REGIME SWITCHING IN INTERNATIONAL SECURITIZED PROPERTY MARKETS

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Summary

Over the past decades, the international securitized real estate market has experienced rapid growth and dramatic development. Although a large number of previous studies have investigated the return and risk performances of securitized property, they are mainly based on the assumption that the movement of risk and return is linear or a single pattern, and this gives little attention to the issue of structural or regime changes. Due to changes in the institutional environment, fiscal and interest rate policy, and sudden external shocks, regime shifts in securitized real estate return and volatility can occur. This would result in different states of the market with different patterns of return and risk behavior and interaction.

This study investigates the existence and nature of return and volatility shifts in international securitized real estate markets as well as the impact of economic factors on them from the regime switching perspective by using the property stock index and macroeconomic data of the US, UK, Japan, Singapore, Hong Kong and Australia over the period between 1987 and 2004. Several state-of-the-art econometric methodologies—univariant Markov Switching model, Markov Switching vector autoregression (MS-VAR) and panel MS-VAR, are applied in order to investigate the international securitized property return and risk in light of regime shifts.

The empirical results suggest that the international securitized property in this study exists in one state (state 0) where the returns are low/negative and the variance is high, and in the other state (state 1) where the returns are high and the variance is low.

The two regimes (low return-high volatility; high return-low volatility) are persistent with differences observed in the expected duration and in the frequency of shifts between the states among the six international markets. Moreover, there also exists common regime shift movement in the international markets.

In terms of the impact of economic factors on securitized real estate market, the results indicate conclusively that the securitized real estate expected returns are significantly related to the domestic economic changes. However, the impacts of economic shocks on securitized real estate expected returns are state-dependent and asymmetric, with the macroeconomic factor shocks impacting the real estate expected returns in recession greater than in expansion. The contributions of the macroeconomic factor shocks on the securitized real estate expected returns are different under the two regimes.

The global economic condition, together with the domestic macroeconomic factors, impacts the international property stock expected returns asymmetrically. The findings therefore have important implications for optimal asset allocation, portfolio performance in global market and international real estate asset pricing.

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Chapter 1 Introduction

1.1 Research problem

Real estate investment has clearly become a global endeavor and the world's biggest business in recent years accounting for approximately 15 percent of global gross domestic product (GDP) with assets worth US$50 trillion compared with US$30 trillion in equities markets (Bloomberg, 2004). Institutional investors have included in their portfolios real estate investments outside their home countries and are increasingly exploring overseas opportunities. Among these opportunities, real estate securities are gaining ground. Listed property has become an increasingly important property investment vehicle in Asia and internationally (Steinet and Crowe, 2001), particularly as a result of the success of Real Estate Investment Trusts (REITs) in the United States, Listed Property Trusts (LPTs) in Australia, the recent establishment of equivalent REIT vehicles in Japan, Korea and Singapore, and the long-established track record of listed property companies in Asia. Many investors have implemented an investment strategy that includes "indirect" real estate investment--securitized real estate, which is also known as property stock, as the real estate asset class in their investment portfolio. In US, securitized real estate is typically proxied by REITs.

There are some good reasons why investors include property stocks to build up their international real estate exposure. Firstly, they are relatively more liquid and are

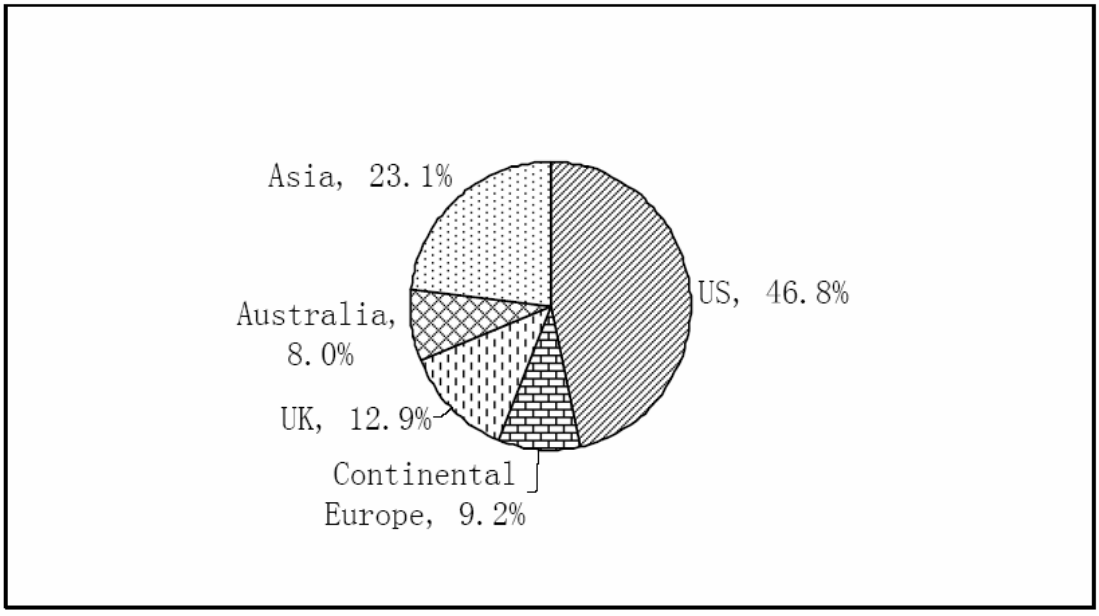
traded on public markets. Public trading which ensures greater transparency is critical for international real estate investors since they are able to mitigate the information disadvantage which they might have when investing unfamiliar markets. At the same time, property stocks can reduce liquidity risk which is significant in direct real estate transaction. Secondly, public securities markets are more efficient than private market in terms of information availability, which guarantees that the asset prices reflect their fundamental values. In other words, even uninformed and passive investors would be able to pay the right price when they buy securitized real estate through the stock market. A consequence of this attribute is that it opens the possibility of a passive investment strategy focusing on diversification. However for direct real estate investment, prices are mainly determined in the negotiating process; hence uninformed investors might pay too much and receive too little for their property investments. Thirdly, international investor of publicly traded real estate securities is able to avoid the monitoring problems that commonly exist in direct real estate investment. The monitoring of foreign indirect real estate investment is undertaken by the local stock markets and the relevant investors active in those markets.

Over the past decades, the global securitized real estate market has grown extensively to an estimated US$648 billion in 2004 (UBS, 2004). As illustrated in figure 1.1 , the geographical distribution of global securitized real estate is as follow : US (46.8 percent), Asia (23.1 percent), the UK (12.9 percent) ,continental Europe (9.2 percent) and Australia (8.0 percent). While the earlier international capital flows were largely directed toward the United States and Western Europe, substantial interest has

developed in the Asia-Pacific region in recent years.[1] The past decade has witnessed a rapid development of real estate securitization worldwide, greater cross-border flows of real estate capital, and the proliferation of diverse investment products and vehicles with a global scope.

Currently, international real estate security investment has become an increasingly important component of efficient, global mixed-asset portfolios. It is now possible to construct a fine-tuned portfolio of real estate securities with exposure to specific cities, regions, and types of real estate. It is also feasible to invest in real estate through listed property companies in emerging markets.

Figure 1.1 Components of international securitized real estate



Source: UBS, 2004

[1] For instance, in Asia-Pacific, the active international real estate investors are: ING Real Estate, AIG Global Real Estate Investment, ERGO Insurance , Morgan Stanley Real Estate and etc.

In view of the rapid growth of international securitized real estate, the property stock market has been an interest area of research from investors and academia, not only because global real estate investment offers significant diversification potential, but also because global real estate asset can produce higher and more stable yields.[2] A substantial body of real estate literature demonstrates the important role played by securitized real estate as an asset class in both country-specific and global mixed-asset portfolios (Eichholtz, 1996; Wilson and Okunev, 1996; Conover, *et al*, 2002; Campbel and Sirmans, 2002, etc). Furthermore, real estate literature also points out that as an asset class, property stock has significant relationship with the equity market and the corresponding economic fundamentals (Giliberto, 1990; Liu, *et al*, 1990; Lizieri and Satchell, 1997; Ling and Naranjo, 1997; Karolyi and Sanders, 1999, etc).

Despite the extensive investigation of international securitized real estate behavior as well as its relationship with the corresponding economic fundamentals, those studies have paid little attention to the sudden structural or regime changes in the international property stock markets. In addition, few papers have investigated the nonlinear relationships between securitized real estate expected return and macroeconomic factors, letting alone investigating this issue in the global scope. However, over the last two decades, many securitized property markets have undergone dramatic growth. This phenomenon suggests that the characteristics of these markets, as well as the stochastic and time-varying behavior of their returns and risks, would have changed.

[2] UBS 2004 report “Global Real Estate Investment Going Mainstream”.

Empirical evidence suggests that the regime switching model is one of the popular nonlinear time series models in the literature, such as Hamilton (1989) and Schaller and van Norden(1997). This model involves multiple structures (equations) that characterize the time series behavior in different regimes. By permitting switching between these structures, this model is able to capture more complex dynamic patterns of market movement. There are motivations for us to investigate the international real estate stock market from the regime switching perspective.

Firstly, although previous studies have extensively investigated the risk and return performance of REITS and property stocks (Sirmans and Sirmans, 1987; Gyourko and Keim, 1992; Han and Liang; Glascock and Davidson, 1985; Kapplin and Swartz, 1999 and Liow, 2001), they are mainly based on the assumption that the movement of risk and return is linear or a single pattern, and this gives little attention to the issue of structural or regime changes. It is likely that regime changes in securitized real estate returns and volatility can occur, for examples, due to changes in the institutional environment, changes in fiscal and interest rate policy, and external shocks such as the 1987 stock market crash and 1997 Asian financial crisis. This would result in different states of the market with different risk and return behaviors and interaction. Hence it is necessary to consider the securitized market behavior in light of regime shifts.

Secondly, in the recent two decades, the international property stock market[3] has

[3] The international property stock market means the markets in North American, Asia and Europe.

grown rapidly and developed dramatically (Worzala and Sirmans, 2003). In the mid-1980s, the combined market value of all listed real estate companies in the world was under US$ 20 billion (Eichholtz and Koedijk, 1996). But till 2001, the market value was an estimated US$ 648 billion (UBS, 2004), expanding more than 30 times from the mid-1980s level. In this development process, the market's speed of increasing or growth pattern would be changed according to the cyclical movement of the world economy and the expansion of the equity market. Hence, it is important to involve regime shifts when investigating the movement of the international securitized real estate market. The international securitized real estate market in this study includes the securitized property markets in North America, Europe and Asia (including Australia).

Finally, the securitized property market appears to be strongly cyclical in nature, undergoing expansion and recession phrases over a long period. Since expansion and recession are different regimes presenting distinct return and risk performances, the linear modeling techniques are unable to capture the characteristics of international real estate stock market structure. In addition, the business fluctuations would impact real estate securities' expected returns across different periods. Therefore, it is reasonable to understand the international securitized real estate movement and investigate its expected return's relationship with macroeconomic factors in terms of the regime switching framework.

1.2 Theoretical and conceptual framework of analysis

The hypothesis of this study is that securitized real estate return presents distinct regime switching movements, and the regime shifts of securitized real estate expected return could be explained by the economic explanations relating stock market movements to the dynamic macroeconomic fundamental influences. It can be explained by Lucas's (1978) exchange-economy asset pricing. In the Lucas model, there are large number of identical, infinitely-lived agents and a fixed number of assets that produce units of the non-storable consumption goods. Since the agents are identical, per capita consumption is equal to per capita dividends (*D*). This assumption of Constant Relative Risk Aversion (CRRA) utility give the following stochastic different equation for equilibrium prices.

$$P_t \cdot D_t^{\gamma} = \beta \cdot E_t D_{t+1}^{\lambda}(P_{t+1} + D_{t+1}) \text{.....(1.1)}$$

Which in turn yields the following equation for fundamental price

$$P_t^* = D_t^{-\gamma} \cdot \sum_{k=1}^{\infty} \beta^k \cdot E_t \cdot D_{t+k}^{1+\gamma} \text{.....(1.2)}$$

Where β is the subjective discount factor, $0 < \beta < 1$, E_t is the mathematical expectation conditioned on information available at time t, and γ is the coefficient of relative risk aversion. Lucas proposes that deviations from fundamental pricing of stock market could cause shifts in the market regime.

As an extension of the Lucas model, Cecchetti *et al.* (1990) consider a Lucas asset

pricing model in which the economy's endowment switches between high economic growth and low economic growth. The switching in economic growth influences the stock return via the dividends, which is the key asset pricing factor in Lucas model. They show that such switching in fundamentals accounts for several features of stock market returns, such as leptokurtosis and mean reversion. The switching in economic growth influences the distribution of stock returns via the dividends. Hamilton and Lin (1996) find that the volatility of stock returns is higher during recessions than during expansions, and also report that the driving force of conditional switching moments is economic recession.

Additional evidence on regime switching in the conditional distribution of stock returns is reported by McQueen and Roley (1993). Classifying three states according to the level of growth in industrial production, they find that announcement effect of macroeconomic news on daily stock prices significantly depend on the state of the economy.

The conceptual framework underpinning the research is concerned with the time-varying structural relationship between the expected securitized property return and the domestic as well as the international macroeconomic factors. Conceptually, the whole underlying framework can be divided into three levels as depicted in Figure 1.2. Each level would be investigated in the subsequent empirical chapters.

The first level is concerned with the movements of the individual securitized real estate markets. Because of macroeconomic, stock market shocks and some sudden

events, the individual securitized real estate market is subject to the cyclical movements that are represented by the recession and expansion phrases. The real estate investors therefore adopt different strategies and investment decisions under different market timing. If real estate investors hold the positive (negative) expectation for regional or global market, they would buy (sell) the property stocks and adjust their regional or global portfolio. Sometimes, the news or events in specific market would affect investors' expectation on such market and region, or the world market. Therefore, the investors would adjust their portfolio components as response to the change of expectation. The different securitized real estate submarkets would be integrated by this mechanism. Even though, the securitized real estate markets are not connected through domestic economic factors directly, important domestic economic news and events sometimes affect the investors' expectations on global or regional markets. As a result, the investors may change their global or regional portfolio. Furthermore, domestic economic factors would change the risk and return profile of domestic securitized real estate market, which many prompt the investors to adjust their portfolios. As such, local economic factors have an indirect effect on securitized real estate market. As investors' activities in turn directly affect the market return and risk, the real estate market performances and the investors' expectation in the recession and expansion periods are therefore different. This first level of the investigation is empirically conducted in the chapter 4.

The second conceptual level is concerned with the relationship between the securitized real estate expected return and the macroeconomic factors under the

domestic and closed economy framework. First, the macroeconomy impacts the securitized real estate expected return through the direct real estate market. Macroeconomic indicators such as GDP, interest rate, inflation rate and etc, have been found to affect the construction and real estate investment markets (See McCue and Kling, 1994; Mei and Saunders, 1995; Ling and Naranjo, 1997,1998). Also, the key factors in the construction market, for example, construction cost, land cost and capital cost are determined by macroeconomic conditions. In fact, the construction market is the product source for the real estate market, which means that construction market supplies the office buildings and houses to the real estate market. Thus, this is the supply side of real estate market. The macroeconomic condition, indicated by GDP is the key determinant of business growth and household income, which directly affect the demand for real estate. In sum, the macroeconomy affects the supply and demand of the real estate market, which would finally determine the prevailing price in the real estate market. The change in market prices in turn affects the return and volatility (two key features) in the direct real estate market. Moreover, this relationship is time-varying because of the complicated movements of the real estate market expected return and the macroeconomic factors.

Interest rate is a major determinant of the expected value of real estate and financial assets. In conventional valuation model, the expected value of the real estate is the sum of discounted of cash flow over a certain period when real estate asset is held. In high interest rate environments, increased yields cause a decrease in the capital value of the real estate asset, and vice versa. Therefore, the changes of interest rate will

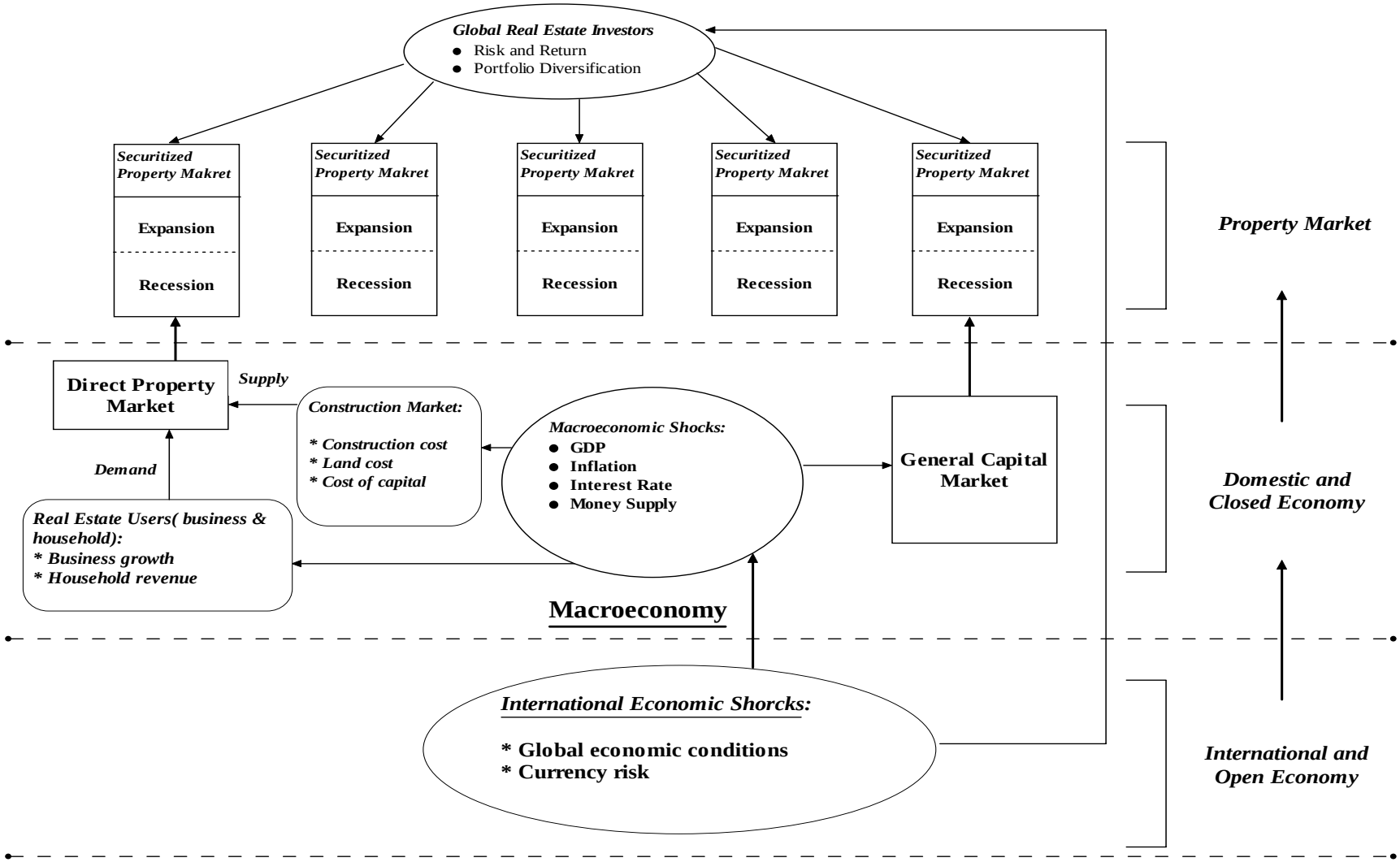
lead to changes of real estate asset expected return.

Inflation rate has close relationship with real estate. Traditionally, it is believed that the prices of real estate would indefinitely rise in the long term due to inelastic and limited supply of land resources. Real estate asset therefore has been regarded as one of the best inflation hedges. In addition, inflation is often seen as having a beneficial effect on real estate investment, as real estate owner benefits from increasing income and capital appreciation, while the real value of their debt, which is necessary for real estate investment, is eroded and depreciated.

Changes in the supply of money will also cause the changes of prices of real estate and other financial assets. Basically, rise of money supply will increase the liquidity of the market. More liquidity in the market will encourage the investment activities including investing in real estate, and asset prices will therefore be pushed up.

There is considerable research evidence which suggest that direct real estate markets are closely linked to securitized real estate markets. This is mainly because, in the long term, the performance of indirect property vehicles such as REITs and property company shares, should reflect the underlying real estate activities. The performance of the REIT and property company sectors will, ultimately, be based on the performance in the underlying direct market. Equity analysts always value the property company shares or REITs on a discounted net asset value (NAV) basis. Thus, their share prices should reflect the underlying property values.

Figure 1.2 Theoretical framework of securitized real estate and the macroeconomy



Source: Author's Construction

In general, there are strong positive contemporaneous correlations and lead/lag linkages between direct and indirect real estate performance (see Giliberto, 1990; Gyourko and Keim, 1992; Myer and Webb, 1994; Acton and Poutasse, 1997).

Securitized real estate contains economically important and timely information about the changing real estate market fundamentals. Therefore, the macroeconomic factors affect the expected return and risk of securitized real estate market, and this relationship is subject to a time-varying structure in the complex and ever-changing economic environment.

Secondly, the macroeconomy would have profound impact on securitized real estate market expected return through capital market. The stock market is a weatherglass of the macroeconomy. According to Lucas (1978) and Fama (1981, 1990), fluctuation of economy would be reflected by movement of the stock market. Thus, the stock market has strong and close relationships with macroeconomic variables. In practice, macroeconomic indicators' shocks would affect investors' expectation positively or negatively that results in the fluctuation of capital market. For example, change in interest rate would lead to changes in cost of capital, and then it will directly affect investors' expected return. As a consequence, the stock price will be changed.

In fact, stock price movement would directly influence two important features of the stock market, i.e. expected return and volatility. However, the movement of stock market responds quickly to changes in the fundamentals of the macroeconomy. Hence, their relationship would be time varying.

As part of the price volatility of capital market, securitized real estate's price would inevitably fluctuate at the same time. Normally, the securitized property sector is a significant sector of the domestic stock exchange. Its movement would be consistent with the corresponding movement of general stock market index. Therefore, the return and risk of securitized real estate are affected by macroeconomic factors in this manner and this relationship is time varying, with respect to the dynamic macroeconomic fluctuations

The third conceptual level is concerned with how the global economic shocks affect the regime switching movement of the international securitized real estate expected return. In recent years, the internationalization and integration of financial markets throughout the world, as evident in the global common stock and bond market investing, have facilitated global real estate investments as well as integration of the global securitized real estate markets. In view of this situation, global real estate investors would adjust their real estate portfolio across the world based on the fluctuation of global economy (such as the globalization of the economy and financial integration), as well as the fluctuation of foreign exchange rates. At the same time, the performances of individual markets would also affect the investors' decisions. The investment capital flow usually moves from the unprosperous market to the flourishing one. Accordingly, in the global village, real estate securities would be affected not only by domestic economic factors but also by global economic shocks and cross market movements. The detailed relationship depicted in Figure 1.2 will underpin the investigative research of this dissertation study.

On the global securitized real estate market, the shocks of one country or stock market would change or affect its securitized real estate market's risk and return profile and expectation. These events will cause investor to re-evaluate their portfolio components and diversification effect. The specific market's weight in their portfolios will change and as a result, investors will implement a series of buy or sell activities in different countries. The capital inflow or outflow will affect the specific return and risk of that market. Therefore, the shocks of one country will be transmitted to other countries through the international investors. In addition, global economic events will sometime affect and change the international investors' expectation and thus resulting in global securitized real estate market to move together in certain period. At this level, the regime shifts also can be explained by the previous Lucas's asset pricing model. In Lucas's model, the switching of economic endowment means not only local economic factors but also the global factors.

The second channel to explain how the regime switching could take place across the global market is the impact of global economic factors. Case, *et al* (1997) observe the global real estate cycle from 1987 to 1997 in 21 countries. And they display that cross-boarder correlations of real estate are due in part to common exposure to flucatuations in the global economy. The global economy tends to be integrated and fluctuation of global economic factors, as well as some international events, such as the "Black Monday" in 1987, would cause the regimes switching to trigger across different continents. In addition, Asian Financial Crisis of 1997 also triggered the regime switching of securitized real estate markets in Asia.

1.3 Research scope and objectives

This study focuses on the international real estate securitized market. The sample includes six major real estate markets. Apart from the US (United States of America) and the UK (United Kingdom), the remaining four are the Asian-Pacific markets of Singapore, Hong Kong, Japan and Australia. Japan is a significantly developed economy in Asia and has a long history of listed real estate. Other markets like Australia, Hong Kong and Singapore have track records of listed real estate companies that play a relatively important role in general stock market indexes. In particular, Australian securitized real estate sector is a leading player in global real estate. The UK real estate market plays a key role in the European property market. Moreover, the six markets represent about 91 percent of the global securitized real estate market and have the world's most significant listed real estate markets in their respective regions (UBS Investment Bank, 2004).

The regime switching research need long period of data in order to completely present the time series' various behaviors and performances in different regimes. The data in this study, obtained from Datastream, start from January, 1987. The continental Europe market and other uncovered markets cannot satisfy the data requirement and therefore have not been covered. However, the six sample markets in the study can represent about 91% of global securitized market in terms of their market capitalization(UBS Investment Bank, 2004), and thus still can depict regime switching movement of the global market.

This study aims to investigate the return and risk performance of international securitized real estate markets as well as the impact of economic factors on them from the regime switching perspective by using the property stock index and macroeconomic data of the US, UK, Japan, Singapore, Hong Kong and Australia over the period from January 1987 to September 2004.

The specific objectives of this study include the following:

1. To assess whether there are regime switching behaviors of the securitized property return in the international securitized real estate market.

2. To investigate the dynamic and asymmetric relationship between securitized real estate expected return and the domestic macroeconomic fundamentals.

3. To explore the relationship between the international securitized real estate expected returns and the macroeconomic shocks, including domestic and global factors, which illustrate how the macroeconomic factors affect the international securitized real estate expected returns.

The alternative methodologies in regime switching modeling are threshold autoregression (TAR), smooth transition threshold autoregressive (STAR) and self-exciting threshold autoregressive (SETAR). However, switching in the TAR is dependent and endogenous, resulting in multiple changes. Choosing a suitable variable, y, and the threshold value c for this model is usually a difficult task. And under the TAR and SETAR model approach, unlike the Markov switching model, the transitions

between regimes are discrete. Also, the STAR model would relate to the exogenous variable that makes it difficult to identify the regimes. Markov-Switching (MS) models are particularly appealing because they allow this switching process to be endogenized and the switching mechanism is controlled by an unobservable state variable that follows a first-order Markov chain.

Therefore, Markov switching would be better able to capture the non-linearity in securitized real estate markets. And one limitation of Markov switching model is that the transition probabilities are assumed to be constant over time. This study does not intend to purely improve the forecasting accuracy of the Markov switching techniques.

1.4 Research data

In this study, the securitized real estate markets in US, UK, Japan, Singapore, Hong Kong, and Australia (6 markets in total) are investigated. The six markets have covered the most of the global property stock market. Of them, Singapore and Hong Kong are major Asian developing economies and have reasonably long-established track records of their listed property investment and development companies. In addition, the four Asia-Pacific markets are compared with the two well established securitized real estate markets of the US and the UK.

Table 1.1 Descriptions of property stock indexes

Markets	Property stock Index
Singapore	Singapore Property Equity Index is a capitalization-weighted index of all the stocks traded on the property sector of Singapore Stock Exchange. The index was developed with base value of 1000 as of 03/01/97. It consists of 21 members with a total market capitalization of S$16.65 billion as at 11/07/03.
Hong Kong	Hang Seng Properties index is a capitalization-weighted index of all the stocks designed to measure the performance of the property sector at the HK Stock Exchange. The index consists of 6 members and its total capitalization was HK$315.8 billion as at 11/07/03.
Japan	Tokyo SE Real Estate index is a capitalization-weighted index designed to measure the performance of the real estate sector of composite index. The index was developed with a base value of 100 as of 04/02/68. It consists of 34 members with a total market capitalization of 2.98 trillion yen as at 11/07/03.
Australia	ASX 300 Real estate index is a capitalization weighted index of property equity traded on the Australian Stock Exchange. The index was developed with base value of 3133.25 as of 31/03/00. It consists of 35 members(LPTs) and its total market capitalization was A$59.01 billion at of 12/09/02
UK	FTSE 350 Real Estate Index is a capitalization-weighted index of stocks designed to measure the performance of the real estate sector of the FTSE 350 index. The index was developed with a base value of 1000 as of 31/12/85. It consists of 18 members and its market capitalization was 16.96 billion pounds as at 11/07/03.
US	The NAREIT Index includes all REITs trading on the New York Stock Exchange, the NASDAQ National Market System and the American Stock Exchange. The index provides a standard with which to measure the REIT industry's growth and performance. It consists of 50 members with a total market capitalization of US$135.0 billion as at 30/06/03.

Source: complied from Datastream.

The samples of US and Australian real estate stocks are mainly composed of REITs and LPTs, which are subject to stringent leverage and dividend payouts constraints, which are different with other 4 markets' property stocks. On the other hand, majority of the property stocks of the other markets are property management and development listed companies. Admittedly, those regulatory or institutional differences would have different impacts on their own securitized property markets.

Since empirically, it is very difficult to eliminate this type of nuisance and develop the completely regulatory same-indices among different countries, this factor is one of the limitations of this study. However, this issue will be highlighted and discussed in the empirical test parts.

Table 1.2 Definitions of macroeconomic variables

Variables	**Definitions and sources**
Gross Domestic Product	Quarterly series are taken from DataStream. Then monthly series are converted from quarterly series using equal step method.
Inflation	Measured by change of Consumer Price Index(CPI) ; series are taken from DataStream
Interest Rate	3 month treasury bill or prime lending rate; series are taken from DataStream and monthly statistical releases
Exchange Rate	Trade-weighted currency index, a rise in the index indicates an appreciation of the country's currency against the rest of the world[4]; series are taken from DataStream.
Money Supply	It is measured by M2, series are taken from DataStream
MSCI world index	The world economy movement indicator; series are taken from DataStream

Table 1.1 provides description of the property stock indexes used in the research. The raw microeconomic variables are inflation, money supply, interest rate, stock market index, exchange rate and GDP as well as the Morgan Stanley Capital International (MSCI) World Index as the global economy indictors. Morgan Stanley Capital International's market capitalization weighted index is composed of company

[4] For example, Canada is trading mostly (80%) with the United States. Thus the USD/CAD exchange rate has a weight of about 80% in Canada's trade-weighted CAD index

representatives of the market structure of 23 developed market countries in North America, Europe, and the Asia/Pacific Region. The MSCI World Index consists of more than 1,500 stocks in 23 countries globally and represents approximately 85 of the total market capitalization in those countries. The definitions of these macroeconomic factors are presented in table 1.2. The study adopts monthly data from January 1987 to September 2004. All data are extracted from the DataStream online information system.

Interest rate variable presents regime switching behavior (Ang and Bekaert, 2002). The change of interest rate regimes (interest rate up or down) causes variation of the cost of investment and investors' expectation. Thus, the securitized real estate return will vary with the change of interest rate. Lizeri and Satchell(1997) and Lezieri, *et al* (1998) determine the regimes of real estate market by interest rate, which assume the regime switching of real estate is completely due to the change of interest rate. And they observe two regimes, with one lower interest rate and the other higher interest rate regime. The lower interest rate regime is characterized by mean reverting behavior about a positive trend. By contrast, in the higher interest rate regime, random walk behavior around a negative trend is observed. In general, the results suggest that the price/return falls in high real interest environments are sharper than the rise associated with lower real rates.

However, this study assumes the regime switching of securitized real estate is caused by a variety of economic factors, like an economic system. Securitized real

estate market exhibits two distinct regimes (low return-high volatility; high return-low volatility). And the impact of interest rate on securitized real estate is state-dependent and asymmetric. And interest impacts securitized real estate in recession higher than in expansion phases.

Money supply will affect the liquidity of the market. More liquidity will encourage the investment activities, including investing in real estate. Darrant and Gloscock (1989) find money supply and money policies cause the change of real estate market expected returns. This is why the study includes the money supply in the model.

1.5 Research methodology

Figure 1.3 provides an overview of the research methodology used in this study. The detailed elaboration appears in the corresponding and subsequent empirical chapters. Briefly, there are three major steps involved:

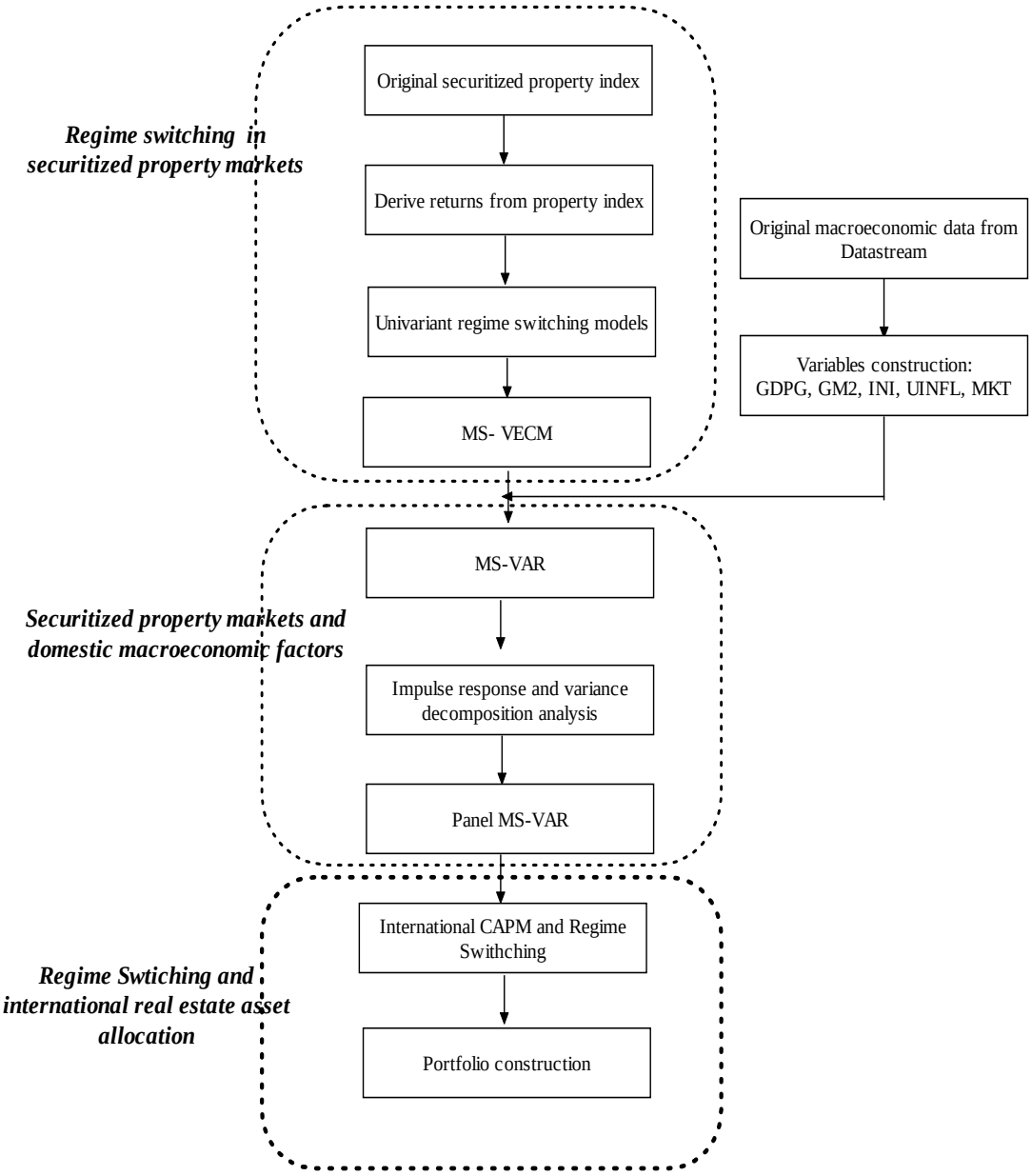
(a) For the individual property stock markets, the univariate regime switching model is conducted to investigate the time-varying return and risk. Thereafter, the Markov Switching Vector Error Correction Model (MS-VECM) model is employed to assess the degree of regime shifts co-movement across the six property stock markets.

(b) For each market, the Markov Switching Vector Autoregression (MS-VAR) methodology is extended to the property stock expected returns and the domestic

macroeconomic variables. This is followed by the associated nonlinear impulse response and variance decomposition analysis.

(c) In the international context, Helmert filter is conducted to remove the fixed effects on the panel data. Therefore, the panel MS-VAR is employed to examine the nonlinear relationship between the real estate stock expected returns and the macroeconomic factors internationally and regionally. Again, the impulse response and variance decomposition analysis are carried out for the panel MS-VAR.

Figure 1.3 Research methodology flowchart



Source: Author's Construction

Notes: *MS-VAR: Markov Switching Vector Autoregression*

MS-VECM: Markov Switching Vector Error Correction Model

1.6 Significance of the research

This research applies several robust econometric techniques to investigate the international securitized property returns and risks from the regime switching perspective. It has two major contributions: first, it uses state-of-the-art methodologies that are seldom used by real estate researchers, such as the univariant Markov switching model and the MS-VAR. Second, the study is investigated within the international securitized property market context in order to examine the relationship between the expected return and the macroeconomic driving forces. In particular, the importance and potential contributions of this study include the following:

1. This study proposes an international regime switching conceptual framework of analysis to investigate the movements of the securitized real estate expected returns as well as their relationships with major macroeconomic factors. Specifically, it provides useful insights into the dynamics of international securitized real estate from the regime switching perspective. The regime switching model is one of the most popular nonlinear time series models in the financial literature. It is able to represent many nonlinear dynamic patterns of the financial time series. But till now, its application to real estate research is very limited. By incorporating the regime switching perspective, this study presents fresh evidence on the dynamics of international property stock markets over the last decade, especially in the aftermath of 1997 Asian Financial Crisis.

2. Methodologically, this study is innovative in two ways. First, it combines a panel analysis with a MS-VAR model. Numerous significant market studies have used the MS-VAR model to report the evidence of the relationship between asset returns and the macroeconomic fundamentals in single market. This study uses the panel MS-VAR model in order to investigate in-depth dynamic relationship between the securitized property expected return and the international macroeconomic factors. Second, this study deploys the impulse response and variance decomposition analysis for the MS-VAR model in order to identify the relationship between the securitized real estate expected returns and the macroeconomic shocks.
3. Overall, this research enhances the understanding of the risk-adjusted return movements in the international real estate stock markets as well as asymmetric regimes in real estate markets. Previous studies (Gyourko and Keim, 1992; Han and Liang; Glascock and Davidson, 1985; Kapplin and Swartz, 1999 and Liow, 2001) examine the returns and risk in the real estate market but focus on the linear or single pattern perspective. Through the regime switching models, this study can investigate the different dynamic patterns of market expected return and risk movements as well as to capture the more nonlinear attributes. Furthermore, this study also investigates the dynamic and asymmetric influence of the macroeconomic factors on international securitized real estate expected returns, by combining the Markov switching technique with the VAR model. International and domestic real estate investors can therefore improve their portfolio performance

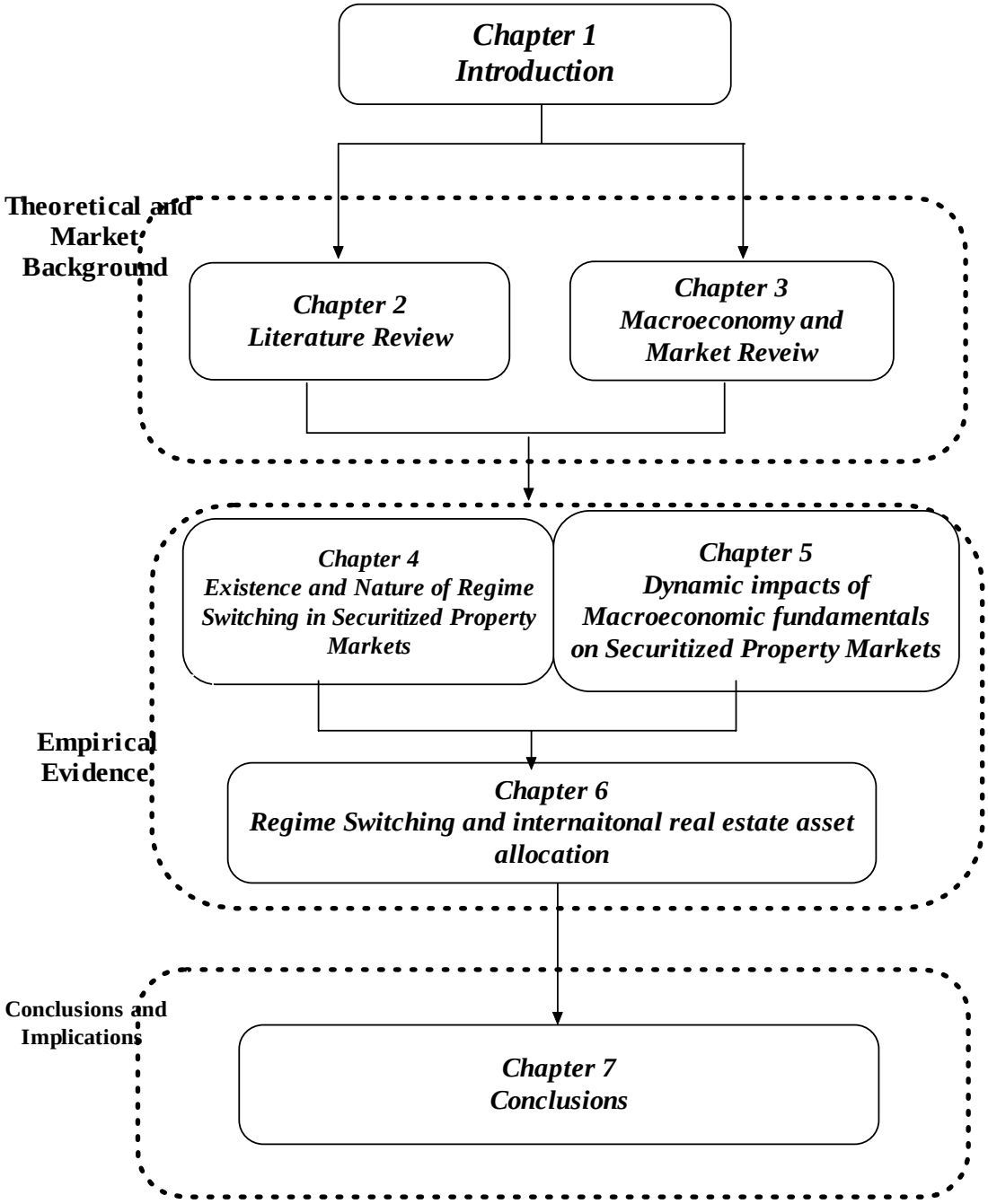
by considering the dynamics in economic fundamentals as the determinants of the property stock market expected returns.

