# TESTS OF INTEGRATION OF REAL ESTATE AND FINANCIAL ASSET MARKETS IN SINGAPORE AND THE ASIA-PACIFIC COUNTRIES

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(B. S., Tsinghua Univ., 2003)

A THESIS SUBMITTED

FOR THE DEGREE OF MASTER OF SCIENCE

DEPARTMENT OF REAL ESTATE

NATIONAL UNIVERSITY OF SINGAPORE

2005

# ACKNOWLEDGEMENT

First and foremost, I would like to deeply thank my supervisor, Professor Sing Tien Foo, for his invaluable support and guidance throughout the whole process of my study, as well as the reviewal and revision process of this thesis.

I would also acknowledge the great financial support from the department of Real Estate of the National University of Singapore for the whole period of my graduate studies.

To my dear parents, I appreciate for their constant encouragement and support for my overseas study.

I am also thankful to my friends and colleagues in NUS. Thanks for their blessing and the useful comments on the thesis.

Lastly, to my dear boyfriend Xingzhi, thanks for giving me the careful tendance and useful suggestion on the thesis.

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# SUMMARY


Maintaining investment returns while simultaneously reducing risk is one of the most important challenges faced by portfolio managers. The outcome can be achieved through portfolio diversification strategies. Portfolio managers seek investments in markets with returns that are not perfectly correlated so that unpredictable shocks in one market are not transmitted instantly to the other markets. The notion of market insulation, or segmentation, is therefore of prime importance.

This study focuses on the tests of market integration hypothesis and the common information factors in Singapore asset markets and the securitized real estate markets in Asia-Pacific countries.

In Singapore market, we test the common information in the direct real estate markets and the financial asset markets. Using the multi-factor latent variable model, we find that there is one common factor in the five asset markets. This result differs from the findings of Liu and Mei (1992). Therefore, investors can capture all risk premiums in one asset market in Singapore.

We also test the three moment asset pricing model in the securitized real estate markets in Asia-Pacific countries, including Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore. We find that the skewness factor is an important factor in the asset pricing models. We also test the common factors including the skewness factor. We find that there is one common factor in the securitized real estate markets in the Asia-Pacific countries, which shows that there is market integration within the

securitized real estate markets in the Asia-Pacific countries so that investors cannot diversify their investments in the securitized real estate markets in the regional markets.

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# Chapter One

# INTRODUCTION

## 1.1 Background

Maintaining investment returns while simultaneously reducing risk is one of the most important challenges faced by portfolio managers. The outcome can be achieved through portfolio diversification strategies. Portfolio managers seek investments in markets with returns that are not perfectly correlated so that unpredictable shocks in one market are not transmitted instantly to the other markets. The notion of market insulation, or segmentation, is therefore of prime importance.

Conventional wisdom suggests that a well diversified portfolio should contain assets such as equities, bonds and property (typically between five and twenty percent in total portfolio holdings distributed across different markets). Increasingly international diversification of portfolios has received more attention by institutional fund managers. In analyzing investment opportunities, either domestically or internationally, the issues of integration/segmentation within the different asset markets cannot be understated. This study, as one of the key objectives, investigates empirically variance issues related to market integration within and across different countries. One of the issues is to test whether direct and indirect property investments are integrated with respect to investments in other financial asset markets in

Singapore. The international/regional integration of securitized property investments, especially across different Asia-Pacific countries, will also be examined.

If the domestic property and financial asset markets are well integrated, risk reduction achieved through holding investments in both markets will be limited. Similarly, if the securitized real estate markets are integrated internationally, international diversification strategies will not be as effective as expected.

For domestic investors who do not have overseas assets in the portfolio, the integration of different asset types within the domestic market is of concern. If there is no integration within different asset markets, the investors can efficiently diversify their portfolios to reduce the unsystematic risks. Some degrees of convergence can be expected with an increasing trend in real estate securitization; therefore, it is important to investigate whether real estate markets are segmented from other markets (Liu *et al.*, 1990). Past empirical tests on market integration predominantly focus on the asset and real estate markets in the US (see Liu & Mei, 1992, Mei & Lee, 1994, Ling and Naranjo, 1999). Other country studies in the UK (Lizieri and Satchell,1997), Australia (Wilson, Okunev and Ta, 1996) and Hong Kong (Fu and Ng, 2001) use mainly evidence of cointegration and Granger-causality relationships as an indirect way to define integration between securitized and direct real estate markets with equity markets.

The real estate investment trust market in Singapore is still at its infancy stage of development. Investment in stocks of listed property companies is often regarded as a close proxy for securitized claims in real estate asset. In an efficient market, the performance of these securitized real estate assets is dependent on the market value of underlying real estate assets held in the portfolios of companies. This hypothesis implies that investors can capture risk premiums embedded in the direct real estate market by investing in property stocks. Empirical tests on the co-movements between property stock returns and direct real estate returns in Singapore have been conducted by Ong (1994 and 1995), Liow (1998 and 2001) and Sing and Sng (2003). Liow (2004) provides evidence on the effects of common macroeconomic risks in the commercial real estate markets. However, there are still no studies thus far that empirically test the existence of common factors among different asset markets in Singapore, and how the common risk factors affect the predictability of the returns in the securitized and the direct real estate markets.

Firstly, this study is intended to empirically investigate the common factors that affect the movements in five different asset markets in Singapore: the stock market, the property stock market, the bond market, the industrial real estate market and the commercial real estate market, using a multifactor latent-variable model. Compared with the findings in the US markets by Mei and Lee (1994), we find that there is only one common factor which contains sufficient market information to explain the price variations of real estate and financial asset classes in Singapore. The property stock is used as an efficient proxy for the securitized real estate market in Singapore case. Our predictability tests further shows that commercial real estate market is the most predictable one among the five asset markets. Variations in the responses of the excess returns of five assets to the common market risk betas suggest that there are different degrees of integration across the asset classes.

Extensive research has been conducted since the 1970s on the benefits of international diversification for stock portfolios. Recent evidence shows that cross-country correlations are lower for real estate investments than those for common stocks, which suggests the existence of an international real estate factor (Ling and Naranjo 2002) and continental factors (Eichholtz *et al.* 1998). Therefore, when constructing a global portfolio of publicly traded real estate stocks, analysis of the correlations across countries (or across continents) should be made. Eichholtz and Huisman (2001) shows that country dummy variables are usually significant in a model that also includes beta, size and interest rate variables. Country-specific factors remain important in diversification strategies.

Evidence of cross-country direct real estate markets and capital markets integration is observed in the studies using the multi-factor analysis by Mei and Hu (2000), Liu and Mei (1998), Liu and Mei (1999) and Bond *et al.* (2003). Ling and Naranjo (2002) investigate the return performance of over 600 publicly traded real estate companies in 28 countries. Mei and Hu (2000) examine the conditional risk premiums of Asia Real Estate Stocks and finds partial explanation of market contagion in the region.

This study carries out empirical tests of relationships of risk premiums of securitized real estate markets in Asia-Pacific countries, which include Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore. Recognizing the limitations of the traditional Capital Asset Pricing Model, Kraus and Litzenberger (1976) use the three-moment model in the empirical tests. Kraus and Litzenberger's model defines the skewness as the third moment factor. The model also includes the mean-variance factors as the first and second moment factors. The three-moment model shows that skewness contributes to the risk premium in an asset price. Kraus and Litzenberger (1976) states that rational investors prefer market returns to be positively skewed.

In this study, we use the standard three-moment model to measure the skewness factor and find that the skewness of asset returns is a significant variable in the multifactor asset pricing models. The results of tests of skewness are consistent with those obtained in earlier study by Peiro(1999), which finds evidence of negative skewness in the stock market indices, with the exception of underperformed markets, that is Philippines in our study, where positive skewness is observed. The investors should pay close attention to skewness when allocating their investments. The result for market integration is consistent with Mei and Hu (2000) that the securitized real estate markets are integrated in the Asia-Pacific countries though including the Australia property stock markets.

Different empirical methodologies have been developed to test the comovement and co-integration between direct and indirect real estate markets. In general, two approaches have been adopted to determine whether real estate and financial markets are integrated or segmented. The first approach uses the asset-pricing framework. Whereas, the second approach examines the relationships between real estate and equity returns using cointegration techniques developed by Engel and Granger (1987). The asset-pricing approach uses single-factor or multi-factor asset pricing models to determine whether investors require an additional risk premium for investing in real estate. This study uses the Generalized Method of Moment (GMM) to estimate the asset pricing structure of direct and indirect real estate and other financial assets, and determine common risk factors underlying different asset markets. The GMM is used to the Kraus and Litzenberger's model because it dose not impose strong distributional assumptions on the asset returns. The GMM test avoids the measurement error problem, and provides asymptotically more efficient estimators by using information from the residual error covariance matrix.

## 1.2 Research Objectives

The main objectives of this study are:

(1) To empirically test the existence of common macroeconomic variables in explaining excess return variations in direct real estate markets and financial asset markets in Singapore, which include the stock market, the property stock market, the bond market, the industrial real estate market and the commercial real estate market.

(2) To empirically test the Kraus and Litzenberger three-moment CAPM model and the relationships between the excess returns and the variance and the skewness risks in the securitized real estate markets in Asia-Pacific countries.

(3) To empirically test the multi-factor models with a skewness factor and to ascertain whether common macroeconomic risk premium exists in the securitized real estate markets in Asia-Pacific countries, which include Australia, Hong Kong, Japan,

Malaysia, Philippines and Singapore.

## 1.3 Research Questions

Given the above objectives, the study is designed to address the following research questions:

(1) Are these common macroeconomic risk factors, which include real 3-month Treasury-bill, the default risk, the growth rate in industrial production output, the term structure and the quarterly unexpected inflation rate, explain the performance in the direct real estate markets and the securitized real estate market and other financial asset market in Singapore? How do the excess returns on these asset returns react to changes in common macroeconomic variables, such as the 3-month treasury bill, the growth rate of the industrial production, the unexpected inflation rate, the yield spread between the 3-month commercial bill and the 3-month T-bill and the term-spread between the 5-year long term government bond yield and the 2-year short term government bond yield? Is the market integration hypothesis significant in the test?

(2) Is the skewness risk an important factor in explaining the excess return variations of securitized real estate markets in the Asia-Pacific countries, which include Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore?

(3) Do the excess returns of securitized real estate markets in Asia-Pacific countries react to a common set of macroeconomic risk premia, such as risk free rate, gross domestic product (GDP), inflation rate and the openness risk? Are these asset

markets integrated, if they share a common information set?

## 1.4 Significance and Contribution of the Study

The main contributions of this study can be summarized as follows:

We extend the traditional asset pricing model by incorporating a three-moment factor proposed by Kraus and Litzenberger in 1976 into the model. This study applies the three-moment asset pricing models to test the market integration hypothesis in the Asia-Pacific property stock markets.

This research differs from the study by Harvey and Siddique (2000), which adds the skewness risk into the Fama and French (1995) three-factor model. The three factors in Fama and French (1995) model are size effect, the SMB (defined as the return on a portfolio of small-size stocks minus the return on a portfolio of large-size stocks) and the HML (defined as the return on a portfolio of high book-to-market stocks minus the return on a portfolio of low book-to-market stocks). In our model, the skewness factor is included in the multifactor model, which is dependent on a set of macroeconomic variables, such as the risk free interest rate, the gross domestic product (GDP), the inflation rate and the openness factor. The three moment multi-asset pricing model (3MM-APM) is used to test the incremental effects of skewness factors on the excess returns of the securitized real estate markets. An openness factor measuring the impacts of globalization on rates of returns, which is defined as the (Import+Export)/GDP, is also included in the 3MM-AP model.

Unlike the traditional test of the integration problem, we use Mei and Lee (1994) multifactor latent-variable asset pricing model to test the common information existing in the different markets. Empirical tests on the co-movements between the property stock returns and the direct real estate returns in Singapore have been conducted by Ong (1994 and 1995), Liow (1998 and 2001) and Sing and Sng (2003). Other studies focusing on the international co-movements within the property stock markets have been done by Bond, Karolyi and Sanders (2003), Ling and Naranjo (2002). They investigate the long-run relationship within the asset markets using the co-integration method or testing the reaction of the coefficients towards the risk factors. The multifactor latent-variable model defines the common information in a different way. It assumes the common information is imbedded the forecasting variables captured by excess returns of one or more assets. The information set is tested using the rank restriction, and the existence of one or more common factors is used to define the market integration.

## 1.5 Organization of the thesis

In chapter one, we present the background, objectives, research questions, research framework and methodology, along with the significance and contribution of the study. Chapter two reviews the literature or research concerning the domestic asset market integration and the international asset allocation in the securitized real estate markets. Chapter three discusses empirical methodology used in this study, which consists mainly of the three-moment asset pricing model and the multifactor latent-variable model. Chapter four and chapter five present the main research findings of the empirical tests. One is the research on the risk premium test on direct real estate markets and the financial asset markets in Singapore. The other one is the research on the risk premium test on the securitized real estate markets in Asia-Pacific countries. Chapter six concludes the main findings, with discussion on implications and limitations, and also providing recommendations for future research.

# Chapter Two

# LITERATURE REVIEW

## 2.1 Introduction

In this chapter, we make literature review on the evidence of the integration research on both domestic asset markets and the international securitized real estate markets. The development of the asset pricing models will also be discussed, especially the three-moment asset pricing model. The common factor tests in the multifactor latent-variable model will also be used to examine the market integration hypothesis.

## 2.2 Evidence of Integration of Domestic Asset Markets

The notion of market integration across different asset markets has significant implications for the well-accepted investment theories. If asset markets are not integrated, the investors can seek to efficiently diversify their portfolios by holding assets in these different markets. Recent literature on market integration tests can be broadly divided into three groups based on the empirical techniques applied in the respective studies: (1) a multi-factor asset pricing approach that test the predictability and risk premia associated with *a-priori* defined macro-economic drivers; (2) a latent multi-factor approach that tests common fundamental factors in the asset classes; and (3) a cointegration approach that examines the long-term contemporaneous relationships between different historical returns of different asset classes.

Applying Jorion and Schwartz (1986) technique in the standard Capital Asset Pricing Model (CAPM) framework, Liu *et al.* (1990) tests the integration between equities, equity REITs and non-farm commercial real estate in the US. Their empirical results support the integration between the equity REIT and the stock market, but reject the integration between the commercial real estate market and the stock market. Miles *et al.* (1990), using a transactions-based real estate risk return index in their tests, finds evidence to suggest that the real estate and equity markets are integrated. In contrast to this finding, Geltner (1990), in a separate study examining whether an asset's return does reflect rational fundamental valuation finds that real estate and equity markets are segmented.

In a study of the US property market, Myer and Webb (1993) examine the relationship between securitized and unsecuritized investments in real estate. These authors find that, in a distributional sense, securitized real estate returns behave much more like the returns on common stock than on unsecuritized real estate, implying the existence of some degree of integration between the securitized real estate and common stock markets.

In a subsequent study on the relationship between securitized retail real estate returns and retail common stock returns in the US, Myer and Webb (1994) find that, after controlling for general stock market returns, there is evidence of a positive relationship between retail stocks and securitized retail real estate. Glascock *et al.* (2000) examine the integration of REIT, bond, and stock returns. Cointegration and vector autoregressive models are employed to test the causality and long-run economic linkages among these securities. Their results show that REITs behave more like stocks and less like bonds after the structural changes in the early 1990s. Overall, their results suggest that the benefits of diversification by including REITs in multi-asset portfolios diminish after 1992.

