2008, Ahlfeldt and Maennig 2015).

Rather than focusing solely on the incentives of homeowners, the subsequent literature has put stronger focus upon the partition of local voting groups into homeowners and renters. It has been particularly observed in the U.S. that the larger the share of households renting their homes in local jurisdictions, the higher the tendency of local governments to spend extensively on public services. Oates (2005) focuses on the mechanisms that let renters drive up local public expenditures in a jurisdiction (the so-called “renter effect”). Consistent with early research on the renter effect by Roche (1986), he finds that the positive association between spending and the rental share is rooted in renters’ perception of public services being ‘not so costly’, rather than simply due to a higher demand for such services compared to homeowners. This advocates for the case of fiscal illusion as a potential source of the renter effect. At the same time, any empirical model that explains local tax choices by homeownership must carefully control for the local level of public expenditure.

Brunner et al. (2015) discuss renter illusion as a possible explanation for the higher willingness of renters to support an increase in property taxes to expand funding for local public services. Using micro-level survey data of registered voters in California, the authors find that renters compared to homeowners are 10-15% more likely to be inclined in favour of a property tax rather than a sales tax increase. Their difference-in-differences estimation strategy controls for individual specific preferences towards public spending. Contradictory to renter illusion, however, their result is *not* driven by the voting behavior of renters: while renters are indifferent between a property tax and sales tax increase to finance additional spending, homeowners strongly oppose a property tax increase relative to a sales tax increase. The strong opposition among homeowners against the property tax is not associated with the relative tax burden faced by this group of residents. As a potential explanation for this finding, the authors refer to the salient nature of property taxes for homeowners.

In order to investigate more deeply how the salience of property taxes for homeowners affects tax rate choice, Cabral and Hoxby (2016) recently exploit cross-local variation in property tax escrow. According to their argument, the exact method by which property tax is collected in U.S. local jurisdictions directly relates to its salience. Variation in tax collection leads to variation in salience over different jurisdictional areas and time that can be considered as random. To study the effect of salience, they make use of the fact that about half of homeowners with mortgages pay their property taxes through tax escrow, a payment method that converts the usually highly visible property tax into an indirect, difficult-to-compute tax that is typically collected through automatic methods. Their findings indicate that areas where property taxes are less salient witness higher tax rates and lower likelihoods of tax revolts, which they use as an indication of tax popularity.

A shortcoming of existing studies on property tax rate choice in the presence of home-voting and differences in tax salience between groups is that they do not take into account the underlying spatial aspects that govern the interactions between renters, homeowners and local governments falling under a particular jurisdiction. Local public spending and tax decisions have been shown to be driven by spatial interaction among local governments. We show in our data section that local tax multipliers, shares of people owning their homes and potentially confounding factors are all strongly spatially auto-correlated. It therefore becomes central to disentangle spatial interactions from spatial patterns of housing tenure. Our attempt to do so draws upon existing empirical research on the form and causes of spatial interaction in property tax rates. So far, this strand of the literature appears surprisingly disconnected from the home-voting/tax salience literature and will be briefly reviewed.

Among the first to use spatial econometric methods to investigate property tax interaction among local governments were Brueckner and Saavedra (2001). These authors estimated a spatial lag model to trace out the property tax reaction function of the representative community within a relatively small sample of 70 cities in the Boston metropolitan area. They find significant spatial lag parameters that vary strongly in size.[6] The model is motivated by a tax competition approach with footloose, heterogeneous consumers and sorting. However, the authors note that their results are observationally equivalent with a local-government version of the seminal yardstick competition framework by Besley and Case (1995). Within this alternative framework, residents are immobile and have homogeneous preferences, but look at tax rates in other jurisdictions to find out whether their own local government is inefficient and deserves to be voted out of office. Self–interested governments choose tax rates knowing that residents make such comparisons, such that strategic interaction among jurisdictions arises just as in a tax competition model.

Following the work of Brueckner and Saavedra (2001), an increasingly long list of studies has looked at spatial property tax dependence in different countries with larger samples. A key goal has been to discriminate among the alternative explanatory approaches of property tax dependence. Bordignon et al. (2003) use a data set including detailed

[6] Their spatial lag parameter estimates range from 0.16 to 0.70, depending on the form of the spatial weighting matrix. Obviously, a concise estimation is strongly limited by the small sample size.

information about electoral behavior and tax setting in a sample of Italian cities. Their results show that local property tax rates are positively spatially auto-correlated among adjacent jurisdictions when the mayors run for re-election, while this correlation is absent where either the mayors face a term limit or where they are backed by an overwhelming majority in the local council. Allers and Elhorst (2005) estimate both spatial lag and error versions of spatial dependence models to analyse property tax choice interaction by neighbouring municipalities in Netherlands.[7] They estimate a spatial lag parameter of 0.35, equivalent with ten percent higher property tax rates in neighbouring municipalities leading to a 3.5 percent higher tax rate in equilibrium. As in Bordignon et al. (2003), interaction in property tax rates is less pronounced among municipalities governed by coalitions backed by large majorities. Fiva and Rattsø (2007) apply a spatial probit model to test whether the decision to have residential property tax in local communities in Norway depends on the observable past decisions of adjacent localities. Their results are also in line with yardstick competition explaining the distinct geographic pattern in local property taxation observed.

Two more recent studies deserve to be mentioned. Dubois and Paty (2010) use a panel of 104 local communities from 1989-2001 in order to test housing tax setting in France. They extend the analysis of yardstick competition by controlling for the impact of tax choices in locations that are not geographically close but comparable with respect to socio-economic characteristics. Their results suggest that voters sanction their incumbents when their own local housing tax is high relative to geographic neighbors, and reward them when similar cities in terms of demographic characteristics have high local taxes. Delgado et al. (2011) use a considerably large sample of 2,713 Spanish municipalities and find evidence of tax mimicking behaviour with a spatial lag parameter of over 0.4 for the property tax. In sum, the

[7] Robust LM-tests, as proposed by Anselin et al. (1996), reject the spatial error versions of their model.

accumulated evidence strongly points towards existence of systematic spatial dependence in property tax choices and yardstick competition as the main driver of this dependence.[8]

3 A Yardstick Competition Model of Local Property Taxation

Tiebout (1956) introduces the "voting-with-their-feet" mechanism where local governments compete for fully mobile consumers. The competing local governments provide a local public good at a random cost ϕ_i and tax a local property at a rate $\tau_i : P_{H,i}$. Thereby, the local governments seek to minimize the average cost of public good provision. In contrast, fully mobile consumers obtain utility from public good consumption and earn disutility from being taxed. Hence, households choose among the location which provides the highest overall utility. The model assumes no externalities and no spatial independence, so that in equilibrium it must hold that $\tau_i = f(\phi_i)$ with $\frac{d\tau_i}{d\phi_i}$. This leads to our first hypothesis:

Hypothesis 1 – Local Public Financing through Property Taxes: *More constrained fiscal conditions in a location go along with higher effective property tax rates.*

In reality, local jurisdictions are not isolated entities, but informational spillovers occur among neighboring jurisdictions (Besley and Case, 1995). The incumbent local governments aim at being re-elected. They provide a local public good of random cost ϕ_i, which is known to them and tax local property at a rate $\tau_i : P_{H,i}$. While "good" governments provide a public good at average cost, "bad" governments engage in rent-seeking. Immobile consumer-

[8] Some recent papers have advocated a quasi-experimental research design to identify strategic interaction in property tax setting. This line of research has argued that reduced-form spatial interaction models rely on comparatively strong assumptions that lead towards a tendency to overestimate the true amount of interaction. Lyytikäinen (2012) uses a reform of the statutory lower limits to property tax rates in Finland as a source of exogenous variation to estimate the response of municipalities to tax rates in neighbouring communities. He finds no evidence of systematic interdependencies in property tax rates. Baskaran (2014) exploits a reform of the fiscal equalization scheme in the German state of North Rhine-Westphalia, which exogenously caused local municipalities to increase their property and business tax rates, to identify tax mimicking by local governments in the neighbouring state of Lower Saxony. While traditional spatial lag regressions suggest immediate strategic interactions, a difference-in-difference analysis also points towards insignificant interaction in tax rates.

voters try to distinguish “good” from “bad” local governments and appraise incumbent’s relative performance to neighboring places. As a consequence they vote “bad” incumbents out of office. In equilibrium the yardstick competition emerges: $\tau_i = f(\phi_i, \overline{\tau}_i)$ with $\frac{d\tau_i}{d\phi_i}, \frac{d\tau_i}{d\overline{\tau}_i} > 0$, from which the second hypothesis on spatial tax mimicking follows:

Hypothesis 2 – Spatial Tax Mimicking: *Local governments mimic each other in setting property tax rates: higher tax multipliers in neighboring local jurisdictions go along with higher tax multipliers in the own municipality, and vice versa.*

Poterba (1984, 1992) emphasizes the duality of housing as consumption and investment good, which allows us to study strategic setting of property tax in the context of the heterogeneous agents model. Under perfect asset market assumptions, the price of housing capital equals the PDV of its future service stream. In equilibrium, the per-period price of rental services equals the user costs of owning:

$$R(H_i) = P_{H,i}(\delta_i + \kappa_i + \tau_i(1-\theta)r - \pi_{Hi}), \tag{1}$$

with rent $R(H_i)$ and property price $P_{H,i}$, appreciation rate δ_i, maintenance costs κ_i, marginal tax rate θ, mortgage rate r, and appreciation rate of house price, π_{H_i}. Since property tax payment ($P\tau$) is capitalized, both owners and tenants fully bear the tax in this model. Under real world assumptions of limited tax shifting as well as “home voting” and “tax illusion” among tenants, tenants bear only incomplete parts of property tax burdens (Dusansky et al. 1981, Caroll and Yinger 1994) and homeowner-voters oppose property taxes more strongly than tenants do (Fischel, 2001). According to Oates (2005), tenants also demand higher levels of public services. This leads us to our third hypothesis on the homeowner effect:

Hypothesis 3 – Homeowner Effect: *Effective property tax decreases with an increasing share of owner-occupied dwellings in a municipality.*

Homeowners possess the economic incentive to oppose high property taxes in order to protect their housing wealth (Fischel 2001). Property taxes are also more salient to homeowners than renters (Oates 2005, Cabral and Hoxby 2016), and homeowners bear the full burden of the property tax irrespective of local market conditions. Our main research hypotheses hence is that higher local shares of owner-occupying households prompt local governments to tax residential property more lightly, *ceteris paribus*. Differences in the strength of this hypothetical effect may arise across local jurisdictions from differences in the local incidence of the property tax between landlords and tenants. Statutorily, landlords can fully shift running costs of property tax to tenants. They might yet fail to do so when the price elasticity of local demand for rental housing services is large. In our empirical analysis, we exploit variation in local shares of vacant non-single family housing. In so doing, we pick up variation in housing demand elasticity in order to investigate whether the size of a possible home voter effect differs between areas of high and low housing demand and therefore discriminate between the tax incidence and the tax salience channels.

4 Data and Estimation Methodology

4.1 Data

Homeownership rates. Data on small spatial scale owner-occupation rates is obtained from the 2011 German Census. The Census encompassed a complete inventory of residential buildings and their housing units, containing detailed information on the type of owner (private individual, owners' association, housing company or cooperative, and other types), property characteristics, and current use (owner-occupied, rented out, or vacant). We clean this data from seasonal and recreational dwellings as well as dwellings used by diplomats and foreign armed forces. In order to avoid data issues related to the special position of Eastern municipalities in connection with horizontal fiscal equalization and solidarity tax, we restrict our sample to Western German municipalities.[9] After accounting for missing values, data on local shares of housing owner-occupied is available for 8,462 municipalities. Figure 1 illustrates the geographical distribution of local owner-occupation rates.

Figure 1: Homeownership Rate Variation across German Municipalities

Source: Own illustration based on data from the 2011 Census.

The figure shows the geographical distribution of the proportion of owner-occupied housing units (in %) in 8,462 German municipalities in 2011.

[9] Data on important possibly confounding fiscal variables, such as debt or public spending, is also not available for Eastern German municipalities in time periods close to the Census year.

The proportion of municipal homeownership has a mean rate of 67 percent with an enormous range, spanning from 20 to 100 percent. High-homeownership jurisdictions appear to particularly cluster in the northwest and northern Bavaria, as well as in the center part of western Germany. Low-ownership locations concentrate in the western Rhein-Ruhr-Area, as well as in major metropolitan areas such as Hamburg, Munich, or Frankfurt and the Rhein-Neckar region.

Property tax multipliers. Property tax in Germany is levied at the municipal level, but follows the same principles country-wide. The annual tax burden for a property *j* of type *k* in a municipality *m* can be calculated as follows:

$$\mathrm{TAX}_{j,k.m} = \mathrm{VAL}_{j}^{\mathrm{ass}} \cdot RATE_k \cdot MULT_m \, , \qquad (2)$$

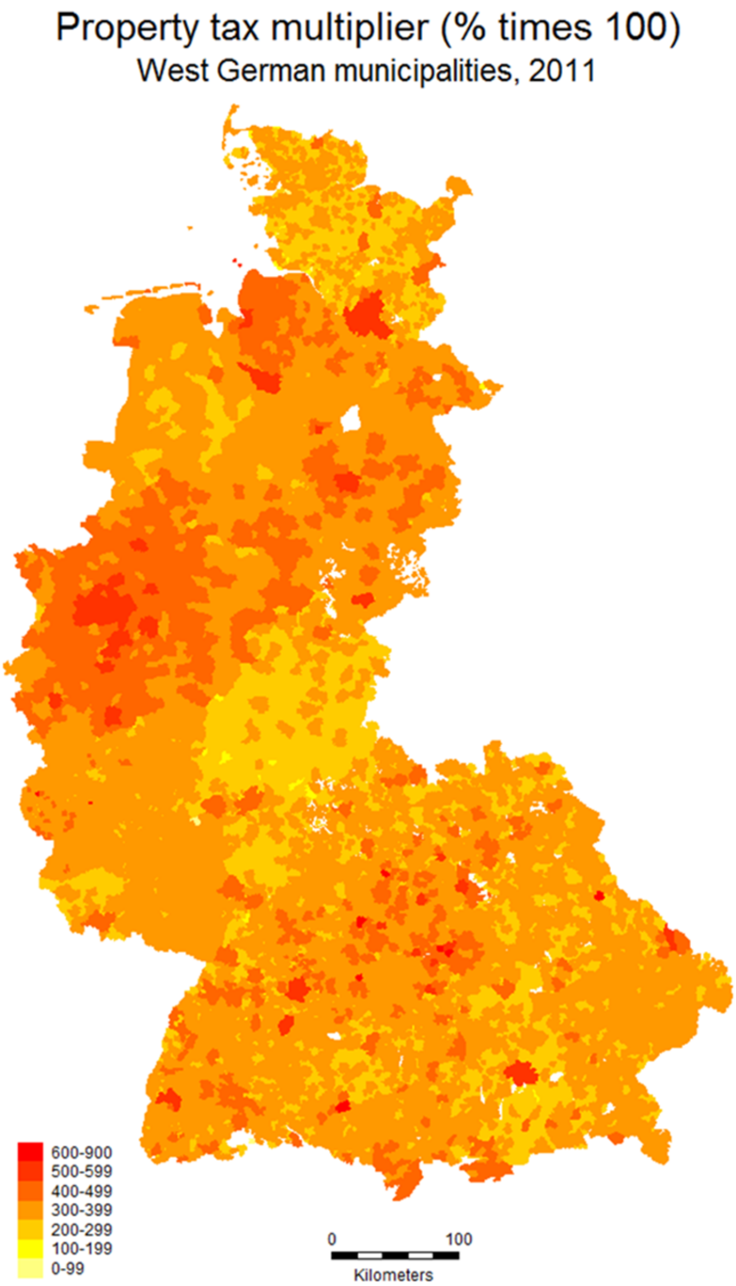
where *TAX*, VAL^{ass}, *RATE* and *MULT* denote the tax burden, the property-specific assessed value, the object-type specific tax rate and the local tax multiplier, respectively. Property-specific assessed values are fixed by the states and refer to 1964 in West Germany (1935 in East Germany), whereas object-type specific tax rates are ruled by federal law.[10] The local multiplier is hence the only component of the effective tax rate that can be directly influenced by local governments, whereas all other components are exogenous.

As illustrated by Figure 2, local tax multipliers vary widely among municipalities. Some local governments set the multiplier to zero, which means no taxation at all. The maximum multiplier is 900 per cent, more than twice the average of 335 per cent. As a result, residing in even fairly adjacent locations can lead to substantial differences in annual tax burdens: moving the ten kilometer distance from Dierfeld (a small municipality of eleven inhabitants in Rhineland-Palatinate with the highest tax multiplier in the sample) to the adjacent municipality of Diefenbach (71 inhabitants) would save a household owning a

[10] The object-type specific tax rate is 2.6 ‰ for single-family houses until the first 38.356,89 euros of the assessed value and 3.5 ‰ thereafter. The rate is 3.1 ‰ for two-family houses and 3.5 ‰ for all other non-agricultural properties.

single-family house worth 80.000 euros of assessed value[11] a tax payment of 1,500 euros annually, which translates into several ten-thousands of euros over the typical duration of a household in a home.

Figure 2: Property Tax Multiplier Variation across Municipalities



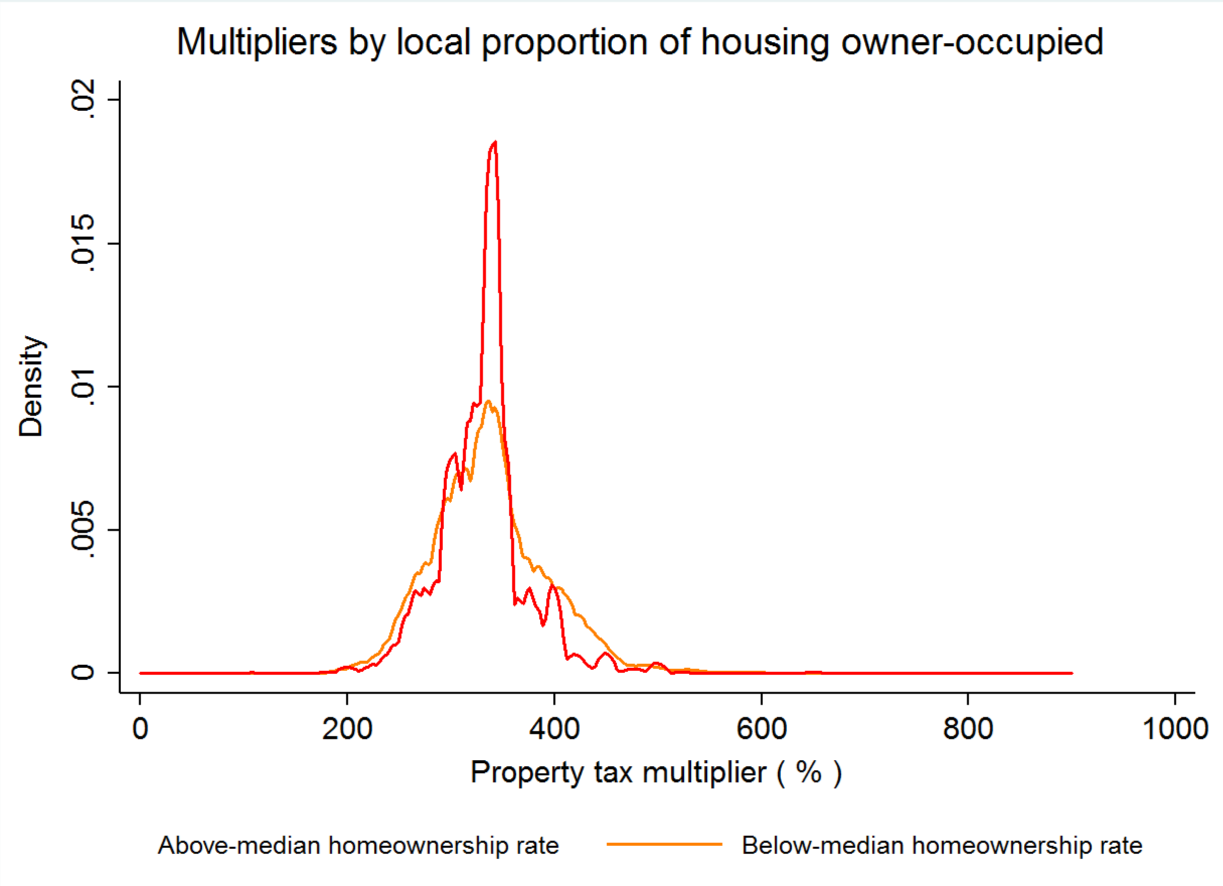
Source: Own illustration based on data from the Federal Statistical Office.

The figure shows the geographical distribution of property tax multipliers (% times 100) for 8,464 Western German municipalities in 2011.

[11] Due to their considerable age, the assessed values used to compute the individual tax burden are typically much lower than contemporaneous property market values, which reduces the effective property tax rate.

Figure 3 shows Kernel estimates of the probability mass functions of local tax multipliers among "low" (below median) and "high" (above median) homeownership municipalities. The estimated density functions are apparently different, indicating a concentration of probability mass at average multipliers among high homeownership locations in comparison to low homeownership ones, with considerable less concentration of probability mass towards the right end of the multiplier scale.

Figure 3: Density Distributions of Tax Multipliers by Homeownership Rate Group



Source: Own illustration based on data from the Federal Statistical Office.

The figure shows Kernel density estimates of property tax multipliers by local proportion of owner-occupied housing. Property tax multiplier distributions above-median multiplier and below-median multiplier municipalities in 2011 are indicated in red and orange, respectively.

Fiscal Conditions. Local levels of property taxation are likely to depend on local fiscal conditions, which can in turn systematically differ with respect to the local share of homeownership. For example, homeowners may have different tastes with respect to the level of local public spending (Oates 2005) or with respect to local public debt levels. In order to account for such variation in local fiscal circumstances, we include the 2010 levels of public spending per capita and municipal debt per capita, as well as the respective levels of per capita revenues from local business tax and vertical transfers of income and value-added tax for the same year. We additionally control for the per-capita size of the local property tax base, which is practically exogenous to local governments in the presence of non-market based valuation due to the extreme durability of housing (Glaeser and Gyourko 2005).

Further Controls. We use population size, squared population size, population density, economic prosperity (proxied by income tax revenues per capita) and socio-demographic structure (share of unemployed persons, share of population aged 10 years or less, and share of population aged 70 years or more) as non-fiscal controls. In order to account for heterogeneous political preferences among locations as another potential confounding factor, we include local shares of valid votes for the three main German left-oriented parties[12] in the 2009 Federal (Bundestag) elections.[13] We include a set of dummy variables flagging municipalities with state or country borders and "metro" municipalities with 100,000 inhabitants or more. We finally reference all municipalities to their respective states.

Table 1 reports key descriptive statistics on the included variables. In addition to the characteristic values of each variable's univariate distribution, it shows the respective Moran's I statistics as indices of global spatial autocorrelation.[14] Both local property tax multipliers and homeownership rates display considerable spatial dependence, as do almost all the control variables. This holds true particularly for debt and shares of left-wing votes.

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[12] The parties belonging to this spectrum include the Social Democratic Party (SPD), Bündnis 90/Grüne and Die Linke.

[13] In the 2009 German Bundestag Election, every voter had two votes: a first vote to elect a local (which can but must not necessarily be associated with a party), and a second vote to elect a party for seats in the German Bundestag. We use only the party-related second votes.

[14] Each Moran's I value is calculated using a 10-nearest-neighbor row-standardized spatial weighting matrix.

Table 1: Descriptive statistics for the included variables

	Mean	**S.D.**	**Min**	**Max**	**Moran's I**
Tax multiplier (pct.)	340.67	51.72	0	900	0.495
Pct. owner-occupied (pct.)	67.92	11.27	20.34	100	0.416
Municipal spending p.c. (euros)	1,245.50	5611.91	-85.94	494,633.2	0.042
Municipal debt p.c. (euros)	1,396.06	867.95	27.00	8,068.00	0.838
Revenue business tax p.c. (euros)	271.37	4182.43	-690.66	380,645.8	0.103
Transfers income tax/VAT p.c. (euros)	352.84	126.30	0	5,416.67	0.553
Property tax base p.c. (euros 1000s)	28.97	24.68	0	2,028.57	0.334
Resident population	8,464	7,599	11	1,348,335	0.160
Population density (inh./km²)	20.59	29.04	0.27	432.63	0.523
Taxable income p.c. (euros 1000s)	15.04	3.84	0.62	100.64	0.467
Unemployed (Pct.)	3.12	1.89	0	80.48	0.300
Persons aged 10 years or less (pct.)	8.79	1.85	1.24	33.33	0.204
Persons aged 70 years or more (pct.)	14.88	3.22	5.23	42.86	0.310
Votes left-wing parties 2009 (pct.)	38.66	10.47	0	81.58	0.686
State or country border (dummy)	0.15	-	0	1	-
Metro city (dummy)	0.01	-	0	1	-
State: Schleswig-Holstein (dummy)	0.13	-	0	1	-
State: Hamburg (dummy)	0.00	-	0	1	-
State: Bremen (dummy)	0.00	-	0	1	-
State: Lower Saxony (dummy)	0.12	-	0	1	-
State: Northrhine-Westfalia (dummy)	0.05	-	0	1	-
State: Hesse (dummy)	0.05	-	0	1	-
State: Rhineland-Palatinate (dummy)	0.27	-	0	1	-
State: Baden-Wurttemberg (dummy)	0.13	-	0	1	-
State: Bavaria (dummy)	0.24	-	0	1	-
State: Saarland (dummy)	0.01	-	0	1	-

4.2 Estimation Strategy

We test our key hypotheses within an integrated spatial model of tax rate choice. We link local property tax multipliers to local homeownership rates, neighbours' tax multipliers and controls within a spatial autoregressive (SAR) framework:

$$\tau = \lambda W\tau + X\Psi + \beta HOR + Z\Theta + \varepsilon \,. \tag{3}$$

Our dependent variable is the municipal property tax multiplier in 2011 in percent times 100. Equation (3) states that the property tax multiplier in a local jurisdiction is not influenced by the traits of this jurisdiction alone, but also by a weighted average of tax rates in adjacent jurisdictions. The strength of this dependence is governed by the specification of the spatial weighting matrix W and the size of the spatial lag coefficient λ. HOR stands for the homeownership rate in municipality i, whereas X and Z reflect the fiscal and non-fiscal control variables.

