



KUNGL
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FIVE ESSAYS IN PROPERTY VALUATION

ZAN YANG

STOCKHOLM 2000

MEMORANDUM 5:52
DEPARTMENT OF REAL ESTATE AND CONSTRUCTION MANAGEMENT
ROYAL INSTITUTE OF TECHNOLOGY

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ISBN 91-973776-3-5
ISSN 1104-4101
TRITA-BFE M 1052
ISRN KTH/BFE/M—1052--SE

Stockholm 2000

Five Essays In Property Valuation

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Doctoral Degree of Technology to be defended in
Kollegiesalen at the Royal Institute of Technology
October 31, 2000, 13:00

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ABSTRACT

Zan Yang (2000): Five Essays in Property Valuation. Department of Real Estate and Construction Management, Royal Institute of Technology, Stockholm.

This doctoral thesis consists of five self-contained essays presented to the Faculty Board of the Royal Institute of Technology. Property valuation is a central issue that forms a common thread in the analysis in these essays. In the thesis property is considered in a mixed asset context in an attempt to build a bridge between valuation, property investment and financial theory. The object of the thesis is to value property for finance, sales and purchases and investment. The investigation of the thesis extends traditional valuation with an integrated approach using econometric technology.

Essay I estimates the market value of townhouses under development in a North American city. The traditional hedonic regression model is used to predict the value of the complex as a whole, as well as of the individual unit. The role of the property tax in explaining property valuation is indicated and the valuation errors of the predicted values estimated in the essay relative to the prices realized in the market suggest the feasibility of regression analysis for preconstruction appraisal.

Essay II investigates the implicit prices of property values in the Beijing residential market. An uncertain attribute—"perceived construction risk" enters the model as a proxy for a consumer's subjective probability of construction quality. Public facilities are found to reduce the value of residences and consumers would be willing to pay a highly substantial amount of money to protect themselves from the risk of poor construction quality.

Essay III studies the long-term relationship between housing prices and property stock prices under the Swedish rent control system from 1980 to 1998. The Vector Autoregressive (VAR) model with a subsystem approach is used to test cointegration and the Error Correction Model (ECM) and Granger Causality are also tested. The tests provide evidence of co-movement between the housing market and property stock market and suggest the role of rentals in raising the speed of movement towards the long-term equilibrium of asset prices.

Essay IV models the volatility of property stock returns in the Swedish market from 1990 to 1999. The General Autoregressive Conditional Heteroskedasticity (GARCH) model is applied to capture time-varying volatility and the GARCH-M model is used to price this volatility. The vacancy rate is found to help explain persistent volatility and risk spillover effects from the bond market and the direct real estate market are expected.

Essay V analyzes the inflation hedging ability of Swedish property stocks from 1980 to 1999. Two expected inflation rates—UND1x inflation and GARCH inflation—and cointegration technology are used for this study. For the period as a whole, no inflation hedging behavior is found, but for the period of 1986–1993 when the vacancy rate was low, short-run inflation hedging is indicated.

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Essays I to V

- I. Christian Janssen and **Zan Yang**. “Estimating the Market Value of a Proposed Townhouse Development”. *Journal of Property Investment & Finance*, Vol. 17 No.5.
- II. **Zan Yang**. “An Application of the Hedonic Prices Model with Uncertain Attribute: the Case of the People’s Republic of China”. *Journal of Property Management*, forthcoming.
- III. **Zan Yang**. “Structural and Vector Autoregressive Model of Housing Prices and Property Stock Prices” Originally presented to the conference of 6th European Real Estate Society, 1999 Athens, Greece. Revised after. Under review.
- IV. **Zan Yang**. “The Volatility Performance of the Property Stock Market” Originally presented to the conference of housing in the 21st century: fragmentation and reorientation, June, 2000 Gävle, Sweden. Revised after. Under review.
- V. **Zan Yang**. “Inflation Hedging Behavior on the Property Stock Market in Sweden”. Manuscript.

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To my parents who tell me the value of human life

ACKNOWLEDGEMENTS

I am fortunate to have an opportunity to study in Sweden; it is even more fortunate for me to have been favored with so much mentorship, friendship and kinship throughout my studies.

First and foremost, I would like to thank my supervisor, Roland Andersson, for his invaluable direction and advice while allowing me the freedom to explore and develop my research according to my own interests and style. I deeply appreciate his encouragement and optimism that keep me self-confident and growing forward. He not only helped me develop my professional goals, but also to think as a good researcher, which will benefit me in my entire career. Without his help and patience, none of my research would have been possible.

Special thanks also go to Christian Janssen from University of Victoria in British Columbia, Canada. His ideas, guidance, working attitude and manner have illuminated the path throughout my entire research. I will never forget the wonderful time spent in Victoria and the hospitality of Christian Janssen and his wife Viveka Janssen.

Furthermore, deep appreciation goes to John Quigley, Nancy Wallace, Peter England and Katinka Hort for inspiring my thinking and learning. Thanks are also due to Alfred Kanis and Barot Bharat for aiding my work immeasurably with their deep understanding of my field and for constructive suggestions. Thanks also to Lewis Taylor for his patient work in checking and correcting my English.

