Risk analysis on real estate investment decision-making

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Proefschrift

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Preface

In the early 1990, the real estate industry was booming in China. For the purpose of benefiting from this "money-machine" industry I left my permanent job and joined a real estate company with a bit of adventure in 1992. The real estate industry in China has enjoyed dramatic growth from 1992 to 1994.

However, the first bottom of the real estate cycle arrived in China in the end of 1994. Everybody in the real estate business started to think about the concept of "risk". Since I graduated with a Master of Science the company asked me to investigate risk before any project is approved.

In 1995, I obtained a grant from the Netherlands Fellowship Program to attend a three-month workshop "Construction Project Management" at IHS (Institute for Housing and Urban Development Studies) in Rotterdam. By chance, the lecturer at this workshop was Rudi Atman who was also lecturer in the Department of Real Estate & Project Management (Bouwmanagement & Vastgoedbeheer-BMVB) at Delft University of Technology. Rudi Atman assisted me to contact this department and Paul Althuis, who is the director of the Central for International Cooperation and Appropriate Technology at Delft University of Technology, for assistance in finding both a research position and funding resources. With the support of BMVB and Paul Althuis, I came to TU Delft in 1996 and started the prepar-ation of my research subject - risk analysis on real estate investment. However, since I had no commitment for either supervisor or budget, the progress was not promising.

Eventually my life reached a turning point when Hans de Jonge decided to be a supervisor for my PhD research. I was more than lucky to have him as my tutor since he offered me the most important thing for any research, which is freedom. I had the freedom to choose a research topic, freedom to attend conferences, freedom to take courses from other universities, freedom to contact anyone who might be helpful for the research. All this freedom was not only backed by his intensive knowledge and extensive network of real estate academics and industry but supported by his resources as well. In my first meeting with Hans de Jonge he surprised me by saying that real estate investors in Holland make their decisions to a large extent relying on their experience instead of quantitative tools. I was thinking that investors here must be equipped with a sound quantitative tool to calculate risks involved before making their decisions. After a few interviews with people from academia and industry, Hans' statement was verified. Naturally, I started to look for the links between risk and judgment. If experience and judgment can play an important role in risk analysis for decision-making in the real world, there must be some theory concerning both subjects (judgment and risk).

A literature search led me to Roger Cooke who is the professor for risk and decision-making at Faculty of Information Technology and Systems of Delft University of Technology. The book "Experts in Uncertainty" provides the Classic Model to measure the performance of expert judgment and further combining group judgment based on individual performance. I realized that this model provides a bridge between judgment and risk analysis. Again, I am very lucky that Roger Cooke was willing to supervise my research. Roger spent a large amount of time helping me to explain the mathematical foundation of the model. In addition, he invited me to join many seminars and presentations of his department to exchange ideas on relevant subjects. I would not have gone on with this subject if I had not been fully supported by Roger Cooke, it was essential to have Roger's model for me to accomplish this research.

After interviews with several institutional investors, I was amazed by the fact that institutional investors are transferring their investment from direct real estate (ownership of buildings) to indirect real estate (ownership of shares). This trend requires investors to analyse their investment risk for both buildings and shares. Professor Piet Eichholtz has studied indirect real estate extensively. He helped me find an appropriate topic of studying real estate shares and gave a lot of important advice during my research. Also, as a partner of Global Property Research (GPR), he convinced GPR to provide me data concerning all listed European real estate companies which was critical for this research.

Since all investors are very strict about data confidentiality, having cooperation from them was critical for this research. Real estate investors such as Shell Pension Fund, ING Vastgoed, PGGM and Winkel Beleggen Nederland (WBN- now Corio) provided support in the form of both data and personnel for case studies.

Based on all support mentioned and almost four years of work, this book aims to provide a practical tool of quantitative risk analysis for real estate investors, it provides a novel approach for quantifying the uncertainty of real estate market variables and then analyse the risk of investment by using expert opinion.

Great thanks to Hans de Jonge and Roger Cooke for their support, guidance and encouragement throughout the course of this research. Thanks to Piet Eichholtz for his support on the subject of real estate shares. Also, I would like to thank Professor Frits Seijffert for his assistance of finding investors who are willing to support this research.

Special thanks are due to Rudi Atman and Paul Althuis for their great help in bringing me to TU Delft. Also, I would like to thank Peter de Jong for his technical support of developing a computer application of the model, many thanks to John Heintz for his great work of checking and correcting English writing of this book, and many thanks to my colleagues of the department of Real Estate & Project Management.

Last but not least, I would like to thank my wife Ping, my son Han and my parents for their support and encouragement during my research.

Qing Xu
March 2002, Delft

1 Introduction

1.1 Real estate investment decision making

Real estate has a long history as an investment vehicle for institutional investors. Although investors hold various forms of real estate from buildings to real estate shares, the principal purpose of holding real estate as a part of the portfolio remains the same: diversifying the risk of the total investment portfolio.

Return on real estate investment is measured by the change in value of the investment portfolio, while risk is related to the chance that future portfolio values will be less than expected. For example, real estate investors buy properties with initial capital investment, and expect the growth of future value of properties. Since this expected return (change in value) is not certain in the future, risk (chance of return which is lower than expected) exists before the return is realised.

Real estate investment may reduce the overall risk of the investment portfolio since its distinctive differences from other asset classes such as common shares, bonds and cash. Therefore, most institutional investors have a clear strategy of holding some kinds of real estate with a certain weight in their portfolio for the purpose of diversification. However, how much real estate, how much in one sector or one location of real estate and what forms should be held, are not as clear as the general strategy.

Investment strategy such as capital allocation has evolved dramatically over the last decades in the financial world. Many sophisticated quantitative models have been developed to measure the investment risk and return in order to construct an optimised portfolio. In the real estate world, the conventional strategy of portfolio construction still plays an important role in making investment decisions, this is called the deal-by-deal approach. In this context, return (yield) on investment is explicitly important for decision makers, while the risk is not formally analysed in most cases, particularly in the portfolio context.

The prevailing view in real estate investment is that attractive portfolio performance is assured as long as a manager assembles a group of "good deals" in one portfolio (Louargand, 1992). The real estate performance in the last several cycles clearly revealed the disadvantage of the "deal by deal" approach. An aggregation of "best" deals may have very poor return when the real estate market is in the bottom of the cycle. Although real estate investment is less volatile than the stock market, ignoring the risk of real estate investment may result in very poor performance, as has been proved in global property markets.

Basically, there are two issues in real estate investment decision-making regarding risk. The first is that the project evaluation is not based on extensive property research and market analysis. The rent and expenses projections are driven by inflation expectations, little attention is paid to the reliability of rent forecasts. The second is concerning portfolio strategy: most investors don't develop their investment strategy based on extensive portfolio risk analysis. Development of a real estate investment strategy must be based on the risk and return profiles, as is required by the investment market. Investors or shareholders are less concerned about the deal-by-deal transaction; they need stable performance of real estate portfolio that could beat or at least equal benchmark performance. The most widely accepted investment performance criterion is risk-adjusted return rather than return only. The target return is not the only criterion for investors, it has to be adjusted by corresponding risk. Real estate investors need clear strategy to realise their investment objectives regarding the risk-return trade off. Therefore, the two issues have the same contents: how to analyse and quantify risk involved in the real estate investment.

In the theory of finance the risk concept has undergone development over recent decades. Knowledge and techniques developed in the financial market are being applied in real estate investment (De Wit, 1994). It helps real estate investors to set up their strategy according to modern portfolio theory and other pricing factor models. However, insufficient data and information frequency limit the real estate investor in making the explicit analysis of real estate assets, just as it does in the financial market. Therefore it is necessary to develop alternative techniques to evaluate real estate investment on the project, portfolio and strategic level to fulfil the investment objectives. The purpose of this research is:

TO DEVELOP A QUANTITATIVE METHOD TO ANALYSE AND MEASURE RISK IN REAL ESTATE INVESTMENT.

So far, real estate investment refers particularly to direct real estate investment, investors directly invest in buildings. In this research we concentrate on risk analysis for direct real estate investment. However, since indirect real estate is becoming a part of the real estate portfolio for most institutional investors, the subject of indirect investment is also studied.

There are various definitions of direct and indirect real estate investment. Sometimes, these are respectively denoted as public and private real estate investment. The major differences between these investments lie in the contents of ownership. Direct investors own the buildings or properties directly; while indirect real estate investors own the share of the building or a portfolio. The share can be listed or non-listed. The risk analysis for both investments also differs with respect to ownership. The trend of investing in indirect real estate is due to the advantage of low operating cost and high liquidity. In recent years, many investors are securitising their buildings into listed and non-listed funds. Indirect real estate has gradually become an essential part of the real estate portfolio for institutional investors. The question is whether this movement really improves the performance of the investment portfolio? The motivation for holding real estate as a part of the investment portfolio is to diversify the risk. The diversification benefit of investing in indirect real estate has been studied intensively. Researchers found that indirect real estate still has diversification effects just as direct real estate does in some cases (Eichholtz and Hartzell, 1996). However, there is some contradictory evidence of diversification effects of indirect real estate investment. For the purpose of assisting investment decision-making over indirect real estate assets, this research will also explore the area of indirect real estate investment.

1.2 Risk and return

Risk is regarded as at least as important as return in the financial market. Financial risk quantification is a routine task for most investment managers. Various techniques are used for measuring the investment risk, e.g., mean-variance approach[1] and value at risk.[2] As an asset class of investment portfolio, real estate investment is also required to be measured by both risk and return in order that it may be compared to the performance of other financial instruments. Due to both the lack of the tool for analysing risk and the tradition of this industry, real estate investors were used to set the target return for their real estate investment, but they were not confident enough to set risk targets. Investment objectives should combine risk criteria to ensure that the investment return fluctuates in an acceptable range.

In general, the return on investment can be defined by some objective economic and financial variables such as net present value, internal rate of return, net yield, cost benefit ratio, capital growth, cash flow return and total return, etc. Risk is considered as a probability distribution of the return. Stated another way, risk is the probability of future return being lower than expected return. Uncertainty is a term related to risk. Some definitions try to draw a distinction between risk and uncertainty in the following manner. Risk is measurable in terms of probability outcomes, so that risk has statistical measures and is therefore "known". Uncertainty is not measurable (Byrne and Cadman, 1996). This distinction may be useful in conceptual terms, but it has limited value in practical risk analysis. In this research, uncertainty refers to unexpected situations and risk is the potential consequence for the investment objectives. In other words, risk is related to the target criteria of investment as a whole as perceived by the decision-maker; uncertainty is all related variables that may have impacts on the target criteria.

1.3 Scope of the research

Since risk is a very broad subject it is necessary to define the scope of risk. There are numerous potential factors influencing the expected return on real estate investment. Four risk categories are presented below (Greer, 1997):

- **Operational risk:** caused by management problems,
- **Credit risk:** the potential loss caused by the inability of a counterparty to meet its obligations,
- **Liquidity risk:** The risk that arises from the difficulty of selling an asset in a timely manner. It can be thought of as the difference between the "true value" of the asset and the likely price,
- **Market risk:** uncertainty of future earnings and capital value resulting from changes in market conditions.

Operational, credit and liquidity risks are subject to individual investor or project involved, investors in general may have control over these risks to some extent. However, market risk is caused by market movement, the individual investor is not able to control this kind of risk, therefore it is crucial to measure and monitor the market risk for investment decision-making.

This research focuses on market risk for real estate investment. There are two concepts of market risk, one is absolute risk referring to the possible loss of the investment due to the change of market situation; the other is relative risk referring to the difference between the performance of a customised investment portfolio and a benchmark sometimes called "tracking error". Both risk measurements are investigated in this study.

After having defined the scope of risk for this research, it is necessary to describe the scope of "Risk Analysis". Risk analysis includes risk identification, risk measurement and risk response. Sometimes, this is partial or the whole risk management. In our research context risk analysis means techniques that can quantify the uncertain factors and their impact on the returns for investment portfolios. In principal, with these techniques we are able to measure the uncertainty of real estate market variables in the form of probability distributions. Further, the risk in objective variables such as return can be quantified. In addition risk analysis can be applied to both the individual project and the portfolio.

Having defined the context of research on risk analysis and real estate investment, the next section sets the research questions of this research.

1.4 Research questions

Quantitative risk analysis has to date not been formally integrated with real estate investment decision-making. In addition, risk analysis is not explicitly expressed in most investment proposals or performance measurements in the portfolio context (Daniel, 1997). The major reasons for insufficient risk analysis in real estate investment are:

1. There is limited historical data for the real estate market, so it's difficult to quantify the uncertainty of those variables. The quantified uncertainty is the critical input for quantitative risk analysis;

2. There is no an appropriate technique for quantifying risk in a real estate portfolio. Although there are many models for general financial portfolios such as shares and bonds, they are not directly applicable to real estate portfolios;
3. Other reasons may result from the tradition in the industry of relying on experience-based decision-making, and also a lack of professionalism compared to the financial industry.

In a word, the obstacles of risk analysis in real estate investment are data and modelling techniques.

The research question focuses on the two major issues of risk analysis in real estate investment, particularly on data resources and simulation techniques. They are presented as follows:

A. How to measure or forecast the uncertainty of real estate market variables such as rent?
B. How to apply portfolio theory to real estate investment regarding risk measurement and portfolio optimisation?
C. What are the risk factors for indirect real estate such as real estate shares?

In answering those research questions, the following sub-questions have to be explored:

1. What is the current state of academic research regarding quantitative risk analysis and the implication for professional investors?
2. What is the current practice among institutional investors concerning risk analysis in real estate investment decision-making?
3. How to apply expert opinion method for forecasting real estate market?
4. How should a quantitative tool for real estate portfolio risk analysis be developed?
5. What are the implications of this research for academics and investors regarding risk analysis?
6. What are the relationships between indirect real estate (real estate shares) and common shares (European market) in terms of risk factors?

The next section describes the goal of this research.

1.5 Objectives of the research

The research questions clearly indicate that this research is to develop a method for quantitative risk analysis on real estate investment. Figure 1-1 shows the expected tool that is consisting of three parts.

Part A: this part is able to assign the probability distribution to variables that have impact on the return of real estate investment. The products of the Part A are the inputs for the simulation model (Part B).
Part B: this part is a processing or calculation engine for the model. Based on

the relation between input variables and investment return, all inputs from Part A are sampled and calculated to generate the probability distribution of return. Sampling of variables follows the rule of correlation between variables. **Part C:** this part is an optimisation model. This model compares the risk-return of alternative investment portfolios and provides the optimal portfolio with highest risk adjusted return or other pre-defined criteria.

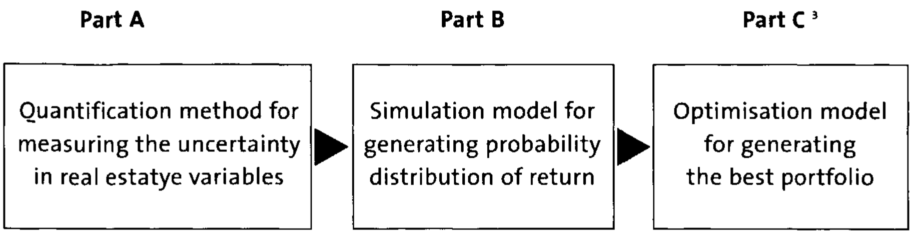


Figure 1-1 Expected results of the research

For realising the goal of the research, all questions in section 1.4 have to be answered. The following section describes the research methodology used for the research.

1.6 Research methodology

Case studies

After defined research questions, the next step is try to select research methods. Literature reviews provided the evidence that input data and appropriate model are major issues for applying quantitative risk analysis. However, there are some questions remaining to be answered before the development of the model. For the purpose of identifying the current problem of risk analysis for both academics and professionals, we select the case study as a tool to collect all information related to issues of uncertainty in the market, the current investment decision-making process, risk measurement and portfolio analysis.

The case study approach includes historical data analysis, review of investment proposals, investigation of decision-making process, and interview and questionnaire surveys among professionals and researchers (Stake, 1995). The results of case studies should generate the research questions and objectives. In addition, important risk factors in real estate investment can be identified. The proposed risk analysis model can be tested in the further case studies. After obtaining feedback from the application, the model can be improved and finalised. We therefore believe that case studies are the most important part of our research technique.

Expert opinion

The next question is about the alternative method of forecasting the uncertainty in the market. Due to insufficient historical data, we have to use other methods instead of using historical and fundamental models. Since real estate investors rely to a large extent on their professional judgement in forecasting the market, we will attempt to find a scientific method for using expert opinion to quantify uncertainty. This method should have two functions including deriving individual opinion appropriately and combining group opinion in a sensible way. The first function provides the quantification of uncertainty based on individual opinion; the second function offers a way of reaching consensus within the group. In his book "Expert on Uncertainty", Roger Cooke (1991) provides a "Classic Model" which can calibrate the expert opinion in the form of a probability distribution and combine the group opinions based on individual performance. Further, we found this model has been applied in various areas and has received positive feedback. In addition, during the application of the "Classic Model", a protocol of deriving individual opinion has been developed which aims to reduce human error (Cooke and Goossens, 1995). After investigating the "Classic Model" and in discussion with Cooke and Goossens, we decided to use the "Classic Model" for forecasting the real estate market.

Simulation and Optimisation

Provided the uncertainty in market variables is quantified, the next step is to measure the risk of the investment by certain methods. There are two frequently used methods for calculating investment risk. The first method is called the analytical method. This method assumes the expected returns on investment follows certain probability distributions, this distribution can be described by a few parameters. For instance, if expected returns are normally distributed, then the risk of the investment can be measured by the variance or standard deviation. Variance or standard deviation can be calculated analytically by certain formula. In addition to the assumption of certain distributions, this method requires a linear relation between return and market variables. Since these two assumptions are not in line with the characteristics of returns on real estate investment, we selected a second method for measuring the risk: the simulation method. Unlike the analytical method, the simulation method has no limitation on the type of distributions and the relation between returns and variables. By sampling the data from distribution of variables, the simulation method recalculates the return, distribution of return is generated by multiple samplings. David Vose (1996) describes the theory and application of simulation for risk analysis.

One of the purposes of risk analysis is to construct the optimal portfolio with highest return below a certain risk level. Optimisation technique is used for generating the optimal portfolio under certain constraints. For instance, by giving the maximum risk constraint, the optimisation tool may find an optimal portfolio that provides the highest return.

Econometric Analysis

In addition to the risk analysis for direct real estate investment, we are also looking for the method to analyse risk in indirect real estate investment. To answer the question of whether indirect real estate may provide the diversification benefits of direct real estate, we should investigate whether the fundamental risk factors of indirect real estate such as real estate shares differ from common shares. Since there are sufficient historical data concerning returns of real estate shares, we select the econometric method (see Greene, 1997) to test following hypothesis:

"Real estate shares have different risk factors from common shares".

1.7 Organisation of thesis

After the introduction in Chapter 1, the development of risk analysis techniques and models in finance will be reviewed. These financial models lay the foundation for risk analysis in real estate investment. The economic and physical environment of real estate investment is then described, and the risk factors in real estate investment are presented. Furthermore the modelling and theory used to identifying the uncertainty in the risk factors and to measure risk in real estate investment are defined in Chapter 2.

The Classic Model is used for forecasting the market uncertainty of real estate variables such as rent. Chapter 3 mainly introduces the Classic Model as a theory of expert opinion. This model will be adjusted for measuring real estate market variables. The rent forecast by the Classic Model is applied to the real estate investment portfolio. For reasons of market data availability, this model is tested by forecasting prime office rents in four major Dutch cities. The results of applying Classic Model to the real estate investment are presented and discussed in Chapter 3.

For the purpose of quantifying the risk of objective variables such as total return on investment, Chapter 4 describes the real estate portfolio simulation. The simulation model uses a covariance matrix to simulate the volatility of variables and their correlation. The probability distribution of total returns can be derived by simulation. If certain constraints are defined such as hurdle return or given risk level, the portfolio can be optimised in terms of optimal weight of sectors or locations. In addition, once the uncertainty of volatility is introduced, the optimised portfolios will not be located in a single efficient frontier, instead the optimal portfolio area is defined. In the end of Chapter 4, the importance and impact of optimal portfolio area on decision-making are illustrated.

In Chapter 5 risk analysis of indirect real estate investment is investigated. First, we make use of econometric techniques to find a systematic relation between the firm's internal characteristics and the risks entailed. Based on well-accepted risk factors of common shares, this Chapter tests the hypothesis that common risk factors have the same roles for real estate shares, and if they have, to what extent? The results of the test are important for investment strategy. If real estate shares have the same risk factors as the common shares, the diversification benefit of holding real estate shares is limited. Otherwise, it's valuable to hold real estate shares as part of real estate portfolio for the reason of liquidity and efficiency.

Chapter 6 describes the computer model for real estate portfolio analysis. Based on the input from the expert opinion method, the simulation and optimisation techniques developed in Chapter 4, this Chapter presents the completed package for portfolio risk analysis. First, the structure and process of the model is explained; second the content and the functionality of the model is discussed; finally the potential application area and limitation are investigated.

(notes)

1 Mean measures the average value of the distribution used for return; variance measures the dispersion of the distribution used for risk.

2 The potential loss caused by the market movement at the certain confidence level within certain period.

3 The best portfolio refers to the portfolio with highest return with an accepted risk.

2 Risk analysis techniques and financial models

2.1 Introduction

This Chapter reviews risk analysis techniques and models applied in the general investment and real estate world. In the business world, risk analysis is usually defined as a process of identifying the possible outcomes of expected return. Risk analysis is a "number crunching" activity. It is a search for probability distributions that yield insight into random returns volatility. However, assessing the degree of risk in investment decisions involves more judgement than mathematical reasoning. It requires pulling together disparate pieces of information and relating them coherently and effectively to the solution of the risk puzzle.

Basically, two techniques are used for identifying the risk involved in the real estate investment, there are qualitative and quantitative techniques. Although this study focuses on the quantitative risk analysis, qualitative techniques are also used for finding out the critical variables.

In this Chapter, we first describe the difference between qualitative and quantitative risk analysis techniques. In the second part of this Chapter, portfolio theory and other financial models are discussed in detail. The mean-variance approach is used for measuring risk in a direct real estate portfolio, while the Capital Asset Pricing Model (CAPM) is used for measuring the risk of real estate shares. In the end of this chapter, the method of deriving input for the risk analysis model is discussed and the Classic Model is suggested for this research.

2.2 Quantitative risk analysis techniques

Quantitative risk analysis aims to represent the likelihood and impact of risks in terms of expected returns on investment. The following is an introduction to the general knowledge of probability and statistics that is the basis for quantitative risk analysis. The details of this knowledge can be found in the book "Introductory Statistics for Business and Economics" (Wonnacott, 1972). Probability is simply the way of measuring uncertainty. In decisions involving uncertainty, probability is often used to describe the degree of uncertainty present. Often it is not actually called probability but named likelihood or chance. The distribution function, or probability distribution function, $F(x)$ is the mathematical equation that describes the probability that a variable X is less than or equal to x, i.e. $F(x)=P(X<=x)$ for all x, where $P(X<=x)$ means the probability of the event $X<=x$.

The objective of a quantitative risk analysis is to calculate the combined impact of the model's various uncertainties in order to determine a probability distribution (risk) of the possible model outcomes.

Two techniques are often used to calculate the outcome distribution. The first is the analytical method, which replaces each uncertain variable by its mean and variance. It is well accepted that the investment returns are normally or log normally distributed, therefore distribution of expected returns can be represented by two parameters i.e. mean and variance. The mean, also called the first moment, is generally measured relative to the origin of a distribution and is indicative of location or central tendency. The mean is referred to as the expected return. The variance is a measure of dispersion about the mean or expected value; it represents the risk of expected returns. Although this method is easy to apply and cost effective, it is only applicable for the situation where there is a linear relation between objective variable and input variables.

If there is non-linear relationship between the parameters such as rent and the expected return of investment, and the probability distribution of variables is not necessarily normally distributed, simulation is used for deriving the probability distribution of expected return. The distribution of returns can be both presented by certain parameters such as mean-variance and the specific value of various percentiles.

The simulation method is a powerful tool available for the analysis of business decisions, especially under conditions of uncertainty. Although all kinds of models can be regarded as simulations, the simulations to be described and used here are all based upon mathematical models. Detailed information about the simulation can be found in the book "Quantitative Risk Analysis, A guide to Monte Carlo Simulation Modelling"(Vose, 1996). These mathematical simulations can be divided into two types:

A. Deterministic simulation models. All the variable factors input to the model either have values that are known for certain, or are assumed to be certain. Sensitivity and scenario analysis fall into this category. In scenario analysis, three estimates for variables usually based on the optimistic, realistic and pessimistic state will represent the uncertainty of the project. The purpose of sensitivity analysis is to identify the most critical variables according to their impact on the output. Both techniques only use the point estimation as the input.

B. Probabilistic simulation models. In these models uncertainty is treated explicitly, and the uncertainty of input to the model are represented not by known single values but are modelled as probability distributions.

2.3 Portfolio Theory

The pioneering work of Markowitz (1959) was to see portfolio selection as a problem of maximizing an investor's wealth under the conditions of uncertainty. He found that portfolio risk could be reduced by investing in multiple assets where the cyclical patterns of their rates of return do not move in perfect lockstep.