1.7 Organization of the thesis

The structure of this dissertation is outlined in Figure 1.4. Following the introduction, the thesis is organized into three major parts. The first part provides the theoretical background and relevant market knowledge. This includes a review of previous literature in Chapter 2 and an overview of the macroeconomy and market in Chapter 3. The second part presents the empirical investigation of the study. This includes the analysis within the securitized property markets (Chapter 4), the investigation of the dynamic impacts of the macroeconomic fundamentals on the securitized property expected returns (Chapter 5), and the analysis of how regime switching would affect the asset allocation for real estate securities (Chapter 6). The final part discusses the final conclusions and implications of the thesis (Chapter 7).

Chapter 2 reviews the various literatures relevant to this study. Chapter 3 focuses on the introduction of the macroeconomy and the market knowledge of the six target markets. Chapter 4 investigates regime switching in the international securitized real estate markets. Chapter 5 investigates the dynamic and asymmetric relationship between the securitized real estate expected returns and their local macroeconomic factors. Chapter 6 apply asset pricing model to show how regime switching would affect the asset allocation for real estate securities. Chapter 7 concludes the thesis.

Figure 1.4 Structure of the thesis



Source: Author's construction

Chapter 2 Literature Review

2.1 Introduction

This chapter provides an in-depth review of the various finance and real estate literature underpinning this study. The literature review is organized into five major components. Section 2.2 provides a brief review of the concept, techniques and empirical evidence on regime switching research. Section 2.3 focuses on relevant studies on real estate market return and risk. Studies on the relationship between stock market, direct real estate market and securitized real estate market are then reviewed in Section 2.4. Section 2.5 provides a review of the literature on the relationship between macroeconomic variables and real estate market. This review will provide useful information and support to the selection of key macroeconomic factors included in this study. Section 2.6 briefly covers of relevant empirical results on international real estate market. The final section 2.7 provides a summary of the chapter.

2.2 Regime switching

Table 2.1 Key studies on regime switching

Year	Author	Main Findings
1972	Quandt	Display the random switching model
1989	Hamilton	Regime switching in US economy growth
1989	Schwert	Stock returns have either a high or low volatility states
1989	Turner *et al*	Consider the switching in means and variance
1990	Tong	Develop the Threshold autoregression (TAR) framework
1990	Engel and Hamilton	Regime switching in exchange rate
1991	Lewis	Regime switching in the term structure of Eurodollor
1993	Granger and Terasvirta	Demonstrate the self-exciting threshold autoregressive(SETAR) model
1994	Cai	Propose a new approach to model the variability of financial time series

Year	Author	Main Findings
1993	Goodwin	Regime switching in stock returns
1994	Engel	Markov switching in US exchange rate
1994	Hamilton and Susmel	Markov switching model provides a better statistical fit
1994	Sola and Driffill	Interest yield spread is subject to regime switching
1995	Ravn and Sola	Investigate the stability of correlation between output and inflation
1995	Van Norden	Exchange rate bubble display the regime switching
1996	Hamilton and Lin	Investigate the joint time series behavior of stock returns and growth industrial production
1996	Layton	Switching of growth rates of leading indexes of US economy
1996	Garcia and Perron	The US ex-post real interest rate is random with means and variance
1996	Gray	Propose a Markov switching GARCH model
1997	Krolzig	Propose the MS-VAR to analyze the regime shifts of multivariate together.
1997	Schaller and van Norden	Strong evidence of switching behavior in the US stock market excess return
1998	Kim and Nelson	Using regime switching model to analyze business cycle
1998	Nishiyama	International stock markets exhibit distinct regimes in volatilithy
2000	Artis *et al*	Identify the common cycle in Europe and confirm such cycle
2000	Clarida *et al*	Forward-looking monetary policy is subject regime switching
2000	Graflund	Regime switching in mean reversion
2001	Ang and Bekaert	Correlation between markets shift between a high and a low states
2001	Dennis	Find significant policy regimes
2001	Krolzig	Identify the cycles in US Japan and Europe
2001	Longin and Solnik	Propose a regime switching asset allocation model
2002a	Ang and Bekaert	Examine the performance of regime switching for interest data in US
2002b	Amg and Bakaert	Using regime switching model to construct a dynamic portfolio
2002	Boivin and Giannoni	Find the changes of systematic elements of monetary policy
2002	Daniel	Compare the Markov switching and stochastic volatility diffusion modles of the short rat
2002	Duan *et al*	Develop a family of option pricing model when the underling stock price dynamics is modeled by a regime switching process
2002	Lieven	The stock volatility spillover varies significantly through time
2003	Bai and Perron	Present multiple structural changes model
2003	Erlandsson	Examine the forecasting properties of endogenous regime switching models for Swedish interest rate volatility
2004	Jorgen and Jacob	Capture the tendency of real rates to switch between high and low volatility states
2004	Cheung and Erlandsson	Markov switching dynamics in three dollar-based exchange rates

2.2.1 Regime switching theory and concept

The regime switching model was first introduced to the economics profession by Hamilton (1989). It proposes a two-state switching-regime Markov model to consider changes in regime. Under this approach, the parameters of a non-stationary time series are viewed as the outcome of a discrete-state Markov process. The shifts are not to be observed directly but instead the probabilistic inference is drawn about whether and when the shifts have occurred, based on the observed behavior of the series. The regime switching model involves multiple structures (equations) that can characterize the time series behaviors in different regimes. By permitting switching between these structures, this model is able to capture more complex dynamic patterns.

The original regime switching model focuses on the mean behavior of variables. This model and its variants have been widely employed to model the economic and financial time series; see e.g., Engel and Hamilton (1990) , Goodwin (1993) , Schaller and van Norden (1997) and Kim and Nelson (1998). Given that the regime switching model of conditional mean is highly successful, it is natural to consider incorporating this switching mechanism into the conditional variance model. For example, Cai(1994), Hamilton and Susmel (1994) and Gray (1996) study various ARCH and GARCH models with Markov switching.

Besides the univariate analysis above, the regime switching mechanism is also extended to the multivariate models. Krolzig (1997) proposes the MS-VAR to analyze the regime shifts of multivariables together. The MS-VAR model allows some

parameters to be conditioned on the state of the Markov chain while the other parameters are regime invariant. The MS-VAR model provides a very flexible framework which allows for heteroskedasticity, occasional shifts, reversing trends, and forecasts performed in a nonlinear manner.

2.2.2 Regime switching techniques

There are some different types of regime switching models, i.e. Markov Switching, threshold autoregression (TAR) and smooth transition threshold autoregressive (STAR). The major differences for these models are the definitions or assumptions of their switching structures or manners. The Markov switching model firstly introduced to by Hamilton (1989) is most popularly used. A novel feature of the Markov switching model is that the switching mechanism is controlled by an unobservable state variable that follows a first-order Markov chain. A Markov switching model is constructed by combining two or more dynamic models via a Markovian switching mechanism. In particular, the Markovian property regulates the current value of the state variable to depend on its immediate past value. As such, a structure may prevail for a random period of time, and it will be replaced by another structure when a switching takes place. The transitional probabilities matrix governs the random behavior of state variables.

In the Markov switching model, the properties of dependent variable are jointly determined by the random characteristics of the driving innovations and the state variables. Particularly, the Markovian state variable yields random and frequent

changes of model structures, and its transition probabilities determine the persistence of each regime.

There are some other models that are all capable of characterizing the time series behaviors in some regimes. However, each of them has its own limitation. For the model with a single structural change, it is very restrictive because only one change is admitted, such as the Chow test and the BLS (Bai, Lumsdaine and Stock, 1998) technique. Although extending this model to allow for multiple changes is straightforward, the resulting model estimation and hypothesis testing are typically cumbersome; see for e.g. , Bai and Perron(2003). Moreover, changes in such models are solely determined by time which is exogenous to the model. The random switching model of Quandt (1972), in contrast, permits multiple changes, yet its state variables are still exogenous to the dynamic structures in the model. This model also suffers from the drawback that the state variables are independent over time and hence may not be applicable to time series data.

In Tong's(1990) TAR framework, the time series switches deterministically from one linear autoregressive model to another, based on the lagged value of an observed variable, with the parameters (including the threshold value at which switching occurs) estimated via nonlinear least squares. The most important feature of TAR model is that the state changes when an observed variable z passes a threshold c.

Threshold models have received renewed attention since the work of Tong (1990). It derives two distinct models by incorporating different threshold principle, called the

self-exciting threshold autoregressive (SETAR) and the smooth transition autoregressive (STAR) by Granger and Terasvirta (1993). In the SETAR model, the regime-generating process is not assumed to be exogenous but directly linked to the lagged endogenous variable. In the STAR model, exogenous variables are mostly employed to model the weights of the regimes but the regime switching rule can also be dependent on the history of the observed variables.

In sum, the regime generating process of Markov Switching model depends on the Markov chain and the unobserved state variable. In contrast to Markov switching model, the TAR, SETAR and STAR's regimes rely on the observable variables, though through different means.

However, switching in the threshold model is dependent and endogenous, resulting in multiple changes. Choosing a suitable variable, y, and the threshold value c for this model is usually a difficult task. And under the TAR and SETAR model approach, unlike the Markov switching model, the transitions between regimes are discrete. Also, the STAR model would relate to the exogenous variable that makes it difficult to identify the regimes. Markov-Switching (MS) models are particularly appealing because they allow this switching process to be endogenized, and allow for inferences regarding the timing and nature of such switches.

2.2.3 Regime switching evidence

In the financial literature, the regime switching model has been extensively used.

Schwert (1989) explores a model whereby returns could have either a high or low volatility and the switches between these return distributions are controlled by a two-state Markov chain process. Turner et al (1989) consider a Markov switching model in which either the mean, the variance or both may differ between two regimes. Using S&P monthly index data over the period 1946-1989, they investigate univariate specifications with constant transition probability. Hamilton and Susmel (1994) consider a model with sudden discrete changes in volatility. They estimate models with two to four regimes in which the latent innovations come from Gaussian and Student t-distributions. They find that Markov switching model provides a better statistical fit to the data than ARCH(Autoregressive Conditional Heteroskedasticity) models without switching. Schaller and Van Norden (1997) find strong evidence of switching behavior in the US stock market excess returns. Additionally, they develop a multivariate regression model to investigate whether price/dividend ratio has marginal predictive power for stock market return after accounting for state-dependent switching. Finally, in a study that covers five industrialized countries' stock market returns (Canada, Germany, Japan, United Kingdom and United States), Nishiyama(1998) finds that each market exhibits distinct regimes in volatility, but not in expected mean return. The persistence of the regimes and the frequency of regime shifts are significantly different among the markets. Additionally, the inter-market correlations of regimes are significantly higher in the post 1987 stock market crash period.

In addition to explaining the switching means of stock return, the regime switching model is applied to characterize the conditional variance of equity return.

Hamilton and Susmel (1994) propose a switching ARCH model in which they allow the parameters of the ARCH process to come from one of several different regimes. Although the ARCH process controls the short-run dynamics, the long-run dynamics are governed by regime shifts in the unconditional variance and an unobserved Markov switching process drives the regime changes. These authors apply the model to weekly return data and show that the ARCH effects almost completely fade away after a month. This tends to indicate that in modeling monthly return no ARCH term may be necessary. Cai (1994) presents a new approach to model more realistically the variability of financial time series process; Gray (1996) extended his methodology to regime switching GARCH(Generalized Autoregressive Conditional Heteroskedasticity) -models. Using this methodology, several studies have found that the persistence in second moments decreases significantly once allowance is made for different regimes. The consequence of the spurious persistence in GARCH models is that volatility is underestimated in the high volatility state, and overestimated in the low volatility state.

Besides the means and variances of the financial time series, the regime switching approach has also been popular for examining the mean reversion in the stock return. (Graflund ,2000) argues that the variance ratio test that is often used for analyzing mean reversion may need to be modified to take account of the changes in variance due to changes in regimes. Ang and Bekaert (2001) and Longin and Solnik (2001) argue that the correlation between markets may shift between a high and a low state because of significant changes in the economic and financial environment, like the state of the business cycle, changes in monetary policy stance and/or policy rules

as well as during periods of financial crises. For instance, previous analysis suggests that correlations are higher during bear markets than during bull markets. Furthermore, Lieven (2002) allows volatility in the different European markets to depend on a purely country specific shock, a regional European shock, and a global shock from the US. He even allows for regime shifts in the shock spillover intensity and finds these regime switches to be very important, which implies that shock spillover intensity varies significantly through time. The importance of EU shocks increased for most markets during the 1990, and has become the dominant force for European countries.

Besides the studies on stock returns, some literature also applies the various regime switching models to investigate regime changes of interest rate. Lewis (1991) implements an estimation method to identify, from the term structure of Eurodollar returns, the market's beliefs that the Federal Reserve may revert to interest rate targeting. The model is not rejected and gives plausible estimates of the probability of a switch in monetary regimes. Sola and Driffill (1994) explore the expectations model of the term structure for US data on three- and six-month treasury bills for the period 1962(1)–1987(3). The analysis allows for the nonstationarity of the data, and for unobserved stochastic switches of regime, by estimating VARs in the yield spread and the change in the three-month rate which allow the time series processes to change between regimes. In contrast to other results for the expectations model, they find that the data do not reject the model.

Garcia and Perron (1996) consider the time series behavior of the US real interest

rate from 1981 to 1986, by allowing three possible regimes affecting both the mean and the variance. The results suggest that the ex-post real interest rate is essentially random with means and variances. Gray (1996) develops a generalized regime switching (GRS) model of short-term interest rate. The short rate exhibits a different degree of mean reversion and a different form of conditional heteroskedasticity. The empirical results indicate that all of these generalizations are statistically and economically significant. Ang and Bekaert (2002a) examine the econometric performance of regime-switching models for interest rate data from the United States, Germany, and the United Kingdom. They find that Regime-switching models incorporating international short-rate and term spread information forecast better, match sample moments better, and classify regimes better than univariate regime-switching models. Smith (2002) empirically compares the Markov-switching and stochastic volatility diffusion models of the short rate. The evidence supports the Markov-switching diffusion model. Estimates of the elasticity of volatility parameter for single-regime models unanimously indicate an explosive volatility process, whereas the Markov-switching model's estimates are reasonable. It is found that either Markov switching or stochastic volatility, but not both, is needed to adequately fit the data. A robust conclusion is that volatility depends on the level of the short rate. Finally, the Markov-switching model is the best for forecasting.

More recent, Erlandsson (2003) examines the forecasting properties of endogenous regime switching models for Swedish interest rate volatility. To obtain a valid statistic for determining the exact number of states, a Monte Carlo procedure is

employed. The results point out the ability of regime switching models to account for even very large degrees of leptokurtosis. The final specification, a three-state model with the lagged level and spread between a one month- and three month rate entering both the level and variance equations, is never significantly worse than the benchmarks at any horizon. Jorgen and Jacob (2004) present a model that captures the tendency of real rates to switch between regimes of high versus low level and volatility, the general shape of the term structure in either regime, the relative frequency of the regimes, and the time varying risk premium associated with the yield curve. They do this by supplementing a pure endowment economy model with a simple constant return to scale technology. The characteristics of the resulting equilibrium shift between those of a pure endowment and production economy. The shift induces endogenous regime switching in the real interest rate.

Another group of literature focuses on examining the exchange rate by regime switching models. The power of regime switching approach for exchange rate modeling was firstly demonstrated by Engel and Hamilton (1990) and Engel (1994). They find that Markov-switching model is a good fit for eighteen exchange rates at quarterly and monthly frequencies. This model fits well in-sample at the quarterly frequency for many exchange rates. By the mean-squared-error or mean-absolute-error criterion, the Markov model does not generate superior forecasts at a random walk or at the forward rate. There appears to be some evidence that the forecast of the Markov model are superior at predicting the direction of change of the exchange rate.

Van Norden (1995) develops a new test for speculative bubbles, which is applied to data for the Japanese yen, the German mark and the Canadian dollar exchange rates from 1977 to 1991. The test assumes that bubbles display a particular kind of regime-switching behavior, which is shown to imply coefficient restrictions on a simple switching-regression model of exchange rate innovations. Test results are sensitive to the specification of exchange rate fundamentals and other factors. Evidence most consistent with the bubble hypothesis is found using an overshooting model of the Canadian dollar and a PPP model of the Japanese yen.

Cheung and Erlandsson (2004) present a systematic and extensive empirical study on the presence of Markov switching dynamics in three dollar-based exchange rates. A Monte Carlo approach is adopted to circumvent the statistical inference problem inherent in the test of regime switching behavior. The results suggest that data frequency, in addition to sample size, is crucial for determining the number of regimes.

In addition, some studies employ regime switching method to model the business cycle features. Regime-switching models, such as the Markov-switching autoregressive model (MS-AR), have been widely used in contemporary empirical macroeconomics to characterize certain features of the business cycle and arguably constitute another distinct approach to modeling the business cycle. Ravn and Sola (1995) investigate empirically the stability of the correlation between output growth and inflation using a technique that allows for changes in regime. They look at quarterly data for the U.S. and U.K and find evidence of changes both in means and

variances in both sources of data. They also find that the covariance between output growth and inflation is typically negative and that inflation was procyclical especially in the inter-war years, albeit countercyclical in the post-war period. Hamilton and Lin (1996) investigate the joint time series behavior of monthly stock returns and growth in industrial production. They find that stock returns are well characterized by year-long episodes of high volatility, separated by longer quiet periods. Real output growth, on the other hand, is subject to abrupt changes in the mean associated with economic recessions. Furthermore, Hamilton and Lin (1996) study a bivariate model in which these two changes are driven by related unobserved variables, and conclude that economic recessions are the primary factor that drives fluctuations in the volatility of stock returns. This framework proves useful both for forecasting stock volatility and for identifying and forecasting economic turning points.

Layton (1996) applies Hamilton's Markov switching to monthly growth rates of leading, long-leading and coincident indexes of the US economy. He provides some evidence that Markov switching models provide timely identification of business cycle turning points. Artis *et al* (2000) use Markov switching VAR (MS-VAR) model to identify the common cycle in Europe and confirm the existence of such a cycle. The European business cycle is dated on the basis of regime probabilities. Krolzig (2001) analyzes regime shifts in the stochastic process of economic growth in the US, Japan and Europe over the last four decades by generalizing Hamilton's(1989) model of the US business cycle to a three-regime Markov-switching vector equilibrium correction model. Empirical evidence is established for the presence of asymmetric business

cycles and structural change.

Apart from the above economic indicators, changes in monetary policy also can occur in either the implementation of policy (shocks) or the objectives of policy (regimes). Therefore, switching monetary policy regimes have garnered some attention recently. Clarida, *et al* (2000) estimate a forward-looking monetary policy reaction function for the US economy, pre- and post-October 1979. The results point to substantial differences in the estimated rule across periods. In particular, interest rate policy in the Volcker-Greenspan period appears to have been much more sensitive to changes in expected inflation than in the pre-Volcker period. Clarida, *et al* (2000) then compare some of the implications of the estimated rules for the equilibrium properties of inflation and output, using a simple macroeconomic model. The pre-Volcker rule is shown to be consistent with the possibility of persistent, self-fulfilling fluctuations in inflation and output. Dennis (2001) finds significant differences between the policy regimes in operation during the Burns-Miller and Volcker-Greenspan periods. Policymakers tended to accommodate movements in inflation and policy shift occurrs with Volcker's appointment to Federal Reserve chairman. Boivin and Giannoni (2002) find that changes in the systematic elements of monetary policy are consistent with a more stabilizing monetary policy in the post-1980 period and largely account for the reduced effect of unexpected exogenous interest rate shocks.

Besides the above major aspects, regime switching model is also used in other economic and financial areas. In option pricing, Duan et al (2002) develops a family of

option pricing models when the underlying stock price dynamic is modeled by a regime switching process in which prices remain in one volatility regime for a random amount of time before switching over into a new regime. They provide the theory for pricing options under such processes, present an analytical solution for the special case where returns provide no feedback to volatility levels, and develop an efficient algorithm for the computation of American option prices for the general case. As for asset allocation, Ang and Bakert(2002b) solve the dynamic portfolio choice problem of a U.S. investor faced with a time-varying investment opportunity using a regime switching process which may be characterized by correlations and volatilities that increase in bad time. International diversification is still valuable with regime changes and currency hedging imparts further benefit.

2.3 Real estate return and risk

Much has been written about the return characteristics of direct properties and securitized property, as well as the roles of property assets (direct and indirect) in the structure of a multi-asset portfolio. For example, Venmore-Rowland (1989) has pointed out that an investor with limited capital may consider the alternative of investing in property stocks as means of accessing direct property exposure without introducing excessive liquidity in his portfolio. On the other hand, direct properties have been reported to earn excess returns and provide a hedge against inflation (Glascock and Davidson, 1995). Table 2.1 provides the summary of these studies.

Table 2.2 Key studies on real estate return and risk

Year	Author	Main Findings
1984	Zerbst and Cambon	Property has a strategic role in institutional portfolio diversification.
1987	Sirmans and Sirmans	The risk-return superiority of property remains inconclusive.
1989	Venmore-Rowland	Property stocks can be considered as means of accessing direct property.
1990	Gyourko and Linneman	Property asset has low variances.
1991	Chan and Sng	Direct property displays high return-low risk relations.
1992	Ambrose, *et al*	Real estate stock returns are nonlinear and time-varying
1992	MacGregor and Nanthakumaran	Commercial property exhibits attractive return and risk characteristics, when valuation-based series are used.
1994	Mei and Liu	Real Estate excess return is easy to predict
1994	Young	Property returns are non-normal distribution
1995	Glascock and Davidson	Direct property earns excess return and provides a hedge against inflation.
1995	Kapplin and Schwartz	Real estate securities failed to provide an effective inflation hedge and REIT types do not provide excess returns.
1995	Han and Liang	REITs performance is consistent with the security market line.
1995	Redman and Manakyan	Location and types of real estate investment determine the performance of REITs
1995	Young and Graff	Individual property returns are non-normal distribution
1995	Webb and Rubens	Historical real estate returns are lower than recent data
1996	Newell and Webb	Highlight semi-annual risk and return of Australian and Canadian property
1997	Chen, *et al*	Arbitrage Pricing Theory (APT) more accurately explains real estate returns.
1997	Hsieh	Equity REITs return relates to stock market and bond factors.
1997	Quan and Titman	Prices and rents of commercial properties in 17 countries are consistent
1997	Webb, *et al*	Examining residential property data
1998	Lai and Wang	Appraisal-based data leads to a higher variance
1998	Clayton	The housing market is inefficient
1998	Liao and Mei	Real estate portfolio similar to bond portfolio
1998	Newell and Webb	Report semi-annual risk and return for New Zealand office
1998	Sivitanidies	There is link between fundamental performance indicators in the space market and the office investment returns.
1999	Clayton and Hamilton	Real estate market is relative imperfect and real estate return is not generated in the same way with stock and bond.
1999	Delisle	Real estate market convergent to capital market
1999	Hardin and Wolverton	Apartment equity REITs pay premiums
1999	Quan and Titman	Significant relationship among real estate values, rents and stock returns
1999	Tse, *et al*	Investigate the returns on office property in 3 major cities of China
2000	Brounen, *et al*	Equity REITs are used for developing properties
2000	Byrne and Lee	Property has the potential benefits of diversification.
2000	Glascock, *et al*	REITs perform more like stocks and less like bonds
2001	Liow	Performance of property stock led real estate market performance.
2002	Newell, *et al*	Overview the development of Malaysia LPTs

Year	Author	Main Findings
2002	Kallberg, *et al*	Real estate markets are subject to structural changes
2004	Newell, *et al*	Australian property returns are nonlinear
2005	Liow, *et al*	There are regime changes in international securitized real estate markets

There are many studies on real estate returns that focus on the performance of different types of direct properties in US. Using various databases, such as the Russell-NCREIF, returns of specific types of properties are examined. Zerbst and Cambon (1984) investigate the risk-return characteristics of direct properties relative to other investment assets like common stocks and bonds. Although there is some agreement that property has a strategic role in institutional portfolio diversification, other evidence to date remains inconclusive regarding the superiority of the risk-return performance of direct properties relative to stock market and other investment types(Sirmans and Sirmans, 1987). Individual property returns are found to have a non-normal distribution in several studies (Young, 1994; and Young and Graff, 1995). Using the condominium housing market data, Clayton (1998) finds the housing market inefficient, since the future price movements are contingent on past housing price movements and the ratio of current rents to house prices. Furthermore, a rise in house prices results somewhat from irrational expectations and, when based on past price movements, signifies a future correction. Mei and Liu (1994) find real estate excess returns easier to predict than returns of all other assets.

Appraisal smoothing has long been noted as a significant factor to consider when analyzing the inherent risk and the level of variances associated with specific real

estate valuation or performance. Gyourko and Linneman (1990) attribute the low variances for income-producing property to synthetic leveraging and the stable nature of rents. Lai and Wang (1998) find that the use of appraisal-based data may lead to a a higher variance than that of true returns and thus suggest that the unique characteristics of real estate market may more likely explain the low variance in real estate. Graff (1998) simulates quarterly appraisal-based returns and concludes that seasonality leads to a bias in returns.

For the U.K., MacGregor and Nanthakumaran (1992) showed that commercial property, up to that time, exhibited attractive return and risk characteristics when valuation-based series are used. From a mean-variance criterion perspective, their results demonstrated that real estate dominated bonds in the U.K., a result comparable to that reported earlier by Ibbotson and Siegel (1984). Byrne and Lee (2000) use UK local and segmental property markets data to investigate potential benefits and limitations of equal and value-weighted diversification of property market.

Studies have also been undertaken for several other countries, such as Australia, Canada, New Zealand and South Africa. Newell and Webb (1996) highlight semi-annual return and risk figures for Australia and Canada for the period 1985 through 1993. In a further study, Newell and Webb (1998) report semi-annual return and risk figures for New Zealand offices over the period 1990 through 1995, and annual figures for South African commercial property for 1980 through 1995. The results for these four countries were different from those observed in the U.S. and the

U.K. From a mean variance perspective, bond returns in Australia, New Zealand and South Africa dominated real estate returns. Sivitanidies (1998) examines the prospects for office property investment for period 1997-2001. It finds that there is link between fundamental performance indicators in the space market and the office investment returns. In China, Tse, *et al* (1999) investigate the returns on office property in three major cities of Shanghai, Guangzhou and Shenzhen.

As an investment alternative of direct property, equity (indirect) property also attracts same attention in the real estate research area. The return and risk on REIT investments are examined in many recent studies. Redman and Manakyan (1995) find variables, such as financial ratios, regional location of properties and types of real estate investments, to be significant in determining the risk-adjusted performance of REITs. Hsieh (1997) find the returns of equity REITs to be significantly related to three stock market factors and two bond market factors. Glascock, *et al* (2000) find that since the early 1990s REITs have performed more like stocks and less like bonds, and that the diversification benefits of REITs have fallen since 1992. It is also found that the risk and returns of REITs can be improved by switching between real estate and large and small stocks using the P* strategy (Bond and Webb, 1995).

Kapplin and Schwartz (1995) examine the returns of 54 USA real estate securities (classified into three types) over a three-year period. Their key findings are that real estate securities fail to provide an effective inflation hedge and REIT types did not provide return in excess of the market. The long-term performance analysis of USA

REITs appears in Han and Liang (1995). Using the traditional Jensen index, their results indicate that the performance of the REIT portfolios was consistent with the security market line in the 1970-1993 periods. They also conduct the Chow Tests on the stability of REIT performance over time. Their evidence indicates that REIT performance was not stable over the sample period. The short-term (six-year) variations in REIT performance were significantly different in some circumstances. This suggests that the historical performance may have limited power to predict the future performance of REITs.

Several studies focus specifically on certain types of REITs. Apartment equity REITs may pay premiums only for specific markets and under certain conditions, according to a study by Hardin and Wolverton (1999). Over half of all infinite life equity REITs are used for developing properties that have a high market capitalization, such as outlet centers and regional malls (Brounen, *et al.* 2000). Chen, *et al* (1997) use equity REIT data to examine whether Arbitrage Pricing Theory (APT) is more accurately applied using either derived factors or macro variables for explaining real estate returns.

Newell, *et al* (2002) presents an overview of the development of the listed property trust sector in Malaysia, with performance analysts over 1991-2000. In Singapore, Liow (2001) investigates the long-term performance of Singapore property stock performance.

Besides the examination of risk and return performance of direct and indirect real

estate, there are some studies comparing the returns of real estate with returns of other financial assets, such as stocks and bonds. The nature of the convergence of real estate and capital market is discussed in Delisle (1999). Several studies compare the performance of real estate to that of other financial assets. Liao and Mei (1998) find expected real estate returns of a portfolio holding both bonds and real estate to be similar to those of either asset alone. Furthermore, investors could achieve higher returns and lower risk from switching back and forth between bonds, stock and real estate instead of holding only bonds or stocks in their portfolios.

Two studies incorporate international differences into these comparisons. An interesting approach by Quan and Titman (1997) concludes that prices and rents on commercial properties in seventeen countries are consistent with stock returns in the international markets, but not in the US. A later study by these researchers confirms the significant relationship among real estate values, rents and stock returns and explains the relationship by stating that changes in real estate value and rents are significantly related to changes in GDP (Quan and Titman, 1999).

Some studies indicate that a wide range of returns are found for real estate and other financial assets. Webb and Rubens (1995) examine data from 1960-1986 and find consistently lower average annual return rates for real estate assets than did those studies examining the real estate assets than did those studies more recent data. Webb, *et al(1997)* examining data from 1979-1995 indicate a rang of 8.17%--8.24% returns for residential real estate. The standard deviations reported for these properties in these

two studies are also higher in the study using more recent data.

Although these extensive investigations of return and risk performance of real estate market are quite significant, most of them are based on the assumption that only one return model is applied in full sample period and give little attention to the issue of structural or regime changes. It is likely that regime changes in securitized real estate returns and volatility can occur, for example, due to changes in institutional environment, changes in fiscal and interest rate policy, and sudden external shocks such as the 1987 stock market crash and 1997 Asian financial crisis. This will result in different states of the market with different patterns of risk-return behavior and interactions. Hence it is necessary to consider the securitized market behavior in the light of discrete regime shifts.

Admittedly, some papers, like Han and Liang (1995) and Kallberg, *et al* (2002), consider the structural changes or regime switching in the real estate market , but they just use some statistical tests such as the Chow test and BLS technique. Furthermore, there is some evidence that real estate stock returns are nonlinear, time varying and unstable over time (Ambrose et al, 1992 and Newell et al, 2004). Liow *et al* (2005) formally explore the presence of regimes in real estate return and volatility using a set of international exchange-based real estate index data from the USA, the UK, Singapore, Hong Kong, Japan and Australia markets. They find that regime changes in securitized real estate markets result in different states of the markets with different patterns of risk-return behavior and state interactions.

2.4 Direct real estate, securitized real estate and stock markets

Table 2.3 Key studies on direct, securitized real estate and stock markets

Year	Author	Main Findings
		Relationship between stock and direct real estate markets
1984	Ibbotson and Siegel	There is a low correlation between real estate and SP stocks.
1986	Hartzell	The quarterly data represent a low correlation between US commercial real estate and stock market.
1990	Geltner	The real estate and stock markets are segmented.
1990	Liu, *et al*	The price movement of the US physical real estate market has different random patterns from that of the stock market.
1990	Miles, *et al*	There exists segmentation within real estate market and stock market.
1993	Worzala and Vandell	The real estate correlation with stock returns is low in UK market.
1994	Fu	There is integration between stock market and residential property market.
1995	Cheung, *et al*	There is integration between stock market and property market.
1996	Eichholtz and Hartzell	There is segmentation between property and stock indexes in Canadian, UK and US markets.
1996	Wilson, *et al*	The Australia physical real estate market is segmented from the stock market.
1997	Fu and Ng	There is a low contemporaneous correlation between a transactions-based real estate index and stocks in Hong Kong market.
1999	Quan and Titman	There is a significant relationship between stock returns and both rents and value changes.
1999	Wilson and Okunev	There is long co-memory effect between stock and property market in Australia market.
2000	Wilson and Zurbruegg	The Strong unidirectional relationship running from stock market to real estate market
2001	Tse	There is integration between stock market and property market.
		Relationship between Securitized Property and Direct Property Markets
1990	Giliberto	Lagged REITs values explain current unsecuritized real estate returns.
1991	Chan and Sng	The differences in real estate and property stock returns are not significant.
1992	Gyourko and Keim	Lagged REIT returns are strong predictors of unsecuritized real estate returns.
1993	Myer and Webb	EREITs are found to lead, or Granger cause, unsecuritized real estate returns.
1995	Barkham and Geltner	The lag in the unsecuritized data is a year or more.
1995 (a)	Ong	There is a cointegration between real estate assets and property stocks.
1995 (b)	Ong	There is no long-term contemporaneous relationship between the property stock and real estate price series.

Year	Author	Main Findings
1996	Newell and Chau	Each of the real estate companies has high positive correlation with the stock market.
1996	Giliberto and Mengden	There is close links between REIT and unsecuritized real estate returns.
1996	Liow	There is a significant co-movement between the property stock market and real estate market.
1997	Acton and Poutasse	The US securitized real estate and unsecuritized real estate market is integrated.
1998 a	Liow	Property stock returns lead property returns by three to six months.
1998 b	Liow	There is no long-term contemporaneous relationship between property stock and commercial property prices.
2001	Chau, Macgregor and Schwann	Securitized real estate returns have low relationship with the appraisal based real estate returns.
2001	Brown and Liow	There is significant price co-movement between the commercial real estate and property stock prices in the long run.
	Relationship between Securitized Property Market and Stock Market	
1990	Giliberto	Lagged REITs values explain current unsecuritized real estate returns.
1991	Chan and Sng	The differences in real estate and property stock returns are not significant.
1992	Gyourko and Keim	Lagged REIT returns are strong predictors of unsecuritized real estate returns.
1993	Myer and Webb	EREITs are found to lead, or Granger cause, unsecuritized real estate returns.
1995	Barkham and Geltner	The lag in the unsecuritized data is a year or more.
1995 a	Ong	There is a cointegration between real estate assets and property stocks.
1995 b	Ong	There is no long-term contemporaneous relationship between the property stock and real estate price series.
1996	Newell and Chau	Each of the real estate companies has high positive correlation with the stock market.
1996	Giliberto and Mengden	There is close links between REIT and unsecuritized real estate returns.
1996	Liow	There is a significant co-movement between the property stock market and real estate market.
1997	Acton and Poutasse	The US securitized real estate and unsecuritized real estate market is integrated.
1998 a	Liow	Property stock returns lead property returns by three to six months.
1998 b	Liow	There is no long-term contemporaneous relationship between property stock and commercial property prices.
2001	Chau, Macgregor and Schwann	Securitized real estate returns have low relationship with the appraisal based real estate returns.
2001	Brown and Liow	There is significant price co-movement between the commercial real estate and property stock prices in the long run.

Direct real estate market is the underlying market of securitized real estate. And the performance of the securitized real estate sector will, ultimately, be based on the performance of underlying real assets. Also, securitized property market is an important part of stock market and generally displays a strong contemporaneous correlation with the overall stock market. Therefore, thoroughly understanding these three markets' interrelationship can provide a whole picture on securitized real estate performance and movement.

2.4.1 Relationship between stock and direct real estate markets

The relationship between stock and property markets has been the focus of real estate literature in recent years. There is however no consensus on whether the two markets are integrated or segmented, either in the short-term or in long run. Empirical studies find different evidence across various countries and time spans.

Some studies find that the real estate market is segmented from the stock market and hence institutional investors benefit from this segmentation because of the low correlation between the two markets. A long list of the literature provides evidence for the segmentation of the two markets. Examples of the studies include Ibbotson and Siegel (1984); Hartzell (1986); Geltner (1990); Liu *et.al* (1990); Miles *et.al* (1990); Worzala and Vandell (1993); Eichholtz and Hartzell (1996); Wilson *et.al* (1996); and Fu and Ng (1997).

Using annual US commercial real estate data from 1947 to 1982, Ibbotson and Siegel (1984) find the correlation between real estate and stocks to be –0.06, while

Hartzell (1986) finds the correlation to be –0.25 using quarterly data from 1977 to 1986. Geltner (1990) tests the integration of various real estate markets and stock markets. He finds that the noise component of real estate and stock returns are different and concludes the two markets are segmented. Evidence from Liu et al (1990) supports the notion of market segmentation with appraisal-based returns. They find that the US securitized real estate market is integrated with the stock market. However, their results indicate that the US commercial real estate market is segmented from the stock market. The price movement of the US physical real estate market, unlike that in securitized real estate market, is found to have different random patterns from that of the stock market.

Besides the US studies above, the literature of other countries also provides support for the segmentation. In UK, Worzala and Vandell (1993) estimate the real estate correlation with stock returns to be low. Eichholtz and Hartzell (1996) further document the segmentation between property and stock indexes using Canada, UK, and US data. In an Australia's study, Wilson *et al* (1996) use the arbitrage pricing framework to investigate the degree of integration between the real estate and stock markets. The results show no conclusive evidence for the integration of the two markets to suggest that the Australian physical real estate market is segmented from the stock market. More recently, for Hong Kong, Fu and Ng (1997) cite a low contemporaneous correlation between a transactions-based real estate index and stocks for over the studying period from 1980 to 1996.

Another group of studies support the integration between the real estate market and the stock market. These studies include Fu (1994); Cheung, *et al*(1995); Quan and Titman (1999); Wilson and Okunev (1999); Okunev, *et al* (2000); and Tse (2001). There is irregularity in respect to the linearity of the relationship and the presence of relationship over different time period intervals. Nevertheless, the studies do provide some significant evidence of the integration between the two markets from various aspects.

Fu (1994) finds that the Hong Kong stock market leads the residential property market prices-- this implies an integration between the two markets. His finding is supported by Cheung, *et al*(1995) and Tse (2001) . Using data from 17 countries over 14 years, Quan and Titman (1999) examine the relationship between stock returns and changes in property values and rents. They find that the contemporaneous relation between yearly real estate price changes and stock returns is statistically insignificant in the 17 countries with the exception of Japan. But when they pool the data across countries and test over longer measurement intervals, they find that the relationship between stock returns and both rents and value changes becomes significant. Wilson and Okunev (1999) do not find evidence of so called “long co-memory effects” between stock and property markets in UK and US, but they find some evidence of this in Australia. More recently, Okunev, *et al*(2000) conduct both linear and nonlinear causality test. While their linear tests produce spurious results, the nonlinear causality tests suggest a strong unidirectional relationship running from the stock market to the real estate market. They hence conclude there is a nonlinear relationship between the

two markets.

2.4.2 Relationship between securitized property and direct property markets

The relationship between securitized real estate and physical real estate markets has been of significant interest in the literature. Some extant studies focus on the time series of REITs and real estate data in US (Giliberto, 1990; Gyourko and Keim, 1992; Myer and Webb, 1993; Giliberto and Mengden 1996; Acton and Poutasse, 1997); while others literature examine property company shares and physical real estate in markets such as UK (Barkham and Geltner, 1995) Hong Kong (Newell and Chau, 1996; Chau *et al* 2001) and Singapore (Chan and Sng, 1991; Ong, 1994, 1995; Liow, 1996, 1998a, 1998b; Brown and Liow, 2001).

Studies on the relationship between the US REITs and appraisal-based real estate indices tend to show strong correlations between the two markets, though the results vary. In view of the significant relationship between the two markets, many researchers conclude that knowledge of the securitized real estate market is an alternate way of understanding the real estate market. Giliberto (1990) presents evidence of significant correlations between equity REITS and real estate returns. He suggests the presence of a common factor or factors associated with real estate that affects both return series. Gyourko and Keim (1992) find that lagged values of EREIT returns are able to predict direct property returns after controlling for "persistence" in the appraisal series. Specifically, they find that important information about real estate fundamentals is impounded in REIT returns, especially when these are adjusted to control for general

market factors; and that REIT returns during the year are a significant predictor of NCREIF index movements at year end. Using a measure of Granger causality, Myer and Webb (1993) examine the inter-temporal relationship between EREIT and real estate returns in US over the period 1978 to 1990. They find that the EREIT index returns Granger cause commercial property returns. In this sense, EREITs are more strongly linked to physical real estate market returns than small capitalization stocks and close-end mutual funds.

Barkham and Geltner (1995) explore the presence of price discovery between securitized and unsecuritized commercial real estate market in the UK and US. They find a strong positive correlation between the securitized and unsecuritized real estate returns by a lag of one year for the two countries. In addition, they find there is a causal relationship between the securitized and unsecuritized real estate markets in the UK.

Unlike the US and UK studies, studies on the Hong Kong market find weak evidence for high correlations between the securitized real estate and the physical real estate markets. The evidence therefore is used to support the claim that diversification benefits exist within the real estate asset class. Newell and Chau (1996) investigate the linkages between Hong Kong property company performance and commercial property performance. Using property company and direct property returns over 1984 to 1994, a range of key property investment issues are assessed, including lead/lag relationships, impounding and informational and structural efficiency of the

commercial property market. Their results show that all their real estate companies have high positive correlation with the stock market. However, they find a low positive correlation between the property stock and real estate markets. Similarly, Chau *et al* (2001) also conclude that the Hong Kong securitized real estate returns convey little or no information about the appraisal based real estate returns.

In Singapore, a general consensus is that there is a relationship between the securitized property market and physical real estate market. Chan and Sng (1991) analyze the returns on property stocks and real estate in Singapore from 1976 to 1988 and conclude that the differences in real estate and property stock returns are not statistically significant. Ong (1995a) test the contemporaneous long-term relationship between property stocks and real estate using the structural and Vector Autoregressive (VAR) approach. The evidence shows the presence of cointegration between the two markets. However, in another study of Ong (1995b), results suggest no long-term contemporaneous relationship between the property stock and real estate price series. Liow (1996) provides evidence on the variations of Singapore property companies' share price discounts/premiums and their relationships with property market returns over a 15-year period. The results indicate significant co-movement between the two markets' performance; changes in property company ratings are found to lead changes in the all-property, residential, commercial and industrial property returns by up to a maximum of six months. Liow (1998a) provides further evidence that property stock returns lead property returns by three to six months. On the other hand, Liow (1998b) demonstrates that there is no evidence of long-term contemporaneous relationship

between property stock and commercial property prices. Finally Brown and Liow (2001) examine the cyclical characteristics of Singapore commercial real estate and property stock prices and their frequency space correlation for the period 1975–1998 by using univariate spectral analysis and cross-spectral analysis. They report that the commercial real estate and property stock prices exhibit cyclical patterns and there exists significant price co-movement between the two markets in the long run.