Spatial Weighting Matrix. There are different ways to specify a weighting matrix. The choice set ranges from different forms of binary contiguity matrices (neighbourhood-based matrices) to distance-based matrices, where weights are typically calculated as reflecting the inverse of physical distance. Alternatively, spatial weights can be based on (socio-)economic distances (Dubois and Paty 2010)[15], or on a combination of both (such as the modified Zhao measure). We base the choice of spatial weights on our theoretical model: we argue that voters plausibly compare their own localities with spatially adjacent ones. We thus refer to the neighbourhood rather than the distance concept, using three different *k*-nearest-neighbour matrices (10, 20, and 30 neighbours). Revelli (2005) argues that when unobserved random shocks hit spatially adjacent municipalities in similar way, this may give rise to spatial autocorrelation in the disturbance process of a tax choice regression. We therefore test all

[15] Dubois and Paty (2010) argue that in yardstick competition, voters consider immediate neighbors and not directly adjacent municipalities of similar socio-demographic characteristics.

disturbances of the spatial regressions for remaining spatial dependence in the error terms using the Moran's I statistic.[16]

Unobserved Heterogeneity. A natural concern related to estimating Equation (3) with cross-sectional data is unobserved local heterogeneity. Even controlling extensively for fiscal and non-fiscal local circumstances will not guarantee that unobserved local factors correlated with homeownership and tax levels remain uncontrolled. Since we lack to historical data that would allow us establishing a panel dimension, we resort to including spatial lags in our covariates as a substitute to estimating a spatial unobserved effects model. Pace and LeSage (2010) establish that models including both a spatial lag in the dependent variable as well as spatial lags in the independent variables are well suited to capture unobserved local heterogeneity when the unobserved factors are spatially correlated.[17]

Endogeneity. In our identification strategy, we face a potential endogeneity issue for the homeownership rate: random unobserved shocks to the local tax rate could provide homeowners seeking to keep home values high with an incentive to migrate to low-tax locations, increasing the homeownership rate. A spatial lag model with endogenous homeownership rate can be estimated by using a generalized spatial two stage least squares method (2SLS), as proposed by Drukker, Prucha, and Raciborski (2013).[18] We consider as instruments variables that are highly correlated with the contemporaneous 2011 local homeownership rate, but simultaneously independent of unobserved shocks to the local property tax rate. We test the following instruments: as proxies of local social capital (which has been shown to be strongly correlated with homeownership, DiPasquale and Glaeser

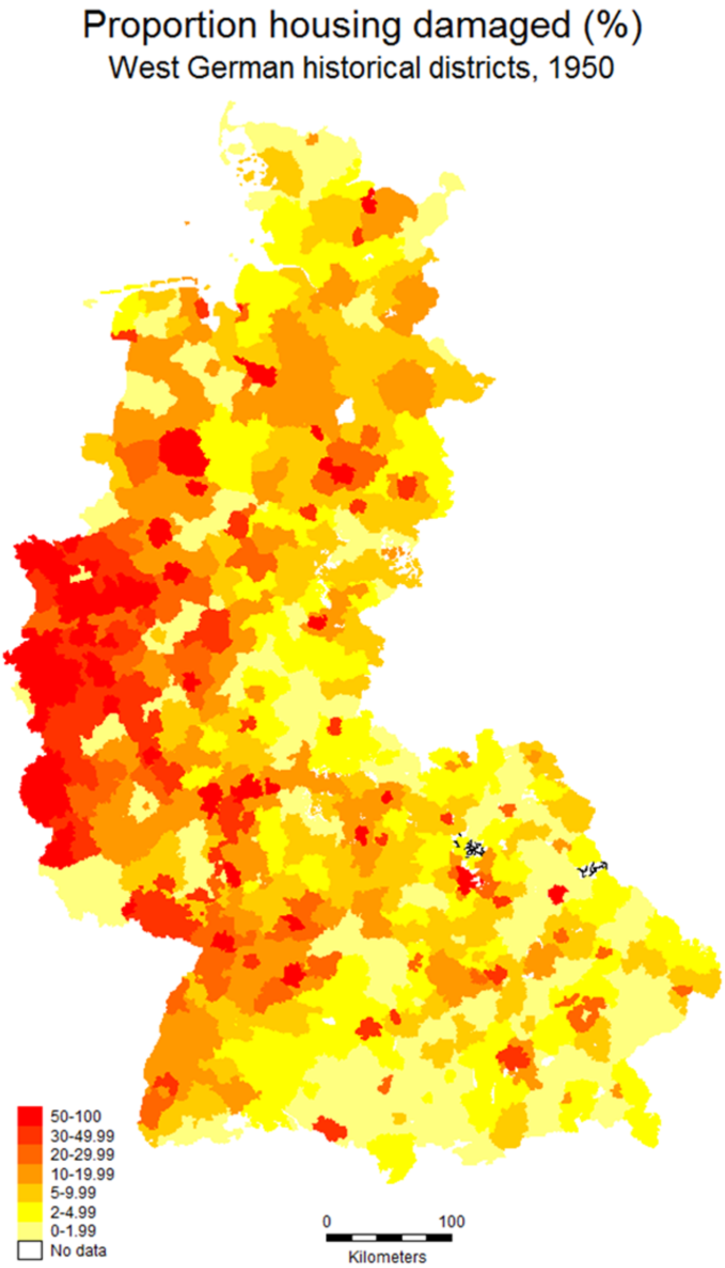
[16] We additionally estimate a mixed-regressive spatial model that contains both a spatial lag in the dependent variable and a spatially auto-correlated error term. The results of this model as well as further alternative specifications of spatial model can be inferred from Table A1 in the appendix.

[17] The Spatial Durbin model can be written as: $\tau = \lambda W\tau + X\Psi + \beta HOR + Z\Theta + \varepsilon$ with $\varepsilon = \rho W\varepsilon + \nu$.

[18] Kelejian and Prucha (1998, 1999) propose using the linearly independent columns of $\mathbf{X}$, $\mathbf{WX}$, and $\mathbf{W}^q\mathbf{X}$ as instruments to solve the endogeneity problem between Y and WY). In general, we can distinguish between spatial lag with exogenous *HOR* versus spatial lag with endogenous *HOR*. For the latter, we specify a generalized spatial two stage least squares model according to Kelejian and Prucha (1999, 1998, 2004, 2009) and Arraiz, Drukker, Kelejian, and Prucha (2009).

1999), we use local membership in sports clubs and voter participation in Federal elections. We also use historical district-level shares of owner-occupied dwellings and buildings destroyed or severely damaged by warfare during World War II. As an example, Figure 4 illustrates local housing damage rates as recorded in the 1950 Census.

Figure 4: War-induced Housing Damage Variation across Municipalities



Source: Own illustration based on data from the 1950 German Census.

The figure shows the geographical distribution of housing damage rates (in %) for historical Western German districts in 1950.

As can be interred from the Figure 4, war-induced housing damages mainly followed a west-east pattern that mimicked the direction of entry of Allied forces into Germany and extended to urban and rural locations. As described in Wolf and Galicia (2015), the destruction of local housing led to large-scale provision of rental housing. Indeed, the first-stage regression reveals that homeownership is today significantly lower in locations that suffered more war-related housing destruction (see Table A2 in the appendix).

5 Empirical Results

Table 2 presents regression results from different specifications of Equation (3). We first estimate a non-spatial, non-instrumental variable version of the equation by OLS in order to allow an assessment of the influence of spatial dependence and endogeneity on our key results. We subsequently report estimation results for two spatial autoregressive (SAR) models that only differ by the contiguity matrix chosen: the first model is estimated based on a 10-nearest-neighbor spatial contiguity matrix, whereas the second model is based on a matrix that extends the connectivity to the first 20 neighbours of each municipality. The fourth and fifth columns of the table contain estimation results for two extended spatial models: a spatial Durbin model that includes spatially lagged versions of all covariates based on the 10-nearest neighbour matrix along with the spatially lagged tax multiplier, and a SAR model treating local homeownership as endogenous using 1950 district-level warfare-related housing destruction and ownership rates as instruments.

Regardless of the exact specification, our model performs generally well in explaining local property tax rate choice. The coefficients estimated on local homeownership as well as the fiscal and non-fiscal control variables turn out to be fairly robust across the different specifications in terms of statistical and economic significance. As indicated by highly significant spatial parameters and a large Moran's I of the OLS disturbances, OLS fails to properly account for the spatial interaction processes governing municipal tax rate choice.

Table 2: OLS and Spatial Regression Results

	OLS	**SL model (10 NN)**	**SL model (20 NN)**	**SD model (10 NN)**	**SL IV (10NN)**
Constant	317.288***	130.555***	105.997***	116.938***	82.114***
	(8.863)	(9.492)	(9.937)	(15.648)	(18.822)
Pct. owner-occupied	-0.199***	-0.214***	-0.201***	-0.253***	-0.284**
	(0.068)	(0.061)	(0.062)	(0.067)	(0.144)
Spending p.c.	0.002***	0.001***	0.001**	0.001**	0.001***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)
Debt p.c.	0.003***	0.001	0.001	0.003**	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Business tax p.c.	-0.012***	-0.013***	-0.013***	-0.014***	-0.013***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Income/VAT p.c.	-0.082***	-0.054***	-0.052***	-0.049***	-0.057***
	(0.010)	(0.010)	(0.010)	(0.002)	(0.10)
Tax base p.c.	-0.128*	-0.025	-0.027	0.021	-0.071
	(0.068)	(0.056)	(0.055)	(0.059)	(0.064)
Population (1000s)	0.545***	0.468***	0.475***	0.470***	0.454***
	(0.089)	(0.092)	(0.096)	(0.088)	(0.096)
Population^2	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Population dens.	0.089***	0.076***	0.072***	0.198***	0.067**
	(0.027)	(0.026)	(0.026)	(0.030)	(0.029)
Income p.c. (1000s)	-0.332	-0.261	-0.215	-0.227	-0.224
	(0.238)	(0.236)	(0.234)	(0.251)	(0.235)
Pct. unemployed	0.254	0.513**	0.535**	0.559**	0.378
	(0.238)	(0.238)	(0.247)	(0.264)	(0.253)
Pct. <10 years	-0.015	0.216	0.230	0.153	0.172
	(0.299)	(0.256)	(0.247)	(0.254)	(0.274)
Pct. >70 years	0.552***	0.421***	0.419***	0.363**	0.421***
	(0.177)	(0.151)	(0.062)	(0.159)	(0.162)
Pct. left-wing votes	0.232***	0.165***	0.166***	0.281***	0.149***
	(0.055)	(0.047)	(0.048)	(0.065)	(0.050)
D border (nat./state)	1.692	2.593**	2.353**	5.747***	2.513**
	(1.285)	(1.165)	(1.184)	(1.565)	(1.233)
D pop>100,000	4.211	4.444	4.753	3.804	5.667
	(13.467)	(14.138)	(14.330)	(13.861)	(14.409)
State dummies	Yes	Yes	Yes	Yes	Yes
λ	-	0.615***	0.691***	0.668***	0.800**
		(0.017)	(0.019)	(0.017)	(0.034)
Spatial lagged cov.	-	-	-	Yes	-
Wald test:lag cov=0	-	-	-	418.53***	-
# obs.	8,036	8,036	8,036	8,036	8,036
R^2	0.385				
Squared corr. coeff.		0.359	0.349	0.398	
Moran's I error term	0.317	0.014	0.061	-0.017	0.104

***, **, and * denote significant coefficients at the 1, 5, and 10% level.

HAC-robust standard errors are reported in parentheses.

The local homeownership share carries the expected negative sign and is statistically significant at the five per cent level or better in every specification. The variables capturing local fiscal conditions are mainly highly significant and carry plausible signs: Higher per capita spending and debt levels are associated with higher property tax multipliers, reflecting higher financing needs. The fact that our regression appears to capture local governments' budget constraint quite well is supported by the negative and strongly significant coefficients on per capita revenues out of local business tax and vertical transfers of income and value added taxes, both of which relax the municipal budget constraint ceteris paribus. The size of the property tax base is found to be insignificant in the majority of specifications.

Concerning the role of socio-demographics and political tastes in local jurisdictions in property tax rate choice, the evidence is again in line with expectations, albeit some coefficients lack statistical significance. We find higher tax multipliers in municipalities with higher population size (with decreasing margins) and density, more unemployment, higher shares of elderly persons, and more left-oriented political preferences. Municipalities at state or federal borders tend to charge higher multipliers, whereas we find no separate level effect for localities with populations of 100,000 or more (while already controlling for size continuously). All specifications include the full set of (unreported) state dummies that are highly significant in every specification, indicating considerable differences in average property tax levels across states that remain unexplained by the remaining covariates. This finding is explained by the multi-tier structure of public finances in Germany, which renders public financial conditions very heterogeneous on state-level and makes average multiplier levels highly dependent on state.

The coefficients estimated on our main variable of interest, the local share of owner-occupied dwellings, are always fairly close to one another, ranging between -0.199 in the OLS specification to -0.284 in the spatial IV specification that allows for spatial dependence in tax multipliers. While caution is warranted for direct comparisons of coefficients estimated in linear non-spatial versus simultaneous spatial models, we conclude that higher shares of homeowners in local populations are indeed associated with systematically lower property tax levels, corroborating the home voter hypothesis. This key result survives an instrumental variable estimation based on exogenous variation in the contemporaneous ownership share derived from long-lagged housing damage and ownership shares at the superordinate district level, indicating that the correlation that we observe in the data lends itself to a causal interpretation. Concerning the economic significance of the effect, we refer to the direct effect interpretation of a change in the ownership rate on the tax rate in the municipality itself, which is comparable to the marginal effect of OLS estimation (LeSage and Pace 2009): shutting down any indirect effects of tax changes emanating from multi-channel feedback that plays out through the system of spatially dependent jurisdictions, a ten percentage point rise in the local homeownership would reduce the local multiplier by 2-3 percentage points on average. For a typical single-family house worth 80,000 euros of assessed value, this direct effect would be equivalent to roughly a one per cent decrease in the annual tax burden, evaluated at the mean local multiplier of 340 points. While this is an economically small effect for the individual household, it is important to remember that municipalities typically consist of several thousands of homes. This implies that marginal homeownership-related house-level tax discounts accumulate to several ten thousands of euros less of property tax revenue in municipal budgets annually.

Since our spatial regressions suggest strong evidence in favor of spatial dependence in municipal property tax multipliers[19], the estimated direct effect of a change in homeownership in some municipality on the local multiplier does not capture the full or total effect of this change. Since the adjacent jurisdictions react to the resulting change in their

[19] The Moran's I statistic for the residuals of the OLS model is 0.317 in comparison to values of around zero for all spatial models' residuals.

neighboring municipality's tax rate with altering their own multiplier, so will do their neighbors, and so on. The steady-state equilibrium size of these indirect effects depend on the size of the spatial dependence parameter and the shape of the spatial weighting matrix (LeSage and Pace 2009). The spatial dependence parameters in our models are estimated between 0.62 and 0.80 depending on specification and are highly significant throughout. Importantly, this result does not hinge upon the choice of the spatial weighting matrix: increasing the number of neighbors from 10 to 20 changes the spatial dependence parameter only slightly[20], while the model's goodness of fit somewhat decreases. Including spatially lagged covariates in the spatial Durbin model improves the goodness of fit remarkably, but does not alter the spatial dependence parameter considerably vis-à-vis the 10-nearest neighbor SAR specification. With a size of 0.8, the largest parameter is estimated for the spatial IV regression.

Following the total effect to an observation viewpoint mathematically exposed by LeSage and Pace (2009), we are able to calculate the average total impact on the tax multiplier of a locality *m* from a global one percentage point rise in local homeownership shares across the entire sample. In the spatial lag model with 10 nearest neighbors, the average total effect is -0.56, more than twice as high the average direct effect of -0.21. This total effect translates into a 5.6 point average decrease in the multiplier in the presence of a global ten percentage point rise in homeownership across the country.[21] Using the estimates from the 10-nearest-neighbors spatial Durbin model, the total effect becomes -0.71. Compared to the direct effect, this is a disproportional increase vis-á-vis the spatial lag model that can be explained by the larger estimate for the spatial lag parameter.

5.3 Discriminating among Tax Incidence and Tax Salience as Possible Channels

[20] Increasing the number of nearest neighbors to 30 yields a dependence parameter of with otherwise very similar results.
[21] The actual homeownership rate exceeded 90 percent in 111 communities in 2011 (1.4 per cent of the sample). The resulting error can be considered negligible.

Differences in property tax incidence between landlords and tenants across locations are a natural candidate that could potentially challenge our claim that differences in tax salience between homeowners and renters drive our key result. While homeowners bear the full property tax burdens irrespective of local market conditions, the incidence of property taxes for the case of rented housing depends on the relative sizes of the local price elasticities of rental housing demand and supply. In regions, where demand for rental housing is considerably elastic, the main portion of property tax burdens will remain with the landlords, while renters are expected to bear the main portion in strong housing demand, "landlord-friendly" markets. In the latter circumstances, the division of local housing use between owner-occupied and rental should be less influential on property taxes because any resident bears the tax.

We test this proposition based on replacing the local homeownership share with two separate and mutually exclusive interaction terms: we interact local homeownership rates with two mutually exclusive dummy variables which flag municipalities in the highest quartile of the non-single family housing vacancy rate distribution ("high vacancy areas") and the lower three quartiles of the same distribution ("low vacancy areas"), respectively. We split the sample at the 75th percentile of the non-single family housing vacancy rate because this distribution is heavily right-skewed: the 75th percentile is 8 per cent vacancy, while median vacancy is 5.6 per cent, a still fairly usual vacancy rate (see Figure A1 in the appendix). Importantly, mean homeownership rates in high- and low-vacancy areas are quite similar (66 vs. 72 per cent).

The homeownership coefficients for the subsamples of high- vs. low-vacancy communities hardly differ from one another. A χ^2-test of the null that the two coefficients be equal cannot be rejected at common significance levels. This lets us conclude that a home-voter effect is present in local property tax multipliers regardless of vacancy in the local rental market. Since vacancies can serve as an adequate proxy for the local price elasticity of rental housing demand, our key result holds regardless of the actual incidence of property taxes between tenants and landlords. That is, a home-voter effect exists *even when* tenants are likely to bear the same property tax burdens as their fellow owner-occupying citizens do. This corroborates that the higher visibility of the property tax for homeowners is likely to be the main mechanism driving our result.

5.4 Robustness tests

1. Neighbor- and distance-based matrix: test for similar economic development or purchasing power

2. See comment OL1: commuting or travel time as distance measure

Table 3: Results of further alternative spatial specifications

	SE model (10 NN)	**SL model (30 NN)**	**SAC model (10 NN)**
Constant	305.047***	130.555***	436.859***
	(7.980)	(7.772)	(15.854)
Pct. owner-occupied	-0.241***	-0.214***	-0.230***
	(0.055)	(0.050)	(0.053)
Spending p.c.	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Debt p.c.	0.003***	0.001	0.004***
	(0.001)	(0.001)	(0.001)
Business tax p.c.	-0.014***	-0.013***	-0.014***
	(0.001)	(0.001)	(0.001)
Income/VAT p.c.	-0.060***	-0.054***	-0.053***
	(0.009)	(0.008)	(0.009)
Tax base p.c.	0.022	-0.025	0.029
	(0.046)	(0.044)	(0.044)
Population (1000s)	0.463***	0.468***	0.445***
	(0.045)	(0.046)	(0.043)
Population^2	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)
Population dens.	0.163***	0.076***	0.179***
	(0.024)	(0.020)	(0.023)
Income p.c. (1000s)	-0.329**	-0.261*	-0.277*
	(0.155)	(0.154)	(0 .149)
Pct. unemployed	0.690***	0.513**	0.643***
	(0.252)	(0.250)	(0.242)
Pct. <10 years	0. 158	0.261	0.190
	(0.262)	(0.266)	(0.251)
Pct. >70 years	0.412***	0.421***	0.388***

	(0.157)	(0.151)	(0.151)
Pct. left-wing votes	0.273***	0.165***	0.269***
	(0.064)	(0.050)	(0.064)
D border (nat./state)	4.658***	2.593***	4.990***
	(1.425)	(1.126)	(1.430)
D pop>100,000	3.262	4.444	3.101
	(8.140)	(8.402)	(7.787)
State dummies	Yes	Yes	Yes
λ	-	0.615***	0.839***
		(0.013)	(0.013)
ρ	0.684***		-0.458***
	(0.012)		(0.044)
Spatial lagged cov.	-	-	-
Wald test:lag cov=0	-	-	-
# obs.	8,036	8,036	8,036
Squared corr. coeff.	0.378	0.359	0.371
Moran's I error term	0.778	0.028	0.535

3. Test of the IVS "sport club membership" and "election participation" as well as all three IVs together. We should include discussion of "social capital" and the problem of selection bias for municipalities with low taxes.

6 Conclusions

In efficient and frictionless property markets, contract arrangements governing the property rights in local housing should not make any difference for how strongly housing is taxed, at least if landlords are statutorily allowed to pass on property taxes to their tenants. Real-world evidence increasingly suggests that owner-occupiers, who bear the full burdens of property taxes independent on local market conditions, experience strong property tax salience and possess strong incentives to protect their housing wealth, oppose high property tax levels much more than renters do. This leads towards a case for a political economy of property taxation.

In this paper, we have presented first-time representative and large-scale empirical evidence in favor of a home-voter effect in local property taxation. Based on data for over 8,000 German local jurisdictions, we have shown local property tax multipliers to be on average 20-30 points lower ceteris paribus if local homeownership increases by 10 percentage points. This effect withstands the inclusion of a battery of potential confounding factors, the consideration of spatial dependence in property tax rate choice and the correction for the bias arising from potential endogeneity of the homeownership share. Interacting homeownership rates with local shares of vacant rental housing suggest that the home-voter effect exists *even when* tenants are likely to bear the same property tax burdens as their fellow owner-occupying neighbors. We interpret this as evidence that the home-voter effect originates from differences in tax salience rather than from differences in tax incidence between owners and renters, which is in line with the recent findings of Cabral and Hoxby (2016) and Brunner et al. (2015).

Our results have at least two important practical implications. First, they provide local governments with evidence enabling them to benchmark their actual tax rate choices against other structurally comparable local jurisdictions. Second, our finding of a home-voter effect in property taxation indicates that actual property tax levels may not be efficient in terms of overall social welfare. If owner-occupiers successfully manage to oppose high property tax rates, property taxation will tend to be systematically too low in homeowner communities, whereas other local fees and taxes will tend to be too high.

The latter second-round effect, while not investigated in this paper, may potentially affect the equity of local access to public and quasi-public goods. We think that examining the questions of whether local governments attempt to compensate lower property tax revenues resulting from higher local political power of homeowners by charging higher fees and non-property taxes could be a fruitful avenue of further research.

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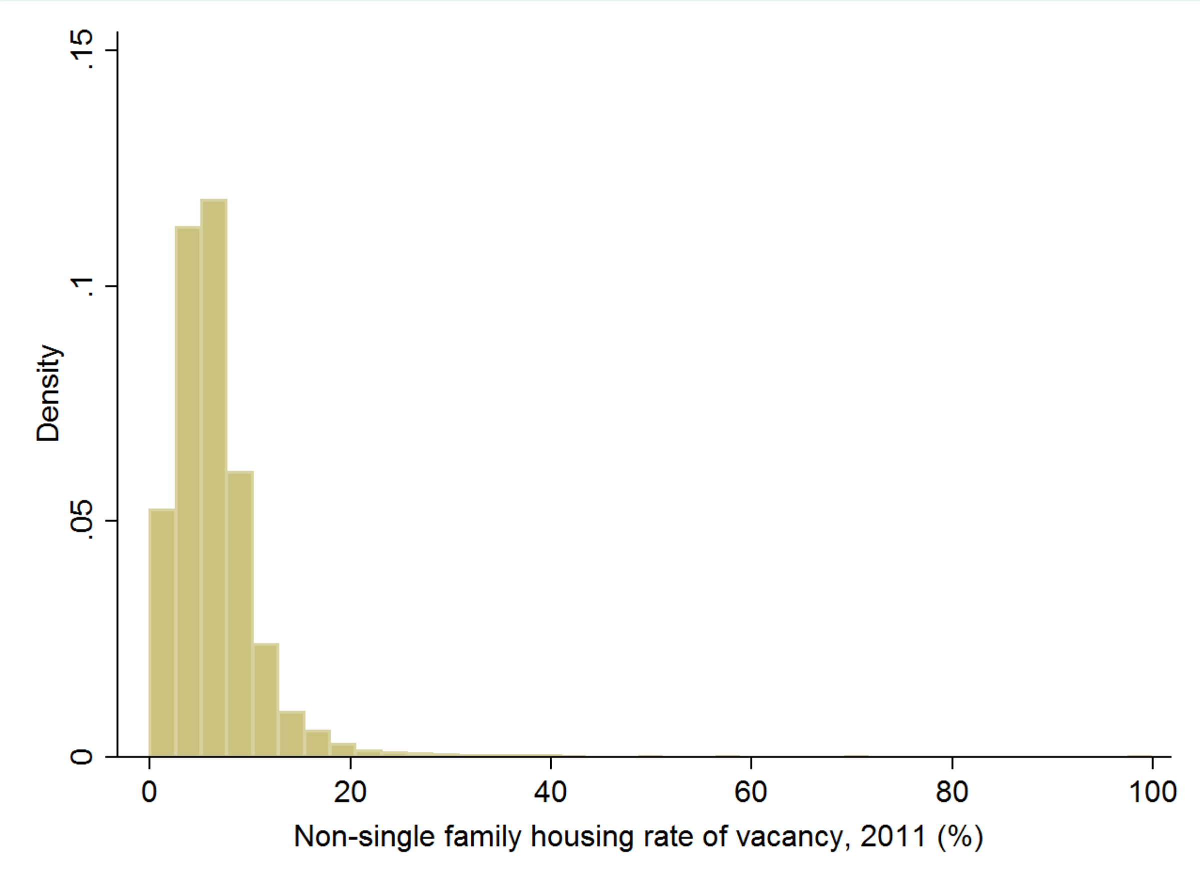
Appendix

Figure A1: Empirical frequency distribution of non-single family housing vacancy in 2011, 8036 German municipalities.



IS THERE ROOM FOR ANOTHER HEDONIC MODEL? –THE ADVANTAGES OF THE GAMLSS APPROACH IN REAL ESTATE RESEARCH

DR. MARCELO CAJIAS

ABSTRACT: Hedonic modelling is essential for institutional investors, researchers and urban policy-makers in order to identify the factors affecting the value and future development of rents over time and space. While statistical models in this field have advanced substantially over the last decades, new statistical approaches have emerged expanding the conventional understanding of real estate markets. This paper explores the in-sample explanatory and out-of-sample forecasting accuracy of the Generalized Additive Model for Location, Scale and Shape (GAMLSS) model in contrast to traditional methods in Munich's residential market. The results show that the complexity of asking rents in Munich is more accurately captured by the GAMLSS approach, leading to a significant increase in the out-of-sample forecasting accuracy.

KEYWORDS: Hedonic modelling, Residential real estate, GAMLSS, GAM, out-of-sample forecast.

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1. INTRODUCTION

The improvement in the field of the statistical modelling of hedonic price equations was enormous during the last three decades. Primarily driven by advances in the field of regression analysis, statistical inference and especially computational speed, the accuracy of hedonic equations has increased considerably, leading to a better understanding of the fundamental factors affecting property rents and prices. These advantages have led econometricians at the same time to carefully decide which model to employ when reproducing real estate markets accurately, as the range of models and their complexity has widened significantly. While contemporary models focus nowadays on the incorporation of non-linear and spatial effect in the hedonic equation, statistical research over the last decade has developed additional methods and instruments to incorporate advanced effects in order to enhance the explanatory power of regression analysis. This paper builds upon this new statistical research and aims at exploring a new approach in hedonic modelling.

In theory, any hedonic model that is designed to decompose the price of a dwelling in a certain market might be able to capture all the underlying factors affecting property prices asymptotically as well as efficiently. But does any hedonic equation considering just non-linear and spatial effects explain real estate prices sufficiently and efficiently? In other words, are there more effects rather than non-linear and spatial effects to consider when estimating hedonic equations? In this context, statistical methods of the "new era" expand the traditional regression by considering further effects such as the distribution of the response as an optimization criterion. This new approach refers to the Generalized Additive Model for Location, Scale and Shape (GAMLSS) introduced by [20] in 2005, which accounts, beside the traditional spatial and non-linear effects, additionally for "non-normal" effects between the response and the underlying covariates. Although models including spatial and non-linear effects in real estate studies have shown an enhanced out-of-sample performance, see for example [4, 16, 24, 5], this paper aims at exploring the GAMLSS method and its explanatory and forecasting features in hedonic regression equations, which at the same has been rarely employed in a real estate context.

Do traditional models fail at explaining real estate prices accurately? The complexity of real estate prices – in contrast to similar consumer goods – lies in their nature. On the one hand, real estate assets are exposed within a certain market to spatial, temporal and intangible interdependences and on the other hand determined by their own building characteristics. When considering all these three effects simultaneously, any hedonic model should be able to control for intertemporal, spatial and property-specific (auto-) correlations dynamically in such a way that the assumptions behind the chosen estimator remain asymptotically valid and the explanatory level reaches a suitable level. As the modelling of these three effects is quite difficult, econometricians chose in general the isolation of one of these factors (so called fixed effects) in order to reproduce the remaining effects accurately. However, research over the last decade has provided evidence that additional – partly intangible – factors such as submarket heterogeneity, local amenities or access to public transport affect real estate prices significantly, see for example [2, 3, 17, 1]. New approaches, such as the GAMLSS, aim thus at applying advanced statistical instruments in order to capture these effects in the hedonic equation and thereby improve the explanatory power.