Many investors seek to reduce their risk by diversification. The investor who uses this approach holds more than one investment simultaneously in the hope that low or negative returns on one or more holdings will be offset by high return of others. When more than one investment is held, the combined holdings are called a portfolio. The calculation of return and risk measures of a portfolio differs from the straightforward calculations for a single investment. Expected return of a portfolio is described as Equation (2-1):

$$E(R_p) = \sum_{i=1}^{n} w_i E(R_i) \qquad (2\text{-}1)$$

$E(R_p)$ is the expected return of the portfolio, wi is the proportionate weight that the dollar amounts of investment represent for each project within the portfolio, and n is the total number of projects included in the portfolio.

The variance of portfolio return is derived from the returns' variances of each component investment in the portfolio and the extent to which the component returns move together or apart. The extent to which the returns of any two investments move together is called the covariance. The covariance (Cov_{ij}) of any two investments is computed by the equation (2-2):

$$Cov_{ij} = w_i w_j r_{ij} \sigma_i \sigma_j \qquad (2\text{-}2)$$

Where w_i, w_j are the proportionate weights that the investment in i and j represent of the total investment in the portfolio. r_{ij} is the correlation coefficient of the returns of investment of i and j. σ_i, σ_j are the standard deviations of the returns of i and j, respectively. The variance of portfolio (σ_p) can be measured by the equation (2-3):

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i w_j r_{ij} \sigma_i \sigma_j \qquad (2\text{-}3)$$

From the equation (2-3), it is easy to see that the standard deviation of the portfolio will be reduced unless they are perfectly positively related ($r_{ij}=1$). The development of portfolio theory is based on the premise that an individual, by investing, can maximise his expected return for a given level of risk or minimise his risk for a given level of expected return. Most of the work in this area and its subsequent development into capital market theory and the capital asset pricing model has then related to the market for equity shares.

2.4 CAPITAL ASSET PRICING MODEL (CAPM) AND ARBITRAGE PRICING THEORY (APT)

2.4.1 CAPM

Following the development of portfolio theory, the capital asset pricing model (CAPM) has been developed (Sharpe, 1963). Figure 2.1 (Brown, 1991) shows by investing in a risk-free asset (rf) in addition to a risk portfolio M, by altering the proportion of funds available for investment between rf and M it is possible to create a portfolio lying at any point along the line rfM. Because the security market line consists only of efficient portfolios this implies that total risk is made up of two components. One part reflects the level of risk that through diversification can be eliminated and the other reflects the level of risk, which cannot be diversified away. In capital market theory these are referred to as the specific and systematic risk components. The total risk of any portfolio or for that matter any asset will be the sum of these two components such that: Total risk = systematic risk + specific risk.

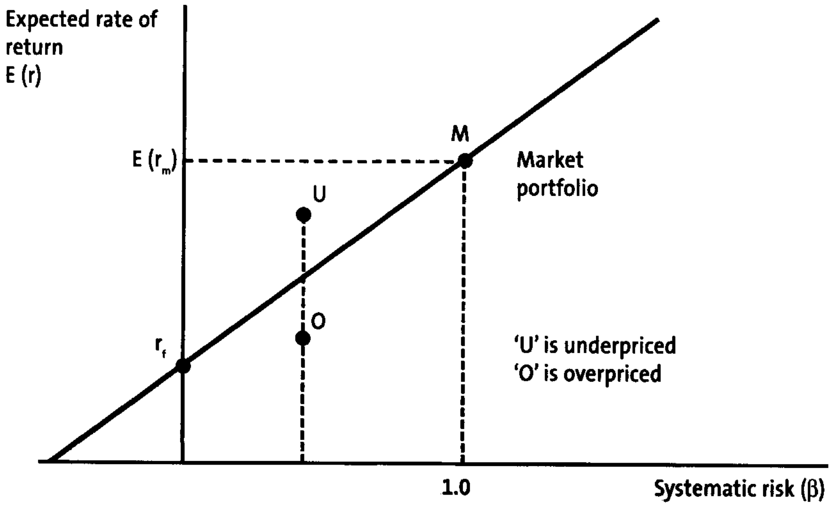


Figure 2-1 The security market line

Systematic risk is characterised by economic and market changes, which affect all assets. Because the effect is market-wide this type of risk cannot be eliminated. Specific risk, on the other hand, can be diversified away and is usually characterised by factors specific to an individual asset.

As specific risk can be eliminated by diversification it will be seen that it is the systematic or market-risk component which assumes major importance. The measure of risk used is expressed in terms of a coefficient that is related to the performance of some index of market movements, and is known as the beta coefficient. Beta can also be defined as the ratio of the covariance for investment i with the expected return for the market portfolio to the variance of the market portfolio. The property which has the same volatility as the market will have a β coefficient of 1.0, whereas assets held to maturity with a guaranteed pay-off will have beta coefficient of zero. The β can be easily obtained in the stock market for specific shares or bonds by using historical market data, but it is rather difficult to achieve in the real estate market since there is lack of frequent transaction data.

Under these assumptions it is possible show that the expected return on any asset for a single period can be given by:

$$E(r_j)=r_f + \beta_j[E(r_m)-r_f] \quad (2\text{-}4)$$

Where
$E(r_j)$ = expected return on asset j for the period under consideration
r_f = riskless rate of return for period under consideration
$E(r_m)$ = expected return on the market portfolio
β_j = systematic risk of the asset j.

According to the capital asset pricing model, Expected return = risk free rate + risk premium. The first element of the risk premium is the risk premium for an asset of average risk. This is $E(r)_m-r_f$, where $E(r)_m$ is the required rate of return for an investment of average risk. The second element in the calculation is beta, this adjusts the mean risk for the relative riskiness of the project under consideration.

So from the CAPM, it is easy to identify the individual risk premium by comparing to the average market portfolio performance. Moreover, during the decision-making on the portfolio expansion and revision, properties with the same systematic risk level sit above the security market line (as point U) should be maintained and invested for the reason of being under priced. If properties are under the security market line (as point O), they should be rejected since they are overpriced.

In summary, the CAPM approach is a potential robust framework for real estate investment analysis. However, the required assumptions and data requirements in terms of real estate applications cast serious doubt on whether this approach is useful. The principal constraints which have a bearing on property are generalised by Brown (1991) as following:

- Normal distribution of returns (real estate returns are not normally distributed);
- Perfectly divisible assets (real estate is indivisible to some extent);
- Borrow or lend at the risk-free rate (unequal lending and borrowing rate);
- Transparency of market data (real estate market is not efficient).J24

2.4.2 Arbitrage pricing theory

Although the empirical evidence substantiating the multidimensional nature of risk goes back to the late 1960s, it 's standing was significantly enhanced through the development of the arbitrage pricing theory (APT) developed by Ross (1976). The APT can be thought of a generalisation of CAPM. Using a somewhat less restrictive set of assumptions (mainly doing away with the need for investors to make decisions on the basis of mean and standard deviation), the theory infers that there may be a multitude of risk premia associated with an individual asset. Unfortunately, the theory does not tell us how many risk factors could be at play. The multifactor arbitrage pricing theory can be formulated as follows:

$$E(R_j) = R_f + \beta 1_j\, [E(F_1) - R_f] + \beta_{2j}\ [E(F_2) - R_f] + \beta_{3j}\, [E(F_3) - R_f] + .. \qquad (2\text{-}5)$$

Where

$E(R_j)$ = expected return on asset (portfolio) j,

β_{ij} = sensitivity of asset j to risk factor i,

R_f = risk-free return,

$[E(F_i) - R_f]$ = expected risk premium associated with factor i.

In general terms, the equation can be described as follows:

$$R_t = Bf_t + E_t \qquad (2\text{-}6)$$

Where

R_t = vector of individual asset excess return for period t,

B = matrix of asset exposure to the different risk factors,

F_t = vector of factor risk premia for period t,

E_t = vector of individual asset residual returns for period t,

With corresponding risks

$$V = B'FB + \Omega \qquad (2\text{-}7)$$

Where

V = covariance matrix of asset return R_t,

F = covariance matrix of factor risk premia f_t ,

Ω = (diagonal) matrix of asset residual risk E_t.

By examining this model, it is obvious that the original Markowitz "full covariance" matrix is broken up into factor-related risks and residual risks. The notion of a multitude of risk factors driving asset returns is now widely accepted. However, the identification of these risk factors remains an empirical exercise about which there is no consensus. Broadly speaking, three approaches can be used to identify these factors, they are :

A. fundamental factor models assume the B as given and estimate f_t.

B. macroeconomics models, on the other hand, take the f_t as given and estimate B.

C. statistical models try to simultaneously estimate B and f_t.

Although APT also called Multi-factor model provides more accurate solution than that of CAPM, it still has limitations when applied in the direct real estate investment. Since additional factors are introduced in the model, more data resources are required for quantifying the correlation between specific investment and factor movement.

Financial models discussed in this Chapter provide a robust framework for investment risk analysis. However, the progress of implementing those models in real estate industries is not promising according to the survey results from both sides of Atlantic. Therefore we need investigating the following issues in this research regarding risk analysis:

1. What kinds of quantitative techniques are used by real estate investors for the purpose of risk analysis of investment decision-making?
2. Since data issue is a major obstacle of quantitative risk analysis for real estate investment, can we apply expert opinion method to forecast the uncertainty of real estate market?
3. How to develop the optimisation technique with the probabilistic input?
4. What is the relationship between direct real estate and indirect real estate, between real estate shares and common shares?

Following chapters try to tackle these issues and develop a quantitative tool of risk analysis. Before move to the application of expert opinion method, we discuss the input of risk analysis model in the following section.

2.5 Input of risk analysis model

In this study, portfolio theory is used for measuring risk in direct real estate portfolios, and the CAPM model is used for measuring risk in indirect real estate investment. The following part discusses how to get the input for risk analysis in direct real estate investment which is Part A of the model. Since this research is based on the Dutch real estate investor's practice and database, we use the data format and method required by ROZ IPD index as the basis for the calculation total return calculation of the real estate investment. Therefore the results of the analysis can be compared to the ROZ index directly. According to the rule of the IPD ROZ index (Cudworth, 1997), the total return on real estate investment is consist of two components as follows:

Total return = Capital growth + Income return

Where

Capital Growth = $(CV_t - CV_{(t-1)} - C_t)/(CV_{(t-1)} + 1/2C_t - 1/2NI_t)$ (2-8)

Income Return = $NI_t/(CV_{(t-1)} + 1/2C_t - 1/2N_t)$ (2-9)

Where:

CV : Capital Value

C : Net ongoing capital expenditure/receipts on standing investments

NI : Net rental income

t : year-end

t-1 : year-beginning

The value of the property refers to the market value that is determined by the cash flow method as follows:

$CV = \Sigma_i (NI_{it})/ (1+r)^t + RV$ (2-10)

Where

RV = residual value

Formula (2-10) indicates that all variables related to the net income are critical for the total return of real estate investment. For measuring the distribution of total return on real estate investment, the rent income and cost are important variables. In the real estate world, there are very few reliable historical data resources for direct real estate investment. In most real estate markets the history of published annual return data is less than 10 years. Deriving the volatility of real estate return from historical data is not feasible for the majority of markets. Also, real estate assets are not homogenous. Each property is unique in location, and the improvement is usually different. Such heterogeneous character makes each transaction unique. This uniqueness and the infrequency of trades of any one piece of property make it difficult to get the necessary historical data.

In addition, even though there are some historical data available for estimating the volatility of the return, the question remains: does the past always forecast the future? The economy constantly injects new elements into most business situations, the past does not necessarily show the movement of the future.

In general, probabilities can be derived by objective or subjective methods. Objective probabilities are obtained by using the random experiment to aggregate the relative frequency. However there are many cases where probability cannot be assessed by the objective methods because:

- The experiment can not be repeated a sufficient number of times;
- Insufficient information is available about the outcomes of past experiments;
- The outcomes cannot be shown to be symmetrical.

Many business decisions are of this kind and real estate decisions are no exception, therefore it is essential to have subjective probability for the risk analysis.

In general, decisions are likely to be determined by subjective probabilities in the real estate industry; it has to be generalized from experience and samples using relative frequencies of occurrence. All objective and subjective evidence currently available should be used in the assignment of subjective probabilities. These probabilities should reflect the decision-maker's beliefs. Decision-makers rely upon both intuition and formal models to assess the worthiness of an alternative. Many decision-makers place great emphasis on intuitive reasoning, following their feeling rather than their 'thought'. "Intuitive thought is not the opposite of the rational thought" (Cooke, 1991). Based on these analyses, we proposed the expert opinion method to derive the probability distribution of real estate variables. This method is discussed in details in the next Chapter.

3 Expert opinion in risk analysis

3.1 Introduction

The critical part of investment analysis is market forecasting since any investment decision is based on an estimation of future developments in the market. If market movements are contrary to the forecast, the end result of investment will vary from expectation as well. In general there are several methods used for forecasting future market conditions, these are so-called fundamental analysis, technical analysis and expert opinion. Fundamental analysis uses the relationship between macro- and micro- economic factors and specific market variables to predict the future movement of that market. Usually this kind of analysis is based on existing theory. Technical analysis uses historical data to describe how the market developed in the past, and tries to extrapolate historical trends into the future using statistical models. In many cases, these two methods are often combined.

These two methods are helpful for real estate market analysis but they are not adequate. As there are so many new factors emerging in various real estate markets, it is certainly not possible to develop a complete model to capture all the important factors which may have impact on real estate market. Also, technical analysis only focuses on past performance and cannot cover new changes in the market. In addition, the real estate market is sensitive to local policy, and this is poorly reflected in the historical data.

This chapter introduces the method of expert opinion for forecasting the real estate market. Expert opinion methods are used extensively in technology areas such as nuclear safety, reliability of engineering projects, space projects and all kinds of R&D projects. In recent years expert opinion has received more attention in the economic and financial world. Table 3-1 shows the where expert opinion has been applied in the field of economy and finance.

Market area	Variables
Capital and money market	Interest rate, inflation rate, stocks and option price, earnings etc.
Product market	Future price of oil and other commodities
Consumer market	Demand and supply of consumer products
Property market	Rent and cap rate etc.

Table 3-1 Application area of expert opinion in finance

Forecasting uncertainty by using expert opinion has been studied in recent years. Many researchers investigate the use of expert opinion to determine uncertainty in economic and financial markets. For instances, studies use expert opinion to forecast stock and option prices (Onkal and Muradoglu, 1994, Yates, McDaniel and Brown, 1991, Overbeek, 1999), earnings (Wolfe and Flores, 1990), sales (Mathews and Diamantopoulous, 1990), oil prices (Abramson and Finizza, 1995), real estate market (Ong and Chew, 1996). Expert opinion has proved to be a very important information source for forecasting in the field of economy and finance.

Onkal and Muradoglu (1994) examine portfolio manager's probability forecasts of stock price movements over a one-week time interval. Using expert, semi-expert and novice forecasters they found that the expert portfolio managers showed superior performance compared to the other groups, especially when the forecast assessment was made using a fine-grained multiple interval scale rather than a dichotomous increase or stay-the-same/decrease response format. Additionally, they found that experts performed better than semi-experts for shorter forecast horizons but that the difference was reversed as the forecast horizon was extended.

Wilkie and Pollock (1986) examine subjective probability forecasting in the currency markets. They utilise and extend the 'covariance decomposition' approach developed by Yates (1982) and generate a general framework for examining the quality of probability judgement in currency forecasting context. This research shows that adjusted statistical model by using expert opinion improves the performance of the forecast.

Although the real estate market is part of the large economy, expert opinion has not been applied to market forecasting formally. Human judgement plays a significant role in most forecasting situations (Dalrymple, 1987; Klein and Linneman, 1984), and real estate market forecast is no exception. In some circumstances, the forecaster relies on expert opinion alone to predict future property values. Despite the substantial use of expert opinion in this context, there has been surprisingly little academic research directed towards its quality. As a major component of real-world market forecasting, expert opinion has been virtually ignored.

This chapter first introduces the historical development of the expert opinion method, and its applications in other areas; then it discusses the Classic Model in detail; finally it applies the Classic Model to the real estate market, particularly to forecasting future rent.

3.2 Development of the expert opinion method

When the value of an uncertain quantity is needed in risk analysis, and limits in data or understanding preclude the use of conventional statistical techniques to produce probabilistic estimates, the only remaining option is to ask experts for their best professional judgement. The past twenty years have witnessed remarkable progress in the development of the understanding of how both experts and laypersons make judgements that involve uncertainty. Much of the new development is relevant to the elicitation of subjective probability distributions from experts. There are several methods developed in last fifty years for collecting expert opinion for the purpose of forecasting and decision-making. The Delphi method is representative of many expert opinion methods.

The Delphi method

The Delphi method was the first method to elicit and use expert opinion in a structured way. It was developed at the RAND Corporation in the early 1950s as a spin-off from an Air Force-sponsored research project, "Project Delphi". In the middle 1960s and early 1970s the Delphi method found a wide variety of applications, current applications of the Delphi method are still in line with past developments. As summarised by Cooke (1991), the Delphi method has undergone substantial evolution and diversification, but the basic approach is described as follows:

A monitoring team defines a set of issues and selects a set of respondents who are experts on the issues in questions. A respondent generally doesn't know who the other respondents are, and the responses are anonymous. A preliminary questionnaire is sent to the respondents for comments, which are then used to establish a definitive questionnaire. The questionnaire is then sent to the respondents and their answers are analysed by the monitoring team. The set of responses is then sent back to the respondents together with the median answer and the interquartile range, the range containing all but the lower 25% and the upper 25% of the responses. The respondents are asked if they wish to revise the initial predictions. Those whose answer remains outside the interqartile range for a given item are asked to give arguments for their prediction on this item. The revised predictions are then processed in the same way as the first responses, and arguments for outliers are summarised. This information is then sent back to the respondents, and the whole process is iterated. A Delphi exercise typically involves three or four rounds. The response on the final round generally show a smaller spread than the responses on the first round, and this is taken to indicate that the experts have reached a degree of consensus. The median values on the final round are taken as the best predictions.

There are many studies of the application of the Delphi method. The most significant critique is that respondents are not treated equally. Delphi method rewards predictions that fall inside the interquartile band with a reduced workload in returning the questionnaire, whereas those whose prediction fall outside this band are "punished" and must produce arguments.

The research group of the Department of Real Estate and Project Management (BMVB) at Delft University of Technology has used the Delphi method to forecast the demand for office space and shopping centres for the period up to

2015. In the prediction of office markets, experts were interviewed individually in two rounds. The workload was so heavy they gave up the third round. In the forecast of future demand for shopping centres, individual opinions were so divided that it was difficult to reach a consensus on the issues such as the impact of on-line shopping. To save time they collected experts' opinion in small groups instead of individually to save time. However, a final consensus could not be reached because of the broad spread of opinions. As shown in both cases, due to the difficulties of heavy workload and difficulties of combining the group opinions, the Delphi exercises have played a limited role in recent years.

Important issues related to the application of expert opinion

The most important tool in rationally incorporating expert opinion in science is the representation of uncertainty. When expert opinion is used as input in a scientific inquiry or report, the question to be addressed is simply this: is uncertainty adequately represented? Some other important questions remain to be answered such as:

- Should the quality of the opinions be measured?
- How can expert opinions be elicited and applied in the decision-making process?
- Is the quality of the information improved by introducing structured expert opinion?
- How can group opinions be acquired and these opinions combined?

The understanding of expert opinion under uncertainty is still very incomplete. Although it is possible to identify things one should or should not do in eliciting expert opinion, many aspects of the design of an elicitation protocol must be dealt with as a matter of judgement and taste. Since the decision-making process in a modern organisation is often in the context of a group, the next part discusses the details related with group opinions.

Dealing with group opinions

Considerable attention has been given to the question of whether to encourage interaction within the group of experts, and if so, what kind of interaction. Research in social psychology has examined the effect of groups on the modification of individual opinions. There is some evidence that work in a group can provide advantages in creative problem solving. Also considerable evidence shows that, for probability assessment, face-to-face interaction between group members can create destructive pressures of various sorts, such as domination by particular individuals for reasons of status or personality unrelated to their ability as probability assessors. (Myers and Lamm, 1975).

In a situation where an analyst has decided that combining judgements can be justified, a large number of alternative procedures might be used. Hogarth (1977) and Seaver (1978) have provided reviews. The simplest approach is the "opinion pool" method, which involves forming a weighted arithmetic means of the component probabilities. The critical issue here is how to apply weight for the pooling. The weights may be chosen by the analysts to reflect their opinion of the relative expertise of the assessors, or may be based on their self-ratings. Dalkey (1970) reports that self-rating can produce better results than equal rating. Other empirical studies (Winkler, 1971; Seaver, 1978) have found little or no difference in the performance of various differential-weighting schemes over simple equal weighting.

Winkler (1968) suggests a Bayesian perspective in which the probabilities assessed by the experts represent new sample evidence for analysts that should be used to update their priors. Morris (1977) generalises this approach by adding a calibration function that represents the analyst's opinions of each assessor's normative expertise. This function is to be used to transform each expert's assessment into a calibrated prior. Analysts then drive a composite posterior simply from the normalised product of the experts' calibrated priors with their own. Although this technique has good conceptual justification, it has not yet found practical application, probably it because of the complex judgements it requires. Seaver (1978) found that the results of Bayesian aggregation methods were considerably less well calibrated (more overconfident) than the simpler linear average schemes, as well as being harder to use. Combining the opinions of multiple experts may not necessarily lead to a better estimation of the uncertainty depending on the aggregation method used. However, there is good reason to believe that the result will be more informative about the central value than using the assessment of a single expert (Winkler, 1971; Seaver, 1976). Later in this chapter, the result of this research shows the importance of more informative results from combining the expert's opinion.

One approach using Bayesian aggregation methods is the Corpula Model (Jouini and Clemen, 1996). This approach uses copulas as the basis for modelling dependence among the experts' opinions. A copula is a function that can be used to join marginal distributions, thereby creating a multivariate distribution function; corpula can specify the stochastic dependence relationships among the random variables. With this copula and the univariate distributions of the experts' assessments, the decision-maker can construct a likelihood function for these opinions. Later in this chapter, an application of this model is illustrated.

Generally, there are two important issues in using the expert opinion method. One is how to elicit expert opinion effectively and efficiently? The other is how to reach a consensus in a group context? After investigating several expert opinion methods, we selected the "Classic Model" as the basis for developing an expert opinion method for real estate market forecasting. The "Classic Model" provides the solution for both issues and has been tested in many areas. The next section discusses this model in details.

3.3 Classic Model

Foundations of the Classic Model

Expert opinion is increasingly recognised as a valuable source of scientific data. Like any scientific measurement, the acquisition, use, and validation of expert judgement data must proceed in a traceable way according to rigorous methodological rules. The goal of applying structured expert opinion techniques is to enhance rational consensus. Necessary conditions for achieving this goal are laid down as methodological principles. The Classic Model is a tool for combining the group experts' opinions by using performance-based weighting. Since the decision-making in most organisations is a process of reaching consensus among a number of decision-makers, it is therefore important to combine opinions of experts in the group instead of simply taking that of one of the decision-makers. In the organisation of institutional investment, many parties are involved in forecasting the market including economists, market researchers and portfolio managers. They have to reach a consensus in order to set-up their investment policies.

The structured method should comply with the following principles:

- **Accountability:** all data, including expert's names and assessments, and all processing tools are open to peer review and results must be reproducible by competent reviewers.

- **Empirical control:** quantitative expert assessments are subjected to empirical quality controls.

- **Neutrality:** the method for combining/evaluating expert opinion should encourage experts to state their opinions truthfully, and must not bias results.

- **Fairness:** experts must not be prejudiced, prior to processing the results of their assessments.

These principles have been operationalized in the Classic Model, a performance based linear pooling or weighted averaging model. The weights are used to combine the experts' opinions. Weights are derived from expert calibration and information performance, as measured on seed variables. The name Classic Model derives from a strong analogy between calibration measurement and classic statistical hypothesis testing and is contrasted with Bayesian models.

The performance-based weights use two quantitative measures of performance, calibration and information. The former requires the use of calibration or seed variables, variables whose true values are unknown to the experts at the time of the elicitation, but whose values are known post hoc. Sometimes calibration variables will be "near future" versions of the variables of interest, and will be observed within the time frame of the study. More often, calibration variables are not themselves variables of interest, but are included in the elicitation to enable performance base weighting. The designation of seed variables is then suggested by their role in "seeding" the combination model. Seed variables serve a threefold purpose: (i) to quantify expert's performance, (ii) to enable performance-optimised combinations of expert distributions, and (iii) to evaluate and hopefully validate combination of expert judgements.

The calibration (I) is defined as the discrepancy between distribution of realisation (P) and sample (S) as shown (3-1):

$$I(S,P) = \sum_{i=1}^{m} S(i) \ln \frac{S(i)}{P(i)} \qquad (3\text{-}1)$$

The information measurement is the entropy associated with a probability mass function P over the integers I=1,....M is (3-2):

$$H(P) = - \sum_{i=1}^{m} P(i) \ln(i) \qquad (3\text{-}2)$$

H(P) is a good measure of the degree to which the mass is "spread out".

Calibration measures the statistical likelihood that actual experimental results correspond, in a statistical sense, with the expert assessments. Information represents the degree to which an expert's distribution is concentrated, relative to some user-selected background measure. "Good expertise" corresponds to good calibration and high information. The weights in the classical model are proportional to the product of statistical likelihood and information.