2.4.3 Relationship between securitized property market and stock market

An extensive literature is available to suggest that the securitized property market generally displays a strong contemporaneous correlation with the overall stock market. Liu *et.al.* (1990) provide evidence of integration of the equity REIT and the stock market. Ambrose *et al* (1992) employ a rescaled range analysis to test the deterministic nonlinear trend in the return series. Their results show that mortgage and equity real estate investment trusts both display similar return generating characteristics to the overall stock market. They therefore conclude that the two markets are integrated. Li (1995) finds that the REIT market in US is strongly integrated with the general stock market and that the unexplained return volatility is similar in magnitude to other industrial sectors. By contrast, Wang *et.al*. (1995) find differences in terms of liquidity, information dissemination, and pricing mechanisms between REITs and matching stocks. Okunev and Wilson (1997) develop a non-linear mean reverting stock price model and find that the US securitized real estate market is not linearly related to the overall stock market, but there is a weak non-linear relationship between the two

markets.

In the UK, Lizieri and Satchell (1997b) find that the securitized property market and the stock market have a strong contemporaneous correlation when they conducted regression analysis on the overall stock index and the lagged property stock index. Their Granger causality tests show that the overall stock index leads the property stock index and this strong relationship is found to be evident in both short-term and long-term lags.

Overall, the current research on the relationships among physical, securitized property and stock markets has presented comprehensive but varying results in different regions. Generally, the three markets relate and affect each other because of the common underlying factors. However, the relevant studies pay a little attention to the nonlinear or time-varying relationship among these markets. Most of the empirical results are based on the linear assumption.

2.5 Real estate in the macroeconomy

Table 2.4 Key studies on real estate in macroeconomy

Year	Author	Main Findings
		Stock Market and Macroeconomic Conditions
1981	Fama	Real economic variables are related to US share returns.
1986	Chen, *et al*	Some macroeconomic variables are rewarded in the stock market.
1989	Bodurtha, *et al*	Both domestic and international forces are determinants of equity returns
1991	Ferson and Harvey	The stock market risk premium is the most important for capturing predictable variation of the stock portfolios.
1993	Ferson and Harvey	Average returns in national equity markets are related to the volatility of their price-to-book ratios.

1994	Harvey	The local information variables represent the variance in the stock returns of emerging markets.
1995	Sill	The conditional variance-covariance of the macroeconomic factors are important drives of the conditional stock return volatility.
1995	Domain and Louton	There is asymmetric relationship between CRSP stock index return and the U.S. unemployment rate.
1997	Liljeblom and Stenius	There is a significant relationship between the stock market volatility and macroeconomic volatility.
1998	Kearney and Daly	Some macroeconomic factors are important determinants of conditional volatility of Australian stock market.
1998	Cheung and Ng	There are long run co-movement between five national stock market indexes and measures of aggregate real activity.
2001	McMillan	The financial variables can provide nonlinear predictability for stock market returns.
2002	Fifield, *et al*	Both international factors and local information explain the emerging stock market returns.
2002	Holmes and Maghreibi	There is nonlinear relationship between Asian equity and foreign exchange
2004	Hess	Foreign stocks exert a strong influence on an integrated stock market, and the stage of the business cycle heavily affects the signals of the shocks.
	<u>Real Estate Markets and Macroeconomic Factors</u>	
1987	Kling and McCue	The office overbuilding and market cycles result from a decline in nominal interest rates.
1990	Chan, Hendershott and Sanders	Bond market risk premiums and stock capitalization explain the variation in REIT returns.
1994	McCue and Kling	The state of economy explains the variation in REIT return series.
1995	Mueller and Pauley	Low Correlation between REIT price and Changes in interest rate.
1997	Ling and Naranjo	Macroeconomic factors have influence on commercial real estate returns.
1997a	Lizieri and Satchell	There is a short term and long term relationship between the real estate market and economy.
1997b	Lizieri and Satchell	The rate of real interest rate has an influence on property company share prices.
1998	Ganesan and Chiang	Real estate assets are not good inflation hedge.
1998	Chen, *et al*	Macroeconomic and financial vairiables affect the cross-section of REIT return variations.
2000	Sing and Low	Real estate provides a better hedge against inflation in Singapore market.
2001	Chau, Macgergor and Schwann	Both capital market and local economic explain the property returns in Hong Kong market.
2002	Glascock, Lu and So	The negative relationship between REITs returns and inflation is a manifestation of the effects of changes in monetary policies.
2003	Downs, *et al*	REITs returns respond differently to changes of macroeconomic variables.
2004	Liow	First and second conditional moments of real estate returns are related to the conditional variances and covariances of the macroeconomic factors.

2.5.1 Stock market and macroeconomic conditions

Economic conditions and forces are important influences on the equity market, and the financial asset returns should reflect the changes in economic activity. There is a great deal of evidence that the expected variations in stock and bond returns are related to the state of the economy as reflected in the key macroeconomic variables. Fama (1981) and Chen *et. al*. (1986) are the first researchers who document that some real economic variables such as industrial production, interest rates, inflation, real GNP and the money supply are related to US share returns. For example, Chen, Roll and Ross (1986) test whether innovations in macroeconomic variables are risks that are rewarded in the stock market. They find that the following macroeconomic variables: the spread between long and short interest rates, expected and unexpected inflation, industrial production, and the spread between high- and low-grade bonds, are significantly priced in the stock market. Furthermore, neither the market portfolio nor aggregate consumption is found to be priced separately. In addition, they conclude that the oil price risk is not separately rewarded in the stock market.

Ferson and Harvey (1991) provide an analysis of the predictable components of monthly common stock and bond portfolio returns. Most of the predictability is associated with sensitivity to economic variables in a rational asset pricing model with multiple betas. The stock market risk premium is the most important for capturing predictable variation of the stock portfolios, while premiums associated with interest

rate risks capture predictability of the bond returns. Recently, using a multi-beta asset-pricing model and allowing for time variation in economic risk premiums and asset betas, Karolyi and Sanders (1998) investigate the time-varying risk premiums in stocks, bonds and REITS return. They find that the economic risk variables from the multi-beta asset pricing models can explain a comparable amount of both of the predictable variation in both the REIT returns and the small stock returns.

Several studies extend to the international and emerging markets. Literature along this trend includes the studies by Bodurtha, Cho and Senbet (1989), Ferson and Harvey (1993), Harvey (1994), Cheung and Ng (1998), and Fifield, Power, and Sinclair (2002). These studies in various markets provide relevant comparison with US and UK evidence. Bodurtha, Cho and Senbet (1989) detail an analytic approach to select macroeconomic factors by reducing the dimensionality of the various relevant economic forces with limited priors. Their findings show that both domestic and international forces are determinants of equity returns.

Ferson and Harvey (1993) study the relationship between average and conditional expected returns in national equity markets and the number of fundamental country attributes of some emerging countries. The attributes are organized into three groups. The first is the relative valuation ratios, such as the price-to-book-value, cash flow, earnings and dividends. The second group measures relative economic performance and the third measures industry structure. They find that average returns across countries are related to the volatility of their price-to-book ratios. Predictable variation

in returns is also related to relative gross domestic product, interest rate levels and dividend-price ratios. Later, Harvey (1994) evaluates the ability of both global and local variables to predict stock returns. He finds that that the local information variables accounted for more than half of the predictable variance in the returns of the emerging markets.

Using the Johansen (1988) cointegration technique, Cheung and Ng (1998) reach a similar conclusion as Bodurtha, Cho and Senbet (1989) and Ferson and Harvey (1993). They find empirical evidence of long run comovements between five national stock market indexes and measures of aggregate real activity including real oil price, real consumption, real money, and real output. Most recently, Fifield, Power, and Sinclair (2002) investigate the extent to which global and local economic factors explain stock market returns of 13 emerging countries. The economic factors are determined using principle components analysis. The results suggest that the local economic variables included in this study can be summarized by GDP, inflation, money and interest rates, while the selected global variables can be sufficiently characterized by world industrial production and world inflation. These components are then used as inputs into a regression analysis in order to explain the index returns of the 13 emerging stock markets over the period 1987 to 1996. The analysis indicates that while world factors are significant in explaining emerging stock market returns, local factors may also play a crucial role.

Instead of investigating predictability of stock returns, some studies analyze the

relationship between conditional stock market volatility and macroeconomic volatility (Sill, 1995; Liljeblom and Stenius, 1997; Kearney and Daly, 1998). Sill (1995) investigates the link between the UK stock market volatility and macroeconomic risk. He relates the expected stock excess returns and the conditional variance of stock excess returns to conditional variance-covariance of a set of macroeconomic factors. Generally, the results suggest that the conditional first and second moments of stock excess returns are time varying and are dynamically related to the macroeconomic risk. The explanatory power of industrial production growth, bond premium, inflation, and short-term interest rates are explored in the study. With the exception of bond premium, Sill (1995) documents that industrial production, T-bill rate and inflation are statistically significant in explaining stock market returns and hence the conditional variance-covariance of the three macroeconomic factors are important drives of the conditional stock return volatility.

Using Finnish data, Liljeblom and Stenius (1997) find significant result from stock market volatility as a predictor for macroeconomic volatility, as well as the converse. Kearney and Daly (1998) conclude that the conditional volatilities of inflation, interest rates, industrial production, the current account deficit and the money supply growth are the most important determinants of the conditional volatility of the Australian stock market. Specifically, the conditional volatilities of inflation, interest rates are directly associated with stock market volatility, while the conditional volatilities of industrial production, the current account deficit and the money supply growth are indirectly related to stock market volatility.

Despite the fertile evidence on the relationship between equity returns and macroeconomic driving forces, most of the studies are based on the linear assumption or suppose single relationship pattern. Given the dynamic and cyclical fluctuation of macro economy, some studies also propose the time-varying, nonlinear or asymmetric relationship between stock market and corresponding economic factors. It argues that the standard method may yield biased results due to the omission of time-varying, state-dependent or asymmetric dynamics in the relationships.

Domain and Louton (1995) display and estimate models of asymmetric relationship between CRSP stock index returns and the U.S. unemployment rate. Their results show that negative stock returns are quickly followed by sharp increases in unemployment, while more gradual unemployment declines follow positive stock returns. According to the forecasting model, the unemployment rate rises by 1.12 percentage points during the 12 months after a 10 percent stock decline. McMillan (2001) tests the evidence of a nonlinear relationship between stock market returns and macroeconomic and financial variables, and whether this nonlinearity can be exploited to improve forecasts of returns. The empirical results illustrate the nonlinear predicictability of stock market returns using financial variables, more specifically interest rates. In addition, he finds that the nonlinear model outperforms the liner model both in-sample and out-of-sample, although the forecast gain is marginal. Holmes and Maghrebi (2002) explore the possibility of a nonlinear relationship between Asian equity and foreign exchange markets. The nonlinearity is modeled using a regime-switching Markov model. They report the evidence of the

nonlinearities where the effect of changes in the exchange rate on stock market return is regime-dependent except for Hong Kong whose strong currency peg contributes to the segmentation of its stock and foreign exchange markets. More recently, Hess (2004) analyze the transmission mechanisms of macroeconomic shocks on the stock market of a small open economy. They use a time-varying vector error correction model that allows analysis of asymmetric impacts that depend on the state of the business cycle. Their results report that foreign shocks exert a strong influence on an integrated stock market, and that the stage of the business cycle heavily affects the signals of the shocks.

2.5.2 Real estate market and macroeconomic factors

There are numerous studies that investigate the relationship between macroeconomic factor impacts on the real estate market. It is believed that the economic fundamentals underlying the stock market and real estate market should be the same given that the two markets are both important segments of an economy. Hence, the macroeconomic factors that appear in the stock market literature should provide some guide on the choice of economic factors that influence the real estate market.

Previous studies support the notion that macroeconomic factors have strong impacts on the real estate market. Kling and McCue (1987) consider the influence that macroeconomic factors have on US office construction. They employ VAR models that include monthly office construction, money supply, nominal interest rates, output

(GNP) and conclude that office overbuilding and market cycles result from a decline in nominal interest rates that raise developers' projections of GNP and future demand for space on a macroeconomic level. In fact, US real estate studies generally utilize the securitized real estate indices to investigate the relationship between the property market and the economy. Using REITs data as proxy, Chan, *et al* (1990) investigate the influence of some pre-specified macroeconomic factors such as inflation rate, interest rates term and risk structure, and industrial production on real estate returns. They find that bond market risk premiums such as the term spread and the risk spread as well as the stock market capitalization are the most important macroeconomic variables for explaining the average variation in REITs returns. In the study of McCue and Kling (1994), they use the VAR model to examine the relationship between macroeconomic variables and real estate returns. The results show that nominal rates, output and investment directly influence the real estate returns. The state of the economy explains almost 60% of the variations in REITs return series. Mueller and Pauley (1995) document a low correlation between REIT price movements and changes in interest rates. Additionally, the study indicates that REIT returns have a lower correlation with interest rate movements than does the stock market.

In the study by Karolyi and Sanders (1998), they find that there are varying degrees of predictability among stocks, bonds, and REITs and that most of the predictability of returns is associated with the economic variables employed in the asset pricing model. In addition, they find that there is an important economic risk premium for REITs that is not represented in conventional multiple-beta asset pricing

models. Chen *et al* (1998) modify the approach presented by Chen, Roll and Ross (1986) and apply it to equity REITs to determine if macroeconomic and financial market variables that have been shown to impact traditional equities also affect the cross-section of REIT return variations. Their study finds that these economic and financial variables have minimal impact upon REIT return volatility. Their study observes that only an unexpected change in the term structure of interest rate significantly affects volatility of the total return of equity REITs. The latest evidence comes from Downs, *et al* (2003), who investigate the relationship of returns of REITs with five economic variables: industrial production, construction starts, mortgage rates, and equally weighted stock market index, and the Treasury bill. They observe REIT returns respond differently to changes in macroeconomic variables to movements in the U.S. equity market.

In the UK, Lizieri and Satchell (1997a) use a two-sector analytic model to explore the relationships between real estate and the economy. Causality analysis suggest that the wider economy leads the real estate market in the short term but that, with a longer lag structure, positive real estate returns may point to negative future returns in the economy. Brooks and Tsolacos (1999) develop a VAR model to investigate the impact of macroeconomic and financial variables on UK real estate return. The rate of unemployment, nominal interest rates, and spread between the long- and short-term interest rates, unanticipated inflation and dividend yield are selected as macroeconomic variables. The results are not strongly suggestive of any significant influences of these variables on the variation of the filtered property returns series.

There is, however, some evidence that interest rate term structure and unexpected inflation have contemporaneous effects on property returns.

There is also evidence of a relationship between the economy and its corresponding property sector in the emerging markets, such as Hong Kong and Singaore, though literature is very limited. Evidence is mirrored from price discovery research. Chau, Macgergor, and Schwann (2001) examine price discovery for four sectors of the Hong Kong property market. The results illustrate that both capital market variables and local economic variables are significant in explaining the appraisal-based returns to Hong Kong property. The two sets of variables account for about 58% to 87% of the total variation in returns, with capital market factors contributing between 32% and 75% to the explanatory power. More recently, Sing (2003) finds manufacturing GDP to account for an average 67.1% of the variance of the private industrial space demand.. Liow (2004) empirically investigate the behavior over time of excess returns on commercial real estate in Singapore. Specifically, the evidence illustrates that the first and second conditional moments on office and retail real estate excess returns are related to the conditional variances and covariances of the macroeconomic factors.

Furthermore, the relationship between interest rate and real estate return has long been tracked by academics. Lizieri and Satchell (1997b) conclude that real interest rate has an influence on property company share prices but the behavior differs in high interest rate and low interest rate regimes. They argue that in conventional valuation

methodologies, rents are capitalized using an initial yield which is dependent on nominal interest rates. As a result, the importance of interest rates and the slope of the yield curve in explaining the intertemporal variation in real estate returns has been the subject of empirical research. Lizieri *et al* (1998) also use threshold autoregressive (TAR) model with regimes defined real rate of interest to examine US and UK commercial real estate markets. Both of these two papers employ the TAR and subjectively define the interest rate as the regime trigger. Actually, the real estate regimes can be triggered by various economic factors, not only by the interest rate. Also, the threshold value for the model is arbitrary. This study distinguishes with these two papers by using Markov Switching models and allowing the switching process to be endogenized, and allow for inference regarding the timing and nature of such switches. And the study also assumes the regime switching of securitized real estate is caused by a variety of economic factors.

Lizieri and Satchell (1997b) and Lizieri *et al* (1998) observe two regimes in U.K. and U.S. property markets, with one lower interest rate and the other higher interest rate regime. The lower interest rate regime is characterized by mean reverting behavior about a positive trend. By contrast, in the higher interest rate regime, random walk behavior around a negative trend is observed. In general, the results suggest that the price/return falls in high real interest environments are sharper than the rise associated with lower real rates.

However, this study display securitized real estate market exhibits two distinct

regimes (low return-high volatility; high return-low volatility). And the impact of interest rate on securitized real estate is state-dependent and asymmetric. And interest impacts securitized real estate in recession higher than in expansion phases.

Chris and Sotiris (2001) consider the effect of short- and long-term interest rates, and interest rate spreads upon real estate index returns in the UK. Using Johansen' s vector autoregressive framework, it is found that the real estate index cointegrates with the term spread, but not with the short or long rates themselves. The bulk of this work is in the context of the US market. Ling and Naranjo (1997) use nonlinear multivariate regression techniques to examine the time-varying risk factor sensitivities and return premia, and to identify the fundamental macroeconomic drivers that systematically affect real estate returns. They find that growth rate in real per capita consumption, real Treasury Bill rate, term structure of interest rates and unexpected inflation have influence on commercial real estate returns. The results report that the term structure of interest rates and unexpected inflation do not carry statistically significant risk premiums in the fixed-coefficient model, but are significant when sensitivities and risk premiums are allowed to vary over time. Mueller and Pauley (1995) looked especially at the effects of interest rates on REIT price changes. Their study did not establish significant effect on REIT prices originating in the movements of short and long-term interest rates either in periods when interest rates are high or in periods of low interest rates.

Relationship between real estate and inflation rate also attracts the interest of real

estate researchers, but the survey of existing studies reveals inconclusive results about the effect of inflation rate variables on the behavior of real estate returns. In the US, Hoesli (1994) demonstrates that real estate provides a better hedge against inflation than common stocks. Likewise, Glascock and Davidson (1995) find that the returns of individual real estate common stocks typically outperform the inflation rate, but typically do not perform as well in a value-weighted portfolio. Copley and Harke (1996) conclude that leverage improves the return of real estate, even during inflation. Commercial real estate is found to be a good long run inflation hedge, but has no hedging characteristics against short term inflation (Quan and Titman, 1999).

Barkham *et al* (1996) test the long-term inflation hedging and causality relationships between U.K. property and the actual and the decomposed inflation rates. They found significant short-term relationships between expected and actual inflation and the direct real estate returns. They also found highly significant long-run relationships between the property returns and all the inflation rates in the cointegration tests. Tarbert (1996) extend the inflation hedging study to test the inflation-hedging characteristics of different property types. Later, Stevenson (2000) examined the long-term relationship between inflation and the housing market, and found strong evidence that housing and inflation share a common long-term trend. In contrast, when studying the inflation hedging ability of the Irish real estate markets, Stevenson and Murray (1999) find that Irish real estate did not provide a good hedge against inflation using OLS and cointegration tests.

The issue of the relationship between inflation rate and property market is also explored in emerging markets such as Hong Kong and Singapore. However, the literature of these markets is limited and less than that in developed countries. In Hong Kong, Ganesan and Chiang (1998) find that real assets generally are not good hedge against inflation, but financial assets seem to have better inflation hedge ability. Sing and Low (2000) conclude that real estate provides a better hedge against inflation than does stock and securitized real estate in Singapore. For real estate in mainland China, Chu and Sing (2004) show no evidence of long-term hedging ability. However, the causality test shows that there is a significant unidirectional causality from the inflation to the real estate return.

Overall, the issue of relationship between real estate and the economic driving forces are widely studied in both emerging and developed markets and reports the extensive results as well. However, the nonlinear, state-dependent or time varying structure of the economic system has long been ignored. In addition, most of the results come from individual markets, thus international and regional common evidence is lacking.

2.6 Global real estate

With the growth of international investment opportunities in real estate, there has been a significant amount of research examining the performance of international equity real estate and reporting mixed findings. Past studies on international real estate stock focus on three major categories: international diversification, international real

estate asset pricing and global real estate market integration. Table 2.5 summarizes the key studies on this topic.

Table 2.5 Key studies on global real estate

Year	Author	Main Findings
		International diversification and pricing
1991	Asabere, *et al*	International property companies are negatively correlated with U.S. T-Bills and only slightly positively correlated with corporate and government bonds and REIT.
1990	Giliberto	Find Correlation coefficients for international combinations are low.
1992	Kleiman and Farragher	International property investments have a superior return but are more risky.
1993	Eichholz, *et al*	Find a continental factor for the European and North American property
1993	Hartzell, *et al*	Regional differences should be included in the investment decision-making process.
1996	Barry, *et al*	As allocations to emerging real estate markets are increased, the portfolio performance improves.
1996	Eichholtz	Correlation coefficients between countries for property investments are significantly lower than for stocks and bonds.
1996	Addae-Dapaah and Kion	Find significant instability in the correlation coefficient across time.
1996	Wilson and Okunev	The property stock markets and the stock market are segmented.
1997	Mull and Soenen	Find strong positive correlation between most counties and U.S. REITs.
1997	Liu, *et al*	Find no evidence that the real estate stocks are any better at inflation hedging than the stock market in most countries.
1998	Eichholtz, *et al*	Strong continental factors in North American, especially in U.S.
1998	Lizieri, *et al*	Find distinct and different interest rate regimes in the US and UK. And these regime can be used to predict returns.
1999	Gaodon and Cantere	Correlation coefficients are not stable over time and vary significantly.
1999	Giliberto, *et al*	Using the QTARCH models can improve portfolio performance in both counties over the conventional asset allocation model.
1999	Wilson and Okunev	There is evidence of cycles in the real estate stock market, as well as co-cycle between the real estate stock and general stock markets.
2000	Conover, *et al*	Find lower correlation coefficients with foreign real estate companies.
2001	Pierzak	Efficient frontier analysis shows gains from international diversification
2002	Bigman	Finds low correlation coefficients among international property companies.
2002	Campbel and Sirmans	There is potential to develop a pan-European REIT structure.

Year	Author	Main Findings
2002	Ling and Naranjo	Find substantial amount of variation across countries
2003	Bond, *et al*	There is evidence of a strong global market risk component in most countries.
2004	Hamelink and Hoesli	Country factors dominate property-type factors, but other factors are important, too.
		Global Real Estate Market Integration
1991	Ziobrowski and Curcio	US real estate shows low correlation with British and Japanese domestic assets
1993	Sweeney	International real estate markets are not integrated.
1996	Wilson and Okuney	No evidence of long term equilibrium between securitized real estate in US, UK and Australia
1997	Myer, *et al*	US, Canada and UK real estate markets are highly cointegrated.
1998	Eichholtz, *et al*	Segmentation generally exists between continents but integration within continents.
1998	Liu and Mei	International real estate markets are segmented.
2000	Case, *et al*	Present strong evidence to support the notion of globalization of property stock markets
2001	Eichholtz, *et al*	There is trade-off between the benefits and cost of such diversification for international real estate.
2005	Zhu and Liow	There is long term relationship between Shanghai and Hong Kong property stock markets.

2.6.1 International diversification

Some studies summarize how the diversification benefits have been achieved in a mixed asset portfolio with international real estate stocks. Asabere *et at*.(1991) are among the first researchers to use stock market returns of international property companies to represent international real estate investment. The researchers find that the international property companies are negatively correlated with T-Bills and only slightly positively correlated with World Index. Their results provide initial evidence on the diversification gains from adding international real estate to a mixed asset portfolio. Similar results are reported in the following papers within different markets

and portfolios(Keiman and Farragher (1992), Barry et al.(1996), Eichholtz (1996), Mull and Soenen (1997), Gordon and Canter (1999) and Conover et al. (2002))

The majority of past studies find that international real estate provides diversification benefits within real-estate-only portfolio context as well. Giliberto(1990) is the first researcher to test the international real estate diversification issue for a real-estate-only portfolio. He first examines currency fluctuations and compares property stock returns and notes that currency markets provide an increase in return for American investor, but also increase the volatility level of investments. Addae-Dapaah and Kion(1996) examine international diversification from the perspective of a Singaporean investor. The Authors find that diversification benefits do exist and benefits are enhanced when returns are adjusted for currency fluctuations from Singapore investor's perspective. Also, Wilson and Okunev(1996), Pierzak(2001), Bigman(2002) report similar results by considering different portfolios.

The study of alternative analysis of international investment opportunities provides plentiful interestind empirical results by employing techniques other than modern portfolio theory. Eichholz *et al* (1993) use principal component analysis to identify a common continental factor based on the economic fundamentals of individual markets. Ling and Naranj(2002) also find evidence of a world-wide factor impacting the international real estate returns. Hartzell et all (1993) examine the economic base of various areas to see if there are regional differences that should be included in the investment decision-making process. They use a chi-squared statistical

approach.

Several studies have included cross-country comparisons of the indirect real estate investment ability to hedge inflation. For example, Liu *et al* (1997) use the Fama and Schewert model, the Fisherian direct causality model and the Geske-Roll model and find no evidence that real estate stocks are any better than the general stock, with the exception of France.

Several other authors have employed regression techniques to analyze more closely and compare performance characteristics of real estate stocks in different countries. For example, Lizieri *et al*(1998) uses a threshold autoregressive(TAR), while Giliberto *et al*(1999) uses QTARCH. Wilson and Okunev(1999) also examine the relationship of real estate stocks to the general stock market on an international basis by employing the spectral analysis. Finally, Campbel and Sirmans(2002) provide an interesting analysis of the policy implications of bringing the US REIT tax-advantage public property company structure to European markets and the potential development of a pan-European REIT structure.

2.6.2 International real estate asset pricing issue

When constructing a portfolio of publicly traded real estate stocks, much emphasis is placed on the analysis of the correlation coefficients across countries (or across continents). We argue that while these correlations are useful, it would be

important to disentangle the effects of various factors on real estate returns. However, there still remains a few evidence on what factors determining the international real estate security returns, and these evidence concentrate on international real estate asset pricing.

Eichholtz, *et al* (1998) examine the extent to which real estate returns are driven by continental factors. They find strong continental factors in North America especially in the United States. For Asia-Pacific region, real estate returns are not driven by continental factors. Bond, et al (2003) investigate the risk and return characteristics of publicly traded real estate companies from 14 countries over the period 1990 to 2001. Using various global- and country-level factor models, they find there is evidence of a strong global market risk component, measured relative to the Morgan Stanley Capital International world index, in most countries. The findings imply that the international diversification opportunities from real estate companies are more complex than previously thought. More recently, Hamelink and Hoesli (2004) use constrained cross-sectional regressions to disentangle the effects of various factors on international real estate security returns. Besides a common factor, pure country, property type, size and value/growth factors are considered. It is found that country factors dominate property-type factors in importance, but other factors are important too. This is the case of the size factor and the value/growth factor, but even after accounting for all these factors, statistical factors determined by means of cluster analysis emerge as factors explaining the cross section of international real estate security returns.

In summary, the present research on international real estate stock market has provided evidence on various portfolios and methodologies. Most of the results indicate that international real estate stocks can provide investors with the diversification benefits from mix-asset and real-estate-only portfolios. Despite extensive investigation of international property stock behavior in a large number of countries, most of the papers have paid little attention to sudden structural or regime changes in international property stock markets. However, over the last decade, the dramatic growth of many property stock markets suggests that the characteristics of these markets should have changed as well as the stochastic behavior of their risks and returns. Therefore, it would be reasonable to consider regimes switching in the international securitized real estate market.

2.6.3 Global real estate market integration

Over the last decade, there has been increasing interest among real estate researchers on the question of whether regional/international real estate markets are integrated or segmented. However, there are diverse and even contradicting empirical results across various data and time spans.

Evidence illustrating that real estate markets are integrated includes research by Myer et al (1997). Using the Johansen cointegration methodology on appraisal based real estate data across three major countries (US, Canada and UK), they find that these markets are highly cointegrated, and that inflationary expectations may be the common linking factors between these markets. Wilson and Okunev (1999) use spectral

regression techniques in a search for long memory among USA, UK and Australia real estate markets and find some evidence of codependence across these markets. In addition, more recently, Case et al (2000), using appraisal based property data over 22 countries, present strong evidence to support the notion of globalization of the property markets.

However, some researchers show that international real estate markets are segmented. These authors argue that, since property is location specific there would, on an intuitive level, be no reason to suppose that such markets should be linked. The common position of this group of researchers is that, in most of cases there are risk-return benefits from either regional or international diversification of real estate holding---- implying regional / international segmentation. Examples of these studies include those by Ziobrowski and Curcio (1991), Sweeney (1993), Wilson and Okuney (1996), Eichholtz et al (1998), Liu and Mei (1998) and Eichholtz et al (2001).

Using the data from USA, Britain and Japan during the period 1973 to 1987, Ziobrowski and Curcio (1991) observe that US real estate shows low correlation with British and Japanese domestic assets. There is also literature to show the correlation coefficients between prime office indices in major cities across the world were negative, thus implying that these international real estate markets are not integrated (Sweeney, 1993). Wilson and Okuney (1996) use Engle-Granger cointegration methods and can find no evidence of long term equilibrium between securitized real estate in US, UK and Australia. Eichholtz *et al* (1998) also find segmentation generally

between continents but integration within continents. This is particularly so for Europe and true to a lesser extent for North America. They find, for instance, that European investors would need to look outside Europe for diversification benefits. However, these authors have not found such a continental factor in Asia-Pacific region. Liu and Mei (1998) illustrate that international real estate markets are segmented and accordingly offer diversification benefits to international real estate investors. Eichholtz *et al* (2001) suggest that, although there are benefits to international diversification, there is a trade-off between the benefits and costs of such diversification. The recent study by Zhu and Liow (2005) find there is long term contemporaneous relationship between the Shanghai and Hong Kong property markets and error correcting price adjustments occur in the two markets to maintain the long term equilibriums.

2.7 Summary

According to the literature review, the current research on real estate market and stock market, as well as their relationship with macroeconomic factors, has reported numerous results domestically and internationally. And the return and risk performances of securitized real estate, as well as their relationships with fundamental economic factors, also have been adequately discussed. In addition, the global real estate markets diversification issue is also discussed. Furthermore, regime switching models are applied extensively in the economics and finance, in particular the mean

and volatility of stock returns, interest rate, exchange rate and business cycle, etc.

However, current real estate studies mainly base and concentrate on the linear assumption of real estate movement. And in the real estate academic circle, the application of regime switching models and their implications are very limited. Additionally, international real estate stock market research ignores the common regime shifts in the global market. Moreover, in terms of the relationship between the financial asset returns and the macroeconomy, seldom papers have considered the panel data analysis to document the empirical evidence globally or regionally; and in real estate context, it is also lacking in international common evidence on the relationship between real estate market and the macroeconomic factors.

From the literature review, the future real estate market research would focus on the dynamic, stochastic and nonlinear movement and performance, which would illustrate real world more accurately. And with the surge of global economy and international investment, the evidence on international and regional markets, as well as interdependences of global real estate markets, is also needed.

This study would fill in the above gap by employing the regime switching, a state of the art dynamic and nonlinear econometric model, to investigate the performance of securitized real estate market, as well as its relationship with the fundamental economy, and also this study will contribute to the real estate literature with its new evidence on nonlinear and international base.

Chapter 3 Macroeconomy and Market Review

3.1 Introduction

International real estate investment has become an increasingly important component of efficient, global mixed-asset portfolios. The past decade has witnessed rapid development of real estate securitization worldwide, greater cross-market flow of real estate capital and the proliferation of diverse investment products and vehicles within a global scope. Many investors have included in their portfolios real estate investments outside their domestic markets and are increasingly exploring overseas opportunities. With this trend, the market size of global securitized real estate is growing rapidly. Meanwhile, the internationalization and integration of financial markets throughout the world, as evident in global stock and bond investing, has significantly facilitated the globalization of real estate. In addition, the accumulation of worldwide investment expertise by many financial institutions, the advancement of telecommunication technologies, and the much improved availability and quality of information have combined to transform global real estate investing into a less costly, more transparent and substantially less risky undertaking. Table 3.1 provides a quick overview of the economic conditions and real estate characteristics in 2004.

Table 3.1 Economic conditions and real estate characteristics (2004)

Economics and real estate indicators		Hong Kong	Singapore	Japan	Australia	UK	US
Macroeconomy							
GDP*	US $ Billion	156.67	93.56	4648.19	588.03	1797.81	11004.1
Exchange rate*	Local per USD	7.787	1.7008	107.1	1.333	0.6118	NA
Interest rate*	%	5	5.31	1.82	4.9	3.69	4.12
Consumer Price*		92.9	101.1	98.1	110.5	106.5	106.8
Unemployment rate*	%	7.9	5.4	5.3	5.9	3.1	6
Stock market							
Stock market capitalization**	US $ Million	714,597	145,117	3,040,665	585,475	2,412,434	14,266,266
Value traded **	US $ Million	331,615	87,864	2,272,989	369,845	2,150,753	15,547,431
Value traded (/market cap)**		0.46	0.61	0.75	0.63	0.89	1.09
No. of companies**		1029	475	3,116	1,405	2,311	5,295
Average firm size**	US $ Million	694.46	305.51	975.82	416.71	1043.89	2694.29
Real estate market							
Real Estate Transparency Rank***		7	9	26	1	4	3
Real Estate Transparency Tier 1-5***		1.50	1.55	3.08	1.19	1.24	1.24
Securitized real estate market							
No. of listed property companies****		98	30	78	46	88	143
Real Estate stock % of stock market****	%	11.44	8.49	1.27	8.95	1.75	1.27
P/E ratio of real estate stock*****		22.60	21.60	35.50	17.10	22.7	25.9
Dividend yield of real estate stock****	%	2.47	2.58	0.94	5.69	2.88	5.54

Sources: * data from IMF country database. ** data from Standard & Poor's Emerging Stock Markets Factbook 2004. *** data from Global Real Estate Transparency Index 2004 (Jones Lang Lasalle, 2004). **** data from Datastream.

This research is based on the analysis of the US, UK, Australia, Japan, Hong Kong and Singapore markets. This chapter therefore provides a discussion on the macroeconomic conditions and real estate markets in those countries. Section 3.2 through Section 3.7 discusses the macro economy and real estate markets situations, emphasizing the observations of regime switching in these markets. Section 3.8 summaries the chapter. This review will enhance investors' understanding of the global macro economic conditions and property stock markets.

3.2 Singapore

Macroeconomic condition

Singapore is a planned city-state and has undergone rapid change and developments in the past decades. Since independence in 1965, it has made significant progress in the economic and political arenas. As one of the four Asian tiger economies, its real GDP grew at an average of 8.6% per annum between 1965 and 1999, while per capita GDP rose about eight-fold, from approximately S$4000 in 1965 to over S$32,000 in 1999. Singapore has a strong capability for long-term economic growth as revealed from the 1999 competitiveness ranking.

In the 1980's, several policies, such as the promotion of business and financial services in the services sector, were introduced to diversify the economic base. As a result, the importance of the services sector in the Singapore economy rose steadily during this period, especially over the past one and a half decades. In the late 1980s, Singapore developed as an international financial center. Over those years, its sound

economic and financial fundamentals, strategic locations and other conductive political and institutional factors attracted many reputable international financial institutions to set up operations in Singapore. According to the latest data from the Singapore Department of Statistics in 2003, financial services accounted for 11.3% of Singapore's GDP. The presence of about 700 local and foreign financial institutions has contributed to the vibrancy and sophistication of Singapore's financial industry.

During this period, the Singapore economy was on the path of high growth. This rapid growth continued into the mid-1990s until the 1997 Asian financial crisis. Although the financial turmoil had a strong negative influence on growth, the Singapore economy has recovered gradually since 1999. From 1999 to 2000, current GDP increased approximately 14.83% per annum. In 2000, the industrial production index also reached a unprecedented peak. Choy (2003) , using the data from 1980 to 2001, finds significant cyclical movements in Singapore business cycles that are caused by both domestic and international factors. Breunig and Stegman (2003) examine a Markov Switching model of Singaporean GDP using a combination of formal moment-based tests and informal graphical tests. The tests confirm that Singapore business cycles can be better characterized by a Markov Switching model than by a linear, autoregressive alternative.

Real estate market

The Singapore property market generally consists of the residential, commercial and industrial sub-markets, which have developed in tandem with the economy. Both

the 1970s and 1980s saw tremendous growth in the economy, to which commercial and industrial property developments contributed substantially. Since the 1980s, Singapore has undergone two distinct periods when residential property price movements rose and fell in tandem with Singapore's real GDP growth. From 1983 to 1993, private residential prices rose by 82%; from the trough in 1986, prices were up by 156%. Driven by a combined influence of high prospective capital gains and low interest rates, private property prices have followed an almost uninterrupted uptrend since 1986, with only a temporary halt in their advance occurring during the Gulf War in 1990. From 1989 to 1993, private property prices grew at an annual rate of 15%, outpacing growth in wages of 8.7%. The rapid escalation in private property prices undermined consumer sentiment and led to deterioration in affordability indexes. At this stage of the cycle, the market was extremely vulnerable to interest rate hikes. As property prices skyrocketed, investment purchases increasingly turned speculative, with investors selling their options on new property developments for oversized profits. The government hence introduced anti-speculation measures in the residential market in May 1996, which along with the subsequent Asian financial crisis in 1997, caused prices of different real estate market to decline substantially in later years.

The securitized property sector is no doubt a significant sector in the Singapore Stock Exchange (SGX). The majority of the listed property companies represent a combination of investment and development, including the common stocks of companies with substantial commercial real estate ownership such as CapitaLand (20.15% of property stock market capitalization), City Developments (24.03% of

property stock market capitalization), Keppel Land (4.98% of property stock market capitalization), Singapore Land (7.84% of property stock market capitalization), and United Overseas Land (7.12% of property stock market capitalization). Liow (2001) demonstrates some significant stages for the Singapore property stock market; from 1981Q4 to 1986Q4 (declining property market), from 1987Q1 to 1996Q2 (rising property market) and from 1996Q3 to 1998Q4 (declining property market). Furthermore, the property stock's risk and return, together with risk-adjusted performances are totally different in these stages.

3.3 Hong Kong

Macroeconomic Condition

Hong Kong is a major economic force in the Asia-Pacific region. Hong Kong's Gross Domestic Product (GDP) grew at an average real rate of over 6 percent per annum over the ten years before 1997, with the GDP per capita at that time exceeding that of Australia, New Zealand and the UK. This strong economic performance has been largely attributable to the economic integration of Hong Kong and mainland China. This has resulted in a significant relocation of Hong Kong industries to areas of southern China, with Hong Kong being transformed from a manufacturing-based economy to a services-based economy. Over 1981-1993, this saw the service sector increase from 33 per cent to 55 percent of the total workforce, while the manufacturing sector decreased from 47 per cent to 24 percent.

Since Hong Kong interest rates are linked to U.S. rates, the change in Hong Kong interest rates reflects part of the contagion effects between Hong Kong and US markets. On the other hand, interest rate movements reflect Hong Kong money market pressures. Before 1990, the interest rate level was relatively high, which was associated with low money supply volume. Interest rates declined from the beginning of the 1990s when the money supply expanded. In October 1997, the Hong Kong dollar was exposed to a speculative financial attack, as a result of the contagion effect of the Asian financial turmoil. The effects of the turmoil period lasted till 2000. Since the new millennium, the growth in the Hong Kong money supply has stabilized and the interest rate along with the price level have dropped sharply.

Chi and Wing (2001) discover some characteristics of business cycles in Hong Kong. They extract the fluctuations at business cycle frequencies (8 to 32 quarters) of macroeconomic time series. The study also describes the patterns of output fluctuations and finds the co-movements of various macroeconomic variables. Wong (2002) illustrates a sharp and protracted downturn of the business cycle in Hong Kong, and finds significant structural change of the Hong Kong economy in response to the opening of China and its gradual integration with Hong Kong since 1997.

Real estate market

As Brown and Chau (1997) state, Hong Kong is a densely populated island with more than six million people living in a total area of 1,092 square kilometers. More than 67% of the total area is woodland and scrubland. Developed land comprises less

than 16% of the total area. For these reasons, the total value of all real estate in Hong Kong exceeds the total value of all shares and money. The importance of real estate in Hong Kong is due to the scarcity of development in Hong Kong. Property and construction currently contribute 23.5 percent to Hong Kong's gross domestic product (GDP), and their contribution has been over 20 percent since 1982 (Walker et al., 1995).

Property cycles are influenced by broader cycles of economic activity as well. The booms occurred predominantly in 1961-1964,1969-1973, and 1977-1981, and the slumps followed in 1965-1968, 1969-1976 and 1982-1984. The three major cycles in the periods: 1976-1983, 1984-1990, and 1991-1994 (see Tse *et.al.*, 1998). In the late 1980s, the property market began to revive with the highly expanding economic environment and interest rate decline. On the other hand, the emergence of negative interest rate in the early 1990s caused sharp volatility of house prices in Hong Kong. During one year in 1997, due to the resumption of sovereignty on 1 July 1997, the average residential property price index rose by about 50 percent, while the price index of large units surged by almost 60 percent. The subsequent periods of the Hong Kong property market suffered from the Asian financial crisis. From October 1997 to July 1998, the real estate market declined by about 30 percent.

After 2000, with China Mainland's entrance into the WTO and CEPA (Closer Economic Partnership Agreement), Hong Kong's economy integrated with China Mainland more closely. Increasing linkage across the two markets has led to a close relationship between the two capital markets and property markets. The recovery of

domestic consumption and influx of Mainland tourists has driven the whole economy and the retail property market. In 2004, the number of Mainland Chinese arrivals increased by 54% during the first ten months of the year. Mainland Chinese tourists, the biggest spenders, now account for 57% of total arrivals in Hong Kong. The residential mass market, riding on a wave of robust economic performance and improving negative equity, recovered strongly in 2004, with price increasing by 35.3% in the year. At the same time, the office market also enjoyed buoyant demand, particularly from the finance, service and trade sectors, and saw an active leasing market driven by corporate expansion and upgrading. The overall vacancy rate dropped to 8.4% from 10.1% a year before.[5]

Before 1995, property and construction company stocks accounted for approximately 25 per cent to Hong Kong's total stock market capitalization, with this being significantly greater than that of other South-East Asian and Western countries. Including consolidated enterprises that were involved in property development and investment, the contribution of property and construction company stocks increased to approximately 45 per cent of total stock market capitalization. The significance of property companies to the Hong Kong stock market was also reflected in six of the top ten companies listed, and ten of the top 20 companies listed, being property or strongly property-related companies (see Walker *et. al.*, 1995). The share of the property sector increased from about 25% to 31% of overall stock market due to a rapid increase in property prices in 1996. According to Tse (2001), real estate-related firms accounted

[5] The data in this paragraph come from the report of Jones Lang Lasalle, http://www.joneslanglasalle.com.hk/en-GB/news/2004/141204cmresproprev3.htm

for over 30 percent of Hong Kong's stock market capitalization. The significant contributions of listed property company shares to the stock market capitalization may come from heavy capital investment expenditure in property.