Beyond the three aforementioned effects – space, time and property-specific – two main issues have arisen when modelling real estate prices: the heterogeneous distribution of the variance of rents and their skewness across space. While the general method of moments – from a strictly econometric point of view – does not require the response to be normally distributed, the explanatory accuracy of any regression model has to deal permanently with extreme non-normally-distributed responses. The non-homogeneity of variance across space indicates that the range in the willingness to pay for rents within certain submarkets varies in the extremes of the distribution. And although this sounds reasonable, its statistical modelling is difficult to capture by traditional dummies variables in the spirit of Ordinary Least Squares (OLS). The latter effect, the skewness of rents, instead provides information that rents within a market are empirically – under any probability density function – not normally distributed and that at the same time after controlling for the available covariates a share of rents tend to be under- or overpriced leading to excess residual heteroscedasticity. Although this phenomenon might be isolated by censoring the response through its quantile distribution or by robust variance-covariance-estimators, it still affecting the accuracy of the hedonic equation.

In order to account for these anomalies, the GAMLSS approach proposes the expansion of traditional Generalized Linear Models (GLM) by modelling the parameters of the response as semiparametric functions of the covariates, overcoming thus the restrictions of traditional methods. In simple words, the GAMLSS approach fits a relationship without involving strong assumptions between the response and the covariates. The consideration of these new effects into a hedonic equation are yet expected to lead to a more accurate estimation of the underlying data generating process of real estate prices and to an enhancement in the accuracy of out-of-sample forecasts.

Having said this, this paper aims at modelling the hedonic equation considering the non-homogeneity of variance over space and skewness in the distribution of a sample of ca. 25k asking rents in Munich, Germany. In doing so, I employ the GAMLSS approach which has been rarely employed in the field of real estate. In contrast, its statistical accuracy in capturing locational effects under different distributions has shown extraordinary results in science areas such as biology, biosciences, energy economics, fisheries, food consumption, growth curves estimation, marine research, medicine, meteorology, rainfall, among others[i]. The main aim of the paper is therefore to explore whether the incorporation of spatial varying variances and consideration of skewed distributions in Munich's hedonic equation via GAMLSS reduces out-of-sample error variances and leads vis-a-vis to more precise forecasts than traditional hedonic regression models.

2. THE GENERALIZED ADDITIVE MODEL FOR LOCATION, SCALE AND SHAPE

The GAMLSS model is a semiparametric regression method, in which all the parameters of observed distribution for the response can be modelled as additive or non-linear functions of the explanatory variables. The four moments of the response – the mean, variance, skewness and the kurtosis – are generated by the observed variable and explicitly accounted by the GAMLSS statistical approach.

--- Please insert Figure 1 here ----

While the traditional OLS estimator $\hat{\beta} = (X'X)^{-1}X'Y$ is restricted in the incorporation of spatial and distributional effects[ii], the generalized linear model (GLM) is able to capture the distribution of the response (Y) only in the mean equation (μ), omitting however the interdependence with the underlying explanatory variables[iii]. A further assumption for unbiasedness of the traditional OLS estimator is that the distribution of the sample is centered about the estimator $\hat{\beta}$, see Figure 1. In other words, the expected conditional variance of the errors is expected to be homoscedastic distributed across the entire sample. The GAMLSS framework instead allows the flexible modelling of both non-linear effects across the several parameters of the response and the distribution parameters of the endogenous and exogenous variables simultaneously.

The GAMLSS hedonic framework depends on the imposed probability distribution (D), the link function applied to each k distribution parameters g and most importantly on the parameterization of equations for the mean (μ), variance (σ), skewness (ν) and the kurtosis (τ) of the response. The single modelling of the mean (μ) equation without considering any distribution corresponds to the OLS estimator. A GAMLSS equation can be expressed thus as:

$$D(Y) = D(Y|\mu, \sigma, \nu, \tau) = \begin{Bmatrix} g_1(\mu) = \boldsymbol{X}^{\mu}\beta^{\mu} + f_{1k}(\dot{X}_k^{\mu})\gamma_k^{\mu} \\ g_2(\sigma) = \boldsymbol{X}^{\sigma}\beta^{\sigma} + f_{2k}(\dot{X}_k^{\sigma})\gamma_k^{\sigma} \\ g_3(\nu) = \boldsymbol{X}^{\nu}\beta^{\nu} + f_{3k}(\dot{X}_k^{\nu})\gamma_k^{\nu} \\ g_4(\tau) = \boldsymbol{X}^{\tau}\beta^{\tau} + f_{4k}(\dot{X}_k^{\tau})\gamma_k^{\tau} \end{Bmatrix} \quad \text{(I)}$$

where the linear effects $\boldsymbol{X}$ and non-parametric or non-linear effects $f(\dot{\boldsymbol{X}})$ of the k endogenous variables need to be parameterized for each of the moments μ, σ, ν, τ of the response. The GAMLSS optimization model is fitted by maximum penalized likelihood estimation l under the assumption that the response is independent for each of the moments. The penalty term for the optimization in a GAMLSS model including non-parametric effects $f(\dot{\boldsymbol{X}})$ is given thus by

$$l = \sum_{i=1}^{n} \log(f(y_i|\mu_i, \sigma_i, \upsilon_i, \tau_i)) - \frac{1}{2}\sum_{k=1}^{4}\sum_{j=1}^{J_k} \lambda_{kj}\gamma_{kj}\boldsymbol{G}_{kj}\gamma_{kj} \quad \text{(II)}$$

where the first term of the equation represents the likelihood of the linear effects $\boldsymbol{X}$ and the second term represents the likelihood of the penalties with respect to the non-parametric or non-linear effects $f(\dot{\boldsymbol{X}})$. The GAMLSS methodology optimizes the likelihood l with respect to β and γ for a fixed hyper parameter λ based on the space spanned by the matrix of penalties $\boldsymbol{G}$. [20] propose two optimization algorithms, the CG and the RS algorithm, which both lead asymptotically to the maximum penalised log likelihood estimated for $\hat{\beta}$ and $\hat{\gamma}$. When estimating the hedonic models, I use for simplicity the standard procedure RS implemented in the gamlss package in R [18]. A more detailed explanation of the underlying algorithm steps and optimization can be found on the manual published by [23], which at the same time is a very suitable introduction on GAMLSS models in R.

In order to provide some stylized facts of the GAMLSS modelling technique, in this case on asking rents in the Munich market, I compare graphically a OLS and a GAMLSS model of asking rents in €/m² per month (p.m.) as response in contrast to flat's area in m². While both models include the same explanatory variable without any logarithmic transformation in the mean equation, the GAMLSS considers a cubic spline of size in the last three moments, allowing the variance, skewness and kurtosis to vary at different values of the covariate.

--- Please insert Figure 2 here ----

Both scatterplots in Figure 2 show the regression "line" of floor space on asking rents as a single regressor. While the left side of the figure shows that the linear OLS model is clearly not able to capture a significant share of heterogeneity of asking prices and that a linear approach might be poor on forecasting the response, the GAMLSS model shows a more accurate and flexible understating of asking rents in Munich's residential market. Very important in this single analysis is the nature of GAMLSS models to account for the different distributions of rents across the increasing values of the covariate. This is reflected by the varying width (variance, skewness and partly kurtosis) of the distribution lines of rents across the different size classes. Yet, the incorporation of different moments into the hedonic equation enables not only a higher understanding rents, but most importantly provides useful information on the different marginal willingness to pay for flats in dependence on flat's size in our simple case. The results based on the AIC rather than the R^2 criterion confirm finally that rents are more accurately modelled by a GAMLSS model rather than by a traditional estimator.

Three different papers – to my knowledge – focus on the usage of the GAMLSS approach in real estate hedonic research. [15] as part of the GAMLSS developing team, present a new algorithm to speed up the optimization of variable selection in GAMLSS environments. Their results confirm that – on the basis of the new developed algorithm – the explanatory power of the GAMLSS approach in Munich's rental market is superior in contrast to the GAM approach as measured by the MSE. The seminal study of [8] employs the GAMLSS model for estimating lot values in Aracaju in Brazil and compares its explanatory performance in contrast to OLS, GLM and a series of GAMLSS specifications. Based on R^2 and gAIC as evaluation criterion, the results point to an increase in the R^2 of ca. 15 percentage points and a decline of the AIC of ca. 3.4 % of the GAMLSS relative to the GLM approach. Finally, [19] employ the GAMLSS approach for deriving collateral values of house prices in Austria. While the study focusses on advanced statistical modelling techniques of quantile, Bayesian and Markow-chain (spatial) effects, the authors provide a deep inside on the contribution of the GAMLSS approach in modelling real estate prices. On the basis of these results, I expect a substantial reduction in forecasting bias when employing the GAMLSS approach in Munich's rental market.

3. MODEL PARAMETERIZATION AND OUT-OF-SAMPLE APPROACH

In a first step, I start with a traditional OLS hedonic equation for Munich's residential market of the form:

$$R_{i,j,t} = \boldsymbol{X}\beta + u_{i,j,t} = \boldsymbol{X_{i,j,t}}\beta + \boldsymbol{W}_j\phi + \boldsymbol{Z}_i\theta + \boldsymbol{\psi}_t\alpha_t + \boldsymbol{\psi}_j\alpha_j + u_{i,j,t} \tag{III}$$

where the response R corresponds to dwelling's i asking rent in quarter t and ZIP area j, $\boldsymbol{X_{i,j,t}}$ in bold correspond to the matrix of dwelling-specific characteristics, $\boldsymbol{W}_j$ accounts for j ZIP-area-specific covariates and the $\boldsymbol{Z}_i$ is a matrix of distances of each dwelling to general amenities such as schools, supermarkets, etc. $\boldsymbol{\psi}_t$ and $\boldsymbol{\psi}_j$ account for time-trend and ZIP-spatial fixed effects, the error term u is set to be iid and i=1,…,26'775; j=1,…,75 and t=2013Q1,…, 2015Q4. In a second step, I model the metric covariates in $\boldsymbol{X}$ and $\boldsymbol{Z}$ in the OLS equation (III) as penalized B-splines $\boldsymbol{f}()$ and optimize the equation as a Generalized Additive Model (GAM) model via the backfitting algorithm [11, 14] based on the following equation:

$$R_{i,j,t} = \boldsymbol{f}(\boldsymbol{X})_{i,j,t} + \boldsymbol{f}(\boldsymbol{Z})_i + \boldsymbol{W}_j\phi + \boldsymbol{\psi}_t\alpha_t + \boldsymbol{\psi}_j\alpha_j + e_{i,j,t} \tag{IV}$$

The GAMLSS approach allows, besides the incorporation of non-linear and spatial effects, the dynamic modelling of a series of parameterizations of the four moments of the response with regard to the response variable. However, two main problems arise when modelling GAMLSS equations: There is no sufficient evidence in the field of real estate on which distribution to use when explaining real estate prices and most importantly, on how to parameterize the g parameters in μ, σ, ν, τ. When trying to put all these parameters together, the combinations increase exponentially requiring several months of estimation[iv]. In order to overcome with these problems, I simplify the estimation as follows: Firstly, I define the set of covariates, both linear and penalized B-splines, for the μ equation and set them as the initial values in the variance, skewness and kurtosis equation under the normal distribution[v]. Secondly, I optimize the parameterization of the model iteratively based on the procedure developed by Rigby and Stasinopoulos denominated “stepGAICCAll.A” in R in order to select the set of optimal covariates for each single equation[vi]. stepGAICCAll.A is a strategy for selecting the covariates using the $gAIC$. In simple words, the procedure starts with a fixed distribution and selects an appropriate model for μ with fixed σ, ν, τ; afterwards it optimizes the σ model holding ν, τ fixed and so on until τ is optimized. The procedure optimizes the model also backwards, i.e. select τ and hold μ, σ, ν fixed until μ is optimized. Finally, stepGAICCAll.A compares the forward and backward models and choses the optimal set of covariates. In a last step, I re-estimate the optimized parameterized equations and provide the results for a model with only the μ equation and for a model with the four optimized parameterized μ, σ, ν, τ. The in-sample evaluation of the explanatory power of each model is completed via the generalized Akaike criterion ($gAIC$) and the unconstrained R-squared (R^2), see [8], whereas the $gAIC$ is defined as the negative likelihood plus a fixed penalty factor k multiplied by the total degrees of freedom df:

$$gAIC = -2\hat{l} + (k.df) \tag{V}$$

In order to assess the forecasting accuracy of the GAMLSS approach, I examine the out-of-sample forecasting accuracy with a bootstrap procedure. I estimate the models excluding 1’300 observations (4.86 %) randomly[vii] and obtain the predicted functional form. Afterwards, I predict the remaining 4.86 % of the sample and calculate the error variance (EV), root mean squared error (RMSE), mean absolute error (MAE), mean percentage error (MPE) and mean absolute percentage error (MAPE). Finally, I repeat the procedure 600 times with replacement and save the results, see [7].

An example of the loop implemented in R to run the simulation is as follows. On a first step, it defines the randomly in- and out-of-sample iteratively with replacement, i.e. 95.14 % and 4.86 % of the sample. In a second step, it estimates the GAMLSS model for the “estimation sample” based on the mu, sigma, nu and tau equations using the RS algorithm. In a final step, it predicts the responses of the “forecast sample” based on the estimated GAMLSS-parameters. Finally, it replaces the sample, repeats the procedure 600 times and saves the results[viii].

```
set.seed(1234);for(i in 1:600){
Estimation_Sample     <- Sample[-sample(1:dim(Sample)[1],1300,replace=T),]
Forecast_Sample       <- Sample[ sample(1:dim(Sample)[1],1300,replace=T),]
Model                 <- gamlss(Mu_Equation,data= Estimation_Sample,
                         sigma.formula = ~ Sigma_Equation,
                         nu.formula    = ~ Nu_Equation,
                         tau.formula   = ~ Tau_Equation, family = NO, method = RS)
Y_hat[[i]]            <- predict(Model, newdata= Forecast_Sample, type="response")
print(i)       }
```

4. DATA AND MARKET DESCRIPTION

Since the sample size is a very important factor either in parametric or semi-parametric or nearly any kind of empirical analysis, it might be worth taking a look at the datasets of the studies focussing on hedonic estimation. In the considered literature, [15] employ ca. 3k dwellings for estimating the hedonic equation in Munich in 2007, whereas [8] focus on ca. 2k lots from 2006 until 2007. Correspondingly, [19] employs ca. 3k data points on single-family houses from 1997 until 2009. For this study in contrast, I merged three different databases. Firstly, I gathered 26’775 observations from multiple listing services (MLS) in Munich from

2013-Q1 until 2015-Q4 as collected by the empirica system database[ix], which contain the most important MLS providers such as Immoscout, Immonet and Immowelt as well as seven others. After filtering and deleting duplicates, the empirica system database provides geographically referenced data with 20 hedonic characteristics. In order to avoid a large drop in sample size due to missing binary hedonic attributes such as wooden floor, sauna or laminate floor, I only include 12 relevant hedonic characteristics. Secondly, I merged two socioeconomic variables: purchasing power per household and the number of inhabitants per households both on a ZIP-code level and yearly basis from the GfK-database[x]. Finally, I gathered the geographical location of relevant amenities from open street map and estimate the lowest Euclidean distance between the amenities and the dwellings[xi]. The matrix $\boldsymbol{Z}_i$ includes the distance vectors in Km. The final database consists finally on 26’775 residential flats, each with a vector of 12 hedonic characteristics, 12 distance variables and 2 socioeconomic variables[xii]. The sample includes only flats rather than single and multi family houses in order to avoid sample bias.

Needless to say, the real estate data employed in this paper measures asking rents rather than transaction or contract rents. As opposed to other European countries, the size of the rental market in Germany – and specifically in Munich – is large, which points to an active use of ML services by landlords and tenants as a traditional marketing channel. In contrast to registry or mortgage approval databases, the advantage of MLS databases such as the empirica database relies on the fast access to real data when estimating hedonic models. Although the data fails at capturing contract rents, the deviation is not expected to lead to a error bias, especially after controlling for 12 hedonic characteristics as explained by [22, 13].

Munich is the capital of the state of Bavaria and with approximately 1.5 million inhabitants the largest city in Bavaria and the third largest city of Germany. Munich is one of the most powerful economic centres of Germany and besides Frankfurt a very important financial centre with important insurance, biotechnological and media companies. Over the last five years, it has developed as one of the most active residential markets in Germany as the demand for living space has been driven by the strong economic growth, strong competition of large companies and mainly by the stable labour demand. The city employs nowadays more people than workers living in the city, i.e. the commuter rate from workers from outside of Munich is very high. Because of its economic strength and excellent infrastructure, Munich recorded a steady population growth, e.g. during 2002 and 2014 the population increased by around 256k inhabitants, whereas at the same time only approximately 60k new apartments were built. With an average household size of 1.8 it is clear that there are some frictions between supply and demand and as it can be assumed that the population in Munich will increase further, the pressure on the housing market remains high leading to rising real estate prices and rents.

During the observation period, the mean asking rent was ca. 15 €/m²/p.m., whereas the lowest and highest rents ranged from ca. 10 €/m²/p.m. to 21 €/m²/p.m. respectably, as table 1 shows. While the average dwelling in the sample is ca. 80 m² and accounts for ca. 3 rooms, the average distances to selected amenities shows that supermarkets or restaurants are accessible within less than 340 m. The density of theatres, fire stations and swimming pools instead is low and accessible within ca. 3 Km. from an average dwelling. An average household in Munich has a purchasing power of ca. 52k €/p.a. The lowest 5 % of Munich's population has a yearly purchasing power of approx. 43'784 €/p.a., which is remarkably 4.8 % higher than the German purchasing power average.

------- Please insert Table 1 here -------

------- Please insert Figure 3 here -------

One of the main improvements of the GAMLSS approach is the incorporation of variances of the response across space and time into the estimation model. In order to validate this preliminary assumption, Figure 3 shows the standard deviation of rents divided by the mean rents in each ZIP area (relative standard deviation). The higher the relative the standard deviation is the higher is the span of rents within the observed ZIP area. The map shows that the deviation of rents relative to their ZIP's mean decreases for rising distance to city centre, providing evidence of a heterogeneous distribution of rents across space regardless of the rent level. Thus, the span of rents diverges by more than ± 19 % from the mean rent in the city centre, whereas dwellings in the east and west of Munich present a more consolidated rent range clearly below ± 12 % from the mean rent.

------- Please insert Table 2 here -------

A further contribution of the GAMLSS model is the consideration of skewed responses. The development of rents as presented in table 2 shows a steady growth path of rents over time with remarkable variations in its moments. Just like in the spatial case, the cross-sectional variation of rents relative to its mean points to a widening of the distribution over time as it increased by almost 4 percentage points to 23.9 % during the entire observation sample. While the skewness of asking rents is stable and positive indicating a significant concentration of observations on the left with a longer tail on the right, the kurtosis shows strong deviations from the univariate normal distribution. On average, asking rents tend to be leptokurtic with fatter tails, which implies that the extreme values in the tails approximate to zero slower than the normal distribution, i.e. outliers are more likely. Yet, in an OLS context, the data would require the usage of robust estimators or large preliminary adjustments, e.g. censoring. Since the descriptive statistics provide evidence for a heterogeneous distribution of variances in both the location and the shape of rents, the GAMLSS approach is expected to capture these anomalies and lead to higher in- and out-of-sample understanding of rents in comparison to traditional methods.

5. IN-SAMPLE EXPLANATORY AND OUT-OF-SAMPLE ACCURACY RESULTS

The paper aims at showing the explanatory as well as forecasting accuracy of the GAMLSS approach in hedonic modelling relative to traditional models such as the OLS and GAM. For this purpose, I gathered 26’775 observations in Munich, Germany, and test the forecasting accuracy of the models leaving ca. 5 percent of the observations with replacement iteratively 600 times and evaluate the results by the error variance (EV), root mean squared error (RMSE), mean absolute error (MAE), mean percentage error (MPE) and mean absolute percentage error (MAPE). While the OLS and GAM approach do not adapt the distribution of the response variable to the underlying covariates, the GAMLSS model allows a more dynamic incorporation of these effects as it considers the four underlying moments of the response separately. I evaluate the in-sample regression models via generalized $gAIC$ criterion and unrestricted R^2, rather than the estimated coefficients since the comparability of estimated coefficients is restricted due to the non-linear modelling of metric covariates. While the OLS approach allows a direct interpretation of the estimated elasticities, non-linear coefficients are merely evaluated by a significance test.

------- Please insert Table 3 here -------

Table 3 shows the $gAIC$, the R^2 and the corresponding degrees of freedom (DF) of each model based on the in-sample sample for Munich (overall sample) as well as the evaluation indicators of the out-of-sample simulation. Firstly, the results confirm that traditional approaches such as the OLS or GAM do not explain the underlying factors of asking rents in Munich’s residential market sufficiently based on the $gAIC$ and the R^2 criterion. While there is a significant increase in the explanatory power of the GAM approach relative to the OLS model, the GAMLSS approach does capture the explanatory power of the covariates remarkably, regardless of the moment equations included, i.e. the GAMLSS model with or without the μ, σ, ν, τ parameters. Although the GAM model outperforms the OLS approach, the GAMLSS models show a higher understanding of the underlying factors based on the

$gAIC$ and the R². The highest increase in the R² of approx. 25 percentage points was obtained by the GAMLSS model including linear and non-linear covariates in the last tree moments of the response relative to the OLS approach. The explanatory power of the full GAMLSS model reflects in the relative decrease of the $gAIC$ by 9.0 % and by 3.3 % relative to the OLS and GAM models respectively.

When looking at the out-of-sample explanatory power in Table 3 and Figure 4, the results confirm that the GAMLSS method has indeed an enhanced understating of Munich's rental market. This understanding is at the same time translated into the forecasting results as the GAMLSS models outperform the traditional models. Based on the EV, the GAMLSS models outperform the OLS model by almost –2 percentage points and the GAM model by almost –30 BP. Yet, based on 600 bootstrap loops, the mean absolute error of the full GAMLSS model has a mean of ca. 1.6 €/m² which corresponds to an improvement of about –3.5 % (–0.06 €/m²) and of –17.2 % (–0.33 €/m²) in contrast to the OLS and the GAM model, respectively. These results indicate that the GAMLSS forecasting errors tend to lie in a closer corridor towards the true values and that extreme forecast are less likely. When looking further into the MPE, the results show that the forecasted rents are positive skewed over all models, i.e. the models forecast rents higher than the actual values, leading to a overestimation of rents. This bias decreases when the estimator controls for skewness in the distribution of the response, i.e. the GAMLSS approach. Finally, the mean absolute percentage error between actual and forecasted asking rents decreases in the full GAMLSS model by ca. 2.26 percentage points in contrast to the OLS model. Thus, the GAMLSS model presents the highest forecasting accuracy, providing evidence that rents are asymptotically more precisely forecasted by the GAMLSS approach, especially when dealing with extreme values and spatial varying rents.

------- Please insert Figure 4 here -------

6. CONCLUSION AND RECOMMENDATIONS

Hedonic models are very useful instruments for institutional investors, researchers and policy makers in order to determine the underlying drivers of rents and prices within a market and consequently to identify future market developments or possible investment opportunities. In view of the advantages in statistical inference and also ascribed to the progress in computational speed, the empirical estimation of hedonic models has faced large improvements during the last three decades, leading at the same time to an increasing number of hedonic functional specifications. Despite of the remarkable statistical improvements, but especially due to the complexity of real estate, hedonic models are still limited in capturing real estate relevant effects such spatially varying prices or non-normal responses. Estimation methodologies of the “new era” have emerged, conceptualizing and expanding the assumptions behind traditional hedonic models in order to maximize the explanatory power and minimize forecasting errors. A very well-known framework of the “new era” – but rarely used in real estate studies – is the Generalized Additive Model for Location, Scale and Shape (GAMLSS), which allows the distribution of the response to vary according to both their own four moments – mean, variance, skewness and kurtosis – and the covariates. While the GAMLSS approach has led to an enormous increase in the explanatory power of models in natural and medical sciences, its advantages in the field of hedonic modelling remain scarce and partly new. This paper explored therefore the main advantages of the GAMLSS approach in the context of hedonic real estate research based on more than 25k observation in Munich, Germany.

The results can be explored from two perspectives. The computational requirements necessary to estimate GAMLSS models are high and might constitute one of the limiting factors for (institutional) researchers, despite the large detailed knowledge on statistical inference and programming. However, the empirical results confirm that Munich’s residential market can be more accurately explained by means of the GAMLSS model than by traditional models such as the OLS or the GAM. Furthermore, the out-of-sample forecasting simulation based 600 loops with replacement confirmed that the complexity of the GAMLSS models does pay off as measured by traditional forecasting evaluation indicators. The mean absolute error fell by almost 17 % and 4 % in the GAMLSS approach in contrast to the OLS and GAM models, respectably.

Overall, the results show that the theoretical and empirical complexity of the GAMLSS approach in estimating Munich's residential market do pay off in view of the increased explanatory power and primarily in view of the substantial increase in the out-of-sample forecasting accuracy. For policy-makers, the advantages of more accurate hedonic models might lead to a more precise market control and to a better understanding of the local factors affecting rents. For (institutional) researchers, instead, the GAMLSS approach offers a new area of investigation since the framework offers a large number of calibrations, depending on the observed market, data deepness and variables' behaviour. Finally, it is – not surprisingly – to expect that further research might find an even higher forecasting accuracy in view of the large potential of the GAMLSS framework.

7. LITERATURE

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Endnotes

[i] See: Hudson, I.L., Kim, S.W. and Keatley 2011; Serinaldi, F. 2011; Hao, L. I. U. and Langman, C. H. E. N. 2011; among others. See also http://www.gamlss.org/?page_id=1050.

[ii] Restricted in the incorporation of spatial and temporal terms in the sense that they only are included as dummy terms or a weighting matrix.

[iii] The GLM model allows a more flexible modelling of the hedonic equation, however the underlying estimator does not consider any interdependence of the endogenous variables.

[iv] Based on e.g. 15 covariates the dynamic combinations between 4 models, different distribution and non-linear effects exploit exponentially.

[v] The GAMLSS approach allows the usage of a series of distributions. However, the optimization of the models under distributions such as student skewed, gama, skewed exponential or sin-arcsinh was very instable, leading to rising likelihood values, variances and partly failures in the likelihood estimations. For simplicity, I focus therefore merely on the normal distribution, which at the same time led to the best results.

[vi] This procedure was very time consuming, it took almost tree weeks to estimate the models based on a RAM of 16 GB.

[vii] The random generator was specifies as set.seed(1234).

[viii] The number of out-of-sample observations was chosen based on the number of quarters.

[ix] www.empirica-systeme.de

[x] www.gfk.com

[xi] www.openstreetmap.com/. I only focus on amenities that might be related to rents rather than including amenities such as speed cameras, pub with darts, flower shop or hair salon.

[xii] The computational requirements for the estimation of the models were very large. The programmed loop in R used continuously a RAM of ca. 14 GB over several days.