Fu *et al.* (2001), using Granger causality tests, finds evidence to support segmentation between the residential property market and the equity market in Hong Kong. Also finding evidence to support the segmentation between residential real estate and equity markets in Australia, using a multi-index model and standard linear techniques, Wilson *et al.* (1995) finds inconclusive evidence of segmentation between physical real estate markets and equity markets in Australia.

For studies on Singapore market, Ong (1994) discovers a contemporaneous long-term relationship between property stock return, real estate return and 3-month Treasury bills interest rate using a structural vector autoregressive (VAR) model. In a separate study by Ong (1995) with data of securitized real estate and direct real estate for the period from 1977 to 1992, his results contradict those in his previous paper. Liow (1998) confirms the segmentation between the commercial real estate market and the securitized real estate market using the same methodology. Using the Generalized Autoregressive Conditional Heteroscedasticity in Mean (GARCH-M) methodology, Sing and Sng (2003) find evidence of incremental information flowed uni-directionally from the conditional volatility of unsecuritized market to the securitized property market. They conclude that the two markets are partially integrated.

## 2.3 Evidence in the International Real Estate Markets

The issue of international diversification of stock portfolios has received close attention in the financial economics literature since the seminal work by Solnik (1974). By widening the investment spectrum to non-domestic stocks, he shows that the risk-adjusted returns of the portfolio increase, geographical diversification has been shown to be more effective than diversification by industry, with international stock markets becoming more and more correlated with each other (Solnik and Roulet 1999).

Data limitation is one of the impediments of research on international integration of securitized property markets (property investment trusts and property stocks). The research that has been undertaken to date has generally supported the segmentation hypothesis. For instance, Giliberto (1990) finds that there are diversification benefits through combining US real estate equities with foreign real estate equities. Case *et al.* (1997) find that returns to commercial real estate tend to move together across property types within each country and that international diversification within three segments of the real estate markets (industrial, office and retail) would have been beneficial over the period 1986-1994. Asabere *et al.* (1991), using a mean-variance model, similarly found that there are substantial benefits from international diversification of investments in securitized property markets. These authors analyze the correlation between returns on international real estate equities, US REITs, and US real estate companies using Capital Investment Perspectives World Equity Index, Standard and Poor's 500 Index and Ibbotson and Sinquelfeld's Corporate and Government Bond Indices. The results indicate that there is substantial diversification benefit associated with investment in international real estate equities for a US investor, and the results do not reject the hypothesis of international segmentation of property markets. Pagliari *et al.* (1998) analyze commercial real estate returns in Australia, Canada, the United Kingdom and the United States over the period 1985-1995, from the perspective of a U.S. investor, using national indices in different property sectors, which include office, retail and warehouse. These analyses convert total returns into their fundamental components: initial yield, growth in income and shifts in capitalization rates. They find that the components of retail returns across the four countries exhibit greater divergence than the returns in the office and warehouse sectors. They also find that idiosyncratic risks are more significant in the real estate space markets than in the real estate capital markets.

Using correlation analysis, Sweeney (1993) finds that the correlation coefficients between prime office indices in major cities across the world were negative, implying that diversification benefits can be achieved through pursuing a strategy of investing in prime office real estate across different countries. Using the same correlation analysis, Eichholtz and Lie (1995) find that there are increasing correlations amongst real estate markets within continents and decreasing correlations between continents suggesting a process of regionalization rather than globalization. Goetzmann and Wachter (2001) also find that cross-border real estate diversification is useful. They show that cross-border correlations are due in part to common exposure to fluctuations in the global economy. However, country specified GDP changes explain more of the variation in real estate returns than the global factor. This indicates a stronger impact of local factors in common stocks.

Goetzmann and Wachter (2001) report that international real estate diversification is more beneficial than international stock diversification for industrial real estate but not for other property types. Bardhan *et al.* (2004) examine the relationship between globalization and rate of return of publicly traded real estate companies in countries around the world. Using a set of multi-factor models and seemingly unrelated regression analysis (SUR) for annual data of 946 firms from 16 countries over the sample period of 1995-2002, they test the impact of country's economic openness on real estate stock returns after controlling for other factors. They find that country real estate stock returns are significantly and negatively related to the openness of a country.

Ziobrowski and Curcio (1991) highlight the importance of exchange rate fluctuations in analyzing the benefits of international diversification. These authors conclude that currency fluctuations are largely responsible for the diversification benefits of US in foreign portfolios. The results concerning the usefulness of currency hedging strategies in international portfolio are mixed. Currency swaps have been shown to be the best option given the long-term nature of real estate investments. Liu and Mei (1998) find that diversification benefits are primarily driven by unanticipated returns, which are related to changes in exchange rate risk. They argue that although exchange rate risk accounts for a larger portion of the return fluctuation in real estate securities compared to common stocks, international real estate securities provide some incremental diversification benefits over common stocks, even after hedging currency risks.

Securitized real estate has been shown to have high correlation with common stocks in international markets (Eichholtz 1997). Evidence in the U.S. shows that the correlation between REIT and stock returns has been declining (Ghosh *et al.* 1996, Brounen 2003). Like in the case of direct real estate (Goetzmann and Wachter 2001), there is also evidence of a worldwide factor in international indirect real estate returns (Ling and Naranjo 2002). They find that a country-specific factor is highly significant, which suggests that international diversification is useful when constructing portfolios of real estate securities. In a study of excess returns of securitized real estate in six countries, Eichholtz and Huisman (2001) find that country dummy variables are significant in almost all instances. They also show that the level of interest rates and the change in that level negatively impact on excess returns, whereas term structure is positively related to returns. Eichholtz and Huisman (2001) also find a negative relationship between size and excess returns, a result that is consistent with those found in the financial economics literature. Importantly, beta does not appear to be an important factor in explaining excess returns of international real estate securities.

Bond *et al.* (2003) find that global and country-specific market risk factors are important, and a country-specific risk factor adds some explanatory power to the securitized real estate returns.

Correlations of real estate securities across countries are lower than cross-border correlations between common stocks (Eichholtz 1996, Gordon *et al.* 1998). Eichholtz (1996) finds that international securitized real estate diversification is more effective than international stock diversification. Wilson and Okunev (1996) use cointegration tests and show that international real estate markets are segmented. Stevenson (2000) also reports evidence on the benefits of international diversification for real estate security portfolios, although he finds that these benefits are greater for common stocks. The positive diversification is also achieved by including international real estate stocks in global equity portfolios.

With respect to the most efficient way of constructing a well-diversified securitized real estate portfolio, Eichholtz *et al*. (1998) analyze whether a strategy that is based on continents is more useful than one that is based on country diversifications. They find evidence of a continental factor in Europe and in North America, but not in the Asia-Pacific region. The results of Eichholtz *et al*. (1998) suggest a growing integration of securitized real estate markets within Europe. This indicates that an international real estate security diversification strategy is efficient when implemented across continents rather than within continents.

On the Asia-Pacific country study, Mei and Hu (2000) use a multi-factor latent variable model to test time varying risk premiums of Asia Property stocks from 1990 to 1997, and they find strong evidence to suggest that property development based on constant discount rate may underestimate the cost of capital. The conditional excess returns of many crisis-stricken economies appear to move closely with each other. This finding supports the hypothesis that the risk premiums in these Asian markets move closely over time, which provides as a result a partial explanation of market contagion in the region.

## 2.4 Skewness Factors

In Markowitz's paper (1959), *Portfolio Selection,* portfolio optimization can be analyzed based on the mean and the variance of asset returns, which is commonly learned as "not putting all your eggs in one basket". The Markowitz's idea of portfolio selection was formalized and widely applied in financial decision. This basic theory was subsequently extended by taking into considering the systematic market risks in the valuation of risky assets the by Sharp (1964) and Lintner (1965). The single-factor capital asset pricing model (CAPM) of Sharp (1964) and Lintner (1965) is one of the most important contributions in the modern finance theory (Black (1993) and Jagannathan and Wang (1996)). However, in recent years, empirical tests show that cross-asset variations in expected returns cannot be explained by the market beta alone. Fama and French (1995) proposed a three-factor model that incorporates the size effect, the SMB (defined as the return on a portfolio of small-size stocks minus the return on a portfolio of large-size stocks) and the HML (defined as the return on a portfolio of high book-to-market stocks minus the return on a portfolio of low book-to-market stocks) to better explain variations in asset's excess returns.

There are a number of responses to these empirical findings. First, the single-factor CAPM is rejected when the portfolio used to proxy the market return is inefficient (Roll 1977 and Ross 1977). Roll and Ross (1994) show that small deviations from efficiency can produce an insignificant relation between market risk and expected returns. Second, Kothari *et al.* (1995) argue that there is a survivorship bias in the data used to test these asset pricing specifications. Third, Kim (1995) further argues that errors-in-variables impact the empirical research. Ferson and Harvey (1998) show that even the new multifactor specifications are rejected because they ignore conditioning information.

Kraus and Litzenberger (1976) first extend the capital asset pricing model to incorporate the effect of skewness in valuation. The empirical evidence is consistent with the prediction of the three moment extension of the traditional capital asset pricing model. The evidence suggests that prior empirical findings that are interpreted as inconsistent with the traditional theory can be attributed to misspecification of the capital asset pricing model with the omission of systematic (nondiversifiable) skewness.

Lim (1989) tests the Kraus and Litzenberger's (1976) three-moment CAPM using Hansen's (1982) generalized method of moments (GMM). The GMM approach does not impose strong distributional assumptions on the asset returns. This is an interesting issue since there is no obvious multivariate distribution for returns that also exhibits co-skewness. Using monthly stock returns in the test, Lim finds evidence that systematic skewness is priced in the asset returns. Kadiyala and Reinganum (2002) investigate whether co-skewness is independently priced in stock returns. However, after controlling for prior cumulative returns, size and B/M ratio, they find no significant co-skewness effect, even in January.

Harvey and Siddique (2000a) decompose the expected excess return into components of conditional variance and conditional skewness. They find that conditional skewness is important and, when combined with the economy-wide reward for skewness, helps explain the time-variation of the ex ante market risk premiums. They suggest that conditional skewness is more significant in explaining the *ex ante* risk premium for the world portfolio than for the U.S. portfolio. Harvey and Siddique (2000b) add the skewness factor into the Fama-French three factor models and find that the momentum effect is related to systematic skewness and the low expected return momentum portfolios have higher skewness than high expected return portfolios.

The assumption of normality in a mean-variance framework is violated, if skewness persists in the capital market (Peiro, 1999). In testing the symmetry of daily returns in eight international stock markets and three spot exchange rates, Peiro (1999)found that under alternative non-normal distributions, the symmetry of the returns cannot be rejected for most markets. Kim and White (2004) provide a survey of measures of skewness and kurtosis from the statistics literature and carry out extensive Monte Carlo simulations that compare the conventional measures with the robust measures in their survey. They suggest that looking beyond the standard skewness and kurtosis measures provides more accurate insight into market return behavior. There are few papers which have examined skewness in real estate securities. In a paper by Bond & Patel (2003), they found that while a large portion of property security returns in the sample do exhibit skewness in the conditional distribution, variations in the skewness parameter are also observed.

## 2.5 Summary

In this chapter, literature on testing of market integration hypothesis and empirical asset pricing models was reviewed. The literature can be categorized into three distinct categories based on the development in the studies, which are evidence of integration in domestic asset market, evidence of integration in international real estate market, and the skewness risk factor. The last category of literature was included to also cover recent studies in finance that examines the assumption of normality in asset prices. The incorporation of this literature allows us to examine the effects of skewness risk factor on the structure of the asset pricing framework in the empirical tests.

Literature on the relationship between both private and traded real estate and also between traded real estate companies and the general equity markets is abundant. Evidence on the relationships between real estate securities and common equities are complex, in particular with regard to REITs in the US. REIT is a proxy for the securitized real estate market. REIT market, however, is relatively new in Asia-Pacific countries except in Australia. Data is limited for robust empirical tests. Therefore, we use the property stock as a proxy for the securitized real estate markets in the Asia-Pacific countries and we use the data of LPT in Australia.

# Chapter Three

# METHODOLOGY

## 3.1 Introduction

This chapter specifies various empirical and theoretical methodologies used to carry out proposed tests of market integration hypothesis set up in this study.

First, capital asset pricing model (CAPM) and Arbitrage Pricing Theory, the two modern finance models, will be introduced. We apply the unrestricted multi-factor models to test securitized real estate and financial markets in Singapore and Asia-Pacific countries. We extend the traditional CAPM by using the three moment capital asset pricing model (3MM-CAPM) of Kraus and Litzenberger (1976) in the test. By adding the third moment---the skewness factor into the multi-factor models, the model tests the incremental explanation of the excess returns in the securitized real estate markets. The latent-variable asset pricing model is a transformation of the multi-factor model, in which the common factors can be tested by means of the Generalized Methods of Moments (GMM).

## 3.2 Capital Asset Pricing Model and Arbitrage Pricing Theory

Capital Asset Pricing Model (CAPM) (Sharp, 1964; Lintner, 1965) is one of the most important contributions in the modern finance theory. CAPM proposes that the expected return on a risky asset is composed of the risk-free rate plus the risk premium. The risk premium, in a portfolio sense, is the excess market return over the risk-free rate multiplied by the level of systematic risk for the specific investment. Formally:

$$E(R_i) = R_f + \beta_i[E(R_M) - R_f] \quad (1)$$

where

$E(R_i)$ = the expected return on asset (portfolio) i,

$\beta_i = Cov(R_i, R_M)/Var(R_M)$

$E(R_M)$ = the expected return on the capitalization weighted portfolio of all assets,

$R_f$ = the risk-free rate.

We can convert the formula (1) into

$$E(R_i) - R_f = \alpha_i + \beta_i[E(R_M) - R_f] \quad (2)$$

where

$E(R_i) - R_f$ = excess return on asset (portfolio) i,

$\alpha_i$ = abnormal return on asset (portfolio) i,

$E(R_M) - R_f$ = excess return the capitalization weighted portfolio of all assets, and

$\beta_i = Cov(R_i, R_M)/Var(R_M)$

In our study, the excess return is used instead of the return of the risky asset, which is estimated as the difference between return on asset $i$ and the risk-free interest rate.

In contrast to the single-factor CAPM, APT allows multiple factors to influence asset returns. The APT assumes that investors compare the sensitivities of investment opportunities to common factors. According to the APT, each risk factor has a risk premium and the risk premia of individual assets will be equal to a weighted average of the factor risk premia. The weighting will reflect the sensitivity of the asset returns to the common factors. Like the CAPM, the APT assumes the asset returns are generated by a linear pricing process, which can be summarized as

$$E(R_i) = f_0 + \sum_{j=0}^{k} \beta_{ij} f_j, i = 1, \ldots N \quad (3)$$

where

$E(R_i)$ = the expected return on asset (portfolio) i,

$f_0$ = the risk-free rate or the expected return on a 'zero-beta' portfolio,

$\beta_{ij}$ = the reaction coefficient which describes the sensitivity of the returns of asset i to the risk factor j,

$f_j$ = the premium for risk j,

N = the number of risky assets, and

K = the number of risk factors.

