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Entrepreneurial technology firms in China’s emerging economy: How technological and institutional regimes shape entrepreneurial conditions

Mark Greeven
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ABSTRACT
In order to explain the success of entrepreneurial firms, it is necessary to identify the conditions that generate new business opportunities. Emerging economies such as China are perceived as high risk environments due to fundamental institutional transformations. Yet, there’s no conclusive evidence how the contextual nature of emerging economies impact the conditions for entrepreneurial firms. This paper proposes that the opportunities for entrepreneurial firms in emerging economies are shaped by technological and institutional regimes. Whereas there has been a lack of attention to the concept of technological regime in the entrepreneurship literature, the concept of institutional regime has recently gained ground, yet, remained relatively disconnected and under-conceptualized in connection to entrepreneurial opportunities and constraints. In our empirical study we explore how technological and institutional regimes impact on the opportunities and strategic decision of
entrepreneurial firms in three distinct software sectors in China. The findings suggest that institutional constraints show sectoral variety because firms in distinct sectors have different resource requirements and are therefore diversely affected by institutional constraints despite belonging to the same institutional regime.

INTRODUCTION

In order to explain the success of entrepreneurial firms, it is necessary to identify the conditions that generate new business opportunities. However, there is no conclusive evidence on such conditions (Shane, 2003). Emerging economies are perceived as high risk environments due to fundamental institutional transformations. Yet, there is lack of conclusive evidence on the exact nature and impact of institutional forces on entrepreneurial firms’ strategic decisions (Bruton, Ahlstrom and Oblój, 2008). Research on new venture creation and survival in emerging economies has provided evidence of institutional constraints, in particular cultural context, that challenge entrepreneurs and their understanding of the emerging opportunity environment (Manolova and Yan, 2002; Lyles, Saxton and Watson, 2004; Tan, 2005). In particular, emerging economies are often characterized by widespread uncertainty and opportunism, limitations in factor markets and higher search costs for critical resources. This has lead to the use of informal institutions (Peng, 2003), institutional coping strategies (Roth and Kostova, 2003) and non-market strategies (Wan, 2005) by entrepreneurial firms and sometimes a co-evolution of entrepreneurial firms and institutional transformation (Ahlstrom and Bruton, 2010; Krug and Hendrischke, 2008). However, there is no conclusive evidence on the exact nature of institutional forces and their impact on the opportunities for entrepreneurial firms in emerging economies (Bruton, Ahlstrom and Oblój, 2008).
This paper proposes that the opportunities for entrepreneurial firms in emerging economies are shaped by technological and institutional regimes. In the field of entrepreneurship there has been a lack of attention to the concept of technological regime and to understanding how it shapes the nature of opportunities (Shane, 2001). Nevertheless, this concept may be usefully applied to understand the nature of opportunities across industrial sectors, in particular market conditions and technological developments (Marsili, 2002; Shane, 2001). The concept of institutional regimes has gained ground in the emerging economies literature (Hoskisson, Eden, Lau, & Wright, 2000; Wright, Filatotchev, Hoskisson and Peng, 2005) and in the strategic entrepreneurship literature (Batjargal, 2010; Autio and Acs, 2010; Bruton, Ahlstrom and Li, 2010). However, exactly how institutional regimes shape entrepreneurial opportunities and constraints for entrepreneurial firms in emerging economies is not yet well conceptualized. We propose that while technological regimes shape competence destruction and appropriability risks, institutional regimes shape governance and resource risks in varying degrees across industrial sectors.

The context of this research is China’s entrepreneurial technology sector. China’s emerging economy in particular draws the attention as the pace and scale of private sector development sets it apart from other emerging economies. Although China’s institutional framework is distinct (Van de Kaa, Greeven et al. 2013, Van de Kaa and Greeven 2017, Van de Kaa and Greeven 2017). The Chinese private business sector emerged since the mid-1990s via entrepreneurship when individuals founded new firms. The development of China’s private sector depends on finding new ways for doing business, new ideas for re-combining productive factors, developing and producing new products or more efficient production technologies in order to not only compete with resource-richer state-owned enterprises and foreign firms, but also for coping with (in)direct political constraints and limitations in factor markets (Ahlstrom, Bruton and Yeh, 2008; Batjargal, 2007; Tylecote & Visintin, 2008). The
emerging private sector developed new technologies, new industries and the commercialization of knowledge-intensive products such as TD-SCDMA, pictographic language software and new anti-malaria drug suggests that China is becoming more innovative (Hu & Matthews, 2008; Zhou, 2008), despite institutional constraints, suggesting that institutional constraints may affect the creation and survival of entrepreneurial technology firms in varying degrees.

In this paper, we consider these issues through an analysis of a detailed comparative case study of 45 software firms in Zhejiang Province, China. The software industry is relatively fragmented with a few major players and many small entrepreneurial firms. The study of software has an exceptional position in that it allows studying both disruptive as well as continuous, accumulative processes of innovation within diverging opportunity environments (Batjargal, 2010; Casper and Whitley, 2004). We focus on technical, market and institutional sources of entrepreneurial risk for three distinct software sectors: enterprise software, middleware and standard application-based software. Section 2 will introduce regional and sectoral variety of the developments of new technology in China. Section 3 will discuss the technical and market challenges of innovating firms and in addition detail the consequences of institutional uncertainty. Attention is paid to the design of qualitative research in China in section 4. Section 5 then reports on and discusses the managerial risks for our sample of 45 Chinese software firms in Zhejiang province.

**REGIONAL AND SECTORAL VARIETY OF NEW TECHNOLOGY IN CHINA**

Recent studies are providing evidence for the foundations China is laying for new technology development (Liu & White, 2001; Hu & Matthews, 2008; Huang, 2010). Interesting examples of recent Chinese break-through innovations are an electronic publishing system for pictographic languages, a new 3G mobile telecommunications standard (TD-SCDMA)
and a new anti-malaria drug. At a more systematic level, China started to overtake Europe with respect to the number of new patent applications filed. Interestingly, the ratio of patent applications by enterprises increased to more than 60% in the 2000s (from 30% in 1985), suggesting an upgrade of enterprise capabilities compared to universities, R&D institutes and government agencies. Recent patent data suggests a significant improvement of innovative capabilities in China and a fundamental shift towards the private sector (Huang, 2010). However, the most telling evidence for China’s increased innovative capabilities is perhaps the recent surge of European R&D involvement in China with Chinese partners (Wu and Callahan, 2005; Zhou and Xin, 2003). Moreover, the surge in the number of patents granted to domestic entities versus foreign entities suggest a rise in China’s indigenous innovative capabilities (Huang, 2010).

New technology development takes place in particular sectors of China’s economy, most notably medical science, semiconductors, communication and computing. The IT sectors draw our attention with respect to overall success and innovation. The IT industries are among the fastest growing industries, surpassing some traditional industries such as oil and steel. Over the last decade, the computer hardware sector had an average annual growth rate in gross industrial output value (current prices) of almost 35%. In the same period, the software sector grew with a steady 30% (China Statistics Yearbook on Science and Technology, 2009). The growth of gross industrial output value in high-tech sectors including the IT sectors is 20%, excluding these sectors only 10%, suggesting a relatively fast growth of the IT sectors compared to other high-tech sectors.

OECD and National Bureau of Statistics of China data show that the IT sectors have the highest input and output of R&D – as the only available measures of innovation performance – of the high-tech sectors. For instance, computer sectors have the highest R&D intensity of all high-tech sectors and the import and export of IT goods is by far the largest.
(OECD, 2007). Beyond the statistics, examples of successful IT innovators can be found in Batjargal’s (2007) study of innovative software ventures in Beijing and Lau, Lu, Makino, Chen and Yeh’s (2004) investigation of large, successful high-tech firms. Furthermore, studies of innovation in the computer hardware industry show similar patterns (Lu, 2000).