I extend special gratitude to my present and former colleagues, Mats Bohman, Erik Persson, Hans Lind, Håkan Bejrums, Kurt Psilander, Stellan Lundström, Sten Löthagen, Lundren Bernt, Christina Pettersson, Jill Atterhult, Åsa Lundgren, Ann Sjöberg, Bo Söderberg, Kicki Björklund, Samuel Azasu, Sigrid Katzler, Svante Mandell, Åke Gunnelin, Mikael Atterhög, Rickard Enström, Kerstin Klingborg-Stark, Anna Hrdlicka, Elisabeth Gustafsson, Sebastian Gustin. Thanks for all of your generously shared wisdom and experiences.

I am also very indebted to my close friend Hui Tang for unwavering support and faith. I would also like to thank my best friends Yang Cao, Hongli Duan, Huiwen Hao, Ruimei, Zhao for their friendship and understanding. Thanks my friend Yue Zou for his helps and encouragement. Specifically, I must thank my officemate, Irena Vlassenko, for readily and enthusiastically giving her time and sharing interesting issues, joys and depressions with me. I also wish to thank Mattias Lundström for his warmly given help in improving my English and

discussing Swedish culture and tradition. Thanks to all my Swedish and Chinese friends in Sweden for the fascinating leisure time we spent together. No one mentioned, no one forgotten.

From the depth of my heart I give sincerest thanks to my family. I thank my parents for never ending love and unconditional support throughout my life. I thank my sister, Yue Yang and her husband, Jianping Wang, her son, Yining Wang and my brother, Jing Yang for all their kind help and encouragement.

I end this acknowledgement with a paragraph from the song “Kind and Generous”, but it is not the end of my appreciation:

You’ve been so kind and generous
I don’t know how you keep on giving
For your kindness, I am indebted to you
And I never could have come this far without you
For everything you’ve done, you know I am bound
I am bound to thank you for it

Västerås, August 2000

Zan Yang

1. INTRODUCTION

A young person directly out of an MBA program was counseled by the wise old master in his first real estate position:

“Son, there are people who know real estate and people who don’t ”

“But sir, what do you mean by ‘knowing real estate’?”

“Son, that reply implies that you don’t know real estate, and that’s why we have to let you go.”

“But...?”

That young person could have been me, had I not been given the chance for graduate studies. Still today, I am not sure of a satisfactory answer, but I think I at least understand the rejection of the young person. In fact, after several years in the doctoral program, I have learned much about how to “know real estate”, as can be assessed from the dissertation. However, there is still a long way to go before I “know real estate”.

This doctoral thesis has been prepared at the Department of Building and Real Estate Economics, Royal Institute of Technology in Stockholm. It consists of five self-contained essays. These essays deal with three different markets in three different countries: North America, China and Sweden. Although these essays are separate and independent, property valuation can, in fact, be regarded as the thread that binds them together. Property valuation here should not be understood as the mere assessment of property; it is defined in terms of the way market information is interpreted and how the market operates. However, apart from the traditional valuation approach, the concern in all my essays is with valuation as a discipline from a practical perspective with reference to both economic and financial theory. This will be discussed further in the following sections. The reason that the thesis contains separate essays, is partly practical need, and partly because the studies were separate research projects.

In 1998, I was encouraged by professor Roland Andersson to cooperate with Professor Christina Janssen of Victoria University in Canada. I spent some time there where we finished Essay I together. Inspired by this essay, I surveyed the Beijing real estate market and collected data with the help of the Beijing Urban Construction Council and the Beijing Urban and Rural Construction Council during my summer vacation in China. Essay II is the result of this survey. In 1999, the project “Direct and Indirect Real Estate Market in Sweden” was financed by the Lars Erik Lundberg Research Foundation, and part of the study within this project is reported in Essay III. In 2000, the project “Risk Performance of the Swedish Property Stock Market” was financed by Bankforskninginstitutet (the Swedish Banking Research Institute) and Essays IV and V are results of this project.

1.1 The challenges of property valuation and the methodology of the thesis

Market valuation is of central importance to business and real estate communities and it has pervaded every segment of the real estate industry: “In virtually every aspect of the real estate industry and its regulation at local, state, and federal levels, market

value considerations are of vital important and essential to economic stability” (Appraisal Institute, 1996). Therefore, research on property valuation has been well documented and widely applied in actual markets. However, recent developments in property markets and econometric technology have highlighted a number of new considerations to which researchers have to pay special attention in undertaking such research. This raises several important points that need to be emphasized at this stage and that frame the analysis in this thesis.

Revolution in Investment Performance

Over the last decade, real estate markets have undergone a series of major evolutionary changes in the underlying structure of the real estate investment industry, in which the two most significant changes are the growing institutionalization and securitization of investment in general. Decision-making is shifting from an entrepreneurial, transaction-based, short-term orientation to a more managerial, more asset-based and longer-term orientation (Geffrey, 1995). It is therefore evident that the researcher should be concerned not only with the value of the property in isolation, but also with the value viewed within the context of other properties, as well as mixed assets. Property valuation should be regarded as part of a much larger range of investment behavior. This obviously raises the issue of seeking to integrate the analysis of property valuation into economic and financial theory and looking at ways to position property valuation from an investor’s perspective.