In the classical model calibration and information are combined to yield an overall or combined score with the following properties.

1. Calibration dominates over information, information serves to modulate between more or less equally well calibrated experts;
2. The score is a long run proper scoring rule, that is, an expert achieves his/her maximal expected score, in the long run, by and only by stating his/her true beliefs. Hence, the weighting scheme, regarded as a reward structure, doesn't bias the experts to give assessments at variance with their real beliefs, in compliance with the principle of neutrality.

Calibration is scored as "statistical likelihood with a cut-off". An expert is associated with a statistical hypothesis, and the seed variables enable us to measure the degree to which that hypothesis is supported by observed data. If this likelihood scores below a certain cut-off point, the expert is unweighted. The use of cut-off is driven by property. Whereas the theory of proper scoring rules says that there must be a cut-off, it doesn't say what value the cut-off should be. The cut-off value for (un)weighting experts is determined by optimising the calibration and information performance of the combination.

Application of the Classical Model

The experts are asked to assess a number of uncertain quantities called seed variables in Classic Model, of which the true values are already known to the analyst or will become available. For every quantity, the experts are asked to give a number of quantiles. For a continuous real valued random quantity X, the r% quantile of the distribution of X is the smallest number X_r, such that probability $\{X<X_r\}$= r%. The 50% quantile is the median. For each expert, the probability distribution built with his quantiles is compared to the outcomes. Based on weights of each expert involved, the consensus can be derived by linear pooling of all weights with their opinions as shown in 3-3:

$$P_{dm} = \Sigma w_e P_e / \Sigma w_e \qquad (3\text{-}3)$$

Where:

P_{dm} = the decision-maker's probability distribution;

W_e = the weight of each expert derived from Classic Model;

P_e = the probability distribution of each expert.

A fundamental assumption of the Classic Model (as well as Bayesian Models) is that the future performance of experts can be judged on the basis of past performance, as reflected in seed variables. Seed variables enable empirical control of any combination schemes, not just those which optimise performance on seed variables. Therefore choosing good seed variables is of great interest, see Cooke and Goossens et al (1995) for background and details.

3.4 EXPERT OPINION IN REAL ESTATE MARKET FORECASTING

3.4.1 Practice of real estate market forecasting

For making investment decisions, it is essential for property investors to estimate the value of properties in the future. According to the valuation, investors may make decisions on buying, selling and holding properties (i.e. asset allocation) to meet their investment objectives.

By using the cash flow method, the value of property is determined by the following equation (Austin 1997):

$$MV = \sum_{t=1}^{n} \frac{NI_t}{(1+R)^t} + V_e \qquad (3\text{-}4)$$

Where:

MV : Market value of property;

NI_t : Net income in the year t;

R : Required rate of return on investment

V_e : the end value after year n.

In general, property investors use 10-15 years cash flow to estimate the value of the property. Equation (3-4) shows that net income in the future has a determining role in estimating the property value. Net income is derived by the difference between rental income and expenditure. Normally, the future expenditure can be estimated with reasonable accuracy based on historical data since it is mostly depends on the technical factors. However, the expected rent in the future is highly uncertain, and point estimates are therefore of limited value. Rent can be influenced by numerous factors including economic, political, and even a specific tenant. Therefore forecasting of property rent with 10-15 year horizon is a difficult but essential task for property investors.

In practice, property investors use three kinds of methods to forecast the rent in the future. The first method uses inflation rate as the growth rate of rent. The rent in next year is equal to the current rent plus the rent growth with inflation rate. This method neglects the uncertainty of market rents. If the market rent and inflation move in opposite direction or differ greatly in magnitude, the rent forecast will not reflect reality.

The second method is the scenario approach. Various market scenarios are considered during the each period of rent estimation. Several rent estimations are derived under different scenarios. However, the probability or likelihood of each scenario is not provided, investors cannot use this directly to make a decision.

The last method is called the causal model, which is often developed by academics and is used for market forecasting. The causal model tries to set up the relationships between rent and other market and even social variables. The model can be derived by historical relationships using econometrics analysis, or developed based on a previous theory which defining the relationship between variables. For dealing with the uncertainty of future rents, Gold (1995) uses bootstrapping techniques[1] to create the probability density function of expected market rent and standard deviation by using the econometric forecast model. In this way, the expected market rent will be described by a probability distribution instead of point estimate forecast, which explicitly represents the uncertainty of the future. Although this technique introduces uncertainty in probabilistic form, it is difficult to apply for estimating expected rent on a property basis. Since the property portfolio includes various properties differing in type, location, tenant structure, lease term and other factors, investors are unable to adapt the general market models for different properties. Therefore the variables involved may differ greatly from each other. Also, those market models do not fully capture qualitative/subjective factors or new relationship arises (Makridakis and Wheel Wright, 1979).

The comparison of two reported survey results by Worzala (1997, 1998) reveals that investors adopt various techniques to forecast the market development for supporting their decision-making on asset allocation. Table 3-1 (page 36) details the percentage of various techniques used in mixed-asset portfolio allocation and asset allocation for real-estate-only portfolio.

Aggregate percentage	General Experience/ Scenario analysis	*Simple correlation	**MPT	***Liability
Mixed Asset Allocation	5%	50%	60%	33%
Real estate only allocation	54%	37%	24%	5%
* Correlation between assets	** Modern portfolio theory		*** Asset liability match	

Table 3-1 Decision-making techniques used for asset allocation

According to survey results, large numbers of real estate investors still rely on experience to make investment decisions. Survey results demonstrate the importance of judgement in real-estate-only asset allocation.

As reflected in the survey results, the majority of investors use the second method (scenario approach) to estimate the real estate variables based on their experience and historical data. However, no probability or likelihood of each scenario is estimated, this limits the usefulness of the scenario approach for the decision-maker. This research introduces expert opinion to estimating future rents. This is in line with professional preference, and also provides the probability estimation with each scenario. The estimated results are probability distributions of rent estimation in the future, which represents uncertainty for decision-makers. The following parts apply the Classic Model to elicit and to combine the expert opinion for forecasting the expected market rent.

3.4.2 Data and Methodology

For testing the "Classic Model" in forecasting real estate markets, we need collect expert opinion on a sample of market and real estate portfolios. We decided to use market rent as seed variables for measuring the experts' performance, and then to combine group opinions based on their performance in forecasting the market rents. Since the Dutch office market is followed by several real estate consultancies companies who published the prime office rent quarterly, we will use the office market for our forecast.

An office portfolio from a Dutch property investor is used for this research. The office portfolio contains 15 properties located in the various cities in the Netherlands[2]. Since there have been dramatic changes in the Dutch office market in recent years, the investor is interested in the revaluation of its portfolios. For this purpose expert opinion is used to forecast property rent.

The first step is to select the experts who will participate in forecasting the property rents. We believe that in-house portfolio managers are able to make more informed forecasts than outside experts, since they have detailed information and follow those properties closely. Five in-house portfolio managers were chosen as experts in this study.

The second step is to determine the seed variables for deriving the weight of each expert. We choose market office rents in four cities in the Netherlands as seed variables. Market rent is similar to the variables (property rent) which we want to estimate. Also, portfolio managers follow the market information very closely. The prime office rent of four quarters in 1998 in each city is estimated before each quarter starts. In early 1999, figures for prime office rent for the 4 quarters of 1998 were provided by the Office Rent Overview in Netherlands (DTZ, 1999). By soliciting rent estimates for four periods and four locations, we get 16 responses from each expert, thus we have 16 seed variables for calibrating the expert's judgement. Based on the estimates of each expert and the real figures of rents from the market, the weight for each expert is calculated by using the program Excalibur[3].

The next step concerns the elicitation of expert's opinion. Research has found that it is not easy to answer questions like "What is the probability at the certain value?", rather it better to ask, "What is the value at certain probability?" Meanwhile, it is hard to get satisfying answers when the interval range of probability is too narrow such as "What is the value at probability of 10%, 20%, 30%.... 90?" The question format we used is " What is the prime office rent for the 1st quarter of 1998 in Den Haag under the following three probability quantiles 5%, 50%, 95%?" This not only has a sufficient interval range, but also corresponds to a natural way of thinking in terms of normal, pessimistic and optimistic scenarios. Previous research has found that there may be biases occurring in expert judgement. Kahneman and others (1982) investigated the biases such as over confidence, anchoring, representatives, availability, which often appear in human judgement. Following is the outline description about these biases:

Availability: ***This is where the expert uses his recollection of past occurrences of an event to provide an estimate. The accuracy of her estimate is dictated by her ability to remember past occurrences of the event or how easily she can imagine the event occurring.***

Representatives: ***One type of bias is the erroneous belief that the large-scale nature of uncertainty is reflected in small-scale sampling.***

Adjustment and anchoring: ***an individual will usually begin her estimate of the distribution of uncertainty of a variable with a single value (usually the most likely value) and then make adjustment for its minimum and maximum from that first estimated value.***

Other sources of estimating inaccuracy: ***inexpert expert, culture of the organisation, conflicting agendas, unwillingness to consider extremes, eagerness to say the right thing, units used in the estimation, expert too busy, (people always seem to be busy and under pressure, asking a lot of difficult questions may not be very welcome), belief that the expert should be quite certain.***

To avoid biases in this study, we follow the guidelines of eliciting expert opinion (Cooke and Goossens, 1995) which has been very helpful in many applications. The complete questionnaire format is shown in the Appendix 1.

The last step investigates the accuracy and consistency of expert opinion in comparison with the real outcome. The weights derived from seed variables are used for combining the individual assessments of property rent estimation. The rent level of 15 properties in 1999 was solicited at the end of 1998 from 5 experts. Experts make their assessments on the three quantiles (see Appendix 2). We obtained the real figures of property rent in the end of 1st quarter in 1999 when all tenants renewed their contracts. By comparing the real values and combined opinions, we test two claims. One is whether the performance of variables of interests can be predicted by the performance of seed variables; the other is whether the global weight combination outperforms the equal weight combination.

The computer program Excalibur, developed at TU Delft is used for processing of expert opinion in this study. The Classic Model is implemented in Excalibur (Cooke, Kritchallo and Solomatine, 2000). In this program, different weighting systems can be chosen: global weights, item weights and user weights. Global weights are the same weights derived by Classic Model. Item weights are determined for each item separately. User weights are defined by user himself. The probability distribution of the decision-maker is determined as the weighted combination of the expert's assessments.

Expert opinion may be influenced by personal bias and social pressure. In our study, it was initially very difficult to elicit managers' opinions. There were two reasons:

1. Managers are reluctant to make judgements of colleague's properties, as this may cause personal conflicts;
2. Managers tend to underestimate future property performance, so that the actual realised performance will appear to be exceptionally good.

By convincing them that this study is purely for the purpose of research and will be kept anonymous, portfolio managers agreed to give their opinion on forecasting property rents. It took a long time to reach this position.

The results of expert opinion on seed variables (market rent) and objective variables (property rent) and two hypothesis tests are presented in the following section.

3.4.3 Results and evaluation

The results are categorised into three parts. Part A generates the weights of experts by their estimation of market rents. Part B uses the weights to combine their rent forecast for properties. By combining the estimations of market rent and property rent, Part C tests the performance of each expert.

Part A. Weighting process with seed variables

As described in previous section, prime office rents from four cities are used as seed variables. Each manager gives his quantiles for rent level. The estimation is made before each quarter starts. Table 3-2 presents the judgements from one-portfolio manager on market rent in 1998 for four cities in the Netherlands (see complete estimation in Appendix 2). All rents discussed in this chapter have the same unit with Dutch Guilders / per year / per square meter.

	5%	50%	95%
Q1Rent Amsterdam	450	470	500
Q2Rent Amsterdam	460	490	510
Q3Rent Amsterdam	470	490	520
Q4Rent Amsterdam	485	500	530
Q1Rent Rotterdam	260	280	300
Q2Rent Rotterdam	280	300	320
Q3Rent Rotterdam	300	330	360
Q4Rent Rotterdam	340	360	390
Q1Rent Den Haag	300	330	360
Q2Rent Den Haag	320	350	380
Q3Rent Den Haag	330	350	390
Q4Rent Den Haag	350	400	420
Q1Rent Utrecht	280	320	330
Q2Rent Utrecht	290	320	360
Q3Rent Utrecht	300	330	380
Q4Rent Utrecht	340	360	400

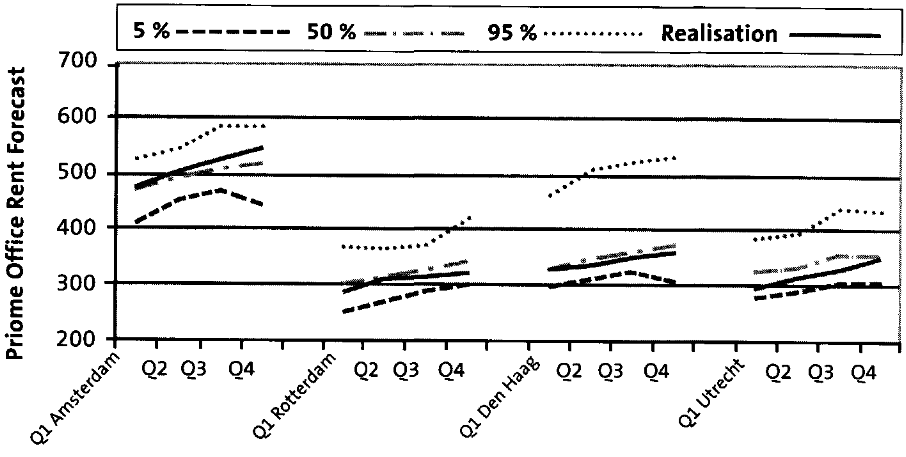
Table 3-2 Market rent estimation under three probability quantiles

Nr.	Id	Calibr.	Mean relat total	Mean relat realizatii	Numb real	UnNormaliz weight	Normaliz.w without DM	Normaliz.w with DM
1	Expert1	0.3305	0.8572	0.8572	16	0.2833	1	0.5
2	Expert2	0.1472	0.9554	0.9554	16	0	0	0
3	Expert3	0.0201	0.1556	0.1556	16	0	0	0
4	Expert4	0.0001	1.5360	1.5360	16	0	0	0
5	Expert5	0.0042	0.6126	0.6126	16	0	0	0
6	DMaker 1	0.3305	0.8572	0.8572	16	0.2833		0.5

Table 3-3 Expert scoring based on market rent variables

Based on the real rents and estimations from 5 experts, the Classic Model scores the experts and uses the scores to derive the weight of each expert. Table 3-3 shows the expert scores derived from their estimation on market rent variables.

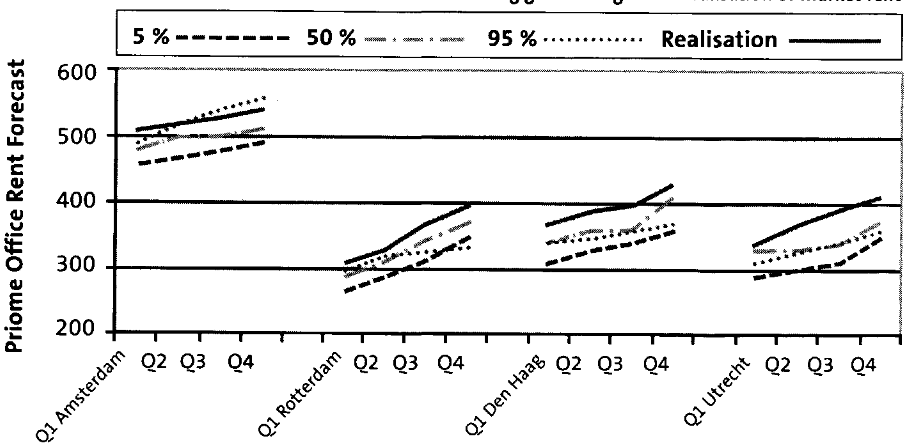
Figure 3-1 Comparison between market rent quantiles with aggregated expert opinions using equal weight and realisation of market rent



It is obvious that Expert 1 is outperforming the other experts: his opinion dominates the group. DM (decision-maker) is the optimal combination with global weight.

Figure 3-1 shows the results of combination of experts' estimation with equal weight and the realisation. Figure 3-2 shows results of combination of expert's opinions with global weights and realisation. The X-axis is 16 seed variables (4 cities and 4 Quarters). The Y-axis is the prime office rent. Four lines correspond to three quantiles and the realisation of the market rent. By comparing

Figure 3-2 Comparison between market rent quantiles with aggregated expert opinions using global weight and realisation of market rent



two figures, we see that the global weight (performance based) decision-maker is more informative than equal weight decision-maker since its forecasts show a smaller range. Part B investigates whether this phenomenon also occurs in the estimation of property rents.

Part B: Applying the global weight to forecast the rent of properties

By using the weight derived from seed variables, the property rent forecast from equal weight combination and global weight combination are shown in Figure 3-3 and Figure 3-4 respectively. The X-axis refers to the 15 properties; Y-axis is the rent of property. Four lines represent three quantiles and the realisation of property rent. Although the accuracy of combined judgement in terms of median value doesn't differ significantly, combined judgement with global weight shows more informative results (less spread) than equal weight combination. Table 3-4 (page 42) shows the scoring weight of experts derived by

Figure 3-3 Comparison between property rent quantiles with aggregated expert opinions using equal weight and realisation of property rent

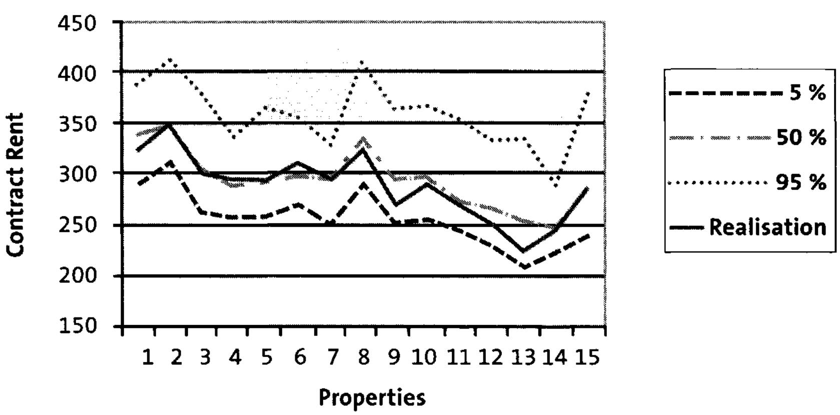
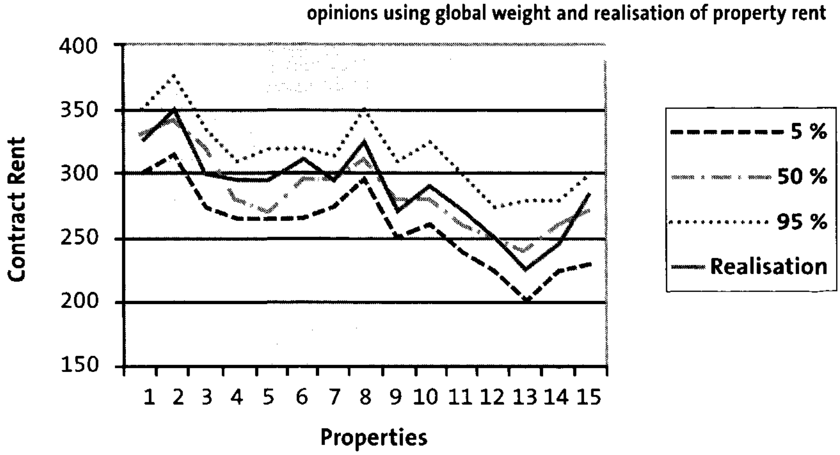


Figure 3-4 Comparison between property rent quantiles with aggregated expert opinions using global weight and realisation of property rent



their estimation on the property rent variables. The results indicate that Expert1 outperforms the rest, he plays important role in-group estimation. This is in line with the result from estimation of seed variables (market rent), which support the assumption of that future Performance of experts and can be measured based on the past performance.

Nr.	Id	Calibr.	Mean relat total	Mean relat realizatii	Numb real	UnNormaliz weight	Normaliz.w without DM	Normaliz.w with DM
1	Expert1	0.3579	0.7112	0.6724	15	0.2406	1	0.5
2	Expert2	0,0001	0.7795	0.7465	15	0	0	0
3	Expert3	0.0006	0.1963	0.1641	15	0	0	0
4	Expert4	0.0390	1.3780	1.3840	15	0	0	0
5	Expert5	0.0390	0.9034	0.9623	15	0	0	0
6	DMaker 1	0.3579	0.7112	0.6724	15	0.2406		0.5

Table 3-4 Project variable rent realisation

The last step investigates the accuracy and consistency of expert opinion in comparison with the realisation. The weight derived from Seed variables are used for combining the individual assessment on property rent estimation. Five experst were asked to give the rent level of 15 properties in 1999. The experts make their assessments also on the three quantiles (see Appendix 2). We obtained the real rents of property rent in the end of 1st Quarter in 1999 when all tenants renewed their contract. By comparing the realised contract rents and combined opinions of rent estimates from experts, we can test two claims. One is whether the performance of variables of interests can be predicted by performance of seed variables; the other is whether the global weight combination outperforms the equal weight combination.

The results of expert opinion of seed variables (market rent) and objective variables (property rent) and two hypothesis tests are presented in the following section.

These results show that performance on seed variables (market rent) accurately predicts performance on variables of interests (property rent). This holds for individual experts and for the combination of experts.

Part C. Combination results

In this section the seed variables and the variables of interests are pooled, to see how performance on pooled variables compared to the results of the previous sections. In other words, 16 observations of market rent and 15 observations of property rent are regarded as a single group of 31 variables.

Table 5 presents the results of scoring based on 31 variables. It once again indicates that Expert1 is outperforming the rest by combing the seed and objective variables, although the expert 5 gains a little weight in the combination.

Nr.	Id	Calibr.	Mean relat total	Mean relat realizatii	Numb real	UnNormaliz weight	Normaliz.w without DM	Normaliz.w with DM
1	Expert1	0.8214	0.7842	0.7678	31	0.6306	0.9996	0.4640
2	Expert2	0.0000	0.8675	0.8544	31	0	0	0
3	Expert3	0.0000	0.1759	0.1597	31	0	0	0
4	Expert4	0.0000	1.4570	1.4620	31	0	0	0
5	Expert5	0.0003	0.7580	0.7818	31	0.0002	0.0004	0.0002
6	DMaker 1	0.9517	0.7811	0.7651	31	0.7282		0.5358

Table 3-5 Scoring result of total variables

Results of scoring experts
Bayesian Updates: no Weights: global DM Optimisation: yes
Significance Level: 0.0003 Calibration Power: 1.0000

All results indicate that the performance based scoring system is helpful in combining the expert's opinions, which yields a more accurate and informative estimation. Based on the combined results, the probability distribution of rent forecasts is derived for each property.

3.4.4 Application of Clemen's model

Results from the Classic Model show that decision-maker (combined opinion with global weight) outperforms equal-weighted experts. For a comparative study of the application of other aggregating methods, Kallen and Cooke (2001) uses Clemen's Model (1996) to aggregate group expert opinion. 16 seed variables (market rent) are used in the Clemen's model. The average correlation between the expert's assessment is 0.32, which gives α (dependence) = 0.054042. The result of Clemen's model is considered as a new expert as the decision-maker (DM) in Classic Model. Table 3-6 shows the comparison of applying Clemen's model and Classic Model.

	Combined DM's:			Experts	
	Global	Item	Equal	Best	Clemen
Calibration	0.3300	0.2200	0.3300	0.3300	0.0200
Information	0.8572	0.2123	0.8572	0.8572	1.5630
Combination	0.2829	0.0467	0.2829	0.2829	0.0313

Table 3-6 Expert calibration results with Clemen's Model

The global and item weighted decision-makers are the same as the best expert, which has been proved in previous results. The Clemen expert is the third best expert out of the six in total (5 real experts and Clemen expert). In addition to this case study, Kallen and Cooke (2001) also applied the Clemen model in a few other cases. They found that the Clemen expert does not perform better than the best expert. In general this expert performs worse than the other experts. More data has to be tested since only a few cases have been used for applying Clemen Model.

3.5 Conclusions and limitations

The results of our research support two claims regarding the use expert opinion on quantifying the uncertainty of rent forecasting: (1) The global weight decision-maker shows high performance in terms of calibration and information. (2) Performance of variables of interests can be predicted by the performance of seed variables.

The application of the Classic Model in forecasting property rents has several distinctive advantages. Expert opinion may take into account a myriad of factors, current situation and potential changes together. Experts may adjust their opinion whenever it is necessary during their decision making process. Another advantage comes from the weighting system, by introducing the global weight based on the performance of each expert, the group opinions are combined in a reasonable way. Most importantly, the Classic model is consistent with decision-making process of property investment. In practice, managers use their opinions frequently to make important investment decision.

Certainly, there are some limitations to this approach. The expert opinion approach cannot be overstated in the overall decision process, it is a good aid for decision-making but cannot replace other techniques. It is flexible enough to cover all kinds of factors which manger can imagine. However, since it is not a mathematical model, the expert opinion approach cannot be regarded as a fixed model. It must be used with caution.