CAPM and APT are two important financial models. First, we test the unrestricted multi-factor models to analysis whether the asset market performance is dependent on macroeconomic factors, such as the real 3-month Treasury-bill (RTBill), the yield spread between the 3-month commercial bill and the 3-month T-bill (DEFAULT), the growth rate in industrial production output (GIP), the term-spread between the 5-year long term government bond yield and the 2-year short term government bond yield (TERM), and the quarterly unexpected inflation rate (UI) in Singapore markets. Next, we examine the relationships of real estate stock market performances with gross domestic product (GDP), the inflation rate, the risk free interest rate and the openness indicator using securitized real estate excess returns in the Asia-Pacific countries.

## 3.3 Three Moment Capital Asset Pricing Model

Based on the capital asset pricing model (CAPM) and the arbitrage pricing theory (APT), the third moment --- the skewness factor is added to the traditional financial models.

For the empirical work, Kraus and Litzenberger (1976) proposed a three-moment capital asset pricing model in which systematic skewness contributes to the risk premium of an asset. The model can be written as:

$$E(\tilde{r}_i) = b_1\beta_i + b_2\gamma_i \tag{4}$$

where $E(\tilde{r}_i)$ denotes the expected excess return of a risky asset $i$ held from time $t-1$ to time $t$, which is estimated as the difference between return on risky asset i and the risk-free interest rate. $b_1$ is interpreted as the market price of the systematic variance and $b_2$ is interpreted as the market price of the skewness risks. It's assumed that the cubic utility function belongs to a non-increasing absolute risk aversion utility class, $b_2$ will have the opposite sign of the market portfolio. In other words, when the returns on the market portfolio are positively (negatively) skewed, the risk premium for the skewness risk, $b_2$, should be negative (positive).

In the equation (4), $\beta_i$ and $\gamma_i$ are the proxy for the systematic variance and the skewness risk, which are defined as follows:

$$\beta_i = \frac{Cov(R_i, R_M)}{Var(R_M)} \tag{5}$$

$$\gamma_i = \frac{E[(R_i - E(R_i))(R_M - E(R_M))^2]}{E[(R_M - E(R_M))^3]} \tag{6}$$

For the empirical tests, we follow the Kraus and Litzenberger (1976)'s methodology by constructing $\beta_{it}$ and $\gamma_{it}$ using the following formula:

$$\beta_{it} = [\sum_{s=1, s\neq t}^{T} (r_{Ms} - \overline{r}_M)(r_{is} - \overline{r}_i)] / [\sum_{s=1}^{T} (r_{Ms} - \overline{r}_M)^2] \tag{7}$$

$$\gamma_{it} = [\sum_{s=1, s\neq t}^{T} (r_{Ms} - \overline{r}_M)^2 (r_{is} - \overline{r}_i)] / [\sum_{s=1}^{T} (r_{Ms} - \overline{r}_M)^3] \tag{8}$$

where $\beta_{it}$ and $\gamma_{it}$ are estimated using the time-series data as the proxies for the systematic variance and the skewness risk for the risky asset *i* at time *t*. $\overline{r_i} = (\sum_{t=1}^{T} r_{it})/T$ is the mean excess return of *i*th risky asset. *M* subscript denotes market portfolio. In order to avoid the spurious correlation problem, $r_{it}$ was excluded from the calculation of the numerators for $\beta_i$ and $\gamma_i$. In the regression, $r_{it}$ is a dependent variable. $\beta_{it}$ and $\gamma_{it}$ are the time-varying variabels in equation (4).

In our study, the three moment asset pricing model (Equation (4)) is used to test whether there is skewness risk in the securitized real estate markets in the Asia-Pacific countries. Then, we add the skewness factor into the multi-factor model to test the incremental effect of the excess returns on property stocks. At last, we also test the common information in the Asia-Pacific capital markets using the latent-variable asset pricing model.

## 3.4 Latent-Variable Asset Pricing Model Framework

The latent factor asset pricing framework used in this study follows that of Liu and Mei (1992), which is a modification to the multi-factor model. On the assumption that capital markets are perfectly competitive and frictionless, asset returns are generated by the following K-factor model:

$$\tilde{r}_{i,t+1} = E_t[\tilde{r}_{i,t+1}] + \sum_{k=1}^{K} \beta_{ik} \tilde{f}_{k,t+1} + \tilde{\varepsilon}_{i,t+1} \tag{9}$$

where $\tilde{r}_{i,t+1}$ denotes the excess return of asset $i$ held from time $t$ to time $t+1$, which is estimated as the difference between return on asset $i$ and the risk-free interest rate. $E_t[\tilde{r}_{i,t+1}]$ is the expected excess return on asset $i$ which is allowed to vary through time conditional on information known at the end of time *t*. $\beta_{ik}$ is the time-invariant factor loadings with each of the *K* factors. The unexpected return on asset $i$ equals the sum of *K*-factor realizations, $\tilde{f}_{k,t+1}$ times their betas $\beta_{ik}$ plus an idiosyncratic error $\tilde{\varepsilon}_{i,t+1}$. We assume that $E[\tilde{f}_{k,t+1}]=0$ and that $E[\tilde{\varepsilon}_{i,t+1}]=0$.

If zero-beta return, $E_t[\tilde{r}_{i,t+1}]$, is not constant, we need to look at both the similarities in betas and the co-movement of $E_t[\tilde{r}_{i,t+1}]$ over time when analyzing the co-movement of excess returns for two or more assets. In other words, it is possible for the excess returns of two assets to move independently even though they share similar betas. This problem will not occur, if the following linear pricing relationship holds:

$$E_t[\tilde{r}_{i,t+1}] = \sum_{k=1}^{K} \beta_{ik}\lambda_{kt} \tag{10}$$

where $\lambda_{kt}$ is the "market price of risk" for the *k*-th factor at time $t$.

By assuming that the information set at time $t$ consists of a vector of $L$ forecasting variables $X_{nt}$, $n=1\ldots L$ (where $X_{1t}$ is a constant), and that conditional expectations are a linear function of these variables, we can write $\lambda_{kt}$ as

$$\lambda_{kt} = \sum_{n=1}^{L} \theta_{kn} X_{nt} \tag{11}$$

and therefore equation (10) can be expressed as

$$E_t[\tilde{r}_{i,t+1}] = \sum_{k=1}^{K} \beta_{ik} \sum_{n=1}^{L} \theta_{kn} X_{nt} = \sum_{n=1}^{L} \alpha_{in} X_{nt} \tag{12}$$

where $\alpha_{in}$ is the risk premium for the forecasting variable $X_{nt}$. Equations (9) to (12) collectively define the multifactor "latent-variable" model. The model implies that expected excess returns are time-varying and can be predicted by the forecasting variables in the information set. Equations (11) and (12) impose restrictions on the $\alpha_{in}$ coefficients, which is given as

$$\alpha_{ij} = \sum_{k=1}^{K} \beta_{ik} \theta_{kn} \tag{13}$$

where $\beta_{ik}$ and $\theta_{kn}$ are free parameters.

Based on the conditional excess returns $E_t[\tilde{r}_{i,t+1}]$ in Equation (12) with the pricing restriction in Equation (13), we first obtain an unrestricted conditional excess return by regressing excess returns on the forecasting variables:

$$E_t[\tilde{r}_{i,t+1}] = \sum_{n=1}^{L} \phi_{in} X_{nt} \tag{14}$$

In the linear regression specified by Equation (14), the risk premium, $\phi_{in}$, for $X_{nt}$, does not have to be the same as $\alpha_{in}$ in Equation (12). This unrestricted model is in the same form of the multi-factor model as we present the formula (3) in 4.2.

Next, we test for common systematic risk factors that affect asset returns in the multifactor latent-variable model by testing the rank restriction, $H_0$: α=ΘB. To test the restrictions in equation (13), we first normalize the model by setting the factor loadings of the first $K$ assets as follows: $\beta_{ij} = 1$ (if $j = i$) and $\beta_{ij} = 0$ (if $j \neq i$) for $1 \leq i \leq K$. We partition the excess return matrix, [$R = (R_1, R_2)$], into $R_1$, which is a $T \times K$ matrix of excess returns of the first $K$ assets, and $R_2$, which is a $T \times (N - K)$ matrix of excess returns for the rest of the assets. Combining equation (12) and (13), we can derive the following regression system:

$$R_1 = X\Theta + \mu_1 \quad (15a)$$

$$R_2 = X\alpha + \mu_2 \quad (15b)$$

where $X$ is a $T \times L$ matrix of the forecasting variables, $\Theta$ is a matrix of $\theta_{ij}$, and $\alpha$ is a matrix of $\alpha_{ij}$. If the linear pricing relationship in Equation (10) holds, the rank restriction implies that the data should not be able to reject the null hypothesis $H_0$: α=ΘB, where B is a matrix of $\beta_{ij}$ elements. The objectives of this study are to use the regression system in equations (15) to test the extent to which the forecasting variables, $X$, can predict excess returns, and at the same time, to test the significance of the rank restriction. In our empirical work, we test the common information in the local Singapore asset markets and in the securitized real estate markets towards the macroeconomic variables including the skewness risk in the Asia-Pacific countries.

## 3.5 Differences between the multi-factor model and the latent-variable model

The multifactor latent-variable model is different from the multi-factor model in terms of defining the 'common information'. The multi-factor model assumes that the excess return is explained by various risk factors. When we examine the common information using the multi-factor model, we focus on similarity of coefficients in relation to the different risk factors. We define that the asset markets are integrated when they share similar betas. The latent-variable model assumes that the excess returns in different capital market are explained by 'information set' which is captured by the different combination of the forecasting variables. We assume there is one and only one 'information set' in each of the capital markets which captures the characteristic in each capital market. If the capital markets are all integrated, we expect that the information set in one capital market can explain the performance in other capital markets. Therefore the rank restriction will equal to 1. We aim to test common information set, which are significant in explaining the market integration among the asset markets in Singapore and the securitized real estate markets in the Asia-Pacific countries.

The unrestricted conditional excess returns of Equation (14) and the restricted conditional excess returns of Equation (15) with the restriction in equation (13) were estimated using Hansen's (1982) Generalized Method of Moments (GMM) methodology. The GMM technique allows for both conditional hetroskedasticity and serial correlation in the error terms in the excess return regressions.

## 3.6 Generalized Method of Moments

In a generalized method of moment test, no stringent distributional assumption is made. The generated orthogonality conditions allow for heteroskedasticity in the errors.

The basic idea underlying the GMM test of Hansen (1982) is to use the orthogonality conditions to construct a criterion function whose minimizer is a vector of estimators of the parameters in the model. Then criterion function is constructed in a manner that ensures the parameter estimator is consistent, asymptotically normal, and has an asymptotic covariance matrix that can be estimated consistently. The estimators are then used in the computation of a test statistic that converges in distribution to $\chi^2_{N-1}$, where the number of degrees of freedom is equal to the number of over identifying restrictions.

## 3.7 Summary

In this Chapter, the empirical methodologies and theoretical framework used in this study are presented. First, we introduce the capital asset pricing model (CAPM) and the arbitrage pricing theory (APT) which are the two main theoretical frameworks that form the basic models of empirical tests of the study. In our empirical research, firstly, we use the basic multi-factor model to test the relationships of the five asset market performance, with respect to the macroeconomic factors using real estate and financial assets in Singapore market, and the securitized real estate market performance in the Asia-Pacific countries respectively. We then use the three moment capital asset pricing model proposed by Kraus and Litzenberger (1976) to test the skewness factor in six Asia-Pacific countries. The skewness factor in the multi-factor model is added to test the incremental effect on explanation on the real estate stock market performance. At each stage, the common information existing in the capital markets is tested in the latent-variable asset pricing model framework. Hansen's (1982) Generalized Method of Moments (GMM) technique is used in the empirical tests, which allows for both conditional hetroskedasticity and serial correlation in the error terms in the excess return regressions.

In the following two chapters, the empirical research in testing the common risk premium on the time-varying returns in the Singapore direct real estate markets and the financial markets and another test on the securitized real estate market performance in the Asia-Pacific countries are presented .

# Chapter Four

# Tests of Time-Varying Returns and Risk Premiums of Real Estate and Financial Assets in Singapore

## 4.1 Introduction

Chapter four discusses the empirical tests of the time-varying returns of the direct real estate markets and the financial asset markets in Singapore.

The market integration hypothesis in the latent common market factors as proposed by Mei and Liu (1994) suggests that when the risk premia of investments can be captured by common risk beta in overall stock, both real estate markets, the financial and real estate markets can be deemed to be integrated. In this chapter, we employ the multi-factor latent variable model of Mei and Lee (1994) to test the predictability of excess returns in five asset markets and also to examine whether there are common risk premiums in the five asset markets in Singapore. We find that there is only one common factor in the Singapore asset markets. Our results are different from the earlier findings by Mei and Lee (1994), which show that the three market factors, inclusive of real estate market risk factor, contain sufficient market information to explain the price variations in real estate and financial asset classes. Our study shows that the Singapore asset markets are much more integrated than the US asset markets, which may be related to the small market size in Singapore.

## 4.2 Research Data and Sample Period

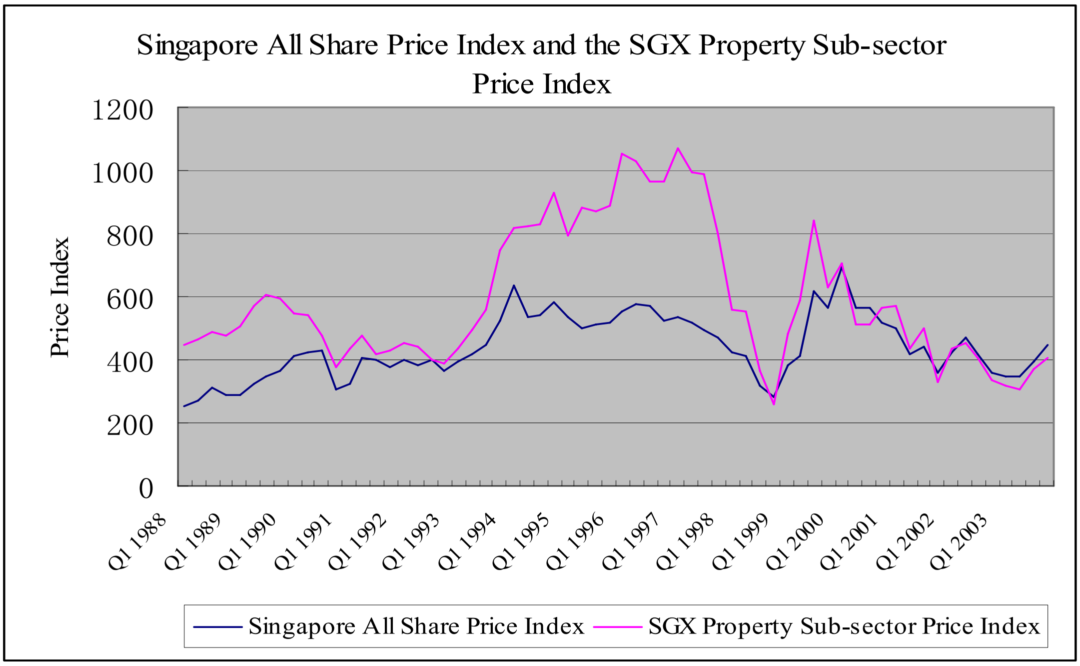
The data consist of quarterly excess returns for five asset markets in Singapore: the overall stock market, the property stock market, the bond market, the industrial real estate market and commercial real estate market. The sample period from 1988Q2 to 2003Q4 is dictated by the availability of the long-term government bond data.