Innovation in the IT sectors mostly takes place in the coastal regions of China. The geographic distribution of firms in the IT industry over China is unequal: most of the best performing firms in the industry are located in the Yangtze River Delta, the Pearl River Delta; the Bohai Sea Rim and areas along the Shenyang - Dalian expressway (OECD, 2007). Beijing, Shanghai, Shenzhen and Xian are the country’s four best-known high-tech cities. Of these, Beijing has by far the largest high-tech area with approximately 8,000 enterprises and 280,000 employees generating 17 % of all high-tech enterprises’ gross output value and 13 % of all high-tech exports in 2002. Moreover, National Bureau of Statistics of China (2008) data suggest that 60% of total R&D expenditures are found in the six coastal provinces. Summarizing, there is considerable evidence that IT sectors in the coastal regions of China are particularly innovative. Interestingly this also suggests that institutional constraints may affect the creation and survival of entrepreneurial technology firms in varying degrees, i.e. across sectors and regions.

**CONDITIONS FOR ENTREPRENEURIAL TECHNOLOGY FIRMS IN CHINA**

In what follows we argue that the following set of constraints affect entrepreneurial technology firms in China: technical and market constraints (i.e. competence destruction risk and appropriability risk) and institutional constraints (resource limitation risk and governance risk). **Figure 1** summarizes the constraints resulting from market and technical characteristics connected to sectors and the institutional constraints connected to China’s emerging institutional environment.
Technical and market constraints: technological regime

The ways in which new technology development within sectors is organized is often explained as the outcome of distinct technologies that characterize the sector and in particular the nature of the technological regime (Breschi, Malerba and Orsenigo, 2000). A technological regime is defined by technological opportunities, appropriability of innovations, cumulativeness of technologies and the nature of the knowledge base (Malerba and Orsenigo, 1993). A technological regime identifies the level and sources of new opportunities. Second, it defines specific appropriability conditions, the extent to which an innovator can protect a new idea from imitation, and gain a competitive advantage from it. Third, the technological regime defines the type and characteristics of knowledge that is core to the technology (for example, whether it involves highly tacit knowledge), in particular the extent of cumulativeness of technological development.

Empirical research shows that sectors with distinct technological regimes exhibit distinct innovation patterns because technological regimes provide certain restrictions on firms’ learning, resources and organization and coordination of innovative activities (Malerba, 2004; Parker & Tamaschke, 2005). Peneder’s (2010) recent research on firm and sector innovation types has confirmed that distinct technological regimes exhibit systematic difference in firm innovation types while at the same time emphasizing the significant variety of individual firm innovation behavior. It cannot be assumed that all firms in a particular sector follow similar innovation strategies because sectors and technologies have their variety. Therefore, in addition to the nature of technological regimes within a sector we need to acknowledge strategic differentiation of individual firms (Peneder, 2010). In this paper we
take the perspective of the firm. In seeking to explain variations in patterns of development of entrepreneurial technology firms in different sub-sectors, it is useful to distinguish two kinds of managerial risks originating in the nature of the technology (Malerba and Orsenigo, 1993; Casper and Whitley, 2004): appropriability risk and competence destruction.

*Appropriability risk* captures the risk of being unable to reap the profits of investment in specific economic activities. In Teece’s (1986) formulation, appropriability was determined by a static appropriability regime that was a combination of legal forces and the imitability/complexity of the technology. The legal forces comprise of patents, copyrights, trade secrets and trademarks and is strongly related to the strength of (intellectual) property rights protection in Western developed economies. The technological knowledge underpinning a firm’s innovation involves various degrees of specificity, tacitness, complexity and independence and thus differs across different technologies (Winter, 1987; Breschi, Malerba, and Orsenigo, 2000). Teece’s argument was that in case of weak appropriability regimes firms need to develop complementary assets, such as marketing, standards, brands and relationships, to mitigate these risks.

Recent studies suggest that the legal protection of property rights is not a prerequisite for good appropriability conditions (Dosi, Malerba, Ramello, Silva, 2006). For instance, the role of supporting institutions and the role of finances cannot be overlooked in determining appropriability. Moreover, Teece (2006) indicates the important role of managerial choice in, for instance, determining the business model. In his words, a business model ‘… is the innovator’s hypothesis about what customers want and how an enterprise can go about meeting those needs, getting paid well for doing so, and hopefully avoiding losing out to imitators’ (Teece, 2006: 1142; Doganova and Eyguem-Renault, 2009). In some cases, great degrees of IPR protection might even deter innovative activity due, for instance, to multiple

conflicting claims, high litigation costs, and user innovations (Dosi et al, 2006). Leiponen and Byma (2009) show that especially SMEs may have different forms of cooperative innovation and alternative rent appropriation strategies. In sum, firms in different sectors with distinct market and technical constraints face different levels of appropriability risk and a variety of possible appropriation strategies.

*Competence destruction risk* reflects the uncertainty of technical development in terms of the technological trajectory taken and market acceptance of the innovation. In a general understanding, innovation involves new knowledge or new combinations of existing knowledge. Competence-enhancing innovation builds upon existing competences, whereas competence-destroying innovation obsoletes existing competences (Gatignon, Tushman, Smith, and Anderson, 2002). Competence destruction creates a need for organizations to attract and motivate experts and resources while the outcomes are often unpredictable and might result in dismissal or organizational failure. Moreover, competence destruction is accompanied by a second need for reconfiguring a firm’s structure and organization (Tylecote and Visintin, 2008). In the case that innovations require radically new skills, abilities and knowledge in the development and production of a product or service, the firm has a high risk of destroying existing competences. In sum, firms in different sectors with distinct market and technical constraints face different levels of competence destruction risk and variety of possible mitigation strategies.

In sum, sectors with distinct market and technical constraints carry different levels of competence destruction – and appropriability risks. These characteristics show sectoral patterns and set constraints on the development of organizational capabilities (Hopkins and Nightingale, 2006; Casper and Whitley, 2004; Malerba and Orsenigo, 1993; Parker & Greeven, M. and Van de Kaa, G., 2017. Entrepreneurial technology firms in China’s emerging economy: How technological and institutional regimes shape entrepreneurial conditions, working paper
Tamaschke, 2005). Following a resource-based view of the firm, these managerial risks identify some conditions that affect the requisite resources for innovation (Breschi, Malerba, and Orsenigo, 2000; Kaniovski, and Peneder, 2002; Peneder, 2010). They influence the required resources, i.e. what kind of resources do firms need in order to successfully innovate within their sector. However, research on organization and innovation in China suggests that innovative activity has additional institutional constraints that need to be managed as well.

**Institutional uncertainty: institutional regime**

Following comparative institutional theory, we conceptualize institutions as rules that guide and constrain the coordination of various economic actors and the way they solve economic problems in terms of the nature of ownership relations, inter-firm connections and governing access to critical resources such as labor and capital (cf. Whitley, 2007).

Specifically, institutions influence the availability and accessibility of labor, knowledge and capital resources (Coriat & Weinstein, 2002). Institutions influence a firm’s potential resource base in two ways: first, institutions influence the provision of facilitative resources on a non-market basis; second, institutions provide constraints on the opportunistic use of such facilitative resources.

First, institutions influence the provision of facilitative resources that are made available on a more or less non-market basis, such as knowledge about new technologies and markets, availability of skilled workers of different kinds and access to capital. Firms can use these goods to develop their own strategies. The extent to which firms can develop particular innovation strategies thus depends on the particular institutional arrangements in their resource environment. For instance, some countries, like the USA or UK, have institutional arrangements that are conducive to the development of project-based entrepreneurial
technology start-ups focusing on discontinuous radical innovations. Other countries, such as Germany, have institutional arrangements that are conducive to industries where more complex and stable organizations are effective (Casper & Whitley, 2004). The extent to which these goods are provided by national, local or sectoral institutions determines the embeddedness of organizations in the institutional context (Whitley, 2007). Institutions influence the availability of facilitative resources such as labor, capital and knowledge in a particular country resource environment.

Second, institutions specify and enforce the power and responsibilities of private firms, especially their authority and discretionary use of resources. These institutions include national and local state regulatory requirements, business associations, labor unions, skill formation systems and state technology policies. It is important to note that institutions do not only provide rules that specify the use of resources but also rules that enforce such specifications. We distinguish two types of enforcement rules. Institutions include explicit enforcement rules that are imposed on all agents. One example is the property rights system. In addition there are implicit enforcement rules that are individually designed and that refer to ‘customs’ and ‘conventions’ that are only imposed on groups of agents (Coriat & Weinstein, 2002). Implicit enforcement rules include informal institutional arrangements. However, this distinction between explicit and implicit enforcement rules goes beyond the distinction between informal and formal institutions. The latter does not allow differentiating between rules that hold for everyone and rules that hold for specific groups. Moreover, the formal-informal distinction is difficult to make in changing institutional environments where institutions are a changing continuum and certain informal institutions may well become formal over time. The latter was the case for private property rights in China which existed de facto since, at least, the 1990s, while being formally recognized only recently. Institutional rules vary considerably across societies as for instance, state regulation, educational systems

and extent of unionization vary considerably across societies and over time and influence the competitive behavior of firms (Whitley, 2007). In short, institutions influence the accessibility of facilitative resources in a particular country resource environment by specifying and enforcing the rules of use.