Above all, our research shows the potential of using expert opinion in forecasting the real estate market. It integrates the expert opinion into a systematic and flexible process to facilitate property market forecast.

Although expert opinion, particularly the Classic Model, is an extremely powerful tool to assess the uncertainty in the form of the probability distribution, and presents the results of combing opinions, some potential limitations and problems are certainly remained.

First, the use of expert opinion is not a substitute for essential market research and other empirical studies on the historical data. Expert opinion can be helpful in the situation where the decision should be made before all necessary information is known. In most cases of real estate investment decision-making, information is very sparse at the beginning when the decision has to be made. However, as the process proceeds, the information increases both in quantity and quality, therefore a follow up quantitative study should be added for improving further decisions on the investment.

The second issue involves the need for appropriate protocol for eliciting experts' opinions. Due to the sensitivity of opinions from each manager in the organization, the protocol must provide an environment which ensures individual experts will provide their opinions truthfully. There is no uniform protocol for eliciting experts' opinions although some principles do exist.

The third issue is concerning the selection of seed variables. Since the weight of experts opinion are determined by using the seed variables, inappropriate seed variables may cause improper weight for individual expert. This issue is still a subjective issue which is difficult to determine that one seed variable is better than others.

(notes)

1 Bootstrapping is sampling with replacement from observed data to estimate the variability in a statistic of interest.

2 The detailed composition of the portfolio is confidential, it may be provided upon request.

3 A computer application for combing group opinions according to the "Classic Model"

4 Portfolio Risk Analysis

4.1 Introduction

In chapter 3 the expert opinion method for measuring the uncertainty of the market variables has been investigated. Uncertainty is represented in expert opinion in the form of probability distribution, which is the input for portfolio risk measurement. Traditional portfolio analysis techniques such as mean variance analysis only deal with the input containing fixed return and risk figures. It's necessary to develop new techniques for portfolio risk analysis that are able to cope with probabilistic input.

This chapter focuses on the development of this technique and tries to provide the theoretical basis for computerised model. The structure of this chapter is organised as following: First, the investment decision-making process is discusses. Second, the method and purpose of portfolio optimisation are illustrated. Third, the current practice of real estate decision-making is investigated. Finally, a model of portfolio risk analysis with uncertain input is developed.

4.2 The investment decision-making process

Top-down and bottom-up

Traditionally, the real estate investor investigates the feasibility of a new acquisition on project basis, return and risk of the project is evaluated separately. This is so called bottom-up investment analysis. In recent years, since it has become expected that investment management should demonstrate a solid strategy to shareholders, institutional investors have had to develop an investment policy for their total investment portfolio, this is so called top-down approach. For instance, the top down approach first divides the asset classes into cash, equity, fixed income instruments, real estate and others. Within each asset class, more a detailed allocation can be developed by other factors. Real estate is one asset class for most institutional investors. Within the real estate portfolio, the asset class can be divided into office, shopping centre, housing, and others according to the type of the property. Moreover, real estate can be categorised by the location, such as US, Europe, Asia etc.

As the investment policy is set-up, the main asset allocation policy is derived. For example, real estate will make up 10 percent of the total investment portfolio in terms of capital investment. Meanwhile the risk-return profile of the portfolio also can be defined. For instance, we expect to achieve a return of 15% with a risk of 10% with real estate portfolio.

Once the real estate portfolio has clear objective in terms of risk and return, then all project valuation should be based on both the individual performance and the impact of individual project on portfolio performance. Therefore portfolio risk analysis is essential for investment analysis both for portfolio and project selection. In other words, even though a project meets the criteria of risk and return of bottom-up policy (minimum criteria on project level), it will be only accepted if the portfolio performance reaches the top-down policy (minimum criteria for portfolio) once this project is included in the portfolio.

Traditionally, the expected return of each asset class is estimated by the average of historical returns on this asset class, the risk is measured by the standard deviation of the historical returns for this asset class. For financial instruments such as equity and bonds, there are sufficient and reliable historical return data; therefore it is relatively easily to measure risk and return for these asset classes. However, unlike most instruments in financial market, the real estate market is not transparent, with insufficient historical data, transactions are not made in an open and mutual market. In a word, the real estate market is illiquid and inefficient. The optimisation in terms of risk return trade-off can be easily executed for financial instruments due to good data and models. For a real estate portfolio, it's even difficult to make an accurate estimation of the historical return and risk due to lack of data. The next part will discuss how the top-down approach can be implemented by using Modern Portfolio Theory (MPT).

Portfolio optimisation

An asset allocation policy shows the various investment percentages for each asset class, how are these numbers generated? This question is involved with the techniques of portfolio optimisation. The purpose of portfolio optimisation is to find out the optimal combination of all assets. By holding the optimal asset combination, such as optimal investment proportion of each asset, the portfolio return is the highest for a certain risk level. Investors are becoming more aware of the use of optimisation techniques to deal with their investment decision-making.

One of the most popular methods of generating the optimal asset mix is portfolio optimisation. The portfolio optimisation technique was developed by Harry Markowitz (1959) as a tool for managers of US equity portfolios whose goal was to outperform a cash benchmark. Since then his original concept has been generalised in three main aspects:

- It has been applied for benchmarks other than cash;
- It has been extended from allocating within individual stock portfolios to decision-making between whole asset classes, such as bonds, equities and cash;
- It has been extended to many markets outside US equities; not just international equities, but bonds, commodities and most recently, to property.

In constructing a portfolio of assets, investors seek to maximise the expected return from their investment given some level of risk they are willing to accept. Portfolios that satisfy this requirement are called efficient portfolios. Portfolio theory tells us how this should be done. To construct an efficient portfolio of risky assets, it is necessary to make some assumptions about how investors behave in making investment decisions. A reasonable assumption is that investors are risk averse. A risk adverse investor is one who will prefer a lower risk with the same expected return. The construction of efficient portfolios depends on measuring the portfolio risk and return. As discussed in the last part, the portfolio return can be a simple weighted average of possible outcomes, where the weights are the relative chances of occurrence. In general, the expected return on the portfolio, denoted E(R), is given by:

$$E(R_p) = \Sigma\, w_i\, E(R_i) \qquad (4\text{-}1)$$

Where $E(R_p)$ is the expected portfolio return, wi is the weight of property in the total portfolio investment, $E(R_i)$ is the expected i property return.

If risk is defined as the chance of achieving returns lower than expected, it would logical to measure risk by the dispersion of the possible returns below the expected value. The most commonly used measures are the variance and standard deviation of returns. The variance of return is a weighted sum of squared deviations from the expected return. The Squared deviations ensure that deviations above and below the expected value contribute equally to the measure of variability regardless of sign. The standard deviation for the portfolio, designated $Var(R_p)$, is given by:

$$\sigma_p^2 = \sum_{i=1}^{n}\sum_{j=1}^{n} w_i\, w_j r_{ij} \sigma_i\, \sigma_j \qquad (4\text{-}2)$$

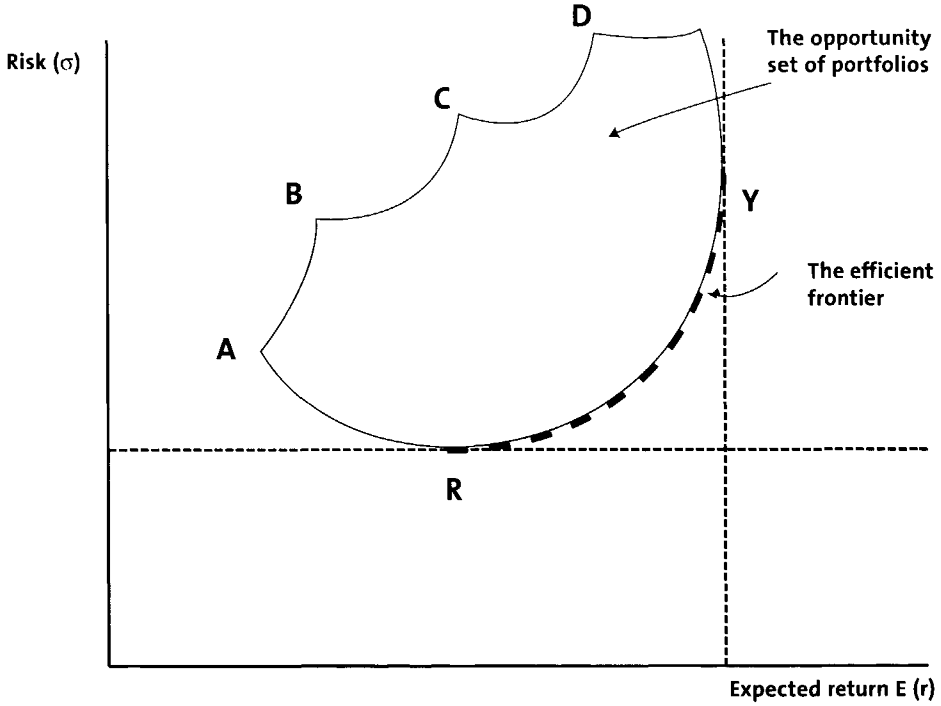
Where W_i, W_j are the proportionate weights that the investments in i and j represent of the total investment in the portfolio; ρ_{ij} is the correlation coefficient of the returns of investment i and j; and σ_i , σ_j are the standard deviation of the returns of investments i and j, respectively.

Standard deviation is defined as the square root of the variance. The larger the variance or standard deviation, the greater the possible dispersion of future realised values around the expected value, and the larger the investor's uncertainty. Historical return distributions for a portfolio of a large number of securities have shown that the distribution is approximately, but not perfectly, symmetric. In contrast, the return for distribution for single security is highly skewed. The most interesting aspect of historical return distributions, however, is the standard deviation of historical returns that tends to be considerably higher for individual securities than for diversified portfolios. This effect is often called diversification, which is the basis of portfolio theory.

An investor who is constructing a portfolio will calculate the portfolio risk measured by portfolio variance and expected return. For a given level of risk, there will be a large number of portfolios, each with its own expected return. The investor will select the portfolio with the greatest expected return for a given risk. This portfolio is the Markowitz efficient portfolio for that level of risk.

By combining all assets with various percentages, a larger number of feasible portfolios can be created which are called a set of feasible portfolios as described in the figure 4-1 (Brown, 1991), a Markowitz efficient portfolio is one that gives the highest expected return of all feasible portfolios with the same risk. A Markowitz efficient portfolio is also said to be A MEAN-VARIANCE efficient portfolio.

Figure 4-1 The efficient frontier



The Markowitz efficient set of portfolios is sometimes called the Markowitz efficient frontier, because graphically all the Markowitz efficient portfolios lies on the boundary of the set of feasible portfolios that have the maximal return for a given level of risk. Base on the efficient frontier, the next step is to determine the optimal portfolio. An investor will want to hold one of the portfolios on the efficient frontier. Notice that the portfolios on efficient frontier represent a trade off in terms of risk and return. Moving from left to right on the efficient frontier, the expected risk increases, but so does the expected return. The question is, which is the best portfolio to hold? The best portfolio to hold of all those on the efficient frontier is called the optimal portfolio.

This is the process of finding the optimal portfolio in other words, the best asset mix. Apart from the assumptions of portfolio theory, we need the following conditions to find the optimal portfolio based on the portfolio risk and return:

1. expected return of each asset
2. variation or risk of each asset
3. correlation between asset
4. investor's preference towards the risk

4.3 Current practice in real estate investment decision-making

This section discusses how institutional investors deal with their real estate investment in terms of their investment strategy, how do they determine the investment potion on real estate, what are the techniques used for investment decision-making and the future development of real estate investment decision-making.

The first major question is whether real estate is an asset class or an industry sector? This is an important question for each institutional investor in terms of investment policy. If real estate is regarded as an industry sector like financial services, health care, oil and chemicals etc., then real estate has to be compared with the financial performance of each industry sector. The usual benchmark is the stock market index for each industry sector. Due to the characteristics of real estate, the performance of real estate can be hardly comparable with that of listed stocks with a short-term holding period, frequent transactions, etc. In most cases, real estate only constitutes a small share in the whole investment portfolio if present at all. However, if real estate is regarded as an asset class, it will play a more constant and therefore more strategic part in the diversification of the entire portfolio. Based on this investment strategy, the weight of real estate in the strategic mix will be determined by portfolio optimisation, real estate constantly plays a role in asset diversification. Certainly, as the return and risk profiles change with the time, the weight of real estate will vary as well. Since real estate differs in a number of characteristics from equity and bonds, real estate will be remained in the portfolio no matter how big the portion is. As pointed out by Goetzmann and Ibbotson (1990) real estate provides a very low correlation with stocks and bonds, this low correlation means it is an effective hedge against fluctuation in financial markets.

The survey conducted by McCadden and McNally (1997) shows that 96% of pension funds viewed real estate as a separate asset class, only 4% of pension funds viewed real estate as an industry sector. This survey had responses from 39 pension funds and 49 real estate investment management firms. However, when the question comes as to the whether securtised real estate is an asset class or just an industry sector, the answer becomes less clear. Based on the survey result by Elaine Worzala (1998), 25.45% of pension funds consider Real Estate Investment Trusts (REITs) as part of their equity real estate portfolio, whereas 31.3% consider them as part of their stock portfolio. The split of opinion on this issue mimics that of the academic community. Private funds as well as medium-sized and larger funds were more likely to place REITs in their common stock portfolio rather than their real estate portfolio. We will discuss the difference between securities real estate and real estate in the next chapter, here we focuse on how the real estate is selected in terms of investment percentage and types of real estate.

The second question in the survey is what is the purpose for investing in real estate? If the investor considers real estate as the long-term instrument, real estate will be held for the reason of stable return, otherwise the investment potion of real estate will be reduced due to the under-performance of real estate compares to returns from bonds and equities in certain period. Rowland (2000) concluded by his survey that investors hold real estate as part of their asset mix because of following reasons:

- Long term stability of returns
- Diversification benefits
- Anticipated high risk-adjusted returns
- Inflation-hedging characteristics

These features are well recognised in the investment world, real estate generally has been viewed as long term investment with distinctive features, and has therefore been regarded as separate asset class from equities and bonds. The next question is how the investment decision is made on the part of real estate?

Rowland (2000) lists the following techniques for making investment decisions:

- Tactical switching between asset class
- An annual allocation by a central board
- Mean-variance optimisation
- Requesting money if opportunities arise
- Asset classes selected by contributors
- Timing income to meet liabilities

This is in line with the survey result from Worzala (1997) that show:

- General experience/intuitive diversification (53.7%)
- Simple correlation of returns between asset class (37.3%)
- Modern portfolio theory (23.9%)
- Index models (9%)
- Duration match between assets and liabilities (3%)
- Maturity match between asset and liability (1.5%)

Responses do not add up to 100% since multiple responses were possible. This survey also found that techniques used for real estate only portfolio are substantially different from those are used for mixed-asset portfolio. For the mixed asset portfolio, almost 60% of the investors indicated that they used MPT, over 50% used correlation, and nearly one-third of the investors attempted to match their assets and liabilities. For explaining this difference, Worzala (1997) argued that "This contrast provides some evidence that there is a different level of expertise and sophistication applied to the initial decision of how much real estate should be acquired, versus the investment decisions as to what real estate should be acquired, once the initial allocation is made". However, we do think the contrast is partly due to the data resources.

The difference is the data availability when the decision has to come for specific real estate type, location etc. in the first level of asset allocation. The risk and return data can be relatively easily acquired by using well-recognised real estate index, which is a good proxy for real estate performance. However, the data for specific real estate containing various types and locations are generally unreliable and insufficient, therefore it is difficult to apply MPT on this front. This is also supported by the survey results by Worzala (1997), he found that larger investors use the more sophisticated models such as MPT (35.7%) since there are more available data resources for such investor. Generally, larger investors obtain more information service from real estate consultants and other channels.

The next important finding is the connection between making allocations within asset classes and between asset classes. More than half (59.7%) of the respondents indicated both decisions are independent. This result suggests that not only is the difference in data availability for real estate market but also the effectiveness of market index of real estate assets. For this reason, the asset allocation within real estate always has been adjusted as there is lack of confidence in real estate data.

The major findings about real estate investment decision-making in practice are far from what theory suggested. In fact, the majority of investors still rely on their experience to make investment decisions within real estate allocation. Even though some investors do use the MPT or other quantitative techniques to calculate the mix of portfolio, the results are often heavily adjusted by fund managers. Both evidences suggest that investors tend to use quantitative techniques to derive their investment strategy, which is in line with the decision making on between-asset allocation. However the results are often adjusted based on the market situation and their experiences. The fundamental reason is simply due to the data insufficiency, we believe.

Apart from making decisions on asset allocation, the other survey focuses on techniques concerning risk management for real estate investors. Actually, portfolio risk analysis can be used both for asset allocation policy-making and risk control and monitoring once the investment policy is implemented. With a survey of over 400-portfolio managers from American real estate investment community with a 29% response, Louargand (1992) found strong evidence that managers had moved away from an accounting view of returns to a discounted cash flow view. Also, there is no evidence that the basic concepts of MPT are in use at the strategic level in most portfolios. About 20% of investors make no explicit risk adjustment in their real estate decision-making. The size of this group is unchanged from Wiely (1972) through Webb (1984) to today. Louargand explains the reason for this unchanged attitude towards risk is probably that the senior managers in this industry come from a "deal-making" background and their education predated the advent of teaching MPT in business school. During the 1980s, the industry grew at an astonishing rate and the focus was on acquisition not in risk management. Early attempts by large companies to incorporate state-of-art research departments were often seen as marketing efforts, and the research results are difficult to spread in the organisation. These conditions are changing today. Portfolio performance and risk management has become very important in the past few years.

Besides survey results from the US and UK, survey by De Wit (1994) of Dutch real estate investors yields similar results. Dutch institutional investors seem nevertheless highly aware of the risk of real estate investments. Most investors ask for minimum cash-on-cash return or allow for some maximum level of vacancy. In addition, many investors require that investment properties meet certain qualitative criteria in order to reduce uncertainty beforehand. As these risk-management practices were anticipated, the investors were asked whether self-imposed constraints existed with respect to, in particular, property type, size, and location.

It's concluded that investors in the Netherlands do not systematically adjust for risk, or use relatively simple methods. Many investors qualitatively control for risk through self-imposed constraints. However, it has been found that large institutions more often adjust risk than small investors. This may indicate a growing acceptance of more sophisticated risk adjustment methods for evaluating real estate in the near future.

4.4 REAL ESTATE PORTFOLIO OPTIMISATION

4.4.1 Special characteristics of real estate (Historical data)

Determining the strategic asset mix requires forward looking estimates for the key characteristics of the assets being considered: their long-term expected mean return, the expected variability of these returns about their means as measured by the standard deviation and the correlation between them.

There is no difference in principal between the procedure for handling property and the procedure for other assets; but a couple of queries do often arise. First, it is sometimes thought potentially dangerous to use historical returns for calculating risk if returns have recently tended to rise, but reversal is not expected. However such a change in direction will not necessarily have any impact on the level of risk, at least as measured by standard deviation; but what will affect the validity of historical derived risk numbers is if there is a change in the way returns fluctuate: if for example, returns have varied widely recently, but are not expected to move in a narrow band. Another respect where the property differs from securities such as shares is that transactions in it take place much less frequently, and their details are often not fully disclosed. This may cause the problems of illquidity and incorrect information. To see how the portfolio performing, we have to rely on the valuations instead of market price. Early users of optimisation on property discovered that one conclusion that the return data calculated based on IPD index tends to more stable series than the security returns in the market. This phenomenon is often called valuation or return smoothing due to valuation process, which may result in the lower volatility of real estate asset than is the actually case.

The traditional optimisation technique is of limited help for real estate investment decision-making. First of all, it only generates a single efficient frontier by using point estimation of future returns. It is hard to believe, giving the uncertainty of the estimates for the future, a single efficient frontier will represent the real optimal portfolio. Secondly, even though the single efficient frontier is a perfect indication of the optimal portfolio structure, investors are never in the position to reallocate their portfolio in a short time due to the illiquidity and indivisibility of property and limitation of budget (Brown, 1991).

If the uncertainty of property returns in the future can be incorporated within the optimisation model, the result of optimisation will not be a single frontier, but with a group of efficient frontiers. This optimisation result may provide flexibility for investors to adjust their portfolio within the range. Gold (1995, 1996) applied the bootstrapping technique to generate the fuzzy frontier by using the error message of general forecasting models. However, for many real estate investors, it is very difficult to develop and update appropriate forecasting models for their widely diversified properties with specific physical and local characters.

This chapter focuses on two issues of real estate portfolio optimisation. The first issue is how to optimise the portfolio under the input return in the form of probability distribution; the second issue is to analyse results of optimisation for the purpose of decision-making.

4.4.2 Data and methodology

In this study, the data of a real estate portfolio (total value 2.5 billion USD) of a Dutch investor is used for optimisation. The portfolio includes office, retail, housing, industrial and other property (parking etc.). The investor is considering restructuring the portfolio based on the results of optimisation. The inputs for optimisation are the sector-based returns, volatility and correlation. The uncertainty of the input is measured by probability distribution by applying the Classic

Model. This model is extensively discussed in Chapter 3. In addition, a protocol is designed for eliciting the expert opinions of real estate professionals (Xu, 1998).

Following the normal practice of Dutch real estate investors, the period of cash flow forecasting is 10 years. Portfolio managers are asked to make estimation of the return of property in the period of 1999-2008. Since most rental contracts are indexed for five years, portfolio managers only need to make estimations on certain years when the contracts expire.

The general process of deriving the expert opinions from portfolio managers is as follows:

- Portfolio managers reach consensus on the forecast of the whole property market and sector market, and generate their judgement on trends of rent, vacancy and other sector variables.
- Managers from each sector analyse their portfolio on the property basis. Each manager gives his (her) judgement on critical variables over a certain period. Usually, managers are asked to give their estimations on 5%, 50%, 95% quantiles for each variable such as income, cost and property return. The selection of relevant variables depends on the complexity of the property. If judgement is made on the basic variables instead of the return on property, the probability distribution of property return and sector return over a certain period can be derived through simulation. During this process, the historical data pattern is useful information for estimation.
- In the case of group decision-making, group estimation can be combined and processed by the Classic Model, more detailed information can be found in the book "Experts in Uncertainty" (Cooke, 1991).
- Portfolio managers may look at the preliminary results of the optimisation, if anything shows strange to them, they may adjust their judgement after discussion again. Certainly, the input data can be continuously modified in the light of new information.

Portfolio optimisation under uncertainty starts from sampling the value from each distribution of sector return data, and then recalculates the portfolio return, risk and covariance. For each set of sampling data including return, standard deviation and correlation matrix, optimisation is implemented to find the optimal portfolio structure under the condition of maximised return and various risk levels.

During the simulation and optimisation, certain constraints are given for the practical reasons. In this case, the weight of each property category is limited between 10% to 70%. The optimisation is at risk levels varying from 2% to 6% as measured by standard deviation. Here the sector-based optimisation under uncertainty is analysed. For the optimisation of property basis, one more constraint has to be added, which is the integer constraint for the weight of property due to the indivisibility of the property. An optimisation program such as "WB"[1] can provide such constraints.

Figure 4-2 shows an example of probability distribution of annual return for the property sector in certain year. The probability distribution in Figure 4-1 comes from three portfolio managers, the judgement is combined by global weight.

Figure 4-2. Probability distribution of Retail sector in year 2003

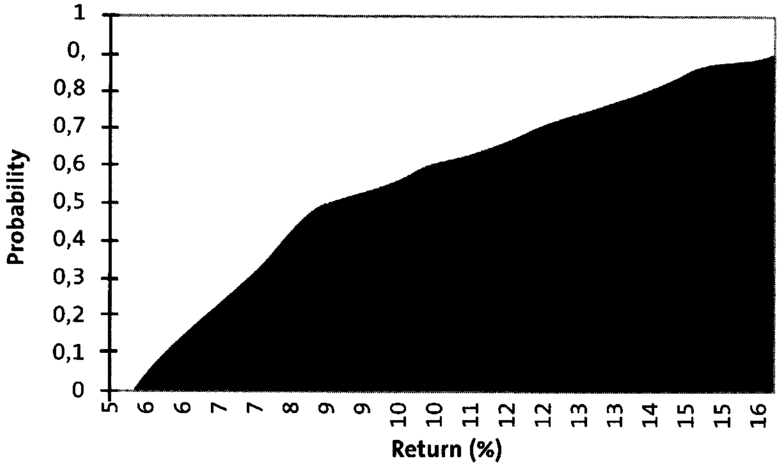


Table 4-2 and Table 4-3 show the expected mean return, standard deviation and correlation of the total portfolio respectively. The weight of each sector is measured by value according to the holding portfolio.

	Return	Std Dev.	Weight(%)
Office	0,113	0,083	29
Retail	0,094	0,043	26
Houses	0,088	0,039	19
Industry	0,091	0,041	16
Others	0,081	0,034	10

Table 4-2 Expected Mean Value of Property-Type Return

	Office	Retail	Houses	Industry	Others
Office	1,000				
Retail	0,294	1,000			
Houses	-0,348	-0,371	1,000		
Industry	0,087	-0,553	0,232	1,000	
Others	-0,243	-0,674	-0,137	0,332	1,000

Table 4-3 Expected Correlation

According to the traditional mean-variance techniques the best estimated return data are used for the purpose of optimisation. Figure 4-3 shows the efficient frontier derived from the mean return data. The optimal portfolio structure under various risk levels and current portfolio structure are shown in Figure 4-4.