The All-share Price Index (ALLSTOCK) published by the Singapore Exchange (SGX) is used to represent the overall stock market performance. The SGX Property Sub-sector Index (PPYSTOCK) represents the performance of securitized real estate market. These two quarterly indices are obtained from the DataStream. Figure 4.1 displays movements of the Singapore All Share Price Index and the SGX Property Sub-sector Price Index in the past 15 years. From figure 4.1, we notice that the property stock market has the similar pattern with the overall stock markets but it is more volatile than the overall stock market in Singapore.

The 5-year government bond (BOND) representing the performance of the bond market is obtained from the Monetary Authority of Singapore (MAS) database. The quarterly 5-year bond yield ($r_{q,t}$) is a compounded rate, which is calculated from the annualized yield ($r_{a,t}$), using the equation: [$r_{q,t} = (1 + r_{a,t})^{1/4} - 1$].

The quarterly industrial (PPII) and office (PPIC) property price indices that proxy the performance of the industrial and commercial real estate markets are obtained from the Singapore Real Estate Information System (REALIS) provided by the Urban Redevelopment Authority (URA) of Singapore. REALIS contains property price indices estimated using transaction prices of properties based on caveats lodged with

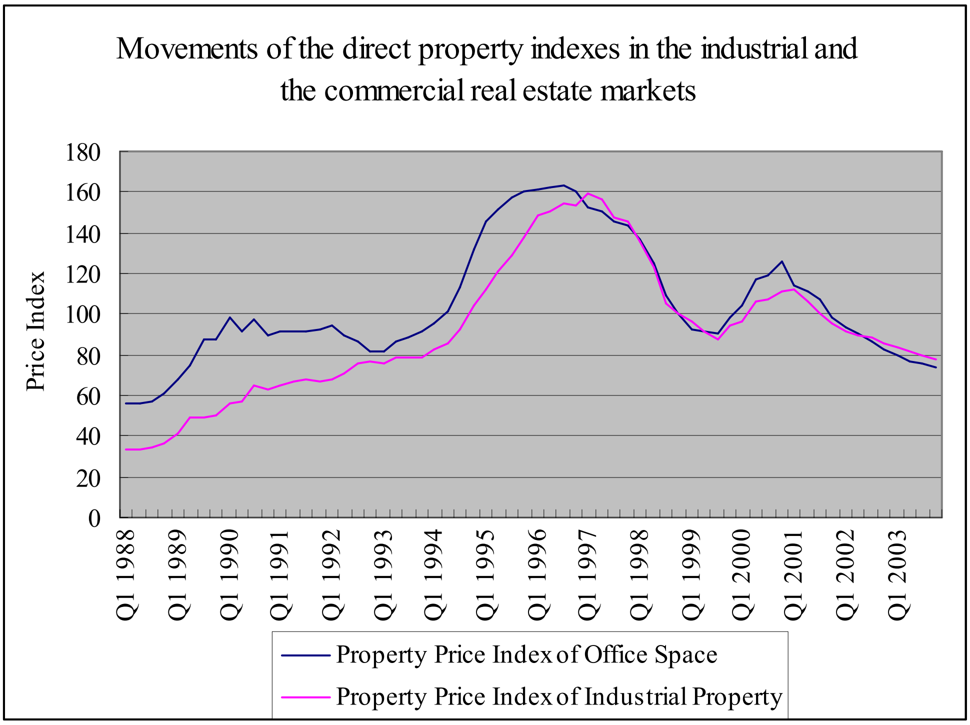
Figure 4.1: Singapore All Share Price Index and the SGX Property Price Index




the Singapore Land Registry. Figure 4.2 provides an indication of the comparative movements of the direct property indexes in the industrial and the commercial real estate markets.

The quarterly returns of the five assets are calculated using the continuous return formula by taking the difference of returns in natural logarithm terms between time $t$ and time $t-1$. The log-quarterly returns are subtracted by the risk-free rate, which is represented by the 3-month Treasury Bill rate ($R_{aq,t}$) published by the MAS, to derive at the excess quarterly returns for the respective asset classes. The quarterly T-Bill yield ($R_{qf,t}$) is a compounded rate, which is calculated from the annualized yield ($R_{aq,t}$) using the same equation for computing the quarterly yield of the 5-year bond. Figure 4.3 exhibits the excess returns of the five asset markets.

Figure 4.2: Movements of the direct property indexes




The forecasting variables used to estimate the unrestricted and the restricted models specified in Equations (14) and (15) are consistent with those widely used in previous studies of conditional risk premiums on asset markets in the US literature. This set of variables includes the real 3-month Treasury-bill (RTBill), the yield spread between the 3-month commercial bill and the 3-month T-bill (DEFAULT), the growth rate in industrial production output (GIP), the term-spread between the 5-year long term government bond yield and the 2-year short term government bond yield (TERM), and the quarterly unexpected inflation rate (UI). These variables are joint proxies for a set of latent variables that determine the asset returns in Singapore markets.

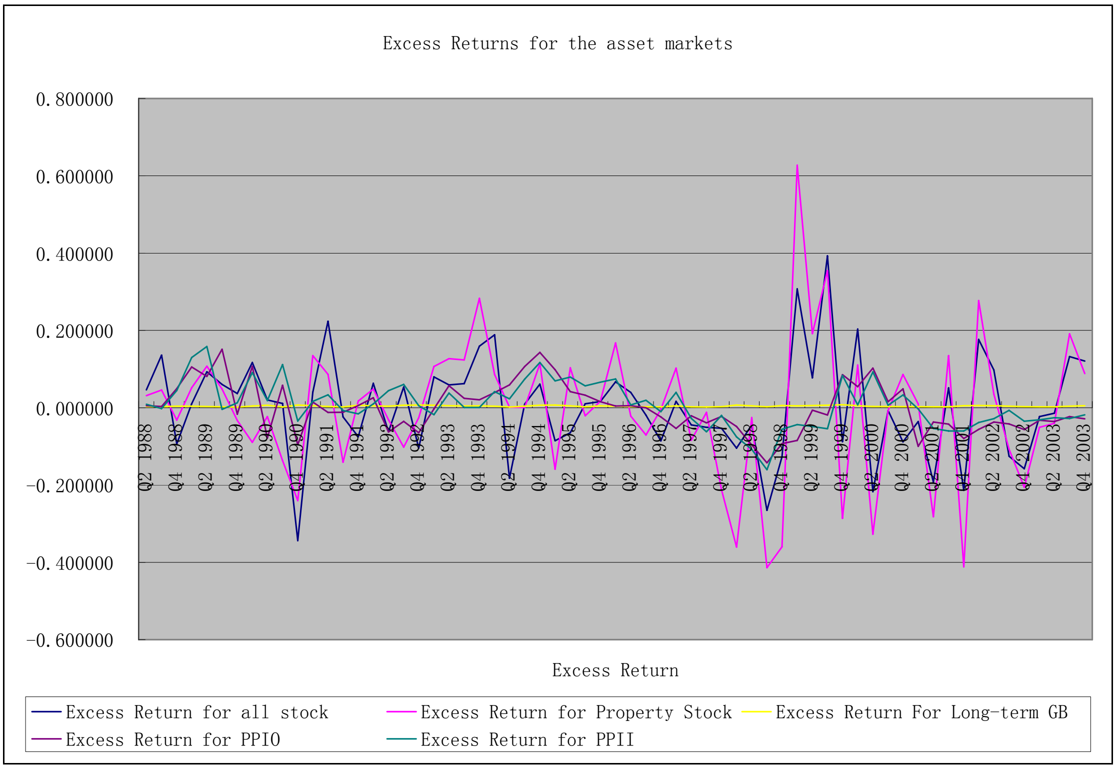
Following Ling and Naranjo (1999), we define the real 3-month Treasury bill rate

(RTBILL) as the difference between the quarterly return on a 3-month T-bill rate and the inflation rate, which is measured by the consumer price index (CPI). The yield spreads between the 3-month commercial bill and the 3-month T-bill proxy the credit risk factor, (DEFAULT), and the yield spreads between the 5-year long term government bond and the 2-year short term government bond reflect the term-structure risk, (TERM). All the yield data are obtained from the MAS database. The growth rate of industrial production, GIP, is defined as the percentage quarterly change in industrial production. The GIP measures the one-quarter lagged change in industrial production. Therefore, we move the GIP data forward by one quarter to represent GIP changes in the same quarter (See Ling and Naranjo, 1999). The quarterly index of industrial production is obtained from the "TREND" (Time Series Retrieval and Dissemination) database by the Department of Statistics, Singapore. The unexpected inflation (UI) is computed as the difference between realized inflation during period $t$ and expected inflation at the beginning of the same period $t$. The expected inflation is calculated using the forecast errors of the first-order moving average process, MA(1).

## 4.3 Descriptive Statistics

Table 4.1 summarizes the descriptive statistics of the excess returns for the five asset market and the forecasting variables. Figure 4.3 plots the excess returns for the five asset markets. For each variable, we report the mean, standard deviation, and the

Figure 4.3: Excess returns for the five asset markets




first order autocorrelation statistics. The industrial real estate has the highest average excess return of 0.8564%, and the risk of this asset measured by the standard deviation is relatively lower than other assets with the exception of the government bond. The property stock exhibits the lowest average excess return with a negative value -0.6447% and the highest volatility 18.3353%. Property stock is the worst performer among the five asset classes. The results are consistent with those reported in Liow (2001). The negative average excess return of the commercial real estate market was partly caused by the weak economic condition in Singapore in the post 1997 financial crisis periods. Bond is the safest investment with the lowest risk volatility of 0.1659%.

Table 4.1: Summary Statistics

*A) Historical Trends*

| Variable | Mean | S.D. | $P_1$ |
|---|---|---|---|
| *a) Dependent Variables* | | | |
| • Excess return on All Sing-Equities (ALLSTOCK) | 0.3976 | 13.0639 | -0.038 |
| • Excess return on All Property Equities (PPYSTOCK) | -0.6447 | 18.3353 | -0.029 |
| • Excess return on government bond (BOND) | 0.4187 | 0.1659 | 0.327 |
| • Excess return on industrial real estate market (PPII) | 0.8564 | 5.8202 | 0.565 |
| • Excess return on commercial real estate market (PPIC) | -0.0545 | 6.3205 | 0.510 |
| *b) Independent Variables* | | | |
| • Real Yield on 3-month T-bill (RTBILL) | 0.1021 | 0.4051 | 0.427 |
| • Yield spread between long and short term bond (TERM) | 0.2370 | 0.0952 | 0.687 |
| • Yield spread between T-bill and commercial bill (DEFAULT) | 0.2136 | 0.2117 | 0.732 |
| • Growth rate of Industrial Production (GIP) | 0.0177 | 0.0370 | 0.329 |
| • Unexpected Inflation (UI) | 0.2877 | 0.8429 | 0.440 |

*S.D. denotes standard deviation* *$P_1$ denotes first order autocorrelation statistics*

*B) Correlations between Excess Asset Returns*

| | ALLSTOCK | PPYSTOCK | BOND | PPII | PPIC |
|---|---|---|---|---|---|
| ALLSTOCK | 1 | 0.8006 | 0.1266 | 0.1406 | 0.1921 |
| PPYSTOCK | | 1 | 0.0980 | 0.1237 | 0.1396 |
| BOND | | | 1 | 0.0327 | -0.0390 |
| PPII | | | | 1 | 0.7442 |
| PPIC | | | | | 1 |

*C) Correlations between Forecasting Variables*

| | RTBILL | TERM | DEFAULTR | GIP | UI |
|---|---|---|---|---|---|
| RTBILL | 1 | -0.2833 | -0.0149 | -0.0816 | -0.8548 |
| TERM | | 1 | -0.3921 | 0.3211 | 0.0699 |
| DEFAULTR | | | 1 | -0.0439 | 0.1137 |
| GIP | | | | 1 | 0.0631 |
| UI | | | | | 1 |

Table 4.1 also shows the correlations of excess returns between the five assets. A high correlation between the overall stock return and the property stock return is observed, which is consistent with the results in the previous studies (Liow, 1998 and 2001, Sing and Sng, 2003). There is also a strong correlation between the industrial

real estate market and the commercial real estate market. However, the evidence of pair-wise correlationship between the two real estate asset returns is not sufficed to draw any conclusion on whether the two direct real estate sub- markets share the same common risk factors. We will use the restricted model to test whether the industrial real estate market and the commercial real estate market are integrated. The two private real estate series have high autocorrelation statistics of 0.565 and 0.510. The GMM methodology is used to reduce the autocorrelation in the analysis. The bond market has low correlations with the other four asset markets. The correlations between the forecasting variables are also relatively weak.

## 4.4 GMM Regression Results

Table 4.2 reports the regression results of excess returns on the five forecasting variables and a constant term. In order to reduce the autocorrelation, we add a lag term into the industrial and commercial real estate market equations. The excess returns of commercial real estate exhibit the most predictable behavior among the five asset classes with an adjusted R-square of 33.9%. The bond's excess return is the least predictable with only 4.0% of the variations in the excess returns explained by the regression.

The predictability of the commercial real estate excess return is dependent on the unexpected inflation rate at a significance level of 10%. The growth rate of industrial production is also significant in explaining the variations in excess returns of commercial real estate at a 5% level. The industrial real estate excess return is dependent on the growth rate of industrial production at a 5% significant level. An increase in industrial production will trigger new demand for industrial, warehouse and office space, which will in turn improve the rental and price performance of industrial and office properties. It is interesting to note that different forecasting variables are incorporated in the excess return generating processes for industrial and commercial real estate assets. The lagged term $r_i$ are also significant for the industrial and commercial real estate excess returns at a 5% significance level. The lagged terms reduce the autocorrelation within the transaction data as shown by the Durbin-Watson statistics 2.077 and 2.015 for the two markets respectively. The excess returns from time $t$ to time $t+1$ on the industrial and commercial real estate markets are dependent on the previous excess returns.

The predictability of the property stock is dependent on most of the forecasting variables except the yield spread between the long and short term government bond. The constant, the real 3-month Treasury bill, the growth rate of industrial production, and the unexpected inflation, are the significant forecasting variables at 5% level. The yield spread between the 3-month Treasury bill and the 3-month commercial bill is the significant variable at the 10% level. The predictability of the all-stock excess returns is dependent on the forecasting variables: the real 3-month Treasury bill, the growth rate of industrial production, and the unexpected inflation, at a 5% significance level. There is the evidence that the property stock market is partial integrated with the all-stock market, which is a different finding with the conclusion in the previous studies in Singapore asset markets. The negative signs for the real 3-month T-bill variable suggest that both the overall stock and the property stock were poor hedges against inflation, and their returns react inversely with the unexpected inflation changes. The GIP risk factor explains the variations in the property stock, the overall stock, the industrial and the commercial real estate markets.