Uncertainty on the Real Estate Market

However, throughout the evolution of the real estate industry, one thing remains certain: risk. In fact, it is argued that greater uncertainty exists in real estate investment than other areas. This is due to the information technology explosion, growth in investment and increasing profits. Particularly, uncertainty has become a popular issue with the development of the equity real estate market. Thus it is an important challenge for scholars to apply risk analysis to the domain of property valuation. Failure to acknowledge property risks means that property valuation cannot capture the dynamics of the property market. It is then worthless to try to identify a suitable risk management strategy for investors. Moreover, the challenging aspect of risk analysis in property valuation itself requires sophisticated methods. Traditionally, research dealing with risk has been in relation to rates of return. However, this approach is limited by data sources and largely unrelated rate-of-return risks. Thus, it certainly suggests a need for better understanding of the risks associated with property from the viewpoint of new econometric technology.

Rapidly Developing Econometric Technology

The significant rapid evolution of the statistical basis of econometric modeling took place during the 1980s. The basis of analysis expanded from the assumption of stationarity to include integrated processes (Granger and Mizon, 1997). The effect of this shift has already radically influenced the choice of model forms and modeling

practices in real estate research. Time series analysis can contend with shortcomings of traditional regression analysis such as measurement errors and short-term static relationships. So it is expedient to apply and develop these new techniques within the area of property valuation.

In summary, the challenge to property valuation springs from the realization that property valuation should be extended from backroom methodologies to the consultant's role, which must be to understand the broader investment markets in which property competes as well as the economic and financial factors that fuel those markets (Hatcher, 1998). Such a program must necessarily be accompanied by risk analysis and the implementation of modern econometric techniques.

Consequently, in this thesis property is treated in a mixed asset context, including consumption goods, investment and security assets. Instead of taking valuation as a sole subject, the main effort of this thesis is to build a bridge between valuation, property investment and financial theory. Hence property valuation here means examining consumer behavior, investment decisions and risk performance, and the thesis treats more than mere assessment. This extension of the traditional valuation of properties in isolation using an integrating approach is undertaken with help of modern econometric and time series methods.

1.2 The Object of the thesis

Valuation is done for a variety of reasons, and it is also possible to have a whole range of different values for a given property at a given moment depending on the purpose of the valuation. The purpose of this thesis is to investigate the market value of property from three perspectives: market valuation for finance, market valuation for sale and purchase, and market valuation for investment.

Market Valuation for Finance

In Essay I, we treat market valuation for financial purposes. Financial institutions that finance property through debt or, very occasionally, equity, will not wish to make a loan unless there is some sort of security that makes it relatively certain that their capital can be retrieved. They investigate to "secure" the loan upon the property and they claim the capital lent out as "borrowed" property should the borrower default in any way. Therefore, a valuation for a financial institution is a valuation for a lender who does not want to take risks (Millington, 1994). In such a case, the valuation is to determine what sum a project, which can be reflected in gross retail value, is likely to fetch if a sale is accepted by the buyers. Since the objective of such a valuation is the proposed property, it is obvious that it is not possible to put the property on the market to get a valid value for sale. The assessor thus has to predict appraised value for the pre-construction development based on a cautious view. To carry out such a valuation is often more difficult than for property that has been sold, and the assessed value can be considerably different from the figure the property is actually sold for, because the former is determined under favorable transaction circumstances (Millington, 1994).

However, such a valuation is still useful for providing transaction information on property.

Market Valuation for Sales and Purchases

In Essay II, the viewpoint is changed from that of the lender to that of sellers and buyers. This is a kind of valuation for sales and purchases. A valuer who makes valuations for sales and purchases may be asked what a property combining certain individual attributes will fetch when sold and what characteristics of a dwelling unit and its location are important in determining different sale prices. The market value derived for this purpose does not give the measure of a particular household's willingness to pay; rather, this valuation is the result of demand and supply interactions of the entire market. In this case, given the price function, consumers select the bundle of characteristics to maximize their utility by equating their marginal willingness to pay with the market marginal price for each characteristic. The sellers select the bundle of characteristics to maximize profit by equating the marginal cost of each characteristic with their marginal prices. The characteristics here are not only the size and quality of the dwelling, but also many other characteristics of the neighborhood such as the quality of the surrounding housing stock, the quality of access to work, shopping and services, and even the existence of uncertain factors, such as the probability of flooding, earthquakes and so on, used to investigate the responses of consumers to hazards.

Market Valuation for Investment

The last three essays investigate property value for investment decisions. They concern two aspects: The first is the portfolio decision, which is the subject of Essay III. The second focuses on the risk performance the investors have to face, and this is analyzed in Essay IV and V.

With the rapid development of the equity market, real estate investors can adjust their portfolios directly, by acquiring properties, or indirectly, by purchasing shares in publicly traded securities or limited partnerships, such as a Real Estate Investment Trust (REIT) or a property company. Indirect investments have been more and more accepted by investors as an alternative to direct real estate investment without its excessive illiquidity and high transaction cost to portfolios. As a "property backed" investment traded in the stock market, indirect property investment may exhibit market performance associated with both the property market and the stock market (Han and Liang, 1992). Therefore, one of the most challenging problems facing institutional property investors is the relationship or linkage between the real estate market and the property stock market. If various markets are well integrated then a high degree of asset substitution is to be expected. Otherwise, this has significant implications for portfolio investment where managers seek to develop well-diversified portfolios (John & Patrick, 1997). Investigation of the relationship between the two markets yields market valuation by providing the value for investors' behavior and enabling investors to develop their investment strategy.