3.4 Japan

Macroeconomic condition

In the 1970s, Japan real GDP growth was half that of the two preceding decades. The decline continued in the first half of the 1980s; in the second half of the 1980s, an economic boom called "Heisei Keiki" occurred. Japan was then labeled by its bubble economy in the late 1980s. The bubble economy was characterized by rising asset prices, an overheating economy and a sizable increase in money supply and credit. As a consequence of the overheating economy, a recession occurred, with real GDP dropping 3% from 1990 to 1991.

Although the Bubble Economy essentially ended in 1990, it wasn't until January 29, 1993, that a Japanese prime minister acknowledged that the "Bubble Economy" had collapsed. In the first three months of 1993, the price level fell by 1.1 percent, which represented a rate of deflation of almost 4.5 percent year-over-year. By August 1993, wholesale prices were falling at an annual rate of 4.2 percent. In the second quarter of 1993 Japan's GNP declined at an annual rate of 2 percent. During this period, the Japanese economy was in serious trouble, though the government attempted to take some measures. Yet even during the recession, Japan's economy was

ranked second only to the US. The real GDP of Japan finally turned upward at the end of 1995 before plunged downward to new depths in 1998. The economic decline then continued until 1999, when the real GDP stabilized. Since 1999, Japan has exhibited very low economic growth. In the early 2000s, most of the East and Southeast Asian economies, especially the PRC, Hong Kong and Singapore, produced much higher GDP growth rates than Japan.

However, during this period the Japanese Yen however was relatively strong in comparison to US dollar, especially in comparison to the first half of the 1980s. This occurred even though Japan's monetary authorities at the Bank of Japan and the Ministry of Finance preferred a weaker yen to encourage exports and better domestic business conditions. The rate was particularly low in 1995 -- it was published as 94 yen to the US dollar. The exchange rate rose to more than 145 yen to US dollar in 1998, before the yen strengthened from June to the fall of 1999 and reached 104 yen when the new millennium approached. Since 2000, the Japanese Yen-US dollar exchange rate has remained volatile.

Real estate market

After World War II, devastated Japanese properties were rebuilt in the recovery period from 1945 through 1950. As the recovery occurred, property prices rose from low wartime levels. Land and building values increased through the bubble expansion period, and finally reached its peak in the early 1990s. The high property values was resulted from land being used as collateral for loans, and also because taxing

authorities tended to use those peak prices in valuing property subject to inheritance tax. After property prices rose to peaks, they fell drastically during the recession of the 1990s. According to Ministry of Construction, in November of 1991 houses and apartments in metropolitan Tokyo had in the preceding year lost 37% of their value, and plots of land in the suburb of Saitama had lost 41%. Since then, the Japan property market has been in a period of depression.

More specifically, the Tokyo office market is a special part and a very important component of the total Japanese real estate market. According to research by the Japan Ministry of Home Affairs about the price of fixed assets, the existing stock of Greater Tokyo[6] office space continued to climb from 1980 through 1997. In 1980, the total office stock approached 8,000 hectares and it was close to 20,000 hectares in 1997. During the "bubble" period from the mid-1980s to the early 1990s, office building starts added substantial office space in the Greater Tokyo area. As an example, within the city of Tokyo, the peak in the late 1989 and early 1990 saw more than 500 hectares of land being added. Building starts then slid quickly down in the early 1990s and stabilized with smaller additions to office floor space (roughly 155 hectares a year) in the last half of the 1990s.

In the residential market, as consumer prices in general rose steadily from the early 1980s to the mid-1990s, urban residential land prices hit a peak in 1991. Afterwards, the market was in recession. In 1996, the nominal gross residential investment reached a peak of 30 trillion yen. But even though the absolute investment

[6] Greater Tokyo includes the city of Tokyo, Kanagawa, Chiba, and Saitama Prefectures

yen value reached a peak at this time, the percent of nominal Japan GNP growth was rather low in terms of trends at 6%. The portion of the nominal Japan GNP represented by private nominal residential investment was even lower at approximately 5.6%. The public sector investment in housing represented about 0.4% of the GNP of Japan or approximately US$16 billion (at 125 yen to US$). Tokyo was still the leader in the price of residential land (525,400 yen) in the world in 1997, according to the Japan National Land Agency.

There has been a long history for many Japanese real estate companies offer securities under the real restate sub-sector of the stock exchange. Some of the larger and older Japanese companies that have offered stocks are Mitsui Real Estate Development, Mitsubishi Estate Co., Sumitomo Realty and Development Co., Tokyu Land Co., and Tokyo Tatemono Co. Other real estate companies that have listed stocks on the stock exchange include newly formed joint ventures.

3.5 Australia

Macroeconomic condition

Australia is the world's 16th largest economy, with output, as measured by gross domestic product, one-twentieth of that of the United States or about one-third of that of the United Kingdom.

Australia experienced severe inflation during the 1970s, which persisted into the early 1990s, along with three severe recessions in the mid-1970s, early 1980s and early

1990s. In addition, unemployment jumped sharply in each of these recessions, reaching a peak of over 11% in 1992. After the recessions, macroeconomic developments in Australia in the 1990s have turned out to be more successful in many ways than would have been expected at the beginning of the decade. Economic growth averaged 3.5 percent, and over 4 per cent since the trough of the recession in mid 1991. After entering the new century, Australia's economy experienced a temporary slowdown, including one quarter of negative GDP growth, because of the introduction of a new indirect tax system in July 2000, which caused some significant transformations in the timing of buying new housing and expenditure on consumer durables. However, Australia has since returned to being one of the fastest growing entities among the developed economies.[7]

In the 1990s, Australia experienced rapid economic growth combined with low inflation and declining unemployment. This economic success was the result of consistent and credible macro-economic policy-making, and a wide-ranging program of structural reforms beginning in the 1980s aimed at opening up the Australian economy to greater domestic and international competition.

Paul and Sam (2004) identified some major economic growth cycles as well as regime changes in Australia. They are 1985:3 to 1986:4, 1989:3 to 1991:4, 1994:3 to 1997:3, and 2000:1 to 2001:1. They find that while there are large asymmetries in the duration and amplitude of phases in Australia's classical cycle, on both measures the Australian growth cycle is much more symmetric. Further, their results indicate that

[7] The data in this paragraph comes from Eslalke (2002)

over the sample period, Australian (filtered) output and prices have moved in a counter-cyclical fashion, suggesting a dominance of shocks to aggregate supply affecting the Australian economy.

Real estate market

In Australia, a very high proportion of national wealth is held in real estate. Estimates vary in line with the method used by the researcher and the relative state of the housing and stock markets, but most work has indicated a figure of between 50 and 60 per cent of net private sector wealth (Beer, 1997). Australia's property market plays a key role in the Asia-Pacific region.

What should be mentioned of the Australia direct property market is that in 2004, the overall market transparency situation was ranked number one by Jones Lang Lasalle, a leading global real estate consultancy firm (see Table 3.1). Its performance was marginally ahead of the United States and United Kingdom. It scored highly in all categories, and stands out most in terms of its legal framework, the availability of public and private performance indices, and market fundamental research on direct real estate investment.

Listed Property Trusts (LPTs) have proven to be a popular choice for Australians with over 800,000 investors. Accounting for over $80 billion in market capitalization, the Australian LPT sector now represents about 10% of the world's listed property and is currently one of the large sectors in the Australia Stock Exchange (ASX). The sector has provided investors with high yields, capital growth and relatively low levels of volatility. While operating since the 1980's, prior to the early 1990's the LPT sector

was small and was dominated by a few property trusts (for instance, General Property Trust, Westfield, Schroders, Stockland). Currently, the number of LPTs in Australia has increased to 46, among which 42 trusts invest primarily in Australian real estate while the remainder focus on international property assets. [8]

Since the 1990s, the LPT sector in Australia has undergone major structural changes, including a significant expanding in the number of LPTs and their corresponding market value. This has seen the LPT market capitalization increase from $5 billion to over $35 billion in the 1990s (Blundell, 2001). Other important factors over this period have been a substantially increased LPT gearing level and LPTs taking on more of the investment performance features of direct property (Newell, 2001) .

In Australia the distribution yields on LPTs are typically between 6% and 10% a year, higher than most shares. The distributions are made either quarterly or twice yearly, allowing investors to regulate their cash flow. Apart from distributions, LPTs also offer the opportunity for capital growth. Rising yields, attractive valuations or movements in other markets, amongst other reasons, can cause unit prices to rise. Over the past 20 years, LPTs have performed similarly to the wider share market. Recent performance has confirmed LPTs status as a “safe haven” investment.

3.6 United Kingdom

Macroeconomic condition

[8] The data in this paragraph comes from the website of Australia Stock Exchange www.asx.com.au

The 1980s and early 1990s were a much more volatile period for the UK than for other major economies. The economic volatility partially came from external shocks such as the oil crisis, the Gulf War, and the economic fallout of the breakdown of Communism and the unification of Germany. In addition, the economic boom in the late 1980s and the following recession in early 1990s contributed to the excessive volatility of the UK economy. In the three years 1986 to 1988, the economy grew at an average rate of 4.5% a year and consumer spending rose at an annual rate of 6.5%. Interest rates then rose to 13% during 1988 and to 15% in 1989, which succeeded in slowing the economy down. However, the inflationary consequences of the boom continued until 1990, by which time the economy was already moving into recession. In the latter years of the 1990s, GDP fell by over 2% in 1991 and unemployment climbed to nearly 3 million by the end of 1992.

The UK inflation fell sharply to around 4% by the beginning of 1992 and interest rates also moved down. However, recovery was not apparent during 1992. The UK monetary framework then operated reasonably well over the four years from 1993 to 1996, with underlying inflation averaging 2.8%. In this period and thereafter, the UK economy has grown steadily and unemployment has fallen by a third, with the inflation and interest rate having kept at the average levels. Figure 3.5 provides a review of the economic growth, interest rate and exchange rate from the late 1980s.

Real estate market

The UK property market experienced a boom period in the late 1960s and early 1970s, although the economy continued to slide down at that time. The next property market boom was seen from 1985 to 1989, during the economic boom of the late 1980s. The recovery of the property market was caused by the deregulation of the financial and property sectors. There were more property market participants than before because investors saw the potentially high yields on real estate. At this time, the performance of properties also attracted real estate financiers to lend to the sector. During the two years from 1985 to February 1987, outstanding banks loans to property companies rose by 30.63% per annum; this accelerated during the late 1980s to an average rate of 50.68% for the three years up to February 1990. It was estimated that by autumn 1988, about 100 banks wanted to lend money to property developers. The growing lending, however, indicated speculation in the property boom.

However, in October 1989, bank base rate was raised to 15%. A market recession then followed at the end of 1989. Property prices dropped severely due to the heavy debt incurred by the property companies. The interest rate hike, which was used to reduce inflation, adversely affected the property market.

At the beginning of 1990, the British property market crash affected all sub-sectors such as residential, commercial and industrial. The impact was so widespread that it slowed down the economic recovery in later years. But the fall in interest rates in 1992 helped to stimulate investment activity, and hence benefited the property market. Property companies took advantage of the booming stock market to repair their balance sheets, making about £2 billion of equity and debenture issues

during the year, the highest level since 1987. As a result, outstanding bank loans to property companies, which had peaked at just over £41 billion in May 1991, fell to £33.5 billion by March 1994. However, as banks continued to steer clear of the market, the lack of bank financing proved a significant constraint on the sector's recovery. The property market therefore has been on the way of weak recovery, which is linked to the economic conditions.

The property boom of the late 1960s, early 1970s and late 1980s stimulated financial innovation, which comprised real estate securitization and unitization. The October 1987 stock market crash caused considerable unease not only in the property market but also in the financial market. Between Black Monday and December 4th, 1987, property shares fell by 29% in absolute terms and 4% against the FTSE All-Share Index. The shares of property development companies were hardest hit. The crash hit trader-developers particularly hard, but had less effect on the "asset-based warhorses", which had gone through their rapid growth phase during the 1950s and 1960s. The number of the listed property companies has increased over time. At December 2002, the market capitalization of the total sector is about A$1,661 million.

3.7 United States

Macroeconomic condition

The American economy is the largest in the world with a GDP over US$10000 billion. Entering the new century, its economy grows bigger and more successful than

ever. However, in the past, the US also experienced the Great Depression in the first half of the 20th century. In the second half of the century, the nation endured the severe problems of high inflation, high unemployment, and enormous government budget deficits. Finally, the country enjoyed a period of economic calm in the 1990s: prices were stable, unemployment dropped to its lowest level in almost 30 years, the government posted a budget surplus, and the stock market experienced an unprecedented boom.

The past decade was the golden time for American economy development. The economy, meanwhile, turned in an increasingly healthy performance as the 1990s progressed. With the crash of the Soviet Union and Eastern European communism in the late 1980s, trade opportunities expanded tremendously. Technological developments brought a wide range of sophisticated new electronic products. Innovations in telecommunications and computer networking incubated the computer hardware and software industry and revolutionized the way many industries operate. The network and internet drive economy growing rapidly, with corporate earnings rising rapidly at the same time. Combined with low inflation and unemployment rate, strong profits sent the stock market surging. For instance, the Dow Jones Industrial Average, which had stood at just 1,000 in the late 1970s, hit the 11,000 mark in 1999, adding substantially to the wealth of many, though not all, Americans.

Real estate market

Real estate is a huge business in the US. A recent survey conducted by the National Association of Realtors indicates that more than half of the household wealth

in the United States is in real estate (Su et al, 2002). As an investment vehicle, Real Estate Investment Trusts (REITs) had not become popular until the late 1960s. With the development of the general capital market at that time, the number of REITs and their asset volume both increased. In the end of 1960s, market capitalization of the REITs sector was above US$ 700 million, and there were 11 REITs.

Entering the 1970s, however, the REITs business suffered a tough time. Although REIT returns were attractive in the early years,, a number of problems soon surfaced. The major problems were poor investment judgment, high levels of leverage, and the conflicts of interest that existed between banks sponsors and their REIT subsidiaries. In addition, the rigid requirements to qualify as a REIT worked to decrease significantly the flexibility of the REIT to adjust to declining markets. In the middle of 1970s, REIT earnings were squeezed further when the accounting profession imposed new, more conservative accounting standards requiring REITs to recognize both the cost of carrying loan losses and their estimated future costs. With these obstacles, in the end of 1970s, even as REIT numbers increased to 115, the average capitalization of REITs fell to US$ 25 million, less than half of the 1960s.

In the 1980s, the market environment of REITs was changing. The Tax Reform Act of 1986 (TRA 86) was the major impetus to make REITs increasingly popular. With this change, REITs not only had a tax advantage, but were also given greater managerial control over their properties and could make substantial investment decisions internally rather than externally. TRA 86 allowed REIT managements to be active and provided a greater alignment of management and shareholder interests. In

this period, the change of market environment provided REITs with the opportunity to improve efficiency of their decisions, and was a major mark toward the creation of entirely integrated REITs. By the end of 1980s, the whole captitalization of the REIT sector was more than US$ 10 billion.

In the 1990s, the government set down a series important policies to modernize the REIT sector. These changes include the Taxpayer Relief Act of 1997, also called the REIT Simplication Act (REITSA), and the REIT Modernization Act (RMA) of 1999. In addition, a structural innovation that contributed REIT growth, umbrella partnership REIT (UPREIT), also came up at that time. It was clear that these changes had made the REIT industry grow rapidly. The number of REITs specializing in distinct types of property such as apartments, offices, shopping malls and others, was also enhanced at that time. With these impetuses, the total market value of REITs was near US$ 130 billion at the end of 1990s.

Over the last four decades, the United States Congress has updated the REIT rules many times to make REITs more investor friendly, to maintain their competitiveness in the real estate marketplace and to realize their full potential. Today, REITs have become part of the investment mainstream. At the same time, REITs are rightly seen as an effective tool to provide diversification within an investor's portfolio. REITs have provided investors with growing dividends, and the preservation of their capital against inflation.

Today, the REIT structure is still consistently being improved to meet investors' requirements. In the most recent legislation, the REIT Improvement Act of

2004, was passed by Congress in October 2004. The major improvements covered in the RIA are to eliminate a discriminatory barrier to foreign investment in publicly traded US REITs and provide the IRS with the ability to impose monetary penalties on REITs in lieu of the loss of REIT status when REIT rules are inadvertently breached.

3.8 Summary

This chapter has provided a review of the macroeconomic situation and real estate market in the six economies included in this research. The knowledge about the markets helps to understand the issues examined in this study. The main findings are: firstly, the property stocks in Hong Kong, Japan, Singapore, Australia, UK and US have developed in tandem with economic conditions. Secondly, fluctuations in the financial and money markets have impacted the behavior of the six property stock markets. Policy makers have played a significant role in influencing the direct property market through macroeconomic policies and these in turn have affected the performance of property company shares and securitized properties. Thirdly, each securitized property market has experienced some major cycle movements or structural changes.

Chapter 4 Existence and Nature of Regime Switching in Securitized Property Markets

4.1 Introduction

This chapter provides an extensive investigation whether there is regime switching in the international real estate stock markets of US, UK, Australia, Japan, Singapore and Hong Kong during1987-2004. Section 4.2 presents the stylized facts of regime switching in the international property stock markets. This is followed by an illustration of the underlying regime switching models. Data analysis is discussed in Section 4.4. The presentation of empirical results and chapter summary appear in Sections 4.5 and 4.6 respectively.

4.2 Stylized facts of regime switching

Before evaluating the regime switching performance of securitized property markets, some description of market price indices movement and relevant analysis are provided. This will provide the visual evidence regarding the presence of regime switching in the securitized property markets.

4.2.1 Individual indexes movement

Figure 4.1 displays the index movement of major real estate markets over the study period. In Hong Kong, the real estate index presents cyclical movements during

certain periods. From 1987 to 1996, Hong Kong experienced a long boom period, though there are several short and temporary slumps, such as the global stock market crash in October 1987. During this boom period, the Hang Seng Property Index increased from 348.5 to 2637.6, inflating more than 7 times. However, the Asia Financial Crisis of 1997 affected the property stock market adversely and consequently, the market went into economic recession period from 1997 to 1999. The index value shrank more than a half. After that, the market entered a slowdown and fluctuated in a narrow range till now.

In Singapore, the listed property market also displayed distinct regimes over the past 17 years. Just as Hong Kong market, the property stock index in Singapore started to hike from 1987. The market went through a stage of consolidation from 1991 to 1993 before surging up from end 1993 to the second half of 1996. Thereafter, the government introduced anti-speculation measures in the real estate market, which along with the Asia Financial Crisis, caused prices of real estate markets to decline substantially in later years. From the end of 1999 to 2001 the market experienced a quick rebound and after that the market declined to a slowdown period again.

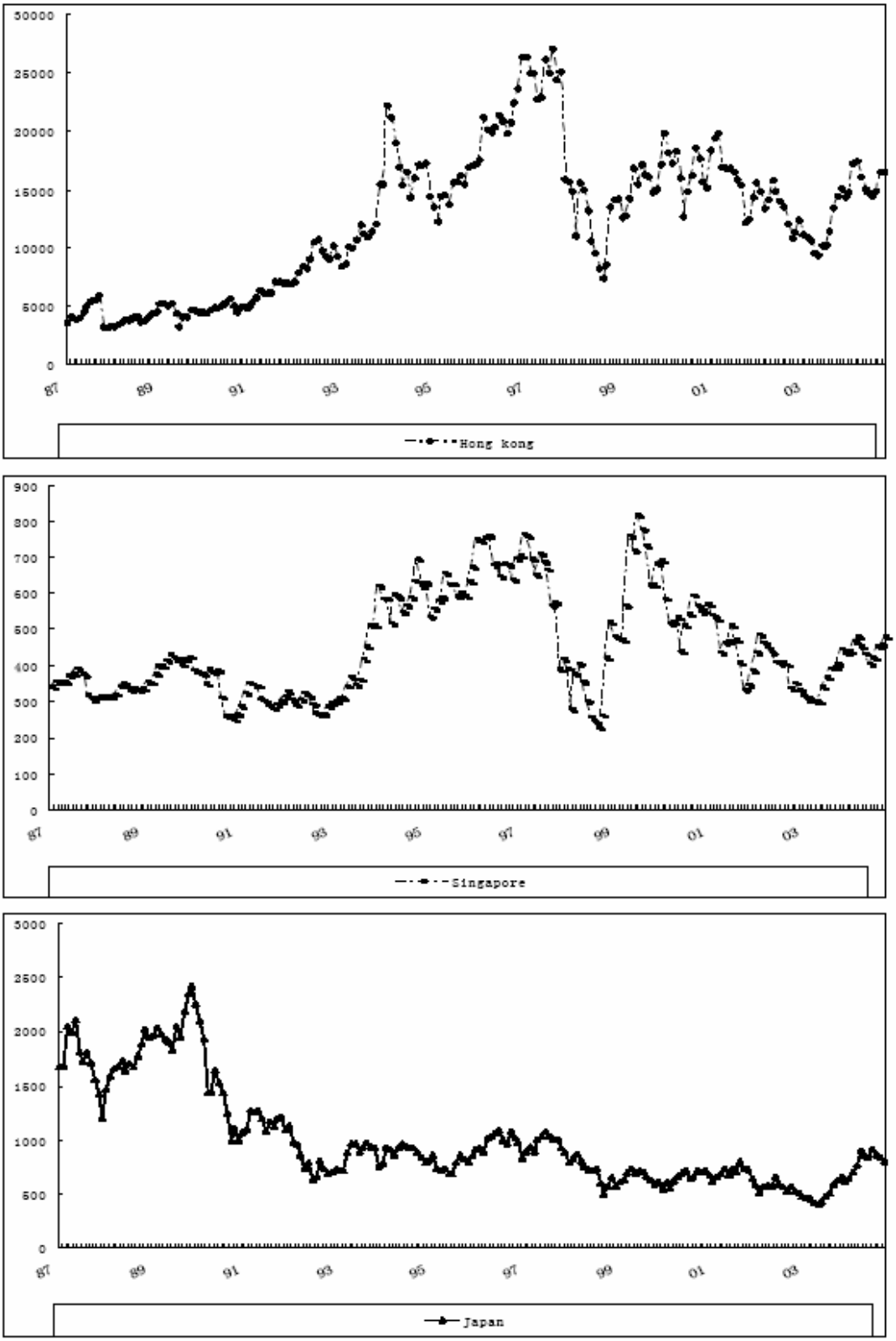
Japanese real estate market is labeled as the bubble economy in the study period. During the 1980s, the overheating economy caused financial asset price as well as real estate price to boost sharply. The real estate index value reached a peak at 2349 at the end of 1989. The bubble collapsed at the beginning of 1990 and made Japanese economy and real estate market in recession for a long period. The bottom of index

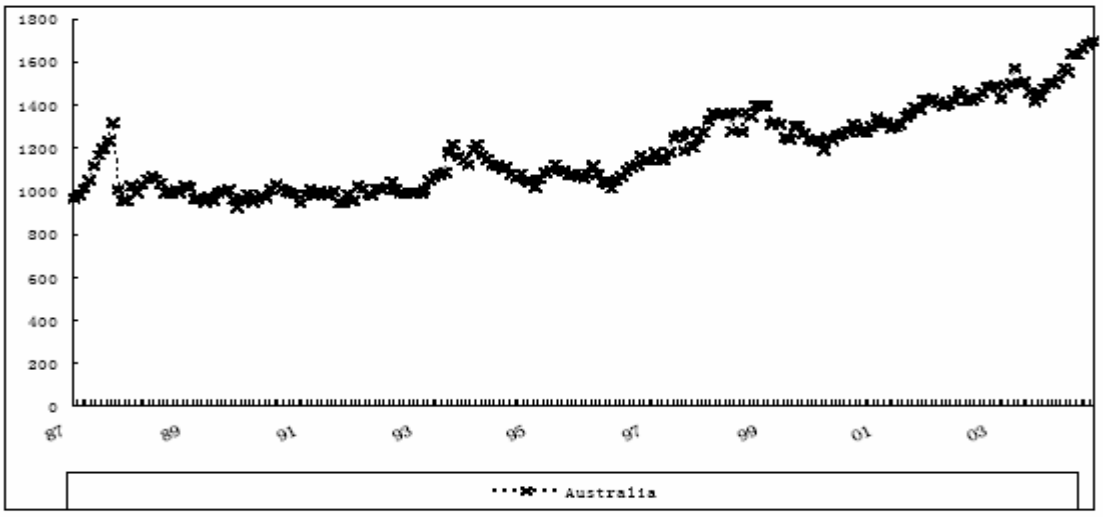
was 511.86, declining almost 4 times.

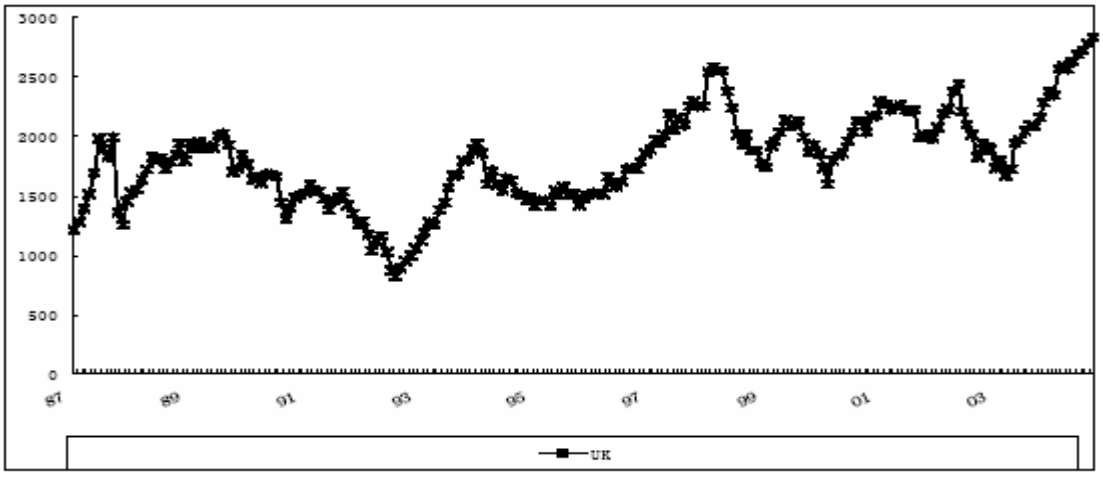
In Australia, the real estate index is relatively stable. However, some structural or regime changes happened as well. Since the 1990s, the LPTs sector in Australia has undergone major structural changes, including significant expanding in the number of LPTs and the corresponding market value. The index value also increased from 985.4 to 1427.7.

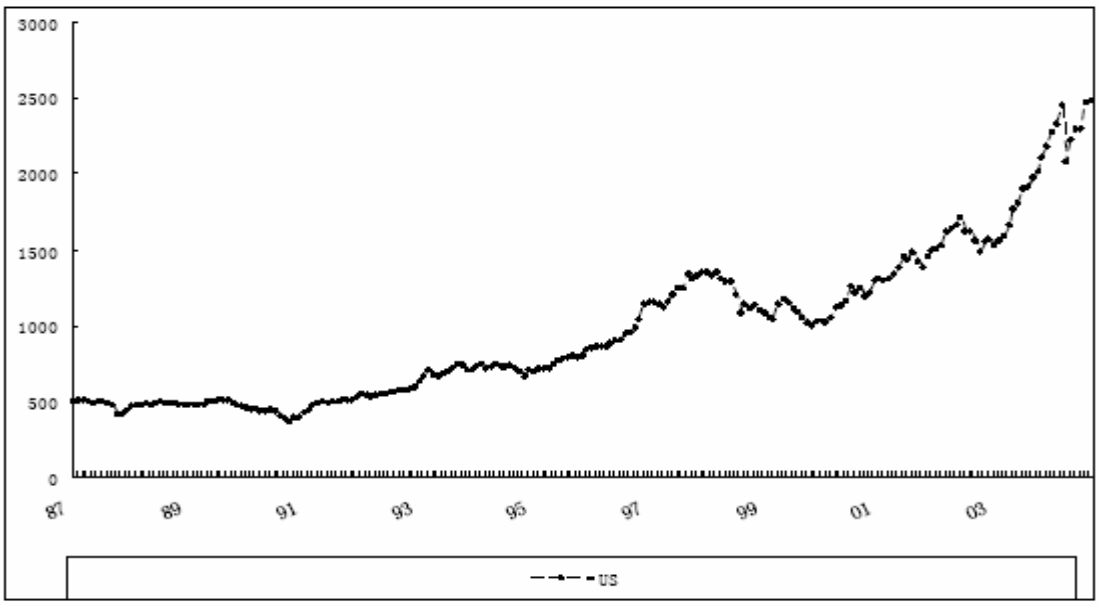
UK property market also experienced several rounds of regime changes. One of the property booms was seen from 1987 to 1989, with the index value increasing over 60% over that period. At the beginning of 1990, the UK property started to decline, covering all the property sectors. From 1990 to 1992, the index decreased more than a half. After that period, the UK property market experienced weak recovery, which is linked to the economic conditions. For example, from the beginning of 1990 to the end of 1992, the UK securitized property index dropped from 1761 to 1056, averagely decreasing 13.3% per year. At the same period, the economic condition was also weak, the average GDP growth rate is -0.13% and inflation rate is 6.27%. The economy was stagnant but endured high inflation rate. From 1993, the economy started to recover, as well as the securitized property market. From the beginning of 1993 to the end of 1998, the securitized property index raise from 1122 to 1771. At the same time, the economic condition was also good; the average GDP growth rate was 3.13% and average low inflation rate was 2.18%.

Figure 4.1 International securitized property price index









Source: DataStream

Finally, the US REITs market also went through some regime shifts due to the changes in institutional factors and market condition, such as the Tax Reform Act of 1986, the policy to modernize the REITs in 1990s, REIT Simplication Act (REITSA) in 1997 and the REIT Modernization Act (RMA) of 1999. The Tax Reform Act of 1986 (TRA 1986) was the major impetus for the increasing popularity of REITs. With this change, the REITs not only enjoyed tax advantage, but were also given greater managerial control over their properties and could make substantial investment decision internally rather than externally. By the end of 1980s, the market capitalization of the REIT sector was more than 10 billion US dollar, which is a typical regime for REITs increasing. In 1990s, the government set down a series of important policies to modernize the REITs sector. These changes came through the Taxpayer Relief Act of 1997, also called the REIT Simplication Act (REITSA), and the REIT Modernization Act (RMA) of 1999. In addition, a structural innovation that contributed to REIT growth, the *umbrella partnership REIT (UPREIT)*, was introduced during that time. These changes significantly contributed to the rapid growth of the REITs industry. The market index value increased from the beginning 90s' 461 to the peak of end of 1997, 1353.

Subsequently, due to maturing world technology and the internet bubble of 1998 to 2000, most of the REITs capital rushed into the internet common stocks, which caused the value of REIT share prices to fall by 20 percent in the first quarter of 1998. Another recession regime thus began and ended in 2000 with the internet bubble calming down.

4.2.2 Co-movement of regime shifts

The global securitized real estate markets have experienced dramatic changes over the last few years — in terms of economic fluctuations, evolving market demand, innovative financial structures, new forms and levels of risk, and a changing investor base. There is a substantial growth of the literature on the co-movement of international financial markets and real estate markets. With the development of financial liberalization across the countries, investment capital flowed through the various securitized real estate markets. At the same time, as a unique alternative asset, real estate can provide attractive benefits with less risk as well as diversification effects for global institutional investors. International real estate can provide the diversification and return enhancement effects to investors, which causes global real estate investment has being a mainstream. Under these circumantances, the common regime shifts among the global securitized real estate seem possible.

As observed from the indexes, the first co-movement happens around 1987 October. “Black Monday”[9], the stock market catastrophe, which caused the global stock markets to crash at that time. In that day, a lot of investors are affected by the pessimistic market expectation and followed to undersell their stocks on hand, including the real estate stocks. Real estate sector, as a significant part of overall stock market, was also affected by the overall market crashing down. The worldwide property stock markets thus could not escape the disaster. During October 1987 , the Hang Seng property index decreased from 5956 to 3200; Singapore: from 373 to 326,

[9] The exact date is October 19th, 1987, when the US stock market plummeted more than 22%.

Japan: from 1715 to 1550, Australia: from 1317 to 1004, UK from 1991 to 1358 and US from 481 to 412. The markets recovered after 1 or 2 months. This is the co-break of the international property stock markets driven by overall stock market's crash. And it is also a typical securitized real estate market typical regime switching case trigged by the overall stock market movement.

In the 1990s, especially from 1993 to 1996, because of the opening up and innovation of the global financial systems and economic boom, the six property stock market indexes climbed up together. From 1993 to 1996, Hang Seng property index increased from 8571 to 21134, Singapore from 297 to 749, Japan from 715 to 920, Australia from 989 to 1116, UK from 1122 to 1522 and US from 631 to 855. The international securitized real estate market exhibited the common upturn during this period. During 1997 and due to the Asia Financial Crisis, the Asia-Pacific property stock markets crashed severely. At that moment, in Asia, the bursting of the financial and property bubble severely hit the investor's confidence and expectation for this market. The financial assets' price, especially for real estate, decreased quickly. In the US, from the beginning of 1998, the Internet Bubble attracted plenty of capital flow from the real estate sector, causing the REIT market decline as well. The US securitized real estate market decreased together with the Asian one, but triggered by different events. However, the UK market had not joined this downward movement at this time. The UK market was climbing up during that period, as can be seen from Figure 4.1. Although the UK market movement deviated from the trend of 5 other markets, this period can also be treated as co-movement activity.

In sum, over the past 20 years, the global property stock markets did experience several times of co-movement of regime shifts affected by international economic fundamentals. Although the markets co-movement in different regimes, the diversification benefit of international securitized real estate market is still possible. This co-movement among the markets is not completely perfect and full synchronized. Therefore, the diversification benefit can still be derived since the correlation coefficients between the markets are still below 1. In addition, the portfolio manager also can gain the diversification benefit by selecting different sub sectors (e.g. residential, office and retail) or individual property stocks. The empirical analysis that follows seeks to test the regime switching phenomenon.

4.3 Methodology

4.3.1 Univariate regime switching model

First, assume returns are drawn from a single Gaussian distribution with mean μ_0 and variance σ_0, equation (4.1) is the specification of no regime switching:

$$R_t = \mu_0 + \sigma_0 \varepsilon_t \quad \text{.....(4.1)}$$

Next, contraction and expansion are modeled as switching regimes of the stochastic process generating the securitized real estate return. In the following equations, s_t denotes an unobservable state or regime, which is denoted by 0 (recession) or 1(expansion)[10]. The transition between the states is governed by a first-order Markov process, which is reported in equation 4.5. Three different models

10 Though it is possible to assume the model with more regimes, using two regimes is standard in the literature, such as Hamilton (1989,1994), Turner, *et al*(1989), Schaller and Van Norden(1997) and Nishiyama(1998) . Moreover, the Likelihood ratio tests are going to be employed to determine the best model specification.

of switching will be tested - regime switching in means (equation 4.2), switching in variances (equation 4.3) and switching in means and variances (equation 4.4) respectively.

$$R_t = \mu_0(1-s_t) + \mu_1 s_t + \sigma_0 \varepsilon_t \quad (4.2)$$

$$R_t = \mu_0 + [\sigma_0(1-s_t) + \sigma_1 s_t]\varepsilon_t \quad (4.3)$$

$$R_t = \mu_0(1-s_t) + \mu_1 s_t + [\sigma_0(1-s_t) + \sigma_1 s_t]\varepsilon_t \quad (4.4)$$

$$\begin{aligned} &P[s_t = 0 \mid s_{t-1} = 0] = p \\ &P[s_t = 1 \mid s_{t-1} = 0] = 1 - p \\ &P[s_t = 1 \mid s_{t-1} = 1] = q \\ &P[s_t = 0 \mid s_{t-1} = 1] = 1 - q \end{aligned} \quad (4.5)$$

Equation (4.5) means that the probability that a given state will occur during this period depends only on the state last period. The probability that state 0(1) will persist from one period to the next is p(q).

For Equation (4.4), the securitized property market will be characterized by two distinguished regimes. State 0 is low return with high variance (bad time for investors), and state 1 is high return with low variance (good time for investors). When the market is in state 1, the market risk is relatively low and real estate investors can earn more return. On the contrary, when state 0 happens, the risk is substantially higher and investors lose money. Either state 0 or state 1 will not be persistent all the time. They will occur with certain duration and frequency. The expected duration is the number of periods (months) during which each state is expected to persist once that state sets in.

According to Hamilton (1989), the formulas of expected duration and unconditional probability for state 0 are $D(s_t = 0) = (1-p)^{-1}$, and $p(s_t = 0) = \frac{1-q}{2-p-q}$ respectively. For state 1, the two formulas are $D(s_t = 1) = (1-q)^{-1}$ and $p(s_t = 1) = \frac{1-p}{2-p-q}$.

The underlying structure of the proposed regime-switching model is characterized by a latent variable s_t, the state or regime. Although it is possible to estimate models with n regimes, adopting two regimes is standard in the literature. The likelihood ratio tests are first used to determine that the model specifications given below are best characterized as having one or two regimes. Each regime has its own return distribution with different expected return and /or variance. In addition, changes in the regimes are governed by a discrete Markov process with constant transition probabilities.

What should be mentioned is that, in this study, the real estate return is divided by two regimes, low return-high variance and high return-low variance. According to the classic asset pricing model, the capital market should hold risk-return trade-off, which means high return-high risk and low return-low risk parities. However, regime switching assumption has not been against the asset pricing model. The regime switching assumption is based on the market time series behavior, subject to the market cyclical movements. But the asset pricing model assumes there is no arbitrage at the same time horizon in an efficient market. In different time horizon, the market

conditions and the asset's sensitivities to different risk factors are subject to change, caused different risk-return trade-off. Therefore, there is no conflict between regime switching assumption and asset pricing model. The two regimes can sustain and be stable in the corresponding sub period.

4.3.2 Estimation

To estimate the models, the techniques proposed by Hamilton (1989) are adopted. The sample log-likelihood function is specified as:

$$\ln L = \sum_{t=1}^{T} \ln\{\sum_{S_t=0}^{1} f(R_t \mid S_t, \psi_{t-1}) \Pr[S_t \mid \psi_{t-1}]\} \qquad (4.6)$$

The marginal density given above can be interpreted as a weighted average of the conditional densities given $S_t = 0$ and $S_t = 1$, respectively. To derive the log likelihood function, it needs to calculate appropriately the weighting factors, $\Pr[S_t = 0 \mid \psi_{t-1}]$ and $\Pr[S_t = 1 \mid \psi_{t-1}]$. For the case of Markov switching, the state variable S_t will be dependent upon S_{t-1}. We will adopt the following filter for the calculation of the weight terms.

Step 1 Given $\Pr[S_{t-1} = i \mid \psi_{t-1}], i = 0,1$, at the beginning of the time t or the t-th iteration, the weighing terms $\Pr[S_t = j \mid \psi_{t-1}], j = 0,1$, are calculated as

$$\Pr[S_t = j \mid \psi_{t-1}] = \sum_{i=0}^{1} \Pr[S_t = j, S_{t-1} = i \mid \psi_{t-1}] \qquad (4.7)$$

$$= \sum_{i=0}^{1} \Pr[S_t = j \mid S_{t-1} = i] \Pr[S_{t-1} = i \mid \psi_{t-1}],$$

where $\Pr[S_t = j \mid S_{t-1} = i], i = 0,1, j = 0,1$, are the transition probabilities.

Step 2 Once R_t is observed at the end of time t, or at the end of the t-th iteration, we can update the probability term in the following way:

$$\Pr[S_t = j \mid \psi_t] = \Pr[S_t = j \mid \psi_{t-1,} R_t] = \frac{f(S_t = j, R_t \mid \psi_{t-1})}{f(R_t \mid \psi_{t-1})}$$

$$= \frac{f(R_t \mid S_t = j, \psi_{t-1}) \Pr[S_t = j \mid \psi_{t-1}]}{\sum_{J=0}^{1} f(R_t \mid S_t = j, \psi_{t-1}) \Pr[S_t = j \mid \psi_{t-1}]} \quad (4.8)$$

Where $\psi_t = \{\psi_{t-1,} R_t\}$

The above two steps may be iterated to get $\Pr[S_t = j \mid \psi_{t-1}], t = 1,2,...,T.$

By now, it is clear that the log likelihood function is a function of $u_0, u_1, \sigma_0, \sigma_1, p, q$.[11]The log likelihood function is maximized numerically by using EM algorithm (Hamilton, 1993). Moreover, the filter generate the conditional probability of each state occurring given all the information up to time t,

Hamilton(1993) finds the estimation of the EM algorithm is numerical robustness and also displays the EM algorithm application for Markov switching estimation does not have the poor convergence problem. If (as seems desirable) one explores a large number of possible starting value for maximum likelihood estimation, the EM algorithm offers a vast improvement in efficiency, since its numerical robustness permits execution of hundreds of maximizations with no adjustments by the user.

[11] This is the estimation sample of Equation 4.4. For the other two models, the processes are similar, just making the means or variances equal.

The normal t statistics is used to test the significance of estimation coefficient. Just like general maximum likelihood estimation, the potential problem of small sample statistics still exists for t statistics. However, in this study, the time series data are long enough to avoid this problem.

4.3.3 Markov Switching Vector Error Correction Model (MS-VECM)

Consider the following Markov-switching vector error-correction model:

$$\Delta y_t = v(s_t) + \sum_{i=1}^{k} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t \qquad (4.9)$$

Where $\Delta y_t = [\Delta y_{1t}, \Delta y_{2t}, ...\Delta y_{mt}]'$ is an m-dimensional vector of differenced variables of interest, $v(s_t)$ is a vector of state-dependent intercepts, the Γ_i are $m \times m$ parameter matrices, and $\sum \varepsilon_t$ are state-dependent covariance matrices. Π are general long-run impact matrices defined by the $r \times m$ matrix of cointegrating vectors. In consistence with the preceding section, it is assume that S_t is a two-state first-order Markov process in which $S_t \in \{0,1\}$ is governed by the transition kernel P, where $P_{ij} = \Pr[S_t = i \mid S_{t-1} = j]$.