Table 1: Descriptive statistics of variables

Variable	Mean	SD	Q5%	Q30%	Q50%	Q70%	Q95%
Metric and binary covariates							
Asking rent €/m²/p.a.	14.823	3.171	10.87	13.06	14.26	15.76	20.833
Living area	79.456	38.38	31.5	58.49	73	90	150
Age relative to 2016	41.323	35.378	1	18	39	51	115
Number of rooms	2.609	1.059	1	2	2.5	3	4
Central heating system (0=else)	0.774	0.418	0	0	1	1	1
Individual heating system (0=else)	0.007	0.083	0	0	0	0	1
Floor heating system (0=else)	0.063	0.242	0	0	0	0	1
Built-in kitchen (0=else)	0.668	0.471	0	0	1	1	1
Balcony (0=else)	0.796	0.403	0	1	1	1	1
Refurbished (0=else)	0.254	0.441	0	0	0	0	1
As-good as new (0=else)	0.108	0.311	0	0	0	0	1
Longitude	11.561	0.059	11.458	11.528	11.563	11.589	11.662
Latitutde	48.137	0.030	48.088	48.118	48.138	48.155	48.185
Inhabitants per household	1.795	0.089	1.655	1.735	1.78	1.822	1.948
Purchasing power per household €/p.a.	53‘806	6‘019	45‘890	49‘562	52‘463	56‘211	64‘586
Distance covariates in Km.							
Theatre	1.783	1.189	0.28	1.018	1.588	2.261	4.009
Swimming pool	3.972	2.411	0.686	2.236	3.617	4.951	8.347
Supermarket	0.333	0.259	0.043	0.184	0.273	0.386	0.774
Subway entrance	0.970	1.182	0.099	0.317	0.518	0.913	3.47
School	0.848	0.627	0.146	0.405	0.646	1.027	2.073
Restaurant	0.247	0.196	0.035	0.111	0.189	0.304	0.667
Pub	0.570	0.449	0.066	0.251	0.441	0.71	1.438
Museum	2.045	1.236	0.336	1.242	1.855	2.551	4.392
Memorial	0.755	0.518	0.168	0.441	0.613	0.901	1.873
Kindergarten	0.421	0.253	0.078	0.264	0.378	0.516	0.891
Fire station	3.488	1.723	0.63	2.406	3.511	4.582	6.151
Biergarten	0.906	0.483	0.215	0.587	0.815	1.146	1.739

Table 2: Descriptive statistics of asking rents over time

Rents in €/m²/p.m.		2013				2014				2015				Overall
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Mean μ_i	Level	13.954	13.743	14.167	14.437	14.505	14.573	14.785	15.080	15.240	15.449	15.687	15.547	14.823
	yoy%	/	/	/	/	4.0%	6.0%	4.4%	4.5%	5.1%	6.0%	6.1%	3.1%	11.4%
Standard deviation σ_i	Level	2.782	2.554	2.691	2.924	3.147	2.996	3.013	3.023	3.186	3.170	3.530	3.712	3.171
	% of mean	19.9%	18.6%	19.0%	20.3%	21.7%	20.6%	20.4%	20.0%	20.9%	20.5%	22.5%	23.9%	21.4%
	yoy%	/	/	/	/	13,1%	17,3%	12,0%	3,4%	1,2%	5,8%	17,2%	22,8%	33.4%
Skewness υ_i		1,383	0.980	1.639	1.432	1.492	1.315	1.220	1.114	1.314	1.082	1.412	1.042	1.323
Kurtosis τ_i		4,315	1.783	8.540	6.109	7.730	4.845	3.666	2.661	3.477	2.262	4.038	2.846	4.367
N	n	2‘259	1‘591	1‘326	1‘621	3‘162	2‘622	2‘393	2‘553	2‘110	1‘954	2‘983	2‘201	26‘775
	% of total	8.4%	5.9%	5.0%	6.1%	11.8%	9.8%	8.9%	9.5%	7.9%	7.3%	11.1%	8.2%	100%

Table 3: In- and out-of-sample model accuracy

In-sample estimation							Out-of-sample forecasting evaluation after 600 loops	
Estimation method	$\sigma_i, \upsilon_i, \tau_i$ parameters	Generalized AIC: Absolute	Generalized AIC: Relative to OLS	Generalized AIC: Relative to GAM	R²	Df		
OLS	/	121’517.8	/	/	27.9%	39	EV	7.2117
							RMSE	2.6855
							MAE	1.9318
							MPE	-3.1496
							MAPE	13.4010
GAM	/	114’436.5	-5.8%	/	45.6%	98	EV	5.5645
							RMSE	2.3589
							MAE	1.6580
							MPE	-2.5102
							MAPE	11.5589
GAMLSS	–	113’339.3	-6.7%	-1.0%	48.0%	114	EV	5.2257
							RMSE	2.2860
							MAE	1.6036
							MPE	-2.3451
							MAPE	11.1916
GAMLSS	+	110’641.3	-9.0%	-3.3%	53.3%	163	EV	5.2799
							RMSE	2.2979
							MAE	1.6001
							MPE	-2.2868
							MAPE	11.1371

Notes: Table provides the out-of-sample forecasting results after 600 loops excluding ca. 5% of the observations with replacement. Error variance (EV), root mean squared error (RMSE), mean absolute error (MAE), mean percentage error (MPE) and mean absolute percentage error (MAPE).

Figure 1: Regression line under homoscedasticity

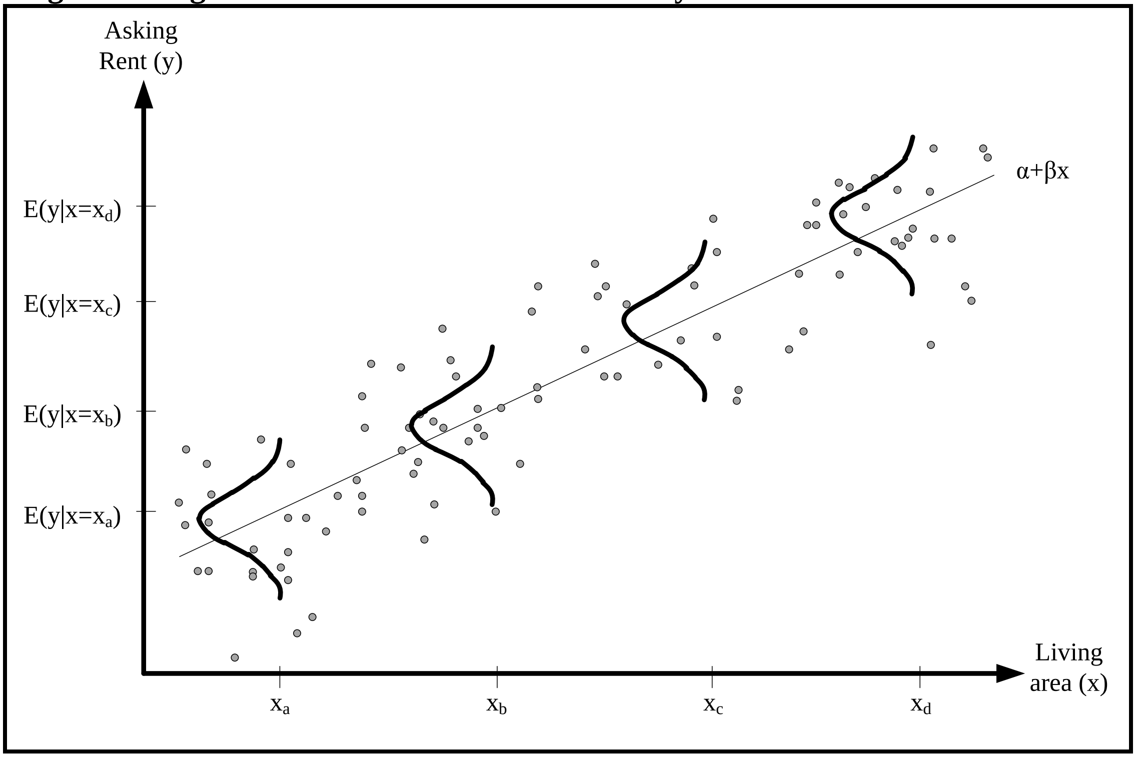
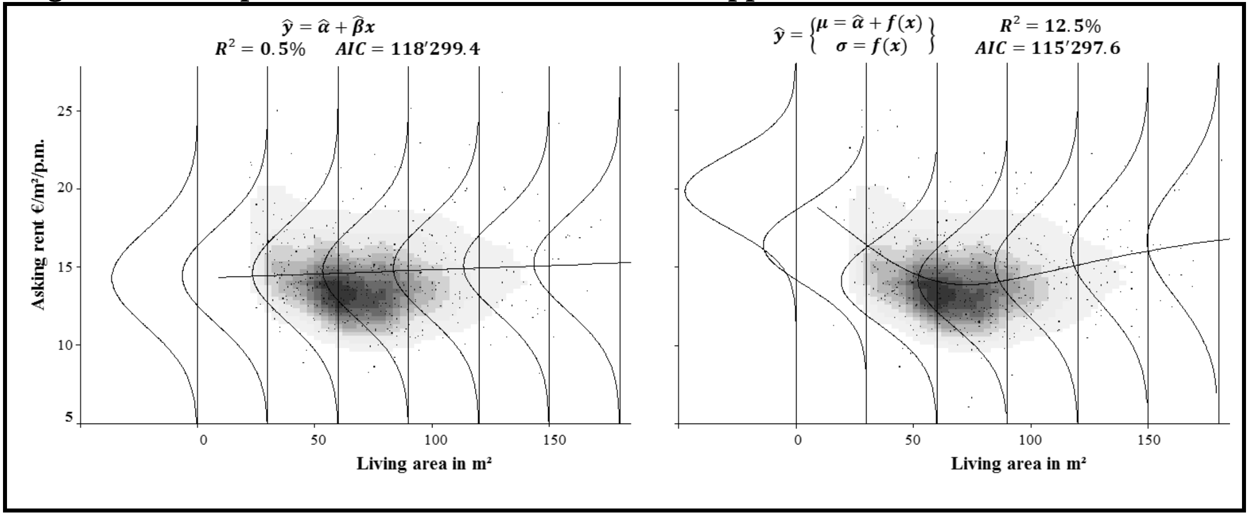
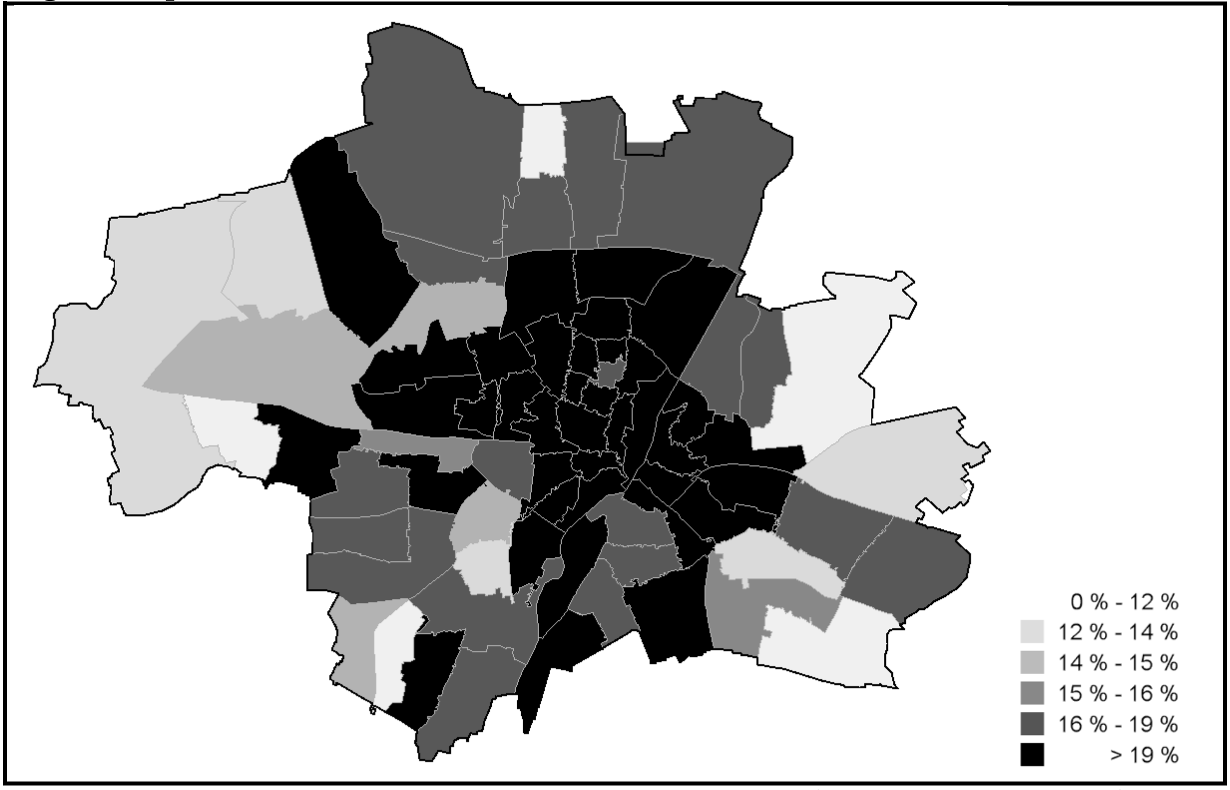


Figure 2: A comparison of the OLS and GAMLSS approach



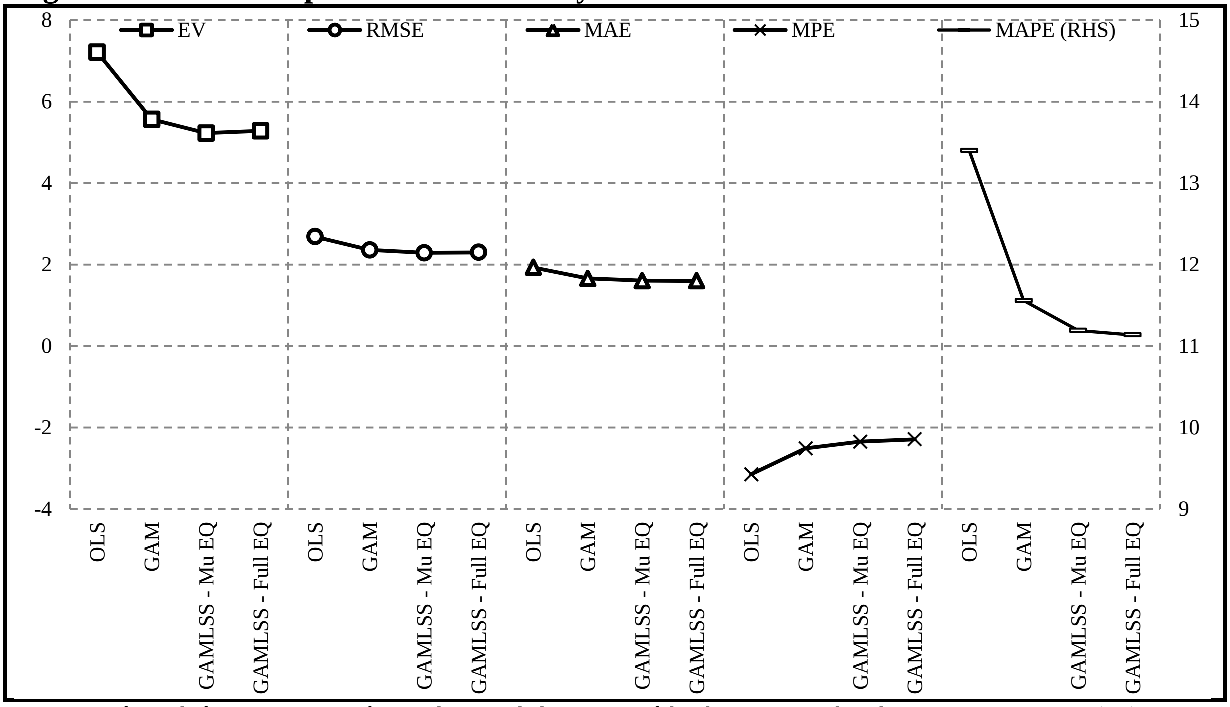
Notes: Models estimated without any transformation in both sides of the equation.

Figure 3: Spatial distribution of the standard deviation as % of mean rent in 2015-Q4



Notes: The map shows the relative standard deviation (standard deviation divided by mean) of asking rents acrossthe ZIP areas of Munich.

Figure 4: Out-of-sample forecast accuracy



Notes: out-of-sample forecast accuracy after 600 loops excluding ca. 5% of the observations with replacement. Error variance (EV), root mean squared error (RMSE), mean absolute error (MAE), mean percentage error (MPE) and mean absolute percentage error (MAPE).

The Interest Rate Sensitivity of Value and Growth Stocks - Evidence from Listed Real Estate

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Abstract

This paper analyzes the return sensitivity of value and growth stocks to changes of five interest rate proxies. The analysis is based on monthly data over the 2000 to 2014 period for a global sample of 487 listed real estate companies in 24 countries. This rich setting offers substantial heterogeneity in interest rates across time and countries. We find that value stocks are more sensitive to changes in the short-term rate than growth stocks. This is consistent with the theory that investors with a short investment horizon trade-off the high initial yield of value stocks against a lower risk short-term rate. In contrast, growth stocks are more sensitive to changes in the long-term rate, which is consistent with the future cash flows of growth stocks being discounted at a higher rate. We also find that value stocks are more sensitive to changes in the credit yield. Since credit costs have a direct impact on a firm's cost of capital, this result is consistent with risk-based theories of the value premium, which argue that value stocks are riskier, because they tend to have higher leverage and a larger default probability.

1 Introduction

There is a substantial body of research examining the varying performance characteristics of value stocks and growth stocks. By definition, value stocks are stocks with a low ratio of price to fundamental value, while growth stocks are characterized by a high price relative to their fundamental value. Numerous studies show that value stocks on average outperform growth stocks (the so-called value premium), both for the U.S. (Rosenberg et al., 1985; Fama and French, 1992) and international stock markets (Fama and French, 2012; Asness et al., 2013). There are two key explanatory approaches for the value premium: First, risk-based explanations (e.g. Davis et al 2000, Zhang 2005, Liew and Vassalou 2000) with the assumption of fundamentals, e.g. leverage, size, are causing the average outperformance of value stocks. Second, behavioral based explanations which imply the return anomaly is due to suboptimal investor behavior (e.g. Lakonishok et al., 1994; De Bondt and Thaler, 1985).

In essence, the risk-based explanations put emphasis on idiosyncratic risk. An alternative further explanation attempt for the value premium are macroeconomic factors linked with systematic risk, e.g. business cycles or monetary policy (e.g. Jensen and Mercer 2002; Hahn and Lee 2006). Lewellen (1999) argues that in asset pricing models like the CAPM (Sharpe (1964) and Lintner (1965),) or the ICAPM (Merton 1973) market return does not completely capture the relevant risk in the economy, and additional factors are required to explain expected returns. To address this issue, Hahn and Lee (2006) extend the three-factor model of Fama and French (1993) by two additional macroeconomic variables. The default spread and the term spread proxy for credit market and the monetary policy conditions. More recently, Lioui and Maio (2014) show that value stocks have higher interest rate risk than growth stocks, suggesting that the value premium can be explained by changes of the monetary policy.

In this paper, we systematically analyze whether and to what extent, the performance of value and growth stocks can be explained by five macroeconomic factors, i.e. different proxies of interest rates and yield spreads. The five factors include changes of the short-term interest rates (STIR), long-term interest rates (LTIR), the term spread (TERM), the corporate bond yield (CBY), and the default spread (DEF). The corresponding research question is: Do the returns of value and growth stocks react differently to changes of various interest rate proxies?

Why are listed real estate companies particularly qualified to analyze the interest rate risk of value and growth stocks? The commonality among previous research is that they separate value and growth stocks according to their book-to-market ratios of equity. Thus, whether explicitly or implicitly, the book value of equity is used as the proxy for a firm's fundamental or intrinsic value. Most academics agree that a firm's intrinsic value is determined primarily by the present value of its future cash flows, which is not necessarily reflected by balance sheet data.

In this study we use a more reliable indicator of intrinsic value, which allows us to better distinguish between value and growth stocks. In particular, we use a global panel of 487 listed real estate companies (REITs and REOCs) in 24 countries over the 2000-2014 period.

Owing to their peculiar characteristics, listed real estate companies are particularly well-suited to study the impact of interest rate changes. In particular, there are three obvious channels through which interest rates may impact the stock market returns of listed real estate companies: 1) interest rate changes impact the relative attractiveness of equities compared to other asset classes such as fixed income or the money market, 2) Interest rates impact the prices of the underlying properties of the listed real estate companies, and 3) interest rates have a direct impact on the operating performance, by influencing a firm's costs of debt.

Combined with the ability to reliably distinguish between value and growth stocks, this provides an ideal research setting to learn more about the relationship between the various interest rates and stock market returns.

Our objective is 1) to examine the interest rate sensitivity of value and growth stocks, by using the NAV as the proxy for intrinsic value, and 2) to identify different patterns of sensitivity for various proxies for interest rates and yield spreads of value and growth stocks, both on a global basis.

Our empirical approach is based on a monthly sorting procedure. At the end of each month, we rank all stocks according to their deviations from intrinsic value, as measured by the NAV spread. We then form three portfolios whose returns are observed over the following month, with the focus being on the value portfolio, which is defined as the quintile of stocks with the highest discount to NAV. In order to examine the interest rate sensitivity, we control for interaction effects between the value, middle and growth portfolio and changes of the respective interest rate proxy. Secondly, we control for risk-adjusted returns and include the interaction terms into four-factor models (Carhart, 1997).

We find that value stocks are more sensitive to changes of the short-term interest rate, the corporate bond yield, and the default spread. In contrast, growth stocks are more sensitive to changes of long-term interest rates and the term spread. To the best of our knowledge, this is the first paper to examine the diverging interest rate sensitivities of value and growth stocks in the context of real estate. Furthermore, this is the first paper to address interest rate sensitivities in the context of NAVs in a global setting.

The remainder of this paper is organized as follows. Section 2 reviews the related literature, and introduces our hypotheses. The data is described in Section 3. Section 4 provides methodology and Section 5 the empirical results. Section 6 provides the discussion of results and Section 7 concludes our findings.

2 Related Literature and Hypotheses

2.1 Value Stocks and Risk

The rationale of the efficient market hypotheses (EMH) of Fama (1970) is that financial markets *"at any time 'fully reflect' all available information"* (Fama, 1970) including such information as the intrinsic value of a listed company. Shiller (1981) contradicts the EMH finding that a substantial proportion of stock volatility is unexplained by changes of fundamental information (e.g. future dividends). The capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) fails to describe such return anomalies. These anomalies include i.a. that the market portfolio does not entirely explain the relevant risk in the economy to expected returns (Lewellen 1999) such as overreactions to new financial information (De Bondt and Thaler 1985). Another return anomaly goes back to the work of Rosenberg et al. (1985) and Fama and French (2012), who find that stocks with high book-to-market ratios of equity have higher returns than those with low ratios (the value premium). Fama and French (1992) address this shortcoming by extending the CAPM by the two additional risk factors size and book-to-market. They provide evidence that the three-factor model has increasing explanatory power and explains risk in expected returns more precisely.

Regarding the value premium, literature exhibits two key explanatory approaches: First, risk-based explanations (e.g. Davis et al 2000, Zhang 2005, Liew and Vassalou 2000) with the assumption that unsystematic stock-specific fundamentals (e.g. leverage, size) are causing the average outperformance of value stocks. The explanation attempt refers to unsystematic risk factors, which are non-diversifiable. Second, behavioral based explanations, which imply the return anomaly is due to suboptimal investor behavior (e.g. Lakonishok et al., 1994; De Bondt and Thaler, 1985).

A further explanatory approach includes risk-based explanations regarding systematic risk: Macroeconomic factors. The rationale behind this approach is that value stocks are particularly prone to macroeconomic factors and thus produce a risk premium. Lewellen (1999) argues that value stocks are particularly sensitive to changing macroeconomic factors owing to the "distress factor" suggested by Fama and French (1993). Jensen and Mercer (2002) provide evidence that the monetary policy is an important additional factor in explaining the risk premia of the three-factor model. Hahn and Lee (2006) extend the three-factor model of Fama and French (1993) by two additional macroeconomic variables, based on the proposition that the long-established factors market, size and book-to-market do not fully proxy systematic risk and business cycle fluctuations. The two additional factors are the *default spread* and the *term spread*. These yield spreads are commonly used as proxies for credit market and monetary policy conditions. Hahn & Lee (2006) provide evidence that value stocks have higher (positive) loadings on positive changes of the term spread than on growth stocks. Other studies provide evidence that value stocks are related to other macroeconomic state variables: E.g. consumption growth (Kang et al., 2011) or market wide fluctuations in expected cash flows (Da and Warachka, 2009).

2.2 Interest Rate Sensitivity of Stock Returns

This section will give a brief review of relevant studies in the context of the interest rate sensitivity of stock returns. The analysis of the interest rate sensitivity of stock returns has been subject of numerous studies in the past. Stone (1974) as well as Lloyd and Shick (1977) were the first analyzing the interest sensitivity of stock returns employing a two-index version of the CAPM (market and interest rate terms). Fama and Schwert (1977) demonstrate that monthly changes of short-term interest rates have a negative coefficient for future returns of commons stocks. Several other studies follow a similar methodological approach, concentrating on financial institutions. These studies include inter alia Chance and Lane (1980), Lynge and Zumwalt (1980), Flannery and James (1984) or Bae (1990). Elyasiani and Mansur (1998) follow a time series approach employing a GARCH-M model to analyze the interest rate sensitivity of bank stock returns.

2.3 Interest Rate Sensitivity of Listed Real Estate Companies

Beside financial institutions, a substantial amount of studies documented the interest rate sensitivity of listed real estate companies (REITs and REOCs). Chen and Tzang (1988) as well as Allen et al (2000) find that US-REITs are sensitive to changes of long-term interest rates and short-term interest rates in parts of the 1980's and 1990's. Consistent with these findings, Devaney (2001) reports a highly significant and negative coefficient for monthly changes of long-term interest rates in explaining the excess returns of US-REITs between 1978-1998. According to Devaney (2001), mortgage REITs (MREITs) have a higher interest rate sensitivity than equity REITs (EREITs). He et al (2003) report similar results, i.e. that MREITs are sensitive to changes to all of the seven incorporated interest rate proxies, while EREITs are only sensitive to changes of long-term rates and corporate bond yields. To the contrary, Liang et al (2009) find no significant interest rate risk factor for equity REITs. As with He et al (2003), Swanson et al (2002) and use a default and term spread as interest rate proxies. Their empirical results reveal that REIT returns are more sensitive to changes of the term spread than to the default spread. In contrast to He et al (2003), they do not find diverging results for MREITs and EREITs.

The majority of the reviewed studies so far, are limited to U.S. data. The paper of Akimov et al (2015) is one the few studies analyzing global listed real estate markets. However, they are using index level data instead of more precise panel data. Akimov et al (2015) demonstrate the importance of interest rate risk for listed real estate companies. In line with the majority of previous research, they find that short-term and long-term interest rates are significant risk factors in explaining the returns of listed real estate. Lizieri et al (1997) confirm the results of previous research as they find an asymmetric effect of the sensitivity of property company share prices to interest rate changes in the U.S. and U.K.. Amending previous research, they hypothesize that listed real estate companies are affected by interest rate changes on two further levels than merely the stock market. 1. The "*underlying direct [real estate] market*" level which is represented by net asset value (NAV), appraised on a discounted cash flow basis. As interest rates rise, the capital values of individual properties are depressed. 2. The corporate level of real estate companies is characterized by high leverage and decreasing profits as costs of borrowing increase when interest rates rise.

To sum up, most of the studies have in common that their results hold true for 1) REITs, 2) selected continental markets like the U.S., 3) index level data and 4) outdated sample periods. We counter these drawbacks with a rich panel data set focusing on REITs and REOCs in 24 countries with a contemporary sample period (2000-2014). The interest rate proxies employed in previous studies can be categorized into three main categories: 1) Short- and long-term interest rates represented by t-bill rates and government bond yields with diverse maturities (e.g. 10 to 15 years), 2) Corporate bond yields, and 3) yield spreads (e.g. default and term spread). The studies have in common that the selection of an interest rates proxy is in most cases inconsistent. Following Akimov et al (2015) the rationale behind the proxy selection is in some way random and the proxies cannot be incorporated into a model simultaneously. To address this issue, we consider the entire set of interest rate proxies in our study. Moreover, we make use of the default and term spread as this allows to simultaneously testing the effect of more than one interest rate proxy in a single model.

2.4 Interest Rate Sensitivity of Value and Growth Stocks

Thus far, only few papers distinguish between the interest rate sensitivity of value or growth stocks. Substantial selected studies include Hahn & Lee (2006), Lioui and Maio (2014) and Jensen and Mercer (2002). Their approaches and findings will be discussed in the following and shape the basis to formulate our hypotheses regarding the sensitivity to changes of five interest rate proxies.

Short-term Interest Rates

In a recent study, Lioui and Maio (2014) employ a macroeconomic asset pricing model and find that value stocks have a stronger interest rate risk than growth stocks. They conclude that interest rate risk is a key factor in explaining the value premium. In their empirical analysis, they find that value stocks load negatively on the monetary factor, represented by the short-term interest rate[1] and the effective federal funds rate as interest rate proxies. Lioui and Maio (2014) hypothesize that value stocks are more sensitive to unexpected decreases of short-term interest rates. They propose that value stocks face continuing underperformance for years, which is likely to induce negative shocks in their cash flows making them *"financially constrained through time"*. According to Bernanke and Gertler (1995) companies under distress are especially sensitive since increasing interest rates directly reduce cash flows as debt expenses rise.