Figure 4-3 Expected efficient frontier under best estimation

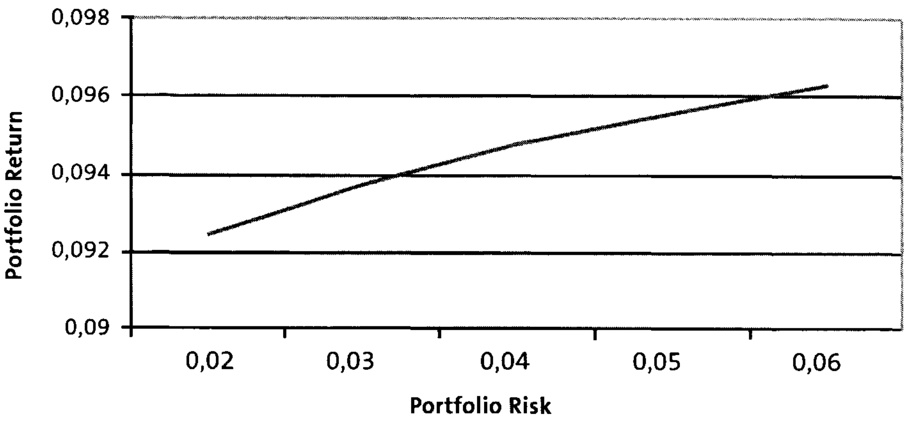
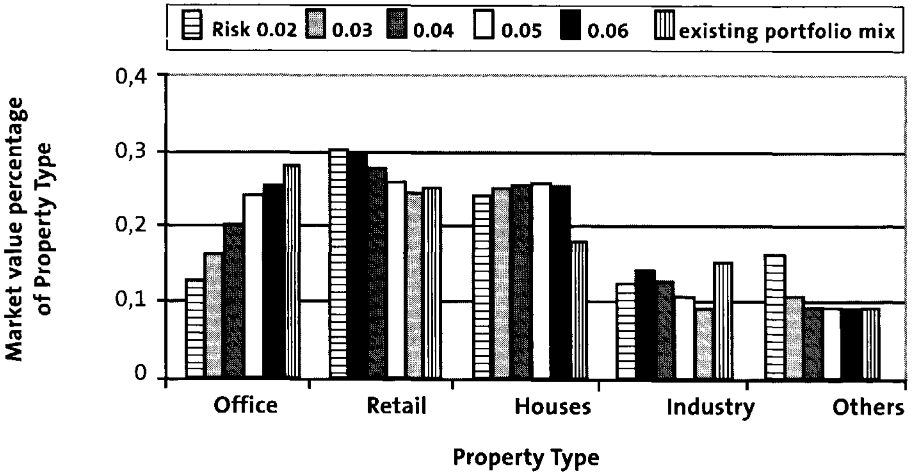


Figure 4-4 Comparison between the optimal portfolio mix with existing portfolio mix under various risk levels



Based on the optimisation result in Figure 4-4, it is obvious that the existing portfolio mix has to be adjusted in all sectors. At each risk level, the weight of all property sectors is out of optimal portfolio mix. In the case of the consideration of transaction cost and illiquid character of real estate, most investors are in difficult position to make decision on a large-scale portfolio revision.

4.4.3 Results

In this study 200 iterations are run in the simulation. Each iteration generates a set of portfolio data of return, variation and correlation. In the end, two hundred efficient frontiers are generated. Figure 4-5 is the result of 200 iterations of simulation and optimisation. It is easy to execute more than 200 runs. Advanced simulation programs such as @risk[2] have an auto-stop function controlled by convergence monitoring. In this case, the output distribution is stable enough after 200 iterations.

Figure 4-5 Efficient frontiers under the uncertainty

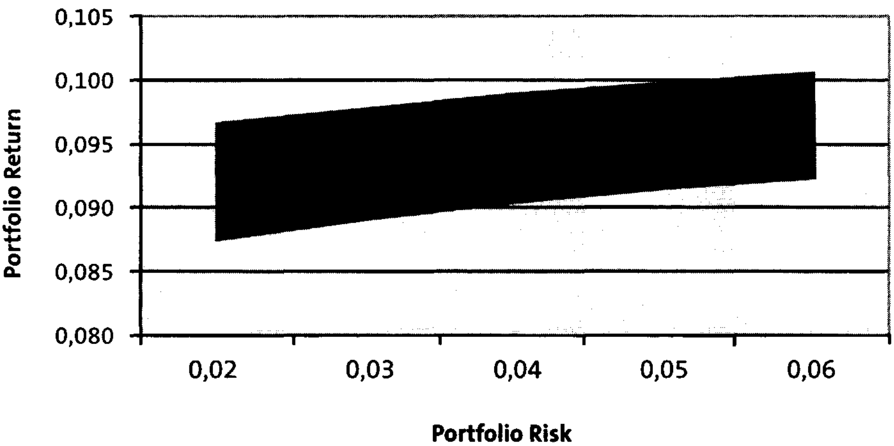
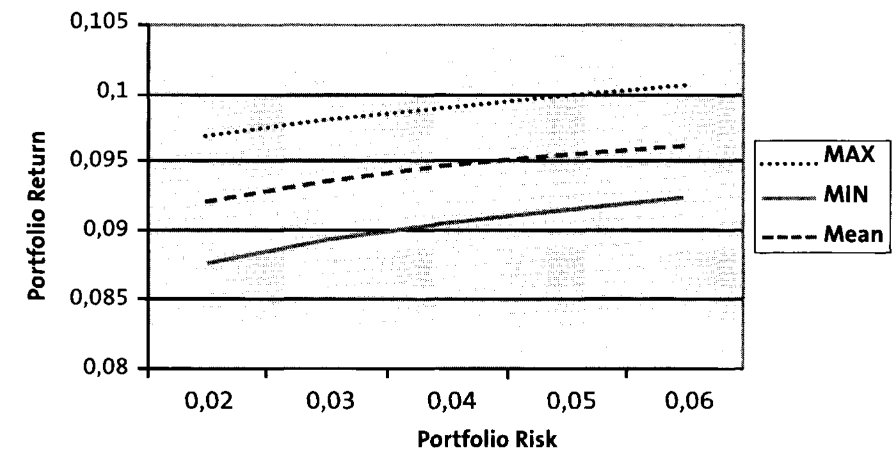


Figure 4-5 reveals the wide range of 200 efficient frontiers. In this study, efficient frontiers with return value within one standard deviation of mean return are selected as indifferent range for investors. Figure 4-6 gives maximum, minimum and mean efficient frontier from selected optimal portfolios.

The comparison of optimal with existing portfolio mix is given in the Table 4-4. It shows that office sector ranges from 10% (minimum constraints) to 31%, retail sector ranges from 10% to 48%, other sectors also show the wide

Figure 4-6 Efficient frontiers within one Std Dev. of mean return



range of proportion. Since range values here originate from those portfolios with a return within one standard deviation of the mean return, investors are satisfied at the same level when they select any portfolio within those ranges. Certainly, the wide range of each sector proportion does not provide a freedom to choose any percentage of each sector within its range, since all sectors are connected to each other. But it is possible to choose the proportion of each sector in sequence. For instance, once the office proportion has been defined as priority, other sectors proportion can be derived with minimum adjustment and cost.

	Office	Retail	Houses	Industry	Others
Holding	**0,290**	**0,250**	**0,200**	**0,160**	**0,100**
Risk 0,02					
MAX	0,174	0,371	0,364	0,253	0,353
MIN	0,100	0,205	0,100	0,100	0,100
MEAN	0,120	0,297	0,245	0,140	0,197
Risk 0,03					
MAX	0,216	0,397	0,393	0,310	0,332
MIN	0,100	0,168	0,100	0,100	0,100
MEAN	0,161	0,289	0,249	0,155	0,146
Risk 0,04					
MAX	0,251	0,415	0,406	0,358	0,314
MIN	0,104	0,176	0,100	0,100	0,100
MEAN	0,196	0,278	0,245	0,158	0,123
Risk 0,05					
MAX	0,284	0,427	0,411	0,371	0,289
MIN	0,144	0,137	0,100	0,100	0,100
MEAN	0,230	0,264	0,236	0,155	0,115
Risk 0,06					
MAX	0,314	0,482	0,414	0,372	0,268
MIN	0,158	0,100	0,100	0,100	0,100
MEAN	0,259	0,255	0,224	0,151	0,111

Table 4-4 Property proportion under various risk level with uncertainty

Figure 4-7 and Figure 4-8 show the comparison between existing portfolio mix and optimal ranges of portfolio mixes. Under a risk level of 3%, it indicates that only the office sector of existing portfolio is out of the range of optimal area. Under a risk level of 6%, weights of all sectors in the current portfolio are very close to the weights of the optimal portfolio. So if the investor would like to take the 6% risk, he would hold his current portfolio without any change.

Figure 4-7 Comparison between optimal ranges of portfolio mixes under risk level of 0.03 and existing portfolio mix

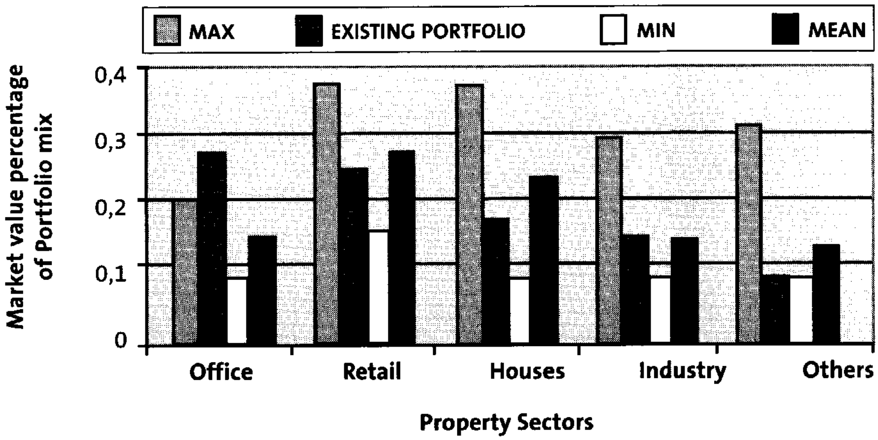
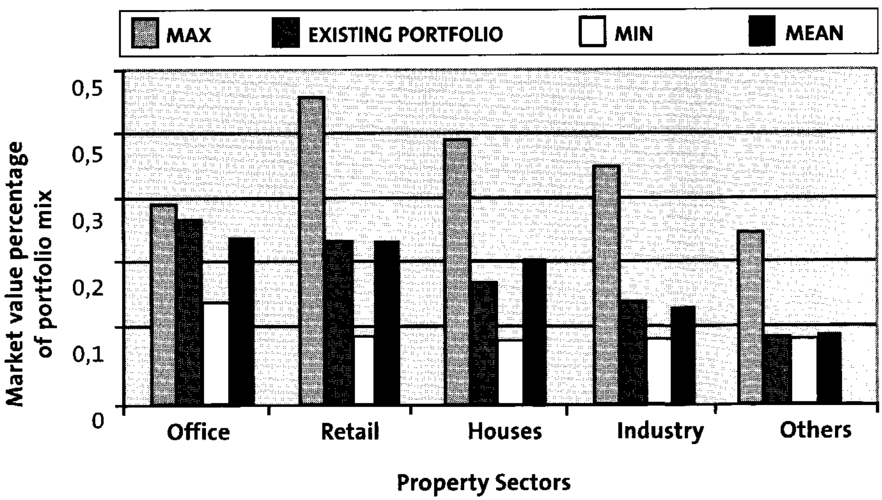


Figure 4-8 Comparison between optimal ranges of portfolio mixes under risk level of 0.06 and existing portfolio mix



Since the uncertainty about the quality of expectation significantly reduces our ability to perform asset allocation with any precision, the range of the weight for each property sector is obvious beneficial for investors. Using the range rather than point estimates largely eliminates the difficulties in rebalancing their portfolio frequently. Also, the result of optimisation under uncertainty provides investors with insight into the risk of their portfolios. Finally, it makes asset allocation more practical and it is consistent with the nature of real estate portfolio (illiquidity, indivisibility and large transaction cost).

4.5 Conclusion

The technique provided here follows the practical decision-making process to a large extent, which starts from judgement and ends in judgement. Since the uncertainty of the future is predicted by the consensus of the in-house view, it gives a good motivation for property portfolio managers to apply expert opinion techniques for optimising their portfolio. Based on results of simulation and optimisation, easy feedback processes will ensure that portfolio managers have flexibility to adjust their estimation.

The uncertainty of investment variables is explicitly quantified on the basis of qualitative thinking. This tool will enhance the quality of a manager's opinions on uncertainty. Meanwhile, the output of portfolio analysis such as portfolio return, risk and efficient frontier will not be a fixed number and shape. It covers a certain range standing for the uncertainty in the future. Obviously, the range provides alternative space for investors to make decisions on asset allocation.

This technique can be used for supporting investment decision-making on strategic (asset allocation), portfolio structure (within real estate) and property level. The core of the method is to define uncertainty appropriately by judgement, so the process of applying this method varies according to different management styles, although the key elements remain the same.

The proposed approach sheds light on the process of using expert opinions from input to output. Stated in another way, the technique can illustrate the impact on portfolio performance clearly if uncertainty of input is given by investors. Although the procedure of quantifying the uncertainty by using expert opinions has been studied in some cases, it is necessary to investigate further in this field. The next step should focus on the data support system for deriving expert opinions on critical variables. Instead of trying to set up forecasting model, the data support system should provide the answer on questions such as what is the necessary historical and future information, what kind of data format is better and how the quality of group opinions can be improved etc. Although there is a lot of research on human judgement on many subjects, unfortunately there are very few studies related to the real estate investment.

(notes)

1 "WB" is an optimisation program with integer and binary functions, it is very useful for property-based optimisation. It is developed by Lindo Systems Inc. in USA.

2 @risk is a major product of Palisade Corporation in USA, it has powerful function to deal with simulation with many possibilities.

5 Relationship with indirect real estate investment

5.1 Introduction

This chapter is concerned with indirect real estate investment. The reason we cover this subject is because institutional investors are increasingly focusing on this sector as is reflected in the market capitalisation. Global Property Research (GPR) property database only covers 423 real estate securities in 14 countries with a combined market capitalisation of 350 billion Euros as of year-end of 1997. Institutional investors, particularly pension funds and insurance companies, have gradually transferred their direct real estate portfolio into indirect real investment. As the research concerns risk analysis on real estate investment, this area should not be ignored. The fundamental assumption of investing indirect real estate is that this asset category could hold the diversification benefits as that of direct real estate. However, since the history of investing in indirect real estate is still short which cannot support this assumption confidently. Therefore it is necessary to test whether indirect real estate holds the diversification benefits for investor's portfolio.

This chapter focuses on following relationships:
1. What is the relationship between direct real estate and indirect real estate?
2. What is the relationship between indirect real estate (shares) with common shares?

In the first part of this chapter, previous research results of this relationship are reviewed. Also, the current trend of securetisation of real estate and the assumption behind this move are discussed. It is well accepted that investing in indirect real estate can benefit from both less management cost and diversification effects with other asset class. There are two ways to test the diversification benefits of investing in indirect real estate. Since many evidences show that direct real estate has low correlation with common shares, if indirect real estate has high correlation with direct real estate, it can be concluded that the diversification benefits still hold for investing in indirect real estate. The other way to test the diversification effects is to test the relationship between indirect real estate and common shares. If both investment vehicles have high correlation, then diversification benefits of investing in indirect real estate are limited. In the second part of this Chapter, we take the second method to test the relationship between indirect real estate (shares) and common shares.

5.2 Development in indirect real estate investment

As real estate is an asset class for institutional investors, all advantages of real estate still hold in the global market. When institutional investors further benefit from global diversification, real estate has become more difficult to maintain in the global portfolio. There are two main obstacles to keeping a global real estate portfolio, local knowledge and high operating cost. Since direct real estate is a very local-oriented business, monitoring global real estate is costly and inefficient. Institutional differences between national capital markets are more cumbersome for direct real estate investments than for stock and bond investment.

The advantage of direct real estate investment is as a hedge against inflation, low correlation with other financial assets such as stock and bonds, etc. However, for international investors who would like to diversify their portfolio across countries and regions, direct holding of real estate becomes very expensive and sometimes inefficient. This brings drawbacks such as high information cost for acquisition and divestment. Research by Eichholtz and Huisman (1999) found that a global portfolio of local property investment companies out performs a portfolio of internationally investing companies. This evidence shows that there is a limited advantage to investing in direct real estate globally.

This issue has motivated investors across the world to look at the opportunity of investing in indirect real estate properties such as exchanged-based real estate shares. REITs and European real estate companies, non-listed real estate funds and other forms of indirect real estate investment attracted many investors' attention. As argued by Eichholtz and Hartzell (1996), the development of the global property share market will reduce the information costs of international real estate investment, which implies a shift in the trade-off between diversification benefits and information costs: diversification will be less costly, and will therefore become more attractive. If it is true, the growth of the global property share market will spur international real estate investment.

In the early 1990s, the market for real estate securities took off. The America REIT boom of 1993, with 47 initial public offerings, occurred more or less simultaneously with strong growth of real estate security markets in other countries both in the number of listed property companies and in market capitalisation (Downs, 1994). In December 1995, this market had a total capitalisation of about 230 billion USD, with some 430 equity real estate companies worldwide. The US REITs market grew by an amount greater than its entire market capitalisation in 1994. Asian real estate securities dropped in USD value 100 billion an amount approximately equal to the market capitalisation of the entire European real estate securities market. The European sector came to life after many years of listless performance and produced a total return of 30% on investment, but with relatively few new listings (Eichholtz and Koedijk, 1996).

While institutional investors are re-thinking their real estate strategy, more and more replace their direct holdings by indirect vehicles. Some investors (especially pension funds) place their direct portfolios in non-listed funds and others are looking for candidates to merge portfolios.

The enlargement of European property investments can fortify the trend of indirect real estate investments and can increase the importance of indirect real estate vehicles. Thissen (2001) investigated that the percentage of direct real estate investments made by insurance companies and pension funds. Dutch institutional investors had 612.4 billion Euros in investment with 38.4 billion Euros (6.27%) in property, divided in 29.9 billion (4.88%) in direct property and 8,5 billion Euros (1.39%) in indirect real estate investment. In 1999, Dutch pension funds held 10.9% of their portfolio in real estate, of which the biggest part (6.3%) was in direct real estate investments and the rest (4.6%) in indirect real estate vehicles. The real estate allocation of Dutch insurance companies has significantly decreased over the last 25 years from 16.1% in 1976 to 4.1% in 1999. The percentage in indirect real estate vehicles compared to the total property investment by insurance companies differs from this percentage by pension funds. While pension funds hold 42.4% of their investment in these vehicles, insurance companies use the vehicles for only 7.8%. The longer investment horizon of pension funds and their goal to achieve a modest return can explain the difference between their high percentage in indirect real estate vehicle, which are risky in the short term.

Although there is increasing focus on indirect real estate, the absolute investment on direct real estate has been increased steadily in recent years. However, the high growth rate of investing in indirect real estate requires more academic attention.

Views of real estate professionals

As differences between direct and indirect real estate investment are intensively discussed among academics, institutional real estate investors also hold different view on both investments. Rowland and Kish (2000) found institutional investors still regarded the diversification benefit is the most important reason to invest in property securities. Investors consider the number one reason to invest in direct real estate is long-term stability returns. The second reason of investing in real estate shares is diversification benefit. Clearly, both investing in direct real estate and indirect real estate is aimed at the diversification benefit for their asset mix. In other words, most institutional investors consider both types of real estate in one asset class instead of the one sector [1].

The reason of investing in real estate shares can be generalised as below:

- More liquid and more transparent market;
- Access to a cost effective capital market;
- Cost and time efficiency for the transactions;
- Well measurable performance;
- Daily price and good historical information;
- Possibility to manage (grow or downsize) the portfolio easily.

The global capital industry has come to expect a performance-related fee across all other asset classes. Compensation arrangements tied to the performance will be seen in Europe as well. The problem is the lack of data for measuring performance in direct real estate. Although IPD publishes an annual index for 6 countries, either the index coverage is small or index is not large enough to be a stable performance benchmark.

Disadvantages of investing indirect real estate:

- More volatility
- Higher correlation with other financial assets

When investors are asked how to select direct real estate properties and real estate securities, not surpassingly, they provided quite different methods in selecting real estate and real estate share:

Factors in selecting real estate :

Property sector
Location
Exploiting current buying opportunities
A minimum value
Mean-variance optimisation

Factor in selecting real estate securities:

Forecast of distributions
The management team
Main assets of the securities fund
Growth in value of securities
Size of the securities fund
Beta of securities
Past volatility of returns
Past returns from the securities

Selection of real estate securities is quite similar to the way of selecting common stocks to large extent. Since there are sufficient data about the historical return, risk, value of the particular security, investors may compare these data with the market performance (benchmark) to make investment decisions. However, the selection of real properties is still very much self-policy dependent. Investors still rely on self-made policy to make investment decisions on sector, location and individual property acquisition. If the selection of real estate securities is similar to common stock selection and is different from real property selection, how do the real estate securities provide the diversification benefits for the asset mix usually including common shares and bonds? The following section describes the research results on the relationship among property, property shares and common shares, which provides the platform for further research.

Questions regarding indirect real estate particular real estate shares?

The international real estate shares specially REITs in United States have attracted many academic researchers. A large number of literatures focus on the performance of real estate shares and diversification benefits comparison among shares, real estate shares, and direct real estate.

The research questions focus on that if real estate shares are indeed different from common shares with regard to risk premium, then the real estate shares should provide constant diversification benefits due to the special risk return behaviour from common stocks. Otherwise the real estate shares may not be a good and consistent diversification investment as an individual asset class instead it is just a sector within the common share asset class.

Eichholtz and others (1998) concluded that the correlation between property share returns and common stock returns shows a decreasing trend, especially in United States. However, the results from other academics deviate from this conclusion. At least, this is not a universe and stable phenomenon. For certain period in some region, real estate shares have strong correlation with common shares. Certainly, the more convincing fact should result from analysing the driving force of real estate share's return and common share's return. If there are different underlying risk factors between real estate shares and common shares, it may be concluded that the diversification benefits still hold. Gorden and Cante (1998) investigated the relationship between global real estate securities and common shares. He concluded that correlation in some countries is tends to be very high while in other countries, it is very low. He proposed the hypothesis that different correlation may result from investment structure (property company or investment trust) and relative weight (market cap ratio of real estate share to total market capitalisation). Particularly, he proposed that if there are dominant real estate shares in the overall equity market, real estate returns tend to be highly correlated with the overall market. The country has special real estate company structures such as real estate trust tend to have lower correlation with the overall equity market. However, he did not provide theoretical prove for both hypotheses.

International real estate investors face a trade-off between diversification and management costs, the optimal point of this trade-off is determined by the efficiency of the markets. Investing in securities real estate is a good combination of avoiding cumbersome management and gaining diversification benefits. Evidence from both academics and practice shows a mixed picture of the benefits of investing indirect real estate investment. Some evidence supports the idea that indirect real estate provides diversification benefits similar to that provided by equity real estate; while other evidence suggests that an increasing integration between real estate share and overall equity market. To clarify the real trend of both markets, it is essential to test the impact of underlying risk factors on both markets.

After a review of direct real estate and indirect real estate investment, the next section discusses the characteristics of common equities. Further, we investigate whether those common risk factors derived from common shares play the same role in real estate shares.

5.3 COMMON RISK FACTORS

5.3.1 Common risk factors of stocks and bonds

Fama and French (1992) identified five common risk factors in the returns on stocks and bonds. There are three stock market factors: an overall market factor, factors related to firm size and book-to-market equity. There are two bond factors, related to maturity and default risks. Since we are focusing on the common shares, we will focus on the risk factors for common stocks, which are market factor (Beta), company size and book-to-market ratio.

The market factor was included and well explained by the Capital Asset Pricing Model, which indicates that share's return can be exclusively explained by market factors measured by Beta. The beta is the correlation coefficient between the specific share's return and market returns. The higher beta implies higher risk therefore higher return. Other researchers found that the market factor cannot explain all return behaviour of common shares, multi-factor CAPM were developed for pricing shares. The research of Fama and French on common risk factors is representative of these kinds of pricing models. Fama and French proved that there are two more pricing factors in addition to market factors that have an impact on share's returns. However, some argued that two extra factors such as size and book-to-market ratio are empirically inspired and lack strong theoretical foundations. For explaining the reason of two extra factors, Fama and French (1993) argued as follows:

Firms that have high BE/ME (a low stock price relative to book value) tend to have low earnings on assets, and the low earnings persist for at least five years before and five years after book-to-equity is measured. Conversely, low BE/ME (a high stock price relative to book value) is associated with persistently high earnings.

Size is also related to profitability. Controlling for book-to-Market equity, small firms tend to have lower earnings on assets than big firms. The size effect in earnings however is largely due to 1980s. Until 1981, controlling for BE/ME, small firms are only slightly less profitable than big firms are. The fact that small firms can suffer a long earning depression that bypasses big firms suggests that size is associated with a common risk factor that might explain the negative relation between size and average return. Similarly the relation between book-to-market equity and earnings suggests that relative profitability is the source of a common risk factor in returns that might explain the positive relation between BE/ME and average return.