The present application focuses on a multivariate model comprising, for our six markets analyzed, $[\Delta y_{1t}, \Delta y_{2t}, ...\Delta y_{mt}]'$ denoting each market's real estate return respectively. Δy_{t-i} is the i time lags of each real estate return series. The MS-VECM model can be estimated using a two-stage maximum likelihood procedure. The first stage essentially consists of the implementation of the Johansen(1988,1991) maximum

likelihood cointegration procedure in order to test for the number of cointegrating relationship in the system and to estimate the cointegration matrix. The use of the Johansen technique in two-step procedure makes one assumption is that the cointegrating relationship remains stable with a rank of one for the duration of the sample period. But the Markov process is based on the premise there are regime changes. Therefore, one weakness of the MS-VECM presented is that it is a two-step procedure in as much as the cointegrating rank and type must first be established prior to running the MS-VECM model.

The second stage then consists of the implementation of an expectation maximization (EM) algorithm for maximum likelihood estimation which yields estimates of the remaining parameters of the model. (Kim and Nelson,1999; Krolzig, 1999)

4.4 Data analysis

This analysis throughout the study uses securitized real estate excess returns .Table 4.1 reports several descriptive statistics for the monthly excess return series of the six markets. These include the mean, the standard deviation of the return, the range (maximum and minimum) of returns, and the measures of skewness and kurtosis. As can be seen, the US REIT market reports the highest average monthly excess returns (0.43%) and the lowest standard deviation (3.47%). Hong Kong and Singapore appear to be the two most volatile markets (standard deviations are 11.61% and 9.53% respectively).

Table 4.1 Monthly descriptive statistics of securitized property excess returns: 1987-2003

	Mean	Maximum	Minimum	Std Dev	Skewness	Kurtosis
Hong Kong	0.28%	45.21%	-61.99%	11.61%	-0.69	8.54
Singapore	-0.08%	47.61%	-39.02%	9.53%	-0.11	7.61
Japan	-0.52%	20.70%	-29.94%	8.71%	-0.16	3.22
Australia	-0.35%	7.59%	-28.08%	3.21%	-1.00	8.76
UK	-0.20%	15.35%	-39.00%	6.31%	-1.28	8.89
US	0.43%	9.07%	-17.13%	3.47%	-0.25	3.73

The skewness statistic shows that all the returns series are negatively skewned although the respective skewness statistics are not large (between -1.28 and -0.11). Finally, the kurtosis measure is more than 3 in all return series. This evidence suggests that for all the six securitized property markets, the distribution of returns has fat tails compared with the normal distribution.

4.5 Empirical results

4.5.1 Test of regime switching

Ang and Bekaert (1998) show that Likelihood Ratio (LR) test can be employed to determine the states for regime switching model. The LR test can be based on the statistics

$$LR = 2(\ln L(\tilde{\lambda}) - \ln L(\tilde{\lambda}_r)),$$

where $\tilde{\lambda}$ denotes the unconstrained estimator and $\tilde{\lambda}_r$ is the restricted estimator. The asymptotic distribution of the statistics can be approximated by a chi-square distribution where the number of degrees of freedom is given by the number of

nuisance parameters of the model with n regimes plus the number of restrictions imposed by regime n on regime n-1. The test statistics is calculated in a usual fashion in likelihood ratio tests.

Table 4.2 Likelihood ratio tests of regime switching in securitized property excess returns

Test	HK	Singapore	Japan	Australia	UK	US
Linearity against 2 regimes	442.42** (0.00)	447.06** (0.00)	393.60** (0.00)	417.36** (0.00)	403.30** (0.00)	399.60** (0.00)
2 regimes against 3 regimes	10.10 (0.26)	11.92 (0.15)	8.98 (0.34)	14.88 (0.16)	12.72 (0.12)	12.84 (0.12)

Notes: ** Indicates two-tailed significance at the 1% level.

Table 4.2 reports the likelihood ratio (LR) and probability for two hypothesis of no regime switching against two regimes and two regimes against three regimes. For the first hypothesis, all the results reject the null hypothesis, which means the two regimes specification is possible. But the results for all the second tests are statistically insignificant, which implies a two-regime model is superior to a three-regime model. Therefore, the LR test results support a two-state regime switching model is sufficient to illustrate the nonlinearity of the securitized property returns in the six markets. The model specification for this test is switching in means and variances since past literature always use this specification to describe stock market returns. Besides, the later likelihood ratio test also illustrate this specification is superior.

4.5.2 Evidence of regime switching for individual markets

The nature of the regime switching in return data will depend on the economic

forces that give rise to regime shift behavior. However, the sources are time variation in the uncertainty of real estate returns. As presented by Schaller and Van Norden(1997), if this is variation in the diversifiable component of returns, then mean returns might be the same across regimes while their volatility differs. However, if the undiversiable risk component weights is also switching, it might expect the constant variance states to have different mean returns. One the other hand, Black(1976) and Christie(1982) suggest that the stock return might have higher variances to be associate with lower average returns. These differences make it interesting to consider about the following 3 regime switching models.

I. Switching in means

The first specification to be examined is one in which securitized property excess returns are drawn from two distributions that differ only in their means, as in Equation 4.2. As illustrated in table 4.3, there is some evidence of significant regime swifts in mean returns (u_0 differs with u_1 significantly) for the USA and UK securitized property markets. In state 0, monthly returns are -7.28% (UK) and -2.24% (US), implying annual (compounded) returns of -59.63% (UK) and -23.80% (USA)[12]. When state 1 occurs, the implied annual returns become 24.16% (UK) and 19.14% (USA). Additionally, the probabilities of remaining in state 1 (q) is higher (between 0.6596 for Japan and 0.9045 for the USA). For state 0, the probability will persist for one more month is between 0.4658 (UK) and 0.7551 (USA).

[12] The annual compounded return assume the state will consistent for the whole year and calculate the 12 months' compounded return using the monthly average return.

Table 4.3 Regime switching in means

$$R_t = u_0(1 - s_t) + u_1 s_t + \sigma_0 \varepsilon_t$$

	Hong Kong	Japan	Singapore	Australia	UK	U.S.
u_0	-1.07% (-0.28)	-2.51% (-0.51)	-2.61% (-1.24)	-0.43% (-0.29)	-7.28%** (-4.83)	-2.24%* (-2.05)
u_1	1.50% (0.41)	0.30% (0.19)	1.94% (1.54)	0.28% (0.19)	1.82%** (3.32)	1.47%** (2.89)
$u_1 - u_0$	31.67%	29.95%	53.12%	8.45%	83.79%	42.94%
p	0.6453 (0.94)	0.6267 (0.52)	0.7305 (1.19)	0.6684** (4.26)	0.4658 (1.28)	0.7551** (3.21)
q	0.7081 (0.24)	0.6596 (0.16)	0.7244 (0.39)	0.6807 (0.04)	0.8621 (1.84)	0.9045 (1.06)
σ	11.51%** (3.04)	8.48% (1.23)	9.14%** (7.94)	3.20% (0.16)	4.39%** (8.15)	3.03%** (3.72)
Log-likelihood	-824.07	-762.83	-781.42	-550.22	-667.89	-562.88

Notes: the mean return is μ_0 in state 0 and μ_1 in state 1. The standard deviation of returns is σ. The transitional probabilities are p (state 0) and q (state 1) that follow a standard Gaussian distribution function. $(u_1 - u_0)$ is the difference in annual (compounded) returns between state 1 and 0. The figures in parentheses are t-statistics.

** Indicates two-tailed significance at the 1% level.

II. Switching in variances

The second specification examined is one in which securitized property excess returns are drawn from two distributions that differ only in their variances, as in Equation 4.3. A picture of two regimes with sharply different variances emerges from Table 4.4 (σ_0 differs with σ_1 significantly). For all the six markets, state 0 is characterized by a variance about 1.7 times to 2.9 times as large as the variance in state 1. The differences in variance between the two states are statistically significantly at the 1 percent level for all the 6 markets. The estimates of the transitional probabilities show that state 1 (low variance state) is highly persistent with an average q value of 0.9831. Similarly, state 0 (high variance state) is also reasonably persistent with a

smaller average p value of 0.7038.

Table 4.4 Regime switching in variances

$$R_t = u_0 + [\sigma_0(1-s_t) + \sigma_1 s_t]\varepsilon_t$$

	Hong Kong	Japan	Singapore	Australia	UK	U.S.
u	1.00%	-0.10%	0.31%	-0.28%	0.09%	0.47%*
	(1.64)	(-0.12)	(0.60)	(0.99)	(0.23)	(1.96)
p	0.7599**	0.8361**	0.9166**	0.7038**	0.8442**	0.7663**
	(6.53)	(5.22)	(18.33)	(2.93)	(7.03)	(3.58)
q	0.9597**	0.8830**	0.9652**	0.9831**	0.9769**	0.8846**
	(34.20)	(4.96)	(41.96)	(44.60)	(42.47)	(7.08)
σ_0	23.50%**	10.52%**	14.73%**	7.52%	10.44%**	4.63%*
	(3.13)	(2.39)	(4.28)	(1.04)}	(2.63)	(2.08)
σ_1	7.98%**	7.10%**	5.74%**	2.74%**	5.06%**	2.71%**
	(8.03)	(2.57)	(5.03)	(5.16)	(7.14)	(2.68)
Log-likelihood	-783.90	-729.11	-748.72	-513.82	-631.38	-551.92

Notes: the mean return is u .The standard deviation of returns is σ_0 in state 0 and σ_0 in state 1. The transitional probabilities are p (state 0) and q (state 1) that follow a standard Gaussian distribution function. The figures in parentheses are t-statistics.** Indicates two-tailed significance at the 1% level.

III. Switching in means and variances

In the univariate specification where securitized property returns are characterized by switching means and variances (Equation 4.4), the results in Table 4.5 reveals the variance in high-volatility state (state 0) is between 1.2 times (USA) and 3.2 times (Australia) as large as the variance in low-volatility state (state 1). The mean return in state 0 is negative for all markets (between -4.36% and -1.12%). In addition, the difference in the mean annual (compounded) returns between the two regimes ranges from 17.30% (Singapore) to 55.46% (HK). Hence, there have a situation in one state the returns are low / negative and the variance is high (state 0), and in the other state the returns are high and variance is low (state 1). The estimates of the transitional

probabilities suggest that low-variance regime dominates (q is between 0.9113: for UK and 0.9652: for Singapore). Moreover, all high–variance probabilities estimates are reasonably high (p is between 0.7589: for HK and 0.9146: for Singapore). Hence, once the low-variance or high-variance state sets in there is a high probability that the same state continues in all markets.

Table 4.5 Regime switching in means and variances

$$R_t = u_0(1-s_t) + u_1 s_t + [\sigma_0(1-s_t) + \sigma_1 s_t]\varepsilon_t$$

	Hong Kong	Singapore	Japan	Australia	UK	U.S.
u_0 (%)	-4.36	-1.12	-3.16**	-4.12%	-3.52*	-2.01
	(-1.01)	(-0.54)	(-3.13)	(-0.40)	(-1.96)	(-1.54)
u_1 (%)	1.10**	0.38**	0.38	0.26*	1.15*	1.61**
	(2.71)	(2.70)	(0.20)	(1.97)	(2.03)	(2.76)
$u_1 - u_0$ (%)	55.46	17.30	36.66	42.81	49.66	42.75
p	0.7589**	0.9146**	0.8326**	0.7864**	0.7766**	0.7797**
	(6.83)	(8.20)	(6.41)	(4.18)	(5.97)	(5.06)
q	0.9588**	0.9652**	0.9442**	0.9702*	0.9113**	0.9126**
	(4.56)	(4.02)	(15.71)	(3.48)	(15.10)	(2.54)
σ_0 (%)	22.62**	14.74**	11.00**	9.06%**	8.67**	3.43**
	(3.17)	(4.16)	(3.11)	(5.02)	(2.54)	(2.54)
σ_1 (%)	8.07**	5.76**	7.53**	2.84%**	4.33**	2.95**
	(7.94)	(4.60)	(5.71)	(6.41)	(2.96)	(5.95)
Log-likelihood	-602.85	-558.55	-566.03	-341.53	-483.47	-367.32

Notes: The mean return is μ_0 in state 0 and μ_1 in state 1. The standard deviation of returns is σ_0 in state 0 and σ_1 in state 1. The transitional probabilities are p (state 0) and q (state 1) that follow a standard Gaussian distribution function. ($u_1 - u_0$) is the difference in annual (compounded) returns between state 1 and 0. The figures in parentheses are t-statistics. ** Indicates two-tailed significance at the 1% level.

The likelihood ration test also can be employed to evaluate the alternative specification performances. Conventionally, the alternative regime switching specifications can be compared on the basis of unconditional moments and forecast

error. However, in above three specifications, the means and variances of the series would shift by different manners; it is hard to compare them with the unconditional moments on a same benchmark. For example, Model II just has one mean, but Model I and III have two means, it is inappropriate compare the three models' means with the unconditional moment. For the forecasting error, since the three models all assume the distributions of return series, not the dynamic time series models such as AR, MA or ARMA, they can not be used as the forecasting models. Krolzig(1997) points out the likelihood ratio test also can be employed to evaluate the performance of regime switching models and specifications.

Table 4.6 Model performance comparison of 3 Markov Switching specifications

Test	HK	Singapore	Japan	Australia	UK	US
Model I against Model III	442.44** (0.00)	408.56** (0.00)	430.78** (0.00)	417.38** (0.00)	368.84** (0.00)	391.12** (0.00)
Model II against Model III	362.10** (0.00)	341.12** (0.00)	365.38** (0.00)	344.58** (0.00)	295.82** (0.00)	369.20** (0.00)

Notes: ** Indicates two-tailed significance at the 1% level. Mode I: switching in means, Model II, switching in variances, Model III: switching in means and variances.

Table 4.6 reports the results of likelihood ratio test for two hypothesis of Model I against Model II and Model II against Model III. The results indicate the significant results for both two hypotheses and Model III outperforms the other two specifications. Accordingly, the regime switching model in both mean and variance are adopted for subsequent investigations. Moreover, in above three switching specifications, the third specification (means and variances) has more practical meaning since investors always consider how the behavior of mean returns and their variance are related across

regimes. Separating the returns and variances is less meaningful in real investment activity.

The above regime switching specifications are based on the assumption that the error term (ε_t) is an IDD Gaussian variable. Schaller and van Norden(1997) suggest a series of diagnostic tests to assess the validity of this assumption. Table 4.7 presents the tests for serial correlation, ARCH(1), high-order Markov effects and a joint test. The results demonstrate there is no evidence of serial correlation in any markets. The

Table 4.7 Diagnostic tests of the Markov Switching specifications

	HK	**Singapore**	**Japan**	**Australia**	**UK**	**US**
AR(1)	0.001	0.04	0.05	0.01	0.02	0.02
Regime 0	(0.97)	(0.84)	(0.82)	(0.91)	(0.89)	(0.89)
AR(1)	0.06	0.01	0.002	0.03	0.001	0.001
Regime 1	(0.80)	(0.92)	(0.96)	(0.87)	(0.96)	(0.98)
ARCH(1)	0.08	0.05	0.22	0.09	0.007	0.04
Regime 0	(0.77)	(0.82)	(0.74)	(0.76)	(0.93)	(0.83)
ARCH(1)	0.06	0.08	0.05	0.22	0.18	0.02
Regime 1	(0.80)	(0.78)	(0.82)	(0.64)	(0.67)	(0.89)
High States	8.55**	3.55	7.89**	0.75	0.70	0.40
effects	(0.01)	(0.06)	(0.01)	(0.38)	(0.40)	(0.52)
Regime 0						
High States	0.07	0.64	0.71	0.37	0.99	0.91
effects	(0.79)	(0.42)	(0.39)	(0.54)	(0.32)	(0.33)
Regime 1						
Joint Test	9.07	3.70	8.00	1.33	1.89	1.25
	(0.17)	(0.72)	(0.23)	(0.97)	(0.92)	(0.97)

Notes: The AR(1) statistics tests for serial correlation in the residuals, ARCH(1) for serial correlation in volatility, and high states effects for evidence that two states Markov switching is adequate to capture the dynamic of returns. Joint test is for the all 6 specifications together. The figures in parentheses are significance level. ** Indicates two-tailed significance at the 1% level.

diagnostic tests also show no evidence of omitted ARCH effects. Schaller and van Norden(1997) point out the test for high-order Markov effects can be designed to

check this assumption.[13] The results suggest that there is little evidence of high states effects. This is consistent with previous results of Likelihood Ration tests. Finally, the joint tests also fail to reveal any evidence of misspecification.

IV. Stock market results comparison

Table 4.8 reports the comparable results of stock market excess return results. Table 4.5 displays that the switching in means and variances model is superior to the other two. Thus, this section only compares the results of switching in means and variances. Table 4.8 reveals the stock markets also illustrate two states, state 0 (low return-high variance) and state 1 (high return-low variance).

In Hong Kong, Singapore and Japan, the variances of stock markets are higher that that of securitized real estate markets. For instance, in state 0, the standard deviations of three countries' stock market returns are 27.61%, 21.94% and 25.92% separately, larger than the standard deviations of their own property stock excess returns, 22.62%, 14.74% and 11.00%. In state 1, which is in boom period, the standard deviations of property stock returns are 8.07%, 5.76% and 7.53%, also less than the corresponding standard deviations of stock returns, 11.75%, 10.76% and 11.13%. This is because the stock market represents the whole economy system. And during recent 20 years, the Asian economy, as well as the property sector, have grown rapidly and developed dramatically. The high speed growth causes the variances of sectors in the stock

[13] Note that *n*th order Markov model with 2 states can always be remodeled as a first-order Markov model with 2^{th} states. Accordingly, these tests for high-order Markovian effects can also be interpreted as tests for appropriated number of states.

market are also high. When these variances are combined together as the whole stock market variance, it will be larger than the sole property sector.

Also, in Australia and U.S., the excess return variances of stock markets are higher than that of securitized real estate. In state 1, the standard deviations of stock returns are 10.32% and 10.48% separately in Australia and U.S., higher than the corresponding property stock's standard deviations, 2.84% and 2.95%. This is mainly because the securitized real estates in these two markets are REITs and LPTs. The yield pass through structures of REITs and LPTs cause investors to hold them longer and also make the return volatility lower.

Table 4.8 Stock market regime switching in means and variances

$$R_t = u_0(1-s_t) + u_1 s_t + [\sigma_0(1-s_t) + \sigma_1 s_t]\varepsilon_t$$

	Hong Kong	Singapore	Japan	Australia	UK	U.S.
u_0 (%)	-3.10**	-1.50	-3.46**	-0.95	-1.05	-2.26
	(-3.02)	(-0.85)	(-3.00)	(-1.38)	(-1.08)	(-2.31)
u_1 (%)	0.97**	0.65**	-0.14	0.53**	0.89**	1.02**
	(2.86)	(2.65)	(0.35)	(3.14)	(2.45)	(3.51)
p	0.7923**	0.7699**	0.8448**	0.8347**	0.8570**	0.7965**
	(6.66)	(4.11)	(5.63)	(2.72)	(14.10)	(2.34)
q	0.9611**	0.9102**	0.9392**	0.9743**	0.8709**	0.9440**
	(3.84)	(18.20)	(7.61)	(3.18)	(7.91)	(4.72)
σ_0 (%)	27.61**	21.94**	25.92**	26.17%**	15.45**	15.74**
	(2.68)	(3.75)	(7.60)	(4.73)	(2.79)	(17.60)
σ_1 (%)	11.75**	10.76**	11.13**	10.32**	3.95**	10.48**
	(24.4)	(3.65)	(4.46)	(3.27)	(6.57)	(5.50)
Log-likelihood	-545.58	-486.85	-477.96	-404.25	-426.59	-413.10

Notes: The mean return is μ_0 in state 0 and μ_1 in state 1. The standard deviation of returns is σ_0 in state 0 and σ_1 in state 1. The transitional probabilities are p (state 0) and q (state 1) that follow a standard Gaussian distribution function. The figures in parentheses are t-statistics. ** Indicates two-tailed significance at the 1% level.

4.4.3 Further evidence of mean-variance switching

(a) Expected duration of the states

Table 4.7 provides estimates of the expected duration of the two states in the context of mean-variance regime swifts. The expected duration provides a useful measure of the duration of each state. As observed, the UK securitized property excess return series has the longest expected duration of low return-high volatility state (state 0) of about 6.99 months. This is followed by Japan (6.44 months), Australia (6.05 months), US (4.91 months), HK (4.81 months) and Singapore (4.34 months). For the high return-low volatility state (state 1), the longest and shortest expected duration are approximately 38.91 months (Australia) and 7.75 months (UK) respectively.

Table 4.9 Expected duration (in months)

	Low return—High volatility Regime (State 0)	High return—Low volatility Regime (State 1)
Hong Kong	4.81	25.71
Singapore	4.34	11.14
Japan	6.44	16.45
Australia	6.05	38.91
UK	6.99	7.75
U.S.	4.91	17.86

Note: The expected duration is the number of periods (months) during which each state is expected to persist once that state sets in.

In Table 4.9, state 1 in Hong Kong, Singapore and Australia was found to have durations above two years. However, the number in Table 4.9 is just the “expected” duration of each regime’s, not the realized durations. Since the market conditions are ever-changing, they may make the real durations longer or shorter than the expected

ones. The length of the duration depends on the state's unconditional probability (see methodology section). However, the expected duration can not tell about the risk premium in the market. It is have to be calculated by the difference between state's expected return and the corresponding risk free rate.

(b) Unconditional probabilities of the regimes

The unconditional probabilities of the two regimes to prevail are provided in Table 4.11. As observed, Australia shows the highest probability of being in the low volatility- high return regime (state 1), which is 87.76 percent of the time. On the other hand, Australia has the lowest probability of being in the high volatility-low return regime (state 0 – 12.24 percent). The Singapore market is expected to be in its low volatility-high return state about 71.05 percent of the time.

Table 4.10 Unconditional probability of each regime

	Low return—High volatility Regime (State 0)	High return—Low volatility Regime (State 1)
Hong Kong	0.1459	0.8544
Singapore	0.2895	0.7105
Japan	0.2487	0.7513
Australia	0.1224	0.8776
UK	0.2842	0.7158
U.S.	0.2840	0.7160

(c) Volatility persistence

For each market, the probabilities of being in state 1 (high return-low volatility) are shown over the sample period in Figure 4.2. There are two main observations. First, all the market's returns are dominated by the low volatility-high return state. The

probability of being in good years (state 1) is reasonably close to 1 for most of the sample period especially in HK, Australia and Singapore markets. Second, the high-volatility state persists in the Singapore and HK markets after the 1997 Asian financial crisis, with the Singapore property stock market exhibiting stronger post-crisis high volatility. Panels A and B of Figure 4.2 display the return-probability trend over the Asian financial crisis period for Hong Kong and Singapore. In summary, our investigations have revealed that the two regimes are persistent with significant differences observed in the degree of regime persistence and the frequency of switches between the regimes among the six markets. However, state 0 dominates six markets.

(d) Individual market evidence

Figure 4.2 and 4.3 report the probabilities of high return-low variance state, through which can identify some typical periods of regime switching.

The panel A of Figure 4.3 indicates the Asian Financial Crisis it caused the Hong Kong market to enter an economic recession from 1997 to 1998. The crisis affected the whole regional economy and stock markets. The real estate market therefore declined about 30% at that moment. Figure 4.2 also displays Hong Kong market rose up and entered the expansion period after 2000. This is because Hong Kong's economy integrates with China mainland more closely during that period. The recovery of domestic consumption and influx of Mainland tourists have driven the whole economy and the retail property market. In 2004, the number of Mainland Chinese arrivals increased by 54% during the first ten months of the year, Mainland Chinese tourists--

the biggest spender, now accounts for 57% of total arrivals in Hong Kong. In residential market, riding on a wave of robust economic performance and improving negative equity, the residential mass market recovered strongly in 2004.

The Singapore market also entered an economic recession from 1996 to 1998. This is because the market was over heat in 1996 and government worried about the too high real estate price causing more risk for its economy. Therefore, the government hence introduced anti-speculation measures for the residential market in May 1996, which along with the subsequent Asian financial crisis in 1997, causing prices of the different real estate markets to decline substantially in later years.

In Australia, the securitized market was in expansion period in 1990s. Since the 1990's, the LPT sector in Australia has undergone major structural changes, including a significant expandsion in the number of LPTs and their corresponding market value. This has been seen the LPT market capitalization increase from $5 billion to over $35 billion in the 1990's (Blundell, 2001) .Other important factors over this period have been substantially increased LPT gearing level, and with LPTs taking on more of the investment performance features of direct property. (Newell, 2001).

In UK, the securitized market was in a recessionary period from 1989 to 1991. Before 1989, the economic boom, deregulation of the financial and property sectors caused the property market to expand very fast, even over heat. Therefore, in October 1989, the Treasury Secretary Nigel Lawson raised bank base rates to 15%. The market recession then followed at the end of 1989, with the banks' base rates

being raised. The property prices dropped severely due to the heavy debt incurred by property companies. The interest rate hike, which was used to reduce inflation, adversely affected the property market.

Figure 4.2 Probability of high return-low volatility state ($P(S_t = 1 | \psi_t)$)

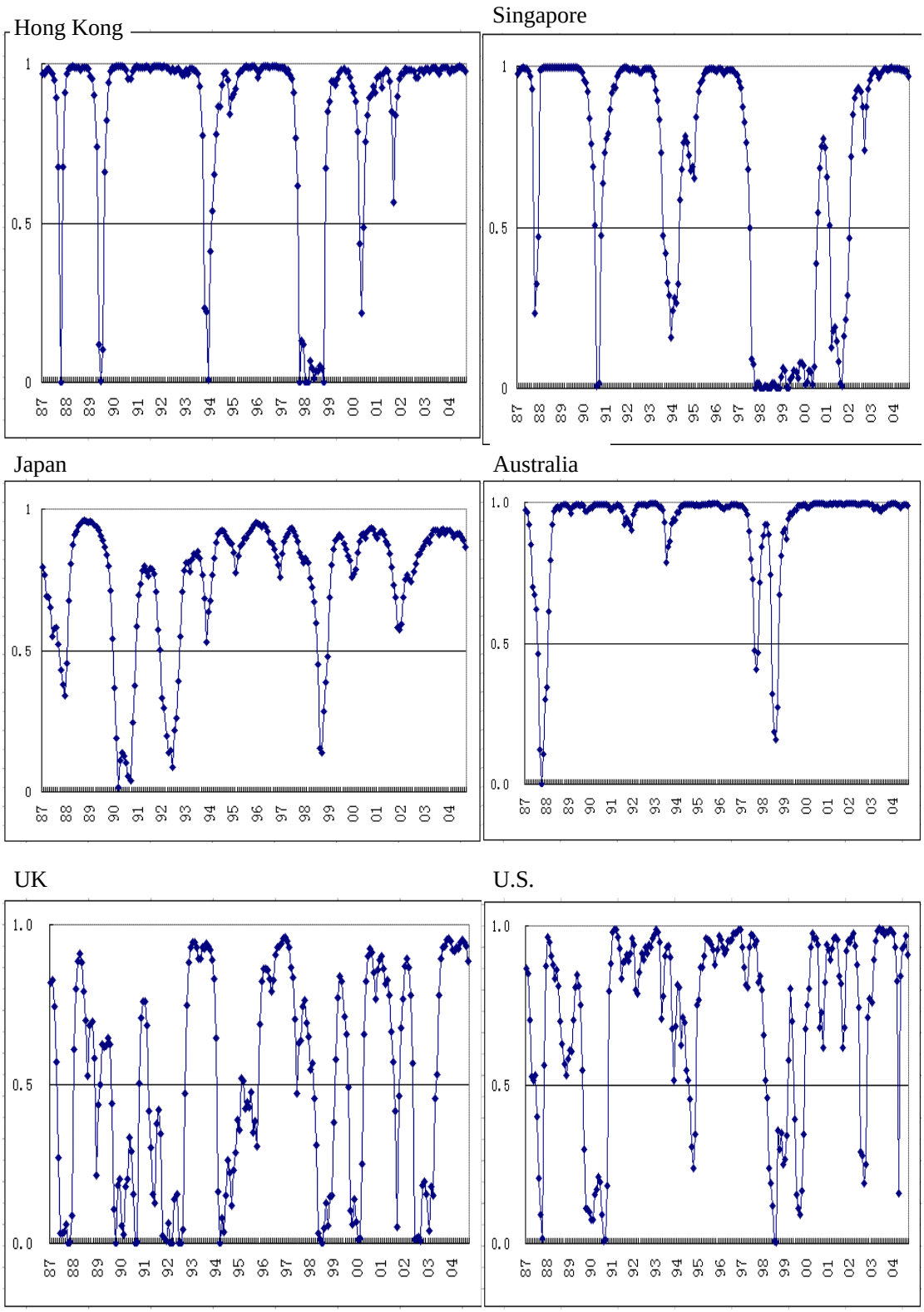
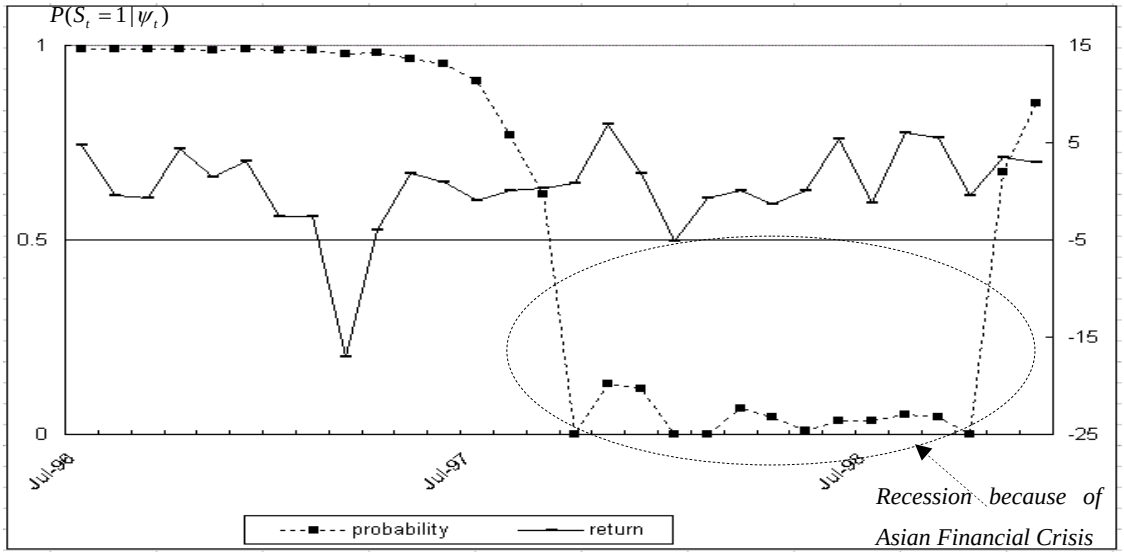
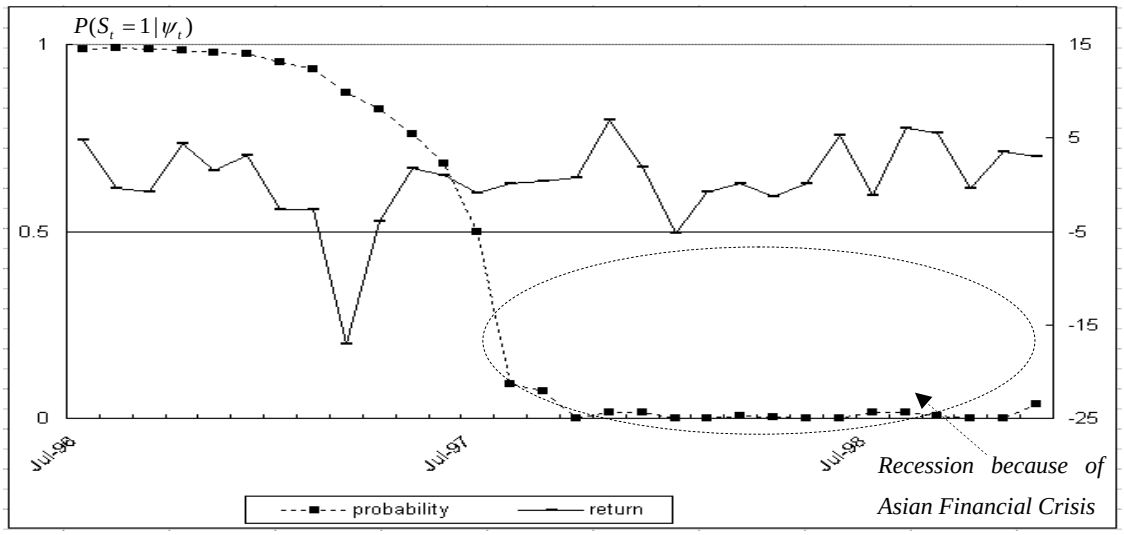


Figure 4.3 Examples of return– probability in recession / crisis periods

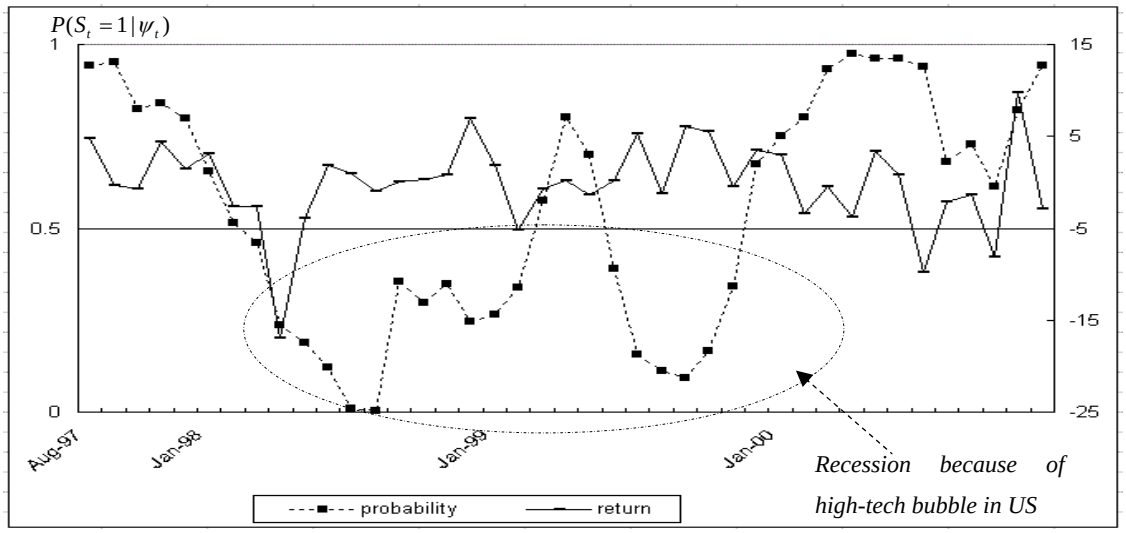
Panel A Asian Financial Crisis and Hong Kong Property Stock Market



Panel B Asian Financial Crisis and Singapore Property Stock Market



Panel C US Technological Bubble and REIT Stocks



(e) US REIT market in the period 1998-2000

As the figure in Panel C of Figure 3.3 shows, shortly after the abrupt of the Asian financial crisis, the US REIT market fell into a "recession" for a period of 19 months (April 1998-October 1999, both months inclusive)[14]. Over the period 1991-2000, the average mean excess return for REIT stocks and their standard deviation were 1.06% and 3.48%, respectively. However, the average monthly return for the REIT stocks was -1.64% and -0.49% for 1998 and 1999 with standard deviation of returns of 4.21% (1998) and 3.83% (1999), respectively. Hence, the years 1998 and 1999 corresponded to the low-return-high volatility regime (State 0). One popularly cited reason for the weak performance of the REIT industry during these two years was the rotation of institutional funds out of REIT stocks to technology and e-commerce stocks. The IT stocks are so attractive that cause the major investment

[14] Based on our analysis, the unconditional probability of State 0 (low return-high volatility) of each of the 19 months is between 0.0182 and 0.4573.

funds enter to high-tech sector and left few investment flow in REITs sector. According to Howard (1998), during these periods many US technology and internet stock prices soared to unrealistic level. Investors' enthusiasm on these stocks and the liquidity crunch in the market caused REIT shares to tumble by nearly 20 percent for the first quarter of 1998. The huge decline in REIT stock prices was thus mainly due to the relatively poor performance of real estate value increases during the 1990s compared to the prices of competitive stock investments, especially technology and e-commerce stocks (Downs, 2000). The technological bubble caused institutional investors rotate their funds to the high-technology sectors. In 2000, REIT stock prices recovered with an average monthly return of 2.01%.

4.4.4 State dependent mean-variance correlation

Table 4.11 presents the cross-market Pearson correlation coefficients of state 1 (low volatility) for the entire period, the 3-year period after October 1987 stock market crash and the 3-year period after July 1997 Asian financial crisis. For the full period (Panel A), the correlation of mean-variance state dependence is the highest between UK and Japan (0.568), followed by US and UK (0.463), Australia and HK (0.457) and US and Japan (0.436). However, some pairs of securitized property markets show negligible correlations. They include Singapore and Japan (0.031), HK and Japan (0.121) and HK and UK (0.117). A final observation is that the US mean-variance state dependence shows stronger positive relationship with all the other five markets (correlation coefficients range between 0.175 and 0.463, all are statistically significant

at the 5 percent level).

Table 4.11 Pearson correlation coefficients $P(S_t = 1 | \psi_t)$ for switching in means and variances

Panel A: Full period

	HK	Singapore	Japan	Australia	UK	US
HK	1	0.354**	0.121	0.457**	0.117	0.269**
Singapore		1	0.031	0.223**	0.116*	0.175**
Japan			1	0.312**	0.568**	0.436**
Australia				1	0.335*	0.310**
UK					1	0.463**
US						1

Panel B: Post-Stock Market Crash Period (Nov 1987—Nov 1990)

	Hong Kong	Singapore	Japan	Australia	UK	US
Hong Kong	1	-0.145	-0.276	0.002	-0.141	-0.282
Singapore		1	0.632**	0.412	0.650**	0.493
Japan			1	0.180	0.591	0.734**
Australia				1	0.332	-0.178
UK					1.	0.732**
US						1

Panel C: Post Asian Financial Crisis Period (Aug 1997—Aug2000)

	Hong Kong	Singapore	Japan	Australia	UK	US
Hong Kong	1	0.431**	0.407	0.520**	0.171	0.020
Singapore		1	0.234	0.206**	0.308	-0.241
Japan			1	0.621**	0.614	0.565**
Australia				1	0.353	0.310
UK					1	0.448**
US						1

Panel D: Results of stock market (full time)

	Hong Kong	Singapore	Japan	Australia	UK	US
Hong Kong	1	0.668**	0.133	0.475**	0.130	0.272**
Singapore		1	0.250	0.272*	0.323**	0.374**
Japan			1	0.361**	0.562**	0.363**
Australia				1	0.371**	0.298**
UK					1.	0.545**
US						1

**,* indicates two-tailed significance at the 1% and 5% level respectively

For the three-year post October 1987 crash period, Panel B of Table 4.11 reveals that mean-variance state correlations for Singapore, Japan and UK improve substantially with the US securitized real estate market. The US-Japan correlation become the highest (0.734), followed by US-UK (0.732) and UK-Singapore (0.650) correlations. The Japan-Singapore state correlation also improves tremendously for the post crash period (0.632) On the other hand, the state correlations for other pairs of securitized property returns decrease or turn out negative for the post-crash period. Our findings are hence different from earlier stock market evidence that increasingly interdependency and volatility spillovers among international stock markets in the post-crash era are documented (Theodossiou and Lee, 1993; Nishiyama, 1998).

When the data are confined to the 3-year post July 1997 Asian financial crisis period, a different picture emerges. As observed in Panel C, the most striking evidence is the mean-variance state correlations of Australia with other three Asian-Pacific markets (HK, Singapore and Japan) which are significantly higher (between 0.431 and 0.565) in the post crisis period. However, the Japan-HK and Japan-Singapore state correlations show weaker positive relationship. As expected, the US and UK

securitized markets display weak state correlations with other pairs of Asian-Pacific markets as they were much less affected by the Asian financial crisis. Finally, as noted earlier, this post Asian financial crisis period coincided with the US REIT technological bubble period. Hence the state correlations of other markets with the US REIT market might have been affected by this event.

The above results seem to indicate that correlation between selected sample markets improved significantly after two crises in 1987 and 1997. The results can be explained by the stock market crisis contagion phenomenon, which means the significant increase of cross-market linkages after a crisis. Forbes and Rigobon (2002) show stock markets of different structures and locations can exhibit high degree of comovement after a crisis. The stock market crisis can increase the relationship of the sample markets. This will reduce the portfolio diversification benefits, although diversification benefits can still be derived since correlation coefficients are below 1.

Panel D reports the state-dependent correlation of corresponding stock markets. Generally, the stock market's correlations of the probability of state 1 are higher than that of securitized real estate markets. For example, the stock market correlation coefficient between Hong Kong and Singapore is 0.668; however, the securitized real estate's coefficient is 0.354. The stock market correlation coefficient between Australia and UK is 0.371; however, the securitized real estate's coefficient is 0.310. Finally, the overall stock market correlation coefficient between U.S. and UK is 0.545 and their securitized real estate's coefficient is 0.463.

These results do make sense since the economic coverage of stock market is larger than that of securitized real estate market. The stock market represents the whole country's economic sectors and the relationships among stock markets can illustrate the degree of connection of the economic system. With today's economy's globalization trend and financial markets integration, this relationship tends to be stronger. Securitized real estate markets, as one sector of the stock markets, just share one part of the global economy connection. Therefore, the correlation coefficients of stock markets are generally higher than that of securitized real estate markets.

4.4.5 Common regime shifts

Since this part is about the relationship of various market indexes, it is unnecessary to adjust the effect of risk free rate. The MS-VECM treats the six property stock markets as a system. By considering the short and long term relationships across the markets, the model is able to capture the common regime switching movements of this system. Before the estimation of MS-VECM, some preliminary tests are required. Firstly, the *p*, length of lags in the model, need to be determined. Krolzig (1997) points out VAR order selection criteria can be use to determine the lag specification in MS-VECM model. Table 4.12 illustrates the results of VAR order selection. For the AIC criterion, the minimum is one time lag with 37.95, and the SC criterion reports one lag (38.62) as the optimal choice as well. Hence, the MS-VECM would select 1 as the length of lags.

Table 4.12 Lag order selection for MS-VECM

p	1	2	3	4	5
AIC Criterion	37.95*	38.13	38.20	38.29	38.48
SC Criterion	38.62*	39.37	40.02	40.69	41.40

Notes: * means the optimal lag selection. AIC means Akaike Information Criterion= $-2l/T+2k/T$. SC means Schwarz Criterion= $-2l/T+(k\log T)/T$. k is the number of parameters, T is the observations and l is the value of the log of likelihood function. According to these two criteria, the minimum one would be the optimal choices for the model.