We argue that another key subject in the context of the return sensitivity of different interest rate proxies is the concept of relative attractiveness amongst asset classes. Investors, who are willing to buy short-term bonds, might pursue a short-term investment horizon. Due to their larger price-to-earnings ratios, value stocks have higher dividend yields. When short-term interest rates fall, short-term investors might reallocate their funds to value stocks since they generate higher (dividend) yield income in the short run. We thus formulate our first hypothesis regarding the sensitivity to changes of short-term interest rates as follows:

[1] I.e. 3-month T-bill rate

Hypothesis 1: *The risk-adjusted returns of value stocks are more sensitive to changes of short term interest rates than the risk-adjusted returns of growth stocks.*

Long-term Interest Rates and the Term Spread

According to Campell and Viceria (2001), long-term bonds are held by risk-averse investors with a long-term investment horizon seeking stable cash flows and a term premium over short-term bonds. REITs have long been praised as a bond-like investment, due to their high cash flow stability. The research question which we seek to answer in this paper is the following: Are value REITs or growth REITs more sensitive to changes in the long term rate?

Changes in long-term interest rates tend to be accompanied by changes in future expectations. In particular, growth stocks are valued based on future cash flow expectations. Increasing long-term interest rates result in higher discount rates (Thorbeke 1997). Thus, future cash flows are discounted at higher rates, which over-proportionally affects the market values of growth stocks. Hence, the returns of growth stocks should be more sensitive to changes in the long term interest rate, than the returns of value stocks. We formulate our second hypothesis accordingly:

Hypothesis 2: *The risk-adjusted returns of growth stocks are more sensitive to changes of long term interest rates than growth stocks.*

Similarly, a widening term spread, i.e. the difference between long-term and short-term interest rates, increases the relative attractiveness of value stocks over growth stocks. Hence, growth stocks should also be more sensitive to changes of the term spread than growth stocks.

Corporate Bond Yields and the Default Spread

Corporate bonds represent one important form of debt financing for real estate companies. He et al. (2003) find that changes of high-yield corporate bonds have the strongest explanatory power in explaining the returns of U.S. REITs in contrast to other interest rate proxies. Increasing corporate bond yields cause an increase of the cost of debt and thus have a negative impact on the corporate performance (corporate level). Hahn and Lee (2006) argue that value stocks tend to be higher leveraged than growth stocks. Thus, increasing corporate bond yields should lead to negative returns as the cost of capital increases (a similar argument is made by Bernanke and Gertler, 1995). Thus, we formulate our third hypothesis as follows:

Hypothesis 3: *The risk-adjusted returns of value stocks are more sensitive to changes in corporate bond yields than growth stocsk.*

Related to the corporate bond yield is the default spread, which is defined as the difference between the corporate bond yield and the long term interest rate. Fama and French (1989) argue that the default spread is an indicator for long-term business conditions and associated with high expected returns near business cycle busts, and low expected returns near booms. Hence, value stocks should also be more sensitive to changes in the default spread than growth stocks.

3 Data and Descriptive Statistics

3.1 Sample Description

Our sample is based on the FTSE EPRA/NAREIT Global Real Estate Index, which is comprised of listed companies with "relevant real estate activities." Four ground rules regarding the constituent underlying REOCs and REITs ensure sufficient index quality: 1) a minimum free-float market capitalization, 2) minimum liquidity requirements, 3) a minimum share of EBITDA (>75%) from relevant real estate activities[2], 4) publication of audited annual accounting reporting in English.[3] The sample period for the analysis is 2000:03 to 2014:05. To avoid survivorship bias, we consider historic changes of the index constituent composition in every month of the period. Our final sample consists of 487 stocks from 24 countries including 345 REITs and 142 REOCs. The advantages of panel data are inter alia increasing degrees of freedom, weakening of multicollinearity, construction of more realistic behavioral models and obtaining more precise estimates of micro relations (Hsiao 2014).

3.2 Construction of value and growth stock portfolios

In order to construct the value and growth stock portfolios we sort stocks according to their price deviation from NAV. In this regard, the NAV per share (or the book value of equity) is calculated by dividing Datastream's "common equity" by "number of shares." The discount to NAV is calculated based on the "unadjusted share price" as reported by Datastream. As stocks may also trade at a premium to NAV, we name our sorting criteria NAV spread:

$$NAV\ Spread_{i,t} = \frac{Price_{i,t}}{NAV_{i,t}} \quad (1)$$

The major shortcoming of constructing the global value portfolio on the (absolute) NAV spread is that the global value portfolio can be overly exposed to country risk. For example, if a country is trading at depressed levels relative to other countries, the global value portfolio may still include growth stocks of the discount country. Thus, the interpretation of the results may be ambiguous. To avoid this shortcoming, we sort stocks according to the *relative* NAV discount of stock *i* with respect to the average NAV discount of country j in a given month *t*:

$$Relative\ NAV\ Spread_{i,j,t} = NAV\ Spread_{i,j,t} - \ Average\ Country\ NAV\ Spread_{j,t} \quad (2)$$

We sort the sample based on month-end data and construct three ranking portfolios. Then we observe the total returns of the portfolios as reported by Datastream over the following month. The quintile with the highest discount to NAV forms the value portfolio (P1), the middle portfolio (P2) and the quintile of stocks with the highest NAV premiums the growth portfolio (P3). All portfolios are equally weighted. We do not consider value-weighted returns as our sample size is relatively small, and value-weighting would put non-essential emphasis on the performance of individual stocks. To ensure that the results are not biased by exchange rate fluctuations, all returns are denominated in local currencies. Note, that in contrast to the majority existing asset pricing studies, we follow a monthly sorting procedure, based on

[2] Which is defined as "the ownership, trading and development of income-producing real estate

[3] http://www.epra.com/research-and-indices/indices/

Datastream's *"Earnings per share report date (EPS)."* We can thus ensure that financial reporting data are actually published as new portfolios are formed. For example, if the annual report for calendar year 2014 is published in April 2015, Datastream will report a new book value of equity from December 2014 onward, but we can shift this information by four months using the "Earnings per share report date." Financial reporting frequency is generally semiannual and may even be quarterly. Thus, NAVs may only change semiannually, but we observe monthly changes in the book-to-market ratios due to share price fluctuations.

3.3 Interest Rate Proxies

Our panel analysis approach allows to consider interest rate sensitivities on individual stock level. Accordingly, the five interest rate proxies are derived for each of the 24 countries in every month of our panel in the 2000:03 to 2014:05 period. With regard to the selection of appropriate proxies we follow previous research on interest rate sensitivities (e.g. He et al 2003, Hahn and Lee 2006 or Allen et al 2000, Jensen and Mercer 2002).

STIR is represented by the 1-year deposit rate in each individual country, *LTIR* by the 10-year government bond yield, *CBY* by the redemption yield of quality (investment grade) corporate bonds; *MPR* is represented by the base interest rate of a country's associated central bank. Following Hahn and Lee 2006 and He et al 2003, the default spread (DEF) and term spread (TERM) of country j in month t are derived as follows:

$$DEF_{j,t} = CBY_{j,t} - LTIR_{j,t} \quad (3)$$

$$TERM_{j,t} = LTIR_{j,t} - STIR_{j,t} \quad (4)$$

The sources of the interest rate proxies are Datastream, Morningstar and publicly accessible databases like FRED (Federal Reserve Economic Data) of the St. Louis FED or the Statistical Data Warehouse of the European Central Bank.

3.4 Summary Statistics

Table 1 contains some summary statistics on returns and (relative) NAV Spreads for our global sample over the 2000:03 to 2014:05 period. The table includes subpanels for the statistics of the three portfolios value, middle and growth (Panel A-C). Panel D includes the summary statistics for the total sample and the five interest rate proxies. On average monthly return of value stocks (1.44%) is notably higher than the average return of growth stocks (0.80%) indicating a value premium. However, the standard deviation reveals that value stocks are riskier than growth stocks, which is in line with previous research (e.g. Rosenberg et al. 1985). On average, the total sample performed on average by 1.07% per month (13.60% p.a.). The total sample traded at an average discount to relative NAV of -0.03.

The summary statistics of the five interest rate proxies are in line with economic intuition. On average, long-term interest rates are higher than short-term rates by 0.08% per month. Although, long-term rates have the least risk as measured by monthly volatility. Corporate bonds outperform both, the short and the long-term interest rate, however the corporate bond yield is also associated with the highest risk. Table 2 contains the contemporaneous correlation coefficients of returns, relative NAV Spreads and the five interest rate proxies.

4 Methodology: Modelling the Interest Rate Sensitivity of Value and Growth Stocks

To determine the interest rate sensitivity of the returns of value and growth stocks, we run the following regression model for the three portfolios, which are constructed according their relative NAV spread. In order to control for different behavior of interest rate changes on the three portfolios we follow Jensen and Mercer (2002) and include three interaction terms:

$$\begin{aligned} R_{i,t} - RF_{i,t} &= \alpha_i + \beta_1 \Delta IR_{i,t} + \beta_2 [RM_{i,t} - RF_{i,t}] + \beta_3 SMB_{i,t} + \beta_4 HML_{i,t} + \beta_5 WML_{i,t} + \\ &\beta_6 (D\_Value_{i,t} * \Delta IR_{i,t}) + \beta_7 (D\_Mid_{i,t} * \Delta IR_{i,t}) + \beta_8 (D\_Growth_{i,t} * \Delta IR_{i,t}) + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where $R_{it} - RF_{it}$ is the total return of the global value, middle, or growth portfolio in month t in excess of the one-month risk-free rate. ΔIR_{it} is the first difference of the respective interest rate in month t, *STIR, LTIR, CBY, DEF, or TER.* $RM_{i,t} - RF_{i,t}$ is the market return in excess of the risk-free rate; $SMB_{i,t}$ is the size factor; $HML_{i,t}$ is the book-to-market factor and $WML_{i,t}$, the momentum factor. D_Value, D_Mid, D_Growth represent dummy variables taking the value 1 if a stock is associated to in the respective portfolio in month t. $(D\_Value * \Delta IR_{i,t})$ is the interaction term for the value portfolio and the respective interest rate proxy.

We obtain the four risk factors from Kenneth French's website.[4] French's data library provides regional factors in USD for "Asia Pacific ex Japan," "Europe," "Japan," and "North America," so we convert the regional USD returns into local currency returns for the respective countries. RM, SMB, HML and WML are not limited to the subsector of listed real estate. We do so to reflect the original rationale of the Carhart four-factor model, which implies that the risk factors are marketwide and are not industry-specific proxies for not diversifiable factor risk. As we follow an international approach, it seems straightforward to use global RM, SMB, HML and WML factors.

To test Hypotheses 1-3 we also directly control differences in regarding the interest rate sensitivity of value and growth stocks by reducing the entire sample to value and growth stocks and performing the following panel regression model:

$$\begin{aligned} R_{i,t} - RF_{i,t} &= \alpha_i + \beta_1 \Delta IR_{i,t} + \beta_2 [RM_{i,t} - RF_{i,t}] + \beta_3 SMB_{i,t} + \beta_4 HML_{i,t} + \beta_5 WML_{i,t} + \\ &\beta_6 (D\_Value_{i,t} * \Delta IR_{i,t}) + \varepsilon_{i,t} \end{aligned} \tag{6}$$

The sign and significance of the coefficient β_6 in equation (6) indicates whether value stocks are more or less sensitive than growth stock to changes of the five interest rate proxies. We use panel regressions with fixed effects to empirically test our hypotheses.

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[4] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/datalibrary.html

5 Empirical Results

Tables 3 to 7 contain the regression results for our five interest rate proxies (STIR, LTIR, CBY, DEF, and TERM), which are used to test our Hypotheses 1 to 3. The tables are structured as follows: Model (1) is the base model, which estimates the general impact of the respective interest rate proxy. The following three models extend the base model by interaction terms for the value (model 2), middle (model 3), and growth portfolio (model 4). Model (5) simultaneously includes interaction terms for all three portfolios. Finally, model (6), directly test between differences in the interest rate sensitivity of value and growth stocks, by excluding the middle portfolio. Hence, our empirical evidence is based on the interaction term between the respective interest rate proxy and the value indicator variable.

Table 3 contains the results for short-term interest rates (STIR). Model (1) shows, as expected, that the returns of real estate stocks are negatively related to changes in the short term interest rate in general. In model (2) the coefficient for the value portfolio interaction term is negative and significant at the 1% level. This result indicates that value stocks are more sensitive and negatively related to changes of STIR than stocks being in the middle and growth portfolio. After including the three portfolio interaction terms and the referred dummy variables, the results of the aggregate model (5) reveals that value stocks are associated with a more negative coefficient (-5.38) than growth stocks (-3.37).

To which extent are value stocks more sensitive to an increase in STIR? The regression results in model (6) are based on a reduced sample, which merely consists of stocks in the value and growth portfolio. Thus, the coefficient for the interaction term of the value portfolio reveals the return difference between value and growth. For the interaction term between value and STIR the coefficient is -2.24 and significant at the 1% level. That is, in the event of an increase of ΔSTIR by 100 basis points, the decrease of return for value stocks is on average by -2.24 pps larger than for growth stocks (ceteris paribus).

In summary, the Table 3 results are consistent with Hypothesis 2, i.e. the risk-adjusted returns of value stocks are more sensitive to changes of the short term rates than growth stocks.

Table 4 contains the regression results for long-term interest rates (LTIR). The related Hypothesis 2 states that the risk-adjusted returns of growth stocks are more sensitive to long-term interest rates changes, than those of value stocks. The regression results shown in Table 4 differ considerably from those in Table 3, which is consistent with hypotheses 1 and 2, which predict diverging interest rate sensitivities for value and growth stocks depending on the chosen interest rate. In model (2) the coefficient for the value portfolio interaction term is positive and significant at the 1% level. In contrast, models (3) and (4) reveal that the middle and growth portfolio are more sensitive to changes in the long term rate, i.e. when the long term rate increases, the returns of these stocks tend to fall more than those of value stocks. The results shown in model (6) are consistent with hypothesis 2. The interaction term between value and LTIR is positive (3.04) and significant at the 1% level. That is, in the event of an increase of ΔLTIR by 100 basis points, the decrease of return for value stocks is on average by 3.04 pps smaller than for growth stocks (ceteris paribus).

Table 5 reports the results for changes of the term spread (TERM). Overall, the results are in line with the Table 4 results. Value stocks are associated with a positive coefficient (2.07) while the coefficient for growth stocks is negative (-1.57). This result is in line with Hahn and Lee (2006) who report a (positive) loading for value stocks to changes of the term spread. Model (6) shows that the coefficient of the interaction term between value and ΔTERM is positive (3.54) and significant at the 1% level. That is, in the event of an increase of ΔTERM by 100 basis points, the decrease of return for value stocks is on average by 3.45 pps smaller than for growth stocks (ceteris paribus).

Table 6 contains the regression results for the corporate bond yield. The comparison of the marginal interest rate sensitivities in models (2) to (4) suggests that value stocks suffer the most when the corporate bond yield increases. This result is supported by model (6). The interaction term of value and CBY in model (6), reveals that the difference in return sensitivities between value and growth is -3.54 and significant at the 1% level. That is, in the event of an increase of ΔCBY by 100 basis points, the decrease of return for value stocks is on average by -3.54 pps larger than for growth stocks (ceteris paribus). This finding is consistent with hypothesis 3 and may be explained by the fact that value stocks tend to be higher leveraged than growth stocks and thus more prone to increasing cost for bond financing.

Table 7 contains the results for default spread (DEF) which are similar to CBY. However, results of the model (6) regression reveal that the return difference for changes of ΔDEF is even larger (-4.19) and significant at the 1% level than for ΔCBY. Hahn and Lee (2006) argue that an increasing default spread (DEF) is commonly interpreted as an indicator for *"the market's expectation of worsening credit market conditions"*. Thus, the results confirm our Hypothesis 3 that increasing corporate bond yields and default spread cause an increase of the cost of debt. Thus, the increase has a stronger negative impact on the corporate performance (corporate level) and as a result the returns of value stocks.

6 Conclusion

The aim of this study was to examine the diverging interest rate sensitivities of value and growth stocks. Using a global sample of real estate stocks and five interest rate proxies, we provide new insights into the relationship between interest rate changes and the returns of stocks with fundamentally different characteristics. In particular, the following results stand out:

First, value stocks are more sensitive to changes of short term interest rates. Due to their low ratio of price-to-fundamental value, value stocks promise higher initial yields than growth stocks. When short term interest rates rise, income-oriented investors tend to remove their funds from risky assets and reinvest in the meanwhile higher-yielding risk-free rate.

Second, growth stocks are more sensitive to changes in the long term rate. This is consistent with the future cash flows of growth REITs being discounted at a higher rate. In contrast, the more front-loaded cash flows of value REITs are less strongly affected by higher discount rates.

Third, value stocks are more sensitive to changes in the corporate bond yield. Credit costs have a direct impact on a firm’s cost of capital. Since value stocks tend to use more leverage, they are also more than proportionally affected by higher bond rates compared to growth stock.

Furthermore, our results support the "macroeconomic risk story", which states the value premium anomaly is related to value stocks having larger interest rate risk than growth stocks (Lioui and Maio, 2014).

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Tables

Table 1: Summary Statistics of Value, Middle and Growth Portfolios

	Mean	Std. Deviation	Min	Max
Panel A: Value Portfolio				
Total Return	1.44	11.74	-79.80	236.42
Rel. NAV Spread	-2.80	7.69	-72.36	4.73
Panel B: Middle Portfolio				
Total Return	1.04	9.68	-97.90	343.07
Rel. NAV Spread	-0.40	1.75	-54.80	11.46
Panel C: Growth Portfolio				
Total Return	0.80	8.84	-60.50	65.75
Rel. NAV Spread	3.65	40.69	-54.72	1773.61
Panel D: Total Sample				
Total Return	1.07	9.96	-97.90	343.07
Rel. NAV Spread	-0.03	18.96	-72.36	1773.61
STIR	0.21	0.15	-0.00	0.74
LTIR	0.29	0.11	0.04	1.29
CBY	0.41	0.19	0.04	1.97
DEF	0.13	0.17	-1.08	1.73
TERM	0.08	0.10	-0.25	1.15

This table contains the summary statistics of total returns, relative NAV spreads and interest rate proxies for the global sample of listed real estate stocks in the 2000:03 to 2014:05 period. All statistics are in monthly frequency and %. Panel A contains the data for the sample of value stocks; Panel B the sample of the middle portfolio and Panel C the sample of growth stocks.

Table 2: Correlation of returns, relative NAV spreads and interest rate proxies

	TR	Rel. NAVS	STIR	LTIR	CBY	DEF	TERM
Panel A: Contemporaneous correlations							
TR	1.00						
Rel. NAVS Spread_t	0.00	1.00					
STIR	-0.08***	-0.00	1.00				
LTIR	-0.03***	-0.00	0.78***	1.00			
CBY	-0.06***	-0.00	0.43***	0.45***	1.00		
DEF	-0.05***	-0.00	-0.01	-0.11***	0.84***	1.00	
TERM	0.09***	0.00	-0.69***	-0.09***	-0.16***	-0.12***	1.00
Panel B: Lagged correlations							
Total Return_t-1	0.04***	0.01	-0.06***	0.00	-0.09***	-0.10***	0.10***
Rel. NAV Spread_t-1	0.00	0.84***	-0.00	-0.00	-0.00	-0.00	-0.00
STIR_t-1	-0.08***	0.00	0.99***	0.77***	0.44***	0.02***	-0.69***
LTIR_t-1	-0.04***	0.00	0.79***	0.99***	0.45***	-0.10***	-0.11***
CBY_t-1	-0.00	0.00	0.40***	0.44***	0.97***	0.81***	-0.13***
DEF_t-1	0.02***	0.00	-0.04***	-0.12***	0.80***	0.96***	-0.08***
TERM_t-1	0.09***	0.00	-0.67***	-0.10***	-0.18***	-0.15***	0.97***

Table 3: Short-term interest rate (STIR) sensitivity of value stocks and growth stocks

	(1)	(2)	(3)	(4)	(5)	(6)
d_STIR_i,t	-0.59**	-0.18	-0.98***	-0.73***	3.33*	0.15
	(-3.13)	(-0.85)	(-3.40)	(-3.48)	(2.05)	(0.34)
d_STIR*D.Value_i,t		-1.87***			-5.38**	-2.24***
		(-4.13)			(-3.22)	(-3.75)
d_STIR*D.Mid_i,t			0.67		-3.64*	
			(1.78)		(-2.22)	
d_STIR*D.Growth_i,t				0.69	-3.37*	
				(1.46)	(-2.01)	
D.Value(P1)_i,t		0.01***			-0.00	0.01***
		(4.41)			(-0.32)	(4.47)
D.Mid(P2)_i,t			0.00*		-0.01	
			(2.08)		(-1.76)	
D.Growth(P3)_i,t				-0.01***	-0.02***	
				(-7.19)	(-3.95)	
RM_i,t	0.90***	0.90***	0.90***	0.90***	0.90***	0.99***
	(89.62)	(89.74)	(89.65)	(89.68)	(89.75)	(58.99)
SMB_i,t	-0.13***	-0.13***	-0.12***	-0.13***	-0.13***	-0.03
	(-7.90)	(-7.91)	(-7.89)	(-8.03)	(-7.92)	(-1.17)
HML_i,t	0.34***	0.34***	0.34***	0.34***	0.34***	0.51***
	(21.06)	(20.91)	(21.11)	(21.13)	(20.79)	(19.14)
WML_i,t,	-0.26***	-0.26***	-0.26***	-0.26***	-0.26***	-0.30***
	(-24.56)	(-24.39)	(-24.49)	(-24.61)	(-24.44)	(-18.04)
Constant	0.00***	0.00***	0.00**	0.01***	0.01**	-0.00*
	(8.72)	(4.79)	(3.18)	(11.24)	(2.95)	(-2.40)
Observations	35221	35221	35221	35221	35221	14520
Adjusted R^2	0.231	0.232	0.231	0.232	0.233	0.238

This table contains the regression results in terms of the return sensitivity of value and growth stocks to monthly changes of short-term interest rates (STIR). The dependent variable is the monthly total return in excess of the risk-free rate of 487 global listed real estate stocks in the 2000:03 to 2014:05 period. P1 represents the value portfolio, P2 the middle portfolio and P3 the growth portfolio constructed according to NAV spread in the previous month. The interest rate sensitivity of value and growth stocks is measured by interacting the monthly changes of STIR with the respective dummy variable for each portfolio. Models (1) to (5) are estimated based on the full sample while model (6) is estimated based on a sample reduced to P1 and P3 in order to control for the direct relationship between value and growth stocks. RM, SMB, HML and WML represent the four-factor-model control variables. The models are

Table 4: Long-term interest rate (LTIR) sensitivity of value stocks and growth stocks

	(1)	(2)	(3)	(4)	(5)	(6)
d_LTIR_i,t	-2.72***	-3.48***	-1.88***	-2.39***	2.45	-4.03***
	(-12.96)	(-14.53)	(-6.30)	(-10.19)	(1.54)	(-8.97)
d_LTIR*D.Value_i,t		3.11***			-2.83	3.04***
		(6.67)			(-1.71)	(4.98)
d_LTIR*D.Mid_i,t			-1.62***		-5.94***	
			(-4.00)		(-3.66)	
d_LTIR*D.Growth_i,t				-1.53**	-6.37***	
				(-3.08)	(-3.85)	
D.Value(P1)_i,t		0.01***			0.00	0.01***
		(4.86)			(0.21)	(4.84)
D.Mid(P2)_i,t			0.00		-0.01	
			(1.87)		(-1.40)	
D.Growth(P3)_i,t				-0.01***	-0.02***	
				(-7.35)	(-3.65)	
RM_i,t	0.93***	0.93***	0.93***	0.93***	0.93***	1.01***
	(90.54)	(90.65)	(90.60)	(90.59)	(90.67)	(59.23)
SMB_i,t	-0.10***	-0.10***	-0.10***	-0.10***	-0.10***	-0.01
	(-6.19)	(-6.49)	(-6.24)	(-6.33)	(-6.51)	(-0.27)
HML_i,t	0.33***	0.33***	0.33***	0.33***	0.33***	0.51***
	(20.66)	(20.56)	(20.63)	(20.73)	(20.43)	(19.31)
WML_i,t,	-0.27***	-0.27***	-0.27***	-0.27***	-0.27***	-0.31***
	(-25.62)	(-25.41)	(-25.63)	(-25.62)	(-25.55)	(-18.74)
Constant	0.00***	0.00***	0.00**	0.01***	0.01*	-0.00**
	(7.93)	(3.84)	(2.91)	(10.67)	(2.48)	(-3.00)
Observations	35221	35221	35221	35221	35221	14520
Adjusted R^2	0.234	0.236	0.235	0.236	0.237	0.241

This table contains the regression results in terms of the return sensitivity of value and growth stocks to monthly changes of long-term interest rates (LTIR). The dependent variable is the monthly total return in excess of the risk-free rate of 487 global listed real estate stocks in the 2000:03 to 2014:05 period. P1 represents the value portfolio, P2 the middle portfolio and P3 the growth portfolio constructed according to NAV spread in the previous month. The interest rate sensitivity of value and growth stocks is measured by interacting the monthly changes of LTIR with the respective dummy variable for each portfolio. Models (1) to (5) are estimated based on the full sample while model (6) is estimated based on a sample reduced to P1 and P3 in order to control for the direct relationship between value and growth stocks. RM, SMB, HML and WML represent the four-factor-model control variables. The models are estimated using panel regressions with effects. t statistics are in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 5: Term Spread (TERM) sensitivity of value stocks and growth stocks

	(1)	(2)	(3)	(4)	(5)	(6)
d_TERM_i,t	-1.18***	-1.86***	-0.49*	-0.87***	-0.71	-2.52***
	(-7.29)	(-10.22)	(-2.01)	(-4.77)	(-0.53)	(-7.18)
d_TERM*D.Value_i,t		3.22***			2.07	3.45***
		(8.28)			(1.49)	(6.91)
d_TERM*D.Mid_i,t			-1.24***		-1.00	
			(-3.87)		(-0.73)	
d_TERM*D.Growth_i,t				-1.42***	-1.57	
				(-3.66)	(-1.13)	
D.Value(P1)_i,t		0.01***			0.00	0.01***
		(4.62)			(0.08)	(4.58)
D.Mid(P2)_i,t			0.00		-0.01	
			(1.95)		(-1.45)	
D.Growth(P3)_i,t				-0.01***	-0.02***	
				(-7.19)	(-3.66)	
RM_i,t	0.91***	0.91***	0.91***	0.91***	0.91***	0.99***
	(89.97)	(90.23)	(90.03)	(90.05)	(90.23)	(59.15)
SMB_i,t	-0.11***	-0.11***	-0.11***	-0.11***	-0.12***	-0.02
	(-6.77)	(-7.07)	(-6.85)	(-6.92)	(-7.27)	(-0.69)
HML_i,t	0.35***	0.34***	0.35***	0.35***	0.35***	0.52***
	(21.59)	(21.47)	(21.65)	(21.65)	(21.61)	(19.54)
WML_i,t,	-0.27***	-0.27***	-0.27***	-0.27***	-0.27***	-0.31***
	(-25.44)	(-24.89)	(-25.29)	(-25.44)	(-24.90)	(-18.31)
Constant	0.00***	0.00***	0.00***	0.01***	0.01**	-0.00*
	(8.82)	(4.75)	(3.34)	(11.34)	(2.63)	(-2.42)
Observations	35221	35221	35221	35221	35221	14520
Adjusted R^2	0.232	0.234	0.232	0.233	0.235	0.239

This table contains the regression results in terms of the return sensitivity of value and growth stocks to monthly changes of the Term Spread (TERM). The dependent variable is the monthly total return in excess of the risk-free rate of 487 global listed real estate stocks in the 2000:03 to 2014:05 period. P1 represents the value portfolio, P2 the middle portfolio and P3 the growth portfolio constructed according to NAV spread in the previous month. The interest rate sensitivity of value and growth stocks is measured by interacting the monthly changes of TERM with the respective dummy variable for each portfolio. Models (1) to (5) are estimated based on the full sample while model (6) is estimated based on a sample reduced to P1 and P3 in order to control for the direct relationship between value and growth stocks. RM, SMB, HML and WML represent the four-factor-model control variables. The models are estimated using panel regressions with effects. t statistics are in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 6: Corporate Bond Yield (CBY) sensitivity of value stocks and growth stocks