Besides the theory developed by Fama and French on the risk factors for common shares, there are other models aiming to pricing the common shares.

Since Fama and French's theory is a well-accepted pricing model in academic circles, we use this model as the basis to test whether these common risk factors have similar impact on the return behaviour of real estate shares.

5.3.2 Common risk factors on Real Estate Investment trusts (REITs)

The risk and return characteristics of real estate and real estate related assets have been the subjects of considerable debates. Early studies used return data based on market appraisals and generally concluded that direct real estate offered risk-adjusted returns superior to investment in common stocks and provided diversification benefits. Since appraisal-based data are not transation driven, recent research has turned its attention to assessing the risk and return characteristics of indirect real estate such as real estate investment trusts (REITs).

There is a substantial volume of research, which seeks to evaluate REIT performance. Most of evidence regarding REIT performance indicates that REITs tends to either outperform or perform about the same as common stocks. The results of previous studies regarding REIT performance depend upon the time period studied and the model assumed to generate REIT returns. There is also evidence, which suggests there is performance difference across REITs.

Peterson and Hsieh (1997) investigated the characteristics of REITs. The purpose of their study is to examine REIT pricing and performance using the 5 factor model of Fama and French (1996). Since variables like size and BE/ME have no direct connection to a theory of asset pricing, their role in explaining the returns on other assets such as real estate is unclear. However, the 5-factor asset-pricing model seems to be a good candidate for the pricing REITs. Since REITs shares trade on the exchange, it's likely that factors that influence the return on common shares also will influence to greater or lesser extent, returns on REITs. The underlying cashflow of REITs also has properties similar to an investment in a bond. Given the fixed nature of some of the underlying cash flows to the REITs, risk factors related to the term structure of interest rates may be important for the pricing of REITs.

Chan, Hendershott and Sanders (1990) find that a term premium, a default risk premium and unexpected inflation influences the REIT return. As many previous studies investigating the outlook character of real estate shares such as the performance and correlation. Their research tries to look at the fundamental difference between real estate shares and common shares in the way of investigating risk factors. The first important finding of this study is that REITs risk premiums are significantly related to the risk premium on a market factor as well as size and BE/ME in returns. Once the size factor and BM/ME in returns are accounted for, the apparent abnormal performance of REITs disappears. When a CAPM framework is used to evaluate performance, the abnormal returns are not significantly from zero. Specifically, the three stock market factors explain returns of REITs, however, the five-factor model doesn't explain returns.

In a word, research in this area generally recognised that common risk factors do have impact on REITs although the extent of impact varies. However, most research concentrates on the US equity market with special instrument as REITS. There is little study of risk factors for other real estate securities such as European real estate shares.

5.3.3 Relationship between real estate shares and common shares

There are many studies of the relationship between real estate shares and common shares. Eichholtz (1996) stated that there is a strong positive relationship between property shares and the overall equity markets as the same results from United Sates (see, for example, Mengden and Hartzel, 1986). He further explained the relationship by following reasons:

Large real estate components in the value of corporate assets changes in the discount rate and in the expectations of long-term economic growth are likely to influence both real estate and the corporate assets in the same direction. The property shares are included in the overall equity markets.

Eichholtz and others' further research (1998) provides new evidence regarding the return behaviour of property shares. He found that diversification benefits of investing in real estate shares is increasing as correlation levels between property share returns and common stock returns show a decreasing trend, especially in United States. Meanwhile, he pointed out that there is as yet no sound theoretical explanation for this phenomenon, it is impossible to determine whether this is just a cyclical effect or a more permanent change, more research is clearly need in this area.

For investigating whether real estate securities are integrated with the common stock market, Gorden and Canter (1998) define the integration as following way:

"In the context of financial market, integration refers to the risk premia (price of the risk) associated with the systematic risk factors must be the same in both markets. That is, the price per unit of exposure to each risk factor must be the same regardless of the asset market in which the risk factor is traded."

Ling and Naranjo (1997) in their study tested whether commercial real estate markets (both securtised and non-securitised real estate) are integrated with stock market using multiple asset-pricing models. The results support the hypothesis that the market exchanged traded real estate companies, including REITs, are integrated with market for exchange-traded non-real estate stocks. Moreover, the degree of integration has significantly increased during 1990s. However, returns of direct real estate investment fail to support the integration hypothesis.

The main distinction among the various asset-pricing models used to test for integration is how they measure risk. A first group of empirical studies on capital asset pricing model used a single factor beta in which asset risk is measured by the covariance of its return with the return on "market portfolio". Some researchers have tested the single factor model for the relationship between the commercial real estate market and stock market. Despite the frequent use of single-factor asset pricing models, much recent research has shown that the stock returns are related to multiple economic risk factors. Thus, potential difficulty with the use of single-factor models to test market integration is that they may be sufficiently misspecified such that the rejection of integration reflects the failure of the models.

Other research found different evidence on the integration of both markets. As we discussed, Eichholtz (1999), Gorden and Canter (1998) found that the correlation between common shares' return and real estate shares' return is decreasing in some regions. However, their empirical evidence is not verified by the pricing model.

Research on risk factors for real estate securities is mainly conducted and focused on US market, there is a lack of fundamental research on European real estate shares. Clearly, for identifying the diversification benefit of investing real estate shares, it's essential to test whether real estate shares provide different risk characteristics, in other words whether European real estate shares rely on different risk factors from common shares?

To answer these questions, we use UK equity market data to test the relationship between property shares and common shares. The following section fully explores the behaviour of UK property shares, it investigates the impact of common risk factors on real estate shares in order to test the effectiveness of those factors on real estate shares.

5.4 RELATIONSHIP BETWEEN UK COMMON SHARES AND REAL ESTATE SHARES

5.4.1 Background information

The performance of international property stocks has been widely studied (Eichholtz and others, 1996, 1998, 1999). Based on the global and country stock and real estate stock indices, previous studies indicated that real estate stocks might possess distinct risk-return characteristics than ordinary common stocks. Therefore, there is diversification potential for investing in international real estate stocks instead of holding real property. However, it is not clear that this phenomenon is just a cyclical or a more permanent change.

This section examines the relationship between returns of UK real estate company shares and company specific variables, to see whether any of the risk factors prevailing among common equities are useful in explaining the cross-sectional return variation in real estate stocks.

Modified Fama-Macbeth regression (1973) is used to test the relationship between monthly cross-section return and company beta and specific variables. The results show that Beta or size alone explains cross section return variation. However, when more than one factor is included in the model, none of them has a consistent relation with expected return. Also, there is no evidence of a significant relationship between beta and size of real estate stocks.

The Sharpe-Lintner-Black model, also called Capital Asset Pricing Model (CAPM) has been extensively tested. The major focus of test is to see weather expected returns variation could be explained by betas.

Recent research questions the adequacy of the CAPM as a model for expected return. Specifically, many papers argue that market beta does not suffice to explain the cross-sectional return variation. Fama and French (1992) conclude that there is a reliable size effect over the 50-year period (1963-1990), but little relation between beta and average return. The relationship between firm size and average stock returns is also documented in Banz (1981). In addition, earlier research finds that debt/equity and earning /price ratios (Bhandari, 1988 and Basu, 1983) also contain information about average stock returns. However, Fama and French find that when used in combination, size and BE/ME capture the apparent roles of leverage and earning/price ratios in returns. Further, Fama and French (1993) develop a three-factor model in which a stock's expected returns depend on the market factor (beta), size and BE/ME.

Despite the empirical evidence of Fama and French, Pettengill, Sundamm and Mathur (1995) and Isakov (1999) argue that CAPM predicts expected return instead of realised return, they find a consistent and significant relationship between beta and returns by adjusting for expectations concerning negative market excess returns.

The next section describes the data and methodology. This is followed by the presentation of empirical results. The final section contains concluding remarks.

5.4.2 Data and Methodology

As mentioned in last section, this study focuses on the UK property shares. Unlike empirical research on common stock market, we investigate on individual stock instead of portfolio since there is a relatively small sample of property shares comparing to common shares.

We follow the criteria of identifying the property shares defined by the Global Property Research (GPR). Until the end of 1998, there are 77 property companies listed in UK stock market. For the reason of estimating the beta and testing the expected return, we select those companies listed from 1984. We use monthly return data of all property shares provided by GPR, the sample period is 1985-1998. Firm specific variables such as size, BE/ME. Earning price ratio, leverage are collected from DataStream. These variables are measured in the same way as Fama and French (1992). We use FTSE all share index as a proxy of market return and UK government bond yield as risk free return.

In general, the sample period (1984-1998) is divided into two sub periods. The first sub period (1984-1988) is used for the beta estimation. Beta of each stock is updated through the sample period. The second sub period (1989-1998) is for testing relationship between return and beta, size and BE/ME. During testing period of 1989-1998, there are 4320 observations of cross sectional return from 40 property shares on monthly average. We use individual stock instead of forming portfolios because of the small sample size. This is the same reason that the shares are not sorted by the beta or other firm specific variables.

Modified Fama and Macbeth regression is used to test the cross sectional return against beta and other firm specific variables. First, beta of each property stock is estimated using rolling 60 months return data starting from January 1985. Then relationship between cross section returns and betas, returns and specific variables are tested from 1990 to 1998 on the monthly basis.

Beta of property shares is measured by general market model as shown below,

$$R_{it} - R_{ft} = \beta (R_{mt} - R_{ft}) + \varepsilon_{it} \quad (5\text{-}1)$$

Where:

R_{it} : Property stock's return in each study month t

R_{ft} : Risk free rate using UK government bond rate

R_{mt} : Market return using FTSE All Share index

ε_{it} : The error term

For testing relationship between betas and cross sectional returns, we use two methods. One is used by Fama and French (1992,1993); another is proposed by Pettengill and others (1995).

The first method is based on the Equation (5-2) ,

$$R_{it} = \gamma_{ot} + \gamma_{1t} * \beta_i + \varepsilon_{it} \quad (5\text{-}2)$$

Equation (5-1) estimates the beta risk for each stock using realised return for both stock and the market, which providing a proxy for the beta in the CAPM. Under the assumption that betas in the estimation period proxy betas in the testing period, a test for a positive risk-return relationship utilise Equation (5-2). If the value of γ_1 is greater than zero, a positive risk-return relationship is supported. γ_1 is the average slope from the monthly regressions of individual stock returns against estimated beta. T-test is used for testing the significance of the value of average slope.

The second method is proposed by Pettengill and others (1995), they argue that the relationship between the return and beta is conditional on the relationship between realised market return and the risk-free return. If $R_m < R_f$, then $\beta_p*(R_{mt}-R_{ft}) < 0$. In this case, the predicted return includes negative risk premium that is proportional to beta. Therefore, Equation (5-3) is used for testing the relation between return and beta.

$$R_{it} = \gamma_{ot} + \gamma_{1t} * \beta_i * \delta + \gamma_{2t} * (1-\delta) * \beta_i + \varepsilon_{it} \qquad (5\text{-}3)$$

Where $\delta=1$, if $(R_{mt}-R_{ft}) > 0$, and $\delta = 0$, if $(R_{mt}-R_{ft}) < 0$

The relations between return and beta is examined for each month in the test period by estimating either γ_1 or γ_2, depending on the different sign of market excess return.

In the same way, the Size and BE/ME of each stock are tested individually and together with beta as three-factor model (Fama and French, 1993). Since we don't sort shares by size or beta because of small sample size, it is necessary to analyse the relation between beta and firm specific variables, which can identify the true explanatory variables for return variation. For this reason, regressions are also applied between betas and firm specific variables.

5.4.3 Results

A. Beta vs. Returns

Panel A of Table 1 presents the estimates of average slope coefficients and t-statistics. The results of first testing method indicated that regression coeffi-

Panel A			
Estimating slope by: $R_{it} = \gamma_{0t} + \gamma_{1t} * \beta_i + \varepsilon_{it}$			
Period (1989-1998)	γ_1	T-statistics	P-value
120 months	0.017	0.340	0.360
Panel B			
Estimation slope by: $R_{it} = \gamma_{0t} + \gamma_{1t} * \beta_i * \delta + \gamma_{2t} * (1-\delta) * \beta_i + \varepsilon_{it}$			
Positive market	γ_1	T-statistics	P-value
excess return 70 months	0.015	2.820	0.003
Negative market	γ_2	T-statistics	P-value
excess return 50 months	-0.025	-7.140	0.000
* Numbers in parentheses are t-statistics and p-values			

Table 5-1 Average slope from monthly regression of stock returns on Beta under two methods (Beta estimation from 1985)

cient associated with the market beta is not significant from zero. This is in line with the findings of Chen and Ross (1986) using ordinary common shares and Fama and French (1992) using non-financial shares. Therefore, our finding in UK property shares does not support CAPM when first testing method is applied.

Panel B of Table 5-1 presents average of slope coefficient and t-statistics under two conditions. Hypothesis here is that a positive relation exists between beta and realised return during periods of positive market excess return and a negative relation occurs during periods of negative market excess return. This hypothesis is supported by the results of Panel B. Mean value of γ_1 is 0.015 which is significantly different from zero. Mean value of γ_2 is -0.025 is also significantly different from zero. The results show that high beta shares outperform in a bull market and under perform in bear market. We therefore support the conclusion that the beta of property shares has reliable relation with expected return.

Beta	Ln(ME)*	Ln(BE/ME)	P/E
	-0.0018 (-1.79) (0.04)		
		0.0068 (1.30) (0.10)	
			0.0002 (0.52) (0.30)
0.002 (0.78) (0.22)	-0.000048 (-0.01) (0.50)		
0.004 (0.66) (0.26)		0.0032 (0.90) (0.18)	
	-0.00065 (-0.2) (0.42)	0.0032 (1.07) (0.14)	
0.002 (0.43) 0.33)	-0.001 (-0.48) (0.32)	0.002 (0.57) (0.28)	

* Numbers in parentheses are t-statistics and p-values

Table 5-2 Average slope from monthly regression of shares returns on Beta, Size and BE/ME of property shares

B. Three Factor Model

As proposed by previous research (Fama and French, 1995), company size represented by market value of equity (ME), the ratio of book value of equity to market value of equity (BE/ME), market factor (beta) are considered as the important factors in explaining and return variation for common shares. Table 5-2 shows the results of average slopes (t-statistics) of the monthly regression of property shares' returns against beta, size, BE/ME and price earning ratio (P/E).

As presented in Table 5-2, size alone helps to explain the cross section of average stock returns, which is consistent with the evidence of previous researches both on general shares and REITs. While BE/ME has no explanatory power for expected return variation, this result is different from results for common shares. Similar evidence is also found by Peterson and Hsieh (1997) on REITs. When more factors are introduced in the regression against expected returns, none of them shows a reliable correlation with expected stock returns. All average slopes are not significant different from zero. Again, this result differs the results achieved from common shares. Fama and French (1992, 1993) presented the consistent relationship between Size, BE/ME and expected returns under the combination with beta. However, our results are in line with the evidence from Peterson and Hsieh (1997), although their findings support the three factor model in explaining expected return on REITs, the results should be considered with reservation, since only time-series returns are used in their study.

	$(R_{mt} - R_{ft}) > 0$		$(R_{mt} - R_{ft}) < 0$	
Beta	0.010 (2.52) (0.01)	0.011 (1.61) (0.05)	-0.005 (-0.96) (0.17)	-0.003 (-0.27) (0.39)
Ln(ME)	0.003 (0.86) (0.20)		-0.004 (-0.43) (0.33)	
Ln(BE/ME)		0.004 (2.24) (0.01)		-0.003 (-0.49) (0.31)

Table 5-3 Average slope from regressions of stock returns on variables under conditional market excess returns

Considering the conditional market excess return, we also investigate the relationship between expected return with various variables under different market situation. Table 5-3 presents the results of regressions of expected return against beta and size, beta and BE/ME. Under the situation of positive and negative market excess return, the mixed results are appeared. As the market excess returns are positive, the coefficients of beta are significant from zero when size factor or be/me is added. The significance of beta is disappeared when the market excess returns are negative. These results are in conflict with the finding of Isakov (1999) on common shares. He found that beta is consistently significant whether the size factor is included or not in the model. However, size factor has no explanatory role in either case, which is in line with the results of table 5-2. Therefore we suggest that, for predicting the expected return, size factor of property shares is not as important as it is for common shares.

The reason for the poor results for beta in Table 2 and part of Table 3 may come from the correlation between beta and other explanatory variables such as size and BE/ME. For the purpose of comparison between common shares and property shares in terms of risk return characteristics, only well-known explanatory variables i.e. size and BE/ME are taken into account in this study. If there is a strong relation between beta and other variables, the true correlation between beta and expected return may be distorted. Therefore, we investigate the correlation between beta, size and BE/ME in the following section.

C. Beta vs. Size and BE/ME

Table 5-4 shows the correlation between beta and Size, beta and BE/ME of UK property shares based on the cross-sectional data in last 10 years.

	Ln(ME)	Ln(BE/ME)
Beta	0.02	-0.11
T-statistics	1.25	-1.15
P-value	0.12	0.13

Table 5-4 Correlation between beta and size, beta and BE/ME

It is obvious that there is no strong relation between beta and size or beta and BE/ME. Particularly, our evidence of extremely low correlation between beta and size (0.023) is in contrast with the finding of Fama and French (-0.988), which again demonstrates the significantly different role of size factor in explaining expected returns of common shares and property shares.

5.5 Conclusion

The role of the common risk factor in REITs is explored extensively in recent years. Our research expands the coverage of real estate stocks to the European market. This paper analyses the risk return characteristics of UK real estate stocks. We find that the beta for real estate stocks has a consistent relation with expected return under two categories of market access returns. Also, the size of real estate company has explanatory power for expected return, while BE/ME has no strong relation with return variation.

However, when more than one factor is included in the model, none of them shows a significant correlation with expected return. Further, we find no evidence of correlation between beta and size or beta and BE/ME. This result implies that there might be other factors important to the risk premium of real estate stocks. Clearly, further research is needed.

Nevertheless, our results have two important implications for real estate investors. First, the reliable relation between beta and expected return indicated that decreasing beta of real estate stocks provides the diversification potential in the future. Second, the three factor model of Fama and French is not sufficient to explain the expected return of real estate stocks, which indicates possible existence of other risk factors related to returns of real estate stocks. Since only UK real estate stocks are studied here, further research is needed to cover other markets and risk factors.

(note)

1 Asset class refers to shares, bonds, cash and real estate; sector refers to industrial group such as utility, oil, Hi-tech etc.

6 Application

6.1 Introduction

For developing the tool of quantitative risk analysis for real estate investment, we applied the expert opinion method to forecast the uncertainty of the real estate market; in chapter 4 we developed the simulation and optimisation tool to generate the optimal portfolio under uncertainty. Based on the achievements from chapter 3 and chapter 4, a computerised model has been developed for quantitative risk analysis. This chapter discusses the computerised model for portfolio risk analysis developed in this research.

The rest of chapter first discusses the structure of the model, and then explains the contents and the function of the model in detail; then describes the results of the model; finally, the limitation of this application is generalised.

6.2 The structure of the system

The general process of the system is described in the Figure 6-1 . It follows the process as "Data collection-Calculation-Results presentation" (Figure.1-1). There are three major parts in the system. The first one is the database containing all historical and expected portfolio information, and also the possibility to add new projects such as target investment projects. The second part is the calculation module including portfolio risk return calculation, simulation, optimisation and Buy & Sell analysis. The last part is the presentation tool for presenting the figures and graphs.

6.3 Database

This application imports the basic data from the individual project and portfolio. Appendix 2 shows the format of the project data. There are two kinds of variables in the project database. One is an input variable including following items:

Sector
Location
Tenants rating
Quality
Geographical data
Estimated rental income
Estimated cost
Capital expenditure
Sales
Market value

The second project database contains derived variables as below:

Net cash flow
Net rate of return
Capital gain
Total rate of return

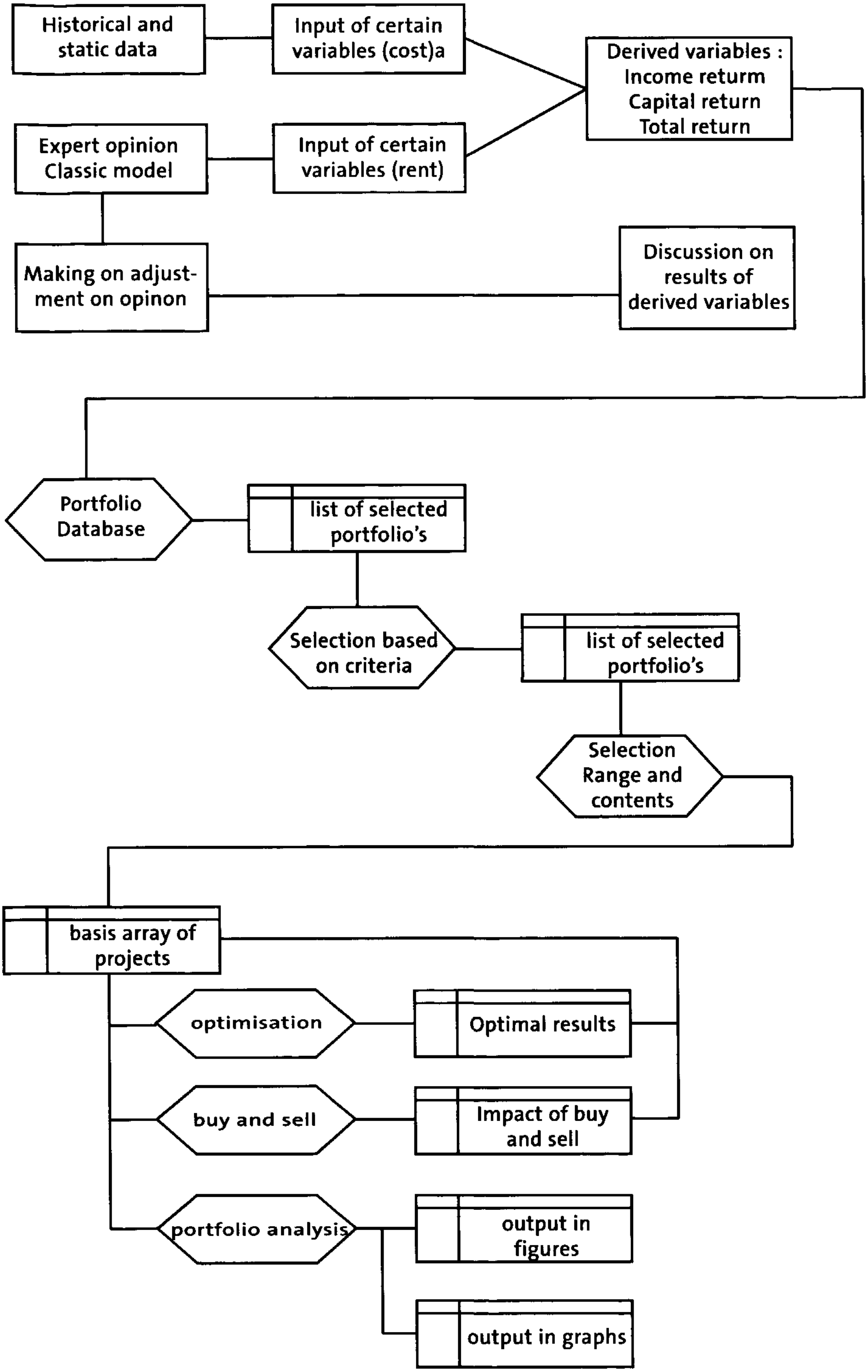


Figure 6-1 The process of model

As described in Equation 2-9, it's clear that the income and cost basically determine the market value and therefore the capital return, meanwhile the income and cost determine the cash returns. Therefore the income and cost are the most important variables for the total returns of real estate investment. Expert opinion method is used to forecast the market rent and further to estimate the future rental income for individual project. Once the future rent is estimated, the return of the project can be simulated by this input. Then the return distribution can be used as input for the portfolio model, the return distribution for the portfolio can be obtained by simulation. For making investment decisions on the context of strategic, portfolio and project, the optimisation can be applied together with the simulation for finding the optimal portfolios. This process is fully described in Chapter 4.

There are two kinds of data used for risk analysis. One is the historical data recording the historical performance of the project and portfolio. The other is expected future data imported from expert opinion tool "Excalibre". Both data are used for the investment risk analysis. Mainly, the historical data is used for static analysis to analyse the historical performance of the portfolio, which can be used for performance measurement by using risk adjusted return figure. The expected future data is used for supporting the investment decision-making. Since all investment decisions are based on the performance of the portfolio in the future, risk analysis should use the expected data instead of historical data. Besides the real portfolio data, the benchmark data is also stored in the database for the purpose comparative risk analysis. The benchmark data is based on the IPD/ROZ index data and updated annually. The benchmark data is also grouped by property type, location, etc.

6.4 Functionality of the system

This application is built as the Microsoft Excel Add-in program as shown in figure 6-2. The first part of application is database. Project database is also built by Excel workbook.