(a) Unit root test results

Secondly, unit root test is employed to examine the stationary of the price indexes. The test is necessary, as finding of unit root in any of the index series indicates non-stationary, which has implication for modeling the long term or cointergration relationships among the indexes. Table 4.13 reports the results of unit root test before and after first difference using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests. The results show that both of the data series are nonstationary and integrated order 1 or *I*(1).

Table 4.13 Unit root test results

	Hong Kong	Singapore	Japan	Australia	UK	US
ADF Level	-1.63	-2.24	-2.22	-0.08	-1.82	0.77
ADF Difference	-8.09	-6.72	-6.19	-8.69	-7.02	-6.27
PP Level	-1.95	-2.19	-1.88	-0.70	-2.10	0.84
PP Difference	-13.96	-12.53	-14.41	-16.01	-12.92	-13.12

Notes: ADF means Augmented Dickey-Fuller test, PP means Phillips-Perron test. ** indicate significance in 1% level. The critical value for 1% is -3.46, for 5% is -2.87

Next, considering the target markets have experienced significant structural break within the study period, such as the Asian Financial Crisis, the Perron's (1989) unit

root test with structural break is adopted to test the unit roots. In Perron's(1989) framework, three different models are considered to test the null hypotheses of a unit root with a possible nonzero drift against trend stationary (TS) alternatives according to the nature of impact on the structure of economic time series examined. More specifically, the three models assume three different impacts on a time series of a specific structural break: an exogenous change in the level of the series (crash model), an exogenous change in the rate of growth (changing growth model), and both (crash with changing growth model).The three hypothesized models are labled as A, B and C respectively. The statistical procedure involves the following regression equations:

$$y_t = a_0 + a_1 y_{t-1} + a_2 t + u_2 DL_t + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad \text{(A)}$$

$$y_t = a_0 + a_1 y_{t-1} + a_2 t + u_3 DT_t^* + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad \text{(B)}$$

$$y_t = a_0 + a_1 y_{t-1} + a_2 t + u_2 DL_t + u_4 DT_t + \sum_{i=1}^{k} \beta_i \Delta y_{t-i} + \varepsilon_t \qquad \text{(C)}$$

Where t is the deterministic time trend, DL_t is a level dummy variable such that $DL_t = 1$ if $t > \tau$ and zero otherwise, τ is the time when the structural break point occurs. DT_t^* and DL_t are the trend dummy variables such that $DT_t^* = t - \tau$, and $DT_t = t$ if $t > \tau$ and 0 otherwise. The test statistics for the null hypothesis $a_1 = 1$ used by Perron (1989) is the standard t-statistic which is based on the proportion of observations occurring prior to the break $\lambda = \tau / T$, T is the total number of observations). The critical values are obtained from Monte Carlo simulations and are asymptotic in nature.

Table 4.14 reports the results of Perron's (1989) unit root test. Given the structural changes in the target markets, the series are still not stationary in level and stationary after first difference according to 3 structural change assumptions.

Table 4.13 Perron unit root test for structural break

	Model	t-value	
		Level	Difference
Hong Kong	A	-2.65	-21.42**
	B	-3.14	-20.42**
	C	-2.58	-23.44**
Singapore	A	-2.23	-19.63**
	B	-3.44	-15.61**
	C	-3.90	-21.28**
Japan	A	-2.15	-19.42**
	B	-3.04	-21.32**
	C	-1.88	-22.44**
Australia	A	-2.23	-21.63**
	B	-2.54	-20.61**
	C	-2.90	-20.58**
UK	A	-2.15	-21.32**
	B	-3.54	-22.72**
	C	-3.38	-23.14**
US	A	-3.43	-21.33**
	B	-3.74	-22.51**
	C	-3.79	-20.28**

Note: model A means "Crash", model B means "Changing Growth ", model C means " Crash with Changing Growth ". The critical values vary with the proportion of observations occurring prior to the break. Here we report the asymptotic critical value based on Perron(1989): Model A= -4.01(1%), -4.34(5%); Model B=-4.55(1%), -3.94(5%); Model C=-4.81(1%), -4.22(5%). ** indicates significance at 1% level.

(b) Cointegration analysis

Table 4.14 reports the results of cointegration test. The results indicate that there is only one cointegration among the six securitized property stock. With this result, the

single co-integration vector can be identified and used to construct the error-correction term for the MS-VECM in the next step. Although the time series data are subject to regime changes, Krolzig (1997) and Francis and Owyang (2003) both point out, in the first stage use of the conventional Johansen procedure is valid without modeling the Markovian regime shifts explicity. [15]

Table 4.14 Cointegration test results

R	Trace	Max
0	112.05(94.15)**	44.09(39.37)*
1	67.96(68.52)	26.70(33.46)
2	41.26(47.21)	21.27(27.07)
3	19.98(29.68)	11.77(20.97)
4	8.21(5.41)	7.26(14.07)
5	0.94(3.76)	0.94(3.76)

Notes: The results (trace tests and maximal eigenvalues) are from the Johansen Full Information Likelihood(FLML) cointegration regressions. The null hypothesis for the trace test is that the number of cointegrating vectors is less than or equal to r, with the alternative of larger than r. The null hypothesis for the maximum eigenvalue test is the number of cointegrating vectors is r, with the alternative of r + 1. Critical values are in parentheses. Significance is indicated by * at the 5% level.

(c) MS-VECM resluts

The estimation results are presented in Table 4.15. The Likelihood Ratio linearity test that compares a non-linear (MS-VECM) against a linear (VECM) alternative, reports the significant result according to the upper significance bound from Davies (1987) and Ang and Bekaert (1998). It indicates that the MS-VECM is necessary and meaningful.

In the MS-VECM specification, the intercepts and variances are subject to regime shifting (Equation 3.6). The results in Table 4.15 reveal the key finding that there are

[15] The Methodology part has detailed explanation.

extensively common regime shifts in the international securitized real estate markets with two distinct states . In state 0, the intercept is low and volatility is high, but state 1 presents high intercept and low volatility, which are similar with previous results on switching in means and variance. More specifically, in state 0, the US presents the highest intercept with 0.39% and Singapore presents the lowest intercept (-1.55%). In terms of volatility, Hong Kong exhibits the highest one with 15.38% while Australia illustrates the lowest one with 2.77%. In state 1, Singapore displays the highest intercept (5.53%), and Japan displays the lowest one (0.30%). As for volatility, Hong Kong market still reports the highest variance (9.40%), while US reports the lowest (2.61%). The transition probabilities of two regimes are 0.7932(recession) and 0.9295(peak) respectively, which imply that the low-variance state dominates. Therefore, the corresponding durations are 4.84 and 14.19 months for the international common regime movement.

According to Table 4.15, the coefficients of error correction terms are all significant, which are consistent with the previous cointegration analysis. However, the six market's error correction adjustment coefficients are different from each other. The coefficients range from -0.08 (Hong Kong) to -0.02 (US). On the other hand, the small coefficients indicate that the error correction speed among international securitized real estate markets is low. Furthermore, there also exists the short term dynamic relationship among the international securitized real estate markets.

Table 4.15 MS-VECM results

$$\Delta y_t = v(s_t) + \sum_{i=1}^{k} \Gamma_i \Delta y_{t-i} + \Pi y_{t-1} + \varepsilon_t$$

	HK	Singapore	Japan	Australia	UK	US
Constant term						
u_0(%)	-0.67 (-0.75)	-1.55* (-2.06)	-0.60 (-0.79)	-0.26 (-1.08)	-0.71 (-1.29)	0.39 (1.33)
u_1(%)	4.51 (0.78)	5.53** (2.31)	0.30 (0.20)	1.50** (3.59)	2.77** (4.02)	2.31* (3.05)
Short-run dynamics						
HK(-1)	0.09 (1.06)	0.01 (0.15)	-0.04 (-0.48)	0.02 (0.84)	0.004 (0.07)	-0.03 (-1.32)
Singapore(-1)	0.07 (0.70)	0.17* (2.23)	0.01 (0.09)	-0.03 (-1.08)	0.01 (0.15)	0.08 (1.44)
Japan(-1)	-0.04 (-0.45)	-0.003 (-0.05)	-0.05 (-0.75)	-0.04 (-1.70)	-0.002 (-0.03)	0.003 (0.14)
Australia(-1)	-0.01 (-0.04)	-0.18 (-0.93)	-0.05 (-0.26)	-0.04 (-0.53)	0.05 (0.38)	-0.03 (-0.36)
UK(-1)	0.02 (0.10)	0.02 (0.18)	0.26 (2.28)	0.04 (1.12)	0.06 (0.85)	0.10** (2.38)
US(-1)	-0.30 (-1.20)	-0.07 (-0.34)	0.51** (2.62)	0.17* (2.16)	-0.05 (-0.42)	0.05 (0.60)
Long-run equilibriums						
Adjustment coefficients	-0.08** (-4.25)	-0.03* (-2.12)	-0.02 (-1.16)	-0.04** (-7.03)	-0.04** (-3.89)	-0.02** (-3.47)
Standard errors						
σ_0(%)	15.38** (3.14)	14.15** (5.60)	8.90** (2.30)	2.77* (2.15)	6.22** (4.90)	4.58** (2.89)
σ_1(%)	9.40 (2.34)**	6.83 (1.97)*	8.03** (4.15)	2.74** (3.67)	3.75** (3.09)	2.61** (5.40)
Log likelihood	-3759.53					
Transition Probabilities	*p* *0.7932*			*q* *0.9295*		
LR Linearity test	Chi(29)** (0.000)			DAVIES** (0.000)		

Notes: The dependent variables are returns of each securitized real estate market. “short-run dynamic” means the autoregressive coefficients. HK(-1), Singapore(-1), Japan(-1), Australia(-1), UK(-1) and US(-1) are one time lag of the securitized real estate returns respectively. Long-run equilibriums are coefficients of each securitized real estate market’s error correction term. The null hypothesis of LR linearity test is the linear VECM model, against the MS-VECM model. ** and * represent significance in 1% and 5% respectively.

Table 4.15 further reports a few significant short run dynamic coefficients, namely the lead/lag relationship among the markets. Singapore displays a significant one time lag autoregressive coefficient (0.17). The US market affects Japan (0.51) and Australia (0.17), and the UK would affect the US market (0.10). Overall, the results indicate that the short term lead/lag relationships among the six property stock markets are not remarkable.

The objective of this section is identifying whether there are common regime shifts among international securitized real estate markets. Renaud (1997) finds, during the period 1985 to 1994, a large number of countries experienced strong real estate booms that peaked around 1989 followed by severe asset price deflation and an output contraction that usually lasted until 1994. Case, *et al* (1997) also display the global real estate cycle from 1987 to 1997.

The regime shifts of each market should have two parts; one part is affected by the local economic factors, causing each market's movement different with others'. The other part is affected by the global economic factors, leading the common regime shifts among international markets. Case, *et al* (1997) present that the cross-border correlations of real estate are due to common exposure to fluctuations in the global economy. Although, Section 4.4.4 shows the probabilities of regime 1 is not highly correlated across the countries[16], based on the empirical results and past evidence, it establishes that exists common regime switching among the six countries.

[16] But some of them are still significant.

4.6 Summary

This chapter examines the existence and nature of the excess return and volatility regime swifts in international securitized property returns during the period January 1987 to September 2004. With the increased significance of international securitized property as a real estate investment vehicle for institutional investors to gain worldwide real estate exposure, the main objective is to shed light on the risk-return performance of securitized property after accounting for state dependent regime switching, and to consider the structural mean-variance implications in optimal asset allocation and the performance measurement exercise.

The main findings are: (a) international securitized property in our sample exists in one state (state 0) where the returns are low/negative and the variance is high, and in the other state (state 1) the returns are high and the variance is low, (b) the two regimes (low return-high volatility; high return-low volatility are persistent with differences observed in the expected duration and the frequency of shifts between the states among the six international markets. However, the high return-low volatility (state 1) regime dominates the six markets between 65.7 and 84.6 percent of the time, (c) examinations of the correlations of mean-variance state probabilities suggest intermarket interactions between some pairs of securitized property markets. There is also some evidence of changes in correlations among some pairs of securitized property markets after the 1987 stock market crash and the 1997 Asian financial crisis, (d) there exist common regime shifts movement in the international markets. The next chapter proceeds to

investigate the influence of macroeconomic factors on the securitized property excess return and volatility.

Chapter 5 Dynamic Impacts of Macroeconomic Fundamentals on Securitized Real Estate Markets

5.1 Introduction

The main objective of this chapter is to investigate the dynamic and asymmetric relationship between securitized real estate expected returns and their local, international and common macroeconomic fundamentals from a regime switching perspective. Section 5.2 describes the methodology regarding the Markov Switching vector autoregression (MS-VAR) model. This is followed by a section illustrating the data and their preliminary analysis. The empirical results are presented in section 5.4. They include the model specifications, estimate results, impulse response, variance decomposition analysis and panel MS-VAR estimation. The final section summarizes the findings and implications.

As discussed in Chapter 1, the economic theory underlying the MS-VAR model is the asset pricing models relating the regime switching of stock market movements to the dynamic and nonlinear macroeconomic fundamental influences. Researchers have found a strong relationship between business cycle and stock market regime shifts (e.g. Campbell, *et al*(2001)). Domian and Louton(1995) point out that business asymmetries would cause nonlinearities in relationships between the stock market and the business cycle (expansion and recession). Therefore, Fama's(1981) relation between stock

expected returns and real variables could turn out to be much stronger when asymmetries are considered.

Meanwhile, a number of studies have examined the risk-return performance and pricing of real estate in the macroeconomic context (e.g. McCue and Kling(1994) and Brooks and Tsolacos(1999)), and found out that the expected return of securitized real estate should also be affected by the switching of economic fundamentals. The securitized real estate expected returns should also hold the nonlinear relationship with the switching of macroeconomic factors under the above asset pricing models.

The earlier and various asset pricing models discussed provide the solid foundation to identify the macroeconomic factors that would affect the securitized real estate market expected return. This chapter intends to study the nonlinear dynamics between securitized real estate market expected returns and their macroeconomic fundamentals. The time series model, e.g. VAR, rather than the asset pricing models, is more appropriate to capture the dynamic relationship.

5.2 Methodology

5.2.1 Markov Switching vector autoregression model (MS-VAR)

MS-VAR models provide the generalized framework of VAR models, which consider the changes in regimes s_t. It can be considered as penalizations of the basic finite order VAR model of order p. Consider the p-th order autoregression for the K-dimensional time series vector $y_t = (y_{1t},.....,y_{Kt})', t = 1,...,T,$

$$y_t = v + A_1 y_{t-1} + ... + A_p y_{t-p} + u_t \qquad (5.1)$$

Where $u_t \sim IID(0, \sum)$ and the coefficient $A_1, ..., A_p$ are fixed. If the time series are subject to shifts in regime, the stable VAR model with its time invariant parameters might be appropriate. Then the MS-VAR model might be considered as a general regime switching framework. The general idea behind this class of model is that the parameters of the underlying data generating process of the observed time series vector y_t depend upon the unobserved regime variables s_t, which represents the probability of being in different state of the world.

Compared with the linear VAR, the main characteristics of the MS-VAR model is the assumption that unobserved realization of the regime $s_t \in \{1, ..., M\}$ is governed by a discrete time, discrete state Markov stochastic process, which is defined by the transition probabilities.

$$p_{ij} = \Pr(s_{t+1} = j \mid s_t = i), ... \sum_{j=1}^{M} p_{ij} = 1 ... \forall i, j \in \{1, ..., M\} \qquad (5.2)$$

In generalization of the VAR(*p*) model in equation 4.1, Markov-switching vector autoregressions of order *p* and *M* regimes are considered:

$$y_t = v(s_t) + A_1(s_t) y_{t-1} + ... + A_p(s_t) y_{t-p} + u_{s_t} \qquad (5.3)$$

In the most general specification of an MS-VAR model, all parameters of the autoregession are conditioned on the state s_t of the Markov chain. However for empirical applications, it might be more helpful to use a model where only some

parameters are conditioned on the state of Markov chain, while the other parameters are regime invariant.

For a given regime s_t and lagged endogenous variable Y_{t-1}, the conditional probability density function of y_t is denoted by $p(y_t \mid s_t, Y_{t-1})$. It is convenient to get the following equation:

$$p(y_t \mid s_t, Y_{t-1}) = \ln(2\pi)^{-1/2} \ln \mid \Sigma \mid^{-1/2} \exp\{(y_t - \bar{y}_{mt})' \sum_m^{-1} (y_t - \bar{y}_{mt})\} \qquad (5.4)$$

Where $\bar{y}_{mt} = E\lfloor y_t \mid s_t, Y_{t-1} \rfloor$ is the conditional expectation of y_t in regime *m*. Thus the conditional density of y_t for a given regime s_t is normal as in the VAR model defined equation 5.1. Thus:

$$y_t \mid s_t = m, Y_{t-1} \sim NID(\bar{y}_{mt}, \sum_m), \qquad (5.5)$$

Assuming that the information set available at time t-1 only consists of the sample observations and the pre-sample values collected in Y_{t-1} and the states of the Markov chain up to s_{t-1}. The conditional density of y_t is a mixture of normal:

$$p(y_t \mid s_{t-1} = i, Y_{t-1}) = \sum_{m=1}^{M} \sum_{i=1}^{M} p_{im} (\ln(2\pi)^{-1/2} \ln \mid \Sigma_m \mid^{-1/2} \exp\{(y_t - y_{mt})' \Sigma_m^{-1} (y_t - \bar{y}_{mt})\}) \quad (5.6)$$

As with the conditional probability density of a single observation y_t in Equation 5.6 the conditional probability density of the sample can be derived analogously. The techniques of setting up the likelihood function in practice are introduced in Krolzig(1997). The basic approach is only sketched.

For given presample value Y_0, the density of the sample Y= Y_T conditional on the states s_t is determined by

$$p(Y \mid s_t) = \prod_{t=1}^{T} p(y_t \mid s_t, Y_{t-1}) \qquad (5.7)$$

Hence, the joint probability distribution of observations and states can be calculated as

$$p(Y, s_t) = p(Y \mid s_t)\Pr(s_t) = \prod_{t=1}^{T} p(y_t \mid s_t, Y_{t-1}) \prod_{t=1}^{T} \Pr(s_t \mid s_{t-1}) pr(s_1) \qquad (5.8)$$

Thus, the unconditional density of Y is given by the marginal density

$$p(Y) = \int p(Y, s_t) ds \qquad (5.9)$$

5.2.2 Panel Markov switching vector autoregression model

This section provides a brief discussion of the specification and estimation of MS-VAR with panel data. This technique combines the MS-VAR approach with a panel data approach.

First, the MS-VAR model is as follows:

$$y_{it} = v\ (s_t) + A_1(s_t) y_{it-1} + f_i + u_t(s_t) \qquad (5.10)$$

Where y_t is the vector of endogenous variables. i indicates different markets. $v_{\backslash}(S_t)$ and $u_t(s_t)$ are regime-dependent intercept and variance respectively.

In applying the MS-VAR procedure to panel data, it is required to impose the

constraint that the underlying structure is the same for each property market. Since this constraint is likely to be violated in practice, one way to overcome it is to allow for "individual heterogeneity" in the levels of the variables by introducing the fixed effects, denoted by f_i in the model[17]. In order to estimate the model, the fixed effects in the model should be eliminated. The general method is the mean differencing procedure. However, under this procedure, the fixed effects are correlated with the repressors due to lags of the dependent variables, which would create biased coefficients. To avoid this problem, the forward mean-differencing filter is applied to remove the fixed effects, also referred to as the Helmert procedure (Holtz-Eakin, *et al,1988*). This filter eliminates only the forward mean, i.e. the mean of all the future observations available for each month.

For equation 5.10, Himmelberg (2000) points out the realizations of u_{it} are orthogonal to y_{it-1}, hence the fixed effects for the equation 5.10 are eliminated by using forward filters like forward-differencing that remove the fixed effects yet preserves lagged instruments in the Helmert filter, which is illustrated in equation 5.11.

$$H_{y_{it}} = \sqrt{\frac{T-t}{T}}\left(y_{it} - \frac{1}{T}\sum_{j=1}^{T-t} y_{it+j}\right) \qquad (5.11)$$

The filter transforms observations into deviations from their future means, and then weights this deviation by $\sqrt{(T-t)/T}$ so maintain the original variance structure, i.e, so that $Var(Hy_{it}) = Var(y_{it})$. Arellano and Bond (1999) report the Helmert

[17] In the panel MS-VAR model, it assumes the fixed effects are stable across the regimes. With this assumption, it is convenient to remove the fixed effects, and keep the regime switching structure at the same time.

transformation is the most efficient forward filter in the dynamic panel models. Then it follows that

$$Hy_{it} = Hv\ (s_t) + HA_1(s_t)y_{it-1} + Hu_t(s_t) \qquad (5.12)$$

In traditional Panel VAR process, it would pool the entire cross sectional data to estimate after removing the fixed effects. But in our Panel MS-VAR process, this is not the case. The regime switching estimation strictly depends on the variables' time sequence. Pooling the data together would cause the bias results. Since the model's coefficients structure would be same after removing the fix effects across the sections, we would take the average of the transformed data to estimate, which would not affect the estimation of coefficient. Equation 5.13 shows this process.

$$\overline{Hy_{it}} = Hv(s_t) + A_1(s_t)\overline{Hy_{it-1}} + Hu_t(s_t) \qquad (5.13)$$

Where $\overline{Hy_{it}}$ is the average vector of the transformed data by Helmert filter. Although taking the average data to estimate would lose some information, coefficients estimation would not be broken and it catches the common factors in the panel. This method is similar to the mean group estimator proposed by Pesaran and Smith (1995), which is also consistent. Finally, EM algorithm is used to estimate the model.

5.2.3 Estimation

The estimation technique implemented for the MS-VAR models is the EM (Expectation-Maximization) algorithm which is discussed in Krolzig (1997) (and in Hamilton (1990) for the univariate case). The EM algorithm has been originally described by Dempster et al (1977).

In the EM algorithm, the parameters must be estimated by maximizing the log-likelihood function. The general problem is that the first order conditions (FOCs) are nonlinear and consequently do not have a closed form solution. Thus, it is not possible to solve them analytically. Consequently, the estimations are implemented in two steps. Firstly, arbitrary initial values of parameters are determined. The first step (called Expectation Step) is based on the computation of transition probabilities which depends on the initial value above mentioned. The second step (the Maximization Step) makes use of the previous probabilities to compute the maximum likelihood estimates of parameters. These two steps are repeated until parameter estimates converge. Hamilton (1990) illustrate EM algorithm is numerical robustness and such algorithm can apply to large vector systems.

5.2.4 Regime-dependent impulse-response analysis

In order to interpret the impulse functions reasonably, the structural shocks that drive the VAR dynamics must be exactly identified. The symmetry properties give an

insufficient number of identifications. The additional restrictions are derived by imposing an order of the variables onto the system which implies that each variable has contemporaneous effects only on itself and on variables ordered below it. This identification scheme corresponds to a Choleski decomposition of the $\sum(s_t)$ matrix. As a result of this ordering, the matrix $\sum(s_t)$ is exactly identified. Real variables are exogenous to financial variables because stock market or interest rate adapt much faster to news than do output or goods prices. These arguments lead to the variable ordering (GDPG, UINFL, GM2, INI, MKT, PPTY)． This ordering of macroeconomic factors is also consistent with Hess(2004).

Impulse response functions (IRF) are important tools in VAR models. They simulate the response of endogenous variables to exogenous shocks.

For the MS-VAR models, they also have similar tools - the regime-dependent impulse response functions. Different from the linear VAR, regime-dependent impulse response functions are conditional on the prevailing regime at the time t when the shock occurs and on the entire horizon length.

The horizon length must reasonably depend on the predicted persistence of the regime prevailing at time t.

As for the VAR models, they need to consider the problem of identification in MS-VAR models. Rewrite equation 5.3 in the following form:

$$y_t = A_{1i} y_{t-1} + ... + A_{pi} y_{t-p} + B_i \varepsilon_t \qquad i = 1,...,M \qquad (5.14)$$

Where M is the number of regimes ε_t is:

$$\Sigma_i = E(B_i u_t u_t^{'} B_i^{'}) = B_i E(u_t u_t^{'}) B_t^{'} = B_i I B_i^{'} = B_i B_i^{'} \qquad (5.15)$$

To compute impulse response functions, it needs to estimate the matrices B_i. The EM algorithm provides estimates of variance and covariance matrices $\Sigma_1,...\Sigma_M$. To identify the matrices B_i, restrictions have to be imposed on the unrestricted model. The identity $B_i B_i^{'} = \Sigma_i$ imposes $K(K+1)/2$ restrictions on B_i because the matrix of variance and covariance is symmetric. For example, it can be imposed when the matrix B_i is lower triangular (the Cholesky Decomposition of the matrix Σ_i). Obviously, the order of variables in the system now assumes a particular importance; in fact it causes that each variable determines only contemporaneous effects on itself and on variables ordered below it.

In the model there are MK^2 impulse response functions corresponding to the reaction of K variables to K shocks in M regimes.

The following equation (5.16) defines the reaction (for an horizon length equal to h) of endogenous variables to one standard shock to *k*-th disturbance at time t.

$$\frac{\partial E_t y_{t+h}}{\partial u_{k,t}} \mid s_t = ... = s_{t+h} = i = \theta_{ki,h} \qquad (5.16)$$

The impulse response functions are demonstrated in the following:

$$\hat{\theta}_{ki,0} = \hat{B}_i \, \varepsilon_0 \qquad (5.17)$$

$$\hat{\theta}_{ki,h} = \sum_{j=1}^{\min(h,p)} \hat{A}_{ji}^{h-j+1} \hat{B}_i \varepsilon_0 \qquad h > 0 \qquad (5.18)$$

The equation (5.18) represents the first impulse response function (at time h=0) and the following ones.

One important assumption here, as mentioned by Tillmann (2004), in this regime-dependent VAR set-up, is that the impulse response functions are calculated separately for each regime. The regime-dependent impulse response function describes the relationship between endogenous variables and fundamental disturbances within each Markov-switching regime. The functions are conditional on a given regime prevailing at the time of the disturbance and throughout the duration of the response. There are no regime shifts within the forecasting period. Therefore, the regime probabilities are constant during the forecasting process.

5.2.5 Variance decomposition

Once the impulse response function is estimated, it is easy to compute forecast-error variance decomposition measure $\omega_{j,f,h} \mid s_t$ for a specific state, i.e. the construction of structural shock *j* to the forecast-error variance of variable *f* at horizon *h*, knowing the state of the system in which the shock occurs:

$$\omega_{j,f,h} \mid s_t = 100 \times \frac{\sum_{i=1}^{h} IRF_{j,f,i}^2}{\sum_{i=1}^{h} \sum_{j=1}^{k} IRF_{j,f,i}^2} \qquad (5.19)$$

The IRF in equation 5.19 is impulse response function value. *K* is the number of shocks.

5.3 Data and preliminary analysis

The local macroeconomic variables included in this study are hypothesized to act as a joint proxy for a set of latent variables that determine the securitized real estate excess returns. They are chosen based on economic prior grounds, supported by relevant literature and dictated by availability of data. The five variables chosen are: real economic growth rate (GDPG), growth rate in money supply (GM2), unexpected inflation (UINFL), short-term interest rate (INI) and market portfolio (MKT). Since the real estate issue is going to be examined in the closed and domestic economy, the exchange rate would not be employed. In addition to the introduction of the securitized real estate returns and macroeconomic data used in MS-VAR, one global variable is included. It is the international factor proxied by Morgan Stanley Capital Index (MSCI), which is the most widely used international equity benchmark. MSCI constructs global equity benchmark indices that contribute to the investment process by serving as relevant and accurate performance benchmarks and effective research tools, and as the basis for various investment vehicles. MSCI covers across 23 developed and 27 emerging markets, and 80% equities in these markets. This consistent approach makes it possible reflect the movements of global equity market efficiently. In the study, MSCI world index is utilized to capture the relative effects of global economy movement and be treated as an exogenous variable in the model.

Furthermore, the currency risk (EX) is necessary to be considered as an important factor. The trade-weighted currency index is used as the proxy of each country's foreign exchange rate or the currency risk. A trade-weighted currency index is a weighted average of a basket of currencies that reflects the importance of a home country's trade and investment with other countries in the world. A rise in the index indicates an appreciation of the home country's currency against the rest of the world, and vice versa.

The first variable GDPG is defined as the geometric mean difference between successive quarter's seasonally-adjusted gross domestic product (GDP)[18]. The performance of real estate is greatly influenced by the general economic conditions. High economic growth would stimulate demand for real estate spaces and services. Firms seeking expansion would require more commercial property space. Under such environment, the performance of listed real estate firms would improve as well. Consequently, growth in GDP is expected to have a positive influence on the risk premium and expected return for securitized real estate. The second variable GM2 is taken to be the geometric mean difference between successive monthly money supply (M2). Similar to the GDP growth, growth in money supply is expected to positively correlate with the expected return. The third variable UINFL is measured by the Consumer Price Index (CPI). Specifically, the ARIMA model of Fama and Gibbon (1984) is used to construct the expected inflation rate series. Many previous researchers find that change in inflation rate follows the first order moving average

[18] The minimum frequency of GDP data is quarterly. Since our analysis are monthly based, the quarterly data are converted to monthly using the "quadratic-match sum" assumption.

procedure (MA(1)) (Ferson and Harvey (1991), Karolyi and Sanders(1998)). As a starting point, we define inflation rate for the period t-1 to t as ln(CPIt/CPIt-1), and the first difference of inflation rate is denoted as DINFLAt, representing the change of inflation between period t-1 to t and period t-2 to t-1. Using this model, we forecast the anticipated inflation rate (EINFLA) for each month in the studying period. The unanticipated inflation rate(UINFL) is then calculated as:

$$UINFL = INFL_t - E[INFL_t \mid t-1] \qquad (5.16)$$

In which INFLt is the realized monthly inflation, E[INFLt|t-1] is the anticipated inflation at the end of time period t-1 for the coming time period t from the MA model. Based on previous literature, the impact of inflation risk on real estate returns could arguably be negative or positive. For example, Flectcher (1995) points out the presence of the real estate stock as an effective hedge against unexpected inflation is to be relied on both methodology and period examined. This indicates the inflation impact on real estate could be positive or negative. However, as Liow (2004) points out, a positive relationship is more likely with respect to the UINFL risk.

The fourth variable INI is measured as the three-month holding period return to a Treasury bill.[19] Although there is no consensus in the literature on the direction of movement in excess returns with respect to the changes in short-term interest rate, the majority of prior research finds an inverse relationship between real estate returns and

[19] Some of the sample markets, such as Hong Kong , do not trade in Treasury Bill. The 3 month interbank lending rate is used as a proxy.

interest rate movement. For example, Ling and Naranjo (1997) find that there is an inverse relationship between interest rate and REIT expected return movements. Muller and Pauley (1995), nevertheless, observe that REITs provide a better hedge against interest rate, meaning there is a positive relationship between the two movements. The final variable MKT is the monthly excess returns on the corresponding overall stock market performance.[20] MKT is expected to have a positive relationship with the real estate expected returns. Table 5.1 provides a summary of the above macroeconomic variables and their predicted relationship with the securitized real estate expected returns.

Table 5.1 Summary of the macroeconomic variables in the study

Macroeconomic Variables	Measurement	Denoted	Expected Sign
Economic growth	Log difference between successive quarter's seasonally-adjusted GDP	*GDPG*	+
Growth in money supply	Log difference between successive monthly money supply	*GM2*	+
Unexpected inflation	Difference between real monthly inflation and expected inflation rate	*UINFL*	+,-
Short-term interest rate	Three-month holding period return to Treasury bill	*INI*	+,-
Market Portfolio	Monthly returns on overall stock market index	*MKT*	+

It is necessary to examine the regime switching of macroeconomic time series prior to estimating the model. The five macroeconomic variables (real economic growth rate (GDPG), growth rate in money supply (GM2), unexpected inflation (UINFL),

[20] The index are: Hang Seng index in Hong Kong, Singapore All Equity index in Singapore, Topix index in Japan,ASX 300 index in Australia, FTSE 350 in UK. S&P 500 index in US.

short-term interest rate (INI) and market portfolio (MKT)) are to be tested. The time series are examined for their regime switching characteristics under the methodology mentioned in the previous chapter. Each variable is subjected to switching in means and variance. Table 5.2 reports the results of regime switching tests.

Table 5.2 Regime Switching results for macroeconomic variables

	$u_0(\%)$	$u_1(\%)$	p	q	$\sigma_0(\%)$	$\sigma_1(\%)$
Singapore						
GDPG	-0.29**	0.80**	0.8824**	0.9635**	4.49**	3.19**
GM2	0.73**	4.09**	0.6147**	0.9780*	6.01**	4.59**
UINFL	0.04	0.13*	0.9217**	0.8673**	3.17*	4.86**
INI	0.18*	0.41**	0.9866**	0.8752*	3.16**	4.47**
MKT	-1.50	0.65**	0.7699**	0.9102**	21.94**	10.76**
Hong Kong						
GDPG	-1.15	1.92*	0.7419**	0.8773**	4.64**	3.38**
GM2	0.91**	1.03**	0.6886**	0.8353*	5.09**	3.94**
UINFL	-0.99*	0.37**	0.9603*	0.5915**	3.23**	5.44**
INI	0.35*	0.72**	0.9878**	0.8591**	2.62**	3.18**
MKT	-3.10**	0.97**	0.7932**	0.9611*	27.61**	11.75**
Japan						
GDPG	-0.50*	0.40*	0.8974**	0.9015**	4.46*	3.17**
GM2	0.34**	0.66**	0.8678**	0.9405*	4.51**	3.52**
UINFL	-0.01	0.48**	0.9147*	0.5299**	3.23**	4.48**
INI	0.05	0.45**	0.9845**	0.8957**	2.09**	4. 94**
MKT	-3.46*	-0.14**	0.8448**	0.9392**	25.92**	11.13**
Australia						
GDPG	-0.49*	1.48**	0.6694**	0.8889**	4.52**	3.30**
GM2	0.32**	0.89**	0.5671*	0.9315**	5.19**	3.31**
UINFL	0.15	0.59*	0.9512**	0.8590**	3.55*	4.56**
INI	0.47**	1.12**	0.9834**	0.8690**	2.95**	3.17**
MKT	-0.95**	0.53**	0.8347**	0.9743**	26.17**	10.32**
UK						
GDPG	-0.01	0.24**	0.8235**	0.9886**	4.40**	3.12**
GM2	0.36	0.71**	0.5144*	0.9651**	4.49**	3.93**
UINFL	0.26*	0.84*	0.9377**	0.7425*	3.32**	5.83**
INI	0.45*	0.94**	0.9709**	0.8940**	3.00*	4.26**
MKT	-1.05	0.89**	0.8570**	0.8709**	15.45**	3.95**
US						
GDPG	-0.18	0.56**	0.8579**	0.9686**	4.42**	3.17**
GM2	0.20*	0.57**	0.8416**	0.9453**	4.73*	3.52**
UINFL	0.23*	0.46**	0.9235**	0.8259**	3.12**	4.89**
INI	0.19**	0.49**	0.9855**	0.8799**	2.90**	3.19**
MKT	-2.26**	1.02**	0.7965**	0.9440**	15.74**	10.48**

Notes: The mean is μ_0 in state 0 and μ_1 in state 1. The standard deviation of returns is σ_0 in state 0 and σ_1 in state 1. The transitional probabilities are p (sate 0) and q (state 1) ** Indicates two-tailed significance at the 1% level.

The results show that all the macroeconomic data series are characterized by switching in means and variances with 2 regimes. The current literature also illustrates that the macroeconomic variables are subjected to regime shifts, such as Hamilton (1989) for GDP , Evans and Watchtel (1993) for inflation, Garcia and Perron (1996) for interest rate, and Schaller and Van Nordern(1997) for stock market. The regime switching testing results also reveal that the fluctuation of stock market is generally higher than other macroeconomic variables. As observed from Table 5.2, the standard deviations of the macroeconomic variables vary between 3% and 6%, with the range for stock market volatility being between 10% and 30%. However, the short term interest rate is observed to be high and more volatile during recession period but low and more stable during the expansion period. This result is consistent with the study of Ang and Bekaert (2000). The inflation rate also displays the high mean-high variance and the low mean-low variance states, which is consistent with the results of Cukierman and Meltzer(1986), who find a positive relationship between inflation uncertainty(volatility) and inflation. Therefore, the inflation rates are expected to be more volatile during a high-inflation period but low and more stable during period of price stability. Since the property stock returns and macroeconomic factors are all subjected to the regime switching, they are to be examined under the MS-VAR framework .

5.4 Empirical results

5.4.1 Model specifications

The MS-VAR model is specified for a system of six variables: securitized property excess return (PPTY), economic growth rate (GDPG), growth rate of money supply (GM2), short term interest rate (INI), unexpected inflation (UINFL) and market portfolio (MKT) from Jan 1987 to Sep 2004. One of the important assumptions behind MS-VAR is that the regimes for all the macroeconomic variables are synchronized. The macroeconomic variables, together with the securitized real estate market, are in one integrated economic system. Each factor varies with the fluctuation of economic cycle. For example, generally, the stock market will boom when GDP grows fast, and vice versa. Basically, the rise of interest rate will cool down the economy, and cause the stock price to fall, and therefore tend to lead to the recession period of business cycle.

In the real world, due to complication of business system and some exogenous impacts, the economic variables may not move together as they suppose to be. For instance, although the economy seems to be stable in 1987, the world stock market still crashed in October in that year. And the stock market also experienced boom periods during both high inflation periods and low inflation periods.

However, some economic literature also studies the economic variables' synchronization in business cycle movement. Stock and Watson (1993) study the issue of co-movement of economic variables through the evolution of the business cycle.

They develop a dynamic factor model where business cycles are measured by co-movements in various components of economic activity. Using several macroeconomic time series, they extract a single unobserved variable and interpret it as the "state of the economy". Terence and Wang (2001) also estimate a model to illustrate two key features of business cycles: comovement among economic factors and switching of regimes of boom and slump, by using quarterly UK data for the last four decades. And both comovement and regime switching are found to be important features of the business cycle.

Table 5.3 Lag order selection for MSVAR

P	1	2	3	4	5
Singapore					
AIC Criterion	7.376*	7.424	7.463	7.470	7.512
SC Criterion	7.487*	7.631	7.766	7.870	8.009
Hong Kong					
AIC Criterion	7.801*	7.830	7.852	7.877	7.896
SC Criterion	7.912*	8.036	8.155	8.277	8.393
Japan					
AIC Criterion	7.207*	7.232	7.262	7.284	7.338
SC Criterion	7.317*	7.439	7.566	7.684	7.835
Australia					
AIC Criterion	5.198*	5.228	5.254	5.237	5.258
SC Criterion	5.329*	5.434	5.557	5.637	5.756
UK					
AIC Criterion	6.541*	6.580	6.575	6.590	6.619
SC Criterion	6.652*	6.787	6.878	6.989	7.116
U.S.					
AIC Criterion	5.286*	5.297	5.316	5.322	5.361
SC Criterion	5.397*	5.493	5.676	5.722	5.855

Notes: * means the optimal lag selection

The past MS-VAR literature (Krolzig, 1997; Hess, 2004; Tillmann, 2004) also incorporates the full synchronization movement of economic factors when studying the regime switching of business cycle. However, it is very hard to impose restrictions to

the model without the full-synchronization assumption. Therefore, the assumption of synchronization is still reasonable in this study.

The first step is to find out the autoregressive lag order of the VAR order for each country. As mentioned by Krolzig (1997), VAR order selection criteria can be used to determine the lag specification in MS-VAR model. In Table 5.3, the Akaike Information Criterion (AIC) and Schwarz Criterion (SC) both report a time lag of one month. Therefore, the MSVAR model adopts the one-month time lag autoregression specification for all six markets.

The second step is to identify whether the coefficients of macroeconomic variables are state-dependent. The Likelihood ration test is employed to test which specification is optimal. Krozig(1997) suggests using the bottom-procedure to determine the specification MS-VAR model. Since the economic variables' regime switching of means and variances are already tested, the below analysis will illustrate whether the coefficients of macroeconomic variables are regime switching.

Table 5.4 LR test for switching of coefficient for macroeconomic variables

Test	HK	Singapore	Japan	Australia	UK	US
No switching against switching	18.16 (0.31)	12.06 (0.74)	13.03 (0.67)	16.00 (0.45)	23.19 (0.11)	18.01 (0.32)

Notes: ** Indicates two-tailed significance at the 1% level. No switching: the coefficients for macroeconomic variables are not state-dependent; switching, the coefficients for macroeconomic variables are state-dependent. P values are in parentheses

Results in Table 5.4 indicate the null hypothesis of no switching of coefficients

cannot be rejected. It thus indicates assumption of no switching in coefficients is optimum. This specification is also consistent with the MS-VAR model specification of Tillmann (2004) and Hess (2004), who assume that the coefficients of the variables are not state-dependent in their MS-VAR specification.

5.4.2 MS-VAR estimation results

Table 5.5 provides the estimated results form the MS-VAR model. It includes the regime-dependent intercept, regime invariant autoregressive coefficient and regime-dependent variances. In the MS-VAR, all variables are treated as endogenous variables, just like a closed and domestic economy system. The Likelihood Ratio linearity test, testing a non-linear (MS-VAR) against a linear (VAR) alternative, reports significant results for all six markets. Hence, it indicates that the MS-VAR model is necessary and superior to the linear VAR.