An important step in evaluating property is to know its risk class. In fact, all financial theory is dominated by consideration of risk (Brown and Matysiak, 1999). Clearly, property valuation cannot diverge from this course. A necessary first step for property investors is to identify the risks to which they are exposed. Decision can then be made on how to invest and control risk. A comprehensive understanding of property value relations to risk characteristics will allow investors to design a strategy to optimize their performance. In this thesis, risk characteristic of property stock market is considered from the volatility performance and inflation hedging performance.

1.3 Property Valuation and Property Price

So far, the thesis is concerned with property valuation. However, the whole thesis is based on the fundamental hypothesis that prices are a good proxy for valuations. This is not only an important issue for empirical research, but it also has important implications about the way the market operates. An increasingly accepted definition of market value is most probable selling price, in cash. Dictionaries define market value as “a price at which both buyers and sellers are willing to do business” and “what a property can be sold for on the open market.” Professional appraisers recognize, however, that market value does not necessarily equal market price, but may be greater, equal to, or less than sale price in an actual market. A price represents the amount a particular purchaser agrees to pay and a particular seller agrees to accept under the conditions of a free market. Market value, on the other hand, is an estimated price made by an experienced, knowledgeable appraiser. Prices and values can vary according to the physical characteristics of properties, locations and the economic conditions of the market environments. Nevertheless, when supply and demand are in equilibrium valuation should, on average, be equal to price. As a consequence, expected prices are good proxies for valuations over a long period (Gerald & Matysiak, 2000).

The four kinds of prices considered in the thesis are normal sale price, transaction price, asking price and property share price. It is necessary to understand these concepts and their relationships before presenting the summary of the essays. Asking price is the listed price that an owner would like to receive. It is a kind of pre-transaction price that has not yet been realized. In self-interest, an owner wants the highest possible asking price. A broker ordinarily prefers to decrease asking price enough to make a fast transaction. However, as an agent, a broker has to keep the principal informed of all material facts affecting the agency relationship (Dasso, *et. al.*, 1995). Transaction price is the amount of money for which the property is traded. But it may not reflect the relative bargaining power of the buyers and sellers and trading under market financing. Therefore, normal sale price can be seen as an adjustment of transaction price based on the conditions of sale and financing terms. It is the amount negotiated between a buyer and a seller in a less-than-perfect market. Property share price, obviously the price of shares issued by property companies, is widely believed to be more volatile than prices in the direct real estate market

2. A SUMMARY OF THE ESSAYS

2.1 Essay I

“Estimating the Market Value of a Proposed Townhouse Development”

The aim of Essay I is to predict the market values for townhouses under construction. The predicted values of the complex as a whole, as well as the individual units are estimated, aiming at providing important information for financial institutions. The predicted values are compared to the prices of the houses realized in the true market in order to investigate the feasibility of the comparative market approach with a hedonic regression model for the proposed project

One of the most widely-used methods, the comparative market approach, is also available for use in the valuation of undeveloped property. The rationale of this technology is to make a valuation by comparing the subject property that is under consideration with similar properties that have been sold, or are even listed for sale. The analysis performed in this approach focuses on similarities and differences among properties and on transactions that affect values: “Adjustments for differences are made to the price of each comparable property to make the comparable equal to the subject on the effective date of the value estimate” (John, *et. al*, 1998). The basic elements of comparison should be considered from transaction characteristics and property characteristics. However, such a straightforward method may have pitfalls to trap the unwary, such as the difficulty of adjusting for some individual property features that have no observable market prices, and some attributes that are not easily quantified. Therefore, aid may be sought from multiple regression analysis where the value of a coefficient can indicate the marginal value of the individual attribute of a property. Once an acceptable set of coefficients is derived for comparable properties, the coefficients can then be applied to adjust for the subject units. Thus, this yields a predicted sale price that can be used as an estimate of market value for financial institutions.

Since Rosen’s (1974) pioneering study, the hedonic price model has been widely applied in property valuation. It offers a good market price for a “standardized” or quality-adjusted property over time or space through statistical estimates (Mason & Quigley, 1996). However, these results require the appropriate specification of explanatory variables and functional form. The latter consideration is not a problem in Essay I, because for the purpose of prediction over the sample, the functional specification bias is not a particularly serious matter (Bulter, 1982). Therefore, the most popular linear equation is employed in the essay. For the choice of variables, two approaches are embodied in Essay I: selecting variables using real estate theory and market knowledge and running different equations with various combinations of the variables involved. During the period of investigation, we have been able to discuss and consult with the agents and accredited appraisers on the importance of different features of projects. As a consequence, variables that appraisers, real estate agents and

market participants consider important for the valuation of townhouse are included in Essay I.

The subject property in Essay I is a sixteen unit townhouse development under construction in a residential neighborhood of a North American city. Comparable properties comprise 233 townhouse units sold or listed for sale on the multiple listing system (MLS) during an 18-month period. These include the latest listing information for units located in a large area surrounding the subject property. A great majority of properties are sold through the MLS. Therefore, it is reasonable to believe that these observations can be regarded to represent market condition during study period.

The research strategy follows this train of thought: For each predicting equation that is examined, based on variable selection technology, the predicted sale value for the 16 individual units in the complex and the gross retail value for the whole project are calculated according to the coefficients estimated in the equations. This is carried out in two steps in the essay.