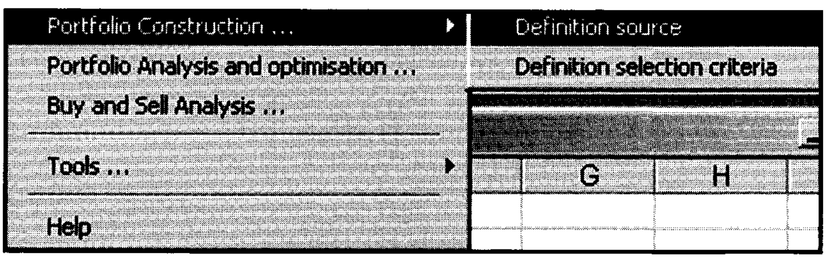


Figure 6-2 Example of Add-in window in the Excel

The second part of the system is the links between database and other application routines such as "@risk" and "What's Best". If the input in the database contains probability distribution, @risk provides a Monte Carlo simulation for sampling the data for further calculation. "What's Best" is used to optimise the result under certain constraints. Both programs are linked to the system for the portfolio risk analysis.

This application contains four major functions, they are constructing portfolio, portfolio analysis, optimisation and buy and sell analysis. Each function provides the specific result for supporting various decision-makings. Following is the general description of each function in this application.

Constructing portfolios

The "portfolio" here is a general term. The portfolio can be constructed from project database as a new portfolio, or existing portfolio, or sub-portfolios. For single portfolio analysis, there will be only one portfolio selected from database. For the purpose of analysing group portfolios or asset allocation study, a single portfolio will be the basic unit in the constructed group portfolio. The way of selecting the portfolio provides the flexibility to do risk analysis on the level of project, portfolio and group portfolios.

For constructing portfolio, many criteria can be used. For example, if one would like to analyse the office portfolio in a certain location, this portfolio can be constructed by defining two factors such as "Location" and "Property type". The figure 6-3 shows the window of "Definition selection criteria". By defining selection criteria defined in the database, all customised portfolios can be constructed for further analysis. In addition, the corresponding benchmark portfolio can also be selected for the purpose of comparison.

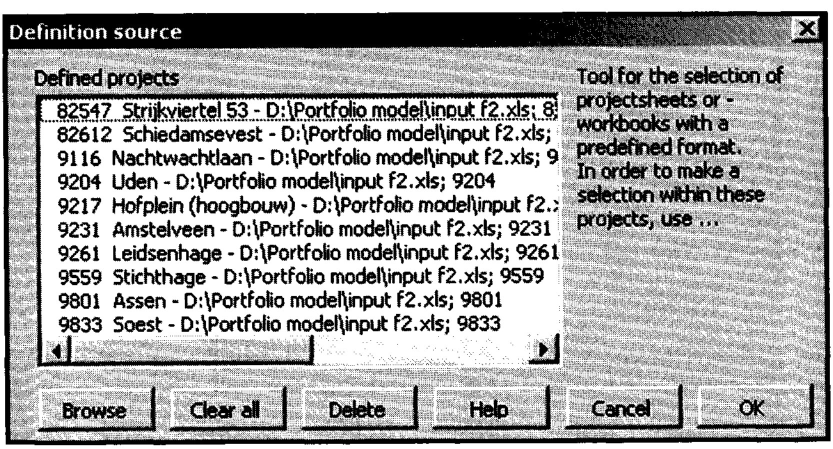


Figure 6-3 Window of construction portfolio

Portfolio Analysis

Portfolio analysis provides the following functions:

- Presentation of input data: sector weight, location weight, sector return, location return, and total return under one or more constraints.

- Financial risk ratios: value at risk, risk ratio, sharp ratio, and efficiency ratio, tracking error, and benchmark comparison.
- Static risk measurement: measurements of mean return and risk (standard deviation on mean return) with fixed input.
- Dynamic risk measurement: measurement of return and risk with uncertain input by using simulation. In the simulation, it is necessary to define the correlation matrix because projects are correlated in many cases. The correlation matrix may be obtained from historical data or from expert opinion.

Portfolio optimisation

The results of portfolio risk analysis provide all kinds of information regarding risk, return and static feature of the portfolio. For the purpose of making investment decisions for the future, the optimisation is necessary to determine the optimal portfolio weight for location, type, and other criteria. Chapter 4 discussed the optimisation process in detail, the following results can be provided by portfolio optimisation:

- **Conditions of optimisation**
  By using the function of portfolio construction, portfolio optimisation can be realised for many purposes. If a portfolio is constructed by property type, the optimal result will be the best mix in terms of property type such as 30% office, 30% shops and 40% housing etc. Portfolios can also be grouped by location, market value, quality, building year, etc. Therefore the optimal result is diversified based on the way of portfolio grouping.
- **Static optimisation:**
  Static optimisation refers to optimisation under the condition of that all risk and return data for each project or portfolio are a single fixed input. This fixed input can be historical return and risk or estimated future risk return. By using this kind of input in mean variance analysis, a single efficient frontier is generated which indicates the optimal portfolio under each risk scenario (see figure 4-3). Since the input of optimisation is fixed, it is called static optimisation.
- **Dynamic optimisation:**
  Dynamic optimisation involves the uncertain input. In our application, dynamic optimisation imports the risk return data of the project or portfolio in the form of probability distribution. Since the input is a distribution instead of the fixed one, the optimisation process becomes more complicated. First of all, the simulation is used to generate all possible scenarios with the risk return data, and then optimisation is executed under each scenario. Therefore the number of optimal results (efficient frontiers) will be the same as the number of scenarios generated by the simulation (see figure 4-5). The procedure of dealing with the multiple optimal results is described in Chapter 4.

Buy and sell analysis

Portfolio analysis and portfolio optimisation are mainly used for strategic and tactic investment decision-making . Buy and sell analysis aims at assisting the operational decision-making. By analysing the risk and return of the targeted project or portfolio, and the impact of the targeted project and portfolio on the existing portfolio, investors may make the decision to buy or sell the project or portfolio. This application only provides the information of risk return on both targets and the impact on existing investment portfolio, investors have to make their decisions based on their own risk appetite. This is the so-called utility function of investors, which is not covered by this research.

6.5 Limitations

Since our research is focusing on the methodology instead of providing a commercial program, this application is certainly not perfect regarding the technical aspects although it covers most functions needed for investment risk analysis.

Besides the technical issue, this application doesn't cover the investor's utility for the further decision-making. Although the results show the risk return of the investment on target project and portfolio, it is not sufficient for the investor to make decisions since different investors have different level of risk tolerance. In other words, the project or portfolio with 15% return and 20% risk is good for one investor may be too risky for other investors. This factor is not considered in our research area and is needed for the further research.

7 Conclusion and Discussion

7.1 Summary

As stated in the title of the dissertation, this research focuses on quantitative risk analysis in real estate investment. A tool for quantitative portfolio risk analysis for real estate investors is developed. All the following questions raised in chapter 1 are answered in previous chapters:

1. What is the current state of academic research regarding quantitative risk analysis and the implication for professional investors?
2. What is the current practice among institutional investors concerning risk analysis in real estate investment decision-making?
3. How to apply expert opinion method for forecasting real estate market?
4. How should a quantitative tool for real estate portfolio risk analysis be developed?
5. What are the relationships between indirect real estate (real estate shares) and common shares (European market) in terms of risk factors?
6. What are the implications of this research for academics and investors regarding risk analysis?

The following is summary of all conclusions and results related to these questions achieved by previous chapters.

Conclusion for question 1:

What is the current state of academic research regarding quantitative risk analysis and the implication for professional investors?

The basis of risk analysis in investment is market forecasting. In general, academic research focuses on two areas regarding market forecasting. The first area of research is in forecasting the market by using causal models. There is a great deal of literature analysing the impact of macro- and micro- variables on real estate supply and demand. By deriving the forecast of future demand and the supply of specific sector of real estate, the future income of a specific investment can be estimated and the variation of returns, i.e. risk, can be measured. The second area of research concerns the historical performance of real estate investment and its relationship with other assets. By analysing the historical behaviour of a specific category of real estate and the relationship between real estate and other asset classes such as shares and bonds, it may assist investors to make investment decisions in both asset allocation and real-estate-only portfolios. In addition to these two areas, some researchers are attempting to apply the methodology developed for the stock market to the real estate market. For example, some researchers apply the Capital Asset Pricing Model (CAPM) to measure the relative risk of real estate investments by using the Beta coefficient. However, those research results are difficult to apply in the real world due to the characteristics of real estate market. Properties are less frequently traded on non-exchange markets, indivisible, illiquid, less informative about market prices, and have high transaction costs. These characteristics create difficulties for both obtaining market data of real estate and complying with assumptions behind these models.

Because of the limitation of historically and financially oriented methods to forecast real estate market, a few researchers used expert opinion to forecast the real estate market (Ong and Chew, 1996). This method provides a promising alternative for forecasting uncertainty in the real estate market. This research applies structured expert opinion method (Classic Model) to forecast the real estate market.

Conclusion for the question 2

What is the current practice among institutional investors concerning risk analysis in real estate investment decision-making?

The results of our interviews with several Dutch institutional investors[1] are very much in line with the findings of surveys conducted in other European countries and the United States. Generally, real estate investors are not using sophisticated financial models such as CAPM, modern portfolio theory (MPT) or statistical tools for risk analysis. For real estate-only portfolio investment decision-making the majority of investors rely on professional experience and intuition. However, the survey also indicated that institutional investors need applicable quantitative tools to assist their risk analysis and further aid their decision-making (see section 4.3 for details).

Conclusion for question 3

How to apply expert opinion method for forecasting real estate market?

Having identified the difference in focus between real estate academics and real estate professionals, this research attempts to develop a quantitative method for market forecasting and portfolio risk analysis. We try to develop an appropriate approach to forecasting the uncertainty in the real estate market for real estate investors. This approach is based on expert opinion method, opinions are used every day by real estate professionals.

This research applies the "Classic Model" (see section 3.3) as a structured expert opinion approach. Classic Model was developed by Cooke (1991) for deriving and combining group expert's opinion on the uncertainty. This model is frequently used for forecasting uncertainty in the field of technology and science. In recent years, some researchers also applied this model to forecasting in the field of economics and finance. One of the examples of application is the stock market forecasting.

There are two major issues related with the application of expert opinion, one is the consistency and predictability of expert opinion, the other is combining of group opinion in order to improve the performance of expert opinions. This research has focused on these two issues and has promising findings.

This research applied the "Classic Model" to forecast the uncertainty of real estate market (see section 3.4). The results of this research concluded that:

- Performance of expert's opinions can be measured by their performance in the past on similar subjects (seed variables);
- The combination of group opinions using the performance weight out performed the combination using the simple average combination.

Conclusion for question 4

How should a quantitative tool for real estate portfolio risk analysis be developed?

After quantifying the uncertainty in the real estate market derived by expert opinion, the next issue is how to use it for portfolio risk analysis in order to make investment decisions based on risk and return trade-offs. This research has developed a portfolio risk analysis tool to incorporate the uncertainty in the real estate market represented in the form of a probability distribution (see section 4.4). The mean variance approach is used together with the Monte Carlo simulation to generate multi-optimal portfolios.

Traditional optimisation process generates a single efficient frontier where investors may achieve the highest return under certain risk level by following the certain composition of the portfolio. If an investor would follow the composition given by the optimisation, a huge cost would be involved for rebalancing their portfolios. For instance, investors have to buy more offices or sell retails frequently to meet the goal of achieving the best return and risk profile reflected in a single efficient frontier. Obviously, this decision process does not fit the characteristics (illiquid and high transaction cost) of the real estate market. The traditional optimisation is based on the assumption that the pattern of risk and return of real estate is constant. This assumption does not hold in the reality, therefore investors are not necessary to keep rebalancing their portfolios according to the single solution provided by the traditional optimisation process.

The method developed in this research incorporates the input (risk and return of each asset) in the form of a probability distribution, then samples risk return figures from this distribution and generates multi-optimal portfolios (see 4.4). Therefore investors may adjust their portfolio with the multiple alternatives instead of following one optimal portfolio. By doing this, investors can avoid the frequent transactions for complying with the requirement of the optimal portfolio.

Conclusion for question 5

What are the relationships between indirect real estate (real estate shares) and common shares (European market) in terms of risk factors?

Since indirect real estate investment is becoming an important part of the asset mix of institutional investors, this research tries to identify the relationship between real estate shares (indirect real estate investment) and common shares. We try to test whether indirect real estate, such as real estate shares, has the same risk factors as common shares. If so, indirect real estate cannot provide the diversification benefits since returns from both asset categories move in the same direction with the market.

This research is based on the three risk premium factors for common shares (Fama and French 1992). The three common risk factors are market risk (Beta), size of the equity and the ratio of book equity to market equity (BE/ME). We tested whether these factors have similar impact on the returns of real estate shares. The results are mixed (see Chapter 5.4). Research shows that the market factor (beta) of real estate shares has a consistent relation with expected returns, which indicates that market factor is applicable to real estate shares. Also, size of the real estate company explains the expected return, while BE/ME has no strong relation with return variation of real estate shares.

However, if more than one factor is involved, none of them shows significant correlation with the expected returns of real estate shares. Further, we find no evidence of correlation between beta and size, or beta and BE/ME. This result implies that other factors might be important in the risk premium of real estate stocks. However, it's safe to say that real estate shares are indeed different from common shares and that to some extent they may provide diversification benefits.

Conclusion for question 6

What are the implications of this research for academics and investors regarding risk analysis?

There will be following implications for both academics and institutional investors:

1. The results of this research provide evidence that expert opinions are a valuable alternative technique for real estate market forecasts. This area is worth developing further as an addition to the fundamental and technical methods for market forecasting. Academics could devote more efforts in this area to market analysis using expert opinions.
2. Although investors frequently use expert opinions, it is worth applying this model to assist their decision-making by using structured expert opinion method (see Chapter 3). The method applied here provides a good solution for combining group opinions, which is common practice of decision-making in organisations. This flexible method will give investors a structured way to reach consistent and conscious decisions.
3. By applying the expert opinion and simulation approach as developed in this research (see Chapter 4), investors may overcome the general difficulties of using quantitative risk analysis (lack of input and model), and improve the quality of the investment decision-making.

4. As tested in this research (see Chapter 5), indirect real estate (real estate shares) has some different risk factors from common shares although some factors are in common with general shares. This result indicates that institutional investor may hold real estate shares as part of their real estate portfolio for the purpose of diversification. Since three risk factors together cannot explain the expected return of real estate shares, it suggests further academic research on this area.

7.2 Application perspective

Currently, there is an increasing demand from clients for asset managers and investment managers to show their investment strategies. Risk, risk-adjusted return and other quantitative performance figures are required by clients. Therefore investors and asset managers are motivated to apply quantitative models to assist their decision-making. Real estate investors are catching up with their counterparts in financial markets in terms of risk analysis techniques. Recent surveys show that increasing numbers of real estate investors apply sophisticated techniques to make decisions over asset allocation and portfolio optimisation.

We followed this demand from the investment industry, and tried to provide a tool for risk analysis to assist decision-making. The industry has a consistent view that the performance of real estate investment should be measured by risk-adjusted returns. As discussed in previous chapters, the tool developed here is not a purely objective program; it incorporates the human input (expert opinions). Expert opinions are calibrated and grouped in a scientific way, the final results from the application of the expert opinions are presented in the form of probability distributions that is suitable for further quantitative risk analysis. Once the input is derived, the portfolio optimiser is able to calculate absolute risk (standard deviation) and relative risk (tracking error) against a benchmark, generate optimised portfolios, provide suggestions on optimised asset allocation, portfolio selection and project in-and-out analysis.

In general, the tool developed by this research can be applied in the following areas:

Real estate market forecast

The future market situation is the critical factor in decision making for real estate investors. The major risk that investors are taking is closely related with future market volatility. If the actual market movement is contrary to investor's expectation, the decisions will yield unfavourable results. Therefore techniques of forecasting the future market are essential for investors. Particularly, decision-making in modern organisations always involves a group of people such as market researchers, portfolio managers, economists, general managers, etc. It's not the performance of individual people that is important instead it's the group performance.

Generally, reaching consensus over forecasts of the future market is a frequent activity of investors. Investors often set-up a long term, medium term and single year investment strategy based on forecast horizons. Certainly, longer horizons have greater inaccuracy regarding the forecasting. Therefore investment strategies have to be adjusted in light of new information, and a new consensus on the market forecast has to be reached.

The expert opinion method applied by this research is based on sound theory and tested in the real world, the results are promising and convincing. The tool consists of three major components. The first component is the protocol for deriving opinions and to collect the appropriate information such as creating the friendly environment in which to encourage experts to present their true opinions. The second component explains how to select and use seed variables for measuring the performance of the individual opinion. The third component processes the individual opinion and combines the group opinions based on their performance on seed variables.

This tool is an alternative way of forecasting the market by using the opinion of real estate investors and is one of the first to use expert opinion in structured way and to combine the group opinions based on performance for real estate markets. Also, since experts are asked to give their opinion in the form of a probability distribution, it provides much more information than estimations in single figures. This application provides a valid input for further quantitative risk analysis.

Portfolio risk measurement

Based on the result of market forecast, investment risk is measured by the standard deviation of the investment returns. As explained in the Chapter 6, investors can input their estimations of return, risk, and correlation matrix (this can also be calculated by the tool) in the system. The return and risk figures of each project can be a single estimation or a distribution, which will give rise to different results for risk analysis. The return and risk of individual projects can be calculated by the tool.

The important ability of the tool is to calculate the impact of a project or a portfolio on the total performance (risk and return). The tool can measure the risk and return of the portfolio, select the optimal project and portfolio in the investment alternatives, create an optimal portfolio or optimal portfolios based on the type of input, provide risk return information for decision making on the level of asset allocation, portfolio optimisation and project selection.

Indirect real estate investment

Since indirect real estate is becoming the part of investor's real estate portfolio, the role of indirect real estate is becoming more and more important in asset allocation. However, the argument for introducing indirect real estate is also obvious the diversification benefit will be reduced once indirect real estate plays a part in the real estate portfolio. This research provides a method to check if real estate shares are highly correlated with the common share market based on the effects of common risk factors. This method can be applied in different target markets in which investors are interested.

7.3 Recommendations and future research

As every research project is part of a process for reaching a final goal, this research also leaves many areas to further exploration and provides some suggestions for future development in the area of risk analysis in real estate investment. The main remaining issues are:

1. The expert opinion method has to be tested in more organisations and under various market conditions. Due to workload and time limitation, we only formally tested with one company office portfolio. This research only provides the general principle of the method, it should be adjusted and customised for different organisation and markets.

2. The computerised model of portfolio analysis has to be modified for the convenience of the users. Since we are not professional software developers, the tool is still very primitive compared to a commercial system. Particularly, the database and interface have to be developed further to create a user-friendly environment. Also, the computerised model is restricted in the number of variables. The reason of this limitation is purely technical. It can be extended for more variables and larger matrix if the system can be fully developed.

3. Due to data issues, the research on indirect real estate is only focused on the UK stock market. For generating a more widely applicable conclusion, it is necessary to use the same technique to examine other European equity markets.

4. Since the real estate portfolio is generally part of the total portfolio of institutional investors, it would be better to present risk figures according to industrial standard. Currently, most institutional investors provide the Value at Risk (VaR) as the standard measurement of the risk for their investment portfolio. This research has not explored this area yet, it is important to introduce this concept to real estate risk analysis for the integration of risk measurement with other financial asset portfolios.

In a word, risk analysis techniques developed by this research provide an efficient and applicable tool for real estate investors and can assist investors to make their investment decisions in a rational approach.

(Note)

1 ABP, PGGM, Shell Pension, ING Vastgoed, WBN and AMVEST are interviewed.

Samenvatting en conclusies

Zoals de titel van deze dissertatie al aangeeft, richt dit onderzoek zich op kwantitatieve risico analyse van vastgoedinvesteringen. Er wordt een instrument ontwikkeld waarmee beleggers in vastgoed een kwantitatieve risico analyse van hun portefeuille kunnen maken. In hoofdstuk 1 is een aantal vragen geformuleerd, welke in de voorgaande hoofdstukken beantwoord zijn:

1. In hoeverre is er wetenschappelijk onderzoek gedaan naar kwantitatieve risico analyse en de (daaruit volgende) implicaties voor professionele beleggers?
2. Hoe kan de huidige praktijk van institutionele beleggers ten aanzien van risico analyse bij besluitvorming rond vastgoed investeringen gekarakteriseerd worden?
3. Hoe kan de 'expert opinion' methode toegepast worden bij voorspellingen ten aanzien van de vastgoedmarkt?
4. Hoe zou een kwantitatief instrument voor risico analyse van de vastgoed portefeuille ontwikkeld moeten worden?
5. Welke relaties bestaan er tussen indirect vastgoed (vastgoed aandelen) en reguliere aandelen (Europese markt) in termen van risico factoren?
6. Welke gevolgen heeft dit onderzoek voor academici en beleggers op het gebied van risico analyse?

Hierna volgt een samenvatting van alle resultaten en conclusies, geordend op basis van bovenstaande vragen.

Conclusies gebaseerd op vraag 1:

In hoeverre is er wetenschappelijk onderzoek gedaan naar kwantitatieve risico analyse en de (daaruit volgende) implicaties voor professionele beleggers?

De basis van risico analyse bij investeringen / beleggingen ligt in het voorspellen van de markt. Over het algemeen richt wetenschappelijk onderzoek naar marktvoorspellingen zich op twee gebieden. Het eerste onderzoeksgebied is het voorspellen van de markt met behulp van causale modellen. Er is dan ook veel literatuur beschikbaar waarin de impact van macro- en micro variabelen op vraag en aanbod van vastgoed wordt geanalyseerd. Door het voorspellen van de toekomstige vraag en het aanbod binnen een bepaalde vastgoedsector, kunnen de toekomstige inkomsten van een bepaalde belegging ingeschat worden en kan de variatie in rendement, i.e. risico, gemeten worden.

Het tweede onderzoeksgebied betreft de historische prestaties van vastgoed beleggingen en de relatie met andere beleggingen. De analyse van het historisch profiel van een specifieke categorie vastgoed en de relatie tussen vastgoed en andere beleggingscategorieën zoals aandelen en obligaties, kan beleggers helpen bij het maken van investeringsbeslissingen. De historische kennis kan behulpzaam zijn bij zowel het alloceren van middelen aan verschillende typen assets als bij portefeuilles die alleen uit vastgoed bestaan.

Naast methoden en technieken uit bovengenoemde onderzoeksgebieden, proberen sommige onderzoekers ook methodologie, die ontwikkeld is voor de aandelenmarkt, toe te passen op vastgoed. Sommige onderzoekers passen bijvoorbeeld de Bèta coëfficiënt van het Capital Asset Pricing Model (CAPM) toe om het relatieve risico van vastgoedbeleggingen te meten. Nadeel is echter, dat de onderzoeksresultaten in de praktijk moeilijk toepasbaar zijn als gevolg van een aantal karakteristieken van de vastgoedmarkt. Vastgoed is incourant, illiquide, slecht in kleinere eenheden te verdelen en heeft hoge transactiekosten. Daarnaast wordt er weinig informatie gegeven over de waarde van vastgoed, waardoor de markt niet transparant is. Deze karakteristieken zorgen ervoor dat het moeilijk is om marktgegevens te verkrijgen en te voldoen aan de aannames waar de modellen op gebaseerd zijn.

De beperkingen van de historische en financiële methoden ter voorspelling van ontwikkelingen op de vastgoedmarkt, heeft een aantal onderzoekers er toe gebracht gebruik te maken van de meningen van experts (Ong en Chew, 1996). Deze methode kan gezien worden als een veelbelovend alternatief om de onzekerheden (ontwikkelingen) in de vastgoedmarkt te voorspellen. Dit onderzoek maakt dan ook gebruik van de gestructureerde 'expert opinion' methode (Klassieke Model) om de vastgoedmarkt te voorspellen.

Conclusies gebaseerd op vraag 2

Hoe kan de huidige praktijk van institutionele beleggers ten aanzien van risico analyse bij besluitvorming rond vastgoed investeringen gekarakteriseerd worden?
De resultaten van de interviews met een aantal Nederlandse institutionele beleggers[1] komen sterk overeen met de resultaten van onderzoeken in andere Europese landen en de Verenigde Staten.

Vastgoed beleggers gebruiken over het algemeen geen ingewikkelde financiële modellen zoals CAPM en de moderne portefeuille theorie (MPT) of statistische instrumenten voor risico analyse. Bij het nemen van vastgoedportefeuille beslissingen maakt de meerderheid van de beleggers gebruik van ervaring en intuïtie. Daarnaast komt uit de interviews naar voren dat institutionele beleggers toepasbare kwantitatieve instrumenten nodig hebben ter ondersteuning van de risico analyse en de besluitvorming (zie paragraaf 4.3 voor details).

Conclusies gebaseerd op vraag 3

Hoe kan de 'expert opinion' methode toegepast worden bij voorspellingen ten aanzien van de vastgoedmarkt?
Nu het verschil in benadering tussen academici en professionals duidelijk is geworden, probeert dit onderzoek een kwantitatief instrument te ontwikkelen om de markt te voorspellen en de risico's van de portefeuille te analyseren. Er wordt geprobeerd een door vastgoed beleggers te gebruiken, juiste benadering te ontwikkelen voor het voorspellen van onzeker-

heden in de vastgoedmarkt. Deze benadering is gebaseerd op de 'expert opinion' methode, aangezien dit het best aansluit op het dagelijks gebruik van professionals.