For bonds, the excess return variations are explained by the zero-beta and the term structure risk factors. A 1% increase in the spread between the government 5-year bond yield and the government 2-year bond yield will cause the excess bond return to increase by 0.454%. Mei & Lee (1994) also reported significant positive relationship between term structure risk premium and the bond returns. With the different responses to the forecasting variables, the bond market is expected to exhibit little evidence of integration with other asset markets in Singapore.

## 4.5 Common Latent Risk Factors

Table 4.3 reports the regression results of the excess asset returns on the forecasting variables based on the restricted model (12) with imposed restriction in Equation (13). In the one-factor model, [$k=1$], the null hypothesis is that all asset returns are driven by one systematic risk factor, which is assumed to be latent in the performance of one of the asset markets. We normalize the beta for the asset markets to unity. If the null hypothesis is not rejected, the beta will be significantly captured in

**Table 4.2: Results of Regressions that Predict the Unrestricted Excess Returns of Five Asset Classes**

Model: $r_{i,t+1} = \phi_1 Cons. + \phi_2 RTBILL_t + \phi_3 TERM_t + \phi_4 DEFAULT_t + \phi_5 GIP_t + \phi_6 UI_t + \tilde{\varepsilon}_i$

$$r_{i,t+1} = \phi_1 Cons. + \phi_2 RTBILL_t + \phi_3 TERM_t + \phi_4 DEFAULT_t + \phi_5 GIP_t + \phi_6 UI_t + r_{i,t} + \tilde{\varepsilon}_i$$

| Asset Market | Costant | RTbill | Term | Default | GIP | UI | $r_i$ | $R^2$ | Adjusted $R^2$ | DW |
|---|---|---|---|---|---|---|---|---|---|---|
| Allstock | 5.372 | -20.981* | -6.358 | -0.618 | 110.738* | -9.188* | | 0.183 | 0.110 | 2.013 |
| | (1.412) | (-3.797) | (-0.559) | (-0.187) | (3.170) | (-3.511) | | | | |
| Ppystock | 12.045* | -36.154* | -19.650 | -9.409** | 142.982* | -15.319* | | 0.214 | 0.144 | 2.065 |
| | (2.203) | (-4.441) | (-1.140) | (-1.869) | (2.652) | (-4.490) | | | | |
| Bond | 0.283* | 0.009 | 0.454** | 0.119 | 0.580 | -0.031 | | 0.118 | 0.040 | 1.772 |
| | (3.770) | (0.114) | (1.945) | (1.251) | (1.355) | (-0.870) | | | | |
| PPII | -1.444 | -0.034 | 1.350 | 3.809 | 20.144* | 1.647 | 0.410* | 0.360 | 0.290 | 2.077 |
| | (-0.808) | (-0.013) | (0.248) | (1.555) | (2.279) | (1.184) | (4.025) | | | |
| PPIC | -1.995 | -1.180 | 1.125 | 1.463 | 41.262* | 2.074** | 0.324* | 0.404 | 0.339 | 2.015 |
| | (-0.935) | (-0.444) | (0.177) | (0.659) | (2.234) | (1.682) | (3.198) | | | |

***J-statistic = 0.253***

** Indicates significance level at 5%; ** indicates significance level at 10%.*

*The above results are based on the Simultaneously regressions of quarterly excess returns on each asset market at time $t+1$ on independent variables, which include the real 3-month T-bill yield, the yield spread between the long and the short term government bond, yield spread between the 3-month T-bill and the 3-month commercial bill, the growth rate of the industrial production and the unexpected inflation rate at time $t$ using the equation (6). The sample period is 1988Q2-2003Q4. Regression coefficients are given by the first line of each row, while the t-statistics are given in parentheses in the second row.*

other asset betas that reflect the ratio of time-varying excess returns of other assets to that of the benchmark asset market.

We use each of the five asset markets as the benchmark asset market and get the results in Table 4.3. The statistics of the chi-square test on the restriction in Equation (13) are the same according to the same J-statistic value. The P-value of 0.710 indicates that the null hypothesis for the one-factor model is not rejected at 10% significance level, which implies that the time-varying excess returns for assets in the five markets are driven by the same information set in Singapore. In other words, the Singapore asset markets are efficient as one of the five asset markets holds all the information in the markets. The result implies that investors obtain no diversified benefits by investing in the different asset markets.

The β for the different asset markets are also examined. The bond market beta is not significantly different from zero, which implies that though there is only one information set which can be captured by any of the five asset markets in Singapore, the bond market is unique, which may have special feature that is different from the other four asset markets.

The industrial real estate market beta is significant only when the benchmark asset market is the commercial real estate market, which implies that the industrial real estate market is integrated with the commercial real estate market. When the benchmark asset markets are the all-stock market and the property stock markets, the commercial real estate market beta are also significant at the 5% significance level. We can say that there is the same information set within the stock market and the

Table 3: Estimation Results for Multi-factor Latent Variable Models

$$E_t[\tilde{r}_{i,t+1}] = \sum_{k=1}^{K} \beta_{ik} \sum_{n=1}^{L} \theta_{kn} X_{nt} = \sum_{n=1}^{L} \alpha_{in} X_{nt} \qquad (4)$$

$$\alpha_{ij} = \sum_{k=1}^{K} \beta_{ik} \theta_{kn} \qquad (5)$$

*A. The number of systematic factors in the economy equals one (K=1) with the all-stock market as the benchmark asset market*

| | $\beta_{i1}$ | S.D. | t-statistic |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on All Sing-Equities (ALLSTOCK) | 1.000 | - | |
| Excess return on All Property Equities (PPYSTOCK) | 1.567* | 0.168 | 9.320 |
| Excess return on government bond (BOND) | 0.001 | 0.006 | 0.883 |
| Excess return on industrial real estate market (PPII) | 0.084 | 0.058 | 1.450 |
| Excess return on commercial real estate market (PPIC) | 0.178* | 0.065 | 2.759 |
| $\chi^2$-statistic of the restriction in equation (5): | 16.109(DF=20) | | |
| Significant level: | P=0.710 | | |

*B. The number of systematic factors in the economy equals one (K=1) with the property stock market as the benchmark asset market*

| | $\beta_{i1}$ | S.D. | t-statistic |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on All Property Equities (PPYSTOCK) | 1.000 | - | |
| Excess return on All Sing-Equities (ALLSTOCK) | 0.638* | 0.068 | 9.320 |
| Excess return on government bond (BOND) | 0.001 | 0.004 | 0.883 |
| Excess return on industrial real estate market (PPII) | 0.053 | 0.036 | 1.493 |
| Excess return on commercial real estate market (PPIC) | 0.114* | 0.041 | 2.778 |
| $\chi^2$-statistic of the restriction in equation (5): | 16.109(DF=20) | | |
| Significant level: | P=0.710 | | |

*C. The number of systematic factors in the economy equals one (K=1) with the bond market as the benchmark asset market*

| | $\beta_{i1}$ | S.D. | t-statistic |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on government bond (BOND) | 1.000 | - | |
| Excess return on All Sing-Equities (ALLSTOCK) | 1161.087 | 7857.822 | 0.148 |
| Excess return on All Property Equities (PPYSTOCK) | 1819.282 | 12347.66 | 0.147 |
| Excess return on industrial real estate market (PPII) | 97.104 | 685.008 | 0.142 |
| Excess return on commercial real estate market (PPIC) | 207.137 | 1142.343 | 0.144 |
| $\chi^2$-statistic of the restriction in equation (5): | 16.109(DF=20) | | |
| Significant level: | P=0.710 | | |

*D. The number of systematic factors in the economy equals one (K=1) with the industrial real estate market as the benchmark asset market*

| | $\beta_{i1}$ | S.D. | t-statistic |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on industrial real estate market (PPII) | 1.000 | - | |
| Excess return on All Sing-Equities (ALLSTOCK) | 11.957 | 8.248 | 1.450 |
| Excess return on All Property Equities (PPYSTOCK) | 18.736 | 12.550 | 1.493 |
| Excess return on government bond (BOND) | 0.010 | 0.073 | 0.142 |
| Excess return on commercial real estate market (PPIC) | 2.133* | 0.888 | 2.401 |
| $\chi^2$-statistic of the restriction in equation (5): | 16.109(DF=20) | | |
| Significant level: | P=0.710 | | |

*E. The number of systematic factors in the economy equals one (K=1) with the commercial real estate market as the benchmark asset market*

| | $\beta_{i1}$ | S.D. | t-statistic |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on commercial real estate market (PPIC) | 1.000 | - | |
| Excess return on All Sing-Equities (ALLSTOCK) | 5.605* | 2.032 | 2.759 |
| Excess return on All Property Equities (PPYSTOCK) | 8.783* | 3.161 | 2.779 |
| Excess return on government bond (BOND) | 0.005 | 0.034 | 0.144 |
| Excess return on industrial real estate market (PPII) | 0.469* | 0.195 | 2.402 |
| $\chi^2$-statistic of the restriction in equation (5): | 16.109(DF=20) | | |
| Significant level: | P=0.710 | | |

* *Indicates significance level at 5%;*

commercial real estate market. In other words, the performance of the commercial real estate market is influenced by that of stock markets. When the benchmark asset market is the commercial real estate market, the beta for the all-stock market, the property stock market and the industrial real estate market are all significant at the 5% significance level, which implies that the commercial real estate market can reflect most of the information in both the stock markets and the direct real estate markets. We find that the betas are not significant in any of the asset markets when we normalize the beta of the bond market into 1. Therefore, the bond market cannot capture all the information in the asset markets. Investors can not diversify all the systematic risks when investing only in the bond markets.

The result is different from the findings in Mei and Lee (1994), which indicates that there are three common factors in the US markets. Whereas, in Singapore asset markets, we find that there is only one information set which can capture all the information in the asset markets. This can be explained by the relative scale of the Singaporean market in comparison to the US. The relative importance of the real estate sector on the general Singapore economy is also naturally going to feed through into the broad equity market to a degree not seen in many markets. Based on the results, investors can adequately capture all market risk premiums by investing in any one of the five asset markets. But considering the significance of the beta, investors should pay attention to the bond market as it can neither be reflected by the performance of other asset markets significantly, nor can it explain the performance of the other asset markets. Therefore, it has unique characteristic that investors should pay attention to when allocating their portfolio. According to Mei & Lee (1994)'s assumption, the results suggest that the direct real estate markets and the financial asset markets are integrated in Singapore.

## 4.6 Summary

In this chapter, we employ the multi-factor latent variable model of Mei and Lee (1994) to test the predictability of the five asset markets and also to examine whether there are common risk premiums in the five asset markets in Singapore. Our results are different from the earlier findings by Mei and Lee (1994) on the US asset markets. We find that there is only one information set which contains sufficient market information to explain the excess returns of the direct real estate markets and the financial asset classes.

In our study, five asset classes: overall-stock, property stock, bond, commercial real estate and industrial real estate, are included. The excess return in the commercial real estate market is the most predictable with the highest adjusted R-square of 0.339. Two macro-variables: growth rate of the industrial production and unexpected inflation are both significant in the commercial real estate model. The predictability of the excess returns in the overall-stock market is dependent on macro-economic variables, such as: real T-bill rate (RTbill), growth in industrial production (GIP) and unexpected inflation (UI). The predictability of the property stock is dependent on all the forecasting variables except the yield spread between the long and short term government bond.

We also test the models with different common risk factors. Unlike in Liu and Mei (1992), we could not reject the null hypothesis that there is only one information set in the five asset markets, which suggests that investors can capture all risk premiums in one asset market in Singapore. But the beta of the bond market is not significant in all the tests, which suggests that investors should still pay attention to the unique characteristic and special performance of the bond market.

By examing the coefficient corresponding to the macro-variables, we can see that there is partial integration within the overall-stock market and the property stock market. The property stock market is also partially integrated with the direct real estate markets, especially the commercial real estate market. The industrial real estate market is somewhat integrated with the commercial real estate markets. In another word, we can say that, the commercial real estate market is influenced by both the industrial real estate market and the stock market risks.

# Chapter 5

# Risk Premiums and Time-Varying Returns of Securitized Real Estate Markets in Asia-Pacific Countries

## 5.1 Introduction

In this chapter, we test the risk premiums and the excess returns of the securitized real estate markets in six Asia-Pacific countries: Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore.

The skewness risk is also tested in this chapter using Kraus and Litzenberger (1976) three-moment capital asset pricing model. Using the GMM method, we also find evidence that the skewness factor has a strong explanatory power on the variation of the excess returns on the property stock markets in all six Asia-Pacific countries. When including the gamma factor into the multifactor models, the R-square increases dramatically, which indicates that the skewness risk should be considered when constructing a portfolio with securitized real estate assets. We then test the common information using the multifactor latent-variable model. We find that there is only one common information set in the six property stock markets. Therefore, the securitized real estate markets are integrated in the Asia-Pacific countries.

## 5.2 Data and Sample Period

The data consist of monthly excess returns of the securitized real estate markets in the six Asia-Pacific countries: Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore. The sample period from Jan 1995 to Nov 2004 is dictated by the availability of the gross domestic product (GDP) data of each country. In order to construct the $\beta_{it}$ and $\gamma_{it}$ as the proxy for the variance and skewness risk factor of the securitized real estate market, we need the price indices of the overall stock markets in all the countries. We get the monthly overall stock indices and the property stock indices of each country from the DataStream which is a company providing data in the financial markets. Figure 5.1 shows the movements of the price indices of the securitized real estate markets in six Asia-Pacific countries. From Figure 5.1, we can see that the Australia securitized real estate market displays a unique moving pattern where the price index drifts up continuously. For other Asian countries, the price indices went down dramatically in 1997 following the financial crisis. The Japanese market is not as volatile as the other five markets. The Singapore, Malaysia and Philippine markets have the similar moving trends during the past 10 years. Empirical tests will be conducted examining whether there is common information within the six property stock markets.