In the first step, four different regressions are run with some variation in the variables used. In equation 1, twelve variables, including physical attributes, neighborhood attributes, location attributes and transaction attributes, are used in the estimation. In equation 1A, instead of using a dummy variable to capture the difference between sold and listed property in equation 1, estimation relies only on townhouses that have been sold. In equation 1B, only the district where the subject is located is considered, while in equation 2, equation 1B is rerun with five neighborhood location variables. As results, all of the above equations on the whole were highly significant and most of the variables were also statistically significant. Therefore, these four equations can be applied to the subject property and differences between predicted prices and developers' asking prices can be obtained.

Findings from this step give some interesting insights about the prediction equation. Generally speaking, the equation that predicts most accurately among the plausible models may be the one that has the minimum variance (like Brown, 1974, Mark & Goldberg, 1988). However, in our samples, an equation with high R^2 may forecast poorly, while an equation that forecasts well may have low R^2 . This could be explained by the fact that the equation predicting best for a particular sample might not predict well for other samples. In choosing the better predicting equation one should not only pay attention to the statistical technology, but should also rely on economic knowledge and market information. Furthermore, our estimations also suggest influences of location variables on the predictive power of the regression equation

Property tax is a potentially useful variable for estimating the market value of property. Many studies indicate that property taxes should be capitalized into property value, at least to some degree (Miller, 1982). Therefore, in the second step, property tax is taken into account. However, the complication here is that the property tax for the new projects is not applied until they are sold or listed for sale. Therefore, the amount of tax for the individual townhouses being studied is estimated with the help

of a property tax equation (tax as the dependent variable), which includes the same variables used in equation 1 and the variable “tax year” in order to capture the difference in the year that the property is taxed.

When property tax enters into the price equation as an explanatory variable, it shows a highly significant effect on townhouse prices with fairly low tolerance value, which suggests that property tax is a rather good estimator of property value and that it needs little modification by other explanatory variables. The predicted value of property with the help of this price equation shows encouraging results. Either as a whole or individually, predicted prices are close to observed prices. For the sample under study, the gross retail value of this project is \$3,977,467 at last and the prediction error is not more than 1.5%.

As a marked conclusion of this essay, the regression technology can be successfully applied in estimation of projects under construction. The method developed in this essay could be useful for financial institutions for purposes of extending financial bans and it can also help investors when considering alternative investment patterns. The contribution of this essay not only provides a useful valuation method, but it also highlights the significant relation between property tax and property value. This study could be extended to individual units for predicting price. Selection criteria for the best fit predicting equation could be further examined by using the theory of real estate economics and other statistical technologies, such as mean absolute error and root mean square error.

2.2 Essay II

“An Application of the Hedonic Price Model with Uncertain Attribute: the Case of the People’s Republic of China”

The background of this study is the Chinese reform of residential distribution, which started in 1998 to replace the traditional welfare residential system. The traditional housing system was characterized by a highly concentrated planning system in housing investment and supply, rigid administrative control in housing distribution and welfare policy in housing consumption (China’s Urban Housing Reform, 1996). Under this system, housing cannot be traded as a market good and it becomes the greatest benefit that can be obtained, depending on ability of the work unit, occupational rank, or the relationship between the worker and leader. In such a situation, the rule of cost-benefit is broken and the residential market is led into a vicious circle of “higher demand and lower market activity”. Therefore, the aim of the 1998 reform was to promote activity on the real estate market and to keep housing transactions in line with market value.

Although the reform is not yet completed today, this is the first time that consumers have to pay for residences with their own income plus housing subsidies and loans. This is also the first time that would-be housing buyers are allowed to enter the

residential market on their own and to choose the best combination of housing attributes based on their tests and affordability. However, in this research, we note the problem that construction quality causes uncertainty for consumers when they make a decision in this new real estate market. Uncertainty in construction quality could be the result of an ineffective legal system and the dishonest behavior of certain departments and builders. So as a consequence, this risk should be capitalized into the market and influence property values.

The aim of Essay II is to use hedonic pricing technology to estimate implicit property values and consumer values of avoiding loss from poor construction quality. The contribution of this paper is to provide information for demanders and suppliers of the characteristics of consumer value in the new Chinese residential market and to demonstrate that the hedonic methodology can be applied to such an embryo market. This paper first gives an explicit estimate of the impact of construction quality risk on property value, and then it infers the importance of further reform in the direction of improving construction quality accompanied by adjustments in the legal system.

In view of the relatively new market and poor local market knowledge, several variables, such as age, noise, or air pollution, regarded as important factors in determining housing value in much research in the Western countries are not included in this study. Thus, nine housing attributes that describe physical structure, location and the environment of the property are considered in the essay. A zero-one dummy variable for perceived construction risk enters the model depending on the state of the world that the consumer perceives (i.e. certainty or uncertainty).

The risk variable in this study functions as a proxy for the consumer's subjective probability of construction quality rather than an endowed probability that is determined by several technology factors. Biases between endowed and subjective probability rely on the quantity and quality of information that arrives to consumers. Therefore, subjective probability can be interpreted as a function of endowed probability, information levels and the consumer's expenditure on self-protection (Kask, 1992). In this special market, consumers choose a level of self-insurance on their property with respect to quality safety based on the information available for them. Information in the Beijing market, which can be useful for consumers to take into account for their decisions on construction quality, includes a real estate company's prestige, residential district awards, and some special quality certifications.