As institutions vary considerably across economies, even amongst relatively stable developed economies, China’s institutional frameworks are significantly different from both developed and other developing economies. China’s scientific and technological development has suffered a severe blow during the Cultural Revolution (1967-1976) which pushed China’s Science & Technology (S&T) system back (Liu & White, 2001). Moreover, China is transforming from a planned socialist economy to a market oriented economy since the reforms started in 1978 (Qian, 2000). Therefore, China poses a substantially different institutional environment for entrepreneurial technology firms.

The emerging and fast developing economy of China undergoes institutional transformations that fundamentally change the key economic agents, available resources and constraints on opportunism (Wright et al, 2005; Peng, 2003; Nee, 1992). China has weak economic institutions as a result of the co-existence of socialist institutions and newly created, market-based institutions (Krug and Polos, 2004). The institutions are not weak because they have a socialist hue, which is traditionally unsupportive of private capitalists, but because there are institutions in place coming from both the socialist era and more market-oriented institutions.

Roth and Kostova (2003) have usefully summarized the consequences of institutional transformation in two features of institutional uncertainty: institutional imperfection and institutional baggage. The former refers to the gap between desired and existing institutions such as a weak commercial code or legal enforcement does not reduce uncertainty caused by technology or market. The latter refers to the legacy of state socialism that is still ingrained
and pervasive in current institutions such as unexpected policy changes, unclear implications of policies and a general lack of trust in the rule of law. Institutions are neither clearly formulated nor effectively enforced, leaving ample room for informal institutions to organize economic exchange. Informal institutions include those traditions, customs, business practices and social norms that are not specified and enforced by regulations that apply to all agents in economic exchange.

The consequences of institutional uncertainty at the firm level can be explained by the constraints that institutional imperfection and baggage put on the availability and accessibility of resources for innovation. In particular, institutional uncertainty increases the risks of governance and limitations of resources. The former refers to the uncertainty regarding which agents are providing constraints on the use of resources, whereas the latter refers to the lack of critical resources.

First, the lack of clarity with respect to who are the key economic actors and what their behavior is increases the risk of governance. Such rules are to reduce uncertainty caused by technology, competition or the market. There is considerable uncertainty regarding who provides resources, i.e. who are the key economic actors. We have seen that there are other key actors in China’s institutional regime as a result of dismantling the socialist state economy: local and central state agents, business associations (business groups both formal and informal), and foreign investors (Zheng, 2007; Krug and Hendrischke, 2008). However, it is unclear how these agents operate and provide constraints. There is geographic and sectoral variation in the involvement of these key actors and the constraints they set on resources (Dougherty and McGuckin, 2008). Moreover, competing levels of government might lead to ambivalent rules, hybrid institutional arrangements and a lack of transparency (Tang, 2010).

Uncertainty also arises when behavior of key actors changes or has unclear implications. For instance, unexpected state policy changes or ambiguous local policies may scare investors and inhibit risky behavior of firms. However, in certain new industries policy makers often cannot keep up with the developments in technology and technology might actually dictate policy. Chinese private entrepreneurs might exploit such institutional delays and institutional ambiguity by moving around relatively quickly and filling niches due to their small size, simple structure, agility and risk-tolerance (Tan and Litschert, 1994; Manolova & Yan, 2002). However, firms might also resort to risk spreading activities like (un)related diversification, developing specific business models and strategic flexibility, creating organization-specific capabilities to offset imitation risks or develop networking capabilities to spot opportunities and resources (cf. Teece’s complementary assets). Summarizing, institutional uncertainty sets additional constraints for entrepreneurial technology firms by increasing the risk of governance.

Second, limitations of resources critically affect entrepreneurship and innovation in China. An example is China’s incomplete labor market. There is scarcity of skilled labor, i.e. availability of qualified labor as opposed to unqualified labor (Farrel & Grant, 2005). Such shortage will lead to heavy competition on the factor market side. This will increase labor mobility and labor turnover in firms (Cooke, 2004). Moreover, skill availability problems create uncertainty for employers as to the competences of the employee. An unpredictable and dynamic labor market leaves employers uncertain with respect to an employee’s willingness to invest in one job or firm and the quality of their skills (cf. Sako, 1992). Strategies for attracting and keeping employees become crucial. One strategy is to have formal labor contracts, however, with incomplete and ill-functioning labor law enforcement, this does not provide good guarantees. Then, there are three alternatives: creating competence...
trust (cf. Sako, 1992); develop work arrangements that commit the employees to the firm; or use corporate governance models to commit employees, all of which increase the costs for firms. So, the risk of resource limitation, such as limited labor resources, can be considerable for firms.

In this study we focus on the potential lack of three critical resources: capital, labor and knowledge. The literature on the liability of newness is relevant here as helps to explain the consequences of a lack of resources at the firm level. Newness is often seen as a liability referring to new organizations’ general resource poverty, lack of legitimacy, and weak ties to external actors provide them with reduced capacity when competing with established players (Teece, 1986; Aldrich and Fiol, 1994). As we have seen in the example of labor resources, these potential liabilities translate into skill availability, competence uncertainty, limited employee commitment that results in high turnover (Cooke, 2004). In the case of capital resources these potential liabilities translate into general scarcity of financial capital, lack of legitimacy and connections to capital providers and/or government officials (Tsui, Bian, Cheng, 2006).

In particular the lack of knowledge has significant effects on Chinese private firms. Considering not only the newness of private firms but also the newness of the whole private sector and the dynamic but uncertain institutional developments, firms are left with a significant lack of knowledge. More precisely, Krug & Polos (2004) identified four types of knowledge that are ‘missing’: business routine, benchmarks, market knowledge, legitimacy.

First, lack of business routine makes it difficult to locate talented employees, business agents such as potential co-operators and banks, and procedures to follow, copy or benchmark. On the one hand, the firm’s inability to increase the level of management to ensure proper coordination and control from within the firm, which might hinder competence enhancement. On the other hand, the firm’s inability to accumulate and develop technical...
skills necessary for innovative competence development might hinder attracting a variety of knowledge for radical innovative activities. Such expertise can hardly be bought or learned through formal or informal education and training. Second, lack of a blueprint: there is no general understanding of how things should go right or wrong and where there is no past experience. In a business environment with few examples of successful firms or few firms in general that could serve as a benchmark, the only way to learn how to run a business is by trial and error, giving rise to risky decisions.

Third, lack of knowledge about the business environment: no general knowledge about demand, prices, or income levels makes it difficult to do systematic research to calculate risks. In radically innovative sectors, where the risk of competence destruction is already considerable, this is less an issue than in incrementally innovating sectors where a lack of understanding market dynamics and procedures to analyse such dynamics, gives rise to additional risks. Especially in a newly emerging industry it is hard to predict which investments are worthwhile. Lastly, lack of legitimacy (Ahlstrom, Bruton and Yeh, 2008): refers to the lack of familiarity and credibility of new activities that constitute the fundamental basis of interaction. In an advanced economy setting, a lack of legitimacy can be interpreted in terms of not understanding fully the nature of the new venture and their conformity to established institutional rules. However, emerging economies usually lack such clearly established institutional rules. It is hard for firms to create such familiarity and credibility in a setting in which it is hard to predict even the overall rules of the game. Especially the unfamiliarity of the market with the new venture and the lack of skills of the customer lead to higher uncertainty of market acceptance. Altogether, institutional uncertainty sets additional constraints for entrepreneurial technology firms by increasing the risk of resource limitation, in particular knowledge resources.
In combination with potential governance risks, firms in China’s uncertain institutional environment face considerable institutional risks for accumulating, mobilizing and employing resources for innovation. Table 1 summarizes the risks originating in institutional uncertainty. Going back to the main research question: why are certain sectors in certain regions of China innovative, especially considering the additional risks of governance and resource limitation? Combining the insights of the sectoral and institutional approaches suggests the following: while sectoral characteristics influence the resource requirements, the institutional conditions influence the availability and accessibility of resources (Figure 1). Therefore, acknowledging the sectoral variety of resource requirements for innovation and variety of the consequences of institutional transition, we expect that institutional transition affects specific sectors more than others because of diverging resource requirements. In what follows we will explore these issues and associated challenges for the design of our empirical study.