The model displays two distinct states of the economic systems. In state 0, the six markets present smaller intercepts (some of which are negative) and higher variance. In state 1, each market reports a positive and larger intercept, and a lower variance. In state 0, Hong Kong demonstrates the lowest intercept (-3.81) and UK presents the highest intercept (2.58). For regime-dependent variances, the highest one is also from Hong Kong (22.23) and the lowest one from Australia (3.31). In state 1, the highest and lowest variances are from Hong Kong and Australia respectively. A key finding is that, the variances of Asian markets (i.e. Singapore, Hong Kong and Japan) are larger than the developed markets (i.e. Australia, UK and US). This is reasonable since over

the past 20 years, Asian markets have experienced some significant fluctuations in

Table 5.5 MS-VAR estimation results

$$y_t = v(s_t) + A_1(s_t)y_{t-1} + ... + A_p(s_t)y_{t-p} + u_{s_t}$$

	Singapore	Hong Kong	Japan	Australia	UK	US
Regime-dependent intercepts						
v_0	-0.21	-3.81	-0.44	0.49	2.58	2.04***
	(-0.17)	(-0.85)	(-0.46)	(0.94)	(1.59)	(2.88)
v_1	5.28	0.40	1.78	1.27	7.16***	2.91***
	(1.14)	(0.29)	(0.54)	(1.48)	(2.68)	(3.02)
Autoregressive coefficients						
PPTY(-1)	0.18	-0.15	-0.07	-0.12	-0.02	0.03
	(1.56)	(-1.00)	(-0.70)	(-1.48)	(-0.19)	(0.46)
GDPG(-1)	1.91**	0.20	3.28*	0.13	0.07	0.11
	(2.05)	(0.76)	(1.79)	(1.18)	(0.03)	(0.71)
GM2(-1)	0.03	0.32**	0.14	-0.21	1.24*	-0.75
	(0.08)	(2.26)	(0.26)	(-1.61)	(1.94)	(-1.00)
INI(-1)	-5.55	-4.45	-7.06*	-1.24	-8.32***	-3.72**
	(-1.36)	(0.15)	(-1.84)	(-1.35)	(3.33)	(-2.12)
UINFL(-1)	0.03	0.85	1.65	-0.85	0.83	-1.50
	(0.01)	(0.94)	(1.22)	(-0.81)	(0.94)	(-1.15)
MKT(-1)	0.20	0.25	0.08	0.01	0.11	0.11*
	(1.32)	(1.19)	(0.56)	(0.03)	(1.03)	(1.86)
Regime-dependent variances						
σ_0	18.92**	22.23***	8.90***	3.31***	5.80**	4.22**
	(2.17)	(5.13)	(2.80)	(3.32)	(2.15)	(2.00)
σ_1	7.65***	7.95***	7.84***	2.80**	5.29***	2.96**
	(4.45)	(7.20)	(8.17)	(1.96)	(4.25)	(2.18)
Transition probabilities						
p	0.6511	0.5267	0.7941	0.8567	0.8154	0.5755
q	0.9365	0.9254	0.9059	0.9223	0.9322	0.8805
Log likelihood	-1294.40	-2123.83	-955.35	-12176.10	-732.90	-730.12
LR linearity test	302.57***	354.71***	253.15***	264.37***	289.42***	186.71***

Notes: The dependent variables are returns of each securitized real estate market. PPTY(-1) means one lag of securitized real estate return. The null hypothesis of the LR linearity test is the linear VAR model, against the MS-VAR model. ***,**,* represent significance in 1%, 5%, and 10% respectively.

their economic developments. Singapore and Hong Kong experienced the “Asian 4 Dragons” golden period and the Asian Financial Crisis, while Japan experienced a bubble economy phase over the past years.

The macroeconomic factors thus present a significant relationship with the securitized property expected returns. In Singapore, the coefficients of PPTY(-1) and GDPG(-1) are significant, indicating lagged changes in property stock expected return and GDP performance significantly affect the property stock expected return.. For the autoregressive coefficients in Hong Kong, the growth of money supply is significant with value 0.32. And in Japan, the growth of GDP value also positively impacts its property stock expected return as attested by a coefficient 3.28. In UK, property stock expected return exhibit positive relationship with a change of money supply (1.24), and a negative relationship with its short term interest rate (-8.32). The US results also report significant coefficients for interest rate (-3.72) and overall stock market (0.11). The different markets demonstrate their particular significant coefficients of macroeconomic variables.

The transitional probabilities of MS-VAR illustrate the two states are both persistent, and the expansion regime (state 1) is more persistent than the recession regime (state 0). Once the good economic situation is established, it is prone to persist and the probability of good situation for the next period is higher. In particular, Singapore records the highest transitional probability (0.9365) in state 1 and Hong Kong displays the lowest probability (0.5267) in state 0.

In summary, the results therefore suggest that in the six markets, each securitized real estate economy is subject to regime switching movements with two distinct states, one is the growing state and the other is the crash state. The macroeconomic factors report the different significant coefficients cross the six markets. The variances of Asian markets are generally higher than the other mature markets. Furthermore, all the LR linearity tests indicate that the MS-VAR models are superior to the linear VAR models for the six economic factors systems.

5.4.3 Impulse response analysis

A shock to the i-th variable not only directly affects the i-th variable but is also transmitted to the other all endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of one-time shock to one of the innovations on current and future values of the endogenous variables. If the innovations are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The i-th innovation is simply a shock to the i-th endogenous variable. Using the regime switching model, the asymmetries of impulse responses can be analyzed conditionally to the states of economy (recession and expansion). Based on the estimation results, 12 periods (1 year) are chosen as response projection. Figure 5.1 displays the impulse responses of securitized real estate market expected returns to shocks in domestic macroeconomic variables. It is evident that for each market, the response relationships are asymmetric in two regimes.

In order to display the details of the results, the response coefficients in first period

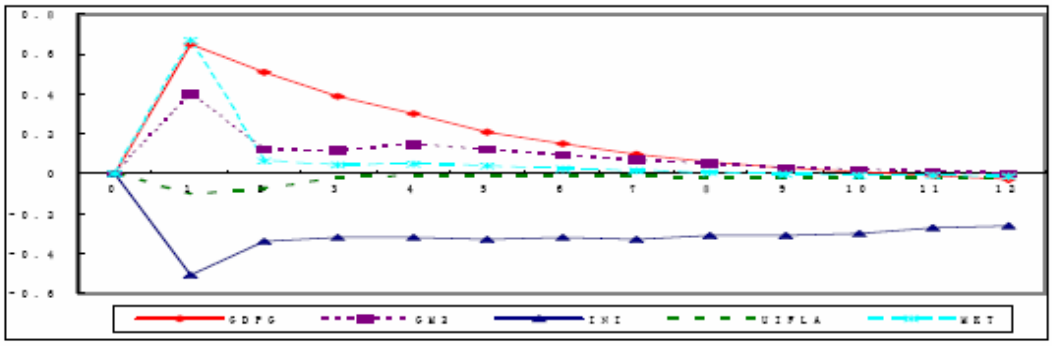
are extracted. Since the stock market and the securitized real estate market respond quickly to the changes of macroeconomic information, the first period results can catch most of the information from the change of macroeconomic factors. Table 5.6 reports the impulse response coefficients of the first period in six markets and includes both states. The T-test compares the mean differences of impulse response coefficients between regime 0 and 1 and all the variables report significant value. It is observed that the responses of the macroeconomic variables under the two regimes are different. Consequently, there are some dynamic and asymmetric linkages between each securitized real estate market expected return and macroeconomic factors.

In particular, the relationship between GDP and real estate expected return is positive. The growth of GDP means positive expectation for the overall economy, which would drive the price of real estate upwards. Furthermore, a significant asymmetry is found in this relationship across the six markets. The impacts of GDP to real estate expected return in recessions are generally greater than the expansion state. For instance, in the first period in Singapore, the impacts are 0.65 in state 0 and 0.35 in state 1. This is the same case in other markets. In Hong Kong, Japan, Australia, UK and US, the responses from GDP are higher in state 0 than in state 1.

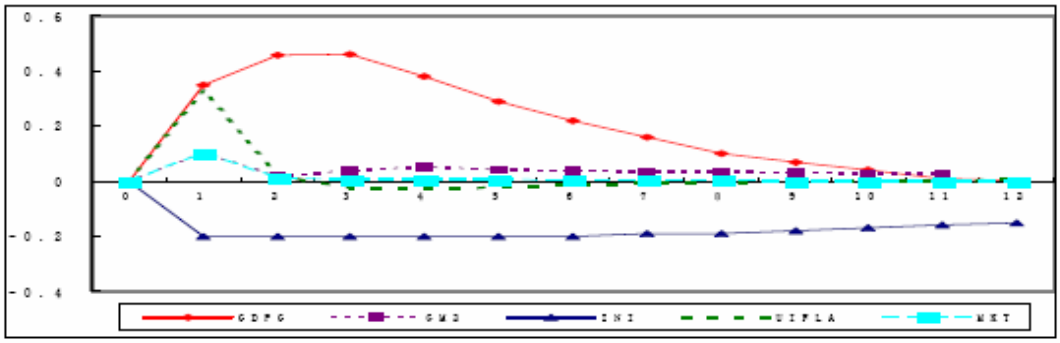
Figure 5.1 Impulse response to a unit shock on securitized property

Singapore

Regime 0

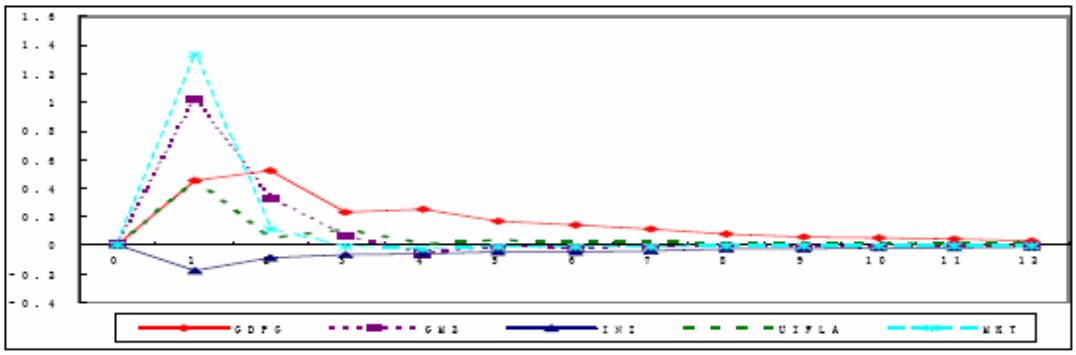


Regime 1

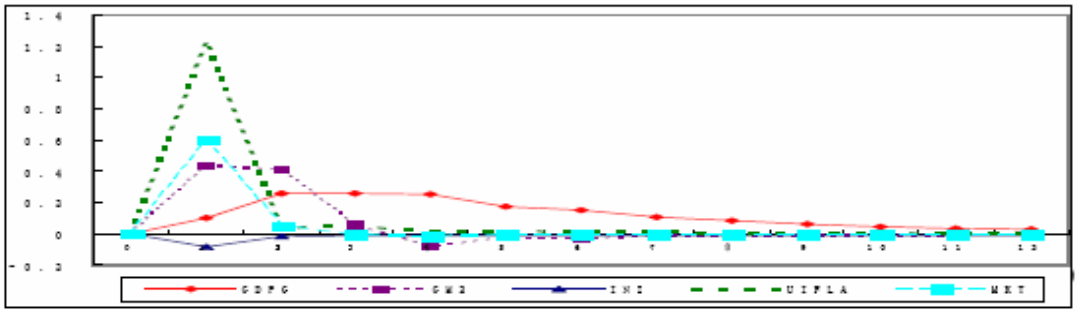


Hong Kong

Regime 0

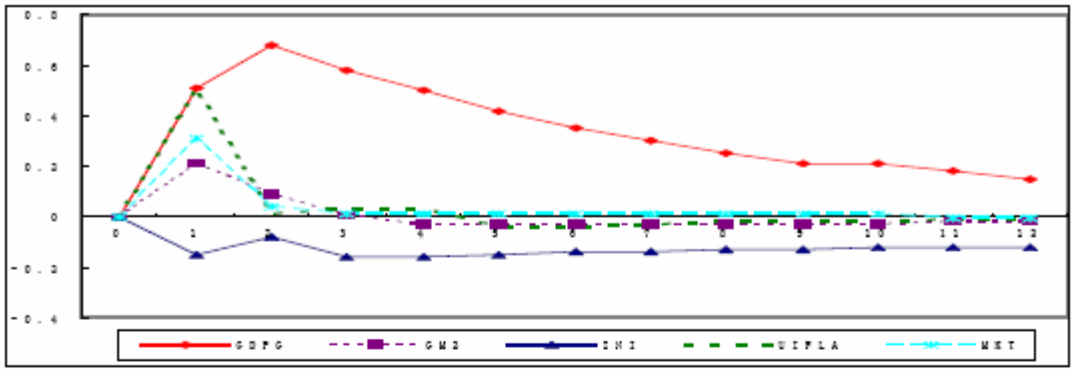


Regime 1

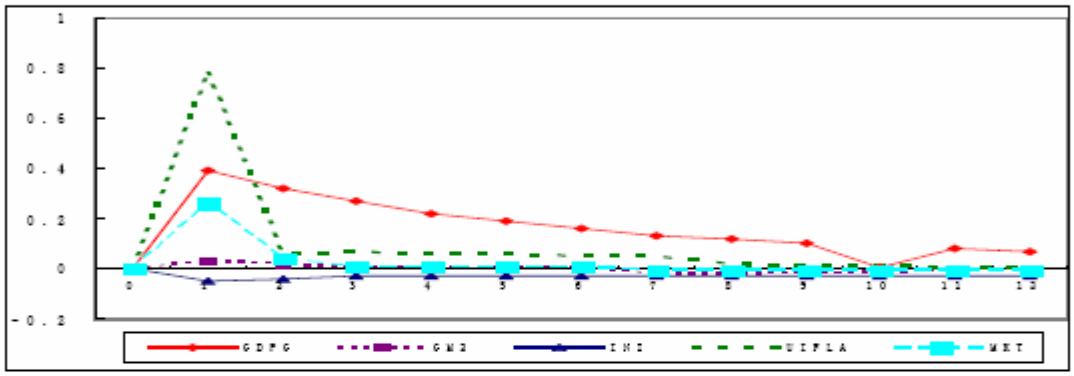


Japan

Regime 0

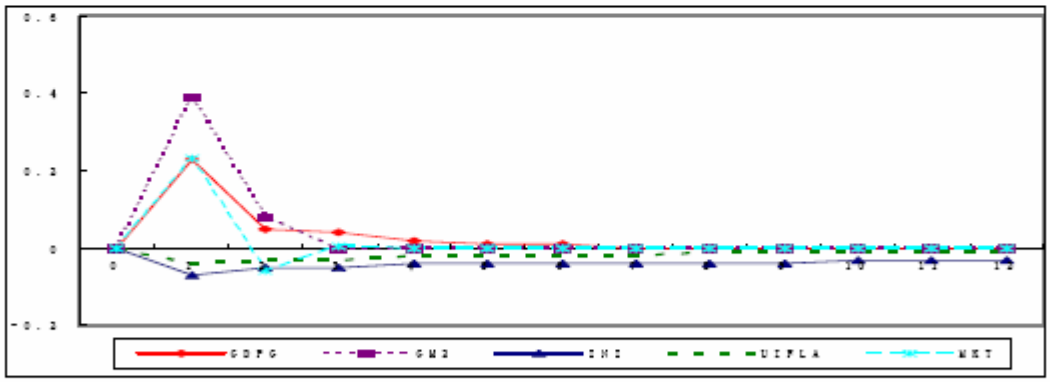


Regime 1

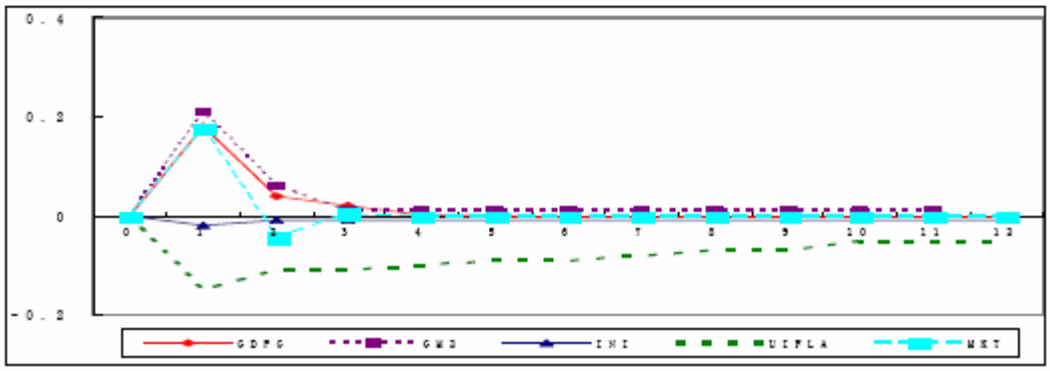


Australia

Regime 0

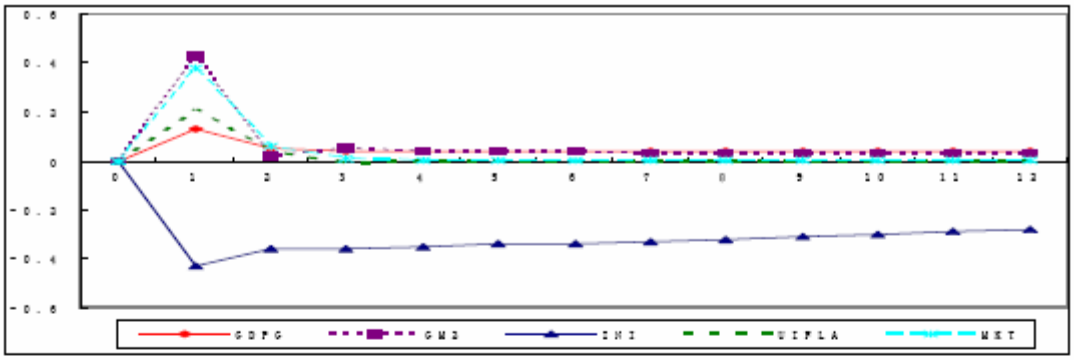


Regime 1

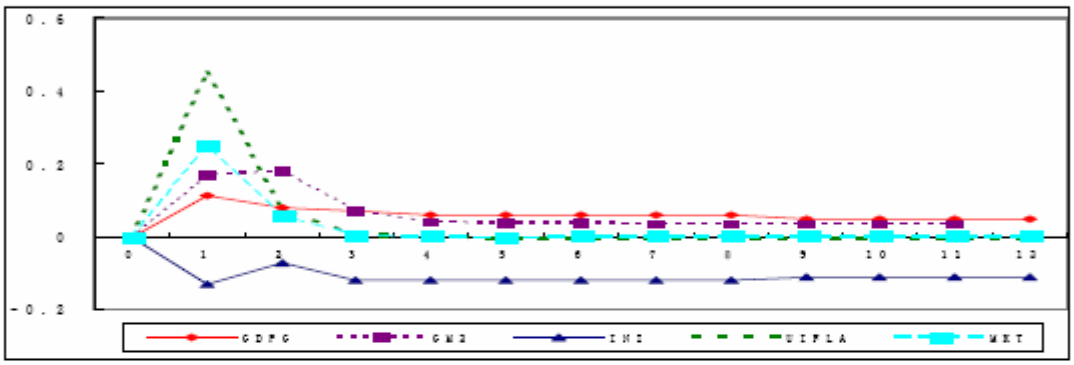


UK

Regime 0

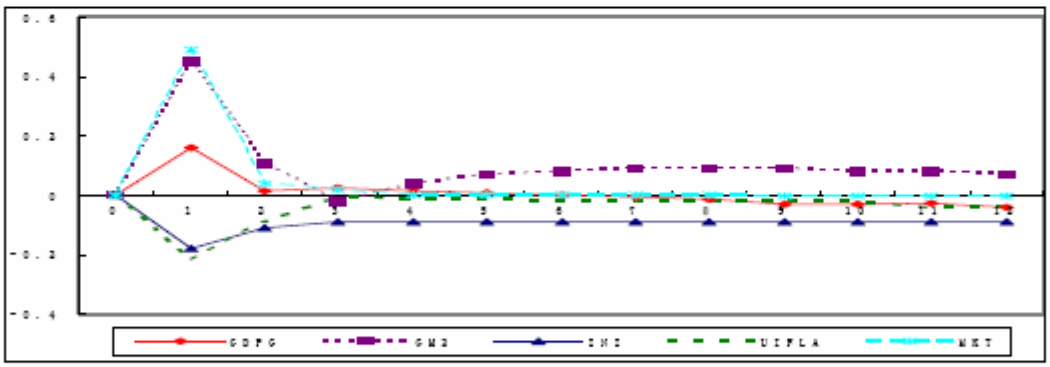


Regime 1

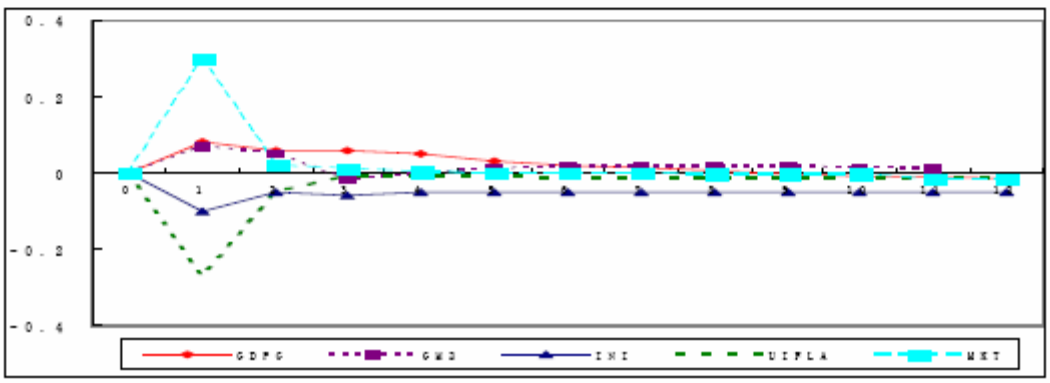


U.S.

Regime 0



Regime 1



Notes: The figure displays the response of the securitized property to a one standard deviation shock to each of the following variables: GDPG, GM2, INI, UINFL and MKT.

The money supply is a key indicator of monetary policy, which is one of the important factors in determining the movements of real estate markets. The general economic logic is that, when the money supply increases, it would lead to lower interest rates, which causes the real estate asset prices to increase. There is evidence of asymmetry for this variable, too. In the U.S. market, the money supply shock to real estate expected return in regime 0 is 0.45 in the first period, and in regime 1 it is slightly small 0.07. Hong Kong market demonstrates highest response coefficient (1.02) of money supply in regime 0, and 0.44 in regime 1.

Changes in interest rates have adverse impact on the real estate expected return. Table 5.5 reveals that all markets report two negative coefficients for this variable. In Singapore, the shocks are -0.51 and -0.20 in the first period respectively. In U.S., they are -0.18 and -0.10 respectively. These negative relationship results are consistent with the previous literature (Ling and Naranjo, 1997; Devaney, 2001). Devaney (2001) reports changes in the real interest rates and their conditional variances are inversely related to REIT excess returns. In addition, it also shows the asymmetric relationship, i.e. they are different in state 0 and state 1, and the impact is higher in state 0 than in state 1.

Table 5.6 Impulse response coefficients comparison

Macroeconomic factors	Regime 0	Regime 1	T-test
Singapore			
GDPG	0.65	0.35	2.94**
GM2	0.40	0.10	7.13**
INI	-0.51	-0.20	9.96**
UIFLA	-0.10	0.33	9.05**
MKT	0.67	0.10	5.53**
Hong Kong			
GDPG	0.45	0.10	4.48**
GM2	1.02	0.44	2.22*
INI	-0.18	-0.08	12.84**
UIFLA	0.45	1.23	2.48*
MKT	1.33	0.60	2.51*
Japan			
GDPG	0.51	0.39	3.97**
GM2	0.21	0.03	10.43**
INI	-0.15	-0.05	27.94**
UIFLA	0.51	0.79	3.47**
MKT	0.31	0.26	9.26**
Australia			
GDPG	0.23	0.18	9.82**
GM2	0.39	0.21	6.15**
INI	-0.07	-0.02	56.16**
UIFLA	-0.04	-0.15	29.24**
MKT	0.23	0.18	12.04**
UK			
GDPG	0.13	0.11	25.96**
GM2	0.43	0.17	6.17**
INI	-0.43	-0.13	15.11**
UIFLA	0.21	0.46	6.31**
MKT	0.38	0.25	8.12**
US			
GDPG	0.16	0.08	13.34**
GM2	0.45	0.07	6.70**
INI	-0.18	-0.10	21.67**
UIFLA	-0.22	0.30	9.60**
MKT	0.29	0.11	6.42**

Notes: T-test compares the mean differences between regime 0 and 1. The critical value is: 2.12 (5%), 2.58 (1%). *, ** indicate the significance at 5% and 1% level respectively.

The securitized real estate expected returns relate positively to their corresponding market portfolio returns. As a significant part of the stock market, securitized real estate moves in tandem with the stock market. Furthermore, under the regime switching environment, this relationship is asymmetric. Table 5.6 reveals that the market portfolio impacts are 0.67 (state 0) and 0.10 (state 1) in Singapore, 1.33 and 0.60 in Hong Kong, 0.31 and 0.26 in Japan, 0.23 and 0.18 in Australia, 0.38 and 0.25 in UK, and 0.29 and 0.11 in US. A coefficient that is greater than one (e.g. Hong Kong in State 0) means the securitized real estate expected return overreacts to changes in the stock market. In particular, the changes of overall stock markets have greater impacts on securitized real estate expected returns in property management and development markets (HK, Singapore, Japan and UK) than that of REIT and LPT markets (US and Australia). This is because, as explained by Allen, *et al* (2000), the low financial leverage of REITs can reduce the sensitivities of their expected returns to stock market changes, as REIT firms can self-manage their investment portfolios.

The “asymmetry” in this study means economic factors impact on the real estate expected return with different degree in different economic phases (recess and expansion). The asymmetric responses have minimum chances to be in the reverse direction i.e. opposite signs in the coefficients. This is because under either economic situation, the responses are supported by the underlying asset pricing model (like APT). The opposite response signs would be against the asset pricing theory unless the special situation or abnormality happens. Therefore, the asymmetric responses do not have to be in the reverse directions.

In summary, the four macroeconomic variables (GDGG, GM2, INI and MKT) report asymmetric shocks to the securitized real estate expected returns. These phenomena can be explained from real estate investor's expectation perspective. When the economy is in recession period, real estate investors' expectation of future market is unstable. Real estate investors and analysts tend to rely more strongly on the general economic environments. Once the good economic news is forthcoming, the market would react soon, which leads the real estate market to perform more susceptibly to the fundamental shocks. Similarly bad news destroys the investors' confidence more hardly. However, in the expansion time frame and prosperous economy, investors generally hold the favorable expectation. Therefore, when the good economic news arrives, investors would react indifferently as they already expect this favorable situation. The signs of better prospects of the economy are much more valuable in recession than in expansion.

Another main finding is the relationship between real estate expected return and inflation. Historically, real estate has long been regarded as a hedge against inflation in many parts of the world. International academic studies in recent years, however, find mixed and contradicting results. Hoesli (1994) demonstrates that real estate provides a better hedge against inflation than common stocks. Likewise, Glascock and Davidson (1995) illustrate that the returns of individual real estate stocks typically outperform inflation rate, but typically do not perform as well as in a value-weighted portfolio. Flectcher (1995) points out that the success of real estate as an effective hedge against unexpected inflation is often demonstrated to be dependent on both research

methodology and the years to be examined.

In particular, when the economy is under recession, the inflation shocks are either slightly negative or have smaller positive coefficients, which are -0.10, 0.45, 0.51, -0.04, 0.21 and -0.22 for Singapore, HK, JP, Australia, UK and US respectively. In the expansion period, the inflation transmissions are positive, which are 0.33, 1.23, 0.79, -0.15, 0.46 and 0.30 for Singapore, HK, JP, Australia, UK and US respectively. The possible explanation is that during the time of economy expansion, investors always earn positive returns. The investors would have strong desire to secure their assets as well as to hedge against the inflation. Consequently, property related assets are popular when the market is favorable and the inflation hedging capacity of the property is strengthened as well. However, when the market is in recession, the first concern of investors' is how to reduce their loss and find new and favorable opportunity to survive. The change of inflation would not strongly drive them to go after property related financial products. Therefore, the inflation hedging capacity of the property under economic recession is weak.

These results might provide us the answer as to why the empirical results on real estate inflation hedging empirical results are mixed and not consistent. As restated, this is because the inflation hedging capacity of real estate is strong under good times and weak under bad times. When we test the inflation hedging in a long period, while ignoring the business cycle movement, the strong and weak effects would offset and cause controversial results. However, in order to make this issue clearer, further

rigorous tests may well be required. For example, the test may divide a long period into several sub periods and compare the different results.

5.4.4 Variance decomposition

Table 5.7 reports the forecast error variance decompositions of macroeconomic factors and securitized real estate expected returns. The percentage of securitized real estate excess returns that is explained by their own innovations are: 88.72%(Singapore), 85.54%(Hong Kong), 81.98%(Japan), 91.93%(Australia), 82.72%(UK) 86.82%(US) in regime 0 and 87.71%(Singapore), 76.37%(Hong Kong), 87.51%(Japan), 93.80%(Australia), 91.85%(UK), 93.21%(US) in regime 1. This result is consistent with the past literature. For example, Cheol and Shim (1989) who present the major international stock markets' variance decomposition results, suggest that average 80% of the variance is related to their own innovations. And David, *et al* (2003) also find the REITs' own innovation accounts for about the 90% variance. The result is inferred by the variance decomposition methodology of MS-VAR, which is stated in 5.2.4. The T-test compares the mean differences of variance decompositions between regime 0 and 1 and most of the variables report a significant value. Again, the forecasting error variance decompositions of the macroeconomic variables under the two regimes are different.

In Asia, macroeconomic shocks in Hong Kong and Japan account for 14.47% and 18.02% of securitized real estate market price variation in recession period (state 0) respectively, as compared to 23.62% and 12.48% in expansion period (state 1). The

shocks of macroeconomic factors in Australia, UK and US are able to explain 8.07%, 17.28% and 13.19% of their securitized real estate market fluctuations in the economic recession phases respectively. In contrast, when economy is in expansion period, shocks on securitized real estate play a relative weak role with 6.20%, 8.16% and 6.79% respectively.

In sum, there exists a sharp difference in the contribution of macroeconomic factors shocks on securitized real estate expected returns when the economy is in expansion and recession.

Table 5.7 Variance decomposition results

Markets	Variables	Regime 0	Regime 1	T - test
Singapore	Securitized RE	88.72%	87.71%	0.78
	GDPG	4.21%	7.94%	4.70**
	GM2	1.02%	0.19%	23.59**
	INI	3.83%	2.78%	1.74
	UIFLA	0.07%	1.27%	92.38**
	MKT	2.14%	0.12%	174.05**
Hong Kong	Securitized RE	85.54%	76.37%	26.20**
	GDPG	2.23%	2.09%	0.47
	GM2	4.39%	3.42%	7.02**
	INI	0.20%	0.07%	14.71**
	UIFLA	0.83%	14.57%	257.38**
	MKT	6.82%	3.47%	221.20**
Japan	Securitized RE	81.98%	87.51%	3.93**
	GDPG	13.06%	4.46%	6.62**
	GM2	0.50%	0.02%	96.65**
	INI	1.12%	0.09%	6.16**
	UIFLA	2.44%	7.14%	140.89**
	MKT	0.90%	0.77%	9.59**
Australia	Securitized RE	91.93%	93.80%	7.34**
	GDPG	1.58%	1.15%	39.42**
	GM2	4.39%	1.60%	183.61**
	INI	0.41%	0.03%	8.44**
	UIFLA	0.12%	2.32%	9.41**
	MKT	1.57%	1.10%	57.84**
UK	Securitized RE	82.72%	91.85%	6.46**
	GDPG	0.37%	0.62%	3.79**
	GM2	2.74%	1.18%	22.66**
	INI	11.41%	1.47%	6.88**
	UIFLA	0.65%	3.74%	213.54**
	MKT	2.11%	1.15%	29.23**
US	Securitized RE	86.82%	93.21%	20.25**
	GDPG	0.57%	0.49%	2.17
	GM2	4.84%	0.26%	39.15**
	INI	1.65%	0.78%	4.60**
	UIFLA	1.15%	2.41%	78.17**
	MKT	4.98%	2.85%	141.82**

Notes: Securitized RE means the shock of property stock market to itself. T-test compares the mean differences between regime 0 and 1. The critical value is: 2.12 (5%), 2.58 (1%). *,** indicate the significance at 5% and 1% level respectively.

5.4.5 Panel MS-VAR estimation results

One important assumption behind the Markov switching panel VAR is that the regimes are synchronized across countries. The international synchronization of business cycles and cross-country synchronization issues has always been a hot topic by economic researchers. Kose and Yi (2002) discuss about the theoretical impact of increasing trade integration on business cycle movement. International trade linkages generate both demand and supply-side spillovers across countries and result in the more highly correlated business cycles across countries. Kose, *et al* (2003) point out, financial linkages could also result in higher degree of business synchronization by generating large demand side effect. Furthermore, contagion effect that is transmitted through financial linkages could also result in heightened cross-country spillovers of macroeconomic fluctuations.

In the real estate field, Case, *et al* (1999) conduct a deep analysis on global real estate cycles and fundamentals. He finds that global real estate markets are largely correlated through common GDP effects, implying the synchronization of real estate and GDP. Moreover, Renaud (1994) considers the global economic cycle may have led to the correlated changes in real estate prices and the global economy. He also discusses the co-cyclicality of global economies and real estate. The global real estate may not completely synchronize with economy, but consider the above evidence, the synchronization assumption is still reasonable.

Table 5.8 Lag order selection for panel MS-VAR

p	1	2	3	4	5
Whole Panel					
AIC Criterion	5.342*	5.413	5.423	5.442	5.463
SC Criterion	5.501*	5.654	5.709	5.826	5.969
Asia-Pacific Panel					
AIC Criterion	5.759*	5.808	5.830	5.843	5.865
SC Criterion	5.859*	6.023	6.098	6.245	6.376
Non-Asia-Pacific Panel					
AIC Criterion	5.163*	5.183	5.232	5.243	5.257
SC Criterion	5.269*	5.298	5.421	5.498	5.653

Notes: * means the optimal lag selection

The PPTY, GDPG, GM2, INI, UINFL, EX and MKT are endogenous variables, and the MSCI is exogenous variable of the economic system. After using the Helmert procedure and averaging the transformed series, the panel estimation can be replaced by the single MS-VAR estimation. The first step of the model specification is determining the lag order. Again, the AIC and SC is used as criterions to select the optimal time lag. Table 5.8 reports the results. According to the criteria, AIC and SC, the optimal lag order in our models is 1 for all 3 panels.

As in MS-VAR estimation, the model employs 2 regimes and switching in intercepts and variances but constant the autoregressive coefficients. In addition to analyze the real estate issue under the whole panel, two sub panels are going to be employed. The sub panels are divided by geographical region, which are Asia-Pacific (Hong Kong, Singapore, Japan and Australia) and Non-Asia-Pacific (U.S. and UK) Panels. Although Non-Asia-Pacific includes two markets, U.S. and UK, their market share in the global market is almost 60%, and can represent the overall market movement as Non-Asia-Pacific panel. Thus, the panel's fixed effect is still effective in

the following tests.

Table 5.9 provides the estimates results from the Panel MS-VAR models. They include the regime-dependent intercepts, regime invariant autoregressive coefficient and regime-dependent variances. In the models, the MSCI are treated as exogenous factor, and the remaining seven macroeconomic variables are treated as endogenous ones. The Likelihood Ratio linearity test, which tests a non-linear (MS-VAR) against a linear (VAR) alternative, reports the significant result for all 3 panels. This means the regime switching model is required.

One argument is that the model should consider about cross-country Granger-causality in the endogenous variables, including both the property stock returns and the macroeconomic variables. Basically, there is no direct channel that causes the causality between different country's macroeconomic variables and each other markets' securitized property returns. For example, the short-term interest changes in Singapore can not affect the UK and US securitized real estate returns.

Table 5.9 reports the cross-country causality results of exogenous macroeconomic variables to property returns. The country specific fixed effects are controlled for the time series. The results indicate that there are no direct cross-country causality effects after controlling the country specific fixed effects. However, the purpose of this chapter is investigating how global and regional economic factors affect the regime shifts of securitized real estate return. The global and regional economic factors are the common factors across the countries, not individual countries factors.

Table 5.9 Cross-country Granger-causality tests

	GDP	M2	INI	UINFL	EX	MKT
HK->SG	1.32	0.60	1.81	0.65	0.21	1.02
JP->SG	0.70	0.36	1.42	1.49	0.35	0.47
AU->SG	0.26	1.35	0.96	0.45	0.62	0.39
UK->SG	0.53	0.20	0.81	0.55	1.01	0.72
US->SG	1.71	0.68	0.88	0.34	0.22	0.56
SG->HK	1.17	0.70	1.65	0.56	0.33	0.87
JP->HK	0.85	0.46	1.53	1.19	0.30	0.70
AU->HK	0.42	1.01	1.29	0.77	0.45	0.52
UK->HK	0.78	0.32	0.90	0.55	1.23	0.88
US->HK	1.74	0.61	0.72	0.42	0.27	0.80
SG->JP	0.25	0.30	0.13	0.87	0.42	0.63
HK->JP	0.33	0.85	0.28	0.29	0.78	0.25
AU->JP	0.56	0.98	1.31	1.01	0.24	0.46
UK->JP	1.10	1.30	0.87	0.48	0.86	0.50
US->JP	1.45	1.59	1.05	0.78	0.95	0.65
SG->AU	0.22	0.19	0.35	0.97	1.09	0.83
HK->AU	0.38	0.31	0.46	1.08	1.43	0.43
JP->AU	1.05	0.40	0.68	1.31	0.79	0.45
UK->AU	1.18	0.77	0.65	1.12	0.21	0.50
US->AU	1.20	0.86	0.67	1.26	0.55	0.86
SG->UK	0.45	0.37	0.49	0.96	0.69	0.44
HK->UK	0.19	0.21	0.91	0.29	0.57	0.87
JP->UK	0.43	0.56	0.87	0.52	0.53	0.80
AU->UK	0.35	0.82	0.20	0.67	1.07	0.33
US->UK	0.48	0.65	0.49	0.28	0.82	0.57
SG->US	0.44	0.36	0.52	0.72	0.69	0.63
HK->US	0.35	0.53	0.68	0.46	0.33	0.38
JP->US	0.80	0.89	0.99	1.25	0.62	0.53
AU->US	0.72	0.46	0.34	0.64	0.56	0.88
UK->US	0.58	0.68	0.92	0..49	0.79	0.49

Notes: the numbers reported are F value of the Granger Causality test. HK->SG means the null hypothesis " Hong Kong macroeconomic variables don't Granger causes Singapore property return". 3 months (one quarter) lag is used. SG: Singapore, HK: Hong Kong, JP: Japan, AU: Australia, UK: United Kingdom, US: United States. All the F values are not significant and thus can not reject the null hypothesis.

The whole panel, representing the international securitized real estate market system, is subject to the regime switching movements. Table 6.3 displays the two distinct regimes, one recession regime (state 0) with intercept -0.32 and variance 3.50, and one expansion regime (state 1) with intercept 1.26 and variance 3.15. In the autoregressive coefficients, significant negative coefficient for short term interest rate (INI) is recorded (the impact coefficient is -5.15). Moreover, the economic growth rate, unexpected inflation and market portfolio impacts report positive coefficients, which accord with expectation. It must be noted that the coefficient of MSCI (0.15) is positively significant. This implies that the exogenous factor, global economic condition, affects the performance of property securities positively. Real estate is a global business. Thus, it should be priced with cognizance both domestic and international factor. The sub panels include the Asia-Pacific panel and the Non-Asia-Pacific panel. As an emerging market, Asia-Pacific property securities have experienced dramatic developments in recent years. Global real estate investors also classify the Asia-Pacific regions as an important market[21]. U.S. and UK are two mature markets, which are named Non-Asia-Pacific in the study. The sub-panel results in the second column of Table 5.10 are for these two groups. It reveals that the securitized real estate systems in the two panels are also subject to the regime shifts. In addition, the relationships between securitized real estate returns and macroeconomic variables are different across two regions. For the Asia-Pacific, it is found the significant EX(-1) and

[21] For instance, in Singapore real estate market, there are some global institutional investors who are active in investment, such as ING Real Estate, ERGO Insurance and AIG Global Real Estate Investment.

Table 5.10 Panel MS-VAR estimation results

	Whole Panel	Asia-Pacific Panel	Non-Asia-Pacific Panel
Regime-dependent Intercepts			
v_0	-0.32	-0.04	0.77**
	(-0.71)	(-0.08)	(2.21)
v_1	1.26**	0.41	2.26***
	(2.29)	(0.62)	(5.47)
Autoregressive coefficients			
PPTY(-1)	0.10	0.10	0.03
	(0.73)	(0.72)	(0.42)
GDPG(-1)	0.29	0.01	0.01
	(0.74)	(0.03)	(0.01)
GM2(-1)	0.17	0.13	0.67
	(0.52)	(0.94)	(1.14)
INI(-1)	-5.15**	-2.57	-7.81***
	(-2.31)	(-1.00)	(-4.61)
UINFL(-1)	1.22	1.97	1.08
	(0.85)	(1.32)	(1.14)
EX(-1)	-0.15	-0.30***	-0.18
	(0.94)	(-2.81)	(-0.97)
MKT(-1)	0.43	0.24	0.06
	(1.02)	(0.20)	(0.56)
Exogenous Impacts			
MSCI(-1)	0.15*	0.14**	0.10
	(1.86)	(1.98)	(1.36)
Regime-dependent Variances			
σ_0	3.50**	4.39***	3.18***
	(2.21)	(3.10)	(4.08)
σ_1	3.15***	3.54***	2.13***
	(4.10)	(3.41)	(5.01)
Transition probabilities			
p	0.9045	0.8757	0.7189
q	0.9408	0.9305	0.9088
Log likelihood	-374.84	-739.92	-483.51
LR linearity test	411.67***	454.12***	387.98***

Notes: The dependent variables are returns of each securitized real estate market. PPTY(-1) means one lag of securitized real estate return. The null hypothesis of the LR linearity test is the linear VAR model, against the MSVAR model. The figures in parentheses are t statistics. ***,**,* represent significance in 1%, 5%, and 10% respectively. The whole panel covers six markets. The Asia-Pacific panel covers 4 Asia-Pacific markets. US and UK are classified in the Non-Asia-Pacific panel.

MSCI(-1) with coefficients of -0.30 and 0.14 respectively. For Non-Asia-Pacific, the interest rate effect (-7.81) is stronger than Asia-Pacific. Finally, the evidence indicates the Asia-Pacific securitized real estate markets experienced higher volatility than the US and UK panel.

Impulse response analysis

Graphs of the impulse response coefficients of securitized real estate expected returns in period 1-12 to one standard error shock from each of the macroeconomic variables in the Panel MS-VAR system are shown in Figure 6.1. The 6 graphs compare the dynamic responses of securitized property expected returns to economic shocks globally and regionally. The vertical axis denotes the securitized real estate expected returns, while the horizontal axis denotes time in months. Solid lines represent point estimates of the coefficients impulse response functions. The results in Figure 6.1 are different from those in Figure 5.1. As discussed, the regime shifts of each securitized market should have two parts; one part being affected by the local economic factors, causing each market's movement different with others'. The other part is affected by the global economic factors, leading the common regime shifts among international markets. Therefore, the results in Figure 5.1 represent the impacts of local factors and Figure 6.1 display the impacts of global factors.