In estimating the hedonic price model, a linear specification, a semilog specification and a Box-Cox transformation are estimated in the Essay II. Two subset models, with observations from apartments located in the north and west, the south and east respectively are tested

Two very significant results are obtained from this study. Public facilities provided for apartments in fact reduce the value of residences in Beijing, and consumers are willing to pay quite a substantial amount of money to protect themselves from the risks of poor construction quality. These results could be expected if we notice consumer

affordability and irrationalities within Chinese pricing system, as well as the seriously low construction quality in the Chinese real estate market. These conclusions are important not only because they can contribute to the property valuation approach in the new Chinese market, but also because they highlight the linkage between policy and property values under some particular market circumstances. Implications are presented for further residential reform in the Chinese market to improve construction quality with effective legal protection and encouragement to develop dwelling units based on consumer preferences.

2.3 Essay III

“Structural and Vector Autoregressive Model of Housing Prices and Property Stock Prices”

Several financial theories such as Capital Asset Pricing Theory (CAPT) and Arbitrage Pricing Theory (APT) indicate that common factors may influence the performance of the property security market and the property market. Therefore, cointegration of housing prices and property stock prices is expected if the only risk that is priced for both real estate and property stock is the systematic risk. Investors thus earn the same expected returns on direct and indirect real estate market (Liu *et al.*, 1990).

However, this assumption is based on the efficient market and homogeneous expectations and the same single-period decision horizon. The cointegration relationship could be broken by many rules and regulations that influence the demand and supply aspects. It is thus of central importance to investigate this long-term relationship between housing prices and property stock prices under the “rental control system”. This is carried out in Essay III in the Swedish context. The Swedish rental market is under a kind of “soft” control system, in which public sectors establish a standardized rental level for negotiating with private landlords. No investigation of this issue has appeared thus far in the literature on understanding the long-term relation of asset prices under this “rental control system” and the role of such system in the relationship of asset prices. Therefore, another contribution of Essay III is highlighting the rental behavior in the equilibrium of housing prices and property stock prices.

Using the quarterly property stock index and residential prices in Sweden from 1980 to 1998, long-run equilibrium between these two markets is examined based on conventional cointegration techniques and the APT paradigm. One distinctive feature of the method used in this study is the embodiment of the Vector Autoregressive (VAR) model with a subsystem approach as suggested by Pesaran, *et al.* (1997). In this method several variables such as long-term government bonds and the marginal tax rate are taken as structurally exogenous variables entering into the Error Correction Model (ECM) because the error correction term has no significant effects on them in the short term. The advantage of this method is that it can better describe the role of these variables in the ECM and can then capture the true relationship between them. In the first step of this study, cointegration between housing prices and property stock

prices is tested. The theoretical background of this test is APT when the only two assets—real estate assets and property stock assets—are considered. The cointegration test is carried out using Johansen's method and the order of the VAR is selected using the Akaike Information Criterion (AIC) and the Schwartz Bayesian Criterion (SBC). When determining the cointegration rank and trend components, unrestricted intercepts with no time trend are chosen in the paper and the validity of these hypotheses is tested using long-run structural modeling techniques.

The long-term relationship between housing prices and property stock prices is found with Johansen's test using a VAR (2). This confirms that the response of property stock market is stable relative to the shocks of the housing market. Therefore co-movement between these two markets can be expected in the Swedish market. It further suggests that although the rental level is “softly” controlled, the risk ratio of different assets can also be expected to be equal so that equilibrium can be reached.

Given the evidence of the cointegration of the two asset prices, the relative ECM can be obtained. The negative error correction term that appears in the ECM and the equation indicates a significant positive relationship between housing prices and property stock prices. However, the low value of the error correction term indicates that it takes a long time to transfer information from the real estate market to the property stock market; therefore the property stock market is characterized as having semi-strong efficiency.

If the cointegration relationship between these two asset prices is a kind of “broad” long-term equilibrium, we can assume that there should be a stable relationship between property stock prices, housing prices and several financial and economic factors that influence the movement of property stock prices. The factors considered in this study include unemployment rate, GDP, lending interest rate, marginal tax rate and government bond rates, which are taken as exogenous variables in ECM. There is still a long-term relationship present between these variables, most of which have significant effects on property stock prices.

Once a long-term stable relationship exists between housing prices and stock prices, it is expected that the long-term variance in the real estate market can have a long-term influence on the property stock market to keep it in the new equilibrium. The tax reform of 1991 in Sweden provides a chance to take a closer look at this cointegration relationship. One consequence of this tax reform in the housing market was the lowering of housing prices. Therefore, the effect of tax reform is expected also to reduce the property stock prices in the long-term if these two prices have a positive long-term relationship. In this essay, this is confirmed by a simple two-stage least-squares equation with a dummy variable to capture the effect of the tax reform. This result once again confirms the long-term equilibrium of housing prices and property stock prices from an investment perspective.

The final point of this study is the role of rentals on the relationship between the real estate market and the property stock market. This study could be quite important for

evaluating the merits of rental control policy and for providing implications for portfolio theory on the efficient market. However, this is not an easy task. In addition to the relatively sparse literature on the subject, at present we know little about the long-term effects of rent control systems on the relationship of the asset prices.. In this study, a simple ECM with rentals as exogenous variables is estimated in an attempt to capture the short-term effect of rentals on the relationship between housing prices and property stock prices. The result suggests a negative effect of rentals on property stock prices and that the speed of adjustment of the real estate market and the property stock market to equilibrium is increased. One possible explanation given in this paper is from the aspect of reduced transaction costs owing to the new but limited information provided by the rent regulation. It is, of course, necessary to carry out further research on this topic with greater understanding of the effects of the “rental control system” on market efficiency and qualitative methods.