	(1)	(2)	(3)	(4)	(5)	(6)
d_CBY_i,t	-1.81^{***}	-1.62^{***}	-1.68^{***}	-2.04^{***}	0.51	-0.76^{***}
	(-23.99)	(-20.88)	(-12.44)	(-24.33)	(0.88)	(-4.62)
d_CBY*D.Value_i,t		-2.79^{***}			-4.92^{***}	-3.54^{***}
		(-9.74)			(-7.74)	(-10.70)
d_CBY*D.Mid_i,t			-0.18		-2.38^{***}	
			(-1.16)		(-4.11)	
d_CBY*D.Growth_i,t				1.10^{***}	-1.46^{*}	
				(6.20)	(-2.46)	
D.Value(P1)_i,t		0.01^{***}			-0.00	0.01^{***}
		(3.50)			(-0.67)	(3.93)
D.Mid(P2)_i,t			0.00^{*}		-0.01	
			(2.23)		(-1.82)	
D.Growth(P3)_i,t				-0.01^{***}	-0.02^{***}	
				(-7.21)	(-4.06)	
RM_i,t	0.84^{***}	0.84^{***}	0.84^{***}	0.84^{***}	0.84^{***}	0.94^{***}
	(81.68)	(81.82)	(81.69)	(81.83)	(81.81)	(55.36)
SMB_i,t	-0.10^{***}	-0.11^{***}	-0.10^{***}	-0.10^{***}	-0.11^{***}	-0.01
	(-6.63)	(-6.82)	(-6.57)	(-6.68)	(-6.87)	(-0.45)
HML_i,t	0.37^{***}	0.36^{***}	0.37^{***}	0.37^{***}	0.36^{***}	0.52^{***}
	(23.26)	(22.86)	(23.30)	(23.42)	(22.89)	(19.69)
WML_i,t,	-0.25^{***}	-0.24^{***}	-0.25^{***}	-0.25^{***}	-0.24^{***}	-0.28^{***}
	(-23.26)	(-22.55)	(-23.31)	(-23.29)	(-22.63)	(-16.40)
Constant	0.00^{***}	0.00^{***}	0.00^{**}	0.01^{***}	0.01^{**}	-0.00^{*}
	(8.41)	(4.80)	(2.90)	(10.98)	(3.03)	(-2.22)
Observations	35221	35221	35221	35221	35221	14520
Adjusted R^2	0.243	0.246	0.243	0.245	0.248	0.249

This table contains the regression results in terms of the return sensitivity of value and growth stocks to monthly changes of corporate bond yields (CBY). The dependent variable is the monthly total return in excess of the risk-free rate of 487 global listed real estate stocks in the 2000:03 to 2014:05 period. P1 represents the value portfolio, P2 the middle portfolio and P3 the growth portfolio constructed according to NAV spread in the previous month. The interest rate sensitivity of value and growth stocks is measured by interacting the monthly changes of CBY with the respective dummy variable for each portfolio. Models (1) to (5) are estimated based on the full sample while model (6) is estimated based on a sample reduced to P1 and P3 in order to control for the direct relationship between value and growth stocks. RM, SMB, HML and WML represent the four-factor-model control variables. The models are estimated using panel regressions with effects. t statistics are in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 7: Default Spread (DEF) sensitivity of value stocks and growth stocks

	(1)	(2)	(3)	(4)	(5)	(6)
d_DEF_i,t	-1.47***	-1.29***	-1.39***	-1.73***	0.21	-0.35*
	(-19.32)	(-16.67)	(-10.15)	(-20.59)	(0.36)	(-2.15)
d_DEF*D.Value_i,t		-3.64***			-5.14***	-4.19***
		(-12.27)			(-8.08)	(-12.21)
d_DEF*D.Mid_i,t			-0.12		-1.75**	
			(-0.78)		(-3.06)	
d_DEF*D.Growth_i,t				1.24***	-0.75	
				(7.16)	(-1.28)	
D.Value(P1)_i,t		0.01***			-0.00	0.01***
		(3.93)			(-0.62)	(4.20)
D.Mid(P2)_i,t			0.00*		-0.01	
			(2.12)		(-1.94)	
D.Growth(P3)_i,t				-0.01***	-0.02***	
				(-7.32)	(-4.19)	
RM_i,t	0.84***	0.83***	0.84***	0.84***	0.83***	0.92***
	(79.32)	(78.49)	(79.28)	(79.48)	(78.53)	(52.07)
SMB_i,t	-0.12***	-0.13***	-0.12***	-0.12***	-0.14***	-0.05
	(-7.68)	(-8.56)	(-7.61)	(-7.73)	(-8.63)	(-1.89)
HML_i,t	0.37***	0.37***	0.37***	0.37***	0.37***	0.53***
	(23.23)	(23.03)	(23.26)	(23.40)	(23.19)	(19.94)
WML_i,t,	-0.25***	-0.23***	-0.25***	-0.25***	-0.23***	-0.26***
	(-23.03)	(-21.54)	(-23.06)	(-23.03)	(-21.55)	(-15.38)
Constant	0.00***	0.00***	0.00***	0.01***	0.01**	-0.00*
	(9.02)	(5.14)	(3.33)	(11.55)	(3.19)	(-2.12)
Observations	35221	35221	35221	35221	35221	14520
Adjusted R^2	0.239	0.243	0.239	0.241	0.244	0.247

This table contains the regression results in terms of the return sensitivity of value and growth stocks to monthly changes of the Default Spread (DEF). The dependent variable is the monthly total return in excess of the risk-free rate of 487 global listed real estate stocks in the 2000:03 to 2014:05 period. P1 represents the value portfolio, P2 the middle portfolio and P3 the growth portfolio constructed according to NAV spread in the previous month. The interest rate sensitivity of value and growth stocks is measured by interacting the monthly changes of DEF with the respective dummy variable for each portfolio. Models (1) to (5) are estimated based on the full sample while model (6) is estimated based on a sample reduced to P1 and P3 in order to control for the direct relationship between value and growth stocks. RM, SMB, HML and WML represent the four-factor-model control variables. The models are estimated using panel regressions with effects. t statistics are in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Understanding real estate markets with big data – liquidity and rental co-movements in Germany

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ABSTRACT:

Market liquidity conditions and rental growth are said to match along "hot" and "cold" market cycles over time. Substantial deviations from these phases explain either overrented or underrented expectations by landlords or an essential change in tenants' housing demand. While the assessment of housing markets by central banks, governments, institutional brokers and private households focus nowadays primarily on price indices, a general liquidity indicator and its potential co-movements along the residential cycle is missing. This paper develops a theoretical model and empirically explores a new form of market equilibrium in which liquidity and rental indices determine residential market cycles. The results with big data capture the development of 250 German residential markets accurately and show that markets do develop across cycles over time, but not always along the "hot" or "cold" phases as described by Krainer, 1999. The paper also explores the results spatially across the strong segmented German rental housing market.

KEYWORDS: German housing; liquidity; survival regression, GAMLSS; K-means cluster.

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Understanding real estate markets with big data – liquidity and rental co-movements in Germany

1. Introduction

A common understanding of the current liquidity conditions in real estate markets is essential for institutional investors when transacting property portfolios as well as for single persons when buying or selling property. In contrast to other investment asset classes such as stocks, bonds, derivatives or fixed income, the concept of liquidity in the real estate industry is highly different as real estate assets are per se heterogeneous and illiquid goods. High due diligence costs are necessary in order to execute deals, which at the same time require relative long time from the property search until fully hand over to the buyer. Several papers have explored liquidity of direct real estate throughout the last decades with an especial focus on market- and property-specific factors affecting assets' time-on-market. There exists for example a strong consensus among research that the initial asking price of an asset plays an essential role in the time it takes to sale it and that "overpriced" assets tend to be subject to price reviews after a certain market exposure (Allen et al., 2009; Anglin et al., 2003; Hoeberichts et al., 2013 and Cirman et al., 2015). Further research shows that asset liquidity responds to macroeconomic and sociodemographic factors, such as households' income or interest rates levels (Kalra and Chan 1994; Krainer 1999; Leung et al. 2002; Hui and Yu 2012 and Cirman et al. 2015). As a result, the assessment of market liquidity conditions remains crucial, but at the same time essential for determining potential imbalances and especially in order to take advantages when transacting real estate.

Liquidity in the real estate industry has been initially examined by the papers of Zuehlke, 1987; Haurin, 1988; Frew et al., 1990; and by Kluger and Miller, 1990. They provide primarily a logic introduction on how to construct an econometric model to explain how covariates affect the time it takes to sale or let a property. Further studies by built upon these results and expand both the econometric modelling via advanced survival regressions and additional factors in explaining the liquidity of, mostly, residential assets. However, while these results show that real estate liquidity depends on dwelling-, market- and spatial-specific factors, a general real estate market “liquidity-price-momentum” indicator remains vague. Real estate price indices in contrast are common indicators used by central banks, governments or institutional brokers in order to assess the price or rental development within a certain market or country. However, a standardized indicator that proxies the current market liquidity and rental conditions in a certain real estate market is – to my knowledge – not existent, which leads to my research question.

In this paper, I derive a market model and propose a general indicator that measures the relative liquidity level in residential markets relative to the rental development over time. Based on the assumption that prices and liquidity match throughout the residential cycle, I test the dynamic behaviour and potential frictions between liquidity and rents with big data in German residential rental markets. My results built upon the hypothesis that the residential price index does reflect in fact general market conditions but that a residential liquidity indicator is essential in assessing possible market movements, especially when supply is unelastic in the short-term. Based upon theoretical assumptions about the dynamics between rents and liquidity indices, I confirm indeed harmonized co-movements between liquidity and rents, but also latent divergences across some markets that may point to an inconsistent development in their fundamental market drivers.

Real estate liquidity is an extensively investigated research topic. A liquid real estate market is said to exist whenever a relative large number of sellers can offer a relative large number of assets which in turn can be found and transacted by a relative large number of buyers within a reasonable time. Based upon this simple definition, three main aspects play a role for a common understanding of the liquidity concept: the market constraints, the searching costs and agents’ utility function. The market constraints refer to the physical, legal and spatial hurdles that difficult the marketability of real estate before an asset is handed over to the buyer. Real estate – as an illiquid asset – is characterized by extensive searching periods and high transaction costs. When focusing on residential markets, the asking price that landlords initially set for properties is generally a function of dwellings’ characteristics, its location and finally dependent on the “taste” of potential tenants. Varying utility functions by landlords and tenants limit during this process the smooth transfer of real estate. The different price signals during the decision-making process are further affected by asymmetric information since landlords usually know more about the asset as tenants, making the asset transfer even more difficult. Real estate liquidity can be therefore described as the process from the decision to sell/let a property, the corresponding price discovery between the parties and until the fully handover of the asset to the byer/tenant, see Kluger and Miller 1990. Consequently, highly liquid rental residential markets are said to exist when the letting process of dwellings is quick, relative to a certain benchmark. In statistical a jargon: liquidity is the inverse of the time elapsed until letting a dwelling after controlling for property-, spatial- and market-specific exogenous factors.

Common literature on direct real estate proxies liquidity by the time-on-market (ToM) of dwellings within a certain market via survival regressions. This approach explains in simple words the elapse of time $\Delta\tilde{t}$ it takes to let a dwelling i in dependence of X_i hedonic characteristics as well of j local and urban particularities Z_j during the observation period $\widetilde{T}$. The approach – formally expressed as the hazard function h of $\Delta\tilde{t}_i$ given X_i and Z_j – has seen a series of improvements during the last decades either regarding the econometric handling of the variable $\Delta\tilde{t}$ or the consideration of further aspects such as Haurin’s degree of atypicality or the market-specific degree of overpricing (see: Krainer 1999; Anglin et al. 2003; Bourassa et al. 2009; Haurin et al. 2010, 2013 and Hoeberichts et al. 2013). While the accuracy of survival models has significantly increased over the last decade, such a model is correspondingly useful when trying to conceptualize a general liquidity indicator. The residential liquidity index is expected to measure the current market balance between landlords and tenants when letting property after controlling for current local factors. Furthermore, it would serve as an indicator for future trends whenever significant discrepancies are to observe with respect to the rental index.

Kluger and Miller 1990 made a first attempt to develop such a residential liquidity index. They argued that liquidity in a residential market corresponds to the empirical hazard rate of a dwelling to leave (or “die”) the market after controlling for X_i and Z_j. In simple words, liquidity is defined as the empirically mortality rate of any dwelling in the sample relative to a hedonic benchmark at every point in time. The notion behind Kluger and Miller 1990 is simple. They compare the mortality rate between dwellings offered in summer and winter and conclude that dwellings “die” quicker in winter than in summer. In contrast, Fisher et al. developed an econometric model that accounts for liquidity in commercial price indices based on the NCREIF data base. Their notion is also comprehensible as they proxy liquidity as the disturbances of hedonic regressions between sellers' and buyers' reservation prices and conclude that liquidity in commercial portfolios goes along with higher price movements across the market cycle, even after controlling for sample selection bias. While their approach is nowadays essential when estimating "constant-liquidity" price indices, non-randomly selected samples are scarce and therefore not directly replicable. In contrast, the liquidity index developed in this paper focusses on the mortality function of rental assets after controlling for current market conditions. Thus instead of focussing on the development of prices by sellers and buyers such as in Fisher et al., the proposed liquidity-price-momentum captures the current letting likelihood along the overall rental development.

The next section focuses on the statistical derivation and statistical inference of both the liquidity and rental indices. Afterwards, the theoretical intertemporal equilibrium between both measures is explained, before providing some descriptive facts. Next, the paper defines the econometric models and the methodology on capturing market liquidity-price-states. The results are presented afterwards providing the current state of the German residential markets in terms of liquidity and rental growth. The last part presents the lessons learned, possible steps to go and the overall conclusion.

2. Real estate rental and liquidity indices

2.1. *The rental market index*

The hedonic regression method enables the decomposition of heterogonous goods into multiple attributes as a bundle of features. The price of a dwelling i can be decomposed into a series of dwelling-inherent characteristics, such as the living space, number of rooms or bathrooms, age and non-dwelling-specific characteristics such as the location, noise level, criminality, availability of hospitals or metro stations, etc. within a respective boundary or ZIP area j. The compound value of a dwelling – formally denoted as the sum of the marginal price contributions – is further affected by the current demand and supply of dwellings in the market, whereas rents are expected to increase in markets with rising demand levels relative to the supply and vice versa. Formally, the hedonic regression decomposes the log rent R of a dwelling in observation period t in X and Z effects. The rent variation not explained by the model is set to be captured by the error term u, which follows a normal distribution.

$$\log(R_{ijt}) = X_{it}\beta + Z_{jt}\alpha + u_{ijt} \tag{1}$$

The hedonic model is further expanded by binary variables capturing the observed time periods $t \in \{t_0, \dots, t_T\}$ relative to a fixed time t_0 as follows:

$$\log(R_{ijt}) = X_{it}\beta + Z_{jt}\alpha + \mu_{it}\theta_t + u_{ijt}, \tag{2}$$

, whereas

$$\mu_{it} = \{1 \Leftrightarrow \text{i in t}; 0 \Leftrightarrow \text{else}\} \tag{3}$$.

After estimating the model, the rental index corresponds to the marginal change of R_{ijt} with respect to μ_{it} as follows:

$$\frac{\partial \log(R_{ijt})}{\partial \mu_{it}} = X_{it}\alpha + Z_{jt}\alpha + \frac{\partial \mu_{it=m}}{\partial \mu_{it=o}}\theta_t = \hat{\theta}_t \tag{4}$$

The rental index corresponds to the estimated $\hat{\theta}_t$ coefficients, which are transformed via $100 \cdot [\exp(\hat{\theta}_t) - 1]$ in a log-log parameterization, and correspond to the marginal change in rents in t_t relative to t_0. Equation 4 corresponds to a time dummy variable hedonic model. Further approaches such as the repeated sales, imputation, appraisal method, among others are of course appropriate, depending on the expected outcome and mainly on the data structure. For simplicity, I employ only a time dummy hedonic index, especially since the data is randomly-selected rather than observable at every point in time[i]. For a further detailed discussion on the different estimation hedonic approaches see: Eurostat 2013.

2.2. *The rental liquidity index*

Liquidity in the context of hedonic modelling is modelled via survival regressions, where the dependent variables is defined as the elapse of the time a dwelling is offered in the market (time-on-market ToM). More specifically, ToM decribes the elapse of time since the landlord puts the dwelling in the multiple listing service (MLS) until it exits the database. The survival regression explains in simple words the factors that boost or restrict the letting process of a dwelling as a probability function, e.g. after "5" days on market a dwelling will be let with a "90 %" probability after controlling for X and Z characteristics. Two main measures are important for understanding the modelling of survival models: the survival function S and the hazard rate function h. While the former estimates the probability of each observation of surviving the event in dependence of the time elapsed $\tilde{t} \in \{\tilde{t}_0, \dots, \tilde{t}_{\tilde{T}}\}$, the former estimates the rate of occurrence per unit of time of an event $\Delta\tilde{t}$. Rather than estimating the marginal contribution of each covariate with respect to the elapsed time $\Delta\tilde{t}_i$ of dwelling i, the empirical survival function explains to which extent a covariate boosts or restricts the probability of a dwelling to "die", i.e. to be let. Both functions are formally expressed as:

$$S(\tilde{t}) = P(\tilde{T} > \tilde{t}) = 1 - \int_{\tilde{t}}^{\infty} f(x)dx \qquad (5)$$

$$h(\tilde{t}) = \frac{P(\tilde{t} < \tilde{T} \leq \tilde{t} + \Delta\tilde{t} | T > \tilde{t})}{\Delta\tilde{t}} \qquad (6)$$

While the survival function gives the probability that a dwelling survives until a certain time $\tilde{t}$, the hazard specifies the rate of failure at $\tilde{T} = \tilde{t}$ given that the flat survived up to time $\tilde{t}$. Since the numerator in equation 6 corresponds to a conditional probability and the denominator is a elapse of time $\Delta\tilde{t}$, the hazard function gives the probability or rate of "mortality" per units of time. The hedonic survival regression is denoted as:

$$h(\tilde{t}_{ijt}) = \exp(X_{it}\beta + Z_{jt}\alpha) + e_{ijt} \qquad (7)$$

whereas h corresponds to the hazard function of i as a function of X and Z. The error term e_{ijt} is iid. Just as in the rental case, the survival function can be expanded to control for time effects as follows:

$$h(\tilde{t}_{ijt}) = \exp(X_{it}\beta + Z_{jt}\alpha + \mu_{it}\delta_t) + e_{ijt} \qquad (7).$$

In this case, the marginal change with respect to μ_{it} in the survival function is captured by a multiplicative way by:

$$\frac{\partial h(t)}{\partial \mu_{it}} = \frac{\partial \exp(X_{ij}\beta) \cdot \exp(Z_{jt}\beta) \cdot \exp(\mu_{it_m}\delta_t)}{\partial \exp(X_{ij}\beta) \cdot \exp(Z_{jt}\beta) \cdot \exp(\mu_{it_0}\delta_t)} = \exp(\hat{\delta}_t) \qquad (8)$$

where the $100 \cdot \text{Exp}(\hat{\delta}_t)$ coefficients correspond to the marginal change in the survival risk of dwelling i in t_t relative to t_0. In other words, the coefficient $\hat{\delta}_{t=1}$ denotes the relative change in the survival of a dwelling i to leave the market, i.e. to be let, in t_1 relative to t_0. The interpretation of the coefficients are expresses as odds, e.g. a coefficient of $\exp(\hat{\delta}) = 1.2$ means a 1.2 times quicker "dead" as the reference. The construction of the liquidity index is therefore based on the estimated $\hat{\delta}_t$ coefficients from the empirical survival regression.

2.3. *Graphical derivation of rent and liquidity indices*

The rental and liquidity indices can be derived graphically. The left plot in Figure 1 shows the standard textbook hedonic rent regression of a market, whereas the right plot shows the standard survival market function $\widehat{S(\tilde{t})}_t$ in dependence of the observation period t and elapsed time $\tilde{t}$ herein.

---- Figure 1 ----

An increase in rents of average dwellings $\overline{X}_t$ from t_0 to t_1 leads to an upward shift of the regression line denoted as $\vec{a}$ and is numerically captured by the coefficient $\hat{\theta}$ in t_1, whereas a rent contraction from t_0 to t_2 is captured by $\vec{b}$. When looking at the survival function, the relationship is inverted. The base survival line $\widehat{S(\tilde{t})}_{t_0}$ represents the average probability of leaving the market in dependence of the elapsed time $\tilde{t}$ in the first observation period t_0. A downward shift $\vec{c}$ in the survival function $\widehat{S(\tilde{t})}_{t_1}$ from t_0 to t_1 leads to a faster mortality rate and consequently on a shorter time-on-market, for which reason the market liquidity level is said to rise by $\hat{\delta}$. In contrast, an upward shift $\vec{d}$ in the survival function to $\widehat{S(\tilde{t})}_{t_2}$ leads to longer time-on-market periods – the average dwelling "dies later" – which in turn worsen the market liquidity conditions. Therefore, higher market liquidity levels are expected with downward shifts in the survival function, and vice versa. The changes in the respective indices are summarized in Table 1:

---- Table 1 ----

2.4. *Intertemporal behaviour of rents and liquidity*

Following the seminal work of Kluger and Miller 1990, real estate liquidity and prices are positively correlated. More specifically, prices and liquidity match along the residential cycle. “Hot markets” are said to be characterized by rising real estate values, strong demand levels and consequently by high transactions, whereas in “cold markets” real estate values fall, the demand for dwellings is poor and transaction plunge. While these movements describe in fact an essential market equilibrium subject to some frictions, they might be generally captured by the rental and liquidity indices. Thus, a “hot” cycle is expected to lead to rising liquidity values, captured by $\hat{\delta}_t$,

and by rising rental levels captured by $\hat{\theta}_t$ and vice versa in the case of “cold” cycles. Although the terms “hot” or “cold” are not formally part of economic theory, the underlying relationship between real estate asset liquidity and real estate price development describes a dynamic movement between letting activities and rents[ii].

---- Figure 2 ----

The relationship between liquidity $\hat{\delta}_t$ and rents $\hat{\theta}_t$ and indices is expected to be initially positive. While hot and cold market cycles are evident – a hot market is expected to move upwards towards $\hat{\theta}_t$ and $\hat{\delta}_t$ and vice versa for cold markets –, the opposite cases represent some market frictions either in the demand for living space or in rental growth. The left plot in Figure 2 shows therefore the expected development path of $\hat{\theta}_t$ and $\hat{\delta}_t$ from A_{t_0} to $\overline{\overline{A}}_{t_m}$ when liquidity and rental development match within a hot residential cycle $m \in 1, \dots, T$. In contrast, a cold market development is captured by the path from A_{t_0} to $\overline{A}_{t_m}$. Market frictions might lead to an uneven development of $\hat{\theta}_t$ and $\hat{\delta}_t$ towards B_{t_0} to $\overline{\overline{B}}_{t_m}$ or B_{t_0} to $\overline{B}_{t_m}$. The former case implies that higher liquidity levels take place along a rental cycle with constrained rental growth, whereas in the latter case rental growth is supported by worsening liquidity levels. The movement towards $\overline{\overline{B}}_{t_m}$ illustrates consequently a market in which rents underreact to rising liquidity, leading to an “underrented” state. The $\overline{B}_{t_m}$ path explains in contrast an overreaction of rents which is not driven by rising liquidity, i.e. an “overrented” state.

3. Data description and stylized facts

3.1. *Data description*

The estimation sample comprises two merged databases. First, I gathered 1’801’587 observations of rental flats from multiple listing services (MLS) in Germany from 2013-Q1 until 2016-Q3 as collected by the Empirica Systems database (www.empirica-systeme.de), which contain the most important multiple listing service (MLS) providers such as Immoscout, Immonet and Immowelt as well as seven others. After filtering and deleting duplicates, the empirica system databank provides geographically referenced data with over 30 hedonic characteristics. In order to avoid a large drop in sample size due to missing binary hedonic attributes such as wooden floor, sauna or laminate floor, I only include 11 relevant hedonic characteristics. On the other hand, I merge two socioeconomic variables the purchasing power per household and number of households on a ZIP-code level from the GfK-databank (www.gfk.com). Furthermore, since the data is georeferenced, I calculate two spatial gravity indicators measuring the Euclidian distance of each dwelling to the geographical centroid to the ZIP and NUTS3 polygon in kilometres, where the latter accounts for the city centre. Both variables might control for the spatial distribution of dwellings within an urban area. Finally, I derive relevant variables in the context of survival regressions: dwellings’ atypicality and the degree of overpricing. The former is estimated based on Haurin’s definition of atypicality as the absolute deviation of the characteristic of each dwelling with respect to the marginal pricing of the average market characteristics, see Haurin (1988). The degree of overpricing is estimated as the residuum from the difference between the empirical estimated rents and the original asking rents resulting from an log-linear hedonic regression of R as a function of X and Z, see Rutherford et al. (2005) and Anglin et al. (2003). NUTS3 regions correspond to the “Nomenclature of territorial units for statistics”, which is a hierarchical system for dividing up the economic territory in Europe. While the NUTS1 consists on major socio-economic regions, the NUTS3 regions cover small regions similar to counties or administrative districts. (www.ec.europa.eu/eurostat/web/nuts/overview)

3.2. *Stylized facts on rents and liquidity*

Prior to describing the econometric models, I provide this section some stylized facts about the German residential market and the behaviour of rents and time-on-market as well as an example conceptualizing the liquidity index derived in section 2.3.

The German residential market has been exposed to a series of structural changes during the last five years. The ongoing urbanization together with the positive migration balance towards the main urban centres have exerted enormous pressure on rents and prices of residential assets. This development has been further fuelled by the restricted construction activities of the last years and since the rental sector plays an essential role for labour mobility and urban development, the monitoring of residential markets has become essential for the government and institutional investors, not least because Germany has the lowest ownership rates (ca. 45 %) in a European context after Switzerland, see Voigtlaender, 2009. The German residential market has a strong regional, polycentric character. Especially the economically strong metropolitan areas like the top-7 markets Berlin, Hamburg, Munich, Frankfurt, Stuttgart, Dusseldorf and Cologne are increasingly exhibiting a high demand for residential real estate. But also smaller secondary and tertiary locations surrounding these cities exhibit high residential demand and increasing rental and purchasing price levels. In Germany all communities have to compete for inhabitants and companies in order to get a larger share of state taxation and gain more locally collected commercial taxes.

Figure 3 and 4 show both the boxplots of asking rents and ToM over time as well as their mutual pattern in a scatterplot in 2013Q1 and 2016Q3. In the former, asking rents show a steady growth over the observation period with the average and the extreme values of the boxplots increasing continuously over time. At the same time, time-on-market initially rose from almost 11 weeks on average in 2013Q1 to ca. 12.5 weeks in 2013Q3 before falling to 2.7 weeks on average in 2016Q3. This development is crucial and points to a substantial reduction in the time required to offer a property, the corresponding price discovery between the parties and until the fully handover of the asset to the tenant. Also interesting in this context is the development of the ToM outliers above the boxplots as they fell in 2016 below the average of 2015, pointing to an extreme increase in dwellings' demand in regions with usually highly abnormal letting periods.

---- Figure 3 ----

---- Figure 4 ----

The scatterplots in Figure 4 shows further the aggregated relationship between asking rents and ToM as the cross-sectional mean across the NUTS3 areas in 2013Q1 and 2016Q3, respectively. As of 2013Q1, the graph points clearly to a negative non-linear relationship in which the decrease of ToM in markets with rental levels above 5 €/m²/p.m. is less pronounced as in markets with rents below 5 €/m²/p.m. In other words, ToM in "cheap" markets ranged between 10 and 22 weeks on average in 2013Q1, whereas ToM in "expensive" markets ranged merely between ca. 6 and 10 weeks on average. The strong reduction in ToM between 2013Q1 until 2016Q3 is clearly observable in the right-handed scatterplot and crucial based the vertical downward shift in ToM.