In order to have a consistent data set in the study, we use the interbank 3-month middle rate of each country as the risk free rate, which is converted to the monthly rate from the annualized rate ($r_{a,t}$), using the equation: [$r_{m,t} = (1 + r_{a,t})^{1/12} - 1$]. The monthly returns of the twelve assets, property stock assets and the overall stock assets

Figure 5.1 Movements of the price indices of the securitized real estate markets

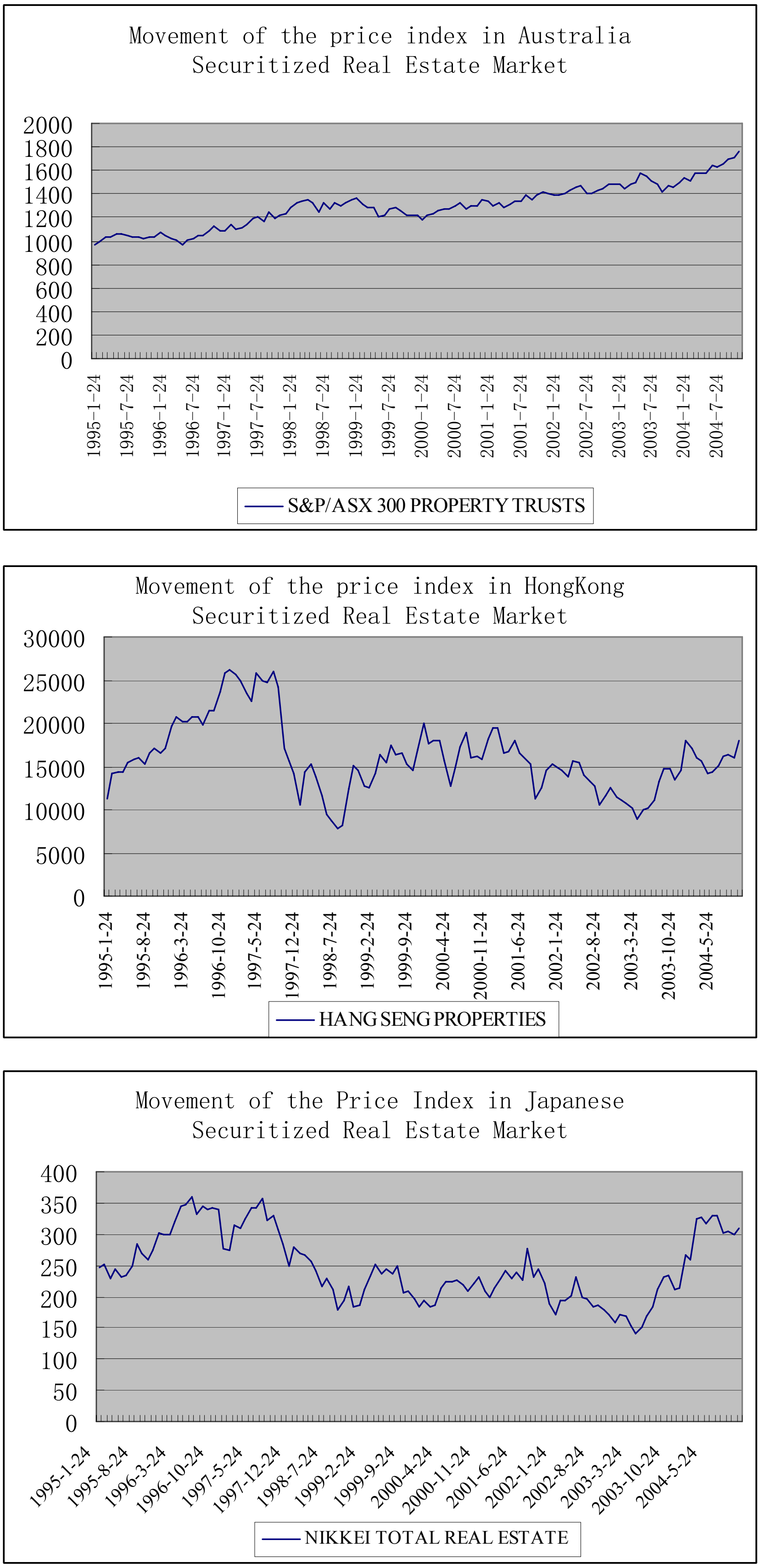
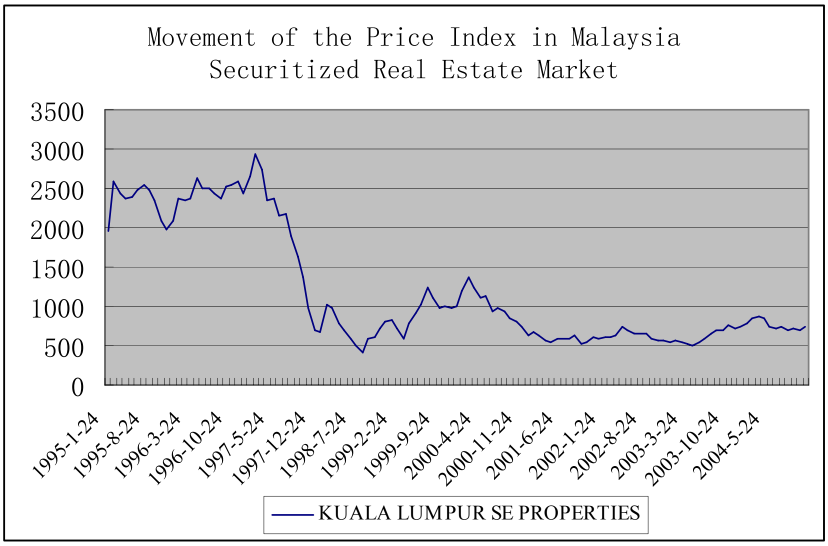
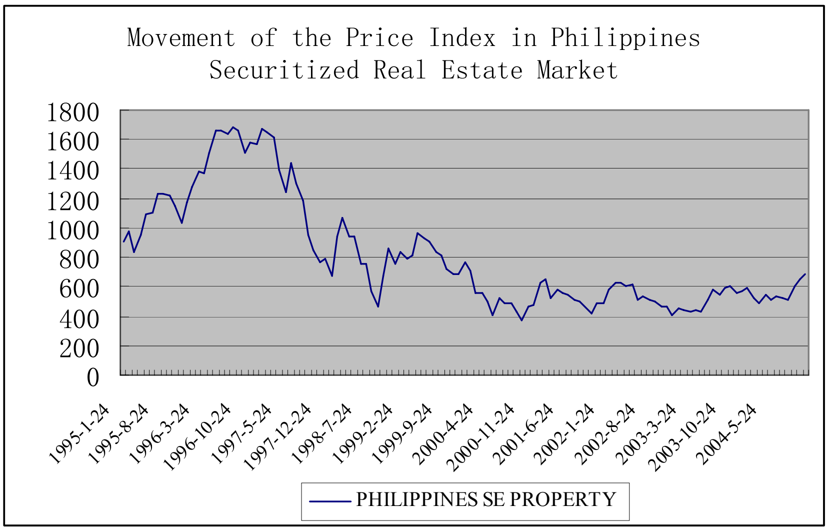
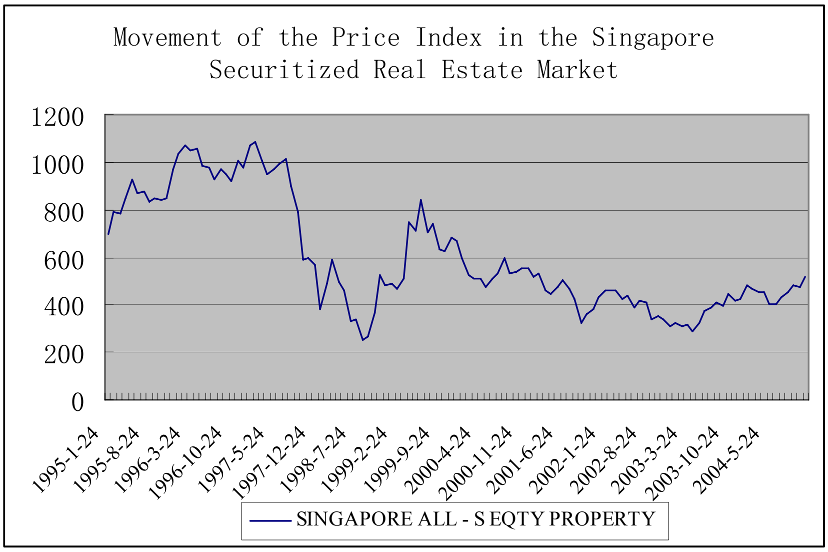


Fig. 5.1 (Continued)



in the six countries, are calculated using the continuous return formula by taking the difference of returns in natural logarithm terms between time $t$ and time $t-1$. The log-monthly returns are subtracted by the risk-free rate, which is represented by the interbank 3-month middle rate ($r_{m,t}$) to derive at the excess monthly returns for the respective asset classes. The time-series beta and gamma of each property stock index are calculated following the equation (7) and equation (8) in chapter 3.

The interbank 3-month middle rate ($r_{m,t}$) is a proxy for the risk-free interest rate which is a macroeconomic indicator used as one of the forecasting variables. Following Ling and Naranjo (1999), the inflation rate is the second macroeconomic variable, which is measured by the consumer price index (CPI) using the continuous return formula by taking the difference in natural logarithm terms between time $t$ and time $t-1$. We can also get the 3-month middle rate, CPI data from the DataStream and the EIU database directly.

Due to the availability of the data in the long-term and short-term government bond and the commercial bond, it's difficult to construct the yield spread as the default risk and the term-structure. Therefore, we don't include these two variables in the cross-region research.

Gross domestic product (GDP) is a macroeconomic variable which is often used in the financial multifactor models. The impacts of local market fundamentals on property stock markets are affected by the local demand. The level of economic activity as measured by GDP growth determines commercial and residential space demand which would influence the securitized real estate market performance. GDP data are only available in the quarterly data basis, and the moving average method is used to convert GDP into the monthly data.

To measure the impacts of globalization on rates of return, openness as defined in Bardhan *et al.* (2003, working paper) is used, which can be defined as (Export+Import)/GDP. If this variable is significant, it means that the property stock market is influenced by the economic activities of other countries. In other words, the performance of the property stock markets may be influenced by the business interaction with other countries. We also get the monthly data of export and import in each country from the DataStream.

## 5.3 Descriptive Statistics

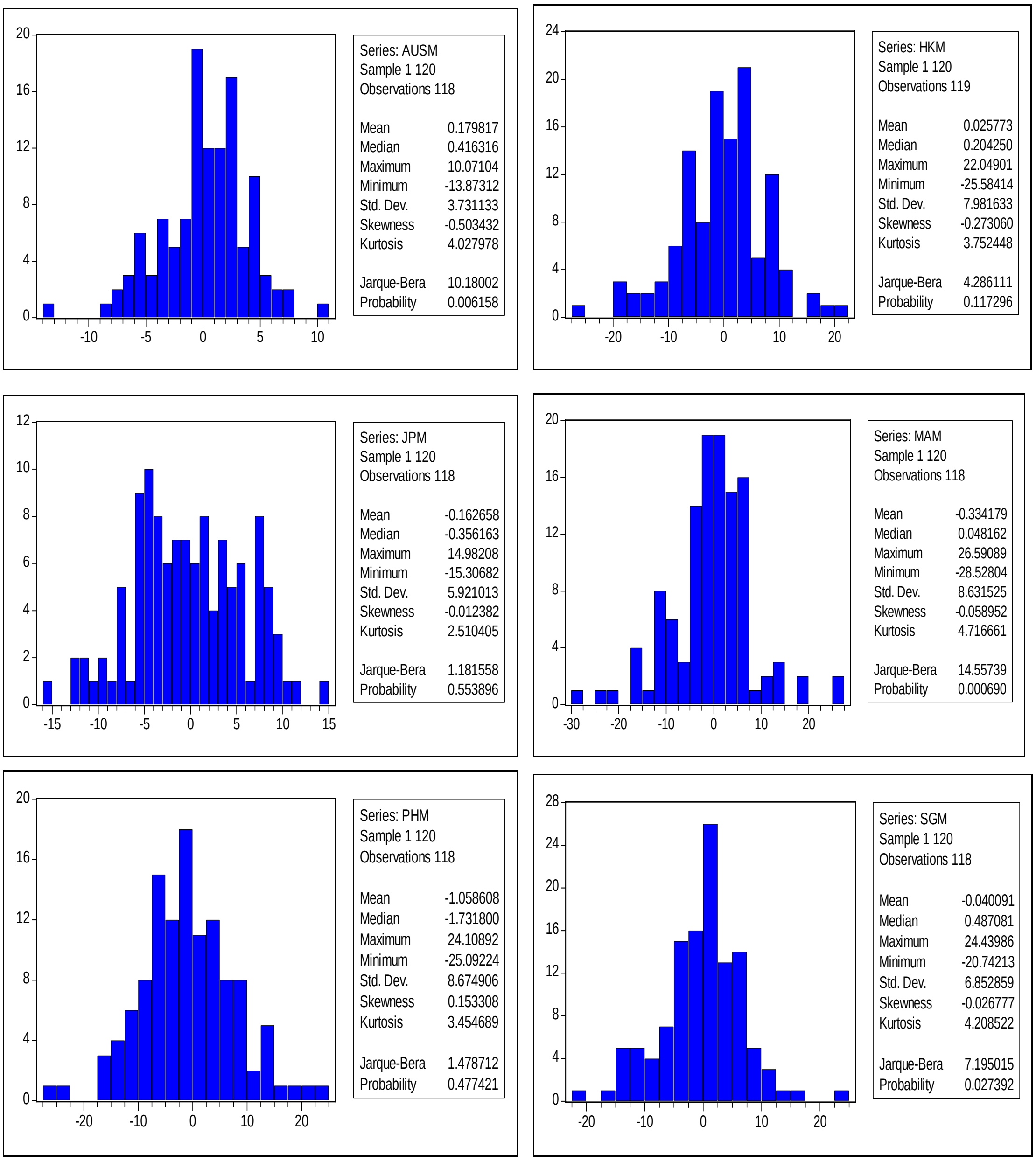
Table 5.1 summarizes the descriptive statistics of the excess returns of the overall stock market performance. Among the six countries, the Australia stock market exhibits the highest return 0.1798 and the lowest standard deviation of 3.7311, followed by the Hong Kong stock market with the positive return 0.0258. The other four market portfolios exhibit negative average returns with the lowest return of -1.0586 in the Philippines overall stock market. The Philippines stock market also has the highest risk of 8.6749, which means that the Philippines stock market is the most volatile one among the six stock markets. It is also the only one stock market, which has the positive skewness in the past 10 years. The Japanese stock market has the smallest autocorrelation of 0.034 in the excess returns, which implies that the

Table 5.1: Statistics for the excess return on the market portfolio of each country:

| Country | Mean | S.D | $P_1$ | Skewness |
|---|---|---|---|---|
| Australia | 0.1798 | 3.7311 | -0.233 | -0.5034 |
| Hong Kong | 0.0258 | 7.9816 | 0.156 | -0.2731 |
| Japan | -0.1627 | 5.9210 | 0.034 | -0.0124 |
| Malaysia | -0.3342 | 8.6315 | 0.266 | -0.0590 |
| Philippines | -1.0586 | 8.6749 | 0.109 | 0.1533 |
| Singapore | -0.0401 | 6.8529 | 0.040 | -0.0268 |

*S.D. denotes standard deviation* *$P_1$ denotes first order autocorrelation statistics*

Figure 5.2: The statistic summary of the excess returns of stock markets in the six countries



Japanese stock market is more efficient than the other five stock markets. From figure 5.2, we can see that except for positive skewness in excess returns in Philippines overall stock market, which means the distribution is left skewed, the other five overall stock markets are all negative skewed. We will test for the signs for $b_2$ in the three moment model and the multi-factor model in the following sections.

Table 5.2 summarizes the descriptive statistics for the excess returns of the property stock market in the six countries. Except for the Australia securitized real estate market, the other five property stock markets show higher volatilities than those in overall stock markets. The most volatile property stock market is in Philippines with a standard deviation of 11.8530. Australia property stock market continues to exhibit the better performance with an average excess return of 0.0405 and the lowest standard deviation of 2.6581. In Hong Kong property stock market shows a negative average excess return of -0.0852. In contrary, the property stock market in Japan exhibits a positive average excess return of 0.1548 from 1995 till 2004. The autocorrelation estimates for the property stocks were close to the results estimated for the overall stock markets. The skewness for the Philippines property stock market is still positive, and the same positive skewness is also found in the property market in Hong Kong and Malaysia. Figure 5.3 exhibits the movements of the excess returns in the six Asia-Pacific countries. We can see that the excess returns move closely with each other. However, the property stock market in Australia is not as volatile as others.