**METHOD**

**The Software Industry in Zhejiang**

We choose the software industry as the field of research. The software industry is relatively fragmented with a few major players and many small entrepreneurial firms. The study of the software industry has an exceptional position in that it allows studying both disruptive as well as continuous, accumulative processes of innovation. Considering the expect importance of sectoral variety and distinct market and technical risks, we choose to study the enterprise software, middleware and standard software sectors (Grimaldi and Torrisi, 2001; Casper & Whitley, 2004). Table 2 summarizes the main characteristics of the three sectors.
Beyond choosing a location for the research, the selection of a location reflects the selection of a local institutional frame. The ‘population’, from which we select one location, is a variety of localities across China. The selection takes into consideration the intensive data collection efforts necessary for getting familiar with the local context in terms of language, local culture and developing local networks with research partners and business enterprises. We used three selection criteria and selected Hangzhou as our location: 1) the presence of a significant software industry with distinct sectors; 2) the private enterprise as a dominant form of economic coordination and organization; 3) the success of the locality in terms of economic prosperity and business prospects. The latter is important because the locality is likely to function as a benchmark for other localities and thus enhances the generalizability of this study.

Hangzhou is the capital of Zhejiang Province, a south-east coastal province. At the forefront of economic development, it offers one of the best business climates in China and is one of the centres for China’s booming private sector (World Bank, 2006). A significant share (95%) of enterprises of other types of ownership, i.e. non-governmental enterprises and 90% contribution to gross industrial output of the city, illustrate this point (Hangzhou Statistics Online, 2011). The software industry in Hangzhou is emerging: 23.7 billion RMB in 2005 sales revenues of software products, 300 million dollars worth of software product exports (Hangzhou Statistics Online, 2011). The official statistics of China Software Industry Association (CSIA) registered about 180 firms in Hangzhou in 2005. Over 90% of the software business in Zhejiang province is located within the Hangzhou locality, making it the software centre of the province.

Sample

The above describes the local population of software enterprises from which we selected a sample for the purpose of this study. The selection criteria for firms were as follows: (1) small or medium size (1-300 employees), (2) privately owned, (3) independent software developers, i.e. firms focused on software development rather than other businesses and (4) in one of the three software sectors. The size of the sample was not determined beforehand. The main criterion was saturation. This is neither a consensus-based cut-off point, as is usual in social science research, nor a convenience criterion but a theoretical criterion. It means that past the saturation point, an additional case does not add much explanatory power.

Our sample consists of 45 software enterprises in three distinct software sectors with an average age of 5.8 years (established between 1995-2007), on average 75 employees (6-260) and, if making sales revenues, between 200.000 (Internet software) and 80 million RMB (large scale ERP project for government). Enterprise software is extensively customized software using platforms or modules. On average these firms are 6.6 years old and employ 73 employees (range: 6-200; sd: 62). Standard application based software is written for large homogenous markets. These firms are on average 5.6 years old and employ 46 people (range: 28-100; sd: 27). Middleware is a new sector focusing on interface technologies that link basic architecture of digital communication networks to standard application software, thereby coordinating various technologies. These firms are on average the youngest with 5.4 years but employ the most people, 95 (range: 8-260; sd: 85).

The only way to show how representative this sample is for the population of software firms in Hangzhou is by comparing the size characteristics. A lack of systematic data for the population of software firms in Hangzhou is one of the data restrictions researchers in China have to deal with. According to the CSIA, Hangzhou’s software industry is structured as follows: standard software (33%), enterprise software (32%), newly emerging middleware.
(18%), and hardware/software combinations (18%). Especially the middleware sector is growing fast last 2 years and many new firms are not included in CSIA yet. Most firms are SMEs (87% less than 200 employees) and these have on average 67 employees and average total asset value of 9,300,000 RMB. **Table 3** compares the size characteristics of our sample with the population of software SMEs Hangzhou. The results suggest that the sample is representative for Hangzhou, at least in terms of size, as the averages and standard deviations do not show a different pattern.

----- INSERT TABLE 3 ABOUT HERE --------

A potential sample selection bias is that access to these enterprises was sought via Zhejiang University, the University Science Park and directly via the authors’ personal networks. We take note of the fact that this might not be considered representative by the usual social-scientific standards of Western research practice because all mediators were likely to have applied their own filters to the sample. This is a context specific research limitation, faced by every researcher in China doing in-depth field interviews (cf. Krug, 2004). However, we believe that we have mitigated the majority of the selection biases by not using every ‘suggested’ firm, doing background research on the selected firm, developing a trust-based relationship with local mediators and only surveying firms that fit our criteria.

**Data Sources**

The empirical study is based on firm-level in-depth interview data triangulated with background information. Prior to and after the firm interviews we collected data on the firms from a variety of sources. First, the firm’s website, usually in Chinese, provides relatively detailed information on history of the firm, products, news announcements and partnerships.

with other firms, universities or government agencies. Second, local investment firms provide
detailed information on firms and news for selected industries. Next, a news search in local
and national news websites supplements the cases. Fourth, we contacted the Zhejiang
Software Industry Association and obtained a list of software firms in Hangzhou with product,
personnel size, asset value and website information.

However, the main data comes from in-depth interviews with the firms. In a society
characterized by a large role of informal institutions, as opposed to formal rules and
regulations, a semi-structured interview with considerable time to ‘dig-up’ the story is
preferred. The interviews also allowed the respondents to express their understanding in their
own terms which allows unambiguous communication and establishes communicative
validity. The semi-structured interviews were done with founders.

The interview protocol consists of 65 open questions. A first set of questions (questions 8-16
and 26) deals with innovation and focuses on several examples of innovation chosen by the
entrepreneur. By using real-life examples the discussion is more focused and also allowed us
to get a better understanding of the type of innovation process. Questions on sectoral
constraints were based on ideas and studies from the sectoral innovation system literature.
Sources for questions about these topics were, among others, the studies by Malerba (2004),
Casper & Whitley (2004), Edquist (1997) on systems of innovation. These studies
operationalize the characteristics of technological regimes in terms of: opportunity conditions,
appropriability conditions, the knowledge base, degree of cumulativeness. These four
features of technological regimes form the basis for designing questions about sectoral
constraints (questions 22-36). Questions on institutional constraints are based on a literature
survey of the consequences of institutional change. The first set of questions relates to
specific institutional constraints (questions 37-49): unpredictability of institutional change;

technological and institutional regimes shape entrepreneurial conditions, working paper
limited legitimacy of private firms; competing levels of government; decentralization of government leading to ambivalent rules; hybrid institutions; weak IPR protection; lack of transparency (see for instance Krug, 2004; Tan, 2005; Qian, 2000; Lyles, Saxton & Watson, 2004; Manolova & Yan, 2002). The second set of questions is related to what firms lack in terms of resources: labor, capital and knowledge. The literature on the liability of newness proved useful in singling out four specific knowledge resource limitations (Krug & Polos, 2004; Aldrich & Fiol, 1994): lack of business routines; lack of a blueprint; lack of knowledge about the business environment; lack of legitimacy (questions 50-54). The third set of questions is related to the broader business environment in terms of competitors, customers, technologies and knowledge base in the industry (questions 22-36).

In order to create a coherent set of questions, the choice and design of questions was eventually determined by the fit with the research problem. We developed the Chinese version of the interview protocol in cooperation with a team of Chinese graduate students from Zhejiang University. After the first translation, the protocol was tested in a pilot interview with a two experienced IT managers. We revised the protocol to better fit the language and understanding of an IT professional. The resulting Chinese interview protocol is consistent, coherent and a valid instrument.