2.4 Essay IV

“The Volatility Performance of the Property Stock Market”

It is a widely held belief that the great advantages and benefits of equity real estate markets have attracted more and more investors. Therefore, an interest in the risk performance of equity property arises, because if there is a trend towards achieving greater rates of return, then greater awareness of the risks involved is needed. However, there has not been much investigation of volatility behavior considering the property stock market as an intersection of the financial market and the property market. That is, there is no research that models property stock volatility relative to property investment performance. It is unclear whether property stock returns can be predicted. Or whether the property stock volatility performance can be captured. We still do not know a great deal about the true relationship between property stock returns and the risks that investors have to face nor about the factors that might influence this relationship.

These problems are investigated in Essay IV. They are important because they play key roles in making investment decisions. The contribution of this research is not only the establishment of a theoretical framework to develop portfolio models on property stock volatility, but also the provision of information for valuating the decisions that investors make as part of developing their investment stage. The General Autoregressive Conditional Heteroskedasticity (GARCH) model is used in the essay. This technology can be regarded as an extension of ARIMA that maintains the restriction of constant unconditional variance, but allows certain conditional variance to change over time as a function of past errors. Therefore, it can be used to capture the time-varying volatility and to model heteroskedastic prices.

The database of this paper is 2508 points of the daily index of the Swedish property stock market from 1990 to 1999. The daily and weekly aggregate stock returns show significant skewness and kurtosis, the clustering of variance, the reduction of

correlation in squared term across aggregation of the data, which suggest that the GARCH specification might be a good approximation to capture the structure of property stock returns in Sweden.

In the first step, MA(1) – GARCH(1,2) model and MA(1) – GARCH(1,1) model are specified for daily and weekly returns respectively according to the Akaike Information and the Schwarz model selection criteria. Under these specifications, the volatility of daily return is explained by the previous day's squared innovation and the previous two days' volatility, while the weekly volatility is captured by the previous week's volatility. In addition, dummy variables are used in the models to capture the regime shift in volatility, because of the changes in economic and financial environment that appeared in 1993 in Sweden. A quasi-maximum likelihood approach, which is a consistent estimation even under the violated normal assumption, is applied. The empirical results indicate the conditional heteroskedasticity and volatility persistence in the Swedish property stock market and also imply the higher volatility performance of the market before 1994.

The finding of persistent volatility is one of the most significant results of this research. It is of general relevance and particularly important because it concerns the structure of the property market and how it can influence investment decisions.

The interpretation of persistence is addressed in the essay from the aspects of illiquidity, small scale and high concentration, which are characteristic of the Swedish property stock market. It suggests that the information shock of the property stock market has a long-term effect in Sweden, and this means this market does not satisfy the assumption of efficiency.

Alternatively, the phenomenon of volatility persistence can be explained by the mixture of distributions of daily returns, in which information arrives stochastically (Lamowtes and Lastrapes, 1990). Therefore, we can expect that the level of persistence can be deduced when the information proxy variable is added to the conditional variance equation. In this paper, I include the interest rate and vacancy rate as mixing information variables on the basis that they are sensitive factors in the property market.

The results confirm that vacancy rate appears to act as mixing information since the level of persistence is decreased to 0.632 from 0.818 when it is added into the model. The result does not imply, however, that interest rate has any effect on the volatility persistence. The implication of this analysis could be interesting for providing a possible method when we investigate the specified stock market section. We note that although the property stock market can be regarded as a segment of broad securities market, the behavior of investors in this particular stock market is influenced by factors pertaining to property because it is a kind of stock market backed by the real estate market.

The null hypothesis has been long accepted that there is a significant tradeoff between risk and return so that high-risk investments will require higher expected returns than low-risk investments. Unfortunately, this is not always the case. Evidence has been provided that the relationship between expected returns and risks is determined, at least partly, by factors such as investor preferences, business cycles, or underlying risk in the economy (Singal and Smith, 1999). However, there is no single conclusion for this area. Therefore, in step 2, GARCH-M models are used to model volatility prices for both daily and weekly series.

The estimated results provide little evidence about the relationship between returns and volatility. For both daily and weekly aggregate data, the coefficients are all positive, but statistically weak, which indicates that forecastable changes in volatility caused by GARCH effects cannot generate excess returns. Why might this be the case? In this paper, I provide an explanation from the point view of risk spillover from other markets, including the general stock market, the bond market and the direct real estate market. This is based on the assumption that for the integrated markets, a better description of the risk faced by the investors might be predicted by use of the covariance of the market indices instead of just the variance.

Because of the limited data, risk spillover effects are intuitively explored by examining the integration between the markets. The high co-autocorrelation between the bond market and the property stock market, as well as cointegration between the direct and indirect real estate markets (see Essay III) imply that risks investors have to face in the property stock market are highly influenced by the bond market and the direct property market. Therefore, it is quite reasonable to expect that the volatility is indeed priced when cross-correlations with the bond market and the direct property market indices are taken into account in the multivariate GARCH model.