---- Figure 5 ----

Finally, I present a simple model to illustrate a survival regression for the city of Munich as defined in equation 7 excluding X and Z covariates, i.e. only including time dummies. The upper panel in Figure 5 shows the mean time on market in weeks and the confidence intervals at every observation time. The plots below show the mean survival function $\widehat{S(\tilde{t})}_t$ of the respective observation period with the reference category 2013Q1. The rise in the mean survival from ca. 2 weeks in 2013Q1 to ca. 3.5 weeks in 2013Q4 follows a steady decline towards 1 week in 2016Q3. As explained in section 2.3, a worsening in the market liquidity conditions is expected to lead to a upward shift in $\widehat{S(\tilde{t})}_t$, which is observable in the upper left graph. In contrast, the remaining survival functions lie clearly below the reference 2013Q1 pointing to better liquidity conditions in Munich's residential market.

4. Econometric approach and determination of market states

4.1. *Parameterization of the hedonic and survival regressions*

For each market p defined by the NUTS3-region I estimate a hedonic rent and a survival model individually as defined by equations (2) and (7) as pooled cross-sectional regressions with ZIP-spatial and time fixed effects, whereas $p \in \{1, \dots, 250\}$. The hedonic equation is estimated via a semiparametric Generalized Additive Model for Location, Scale and Shape GAMLSS[iii] (Rigby and Stasinopoulos, 2005). I parameterize each hedonic equation as follows:

$$\log(R_{ijt}) = X_{it}\beta + Z_{jt}\alpha + \mu_{it}\theta_t + \mu_j\rho_j + u_{ijt} \; \forall \, p; \; p \in 1, \dots, 250 \tag{9}$$

where the response R rents is the vector of asking rents in log €/m²/p.m. of dwelling i, X_{it} corresponds to the matrix of dwelling-specific characteristics without time-on-market, the degree of atypicality and overpricing. Z_{jt} accounts for j ZIP-area-specific covariates, μ_{it} captures time fixed effects and μ_j accounts ZIP fixed effects. The error term is $u \sim iid$. The sigma equation includes the covariates log floor space, number of rooms and the log distance to the ZIP centroid. All hedonic models were estimated with R (www.r-project.org) based on the package "gamlss".

In this paper, time on market is defined as the elapse of time since a dwelling enters the MLS until it leaves the database in weeks (see Benefield and Hardin 2015). Very important in survival analysis is the fact that some observations or dwellings do not change their event status, either because they remain available on the market or the landlord does not change the status in the MLS database, the latter constituting a data error or false negative result. In this case, the response variable is said to be right-censored. While simple models such as Kaplan-Meier or Kernel estimators estimate the survival function, they are unable to control for the latter effect properly. To resolve this problem, proportional Cox hazard models (Cox, 1972) do account for censoring in the response variable as they transform the response into a count variable per unit of time in order to estimate the effect of the covariates in a multiplicative way. In other words, the proportional Cox-hazard model decomposes the time of an event in units of time incorporating censoring into the count regression. Since the response variable is expressed as time, survival models estimate a conditional survival probability for an event for each observation rather than estimating a single fitted value in the sense of the traditional OLS regression. I parametrize a semiparametric cox-proportional hazard equation in a semiparametric model as follows:

$$h(\tilde{t}_{ijt}) = \exp(\dot{X}_{it}\beta + Z_{jt}\alpha + \mu_{it}\delta_t + \mu_j\rho_j) + e_{ijt} \; \forall \, p; \; p \in 1, \dots, 250 \qquad (10)$$

where $\tilde{t}_{ijt}$ captures the time-on-market of dwelling i, in the listing period t and ZIP-area j. The Z_{jt} matrix contains the identical covariates as in hedonic model model, whereas $\dot{X}$ includes additionally to X asking rents in log, the degree of atypicality and overpricing as additional explanatory variables. All survival models were estimated with R (www.r-project.org) based on the package "survfit".[iv]

4.1. *Statistical inference of econometric models*

Endogeneity and the use of instrumental variables methods are a highly discussed topic in the context of survival equations. As proposed by Benefield et al. (2014), the estimation of both equations would lead primarily to inefficient estimators whenever they are used as endogenous and exogenous simultaneously. The two stage least square (2SLS) approach has been therefore recommended in order to avoid endogeneity problems and provide efficient estimates. Very important in the approach to be applied however is a closer look at the data generating process (DGP) of both variables (Davidson and MacKinnon, 2003). That is, when rents and time-on-market are simultaneously used on both the left hand and right hand side of the equations simultaneously.

In this paper, the DGP of rents R and time-on-market $\Delta\tilde{t}$ is defined as follows. Landlords willing to let assets set an initial asking rent R_0 at time t_0 and wait $\Delta\tilde{t}$ in order to either hand over the asset to the tenant or reconsider a different rent level, $\dot{R} > R$ or $\widetilde{R} < R$, and wait afterwards for a second letting agreement. During the first period $\Delta\tilde{t}$, the DGP of R_0 is not determined by $\Delta\tilde{t}$ as landlords are not aware of $\Delta\tilde{t}$ in achieving the initial asking rent R_0. Therefore, the variable time-on-market is not included in the hedonic equation as it is ex-post generated by R_0 and the market conditions. In contrast, the DGP of $\Delta\tilde{t}$ is indeed influenced by the initial R_0 and by dwelling's size, age, location, etc., for which reason the vector of asking rents is used as a covariate in the survival regression. Since the data base used here captures merely $\Delta\tilde{t}|R_0$ rather than $\dot{R}$ and $\widetilde{R}$, the use of 2SLS is not indispensable.

4.2. *Determination of market movements*

In order to determine market movements proceeding from rental and liquidity indices, I explore their intertemporal behaviour graphically as described in Figure 2 trough different observation periods. Thus, I plot the $\hat{\theta}_t$ and $\hat{\delta}_t$ values for all p markets at different times and examine their development towards $\overline{\overline{A}}_{t_m}$, $\overline{A}_{t_m}$, $\overline{\overline{B}}_{t_m}$ and $\overline{B}_{t_m}$. Further, in order to determine co-movements between markets I define the matrices $\widehat{\Pi}_{t,p}$ and $\widehat{\Omega}_{t,p}$ that contain the $\hat{\theta}_t$ and $\hat{\delta}_t$ values of each p market respectively over time t as

$$\widehat{\Pi}_{t,p} = \begin{pmatrix} \hat{\theta}_{t,p} & \cdots & \hat{\theta}_{t,P} \\ \vdots & \ddots & \vdots \\ \hat{\theta}_{T,p} & \cdots & \hat{\theta}_{T,P} \end{pmatrix} \quad (11)$$

and

$$\widehat{\Omega}_{t,p} = \begin{pmatrix} \hat{\delta}_{t,p} & \cdots & \hat{\delta}_{t,P} \\ \vdots & \ddots & \vdots \\ \hat{\delta}_{T,p} & \cdots & \hat{\delta}_{T,P} \end{pmatrix} \quad (12).$$

At the last observation period T, I group the markets into k clusters and aggregate the values of each k cluster/path for $\widehat{\Pi}_{t,p}$ and $\widehat{\Omega}_{t,p}$. In other words, I group the markets in the sample with the highest statistical similarities in T in k clusters. The employed cluster methodology corresponds to the algorithm developed by Reynolds et al. (1992), which is an adjusted version of the k-means procedure for bivariate clusters implemented in the R package "cluster". The aggregation of each liquidity-rent-index is estimated as the mean conditional on markets in each k over t. Finally, I present the aggregated paths graphically in order to examine possible turning points and/or similarities.

5. Empirical results and market co-movements

5.1. *Hedonic and survival regressions*

In this section I present the aggregated regression results of equations (9) and (10). More specifically, I present the distribution of the coefficients based on the median and the quantiles 30% and 70% of the 250 regressions/ markets. Table 2 shows the results of the semiparametric GAMLSS and the cox proportional hazard models, whereas the unconstrained R^2 and the Pseudo R^2 illustrate the goodness of the models respectively. Since hazard models estimate event probabilities per units of time, a coefficient of determination just as in the OLS is difficult to obtain. As a substitute, the Pseudo-R^2 based on Kendall's Tau measures the concordance between estimated survival time and the observed survival time for only the non-censored response sample. Values between 100 % and 80 % mean perfect concordance, between 80 % and 60 % are common in survival studies and values between 40 % and 30 % point to poor estimation[3].

---- Table 2 ----

The results show strong evidence that large dwellings tend to be offered at lower prices as the coefficients for the GAMLSS model range between -0.214 and -0.135. The hazard ratios in the cox model of the size covariate are below one and pointing to a negative relationship, i.e. the larger the dwelling the lower is dwellings' liquidity since coefficients below 1 point to a longer survival and therefore to a higher liquidity. When looking into the median effect of the gravity covariates the results show that the closer the dwellings is to the ZIP and NUTS3 area, the higher is the asking rent but the lower is the liquidity. These effects show however strong variations within the observed markets, especially for the distance to city centre (NUTS3). Interestingly, the results of the dummy for bathtub (yes =1) shows a weak effect on price (-0.8% and 0.2%) but a negative influence on the letting process as the hazard ratios are below 1 pointing that dwelling with bathtub are transacted less quickly than those with a bathtub. The results show also the estimated coefficients $\hat{\theta}_t$ and $\hat{\delta}_t$, thus the cross-sectional medians. Starting at the reference category 2013Q1 both vectors show rising rents as well as rising liquidity, i.e. falling survivals. Finally, the cox proportional hazard regression confirm that time-on-market is positively related with initial asking rents, but negatively related to the degree of atypicality and overpricing. The coefficients of determination are suitable as the R^2 is above 50 % and the Pseudo R^2 above 60% in 70% of the regressions.

5.2. *Market co-movements of liquidity and rental indices*

In this section I present the development of the liquidity index $\hat{\delta}_t$ and rental index $\hat{\theta}_t$ over time. Figure 6 shows both indices at four observation times 2013Q4, 2014Q4, 2015Q4 and 2016Q3 as contour plots with 2013Q1 as the reference observation period. Contour plots are used when exploring latent relationships between two variables by showing the concentration of both variables via contour lines in two dimensions. During 2013 three main developments were to observe. Firstly, in almost half of the markets liquidity fell despite the rental growth, pointing to a substantial overrented state. Secondly, a significant share of the markets moved at a fast pace towards the state hot as higher rents and lower time-on-market levels were to observe. Finally, only a small number of markets moved around the initial reference time with no clear intertemporal development. On average liquidity and rents moved in 2013 for the entire market by -0.07 and +1.2 % respectively.

---- Figure 6 ----

After two years, German markets moved in general horizontally towards rents without a significant rise in liquidity. Markets that showed a rental growth during 2013 continued their expansion in both liquidity segments – falling or rising liquidity –, whereas at the end of 2014 a significant share of markets moved deeper towards the underrented state. At the same time, a small share of markets presented either small movements towards the overpricing state or remained without significant movements compared to the initial point. The overall market moved until 2014Q4 by +0.04 and +3.62 % in liquidity and rents respectively.

When looking back into the descriptive statistics presented in Figure 3, the development of time-on-market and asking rents as off 2015 is crucial in the German housing market. The contour plot in 2015Q4 in Figure 6 shows four important movements. First, while rental growth continued over practically all markets, it expanded at a much faster rate as during 2013 and 2014. Secondly, market liquidity shows a substantial momentum compared with the two initial years, as it rose by 0.29 compared with the reference 2013Q1. This development may be seen as a response to the increased rental growth of prior years, but at this point I do no derive conclusions on the lead-lag structure of liquidity and rents indices. Thirdly, only one market presented a liquidity and rental decrease in 2015Q4, in contrast to the prior years. Finally, the results show that up to 2015Q4 a notable share of markets consolidated through the overrented state with persistent falling liquidity levels and rising rents rose.

The contour plot of 2016Q3 corresponds to the last observation period. It shows a consistent development of the German residential markets through the hot state with both rising liquidity and rents levels. Compared with the reference 2013Q1, asking rents grew by up to +9.41 %, whereas liquidity rose by 0.51 on average. At this point, none markets were to observe in either a cold or an underrented state, whereas just 17 markets continued in the overrented state, that is with liquidity levels below 2013Q1.

The analysis shows up to this point a consistent understanding of the German housing market based on the econometric models for liquidity and rental indices. The results provide evidence that liquidity and rents have co-movements over time, regional dispersion and present different liquidity-rent-momentum patterns. The following section aims at finding aggregated clusters across markets in order to derive both market co-movements as well as regional patterns.

5.3. *Clustering and spatial analysis of market states*

In this section I show the results of the clustering of markets across the estimated liquidity and rental matrixes $\widehat{\Pi}_{t,p}$and $\widehat{\Omega}_{t,p}$ from equations 11 and 12. Thus, after clustering the markets at the observation period 2016Q3 in four groups, Figure 7 and 8 present the cross-sectional averages graphically and as a map.

---- Figure 7 ----

---- Figure 8 ----

The results presented in Figure 7, show the aggregated liquidity and rental indices for each clusters. Four different patterns are to observe. Markets in clusters 1 and 3 show a joint liquidity and a rental growth close to the overall market development, i.e. neither an accelerated deviation from the overall rental development nor a faster letting behaviour. Liquidity and rents grew in these markets by almost 10% and 50 % respectively on average. The top 7 residential markets, which account for almost 11 % of the sample, belong to these two clusters (Hamburg, Frankfurt, Berlin, Munich, Cologne, Dusseldorf and Stuttgart). As the top 7 markets are seen as the main German markets their development serves at the same time as a benchmark for the overall German housing development. Thus, in view of the results in Figure 7 markets outside clusters 1 and 3 experience either an abnormal increase in liquidity relative to rental growth such as cluster 2, or a stagnation in liquidity despite rental growth as seen in cluster 4. Liquidity within cluster 2 doubled across observation period relative to the rental development, which points to an abnormal absorption rate of the housing stock in short-term. In other words, the strong rise in liquidity is expected to lead to enhanced levels of letting activities, shortening stock supply and exerting further pressure on rents. Since new supply is unelastic in the short-term, it is to expect that either rents or letting activities stop growing in the medium-term, leading to a contraction in the liquidity-rent-cycle, unless other factors are essential. In contrast, markets within cluster 4 show reduced liquidity, i.e. letting activities, but a steady rise in asking rents. As these markets are denominated as overrented following the intertemporal model from section 2.4, they might be prone to suffer from an abrupt fall in asking rents in the medium-term as demand falls and new supply may lessen in comparison to markets outside this cluster. The overall development of the liquidity-rent-momentum of cluster 4 in Figure 7 shows some signs supporting the latter assumption as a slight rise in liquidity in 2014 has been damped.

The map in Figure 8 shows the observed markets by means of the clusters. The boundaries of the main states (“Bundesländer”) are presented in bold, whereas Hamburg and Berlin are city-states. The clusters are widely geographically disperse, with some interesting patterns. Markets within clusters 2 – which show accelerated liquidity-rent-indices – are either mainly located in the states with the highest rise in demographic demand and economic growth such as Bavaria, Baden-Wurttemberg in the south or surrounding important markets such as Berlin, Frankfurt, Munich or Stuttgart. In contrast, cities with overrented liquidity-rent-indices are mainly located within Eastern Germany, where negative net migration balances and slow economic growth are to observe.

5.4. *Summary of empirical results*

Overall the results can be summarized as follows. The theoretical assumptions with regard to the co-movements of liquidity and rents proved to be an appropriate instrument for measuring and capturing market co-movements across Germany. During the observation period of 15 quarters and a data basis of approx. 1.8 million observations, German markets showed a strong persistence towards the hot liquidity-rent-state, which is characterized by co-movements towards rising rents and liquidity levels, whereas few markets were rather accompanied by falling liquidity levels in an overrented state. In the short-run, some markets are expected to observe a change in the liquidity-rent-path towards decelerated growth as they present an abnormal rise in liquidity compared to the overall market development. In contrast, the results provided evidence that a share of markets with some damage in their fundamentals present a strong persistence in rental growth not justified or accompanied by rising liquidity levels which may affect their stability negatively in the medium-term. In search for possible explanations, the regional distribution of markets’ clusters illustrated that economically and demographically strong regions such as Bavaria or around of major cities such as Berlin and Stuttgart are prone to be surrounded by cities with abnormal liquidity-rent-momentum rather than by cities with unstable fundamentals.

The presented and empirically tested methodology in this paper constitutes an original way of simultaneously capturing liquidity and rental co-movements in residential markets with an active and large institutional/private rental sector such as in Germany. The assumptions of the estimated liquidity-rent-indices and their analysis are simple in terms of Granger causality, spatial lagged effects or cluster aggregation. The employed semiparametric hedonic and survival methods are consistent in view of the big data sample of over 1.8 million observations. Future research might subsequently focus on exploring the indices on either socio-demographic, economic or housing fundamentals over time or simply exploring their time- and spatial-dependency from a closer statistical point of view.

6. Conclusions

A common understanding for liquidity and rental developments in real estate markets is essential for private, institutional and governmental market players. Nowadays, the assessment of housing markets by central banks or governmental institutions is commonly done by capturing aggregated rental or price indices leaving liquidity conditions behind. While this notion might be accurate, liquidity conditions in housing markets and their changes over time are essential, especially when assessing cyclical changes over time. The assessment of liquidity in terms of letting conditions is even more essential in markets where almost half of the existing stock is privately or institutionally rented such as the German housing market.

This paper has proposed a theoretical model for simultaneously capturing co-movements between liquidity and rental changes across four different states over time. I derived the market equilibrium as the marginal change in dwelling’s letting probability from a cox survival method over time in contrast to the rental index as by the time-dummy-approach. While hot and cold markets are characterized by rising and falling liquidity-rents-movements correspondingly, overrented and underrented markets show abnormal developments towards either letting activities or rents. Based on big data of approx. 1.8 million observations I empirically test the aforementioned assumptions across 250 German rental markets and confirm three essential aspects.

First, the development of the German housing market over the last four years is accurately captured by the theoretical model as the empirical results identify common movements towards liquidity and rental levels with a strong persistence towards the hot and overrented state. Secondly, while a noticeable share of markets including the top 7 are currently showing rental growth accompanied by rising letting activities, some markets present either an abnormal rise in letting activities relative to rental growth, i.e. “very hot”, or rising asking rents accompanied by falling letting activities, i.e. overrented. Finally, the spatial distribution of the identified states confirms that “very-hot” markets generally surround the top 7 cities, whereas overrented markets are mostly located in demographically and economically fragile regions such Eastern Germany.

Although model calibration and essentially the consideration of lead-lag-effects or socioeconomic information might further enhance the understanding of market co-movements, the results based on big data confirm that the dynamic in German rental housing markets do responds to an equilibrium between liquidity and rental developments. Thus, in order to accurately understand the fundamentals in (German) rental markets further research might focus on the explicit inclusion of liquidity as an indicator driving price and market movements fundamentally.

7. Literature

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NOTES

[i] Based on the Handbook of residential property price indices from Eurostat the different approaches differ in level rather than in direction, i.e. rising or falling price cycles are to observe with each approach.

[ii] The causality between liquidity and rents is ambiguous, especially in residential markets with low ownership rates, just as in the German case where the rate is almost 1:1.

[iii] The Generalized Additive Model for Location, Scale and Shape GAMLSS corresponds to a regression method in which all the parameters of observed distribution for the response are modelled as additive (non-linear) functions of the explanatory variables. The four moments of the response – the mean, variance, skewness and the kurtosis – vary depending on the observed variable and consequently on the underlying explanatory variables. Based on the research results of Mayr et al. 2010; Florencio et al. 2011 and Razen et al. 2014, the GAMLSS has shown to be an accurate regression model where the underlying variables are skewed and where the sample is not centered about the estimators. In other words, the GAMLSS is a robust estimator whenever the expected conditional variance of the errors is not expected to be homoscedastic distributed across the sample.

[iv] The simultaneous estimation of the hedonic and survival models required large computational resources. Based on the sample of 1.8 million, R estimated the models in three weeks demanding ca. 95% of the 20BG RAM.

Table 1: Intertemporal market movements

	Shift	Market effect
a	$\widehat{R}_{t_0} < \widehat{R}_{t_1}$	Rising market rents
b	$\widehat{R}_{t_0} > \widehat{R}_{t_1}$	Falling market rents
c	$\widehat{S(\tilde{t})}_{t_0} < \widehat{S(\tilde{t})}_{t_1}$	Lower survival ⇒ better liquidity conditions
d	$\widehat{S(\tilde{t})}_{t_0} > \widehat{S(\tilde{t})}_{t_1}$	Higher survival ⇒ worse liquidity conditions

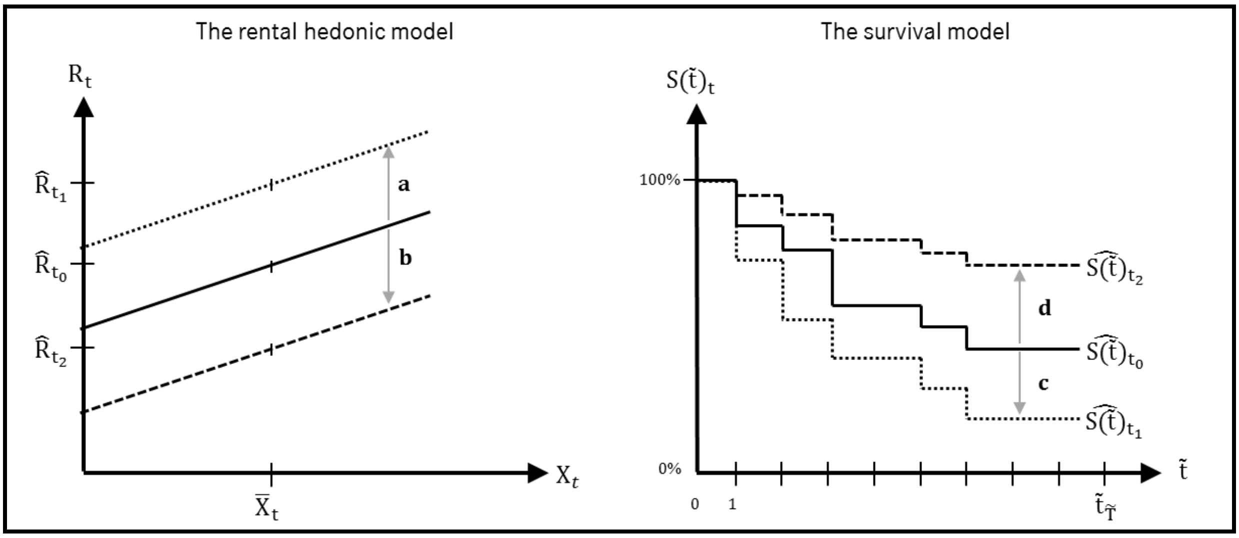
Notes: The table shows the effects of intertemporal market movements in rents and time-on-market. A rise in the $S(\tilde{t})$ leads to a longer survival and consequently on a lower liquidity relative to t_0.

Table 2: Distribution the coefficients of semiparametric hedonic and cox proportional hazards regressions

Estimation method	GAMLSS				Cox-proportional hazards			
Dependent variable	Log rents €/m²/p.m.				Time-on-market weeks			
Covariate	Coefficients				Hazards in antilog			
	Median	SD	Q30%	Q70%	Median	SD	Q30%	Q70%
	X_{it}				X_{it}			
Log living area	-0.180	(0.070)	-0.214	-0.135	0.453	(0.386)	0.381	0.547
Age	-0.002	(0.003)	-0.004	-0.001	1.001	(0.013)	0.995	1.007
Number of rooms	0.011	(0.014)	0.003	0.018	1.146	(0.082)	1.109	1.188
Log ZIP centroid	-0.017	(0.021)	-0.024	-0.009	1.059	(0.124)	1.001	1.124
Log NUTS3 centroid	-0.013	(1.287)	-0.048	0.014	1.001	(0.100)	0.972	1.024
With bathtub	-0.002	(0.011)	-0.008	0.002	0.936	(0.083)	0.902	0.979
With built-in kitchen	0.040	(0.018)	0.033	0.052	0.965	(0.217)	0.883	1.061
With parking slot	0.028	(0.014)	0.020	0.034	0.956	(0.121)	0.902	1.006
With terrace	0.034	(0.015)	0.024	0.042	0.997	(0.144)	0.93	1.069
With balcony	0.018	(0.015)	0.010	0.025	0.944	(0.109)	0.89	0.979
With elevator	0.028	(0.031)	0.012	0.043	0.815	(0.172)	0.753	0.893
Initial letting	0.081	(0.026)	0.069	0.092	0.836	(0.325)	0.683	0.976
Refurbished	0.026	(0.016)	0.019	0.034	0.911	(0.120)	0.865	0.956
	Z_{jt}				Z_{jt}			
Log ZIP purchasing power	-0.021	(1.932)	-0.608	0.505	0.546	(5.818)	0.02	4.067
Log ZIP household density	0.015	(1.563)	-0.078	0.102	0.896	(1.654)	0.56	1.488
	$\mu_{it} \rightarrow \widehat{\Pi}_{t,p}$				$\mu_{it} \rightarrow \widehat{\Omega}_{t,p}$			
2013Q2	0.002	(0.017)	-0.005	0.012	0.951	(0.153)	0.883	1.001
2013Q3	0.006	(0.018)	-0.001	0.015	0.918	(0.170)	0.845	0.971
2013Q4	0.011	(0.018)	0.002	0.020	0.866	(0.186)	0.815	0.937
2014Q1	0.017	(0.016)	0.008	0.025	1.028	(0.164)	0.94	1.1
2014Q2	0.024	(0.018)	0.014	0.034	0.982	(0.175)	0.906	1.073
2014Q3	0.028	(0.019)	0.018	0.037	1.034	(0.205)	0.923	1.135
2014Q4	0.034	(0.021)	0.024	0.046	1.029	(0.223)	0.922	1.14
2015Q1	0.044	(0.023)	0.033	0.057	1.032	(0.227)	0.917	1.153
2015Q2	0.047	(0.026)	0.036	0.062	1.153	(0.232)	1.033	1.288
2015Q3	0.056	(0.027)	0.041	0.070	1.358	(0.261)	1.218	1.529
2015Q4	0.067	(0.028)	0.052	0.082	1.297	(0.288)	1.154	1.494
2016Q1	0.075	(0.030)	0.060	0.094	1.514	(0.333)	1.292	1.706
2016Q2	0.080	(0.032)	0.067	0.102	1.487	(0.326)	1.228	1.734
2016Q3	0.089	(0.033)	0.074	0.113	1.705	(0.368)	1.468	1.936
					$\dot{X}_{it}$			
Log rent					1.585	(1.987)	1.000	4.178
Atypicality					0.644	(2.004)	0.205	1.452
Overpricing					0.723	(0.389)	0.609	0.856
Construction dummies	+				+			
Gaussian coordinates	+				+			
ZIP dummies μ_j	+				+			
Intercept	+				+			
Number of regressions	250				250			
R^2 / Pseudo R^2	58.61	/	53.39	64.62	63.56	/	62.45	64.51
Number of NUTS3 regions	250							
Number of ZIPs	7'948							
N	1'801'587							

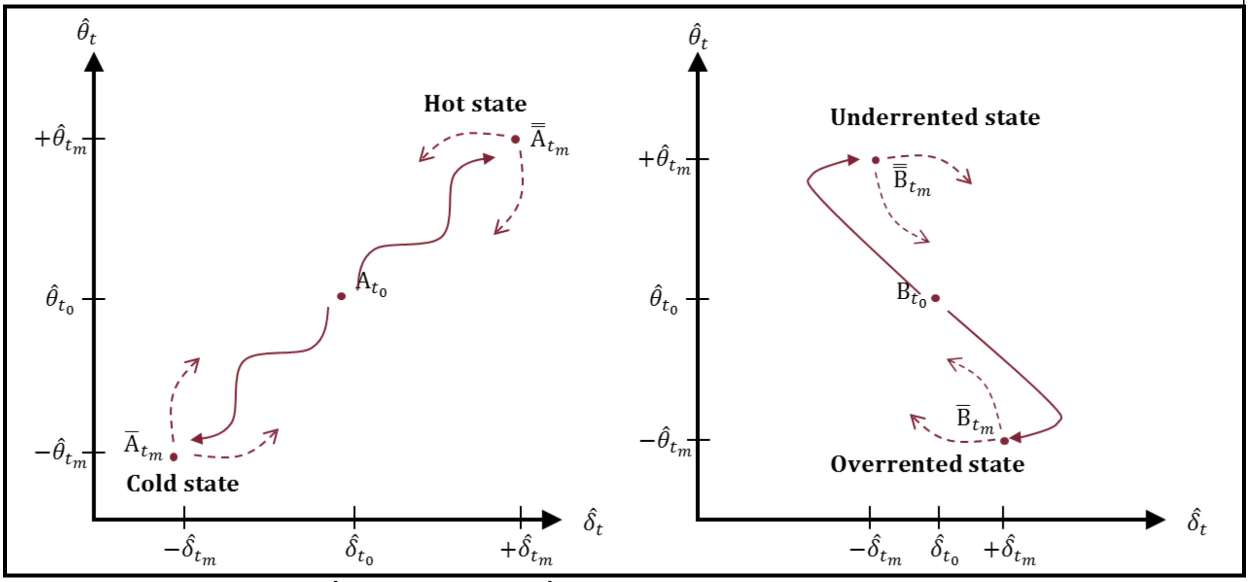
Notes: The table shows aggregated regressions results. For each market I estimate a hedonic and a survival regression separately based on equations (9) and (10), which capture to pooled cross-sectional observations and control for quarterly-time, ZIP and spatial effects. The results provide thus the aggregated distribution of the coefficients based on the median, 30 % and 70 % quantile and the standard deviation. The coefficient of determination corresponds to the unrestricted R^2 in the hedonic model and the Pseudo R^2 for the survival model.