Table 5.3 reports the summary statistics for the time-series beta and gamma on

Table 5.2: Statistics for the excess return on the property stock indices of each country:

| Country | Mean | S.D | $P_1$ | Skewness |
|---|---|---|---|---|
| Australia | 0.0405 | 2.6581 | -0.205 | -0.2877 |
| Hong Kong | -0.0852 | 11.5667 | 0.156 | 0.0094 |
| Japan | 0.1548 | 8.4525 | -0.056 | -0.0123 |
| Malaysia | -1.2360 | 11.5649 | 0.250 | 0.2992 |
| Philippines | -1.0775 | 11.8530 | -0.018 | 0.3883 |
| Singapore | -0.3749 | 11.7300 | 0.040 | -0.0844 |

*S.D. denotes standard deviation* *$P_1$ denotes first order autocorrelation statistics*

Figure 5.3 Movements of the excess returns in the six Asia-Pacific countries

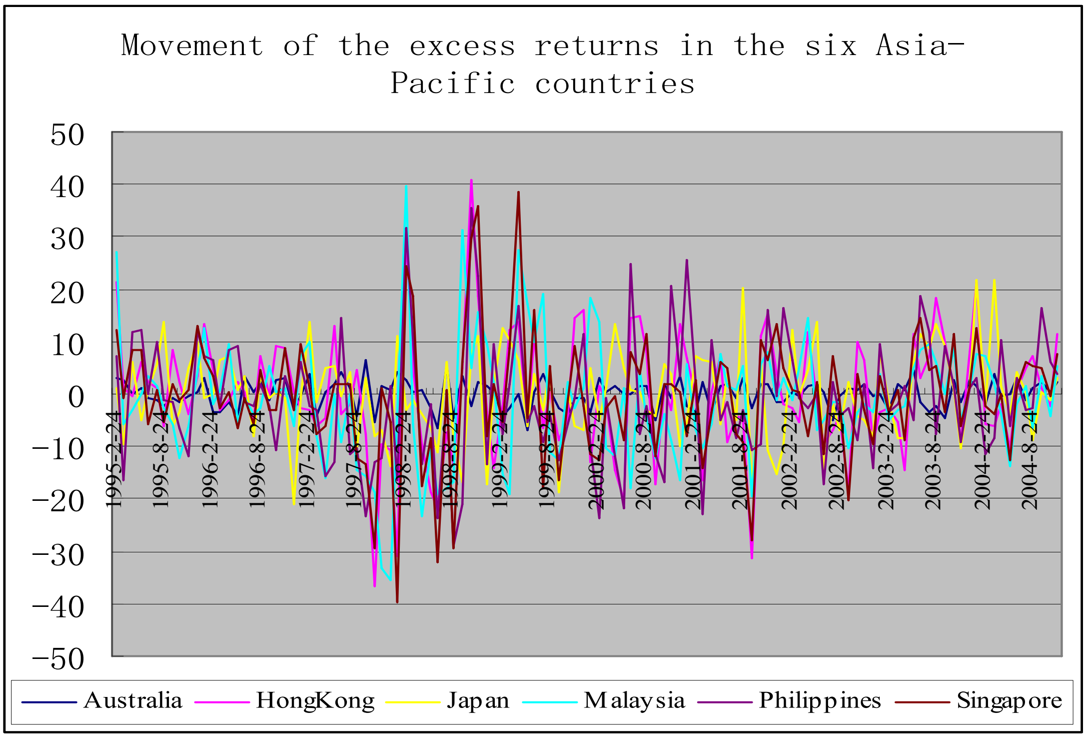



Table 5.3: Statistics for the time-series beta and gamma on the property stock indices of each country:

| Country | Mean of Beta | Mean of Gamma | Correlation between beta & gamma |
|---|---|---|---|
| Australia | 0.3085 | 0.4294 | 0.5086 |
| Hong Kong | 1.2919 | 1.0496 | 0.1820 |
| Japan | 0.7617 | 4.7169 | 0.3101 |
| Malaysia | 1.1361 | -4.5760 | -0.4544 |
| Philippines | 1.2375 | 1.9027 | 0.2588 |
| Singapore | 1.5181 | 0.4369 | -0.2409 |

Table 5.4: Statistics for the forecasting variable of each country:

| Country | Variables | Mean | S.D |
|---|---|---|---|
| Australia | AUSGDP | 16.012 | 2.795 |
| | AUSINF | 2.674 | 1.688 |
| | AUSINT | 0.470 | 0.086 |
| | AUSOPEN | 10.772 | 0.868 |
| Hong Kong | HKGDP | 3.122 | 0.193 |
| | HKINF | 0.022 | 0.572 |
| | HKINT | 0.391 | 0.240 |
| | HKOPEN | 8.403 | 1.226 |
| Japan | JPGDP | 5.284 | 0.184 |
| | JPINF | -0.001 | 0.359 |
| | JPINT | 0.034 | 0.033 |
| | JPOPEN | 14.245 | 1.122 |
| Malaysia | MAGDP | 3.596 | 0.330 |
| | MAINF | 0.200 | 0.291 |
| | MAINT | 0.401 | 0.210 |
| | MAOPEN | 1.338 | 0.267 |
| Philippines | PHGDP | 2.380 | 0.242 |
| | PHINF | 0.502 | 0.493 |
| | PHINT | 0.835 | 0.279 |
| | PHOPEN | 9.435 | 3.014 |
| Singapore | SGGDP | 3.596 | 0.330 |
| | SGINF | 0.070 | 0.231 |
| | SGINT | 0.120 | 0.066 |
| | SGOPEN | 9.701 | 1.137 |

the property stock indices of each country. We constructed beta and gamma according to the equation (7) and equation (8) in chapter 3. We put the mean value of the beta and gamma and their correlation in table 5.3. The correlations between the beta and gamma are tested to avoid any spurious problem when running the regression of excess returns on beta and gamma in the property stock markets. The highest correlation between the beta and gamma is 0.5086 in the property stock market in Australia. The property stock market in Australia exhibits the lowest beta 0.3085

Table 5.5: Correlation between the forecasting variables of each country:

Australia:

| | AUSGDP | AUSINF | AUSINT | AUSOPEN | AUSPGAMMA |
|---|---|---|---|---|---|
| AUSGDP | 1 | 0.107 | -0.556 | 0.181 | -0.0171 |
| AUSINF | | 1 | 0.387 | 0.343 | 0.031 |
| AUSINT | | | 1 | -0.212 | 0.115 |
| AUSOPEN | | | | 1 | -0.050 |
| AUSPGAMMA | | | | | 1 |

Hong Kong:

| | HKINF | HKGDP | HKINT | HKOPEN | HKPGAMMA |
|---|---|---|---|---|---|
| HKINF | 1 | -0.167 | 0.1877 | 0.003 | -0.217 |
| HKGDP | | 1 | 0.162 | -0.026 | -0.175 |
| HKINT | | | 1 | -0.6101 | -0.238 |
| HKOPEN | | | | 1 | -0.089 |
| HKPGAMMA | | | | | 1 |

Japan:

| | JPGDP | JPINF | JPINT | JPOPEN | JPPGAMMA |
|---|---|---|---|---|---|
| JPGDP | 1 | 0.014 | -0.677 | 0.857 | 0.058 |
| JPINF | | 1 | -0.013 | 0.148 | 0.101 |
| JPINT | | | 1 | -0.540 | -0.072 |
| JPOPEN | | | | 1 | 0.073 |
| JPPGAMMA | | | | | 1 |

Malaysia:

| | MAINF | MAGDP | MAINT | MAOPEN | MAPGAMMA |
|---|---|---|---|---|---|
| MAINF | 1 | -0.194 | 0.349 | -0.163 | 0.229 |
| MAGDP | | 1 | -0.617 | 0.656 | -0.091 |
| MAINT | | | 1 | -0.644 | -0.078 |
| MAOPEN | | | | 1 | 0.014 |
| MAPGAMMA | | | | | 1 |

Philippines:

| | PHINF | PHGDP | PHINT | PHOPEN | PHPGAMMA |
|---|---|---|---|---|---|
| PHINF | 1 | -0.171 | 0.293 | -0.162 | -0.139 |
| PHGDP | | 1 | -0.711 | 0.865 | -0.021 |
| PHINT | | | 1 | -0.580 | -0.043 |
| PHOPEN | | | | 1 | 0.018 |
| PHPGAMMA | | | | | 1 |

Singapore:

| | SGGDP | SGINF | SGINT | SGOPEN | SGPGAMMA |
|---|---|---|---|---|---|
| SGGDP | 1 | 0.012 | 0.057 | 0.299 | -0.093 |
| SGINF | | 1 | 0.015 | 0.143 | 0.112 |
| SGINT | | | 1 | -0.313 | -0.168 |
| SGOPEN | | | | 1 | 0.009 |
| SGPGAMMA | | | | | 1 |

which shows that the market has the lowest systematic risk and required for lowest return.

Table 5.4 reports the mean and the standard deviation for the forecasting variables of each country. We have rescaled the value of GDP and the value of openness in each country in order to have consistent coefficients during the regression. Table 5.5 shows the correlation between the forecasting variables including the gamma. It obviously that gamma has little correlation with the other macroeconomic variables in all the six countries. The correlation between the GDP and the Openness is higher in Japan, Malaysia and Philippines, which may show that these three countries are more open in terms of their economic activities.

## 5.4 Three-Moment Asset Pricing Model Test

To analyze the skewness risk, regressions of the excess returns on beta and gamma for the property stock indices using the Kraus and Litzenberger (1976) three-moment CAPM model are estimated for each country. The results are reported in Table 5.6. This table, shows that the coefficients for $b_1$ are all significant at 5% level. This finding is consistent with the findings in Kraus and Litzenberger (1976), which shows that the beta was a significant variable after including the gamma into the regression models. This finding shows that the systematic risk according the traditional CAPM is an importation factor in explaining the excess returns.

The results of $b_2$ are all significant at the 5% level. The signs of the coefficient

Table 5.6: Regression of the excess return on beta and gamma for the property indices of each country:

$r_t = b_1\beta_t + b_2\gamma_t$

| Country | $b_1$ | $b_2$ | $R^2$ | Adjusted $R^2$ | DW |
|---|---|---|---|---|---|
| Australia | -72.690* | 52.500* | 0.333 | 0.328 | 2.231 |
| | (-3.996) | (4.051) | | | |
| Hong Kong | -34.794* | 42.802* | 0.594 | 0.591 | 1.905 |
| | (-7.143) | (7.083) | | | |
| Japan | -21.146* | 3.417* | 0.475 | 0.470 | 1.854 |
| | (-4.540) | (4.684) | | | |
| Malaysia | 38.738* | 9.784* | 0.521 | 0.517 | 1.704 |
| | (9.429) | (9.861) | | | |
| Philippines | 49.898* | -33.111* | 0.577 | 0.573 | 2.100 |
| | (5.579) | (-5.816) | | | |
| Singapore | -1.029* | 3.968* | 0.495 | 0.491 | 2.006 |
| | (-2.389) | (5.372) | | | |

*Indicates significance level at 5%;*

*The above results are based on the GMM regression. Regression coefficients are given by the first line of each row, while the t-statistics are given in parentheses in the second row.*

are positive except for that in the Philippines market. This is consistent to the theoretical framework, which dictates that the expected utility function *U(.)* of the three moment Capital Asset Pricing Model is assumed to follow the non-increasing absolute risk aversion utility class, and $U''' > 0$, which implies that investors prefer the positive skewness. $b_2$ will have an opposite sign of the market portfolio. With the exception of the Philippines overall-stock market that is positively skewed, the other five market portfolios are negatively skewed. Therefore, the coefficients of $b_2$ in these five securitized real estate markets are expected to be positive.

The R-square are high for all of the six property stock markets, which show strong explanation power of beta and gamma on the variation of excess returns in these countries. The Hong Kong property stock market has the highest R-square of 0.594. The lowest R-square was estimated in Australia property stock market with a value of 0.333. The GMM technique used allows for both conditional hetroskedasticity and serial correlation in the error terms in the excess return regressions. Hence, the DW values are all around 2 in our cases.

## 5.5 Multi-factor Model Test

Table 5.7 shows the regression of the excess returns on the macroeconomic variables excluding the gamma variable for property indices in the sample markets. The highest R-square of 0.231 is estimated in Malaysia market, whereas the R-square for all other markets are low. The constant, GDP, inflation rate, risk free rate and the openness indicator are all significant variables in the Australia securitized real estate market. However, none of these variables are significant in the Japanese property stock market. The lowest R-square is estimated in the Japanese securitized real estate market with a value of 0.013. The macroeconomic variables, except for the openness factor, exhibit strong explanatory power in Malaysia compared to the results in other countries. The constant, GDP, inflation rate and the risk free rate are all significant at the 5% level in the model for Malaysia property stock market. The Malaysia securitized real estate market is influenced by the local economy strongly. The risk free rate and the openness are significant variables at the 10% level in Hong Kong

Table 5.7: Regression of the excess return on the forecasting variables excluding the gamma for the property indices of each country:

| $r_t = b_0 + b_1 GDP_t + b_2 INF_t + b_3 INT_t + b_4 OPEN_t + \varepsilon_t$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| Country | $b_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $R^2$ | Adjusted $R^2$ |
| Australia | -9.719*<br>(-2.370) | 0.154*<br>(2.248) | -0.321*<br>(-2.459) | 6.418*<br>(2.045) | 0.476**<br>(1.913) | 0.031 | -0.003 |
| Hong Kong | 42.629*<br>(2.189) | -7.133<br>(-1.475) | -2.563<br>(-1.200) | -13.737**<br>(-1.876) | -1.775**<br>(-1.616) | 0.099 | 0.067 |
| Japan | -21.922<br>(-0.714) | 5.797<br>(0.778) | 1.749<br>(1.048) | -6.920<br>(-0.290) | -0.583<br>(-0.501) | 0.013 | -0.022 |
| Malaysia | 60.912*<br>(3.246) | -14.912*<br>(-3.142) | 12.198*<br>(2.343) | -31.089*<br>(-4.316) | 1.147<br>(0.285) | 0.231 | 0.204 |
| Philippines | -30.412<br>(-1.577) | 15.412**<br>(1.706) | 5.604*<br>(2.596) | 0.285<br>(0.046) | -1.103<br>(-1.563) | 0.075 | 0.043 |
| Singapore | 11.628<br>(1.049) | -3.006<br>(-1.295) | 4.205<br>(0.764) | -41.160*<br>(-2.599) | 0.358<br>(0.396) | 0.076 | 0.043 |

* *Indicates significance level at 5%;* ** *indicates significance level at 10%.*

*The above results are based on the GMM regression. Regression coefficients are given by the first line of each row, while the t-statistics are given in parentheses in the second row.*

property stock market. The GDP and the inflation rate are significant at 10% level and the 5% level respectively in Philippines regression model. The risk free rate is the only significant variable in the Singapore property stock market. From table 5.7, we can see that different securitized real estate markets exhibit different relationships with the macroeconomic variables. We will test for the common information set using the latent-variable model later in the following section.