**Data Collection and Analysis**

Our data collection and analysis involved three phases. The *first phase* involved semi-structured interviews with Chinese software entrepreneurs by the authors and a research team of Chinese graduate students. The graduate students were all trained by the first author and sat-in at least one interview. The interviews were done in Chinese. The first author was always present and the interviews were done in tandem. The questions were asked by the
students whereas both interviewers took notes. The interviews were not allowed to be recorded. Therefore, interviewers took detailed notes, discussed the notes directly after the interview and then later send and compared each other’s notes. The interviews on average took 1 hour and 15 minutes.

The second phase involved an organized interpretation of our initial data (30 firms) and additional fieldwork (15 firms). The analysis involved a confrontation of our working theory and the extant literature on innovation and technical, market and institutional constraints with the empirical data. This phase involved the creation of cross-sectional displays that indicate the constraints that were unambiguously named by our respondents, similar to Uzzi (1997). After drafting our initial ideas we went back to the field to do return visits to 11 firms and 15 additional interviews with other entrepreneurs. The return visits allowed us to present and communicate some of our initial ideas to create communicative and face validity. Additional interviews were necessary to reach a saturation point, beyond which adding an additional case causes no significant change in the identified pattern.

**Explanation and operationalization of constraints**

The findings show the intensity of the following set of constraints for the private software firms: market & technological constraints (i.e. appropriability risk and competence destruction risk) and institutional constraints (governance risk and resource underinvestment risk). The intensity of constraints can range from low, limited to considerable and high. Low refers to no risks or constraints (i.e. the data suggest that this factor is not identified as a constraint; no uncertainty arises from this constraint and all potential risks are manageable), limited refers to some constraints but that are manageable (i.e. the data suggest that it is noticed as a potential constraint but relatively easy managed, which means that the firm does not have to make specific efforts to deal with the constraint beyond the daily ways of
operating), considerable refers to constraints that require specific efforts but are within the scope of the firm to manage, high refers to constraints that pose serious risks and there is a high amount of uncertainty as to how to deal with this constraint. In short, the move from low to high intensity of constraints corresponds to a move from manageable and calculable risks to high uncertainty.

EMPIRICAL FINDINGS: DIVERGING CONSTRAINTS

The findings are presented as dominant patterns across firms, i.e. the intensity of the constraint and the reasons why these constraints have such intensity are reasons found in most of the interviews. The assessment of intensity never relied on one instance or observation in one interview, it is always based on at least 2 instances across firms in the same sector. Some firms in the same sector may have the same intensity of a particular constraint but for different reasons. If so, this is indicated in the following discussion.

Technological regimes: competence destruction and appropriability risk

First, firms may have competence destruction risks. The innovative activities in the enterprise software sector carry relatively low risks for competence destruction for three reasons. Firstly, the interviews suggested that there are few sudden and unexpected changes in technology. On the one hand, due to the relative unimportance of following state-of-the-art technologies, such as in case 4, 8 and 50. On the other hand, customers required certain technical changes which reduced the uncertainty of adopting a new technology but at the same time increasing customer-specific investments, such as in cases 2, 4, 19. Secondly, firms in this sector extensively customize and integrate products/services for customers’ specific needs, as indicated for instance in interview with firms 4, 10, 12, 19, 52 and 54. For instance, firm 54 develops community management software for government departments. The firm cooperates

with local government departments on so-called ‘informatization’ and e-government projects that require extensive customization. The local government department participates in the development in two stages: early in the research stage, where they propose their demands and in the second round of software development. Fourthly, the customer base is stable either as a result of predictable demand, such as in firms 4, 19, 50, or as a result of high switching costs for the customers, such as in firms 10, 12, 52, 54. Most firms have a few large businesses or local government departments as customers. The firms with government customers develop and maintain rather crucial parts of the software system, resulting in relatively high switching costs for departments and thus lower political risks.

The innovative activities in the standard software sector carry considerable risks for competence destruction for three reasons. Firstly, the developments in technology are fast and often require changes in the technologies the firm use. However, most important is not matching the state-of-the-art technologies but matching technology to the market, such as in firms 17, 42, 46 and 60. For instance, in cooperation with Zhejiang University, firm 42 developed a fast development platform for mobile phone games and data storage technology for successful game development. However, these changes are market-driven and the success of the firm depends on the marketing capability of the firm not the state of their technology. Secondly, the market is the main source for uncertainty. The market is new and customers are unfamiliar with the products which makes it a highly unpredictable market. Customers often want to try out new products and change preferences frequently. Thirdly, customers appear to show little loyalty to products although the evidence is inconclusive mostly because firms find it difficult to say anything about loyalty of customers in such new markets.
The innovative activities in the middleware sector carry relatively high risks for competence destruction for three reasons. Firstly, the developments of software in this sector are strongly dependent on technological changes such as such as the transition from 2.5G to 3G platforms for music and video applications, and three-dimensional applications in websites, such as in firms 13, 18, 22, 45, 47 and 51. In general, the development of technology is fast, so fast that the university cannot keep up and firms resort to industry coordinated development, as illustrated by the so-called Web 2.0 club in Hangzhou with CEOs from the major search engine software developers. Whereas the other sectors technology is still developed by state institutes and universities, in the middleware sector it depends on foreign trends and coordinated industry development. Secondly, the demand of customers is rather uncertain and hard to predict. Although the potential market is large, interviews suggest that the customers are very young and inexperienced with the Internet, making it hard to predict market acceptance. Thirdly, there is much uncertainty about technical standard setting which is done by the government instead of the industry (cf. Casper and Whitley, 2004). Most recently firms are unsure which 3G telecom standard will be assigned to which service provider. They have developed partnerships with state-owned telecom firms in order to get access to large markets and information about standards, not for coordinating technical development.

Second, firms may have appropriability risks. The potential risks of appropriability are high in enterprise software sector for three reasons. Firstly, the core technologies of enterprise firms are relatively simple and suspect to imitation, such as in cases 4, 10, 12, 19 and 50. Secondly, the market is increasingly competitive due to the low entry barriers: either state-owned firms or non-state owned firms or a mix, but all are domestic and mostly local competitors. Although there are some foreign competitors on the market, they are not competing on the same local market. However, the interviews suggest that foreign
competition may increase in the near future, such as in cases 6, 19, 38 and 54. Thirdly, all firms in this sector were concerned about the protection of their intellectual property rights although the interviews suggested that the firms succeeded in developing certain complementary competences, which lowers the risks but increases the coordination costs with other firms.

The potential risk of appropriability is limited in the standard software sector for four reasons. Firstly, the core technology of most of the products – for instance in firms 17, 36, 42 and 58 - is developed over a longer period of time with significant capital and human resource investments, resulting in a relatively hard to imitate and complex product. Secondly, the potential competition in this sector is strong, from both domestic and foreign firms, such as in firms 17, 36, 42 and 46. Thirdly, however, the current environment is still one with few real competitors which facilitates the use of pioneering strategies to create first-mover advantages, such as in cases 36, 58 and 60. Fourthly, the risks of a weak appropriability regime seem to be acknowledged by most firms. However, such risks are not considered to be of central concern for these firms. On the one hand, the firms are very aware of this environment, especially operating in the software business so their strategies consider and acknowledge these risks from day one and focus on mitigating such risks. For instance by developing complex, hard to imitate core technologies and/or create first-mover advantages.

The risks of appropriability are limited in the middleware sector for two reasons. Firstly, most firms do not use very complex technologies but complex, unique business models. Radical innovative activity in this sector is in terms of opening up new market with innovative business models, in contrast to technological innovations. For instance, firm 18’s combination of an acquired BBS community customer base with the E-City brand name – a
popular 3D online digital city plan, also acquired – is a unique model. Firm 22, in contrast, chooses to present itself as a service with traditional values and diversity focusing on localized search capacities. Secondly, we have to note that most firms expect an increase in foreign competition – such as Google and Yahoo – that might hinder appropriability of innovation rents, as suggested by firms 13, 22, 34, 47 and 48.