Figure 1: Graphical description of intertemporal market index behaviour



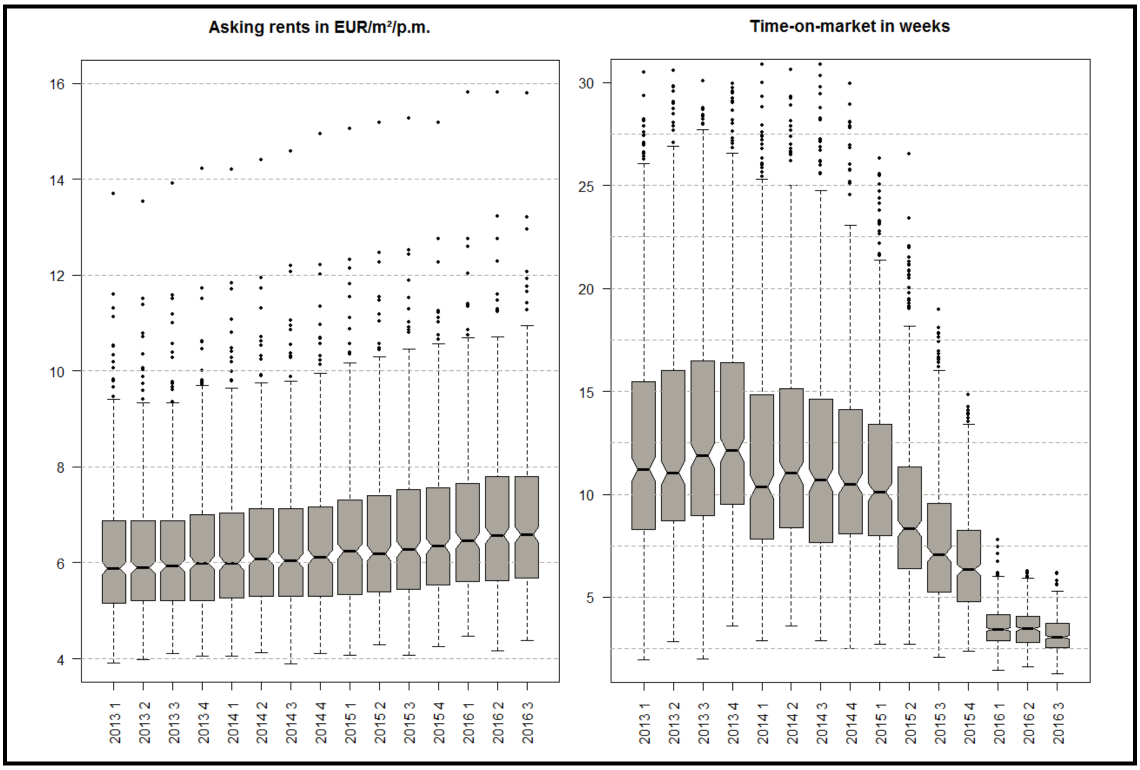
Notes: Both models show the temporal shift in either the mean asking rent R on the left-hand side and the survival function on the right-hand side. The path "a" ("b") corresponds to a rise (fall) in rents R, whereas the path "d" ("c") represents a rise (fall) in the survival function $S(\tilde{t})$ with respect to the reference in t_0.

Figure 2: Theoretical co-movements of liquidity and rental indices



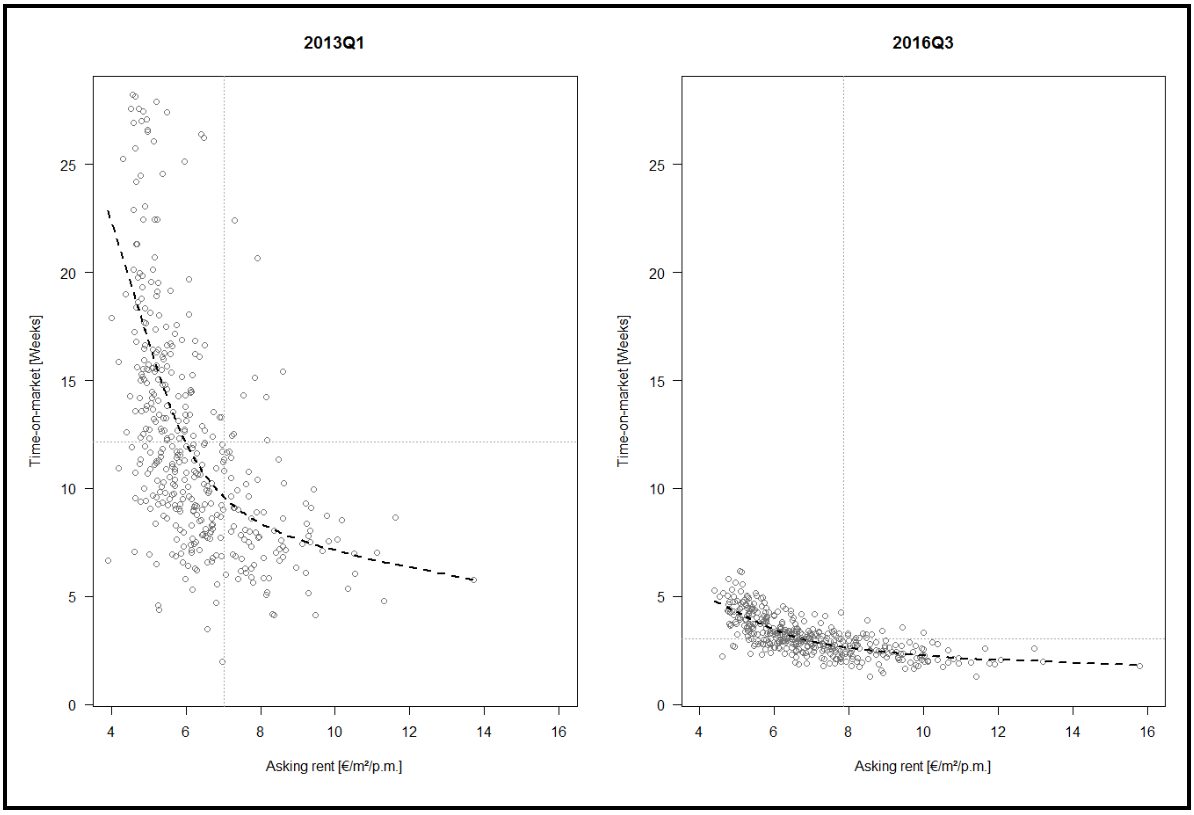
Notes: The derived rental index $\hat{\theta}_t$ and liquidity index $\hat{\delta}_t$ build a market equilibrium over time. Based on the starting point t_0, a simultaneous rise in rents and liquidity leads to a hot market and vice versa to a cold market. Rising rents in a market with falling liquidity are said to be overrented, whereas higher liquidity levels and falling rents lead to an underrented market. m captures the number of time-periods corresponding to a housing cycle.

Figure 3: Cross-sectional development of rents and time-on-market



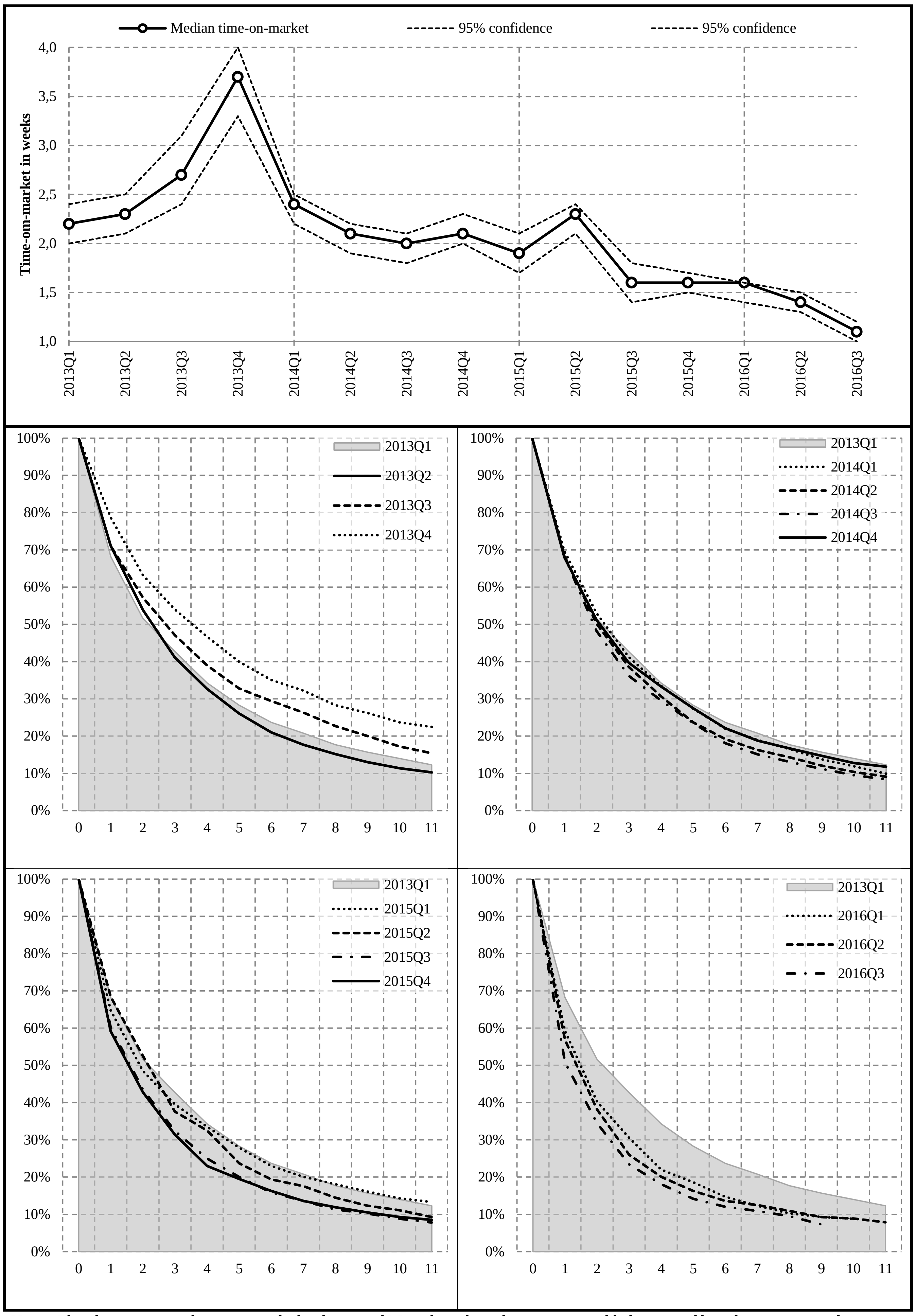
Notes: The boxplots show the median, 25%, 75% quantiles and outliers of the variables asking rents and time-on-market in weeks over 250 NUTS3 regions from the sample of over 1.8m observations.

Figure 4: Co-movements of time-on-market and rents at different periods



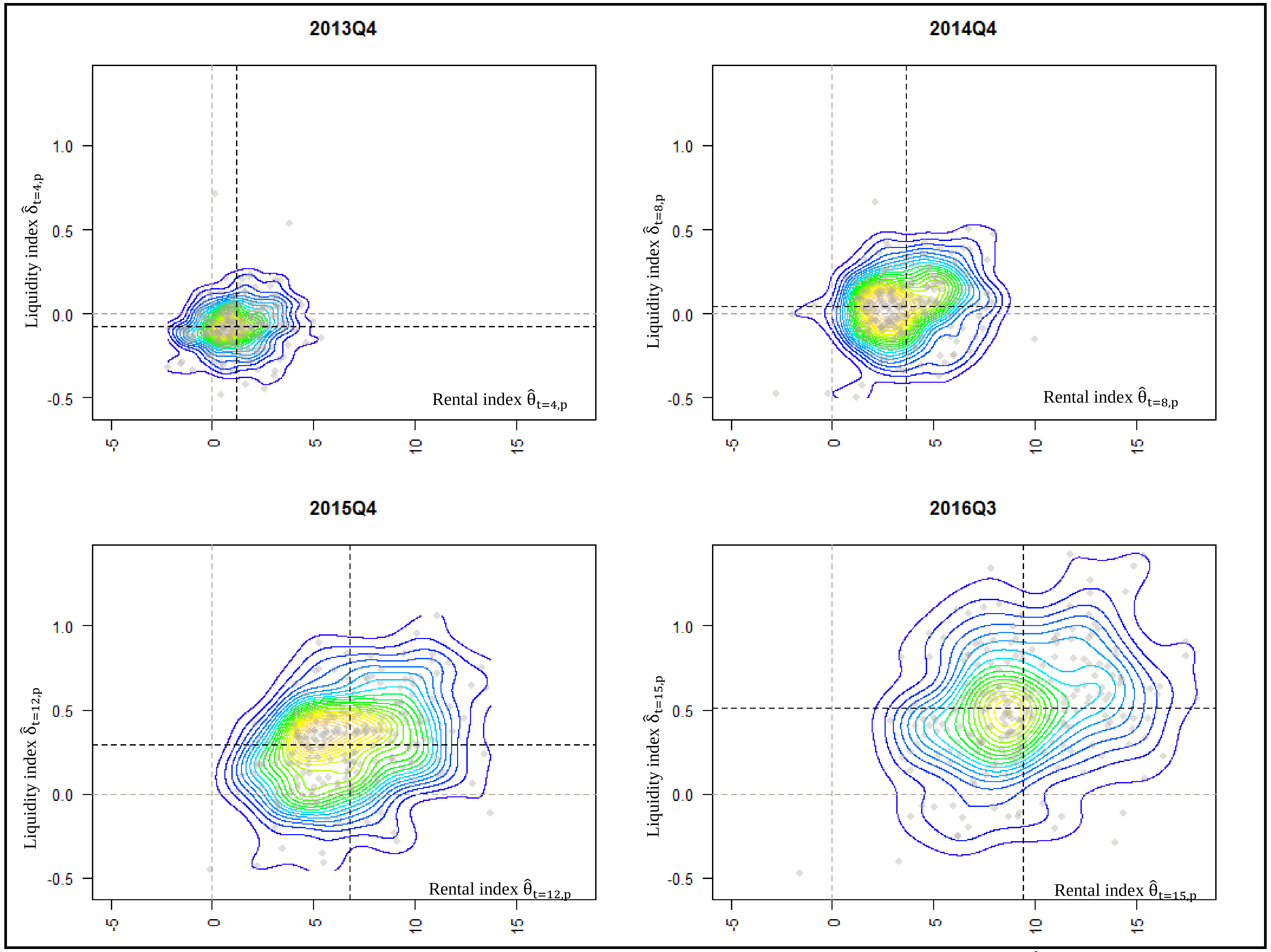
Notes: The scatterplots show the cross-sectional mean of time-on-market and asking rent for each of the 250 markets in two different periods. The regression line is estimated as a penalized cubic spline, whereas the horizontal and vertical lines represent the overall cross-sectional mean at each point in time.

Figure 5: Cross-sectional time-on-market and survival functions in Munich



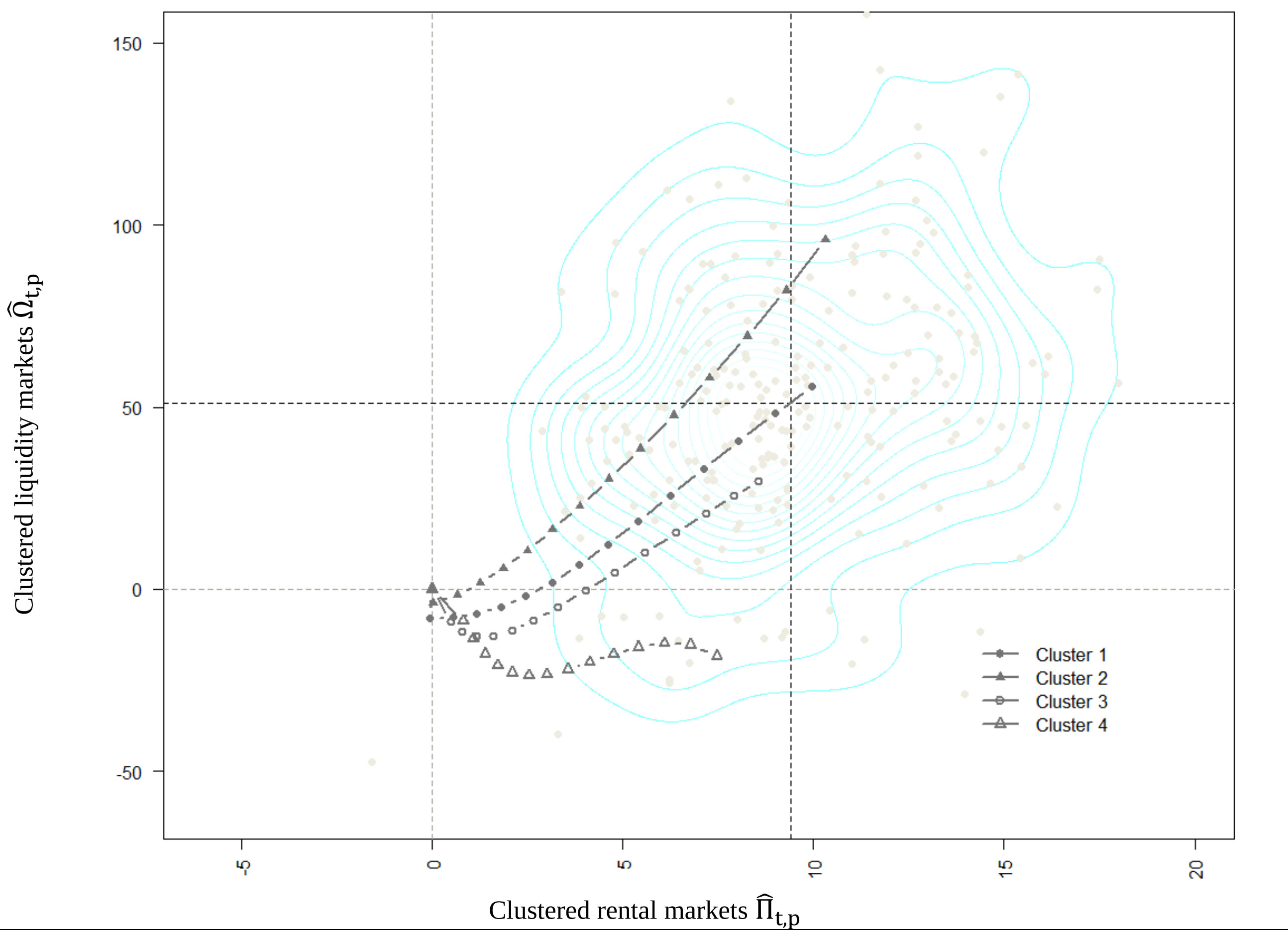
Notes: The plots correspond to an example for the city of Munich to show the intertemporal behavoiur of liquidity in a survival regression. The first plot shows the cross-sectional mean of time-on-market with a 95% confidence intervall. The four plots in the bottom correspond to the empirical derived survival functions from Exhibit 1. The reference survival corresponds to 2013Q1. The respective survival lines are interpreted in relation to the reference. Survivals above the reference point to a longer survival function and therefore to a decreased liquidity level. The survival probability is represented as a function of the time.

Figure 6: Empirical results of market co-movements based on liquidity and rental indices



Notes: The plots show the co-movements of the liquidity and rental indices of all 250 markets at for observation periods. The vertical axis shows the estimated $\hat{\delta}_t$ coefficients of the liquidity index and the horizontal axis the estimated coefficient $\hat{\theta}_t$ of the rental index. The co-movements are presented as contour plots, which show the concentration of the indices. The lines within the plots show the reference of the indices as t_0 and the corresponding mean of the liquidity indices cross-sectionally. The centroids of the contour plots are based on median values rather than on means.

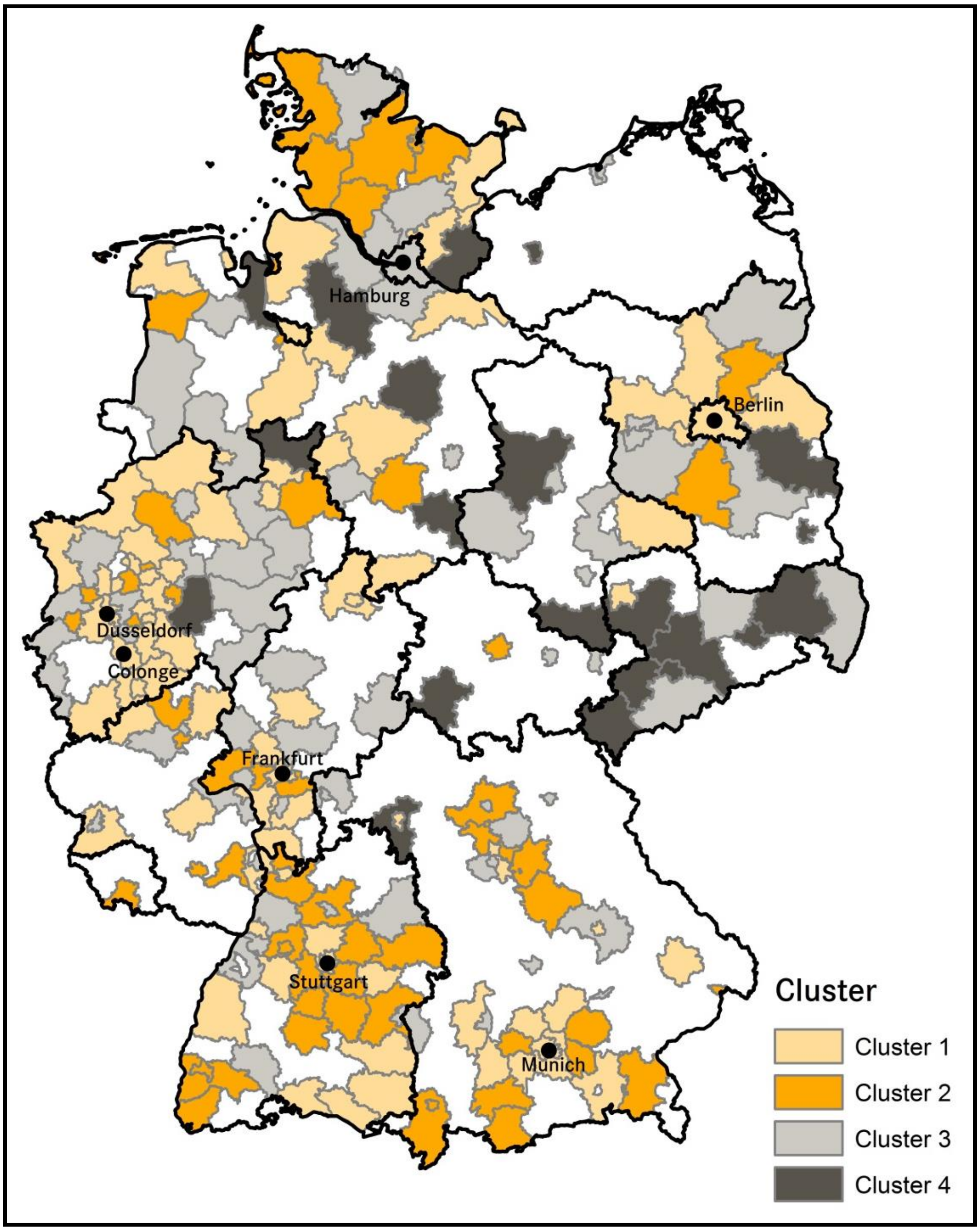
Figure 7: Clustered co-movement of markets until the last observation period



Cluster		2013				2014				2015				2016		
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
K=1	$\overline{\widehat{\Pi}_{t,p}}$	0,0%	-0,1%	0,6%	1,2%	1,8%	2,5%	3,1%	3,9%	4,6%	5,4%	6,2%	7,1%	8,0%	9,0%	10,0%
	$\overline{\widehat{\Omega}_{t,p}}$	0,0%	-7,9%	-7,7%	-6,7%	-4,8%	-2,0%	1,9%	6,6%	12,3%	18,7%	25,7%	33,1%	40,7%	48,3%	55,5%
K=2	$\overline{\widehat{\Pi}_{t,p}}$	0,0%	0,0%	0,7%	1,3%	1,9%	2,5%	3,2%	3,9%	4,6%	5,5%	6,3%	7,3%	8,3%	9,3%	10,3%
	$\overline{\widehat{\Omega}_{t,p}}$	0,0%	-3,7%	-1,5%	1,7%	5,8%	10,6%	16,3%	22,9%	30,3%	38,5%	47,8%	58,1%	69,4%	82,0%	96,0%
K=3	$\overline{\widehat{\Pi}_{t,p}}$	0,0%	0,5%	0,8%	1,2%	1,6%	2,1%	2,7%	3,3%	4,0%	4,8%	5,6%	6,4%	7,2%	7,9%	8,6%
	$\overline{\widehat{\Omega}_{t,p}}$	0,0%	-8,9%	-11,7%	-13,0%	-12,8%	-11,3%	-8,6%	-4,9%	-0,4%	4,6%	10,0%	15,5%	20,8%	25,6%	29,5%
K=4	$\overline{\widehat{\Pi}_{t,p}}$	0,0%	0,8%	1,1%	1,4%	1,7%	2,1%	2,5%	3,0%	3,6%	4,1%	4,8%	5,4%	6,1%	6,8%	7,5%
	$\overline{\widehat{\Omega}_{t,p}}$	0,0%	-8,7%	-13,6%	-17,7%	-20,9%	-22,9%	-23,7%	-23,3%	-22,0%	-20,1%	-17,8%	-15,9%	-14,8%	-15,3%	-18,3%

Notes: The plot shows the aggregated mean of the liquidity and rental indices at the last observation period 2016Q3 as well as the contour lines. The liquidity and rental indices were clustered in four groups based on similarity groups with an k-mean algorithm. The lines correspond to the cross-sectional mean of the clustered markets, showing the respective market sensitivity to changes in market fundamentals, e.g. markets in cluster 2 show a substantial increase in liquidity rather than in rental growth, whereas markets in cluster 4 show an overrented state as higher rents are not accompanied by rising liquidity.

Figure 8: Spatial distribution of clustered markets at 2016Q3



Notes: The map shows the clustered markets as presented in Figure 7 at 2016Q3.


management
Sustainability
building performance
analysis development
Urban Residential Portfolio
Cycles Commercial Public Hedonic
REITs Valuation Risk price
markets Land
Real estate
factors policy
buildings
Business
Regional funds Financial
Office
Property
prices value
Quality
Data
model Social Asset education
House Energy models Corporate
Green market planning
choice
Work Workplace
Sustainable Investment
Housing