Based on the multi-factor model above, we add a skewness factor into the multi-factor model above to test the risk premium for the skewness. Table 5.8 reports the regression of the excess returns on the forecasting variables including the gamma

Table 5.8 Regression of the excess returns on the forecasting variables including the gamma for the property indices of each country:

| $r_t = b_0 + b_1 GDP_t + b_2 INF_t + b_3 INT_t + b_4 OPEN_t + b_5 GAMMA_t + \varepsilon_t$ | | | | | | | |
|---|---|---|---|---|---|---|---|
| Country | $b_0$ | $b_1$ | $b_2$ | $b_3$ | $b_4$ | $b_5$ | Adjusted $R^2$ |
| Australia | -32.618*<br>(-4.377) | 0.102<br>(1.650) | -0.280*<br>(2.526) | 3.051<br>(1.092) | 0.501*<br>(2.592) | 58.052*<br>(3.614) | 0.365 |
| Hong Kong | -49.202*<br>(-4.125) | -0.145<br>(-0.053) | 0.116<br>(0.108) | 0.510<br>(0.109) | 0.611<br>(0.934) | 42.224*<br>(6.230) | 0.574 |
| Japan | -37.361**<br>(-1.921) | 6.749<br>(1.170) | 0.236<br>(0.171) | 4.289<br>(0.240) | -0.846<br>(-0.847) | 2.919*<br>(4.177) | 0.464 |
| Malaysia | 75.026*<br>(5.753) | -9.566*<br>(-2.803) | 4.737*<br>(2.008) | -19.877*<br>(-3.489) | 0.799<br>(0.282) | 7.842*<br>(10.114) | 0.568 |
| Philippines | 45.381*<br>(2.368) | 7.114<br>(1.238) | 3.285*<br>(3.135) | -2.323<br>(-0.569) | -0.674**<br>(-1.745) | -29.816*<br>(-5.771) | 0.592 |
| Singapore | -1.885<br>(-0.281) | -1.177<br>(-0.661) | -0.290<br>(-0.08) | -18.154<br>(-1.583) | 0.690<br>(1.160) | 2.882*<br>(4.091) | 0.565 |

** Indicates significance level at 5%; ** indicates significance level at 10%.*

*The above results are based on the GMM regression. Regression coefficients are given by the first line of each row, while the t-statistics are given in parentheses in the second row.*

for the property indices in each country. We can see significant increases in the R-square estimates for each country. The coefficients for the gamma are all significant at 5% level. The signs are positive for the skewness factor in all markets, except for the skewness coefficient in Philippines property stock market. The GDP and the risk free rate are no longer significant in the Australia securitized real estate market, which has a better adjusted R-square of 0.365. The risk free rate and the openness are not significant in the Hong Kong market. In the Japanese property stock market, the R-square jumps from 0.013 to 0.464. The constant, the GDP, the inflation rate and the risk free rate remain significant compared to the earlier model that excludes the gamma factor in the Malaysia property stock market. The highest adjusted R-square was found in the Philippines property stock market with a value of 0.592. The risk free rate is not significant after including the gamma into the multifactor model in the Singapore property market.

## 5.6 Common Latent Risk Factors

Table 5.9 reports the regression results of the excess asset returns in securitized real estate markets in relationship to a set of macroeconomic variables including the skewness risk. The regression is based on the restricted model (12) with imposed rank restriction in Equation (13). In the one-factor model, [$k=1$], we assume that all asset returns are driven by one systematic risk factor, which is assumed to be latent in the performance of one of the property stock markets. If k equals to 1, the conclusion is that the property stock markets in the Asia-Pacific countries are integrated. These property stock markets share the same common information within the markets. In order to test the rank restriction, we normalize the beta for the Singapore real estate market. If the null hypothesis is not rejected, the beta will be significantly captured in other asset betas that reflect the ratio of time-varying excess returns of other property stock markets to that of the Singapore property stock market.

The regression results are showed in table 5.9. The statistics of the chi-square test on the restriction in Equation (13) are based on the J-statistic value of 1.07E+10. With the degree of freedom 25, the Chi-square is 16.512. The P-value of 0.899 indicates that the null hypothesis for the one-factor model is not rejected at 10% significance level, which implies that the time-varying excess returns for the securitized real estate

Table 5.9 Estimation Results for Multi-factor Latent Variable Models

$$E_t[\tilde{r}_{i,t+1}] = \sum_{k=1}^{K} \beta_{ik} \sum_{n=1}^{L} \theta_{kn} X_{nt} = \sum_{n=1}^{L} \alpha_{in} X_{nt} \quad (12)$$

$$\alpha_{ij} = \sum_{k=1}^{K} \beta_{ik} \theta_{kn} \quad (13)$$

*The number of systematic factors in the economy equals one (K=1) with the Singapore property stock market as the benchmark market*

| | $\beta_{i1}$ | t-statistic | Adjusted $R^2$ |
|---|---|---|---|
| Estimated beta coefficient for the following asset: | | | |
| Excess return on Singapore property stock market | 1.000 | - | 0.555 |
| Excess return on Australia property stock market | 0.034* | 2.425 | -0.003 |
| Excess return on Hong Kong property stock market | 0.734* | 12.428 | 0.255 |
| Excess return on Japanese property stock market | 0.237* | 7.384 | 0.012 |
| Excess return on Malaysia property stock market | 0.583* | 13.250 | 0.168 |
| Excess return on Philippines property stock market | 0.649* | 13.673 | 0.175 |
| J-statistic | 1.07E+10 | | |
| $\chi^2$-statistic of the restriction in equation (5): | 16.512(DF=25) | | |
| Significant level: | P=0.899 | | |

* *Indicates significance level at 5%;*

markets in the six Asia-Pacific countries are all driven by the same information set as captured by the Singapore property stock market. In other words, the property asset markets are efficient in Asia-Pacific countries. One of the six property asset markets explains all the risks in the markets.

The β for the other five securitized real estate markets and the R-square of the GMM regression give useful information on the integration of the six property stock markets. The β for the Australia securitized real estate market is small and the R-square is low, which indicate that the characteristic of the Australia securitized real estate market is different from the other five asset markets. The low R-square of the Japanese property stock market may suggest that the Japanese property stock market is less dependent on the macroeconomic risks. The performance of the Hong Kong, Malaysia, and Philippines property stock markets are comparable, which may suggest some degree of integration in these markets. However, the $\beta$ for all the six property stock markets are significant at 5% level, which confirm the rank test that there is only one information set within the six Asia-Pacific countries.

## 5.7 Summary

In this chapter, we test the risk premium on the excess returns of the securitized real estate markets in the six Asia-Pacific countries: Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore.

The traditional capital asset pricing model (CAPM) of Sharpe (1964) and Lintner (1965) remains one of the most important contributions in the modern finance theory. However, the validity of this Capital Asset Pricing Model has been questioned by empirical tests in recent years. Kraus and Litzenberger (1976) proposed a three-moment capital asset pricing model in which systematic skewness contributes to the risk premium of an asset. We test the three-moment CAPM model in the Asia-Pacific countries, and find that the expected utility function *U(.)* of the three-moment CAPM is assumed to belong to the non-increasing absolute risk aversion utility class, $U''' > 0$, which implies that the investors prefer the positive skewness. The coefficient of the skewness risk, $b_2$, has an opposite sign of the market portfolio.

We also find evidence that the skewness has a strong explanation power on the variation of excess returns in the securitized real estate markets in the six Asia-Pacific countries. When including the gamma factor into the multifactor models, the R-square increases dramatically, which indicates that the skewness risk should be considered when constructing a portfolio with the securitized real estate assets.

We test the common information factor in the six asset markets. Using the multifactor latent-variable model, we test the rank restriction assuming that all asset returns are driven by one systematic risk factor when k equals to 1. We use the Singapore securitized real estate market as the benchmark market and get a chi-square of 16.512 and a P-value of 0.899, which indicates that the null hypothesis for the one-factor model is not rejected at 10% significance level. This result implies that the time-varying excess returns for the securitized real estate markets in the six Asia-Pacific countries are driven by the same information set, which can be captured by the Singapore property stock market. The $\beta$ for the other five securitized real estate markets and the R-square in the GMM regression can also give indirect evidence on integration of the six property stock markets. The Australia and Japanese property stock market have different characteristics compared to the Singapore property stock market. However, the Hong Kong, Malaysia and Philippines property stock markets show close resemblance in terms of beta with the Singapore property stock market. The $\beta$ for all the six property stock markets are significant at 5% level, the rank test showed that there is only one information set within the six Asia-Pacific countries.

# Chapter Six

# CONCLUSIONS, IMPLICATIONS, LIMITATIONS AND FURTHER RESEARCH

## 6.1 Conclusions and Implications

In this study, we focus on the tests of market integration hypothesis and the common information factors in Singapore asset markets and the securitized real estate markets in Asia-Pacific countries.

For the Singapore market study, we test the time-varying returns of the direct real estate markets and the financial asset markets in Singapore using the multi-factor latent variable model of Mei and Lee (1994). Tests of the predictability of the five asset markets and the existence of common risk premiums in the five asset markets in Singapore were conducted. Our results are different from the findings in the earlier study by Mei and Lee (1994) on the US asset markets. We find that there is only one information set which contains sufficient common information to explain the excess returns of the direct real estate markets and the financial asset classes.

In our study, five asset classes: overall-stock, property stock, bond, commercial real estate and industrial real estate are included. The excess return in the commercial real estate market is the most predictable one with the highest adjusted R-square of

0.339. Two macro-variables: growth rate of the industrial production and unexpected inflation are both significant in the commercial real estate model. The predictability of the excess returns in the overall-stock market is dependent on: real T-bill rate (RTbill), growth in industrial production (GIP) and unexpected inflation (UI). The predictability of the property stock is dependent on all the forecasting variables except the yield spread between the long and short term government bond.

We also test the models with different common risk factors. Unlike in Liu and Mei (1992), we could not reject the null hypothesis that there is only one information set in the five asset markets, which suggests that investors can capture all risk premia using one common asset market factor in Singapore. The beta of the bond market was not significant in most of the models, which suggests that investors should not neglect the unique characteristic and special performance of the bond market in their portfolio.

By examing the coefficients corresponding to the macro-variables, we can see that there is a partial integration between the overall-stock market and the property stock market. The property stock market is also partially integrated with the direct real estate markets, especially with the commercial real estate market. The industrial real estate market is integrated with the commercial real estate markets. The evidence shows that the commercial real estate market is influenced by both the industrial real estate market and the stock markets.

We continue to test the common information in the securitized real estate markets in the six Asia-Pacific countries: Australia, Hong Kong, Japan, Malaysia, Philippines and Singapore.

The skewness risks as proposed in Kraus and Litzenberger (1976) three-moment CAPM model were estimated for each of the sample markets. We then regress the excess returns of securitized real estate on the macroeconomic variables using the multi-factor model. Using the GMM method, we found that the skewness factor has a strong explanatory power on the variations in the excess returns of the property stocks in all of the six Asia-Pacific countries. When including the gamma factor into the multifactor models, the Adjusted R-square increase dramatically. The results imply that the skewness risk should be considered when constructing a portfolio with the securitized real estate assets. Using the multifactor latent-variable model, we teste the rank restriction of different common factors assuming that all asset returns are driven by one systematic risk factor, when k equals to 1. We use Singapore securitized real estate market as the benchmark market, the chi-square of 16.512, and the P-value of 0.899 were estimated, which indicate that the null hypothesis for the one-factor model was not rejected at 10% significance level, therefore, the time-varying excess returns for the securitized real estate markets in the six Asia-Pacific countries are all driven by the same information set which can be captured by the Singapore property stock market. The β for other five securitized real estate markets and the R-square of the GMM regressions also offer some evidence of integration between the six property stock markets. Therefore, investors can capture the entire risk premium by holding securitized real estate in one of the Asia-Pacific markets.

## 6.2 Limitation of the Study

The conclusion and implications of this study could be limited in several ways. First, the conclusion is only based on the testing sample periods due to limitations of data in some markets. Empirical tests when applied in cross-country studies were limited by data availability. The two sets of data used in domestic and cross-country study were the results of lack of data at national level in some markets. For example, as a result of the lack of long-term and short-term government bond rates and the commercial bond rates data in some sample markets, the yield spread, the default risk and the term-structure variables can not be computed in the cross-country models. Second, the GDP data in all countries are published on yearly basis. Therefore, there might be some errors when constructing the openness factors, especially monthly average smoothing to convert from quarterly data into monthly frequency. Third, the macroeconomic variables do have explanatory significance on the excess return on the property stock indices, but only small part of variations are explained by the macroeconomic variables. To improve the explanatory power of the forecasting variables an excess return by including more proxies of macroeconomic variables could be the extension of this study. Another extension may involve individual securitized real estate stocks in the three moment multifactor latent model tests.

## 6.3 Future Research

First, due to the unavailability of data, especially the direct real estate market price indices in different countries, we cannot do the empirical test for the asset market integration in individual country. The tests of market integration of different asset classes in individual countries can be extended in the future empirical test subject to the availability of data in the regional markets.

Second, the possible impact of structure change in the market following the Asian financial crisis in 1997 was not tested in this study. This structural effect could be included in the future studies.

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# APPENDIX

## ELABORATION OF THE ESTIMATION PROCEDURE OF THE RANK RESTRICTION

Followed the Liu & Mei (1992) multifactor latent-variable model, we test the rank restriction using a GMM method.

Theoretically, we construct a $N \times L$ sample mean matrix: $G_T = U'X/T$, where $E(U'X) = 0$ because the error term in system equation (15) has conditional mean zero, given the instruments X from equation (12). Next, we stack the column vector on top of each other to obtain a $NL \times 1$ vector of $g_T$. Then, we try to find an optimal solution for the quadratic form, $g_T'W^{-1}g_T$ by minimizing over the parameter space of ( $\Theta$ , $\alpha$ ) using a two-step algorithm. In the first step, the identity matrix is used as the weighting matrix W. After obtaining the initial solution of $\Theta_0$ and $\alpha_0$, we next calculate the residuals $\mu$ from the system of equation (15) and construct the following weighting matrix:

$$W = \frac{1}{T}\sum_t (u_t u_t') \otimes (z_t z_t')$$

where $\otimes$ is the Kronecker product. Next, we use the weighting matrix in above equation to resolve the optimization problem of minimizing $g_T'W^{-1}g_T$ over the choice of ($\Theta, \alpha$). Hansen proved that under the null hypothesis, $Tg_T{}'W^{-1}g_T$, is asymptotically chi-square distributed, with the degrees of freedom equal to the difference between the number of orthogonality conditions and the number of parameters estimated: $N \times L - [K \times L + (N-K) \times K] = (N-K)(L-K)$, where N is the number of assets studied, K is the number of factor loadings, and L is the number of forecasting variables.

After obtaining the weighted sum of squared residuals, we perform a chi-square test to determine if the data reject the restricted regression system (15).

Empirically, we can get the chi-square using the J-statistic from the GMM regression results to multiply the observation number in the system regression (15).

If the restricted regression system (15) can not be rejected, we can use equation (15) to study how much of the variation-in-asset returns these forecasting variables predict. We can also interpret the regression results as to what extent these economic conditions affect conditional factor risk premiums. Even if the overidentifying restrictions of equation (14) are rejected, the estimated coefficients may still be of interest. The fitted values from equation (14) are the best possible forecasts of asset returns subject to the restriction that there are K major systematic factors in the economy. They can thus be interpreted as estimates of a common component in expected asset returns.