It is useful to compare the findings between sectors. Firms in the enterprise software sector face low competence destruction risks because there are high levels of customization of products. Moreover, enterprise software firms follow foreign trends and technologies that have been proven to be useful and successful for certain software developments. However, the sector has high appropriability risks due to intense competition but also due to weak IPRs and mostly local domestic competition. Firms in the standard software sector face high competence destruction risks due to technical uncertainty but also due to unfamiliarity with market requirements. Firms have low appropriability risks because of the technical complexity of their products but are also limitedly constrained by weak IPRs. Firms in the middleware sector face high competence destruction risks as a result of uncertainty about standard setting by the government. Middleware firms have low appropriability risks due to complex technology but also face limited constraints from weak IPRs. They innovate radically in business model, while often employing simple, existing technologies.

**Institutional regimes: governance and resource limitation risk**

First, firms may have governance risks. The uncertainty arising from ambiguous governance of resources is high for enterprise software firms. First, many firms face a political risk as most of the enterprise software firms have local government agencies as customers. The highly customized nature of enterprise software development involves specific investments in
individual customers. In the case of business customers this creates stable business relationships based on mutual dependence (or lock-in). In the case of local government agencies that have interests beyond economic interests, such specific investments carry a political risk. Second, one of the reasons mentioned is that after WTO access and opening-up foreign firms get increased attention and supporting legislation that hinders the development of local firms, an argument also found in the critical work of Huang (2003) on the effects of FDI in China. More specifically, local firms are uncertain about how local policy makers will respond to increased foreign competition.

Third, policy changes are unpredictable and unclear in their implications. We can distinguish two types of policy changes: software policy changes and customer’s industry policy changes. In the former the changes potentially affect the strategy and could restrict technology development. However, uncertain changes in policies in the industries of the customers are just as important. For instance, firm 38 operates in the financial industry and explains that the entry to the WTO requires financial reforms which are rather unpredictable for his firm, giving rise to much uncertainty. This implies that preferential policies for software firms are not sufficient for facilitating the development of this industry. In sum, these firms need to accumulate flexible competences that can handle such environment, without destroying their own competences; i.e. increased competence destruction risk.

The uncertainty arising from ambiguous governance of resources is considerable for standard software firms. In addition to changes in current policies some firms are uncertain how the policy environment will respond to the expected increase in competition from both domestic firms and foreign firms, a concern also found in the enterprise software sector. Moreover, the implementation of policy (changes) appears to strongly affect the behavior of firms. The effect of the policies seems unpredictable due to the local implementation of policy. The

oftentimes preferential regulations only appear supportive but – in combination with high implementation costs – stimulate standard strategies and behavior of firms. In contrast to promoting innovation, it promotes homogeneity in products and development processes. The policies are too general to be useful and are more intentions rather than clearly implemented guidelines, as is the case with the policy for supporting university student entrepreneurship that actually does not exist in practice. Furthermore, the preferential tax policy for software firms has many requirements, such as a high annual turnover, which favour large firms instead of small, entrepreneurial firms. However, it must be noted that in many other cases, for instance in technology policy and market policy, the lack of regulation opens up possibility for innovation. In short, the preferential policies often are not implemented to their full purpose but at the same time a lack of ‘constraining’ technology policies opens up opportunities.

The uncertainty arising from ambiguous governance of resources is limited for middleware firms. The firms are not burdened by a large, conservative bureaucracy, can easily establish new networks and expand networks using modern technologies such as e-mail, MSN, QQ and blogs, have enough examples of success and failure in the industry and have limited HRM issues due to their smallness. In general, the role of coordinated development and cooperation within the industry – and little involvement of the government – seems larger than expected. Middleware is an emerging industry, with little direct regulation (mostly indirect via telecom operators). Secondly, there have been considerable changes in policies, such as the earlier mentioned 3G telecom policy and changes in media laws that affect firms such as online advertisement and broadcasting firms 26, 28 and 50. However, the interviews suggest that these policies often follow technical changes instead of influencing technical development. Summarizing, little state interference, newness and incapability of the

government apparatus to follow advanced technological changes limit the institutional constraints. Table 4 summarizes the main sources of governance risk in our sample.

Second, firms may have resource limitation risks. In addition to technical and market risks, the enterprise software firms face considerable constraints from a lack of resources. First, locating and attracting talented employees is difficult and results in a lack of human resource capacity for the firms. Next to an overall scarcity of high quality technical employees, there is competence uncertainty. Competence uncertainty refers to a lack of standardized competences and skills of employees. As a result of limitations in the formal education system and ad hoc in-house training, it is difficult for employers to judge the competences and skills of new but also of existing employees. The HR systems in enterprise firms emphasize stable work relations by using of formal labor contracts and standardized work arrangements. One often used method of standardizing work arrangements and increasing employee commitment to the firm is by organizing in-house training. Therefore, once appropriate employees are recruited, the firms are able to keep them, as a relatively low labor turnover suggests.

Second, the fact that these small firms are recruiting many new employees suggests that they have sufficient financial resources. In fact, 10 out of 14 entrepreneurs do not consider financial resources to be constraining their firm’s development. Only 4 entrepreneurs mentioned that financial constraints might become obstacles for future growth. On the one hand, enterprise software firms have generally low requirements for financial resources. Enterprise software development usually involves the customer and requires relatively limited investments in new technology, as opposed to improving existing

technology. Moreover, such technological development carries relatively limited financial risks which reduce the need to abundant financial resources, such as risk capital. On the other hand, the enterprise software firms receive considerable support from the local government in terms of funding innovative activities and subsidies for office, equipment and tax.

Third, limited market knowledge in combination with a lack of strong brands is a source of concern for firms such as 4, 6, 8, 19 and 38 and partly relates to the inability to locate and attract talented employees and target customers. Next to that, firms face coordination uncertainty. The interviews suggest that there is considerable asymmetric information in the market, where government agencies (capital), business (knowledge and labor) and universities (labor, knowledge) all have parts of information and provide access to key resources. It is noteworthy that the interviews suggest the usefulness and wide variety and high quality of university research in Hangzhou, on which much of the local firms’ technologies are based. Enterprise software needs to coordinate these information sources since they need to integrate labor, capital and knowledge resources for specific customers in customized products. It is noteworthy that there are extensive business networks within the enterprise software market to the effect that they function as mobilization mechanisms for resources and information. The connections within the network are often formalized in contracts or joint development programs.

However, these networks are often exclusive, i.e. not collectively accessible by any firm. These networks are non-rivalrous but exclusive. A potential alternative source for technical knowledge is the foreign firm, however, the entry of foreign firms in the strongly localized enterprise software market is slow. Moreover, even though foreign firms could provide superior technical knowledge, they lack the expertise and experience to meet the requirements of the highly customized and localized enterprise software development.

Although the firms are considerably constrained by lack of certain resources, the highly

competitive environment gives firms enough examples of success and failure to learn from. As a result of intense competition there are many failing firms and some firms do not have successful firms in the same sector to learn from as a result of a niche strategy, as indicated by most firms. Summarizing, the lack of labor, capital and knowledge resources is posing considerable, limited and considerable constraints respectively.

Standard software firms face considerable constraints from a lack of resources. First, new standard software firms have a relatively low legitimacy in labor markets and face a general scarcity of technical employees. Considering the attractiveness of foreign firms and large firms for graduates and experienced employees, new small firms in relatively risky private software business do not often provide an attractive offer for job hunters. Small software firms lack reputation and lack a clear ‘evidence’ of success (i.e. most firms have limited revenues or none at all). Combined with the relatively high failure rates of these firms, it is not surprising that the preference of job hunters is for stable large (foreign) firms. The interviews suggest that attracting suitable employees is one of the major obstacles for developing innovations. In contrast to enterprise software firms, standard software firms know how to locate human resources but lack sufficient finances and credibility as a suitable employer. Moreover, interviews suggest that standard software firms have problems developing routines, gaining market insights and developing and managing technological skills. One of the consequences is a high labor turnover of an average 20-30% per year.

Second, new standard software firms have a relatively low legitimacy in financial markets. The lack of legitimacy plays a role here because the interviews suggest that new, inexperienced firms have trouble getting investments. Considering the relatively underdeveloped formal financial market, i.e. hard to get bank loans, legitimacy and reputation are important to attract private capital or foreign capital. Even though this does result in

considerable constraints in the start-up and early growth phase, only 3 of the enterprises mention that access to capital might become an obstacle for future growth. Standard software firms require large initial investments to start and commit themselves to R&D necessary for developing radical, break-through innovations. One of the constraints on acquiring these initial investments is the lack of diversity in financial sources. Basically, standard software firms have to rely on privately organized capital and complement it with the funds and subsidies they get from for instance Technology Zones. Given their smallness and lack of alternative means of finance, the firms face considerable constraints of financial capital in the early phases of their history.