2.5 Essay V

“Inflation Hedging Behavior on the Property Stock Market in Sweden”

It is hardly a new idea to investigate real estate's performance as a hedge against inflation risk, but it is a very important aspect, particular in today's economic conditions, compounded by structural oversupply, and in today's technological conditions, when the use of a more sophisticated approach is possible. An understanding of real estate as an inflation hedge is essential for investors and managers who are keen to protect the purchasing power of their assets.

Although the research on the inflation hedging behavior has been well documented internationally, there is no single answer to the question as to whether property is a hedge against inflation, even in the same market. Besides the different time periods and property types considered in the research, the most difficult part of such testing is estimating the expected rate of inflation and selecting the appropriate method to be used for the test.

These two problems are focused upon in Essay V, in which the aim is to consider the inflation hedging effectiveness of property companies in the Swedish market. After reviewing the previous studies that have been carried out round the world, including Australian studies, UK studies, US studies, Swiss Studies, Hong Kong studies and Irish studies, two expected inflation rates—UND1x inflation and GARCH inflation accompanied by cointegration technology—are chosen for this Swedish study.

UND1x inflation is calculated and published by Statistics Sweden (SCB) based on the definition of UND1 made by the Swedish Central Bank. This inflation rate takes into account the effects of taxes and subsidies, but not the temporary effect on CPI. GARCH inflation rate is a kind of rate that is calculated using the GARCH model developed in this study. The AR (1) – GARCH(1,1) model is used to estimate the expected inflation rate, assuming that inflation rate can be well explained by the past inflation information and that the conditional variance is non-stationary. The GARCH inflation method overcomes the shortcomings of the traditional Fama and Schwert (1997) method, which rely on the constant real returns on treasury bills. It also has advantages over the Autoregressive Integrated Moving Average (ARIMA) method, which is constructed on the stationary data series.

Correlation matrices between Actual inflation, UND1x inflation and the GARCH expected inflation are presented in the essay and high levels of correlation these suggest that UND1x inflation and the GARCH inflation provide good proxies for the actual inflation; in particular, the correlation value of 0.987 between actual inflation and the GARCH inflation is very high.

The effective inflation hedging ability of property could result in long-run influences from property to inflation, and the property market is unlikely to adjust instantaneously to changes in inflation. The static regression method is limited in its ability to capture this long-term dynamic movement, because it cannot distinguish long-run adjustments from short-run dynamic movement. Besides, regression analysis based on time series implicitly assumes that the underlying series are stationary, which is probably not true for time series such as the inflation rate. To improve such a static regression model, a cointegration test that focuses on long-term inflation hedging behavior is applied in this paper. This technology is also able to explain the short-run dynamic adjustment if there is a cointegration relationship between property stock returns and inflation rates.

However, this paper cannot directly examine the cointegration relationship between returns on property stock and expected or unexpected inflation. This is because the unit roots tests for return series reject non-stationary characteristics, which is the premise for the cointegration test. Therefore, in this paper, the examination of effective inflation hedging behavior is carried out by testing the cointegration between stock prices and expected and unexpected inflation rate.

Here, it is necessary to mention that it is difficult to get the long-run relationship between property returns and inflation rate directly from the cointegration between property index and inflation rate. A complete hedge against inflation is defined as one-to-one relationship between property returns and expected and unexpected inflation rate. Therefore the nominal return of an asset can be expressed as the sum of the real return and the inflation rate (Brown and Matysiak, 1999). Rubens, *et al.* (1989) also defined partial hedge against inflation and indeterminant hedge against inflation, which all depend on the value of coefficient of inflation rate. In this paper, the further investigation on the inflation hedging ability over the cointegration period is based on the short-term relationship, which is examined using the regression of property stock returns on the first differenced inflation rate.

The focus of Essay V is not only on evidence of inflation hedging capability, but also on understanding the performance of inflation hedging in different economic environments, as this is an important part of portfolio management. Such information can help investors to realize the investment opportunities in the different periods and markets to protect themselves from the inflation risk.

Such research is based on the assumption that property returns is a function of the overall price level of the market, which can be estimated by inflation rate, and the supply and demand balance in the market, where vacancy rate is used as a proxy. (Wurtzebach, *et al.*, 1991). Therefore, the estimations are carried out over periods of high and low inflation, and high and low vacancy rate scenarios. In addition, the volatility of the inflation rate is calculated using the GARCH method and the cointegration test is also done during the highest inflation volatility period (1990–1994).

It is evident that market balance conditions play an important role in the performance of inflation hedging. The long-term relationship between stock price index and inflation rate is found when the vacancy rate is low (1986–1993), and furthermore the partial short-run inflation hedging ability is presented. While in the other period, even when the inflation rate is high and highly volatile, there is no evidence of inflation hedging capability. Therefore, the important point of this essay is that investors can avoid inflation risk by holding property stock when supply and demand is in balance. If the market is characterized by oversupply, investors cannot pass on their increased costs to respond to inflation rate and then, the property is unable to capture the inflation effects. Therefore, an effective inflation hedge is a mixed affair, and it relates to the existence of a market balance.

It is noticed that high inflation rate is not always consistent with high property returns, while returns are more sensitive to the economic factors, such as tax system, financial conditions and market performances. Therefore, though these results might be of interest, the ability of inflation hedging is more independent upon inflation environment, and investors cannot benefit from property stock during high inflation period in Sweden.

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