In dit onderzoek wordt het Klassieke Model (zie paragraaf 3.3) toegepast als een gestructureerde 'expert opinion' benadering. Het klassieke model is ontwikkeld door Cooke (1991) om de opinies van experts ten aanzien van onzekerheden te bepalen en te combineren. Dit model wordt regelmatig gebruikt om onzekerheden te voorspellen op het gebied van technologie en wetenschap. Sommige onderzoekers hebben recentelijk dit model toegepast om voorspellingen te doen op het gebied van economie en financiering. Een voorbeeld van een dergelijke toepassing is het voorspellen van de aandelen markt.

Er zijn twee belangrijke aspecten bij de toepassing van de 'expert opinion' methode. Het eerste aspect betreft de consistentie en voorspelbaarheid van 'expert opinion'. Het tweede aspect betreft het combineren van groepsopinies ter verbetering van de prestaties van 'expert opinions'. Dit onderzoek focust op beide aspecten en heeft geresulteerd in veelbelovende resultaten.

In dit onderzoek is het Klassieke Model gebruikt om de onzekerheden van de vastgoedmarkt te voorspellen (zie paragraaf 3.4). De resultaten hiervan zijn:

- De kwaliteit van 'expert opinion' kan gemeten worden op basis van prestaties in het verleden op vergelijkbare onderwerpen (deze worden 'seed variables' genoemd in het Klassieke Model) .
- Wanneer de groepsopinie gebaseerd is op een gewogen gemiddelde worden betere resultaten behaald dan wanneer de groepsopinie gebaseerd werd op het gemiddelde.

De resultaten geven aan dat de 'expert opinion' methode een valide instrument is om voorspellingen te doen ten aanzien van de vastgoedmarkt. Daarnaast blijkt dat het bepalen van een groepsopinie, met behulp van het Klassieke Model, de nauwkeurigheid van de voorspelling verbetert.

Conclusies gebaseerd op vraag 4

Hoe zou een kwantitatief instrument voor risico analyse van de vastgoed portefeuille ontwikkeld moeten worden?

Nu de onzekerheid in de vastgoedmarkt bepaald is met behulp van 'expert opinion', zal bepaald moeten worden hoe deze informatie gebruikt kan worden bij portefeuille analyses, zodat investeringsbeslissingen gebaseerd worden op basis van risico en rendement. In dit onderzoek is een instrument ontwikkeld voor portefeuille risico analyse waarin de onzekerheid van de vastgoedmarkt opgenomen is in de vorm van een waarschijnlijkheidsverdeling (zie paragraaf 4.4). De gemiddelde variantie benadering wordt gebruikt in combinatie met de Monte Carlo simulatie om meerdere optimale portefeuilles te bepalen.

Het traditionele optimaliseringproces resulteert slechts in één optimale portefeuille (single efficient frontier) waarmee beleggers het hoogste rendement zouden kunnen behalen bij een bepaald risico. Als een belegger die samenstelling nastreeft, zijn er vaak hoge kosten verbonden aan het opnieuw uitbalanceren van de portefeuille. Beleggers moeten dan bijvoorbeeld regelmatig meer kantoren kopen of winkels verkopen om de doelstelling betreffende het beste rendement risico profiel te realiseren. Het moge duidelijk zijn dat dit proces op gespannen voet staat met de karakteristieken van vastgoed (illiquide en hoge transactiekosten).

Het traditionele optimaliseringproces is gebaseerd op de aanname dat het patroon van risico en rendement van vastgoed constant is. Deze aanname gaat echter niet op in de praktijk, hetgeen betekent dat beleggers zich ook niet noodzakelijkerwijs hoeven te houden aan de portefeuillesamenstelling die resulteert uit het traditionele optimaliseringproces.

Bij de methode die in dit onderzoek wordt toegepast neemt de input (risico en rendement van elke investering) de vorm aan van een waarschijnlijkheidsverdeling. Vervolgens worden op basis van deze verdeling risico rendement figuren en meerdere optimale portefeuilles gegenereerd (zie 4.4). Dientengevolge kunnen beleggers hun portefeuille aanpassen op basis van een aantal alternatieven, in plaats van slechts één optimale portefeuille te volgen. Dit voorkomt dat beleggers frequent transacties moeten plegen om de optimale portefeuille te realiseren.

Conclusies op basis van vraag 5

Welke relaties bestaan er tussen indirect vastgoed (vastgoedaandelen) en reguliere aandelen (Europese markt) in termen van risico factoren?

Aangezien beleggingen in indirect vastgoed een steeds belangrijker deel vormen van de portefeuilles van institutionele beleggers, probeert dit onderzoek de relatie tussen vastgoed aandelen (indirecte vastgoed belegging) en gewone aandelen te bepalen. Het gaat hierbij om de vraag of indirect vastgoed, zoals vastgoed aandelen, dezelfde risico factoren heeft als gewone aandelen. Als dat zo is, kan indirect vastgoed geen diversificatie voordelen bieden, aangezien de rendementen van beide groepen investeringen zich in dezelfde richting bewegen als de markt.

Dit onderzoek is gebaseerd op drie risico factoren voor gewone aandelen (Fama en French, 1992). De drie algemene risico factoren zijn markt risico (Bèta), omvang van de waarde en de relatie tussen boekwaarde en marktwaarde (BE/ME). Er is getest of deze factoren dezelfde gevolgen hebben voor het rendement op vastgoedaandelen. De resultaten zijn wisselend (zie paragraaf 5.4). Onderzoek wijst uit dat de markt factor (Bèta) van vastgoedaandelen een consistente relatie heeft met verwachte rendementen, hetgeen betekent dat de markt factor van toepassing is op vastgoedaandelen. Daarnaast verklaart ook de grootte van de vastgoed onderneming het verwachte rendement. Daarentegen blijkt de BE / ME ratio geen sterke relatie te hebben met variatie in rendement op vastgoedaandelen.

Echter, wanneer er twee of drie factoren gecombineerd worden, zal geen van de factoren een significante correlatie vertonen met het verwachte rendement op vastgoedaandelen. Daarnaast is er geen bewijs dat er een correlatie bestaat tussen Bèta en omvang of Bèta en BE/ME. Dit resultaat impliceert dat andere factoren mogelijk een belangrijke rol spelen in de risicofactoren van vastgoedaandelen. Echter, het is ook mogelijk te concluderen dat vastgoedaandelen wel degelijk verschillen van gewonen aandelen en dus tot op zekere hoogte kunnen zorgen voor diversificatie.

Conclusies op basis van vraag 6

Welke gevolgen heeft dit onderzoek voor academici en beleggers op het gebied van risico analyse?

De volgende gevolgen hebben betrekking op zowel academici als institutionele beleggers:

1. De resultaten van dit onderzoek bewijzen dat 'expert opinions' een waardevolle alternatieve techniek is voor vastgoedmarktvoorspellingen. Het loont de moeite dit gebied verder te ontwikkelen als een toevoeging aan de fundamentele en technische methoden voor marktvoorspellingen. Academici zouden meer inspanningen op het terrein van marktvoorspellingen met behulp van 'expert opinion' moeten verrichten.
2. Alhoewel beleggers al regelmatig gebruik maken van 'expert opinion', is het toch waardevol dit instrument toe te passen tijdens de besluitvorming (zie hoofdstuk 3). The methode die hier toegepast wordt voorziet in een goede oplossing voor het combineren van groepsopinies, hetgeen in de praktijk regelmatig gebruikt wordt bij besluitvorming in organiaties. Deze flexibele methode zal beleggers een gestructureerde manier geven om consistente en bewuste keuzes te maken.
3. Door het toepassen van 'expert opinion' en simulatie, zoals ontwikkeld in dit onderzoek (zie hoofdstuk 4), kunnen beleggers de algemene moeilijkheden die ontstaan bij het toepassen van kwantitatieve risico analyse (gebrek aan input en model) te boven komen en de kwaliteit van de besluitvorming rond beleggingen verbeteren.
4. Zoals getest in dit onderzoek (zie hoofdstuk 5), kent indirect vastgoed (vastgoedaandelen), naast een aantal overeenkomende factoren, ook een aantal afwijkende risicofactoren ten opzichte van gewone aandelen. Dit wijst er op dat institutionele beleggers vastgoedaandelen in hun portefeuille op kunnen nemen met als doel diversificatie. Aangezien de drie risicofactoren tezamen niet het verwachte rendement op vastgoedaandelen kunnen verklaren, is aanvullende academisch onderzoek op dit terrein noodzakelijk.

(Noot)

1 ABP, PGGM, Shell Pension, ING Vastgoed, WBN en AMVEST zijn geïnterviewd.

APPENDIX 1. QUESTION FORMAT FOR ELICITING THE EXPERT'S OPINION

Giving the 5, 50, 95% quantiles for the following uncertain rents:

Part A. Seed Variables

1. The prime office rent in the first quarter of 1998 in the following cities

Amsterdam:	5%__________	50%__________	95%__________
Rotterdam:	5%__________	50%__________	95%__________
Den Haag:	5%__________	50%__________	95%__________
Utrecht:	5%__________	50%__________	95%__________

2. The prime office rent in the second quarter of 1998 in the following cities

Amsterdam:	5%__________	50%__________	95%__________
Rotterdam:	5%__________	50%__________	95%__________
Den Haag:	5%__________	50%__________	95%__________
Utrecht:	5%__________	50%__________	95%__________

3. The prime office rent in the third quarter of 1998 in the following cities

Amsterdam:	5%__________	50%__________	95%__________
Rotterdam:	5%__________	50%__________	95%__________
Den Haag:	5%__________	50%__________	95%__________
Utrecht:	5%__________	50%__________	95%__________

4. The prime office rent in the forth quarter of 1998 in the following cities

Amsterdam:	5%__________	50%__________	95%__________
Rotterdam:	5%__________	50%__________	95%__________
Den Haag:	5%__________	50%__________	95%__________
Utrecht:	5%__________	50%__________	95%__________

Part B. Objective variables

1. Give the 5, 50, 95% quantiles for the following property rents in 1999

Property 9001:	5%__________	50%__________	95%__________
Property 9002:	5%__________	50%__________	95%__________
Property 9003:	5%__________	50%__________	95%__________
Property 9004:	5%__________	50%__________	95%__________
Property 9005:	5%__________	50%__________	95%__________
Property 9006:	5%__________	50%__________	95%__________
Property 9007:	5%__________	50%__________	95%__________
Property 9008:	5%__________	50%__________	95%__________
Property 9009:	5%__________	50%__________	95%__________
Property 90010:	5%__________	50%__________	95%__________
Property 90011:	5%__________	50%__________	95%__________
Property 90012:	5%__________	50%__________	95%__________
Property 90013:	5%__________	50%__________	95%__________
Property 90014:	5%__________	50%__________	95%__________
Property 90015:	5%__________	50%__________	95%__________

Part A. Expert assessment on seed variables (market rent:

Experts	Item	5%	50%	95%
Pension1	Q1Rent_Amsterdam	450	470	500
Pension1	Q2Rent_Amsterdam	460	490	510
Pension1	Q3Rent_Amsterdam	470	490	520
Pension1	Q4Rent_Amsterdam	485	500	530
Pension1	Q1Rent_Rotterdam	260	280	300
Pension1	Q2Rent_Rotterdam	280	300	320
Pension1	Q3Rent_Rotterdam	300	330	360
Pension1	Q4Rent_Rotterdam	340	360	390
Pension1	Q1Rent_Den Haag	300	330	360
Pension1	Q2Rent_Den Haag	320	350	380
Pension1	Q3Rent_Den Haag	330	350	390
Pension1	Q4Rent_Den Haag	350	400	420
Pension1	Q1Rent_Utrecht	280	320	330
Pension1	Q2Rent_Utrecht	290	320	360
Pension1	Q3Rent_Utrecht	300	330	380
Pension1	Q4Rent_Utrecht	340	360	400
Pension2	Q1Rent_Amsterdam	450	480	520
Pension2	Q2Rent_Amsterdam	470	490	530
Pension2	Q3Rent_Amsterdam	490	510	550
Pension2	Q4Rent_Amsterdam	510	530	570
Pension2	Q1Rent_Rotterdam	250	275	290
Pension2	Q2Rent_Rotterdam	280	300	320
Pension2	Q3Rent_Rotterdam	300	320	340
Pension2	Q4Rent_Rotterdam	320	340	360
Pension2	Q1Rent_Den Haag	300	320	340
Pension2	Q2Rent_Den Haag	320	340	360
Pension2	Q3Rent_Den Haag	320	340	360

Dutch Guilders/sqm.year)

Experts	Item	5%	50%	95%
Pension2	Q4Rent_Den Haag	300	320	340
Pension2	Q1Rent_Utrecht	320	340	360
Pension2	Q2Rent_Utrecht	340	360	390
Pension2	Q3Rent_Utrecht	350	380	400
Pension2	Q4Rent_Utrecht	300	340	380
Pension3	Q1Rent_Amsterdam	410	430	460
Pension3	Q2Rent_Amsterdam	450	480	550
Pension3	Q3Rent_Amsterdam	460	560	600
Pension3	Q4Rent_Amsterdam	430	480	580
Pension3	Q1Rent_Rotterdam	250	350	380
Pension3	Q2Rent_Rotterdam	260	310	380
Pension3	Q3Rent_Rotterdam	279	320	390
Pension3	Q4Rent_Rotterdam	300	350	450
Pension3	Q1Rent_Den Haag	300	400	500
Pension3	Q2Rent_Den Haag	350	450	540
Pension3	Q3Rent_Den Haag	360	450	560
Pension3	Q4Rent_Den Haag	370	460	570
Pension3	Q1Rent_Utrecht	280	350	400
Pension3	Q2Rent_Utrecht	300	350	410
Pension3	Q3Rent_Utrecht	320	380	460
Pension3	Q4Rent_Utrecht	300	360	420
Pension4	Q1Rent_Amsterdam	470	490	500
Pension4	Q2Rent_Amsterdam	490	500	520
Pension4	Q3Rent_Amsterdam	500	510	520
Pension4	Q4Rent_Amsterdam	510	525	540
Pension4	Q1Rent_Rotterdam	310	330	340
Pension4	Q2Rent_Rotterdam	315	335	350

Part A.

Experts	Item	5%	50%	95%
Pension4	Q3Rent_Rotterdam	320	330	340
Pension4	Q4Rent_Rotterdam	325	335	345
Pension4	Q1Rent_Den Haag	320	330	340
Pension4	Q2Rent_Den Haag	320	340	350
Pension4	Q3Rent_Den Haag	350	360	370
Pension4	Q4Rent_Den Haag	360	370	380
Pension4	Q1Rent_Utrecht	280	290	300
Pension4	Q2Rent_Utrecht	290	300	310
Pension4	Q3Rent_Utrecht	320	330	350
Pension4	Q4Rent_Utrecht	330	340	360
Pension5	Q1Rent_Amsterdam	420	470	550
Pension5	Q2Rent_Amsterdam	450	490	560
Pension5	Q3Rent_Amsterdam	480	550	580
Pension5	Q4Rent_Amsterdam	490	560	600
Pension5	Q1Rent_Rotterdam	280	330	350
Pension5	Q2Rent_Rotterdam	330	350	370
Pension5	Q3Rent_Rotterdam	320	340	370
Pension5	Q4Rent_Rotterdam	300	340	360
Pension5	Q1Rent_Den Haag	300	320	380
Pension5	Q2Rent_Den Haag	310	330	370
Pension5	Q3Rent_Den Haag	330	360	390
Pension5	Q4Rent_Den Haag	340	360	410
Pension5	Q1Rent_Utrecht	300	330	370
Pension5	Q2Rent_Utrecht	310	340	390
Pension5	Q3Rent_Utrecht	330	360	400
Pension5	Q4Rent_Utrecht	360	400	450

Part B. Expert opinion on objective variables (Property rent)

Experts	Item	5%	50%	95%
Pension1	9001 Rent	300	330	350
Pension1	9002 Rent	315	340	375
Pension1	9003 Rent	275	320	335
Pension1	9004 Rent	265	280	310
Pension1	9005 Rent	265	270	320
Pension1	9006 Rent	265	295	320
Pension1	9007 Rent	275	295	315
Pension1	9008 Rent	295	310	350
Pension1	9009 Rent	250	280	310
Pension1	9010 Rent	260	280	325
Pension1	9011 Rent	240	260	300
Pension1	9012 Rent	225	250	275
Pension1	9013 Rent	200	240	280
Pension1	9014 Rent	225	260	280
Pension1	9015 Rent	230	270	300
Pension2	9001 Rent	325	350	375
Pension2	9002 Rent	325	350	375
Pension2	9003 Rent	300	325	350
Pension2	9004 Rent	280	300	325
Pension2	9005 Rent	325	350	375
Pension2	9006 Rent	300	325	350
Pension2	9007 Rent	280	300	325
Pension2	9008 Rent	325	350	375
Pension2	9009 Rent	280	300	325
Pension2	9010 Rent	300	320	350
Pension2	9011 Rent	260	275	300

Part B.

Experts	Item	5%	50%	95%
Pension2	9012 Rent	260	280	300
Pension2	9013 Rent	230	250	280
Pension2	9014 Rent	240	260	300
Pension2	9015 Rent	280	300	325
Pension3	9001 Rent	275	350	400
Pension3	9002 Rent	300	375	425
Pension3	9003 Rent	270	345	395
Pension3	9004 Rent	250	300	350
Pension3	9005 Rent	250	300	350
Pension3	9006 Rent	270	320	370
Pension3	9007 Rent	240	290	340
Pension3	9008 Rent	280	330	360
Pension3	9009 Rent	280	330	380
Pension3	9010 Rent	280	330	380
Pension3	9011 Rent	270	320	370
Pension3	9012 Rent	250	300	350
Pension3	9013 Rent	250	300	350
Pension3	9014 Rent	220	250	275
Pension3	9015 Rent	270	345	395
Pension4	9001 Rent	300	325	340
Pension4	9002 Rent	325	340	350
Pension4	9003 Rent	260	275	280
Pension4	9004 Rent	260	270	280
Pension4	9005 Rent	260	270	280
Pension4	9006 Rent	275	280	290
Pension4	9007 Rent	275	290	300

Part B.

Experts	Item	5%	50%	95%
Pension4	9008 Rent	300	315	330
Pension4	9009 Rent	250	265	280
Pension4	9010 Rent	285	290	300
Pension4	9011 Rent	250	260	275
Pension4	9012 Rent	240	260	275
Pension4	9013 Rent	240	265	275
Pension4	9014 Rent	230	240	250
Pension4	9015 Rent	270	285	290
Pension5	9001 Rent	325	350	375
Pension5	9002 Rent	325	350	375
Pension5	9003 Rent	275	290	310
Pension5	9004 Rent	275	290	315
Pension5	9005 Rent	280	295	320
Pension5	9006 Rent	270	295	305
Pension5	9007 Rent	280	290	325
Pension5	9008 Rent	350	375	425
Pension5	9009 Rent	275	300	325
Pension5	9010 Rent	250	275	295
Pension5	9011 Rent	260	275	290
Pension5	9012 Rent	245	255	275
Pension5	9013 Rent	230	240	250
Pension5	9014 Rent	230	240	260
Pension5	9015 Rent	265	280	295

APPENDIX 3. DATABASE FORMAT OF THE APPLICATION

PROJECT NAME				
Factor analyses				
Size				
Location				
- zip code				
- quality (A/B/C)				
Region				
Sector				
Year of construction				
Technical quality				
Lease Terms				
- indexation				
- normal contract duration				
Period				
Tenant structure				
- number				
- quality				
- duration				
- average size				
Input variables	*YEAR*	*YEAR*	*YEAR*	*YEAR*
Theoretical market rent				
Contract rent				
Market rent vacancy	*0*	*0*	*0*	*0*
Theoretical rent				
Other income				
Vacancy				
Total income	*0*	*0*	*0*	*0*
Rent related costs				
- period rent free				
- brokers fees				

- refurbishment costs				
- vacancy costs				
- promotion and publicity				
Fixed Costs				
- insurance				
- taxes				
- ground lease				
- management fees				
Maintenance				
other costs				
Operational CF	***0***	***0***	***0***	***0***
Capital Expenditure				
Mortgage				
Sales				
Project CF	***0***	***0***	***0***	***0***
Value				
Cap rate				
Inflation (only prediction)				
Derived Variables	***YEAR***	***YEAR***	***YEAR***	***YEAR***
Financial occupancy rate				
Gross Income				
Net income				
Capital gain				
Net Cashflow				
Gross rate of return				
Net rate of return				
Capital gain				
Total rate of return				

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About the author

Qing Xu was born on 25 September 1965 in Anqing, China. In 1989 he obtained a master's degree in Civil Engineering at Beijing Graduate School of Management Engineering of Wuhan University of Technology in Beijing, China. He worked as an valuation engineer at Wuhan Urban Building Design & Research Institute in Wuhan, China between 1989 and 1992. He then joined The ShenZhen Gintian Industrial Group, a real estate development company in ShenZhen, China. In 1995, he participated the three-month workshop on construction project management at The Institute for Housing and Urban Development Studies, Rotterdam. Qing Xu started his PhD research in October 1996 and was formally accepted as a PhD candidate in the Department of Real Estate & Project Management at the Faculty of Architecture at Delft University of Technology in August 1997.

Qing Xu is now a risk manager at ING Investment Management in Den Haag, The Netherlands.

Stellingen behorende bij het proefschrift
Risk analysis on real estate investment decision-making

Qing Xu Maandag, 25 maart 2002

1. Het idee dat de opinies van experts een belangrijke bron zijn voor besluitvorming is algemeen geaccepteerd. Minder bekend is dat de opinies van experts omgezet kunnen worden in effectieve, kwantitatieve data.

2. Het is belangrijk om experts aan te moedigen om hun ware opinie te uiten. Verhulde opinies kunnen de uitkomsten van elk model, hoe goed het ook is, teniet doen.

3. Het zou een vergissing zijn om te veronderstellen dat vastgoedinvesteerders ook goed kunnen presteren door te investeren in indirect vastgoed. Beide markten vragen om verschillende expertise en kennis.

4. Het vergroten van de variëteit aan investeringsobjecten en het uitbreiden van het geografisch gebied van een investering zijn niet nodig voor het reduceren van het risico vanwege het correlatie-effect. Hierin verschillen investeringen duidelijk van vakantieplanning waar geldt: hoe meer verschillen, hoe beter.

5. Het is moeilijk om een model te ontwikkelen dat de realiteit simuleert. Het is nog moeilijker om een model te ontwikkelen dat de prestaties van menselijke opinies beoordeelt.

6. Het zou een vergissing zijn om te veronderstellen dat er een positieve correlatie bestaat tussen de kredietwaardering van een investeerder en zijn risicomanagementvaardigheden. Ook bedrijven met "AAA" waardering kunnen gewoon failliet gaan.

7. 'Securitisation' van vastgoed is geen nieuw concept, maar een voorbeeld van de mondiale trend naar standaardisering. Net als bij de standaardisering van 'fast food' geldt ook hier: het is efficiënt, maar het biedt geen garantie voor kwaliteit.

8. Chinezen betalen dokters om hen gezond te houden, de rest van de wereld betaalt dokters pas bij ziekte.

9. In de meeste commerciële bedrijven wordt risicomanagement gezien als kostenpost. Het kan echter een cruciale invloed hebben op de ondernemingsbalans.

10. Als we stellen dat risicoanalyse eerder kunst dan wetenschap is, dan is een risicomanager eerder artiest dan analist.

11. In de financiële wereld hebben experts in 'efficiënte' markten, zoals de aandelenmarkt, behoefte aan goede informatie. In 'inefficiënte' markten, zoals de vastgoedmarkt, hebben experts behoefte aan een goed persoonlijk netwerk.

Propositions to the PhD thesis
Risk analysis on real estate investment decision-making

Qing Xu Monday, 25 March 2002

1. It is well accepted that expert opinion is a very important resource for decision-making, however, it is not well known that expert opinion can be converted into effective quantitative data.

2. It is important to encourage experts to express their true opinions. Covered opinions from experts may disable any well-developed calibration model.

3. It would be mistake for real estate investors to think that a good direct real estate investor can also perform well by investing in indirect real estate, since the two markets require different expertise and knowledge.

4. Increasing the variety of investment vehicles and geographical area of investment is not necessary for risk reduction, due to the correlation effect, therefore, diversification of investment is distinct from holiday planning where the greater difference the better.

5. It is difficult to develop a model that can simulate the reality; it is even more difficult to develop a model that can calibrate the performance of human opinion.

6. It would be a mistake to presume that there is a positive correlation between the credit rating of the investor and their capacity for risk management. This is why companies with "AAA" rating may still go bankrupt.

7. Securitisation of real estate is not a new concept, it is just another example of the global trend towards standardisation, like the standardisation of fast food. It brings efficiency without any guarantee of quality.

8. Chinese pay their doctors for keeping them well, the rest of the world only pay them when they were ill.

9. In most commercial organisations, risk management is regarded as an additional cost for the organisation, however, risk management can be critical for the bottom line of the organisation.

10. If we agree that risk analysis is more an art than a science, then a risk manager is more an artist than an analyst.

11. In the investment world, experts in efficient markets such as the stock market need good information. Experts in inefficient markets such as the real estate market need a good personal network.

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