Thirdly, most firms in the sector have very few similar firms to benchmark or imitate. They are ‘desperate’ for learning skills from anyone available, suggesting that management skills are a key issue, such as in firms 17, 42, 46, 53 and 60. The interviews suggest that the firms lack marketing skills, more specifically, the management and use of brands. The industry in general is too young and dynamic to have built up a collective memory and knowledge of markets, technologies and management. As in the enterprise software sector, extensive informal business networks operate as informal mechanisms to overcome such constraints. In contrast to the enterprise software sector, networks in the standard software sector do not focus on mobilization of resources only but also on coordination of resources. Similar to the enterprise sector, this leads to exclusive use of certain resources for specific groups of economic agents. It is noteworthy that university research plays a significant role in providing knowledge resources, similar to the enterprise software sector. One remaining issue is the scarce IPR protection that constrains firms’ strategic decisions. Firms face the issues of weak IPR protection, resulting in higher appropriability risks. Summarizing, the lack of labor, capital and knowledge resources is posing high, limited and high constraints respectively.
Middleware firms face limited constraints from a lack of resources. First, attracting and managing human resources is a problem for firms. Consistent with the other sectors, there is a scarcity of technical employees. This suggests that there is an overall scarcity of qualified labor in the whole software industry in Hangzhou. However, it is not considered a strong constraint on the development of innovations. One specific result stands out. As opposed to formal labor markets with labor agencies, standardized competences and trustworthy education systems, the interviews suggest that labor mobility in the middleware sector is efficiently coordinated via informal labor markets. Networks of firms keep track of the qualities of their employees and how well they match the firm’s requirements. If they appear match, firms will often suggest employees to move to a firm that is within the partner network. These networks are substantial and include several dozen if not more than hundred firms. As far as my data suggests, this kind of resource sharing is only found within the middleware market. It is not entirely surprising considering the coordinated efforts necessary for innovation and development in the middleware business.

Moreover, the results for lack in capital resources suggest roughly the same as in the enterprise software sector. Only 4 out of 15 entrepreneurs indicated that limited financial resources might pose constraints. The interviews suggest three reasons. First, there is a relatively low need of financial capital. As opposed to enterprise firms, which need long term commitments, and standard software firms, who need large initial investments for R&D, middleware firms are not capital-intensive at all. Second, the abundance of personal capital and venture capital suffices to fulfill the capital needs. Last, also these firms receive additional local government subsidies in the form of offices and tax rebates.

Furthermore, there are limited constraints of lack of knowledge resources. On the technology side, firms collectively follow international standards and technical developments. The firms are relatively weak in technology development. The adaptation of foreign
technology with the use of R&D partnerships with universities provides the firms with enough technical resources. The middleware firms seem to draw on a collective local knowledge of the local business environment. The collective dimension of such knowledge is caused by the presence of extensive business networks that coordinate business information. Again, these networks are diverse and often overlapping, resulting in extensive information distribution among local firms. These networks often include major state-owned enterprises such as local telecom firms. The majority of firms see the presence of telecom operators in Hangzhou and the extensive networks of these middleware firms as a way to mitigate risks of uncertain policy changes and standard setting insecurity. For instance, via early information sharing, as indicated by firms 39, 48 and 49. Summarizing, the interviews suggest limited problems of lack of resources. Table 5 summarizes the main sources for resource limitation risks in our sample.

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DISCUSSION
By opening up and conceptualizing institutional uncertainty and translating it to firm-level effects, we can be more precise about the consequences of institutional transformation. Indeed, technical, market and institutional constraints vary to a great extent across different sectors within the same institutional regime. Table 6 provides a comparison of the findings. Private software firms in a transition economy face the additional problems of lack of resources and the uncertain governance of these resources. The findings in this paper confirm that software sub-sectors have distinct competence destruction and appropriability risks, based on distinct characteristics of different technological regimes. There is also evidence for the diverging consequences of institutional constraints at the firm level. The differential

effects of institutional risks might be explained by the differences in required resources for the various innovative activities. As a consequence not all firms face the same institutional constraints, even if they operate in the same institutional regime. At the same time, this finding underline the importance of understanding the conditions for innovation in relation to the type of innovation and sector while at the same time acknowledging the institutional regime.

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**One institutional regime with diverse consequences**

Although the consequences of institutional uncertainty vary considerable across sectors, these patterns of constraints are within the same institutional conditions. All three sectors are located within and subject to the same institutional conditions; it is the effects of these conditions that vary significantly. If we compare our results across sectors then we find that there is a set of core institutional conditions that matter across the three sectors. More precisely, we find that political risk and changing policies crucially affect the extent of governance risk. For instance, middleware firms do not face political risks as they operate relatively independent from the government as opposed to enterprise and standard software firms. These last two sectors have frequent interaction with local government agencies either because they are customers or important business partners. However, enterprise software firms seem to be most influenced by policy considerations. In general, the enterprise sector is more regulated than the other two sectors. The interviews in the other two sectors do not seem to indicate that this is a problem but opens up possibilities. Even to the extent that technology and market is dictating policy instead of the other way around, as is the case in the middleware sector.

Furthermore, we find that resource scarcity, private capital, local government subsidy, market knowledge, university research, exclusive business networks crucially affect the extent of resource limitation risk. First, scarcity of qualified labor is a key constraint of labor resources. However, in contrast to the competence uncertainty of enterprise software firms and foreign competition for labor in the standard software sector, the middleware sector has developed an alternative informal labor market. Second, all three sectors receive considerable local government support in the form of subsidies and tax cuts. Furthermore, where constraints on capital for enterprise - and standard software firms arise in the limited availability of long-term finance, middleware firms face no such constraints as the provision of personal and venture capital is sufficient. Therefore, the middleware firms have a competitive advantage over the other sectors and are more likely to be successful in attracting necessary capital. Third, the findings suggest that enterprise software and middleware firms lack a collective memory and have limited market knowledge as opposed to middleware firms. They have an advantage of strongly localized knowledge. All sectors have extensive business networks that differ in level of formality and governance mechanism. Next, foreign technology plays a role for enterprise software and middleware firms but not for standard software firms. University research appears to be a strong collective resource across the sectors.

Findings compared
It is useful to compare our results to Casper and Whitley (2004) because they also analysed the connection between institutions and technological risks for the software sectors. The managerial constraints seem to follow the general pattern of the software industries in Sweden, UK and Germany but for different reasons. Obviously, Hangzhou’s institutional regime is different from those of Sweden, UK and Germany. The key differences are in the
governance systems. The labor market in Hangzhou there has a general scarcity in competences, low geographic mobility and high workplace mobility that makes it difficult for employers to commit employees to their firm. Furthermore, the labor market is inefficient in terms of recruiting and retaining employees. The financial system is highly biased towards private capital and foreign investments. Increased private savings and (foreign) investments in tertiary industries provide opportunities while a low availability of bank loans and strong competition for private and foreign capital limits the effectiveness of the local financial market. Germany on the other hand has a relatively coordinated financial and labor market, with powerful trade and industry associations and labor organizations that coordinate the labor mobility. Again different is England’s liberal market. Financial and labor markets are largely deregulated and have little room for collective actors such as unions.

The enterprise software sector faces low competence destruction risks because there is high customization but also by following foreign trends. The sector has high appropriability risks due to intense competition but also due to weak IPRs and mostly local domestic competition. The standard software sector has high competence destruction risks because of the technical uncertainty but also due to the unfamiliarity of the unskilled customer. Firms have low appropriability risks because of the technical complexity but are also limitedly constrained by weak IPRs. Middleware firms indeed face high competence destruction risks due to uncertainty about standard setting, but not by the industry but by the government. Lastly, middleware firms have low appropriability risks due to complex technology but also face limited constrains from weak IPRs. They indeed innovate radically but in business model, often following existing technologies developed in the US. In combination with the insights from our analysis of liability of newness and institutional uncertainty, this study provides insights in how the Chinese software sectors are different from the European counterparts.
Limitations

The study’s explanatory power is constrained by the location and sectors. First, the study is done in Hangzhou; for the purpose of this study Hangzhou is an appropriate research setting. However, the findings cannot directly be used in other institutional settings. Nevertheless, we expect that the lessons learnt from local samples can tell us something about mechanisms, or relations between variables, even though the local contexts might differ. It should be noted that Hangzhou is at the forefront of economic and technical developments and therefore is likely to be a benchmark for other regions, which increases the potential generalizability of our findings. Moreover, it is likely to find similar patterns in regions with similar business climates such as Qingdao, Shaoxing, Suzhou, Xiamen and Yantai (World Bank, 2006).

Second, the study uses a sample of software firms. Innovation patterns differ markedly across sectors, as evidenced by the sectoral innovation system literature (Malerba, 2004). Nevertheless, sectors that are dominated by private firms and have similar technical and market characteristics are likely to share similar patterns of innovation and antecedents. Further research in sectors such as IT services and biotechnology should validate this expectation while new studies on dissimilar sectors should explore different patterns of innovation.

CONCLUSION

The consequences of institutional uncertainty for firm innovation in China are not straightforward and not necessarily negative. Although the firms in our sample face the same institutional regime (i.e. one locality), our findings suggest that the constraints for entrepreneurial technology firms caused by institutional uncertainty are not similar across sectors. In particular, resource limitations and governance problems have different

consequences for different sectors. Institutional constraints appear not only to constrain the development of competence enhancing innovations – such as in the enterprise software sector – but also the development of particular competence destroying innovations – such as in the standard software sector by increasing competence destruction and appropriability risks. However, innovative activities of middleware firms do not appear to be constrained by lack of resources or institutional uncertainty. This suggests that institutional constraints are not always constraints as such. Considering these different effects, we can no longer assume that institutional constraints are similar across sectors because resource and governance requirements differ across sectors. Moreover, as this study was done in one particular locality, Hangzhou, with its particular institutional conditions, it is likely that the effects of institutional transformation for organization across different localities in China are also diverging. These findings lead us to the following insight: Institutional constraints have diverse effects on entrepreneurial technology firms across different sectors as a result of diverging resource requirements.

The analysis shows why we find a wide variety of innovation at the firm and sector level despite the joint situational constraints of institutional transformation. The findings of the analysis emphasize the double faced character of institutional transformation: restrictions and opportunities. Certain institutional features, such as limited access to bank loans, limit the development of enterprise software firms, while less affecting middleware firms which therefore enjoy a competitive advantage. All in all, this study shows that the effects of institutional transformation vary across sectors and firms with different resource requirements.
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Figure 1: Institutional and technological regimes affecting the resource base for entrepreneurial technology firms

- Technological regime
  - Competence destruction risk
  - Appropriability risk
- Institutional regime
  - Governance risk
  - Resource limitation risk

Resource base for strategic consideration

available & accessible resources

resource requirements

Table 1: Institutional uncertainty

<table>
<thead>
<tr>
<th>Limitations in resources</th>
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<tbody>
<tr>
<td>• Labor resource limitations: skill availability, competence uncertainty, employee commitment</td>
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<tr>
<td>• Capital resource limitations: general scarcity, lack of legitimacy and connections to capital providers</td>
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<td>• Knowledge resource limitations: lack of legitimacy, market knowledge, business routine, benchmarks</td>
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<th>Risks of governance of resources</th>
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<tbody>
<tr>
<td>• Variety of economic agents: local, central governments; business groups; foreign investors</td>
</tr>
<tr>
<td>• Unpredictable behavior of key actors and regulators: uncertain implications</td>
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<tr>
<td>• Competing interests among economic actors</td>
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Table 2: Characteristics of software sub-sectors

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<th><strong>Enterprise software</strong></th>
<th><strong>Standard software</strong></th>
<th><strong>Middleware</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Product/service</strong></td>
<td>‘Total-solution’ (e.g. ERP†)</td>
<td>Novel product (e.g. Computer games, CAD‡)</td>
<td>Application, interface (e.g. Search engine, secure payment)</td>
</tr>
<tr>
<td><strong>Customers</strong></td>
<td>Few, heterogeneous</td>
<td>Many, homogenous</td>
<td>Very few, many users, homogenous</td>
</tr>
<tr>
<td><strong>Cost model</strong></td>
<td>Service contract, initial sale, upgrade</td>
<td>Sale, licensing</td>
<td>Revenues of users</td>
</tr>
<tr>
<td><strong>Customization</strong></td>
<td>High</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Innovation Pattern</strong></td>
<td>Incremental, systemic</td>
<td>Radical, stand alone</td>
<td>Radical, modular</td>
</tr>
<tr>
<td><strong>Capabilities</strong></td>
<td>Knowledge of full process; collective/firm capabilities</td>
<td>Novel, creative development; individual capabilities</td>
<td>Coordinating innovative activities; individual capabilities</td>
</tr>
</tbody>
</table>

† Enterprise Resource Planning
‡ Computer Aided Design
Table 3: sample versus population size characteristics

<table>
<thead>
<tr>
<th></th>
<th>Population</th>
<th>Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard software</td>
<td>Mean: 65; sd †: 53</td>
<td>Mean: 46; sd: 27</td>
</tr>
<tr>
<td>Middleware</td>
<td>Mean: 75; sd: 61</td>
<td>Mean: 95; sd: 85</td>
</tr>
<tr>
<td>Enterprise software</td>
<td>Mean: 62; sd: 79</td>
<td>Mean: 73; sd: 62</td>
</tr>
<tr>
<td><strong>All</strong></td>
<td><strong>Mean: 67; sd: 64</strong></td>
<td><strong>Mean: 71; sd: 58</strong></td>
</tr>
</tbody>
</table>

† sd = standard deviation
Table 4: Determinants of governance risk

<table>
<thead>
<tr>
<th>Institutional constraints: governance risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Political risk: Local government as customer and business partner, conflict of interest with local government, local government as regulator</td>
</tr>
<tr>
<td>• Changing policies and industry regulation: Changing local policies: either influencing government as customer or changing customer’s industries’ legislation. Uncertain response to (foreign) competition and policy for foreign firms inhibiting local firms</td>
</tr>
<tr>
<td>• Unclear implementation and enforcement at local level: Policy lagging behind technology and market developments and policies promoting standard behavior, inhibiting innovation</td>
</tr>
</tbody>
</table>
Table 5: Determinants of resource limitation risk

<table>
<thead>
<tr>
<th>Institutional constraints: resource limitation risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources for limitations in labor resources:</td>
</tr>
<tr>
<td>• Overall scarcity: Scarcity of high quality technical employees and foreign firm competition in labor market</td>
</tr>
<tr>
<td>• Competence uncertainty: need for in-house training and recruitment from other firms</td>
</tr>
<tr>
<td>• Informal (personal) labor markets</td>
</tr>
<tr>
<td>• High labor turnover</td>
</tr>
</tbody>
</table>

| Sources for limitations in capital resources:     |
| • Extensive government funding and subsidies with restricting requirements. |
| • Limited availability of committed long-term professional finance and (over)reliance on private capital |

| Sources for limitations in knowledge resources:   |
| • Limited market knowledge: Slow entry of foreign firms with superior knowledge; localized knowledge and extensive local informal business networks; limited collective industry knowledge |
| • Coordination uncertainty: government/business/university, reliance on university research |
| • Weak enforcement intellectual property rights    |
Table 6 – Comparison of findings: diverging technological and institutional constraints

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Enterprise software</th>
<th>Standard software</th>
<th>Middleware</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competence destruction</td>
<td>Low</td>
<td>Considerable</td>
<td>High</td>
</tr>
<tr>
<td>Appropriability risk</td>
<td>High</td>
<td>Limited</td>
<td>Limited</td>
</tr>
<tr>
<td>Labor resource limitation</td>
<td>Considerable</td>
<td>High</td>
<td>Limited</td>
</tr>
<tr>
<td>Capital resource limitation</td>
<td>Limited</td>
<td>Considerable</td>
<td>Low</td>
</tr>
<tr>
<td>Knowledge resource limitation</td>
<td>Considerable</td>
<td>High</td>
<td>Limited</td>
</tr>
<tr>
<td>Governance risk</td>
<td>High</td>
<td>Considerable</td>
<td>Limited</td>
</tr>
</tbody>
</table>