A number of interesting results emerge from Figure 6.1. The first period results are summarized in Table 5.11. The T-test compares the mean differences of impulse response coefficients between regime 0 and 1 and most of the variables report the

Table 5.11 Impulse response coefficients comparison

Macroeconomic factors	Regime 0	Regime 1	T-test
Whole Panel			
GDPG	0.25	0.11	13.70**
GM2	0.12	0.05	2.93**
INI	-0.23	-0.13	19.19**
UIFLA	0.06	0.21	0.49
EX	-0.09	-0.04	6.02**
MKT	0.19	0.10	2.56*
Asia-Pacific			
GDPG	0.19	0.04	7.89**
GM2	0.10	0.06	2.33*
INI	-0.10	-0.07	11.05**
UIFLA	0.13	0.29	1.93
EX	-0.06	-0.02	18.19**
MKT	0.30	0.19	1.34
Non-Asia-Pacific			
GDPG	0.10	0.04	24.60**
GM2	0.23	0.15	3.41**
INI	-0.24	-0.11	3.13**
UIFLA	0.06	0.14	1.73
EX	-0.12	-0.09	3.39**
MKT	0.31	0.14	2.40*

Notes: the table reports the impulse response function in the first period. GDPG means the growth rate of GDP, GM2 means the grow rate of money supply, INI means short term interest rate, UIFLA means unexpected inflation rate ,EX means exchange rate and MKT means stock market. T-test compares the mean differences between regime 0 and 1. The critical value is: 2.12 (5%), 2.58 (1%). *,** indicate the significance at 5% and 1% level respectively.

significant value. In general, the strong and significant impacts always happen in the first one to three months, after that, the impacts coefficients are close to 0. In the whole panel, similar to the results in the previous chapter, the shocks are asymmetric across two regimes. Specifically, the macroeconomic shocks to property security expected returns are stronger in regime 0 (recession) than in regime 1 (expansion). For instance, the shocks in first period for the whole panel in regime 0 and regime 1 are: 0.25, 0.12, -0.23, -0.09, 0.19 and 0.11, 0.05,-0.13, -0.04, 0.10 respectively for GDPG, M2G, INI, EX and MKT.

However, the results for unexpected inflation are exceptional — the shock is stronger in expansion time than in recession. This is due to the inflation hedging attribute of property related assets. Investors desire more to hedge the inflation and secure their return in good time than recess time. Again, the evidence implies dynamic and asymmetric impacts of macroeconomic fundamentals on the international securitized real estate market. Notably, this is because investors and analysts react more susceptibly to macroeconomic fundamental shocks in economic recessions than in expansions.

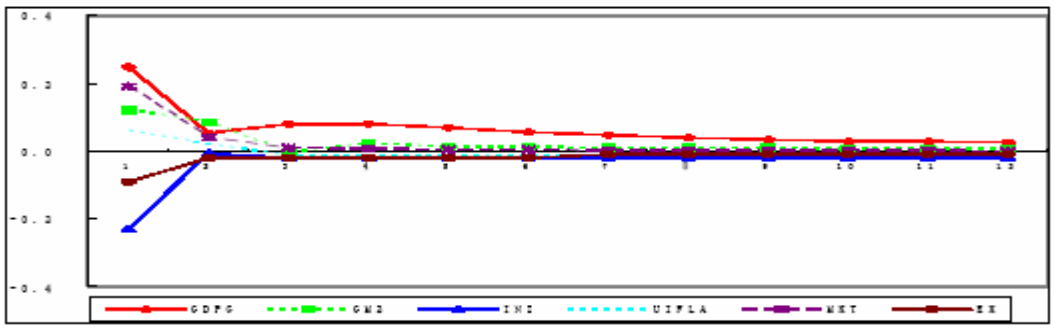
The two sub panels experienced similar shock impact from the international evidence. However, there still exist some differences across the two major property regions. Firstly, the interest rate impact is more significant in Non-Asia-Pacific than Asia-Pacific region. The shocks in first month are: -0.24, -0.11 in Non-Asia-Pacific panel and -0.10 and -0.07 in Asia-Pacific panel respectively for regime 0 and 1. It indicates the Non-Asia-Pacific markets are more interest sensitive than the Asia-Pacific markets.

Hence, the interest rate instrument is more effective in Non-Asia-Pacific panel than in Asia-Pacific panel. Secondly, in terms of the relationship between property security returns and unexpected inflation, the impact is stronger in the Asia-Pacific than the Non-Asia-Pacific panel. This result might make sense because, in Asian countries, property holding and investment are extremely popular, and property assets enjoy higher capital appreciation as well.

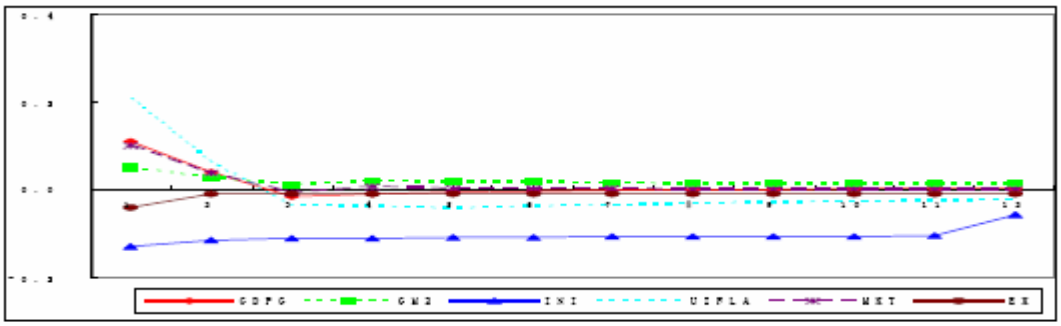
Figure 5.2 Impulse Response Functions of Panel MS-VAR

Whole Panel

Regime 0

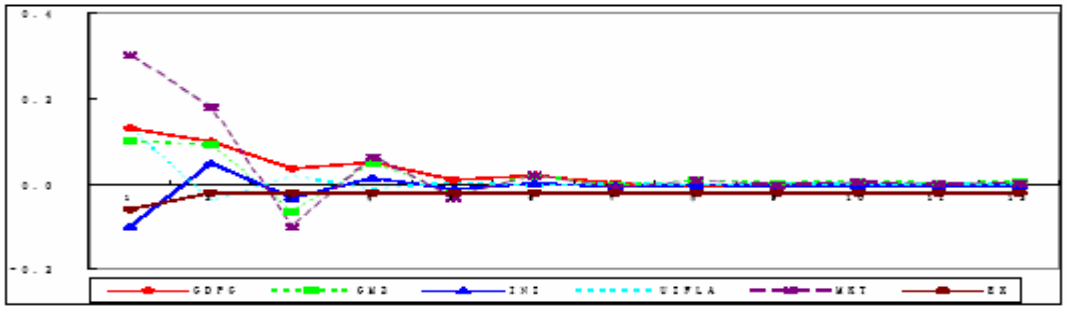


Regime 1

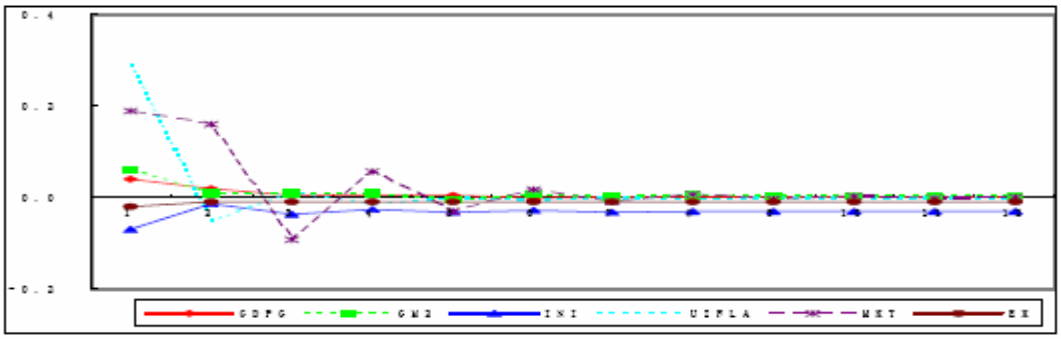


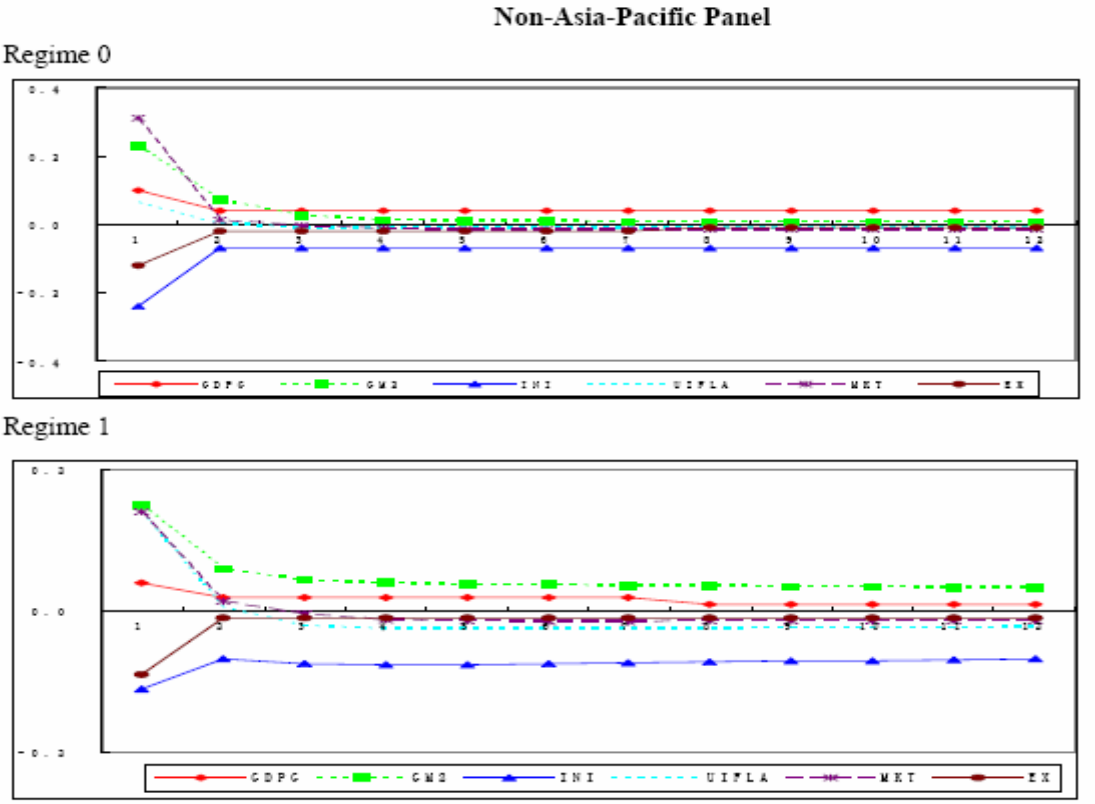
Asia-Pacific Panel

Regime 0



Regime 1





Variance decomposition

Table 5.12 reports the forecast error variance decompositions of macroeconomic factors and property stock expected returns for the panel MS-VAR model. Consistent with the individual markets, real estate expected returns show different sensitivity to the macroeconomic variables during different regimes. The T-test compares the mean differences of variance decompositions between regime 0 and 1 and most of the variables report the significant value.

From Table 5.12, it is also observed that the forecasting error variance decompositions of the macroeconomic variables in two states are different. For the

Table 5.12 Variance decomposition results

	Variables	Regime 0	Regime 1	T-test
Whole Panel	Securitized RE	94.33%	94.95%	1.48
	GDPG	2.19%	0.42%	21.85**
	GM2	0.59%	0.13%	23.34**
	INI	1.48%	2.49%	2.88**
	UIFLA	0.13%	1.61%	43.06**
	EX	0.26%	0.06%	27.89**
	MKT	1.02%	0.34%	145.84**
Asia-Pacific	Securitized RE	95.18%	95.34%	0.86
	GDPG	0.64%	0.05%	22.78**
	GM2	0.51%	0.11%	13.65**
	INI	0.29%	0.26%	1.12
	UIFLA	0.41%	2.34%	326.00**
	EX	0.13%	0.03%	10.72**
	MKT	2.85%	1.87%	8.18**
West	Securitized RE	91.93%	94.33%	6.04**
	GDPG	0.54%	0.15%	8.05**
	GM2	1.69%	1.43%	4.17**
	INI	2.44%	1.82%	2.25*
	UIFLA	0.13%	0.98%	38.48**
	EX	0.47%	0.38%	10.62**
	MKT	2.80%	0.91%	341.93**

Notes: the table reports the average of variance decomposition of 12 periods. Securitized RE means the securitized real estate return, GDPG means the growth rate of GDP, GM2 means the grow rate of money supply, INI means short term interest rate, UIFLA means unexpected inflation rate ,EX means exchange rate and MKT means stock market. T-test compares the mean differences between regime 0 and 1. The critical value is: 2.12 (5%), 2.58 (1%). *, ** indicate the significance at 5% and 1% level respectively.

whole panel, the macroeconomic shocks account for 5.67% of securitized real estate market expected return variation during the recession period, as compared to 5.05% during the expansion period. In the two sub panels, the shocks of macroeconomic factors in Asia-Pacific and Non-Asia-Pacific explain 4.83% and 8.07%, respectively, of their securitized real estate market expected return's fluctuations in economic recession. When economy is in expansion stage, shocks on securitized real estate

expected return account for 4.66% (Asia-Pacific) and 5.67% (Non-Asia-Pacific) of the price variation. Hence, there are disparities in the contribution of macroeconomic fundamental shocks on securitized real estate expected returns when the economy is in expansion and recession internationally.

Comparing with stock market results

The issue of comparing the performances of real estate market with stock market has attracted the interest of real estate academics for a long period. Table 5.13 and 5.14 compare the macroeconomic impact on securitized real estate and stock markets in light of regime shifts. Table 6.6 demonstrates the impulse response function comparison in the first period.

Table 5.13 Impulse response function comparison

Macroeconomic factors	Regime 0		Regime 1	
	Stock	Property Stock	Stock	Property Stock
GDPG	0.41	0.26	0.16	0.11
GM2	0.17	0.12	0.10	0.05
INI	-0.28	-0.23	-0.13	-0.13
UIFLA	-0.13	0.06	-0.06	0.21
EX	-0.11	-0.09	-0.06	-0.04

Notes: the table reports the impulse response function in the first period. GDPG means the growth rate of GDP, GM2 means the grow rate of money supply, INI means short term interest rate, UIFLA means unexpected inflation rate and EX means exchange rate.

In state 0 (recession period), the stock market's response (0.41) to the shock of GDP is stronger than the property stock (0.26). This is the same case for INI and EX with -0.28 compared to -0.23 and -0.11 compared to -0.09 respectively. However, there is significant difference in their responses to the shock of unexpected inflation rate.

The property stock displays positive coefficient (0.06), and stock market reports negative coefficient (-0.13).

In state 1(expansion period), the stock market's response (0.16) to the shock of GDP is also stronger than the property stock (0.11). The interest rate and exchange rate present similar performances as well. For unexpected inflation rate, the coefficient of securitized real estate is still positive (0.21) and stock is negative (-0.06). The evidence implies that the securitized real estate and not stock can provide a hedge against the unexpected inflation in both recession and expansion period. Finally, the results again suggest that there is dynamic and asymmetric relationship between the stock market and the macroeconomic factors, as securitized real estate market does.

Table 5.14 Variance decomposition comparison

	Regime 0		Regime 1	
	Stock	Property Stock	Stock	Property Stock
Self variance	92.10%	94.33%	96.15%	94.95%
GDPG	4.05%	2.19%	0.62%	0.42%
GM2	1.12%	0.59%	0.23%	0.13%
INI	2.05%	1.48%	2.85%	2.49%
UIFLA	0.41%	0.13%	0.08%	1.61%
EX	0.27%	0.26%	0.07%	0.06%

Notes: the table reports the average of variance decomposition of 12 periods. GDPG means the growth rate of GDP, GM2 means the grow rate of money supply, INI means short term interest rate, UIFLA means unexpected inflation rate and EX means exchange rate.

Table 5.14 presents the variance decompositions of two assets in the two distinct states. Together, the five macroeconomic shocks account for 8% of stock market

expected return variation during the recession period, as compared to 3.3% for the securitized real estate market expected return. In economic expansion period, the shocks of macroeconomic factors explain 3.85% and 5.05% of the stock and securitized real estate market expected returns' fluctuations respectively. Both markets report the asymmetric impulse response and variance decomposition for the macroeconomic fundamental shocks. This finding is, to some extent consistent with Hess (2004), who reports the dynamic and asymmetric impacts of macroeconomic factors on the stock market and its expected return shows different sensitivity to the macroeconomic variables during different regimes.

5.5 Summary

This chapter examines the dynamic relationships between the securitized real estate expected returns and their domestic macroeconomic factors, and assesses the asymmetries of macroeconomic shocks to the securitized real estate expected returns. To highlight the nonlinear and asymmetric transmission channels of economic fundamentals shocks to real estate expected returns, the impulse response and variance decomposition analysis are employed under the economy framework. This chapter is important to help local and global real estate investors understand the differential relationship between securitized real estate expected returns and the domestic economic conditions after accounting for state dependent regime switching and adjust their optimal asset allocation and risk adjusted return performance measurement exercise according to the macroeconomic news in different regimes.

The main findings are: (a) the securitized real estate market expected returns and the macroeconomic systems are subject to regime dependent movements, (b) the macroeconomic shocks to the securitized real estate expected returns are asymmetric. Specifically, in recession(state 0), the change of macroeconomic factors, including GDP, money supply, interest rate, inflation and market portfolio, impact the real estate expected returns greater than in expansion (state 1). This evidence implies that the signs of better prospects of the economy are much more valuable in recession than in expansion, (c) the securitized real estate asset's ability to hedge against inflation is also regime dependent, and this might explain why the empirical results on real estate inflation hedging are mixed and controversial. It shows that traditional linear models substantially underestimate the impacts as different and sometimes offsetting effects of fundamental shocks across the economy states, (d) the variance decomposition analysis also confirms that the contribution of macroeconomic factors shock on securitized real estate expected return fluctuations are asymmetric under the two different regimes, (e) internationally and regionally, the securitized real estate market expected returns and macroeconomic systems are both subject to regime-dependent movements. Securitized real estate market expected returns are sensitive to the macroeconomic news. The securitized real estate expected returns show different sensitivity to the macroeconomic variables during different regimes.

The findings are important for real estate investors to improve their portfolio performance. Although it is now well recognized that real estate expected returns react to fluctuations of macroeconomic factors, the previous investigation of relationships

between expected returns on real estate and major macroeconomic risks is based on linear assumption. The MS-VAR model illustrates the time-varying and asymmetric relationship between real estate expected returns and macroeconomic risks. By knowing the asymmetric macroeconomic impacts, investors therefore can also adopt different strategies to adjust their portfolio in different cycle phase according to the macroeconomic news. Additionally, policy makers may play a role in influencing the expected returns on real estate market through the use of macroeconomic policy in different phases.

Chapter 6 Regime Switching and International Real Estate Asset Allocation

6.1 Introduction

The main objective of this chapter is to investigate how do regime shifts affect the real estate asset allocation by following Ang and Bakaert (2002 and 2003). Section 6.2 provides an explanation of methodologies. The empirical results are reported and discussed in the Section 6.3. The final section concludes the study.

6.2 Methodology

The methodology part is to explore a regime-switching asset allocation model for international real estate by following Ang and Bakaert (2002 and 2003). The main components are described below.

6.2.1 Theoretical support

Equation (1) is a standard version of the world CAPM for real estate returns:

$$R_{it} - R_{ft} = \alpha_i + \beta_{iw}[R_{wt} - R_{ft}] + \varepsilon_{it} \quad (6.1)$$

where R_{it} and R_{ft} denote real estate return and risk-free return respectively, $R_{wt} - R_{ft}$ is the world market excess return, β is the systematic risk for each real estate market and ε_{it} is real estate market idiosyncratic risk and cannot be diversified. Assume further that the world market excess return is drawn from a single Gaussian distribution with expected return u^w and variance $\sigma^w \varepsilon_t^w$, then:

$$y_t^w = u^w + \sigma^w \varepsilon_t^w \qquad (6.2)$$

where $y^w = R_{wt} - R_{ft}$

Next, suppose that the world market expected excess return and conditional volatility can be characterized by two different regimes as contraction and expansion The regime specification of the world market excess return is given by Equation (3) where s_t defines an unobservable state or regime; which is denoted by 0 (contraction) or 1(expansion). The transition between the states is governed by a first-order Markov process as shown in Equations (6.3).

$$y_t^w = u_0^w(1-s_t) + u_1^w s_t + [\sigma_0^w(1-s_t) + \sigma_1^w s_t] \qquad (6.3)$$

$$P[s_t = 0 \mid s_{t-1} = 0] = p$$
$$P[s_t = 1 \mid s_{t-1} = 0] = 1 - p$$
$$P[s_t = 1 \mid s_{t-1} = 1] = q$$
$$P[s_t = 0 \mid s_{t-1} = 1] = 1 - q$$

As noted in Equations (4.1-4.4), the regime variable follows a Markov process with constant transition probabilities p and q. For example, if investors are currently (at time t) in regime 1, the probability of remaining in that regime is q and hence the probability of transitioning in the other regime (i.e. regime 0) is (1-q). The expected return (u_1^w) specification is shown in Equation (6.4). Next the expected return for next period (t+1) depends on the investor's expectations for the regime realization u^w at time t+1with relevant probability, and if the world market at time t+1 is in regime 0, the expected return is u_0^w with transition probability P (Equation 6.5).

$$u_1^w = (1-q)u^w(s_{t+1}=0) + qu^w(s_{t+1}=1) \qquad s_t = 1 \qquad (6.4)$$

$$u_0^w = pu^w(s_{t+1}=0) + (1-p)u^w(s_{t+1}=1) \qquad s_t = 0 \qquad (6.5)$$

The expected variance for the world market excess return also depends on the regimes. Its specification has two components. The first component is the weighted average of conditional variance in two regimes; the second component is a jump component that originates because the condition mean is different across the regimes. The specifications for regimes 1 and 0 are shown in Equations 6.6 and 6.7 respectively.

$$(\sigma_1^w)^2 = (1-q)(\sigma^w(s_{t+1}=0))^2 + q(\sigma^w(s_{t+1}=1))^2 + q(1-q)[u^w(s_{t+1}=1) - u^w(s_{t+1}=1)]^2 \text{..(6.6)}$$

$$(\sigma_0^w)^2 = p(\sigma^w(s_{t+1}=0))^2 + (1-p)(\sigma^w(s_{t+1}=1))^2 + p(1-p)[u^w(s_{t+1}=1) - u^w(s_{t+1}=1)]^2 \text{..(6.7)}$$

6.2.2 Expected returns and volatilities for real estate markets

Expected returns differ across the individual real estate markets through their different betas (i.e. systematic risks) relative to the world market. Since the mean of the world market excess return switches between regimes, the expected excess return of each market is given by Equation 6.8:

$u_j = \alpha_i + \beta e_j^w$ (j denotes two different regimes: 0 and 1)……..(6.8)

Next, the expected variance-covariance matrix has three components. First, there is an idiosyncratic volatility term (unrelated to its beta exposure). Second, when the world market excess return switches between regimes, the market's conditional

variance also depends on the regime prevailing at time t. Hence there are two possible variance matrices for the unexpected returns next period (Ω), given by Equation (6.9).Third, the variance of an individual asset depends on both the realization of the current regime and a jump component. Consequently, the conditional variance of individual markets can be written as shown in Equation 6.10 (regime 0) and Equation 6.11 (regime 1):

$$\Omega_i = (\beta\beta')(\sigma^w(s_{t+1} = i))^2 + V \qquad (6.9)$$

$$(\sigma_0)^2 = p\Omega_0 + (1-p)\Omega_1 + p(1-p)(e_1 - e_0)(e_1 - e_0)' \qquad (6.10)$$

$$(\sigma_1)^2 = (1-q)\Omega_0 + q\Omega_1 + q(1-q)(e_1 - e_0)(e_1 - e_0)' \qquad (6.11)$$

where V captures the idiosyncratic volatility term and is a matrix of 0 with $\overline{(\sigma_i)^2}$ along the diagonal.

6.2.3 Asset allocation under regime switching

Mean-variance optimization under regime switching with monthly rebalancing for the portfolio is used, consistent with our data frequency. The standard optimal mean-variance portfolio specification is given in Equation (6.12), where γ is real estate investor's risk aversion, $\sum(j)$ is the covariance matrix with regime j and $e(j)$ is the vector of conditional means for regime j. In addition, we specify 3-month T-bill rate as the portfolio risk-free rate.

$$w(j) = \frac{1}{\gamma} \sum (j)^{-1} e(j) \qquad (6.12)$$

In the proposed asset allocation model, there will be two optimal tangency portfolios the investor would choose, one for each regime. Finally, it will show how mean-variance asset allocation with regime switching performs in an out-of-sample exercise.

6.3 Empirical results

In this chapter, all of the data are translated on US dollar in order to avoid the exchange risks across the countries. The portfolio form therefore is constructed from US real estate investor perspective. MSCI index is used as proxy of world market portfolio. US 3-month Treasury bill rate is the proxy of risk free rate.

6.3.1 International real estate parameter estimates

Table 6.1 reports the estimates of regime switching in the world market return, which denoted by MSCI index, and international asset pricing model with MSCI as our market portfolio. As to the world market excess return, our specification is one in which stock market return are drawn from distributions that differ in both means and variances, as in equation (6.3). Empirical results report two significant regimes on world market movement. State 0 is characterized by a low return (-1.54%), with the high variance (6%). Adversely, State 1 has a high return (1.31%) and low risk (3.38%). The two different states are both persistent with high transitional probabilities, which are 0.8200 and 0.9312 respectively.

Table 6.1 Parameter estimates under regime switching

Transition Probabilities	**p**	**q**
Estimate	0.8200	0.9312
Std error	0.18	0.05

World Market Return(MSCI) (%)				
	$u^w(0)$	$u^w(1)$	$\sigma^w(0)$	$\sigma^w(1)$
Estimate	-1.54	1.31	6.00	3.38
Std error	1.62	0.34	1.62	0.66

Country Beta β_i						
	Hong Kong	Singapore	Japan	Australia	UK	US
Estimates	1.42	1.30	1.02	0.58	0.78	0.29
Std error	0.15	0.14	0.13	0.07	0.09	0.03
Abnormal Return α						
Estimates	0.14	-0.45	-0.77	-0.14	-0.06	0.36
Std error	0.69	0.62	0.59	0.30	0.40	0.22
Idiosyncratic Volatilities $\overline{\sigma}$						
Estimates	9.89	8.88	8.49	4.35	5.73	3.20

Notes: The return and variance data are presented with percentages and monthly. The mean return is $u^w(0)$ in state 0 and $u^w(1)$ in state 1. The standard deviation of returns is $\sigma^w(0)$ state 0 and $\sigma^w(1)$ in state 1. The transitional probabilities are p (state 0) and q (state 1)

The other estimation is for our international real estate asset pricing model. The key estimation parameters are country beta β_i the return sensitivity (exposure) of country i's real estate returns to returns on the world market portfolio, also called systematic risk. When β_i is above 1, the country real estate market will be more risky than world market, and vice versa. As Table 6.1 illustrates, the securitized real estate

markets in Asian (Hong Kong, Singapore and Japan) are more volatile than world market with β_i 1.42, 1.30 , 1.02 respectively. However, the remained three established markets are less risky. One byproduct of our CAPM model is abnormal return α_i, which indicates whether the real estate market is outperform the world benchmark market or not. The results demonstrate that only Hong Kong and US real estate security markets are outperform the world market with abnormal return 0.14% and 0.36% in our sample period. One preliminary finding is that US REITs market performs best in our six markets with highest return and lowest risk.

6.3.2 Expected returns and volatilities for individual markets

For the individual assets, we maintain the equations 6.8--6.11 to get our expected returns and volatilities. The model generates rich patterns of stochastic variances and time-varying correlations structure. Particularly, the equations can capture the asymmetric correlation structure in global securitized real estate markets that motivates our current analysis. Ang and Bekaert (2002 and 2003) reports international equity returns are more highly correlated with each other in bear markets than in bull times. Hence, if one regime is more volatile than the other regime, then the correlation between the different asset returns increases in that regime.

Table 6.2 reports the implied expected excess returns for the six markets. The expected return in regime 1 is higher than in regime 0. The exhibit also shows the covariance and correlation in the two regimes. Given that the first regime is a high volatility regime, we expect the model will generate asymmetric correlations, with

correlations being higher in regime 0. For example, referring to the correlation

Table 6.1 Regime-dependent expected returns and covariances

Panel A: Regime-Dependent Excess Return (%)						
	Hong Kong	Singapore	Japan	Australia	UK	US
Regime 0	-1.32	-1.79	-1.82	-0.74	-0.86	0.06
Regime 1	1.72	1.00	0.37	0.51	0.81	0.68
Panel B: Regime-Dependent Covariances (%) / Correlations						
Regime 0						
Hong Kong	1.60	[0.41]	[0.36]	[0.38[	[0.39]	[0.29]
Singapore	0.59	1.33	[0.36]	[0.39]	[0.39]	[0.29]
Japan	0.47	0.43	1.06	[0.34]	[0.34]	[0.26]
Australia	0.27	0.24	0.19	0.30	[0.37]	[0.27]
UK	0.36	0.33	0.26	0.14	0.52	[0.28]
US	0.13	0.12	0.10	0.05	0.07	0.13
Regime 1						
Hong Kong	1.10	[0.23]	[0.20]	[0.22]	[0.22]	[0.16]
Singapore	0.25	1.02	[0.19]	[0.21]	[0.21]	[0.15]
Japan	0.19	0.18	0.86	[0.18]	[0.18]	[0.13]
Australia	0.11	0.10	0.08	23.44	[0.20]	[0.14]
UK	0.15	0.14	0.11	0.06	0.41	[0.14]
US	0.06	0.05	0.04	0.02	0.03	0.12

Notes: We display the regime-dependent means and covariances of excess return for six real estate markets. all numbers are listed in percentages. For the covariance matrix, the correlation coefficients are placed in the upper-right triangular matrix in square brackets.

coefficient between Hong Kong and Singapore, in regime 0, the coefficient is 0.41, but it becomes 0.23 in regime 1. Another finding is, the correlation among Asian markets is tighter comparing with other markets. With this expected returns and covariances structure, next step will construct regime switching asset allocation strategy.

6.3.3 Mean-variance optimization under regime switching

Table 6.3 Tangency portfolio weights for different strategies

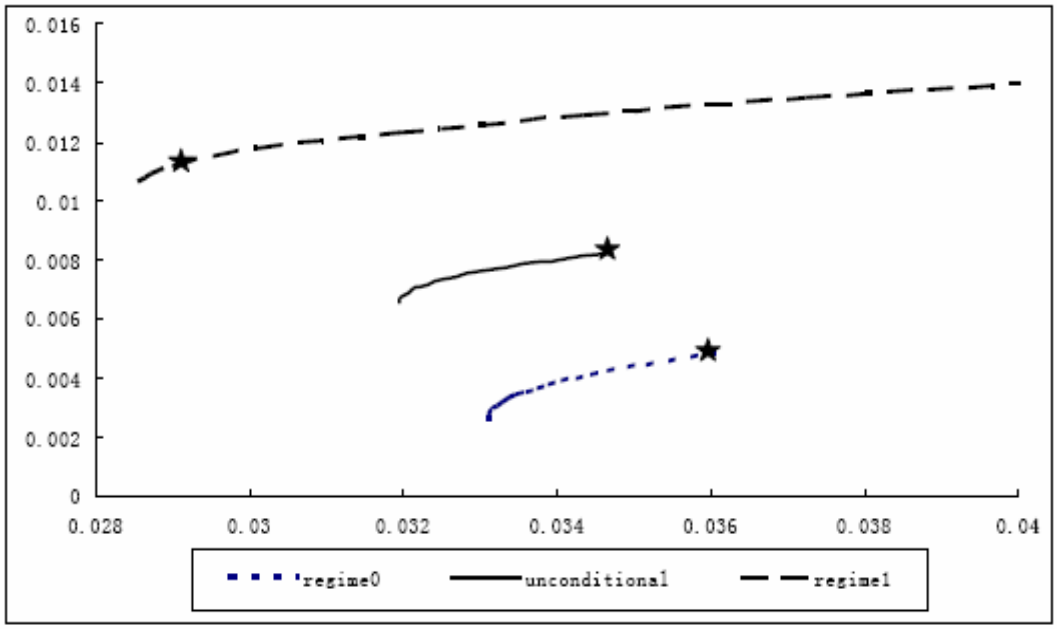
	Hong Kong	Singapore	Japan	Australia	UK	US
Regime 0	0	0	0	0	0	100%
Regime 1	33.31%	6.38%	0	0	13.17%	47.14%
Conventional	0	0	0	39.97%	23.83%	36.20%
Equal Weights	16.67%	16.67%	16.67%	16.67%	16.67%	16.67%

Notes: we report the mean variance optimal risky portfolios, computing with risk-free rate 0.42% each month , which is the average rate in the whole sample period. The equal weights means put the asset across six markets with equal parts. Conventional portfolio means using historical average return and variance as expected return and variance to construct the portfolio.

Table 6.3 displays the optimal risky portfolios in regime 0 and 1. We compare the regime switching allocation results with the unconditional asset allocation method, which employs the historical mean and variance as our expected return and volatility, and supposes the correlations among the markets are constant all the time. In the bear regime 0, the real estate investor places 100% of his wealth in US REITs market. When global economy is in bad time, the global real estate markets are highly correlated and US REITs market outperforms the other five markets from both return and risk perspective. Therefore, when the market expectation is not good, it is hard for the real estate investor to find the diversification outside the US market. When the economy is good and in bear regime 1, we can expand our invest opportunities in the international markets. Table 6.3 shows, in regime 1, the investor allocates 47% of his

asset in US portfolio, the remained is distributed to UK, Hong Kong and Singapore with 13%, 33% and 6% respectively. Almost half of our real estate asset should be assigned to US market, and the other is diversified in Asian and European markets when the world economy is expected to be expansion. For the unconditional asset allocation, the all of capital is put in the Australia, UK and US market, all of which are relatively established securitized real estate markets.

Figure 6.1 Mean-variance efficient frontiers of regime switching portfolio



Notes: It plots the mean-variance frontier of regime 0 (bear market) , regime 1(bull market), and the unconditional mean-variance frontier. The optimal risky portfolios are also marked. Conventional portfolio means using historical average return and variance as expected return and variance to construct the portfolio.

Figure 6.1 depicts the efficient frontiers of our asset allocation strategies. The main implications of regime switching for real estate allocation are shown The solid line represents the frontier using unconditional method, ignoring regime switching.

The other two frontiers are the ones applicable in two different regimes. The top frontier is for bull regime, with better risk-return trade-off here, because the expected return is high but correlation is low. The Sharp ratio for the optimal risky portfolio is 0.2304 for this line. In the bear market regime, the risk-return trade-off worsens and the investor selects a totally different portfolio, only realizing a Sharp ratio of 0.0957. When ignoring the regime switching, it obtains another portfolio from the unconditional optimization method, which results a Sharpe ratio of 0.1099.

6.3.4 Out-of-sample allocation and comparisons

In contrast to the in-sample portfolio results of Exhibit 8, in this section we conduct out-of-sample analyses to examine whether the RS asset allocation strategy outperforms the unconditional allocation strategy. Assume that the investor rebalances her portfolio once a month; the first analysis uses historical data from January 1987 to January 2003 to construct various asset allocation models as of February 2003. The RS and unconditional asset allocation models are estimated using information available only up to time t. The process is repeated every month until September 2004, total 20 months periods.. Finally, the portfolio performance is evaluated by using ex-post coefficient of variation (CV), Sharpe index (SI), Jensen α (JI) and Treynor index (TI) realized by the various strategies - RS, unconditional, world portfolio and equally-weighted allocations.

Table 6.4 reports that over the out-of-sample, the RS strategy yields an average monthly return of 2.42%. Its standard deviation is 4.28%. The return and risk

performance for the other three strategies are also reported. Notably, the non-regime dependent (i.e. unconditional) strategy's monthly average return and standard deviation are 2.15% and 4.00% respectively. Figure 6.2 further shows how wealth cumulates over time in these strategies. At the end of the sample period (i.e. September 04), the cumulative returns are 48.30% (RS), 43.03% (unconditional), 25.50% (world portfolio) and 45.94% (equally-weighted). These results imply that RS allocation strategy outperforms the non-regime dependent strategy, equally-weighted portfolio and world portfolio when return only is considered, particularly in 2003 and 2004.

Table 6.4 Out-of-sample portfolio performance evaluation for different asset allocation strategies

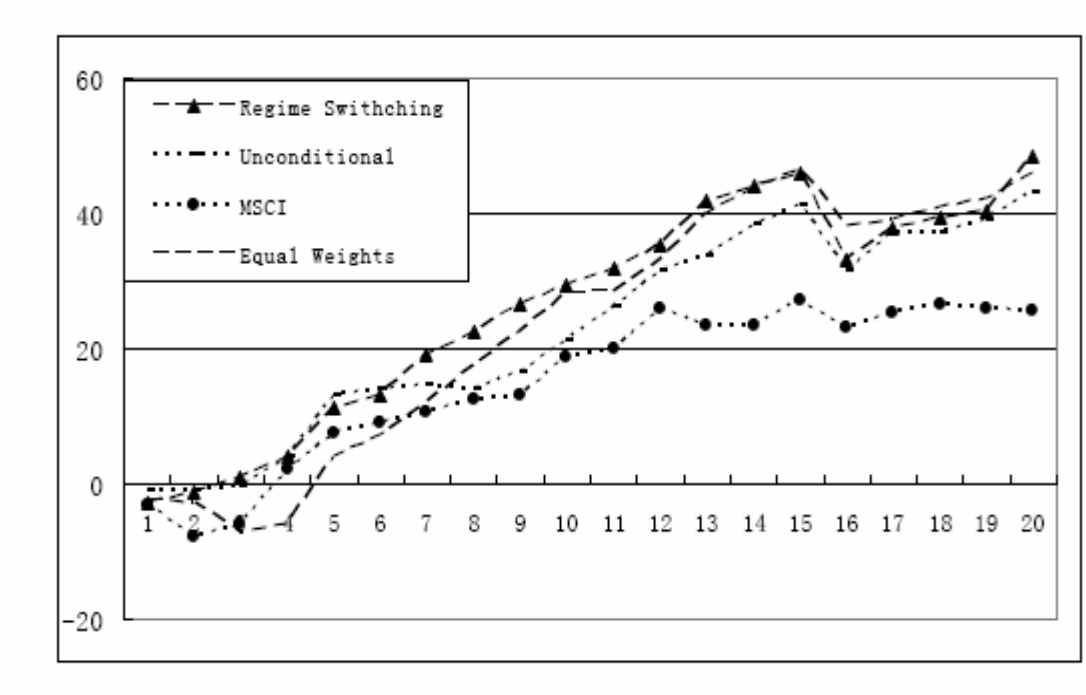
	Regime Switching	**Unconditional (Non-regime dependent)**	**World portfolio**	**Equally-weighted**
Mean Return (%)	2.42	2.15	1.28	2.29
Standard Deviation (%)	4.28	4.00	3.36	4.09
Coefficient of Variation (CV)	1.77*	1.86	2.63	1.78
Sharpe Index (SI)	0.47*	0.44	0.24	0.46
Treynor Index (TI)	3.26*	2.55	0.82	2.59
Jensen α (%) (JI)	1.57*	1.22	0.00	1.31

Notes: We report the mean, standard deviation, CV, SI, TI and JI of out-of-sample returns following the respective asset allocation strategies. * means indicator superior to the other 3 strategies.

Four risk-adjusted return indicators for the out-sample comparisons are also provided in Table 6.4. As the figures indicate, the RS strategy's coefficient of variation (CV) is 1.77, outperforms the unconditional (non regime-dependent) strategy (CV = 1.86) and is also much lower than the world market portfolio CV (2.63) and the

equally-weighted portfolio (CV = 1.78). Second, the RS allocation yields a SI of 0.47 and is marginally higher than the SI of the conventional strategy (SI = 0.44). This is also about 95% higher than the world portfolio (SI = 0.24) and 2% higher than the equally-weighted portfolio (SI = 0.46). Third, the RS strategy also performs better in TI (3.26), more than the TIs for the conventional portfolio (2.55), world portfolio (0.82) and equally weighted portfolio (2.59). Finally, the RS strategy also does very well in its JI (1.57%), much higher than the unconditional portfolio JI (1.22%), and is also about 20% higher than the equally-weighted portfolio JI (1.31%).

Figure 6.2 Cumulative returns for asset allocation strategies (%)



In all, the out-sample tests have reasonably indicated that the RS allocation strategy out-performs the non-regime dependent strategy (unconditional), the world market and the equally-weighted portfolio consistently. One possible explanation is

because the RS allocation strategy helps establish a defensive portfolio in the bear market regime (i.e. regime 0) that hedges against higher correlations and low returns in international real estate markets. Furthermore, as the RS allocation strategy relies less on historical moments, it is likely the resulting optimal portfolio could even be more internationally diversified (Ang and Bakaert, 2002). Consequently, it is equally possible to add value in real estate portfolios as the presence of a bear market with high correlation regime does not necessarily erode the benefits of international diversification in real estate.

6.4 Summary

Given the importance of international securitized property as a real estate investment vehicle for institutional investors to gain worldwide real estate exposure, this chapter is set out to develop an advanced asset allocation to improve our global real estate portfolio performance under regime switching environment. In addition, the out-of-sample tests demonstrate the dynamic strategy dominates the unconditional asset allocation strategies. The study is important to allow international real estate investors understand the asymmetric return structure on securitized property, and help them improve the real estate portfolio performance after accounting for regime switching in global markets.

The major findings are: (a) International real estate returns present strong evidence of asymmetric correlation coefficients under regime switching. The worldwide securitized real estate markets are more highly correlated with each other in bear

markets than in bull times. Specifically, the return correlation coefficients are generally higher in regime 0 (recession) than in regime 1 (expansion), which causes different asset allocation strategies in different regimes.(b) The results of out-of-sample tests illustrates the regime switching asset allocation strategy outperforms the unconditional and conventional strategies and general market , no matter from return, risk and risk-adjusted performance perspectives. It shows the regime switching strategy is advanced and dominant. Also could help investors to improve their portfolio performance.

Chapter 7 Conclusions

During the last two decades, global securitized real estate market, together with economic and financial systems, has undergone an extraordinary period of rapid growth, encouraging overseas real estate investment and diversification. These changes impact both the structure and functioning of the securitized real estate market as well as to cause the regime switching movement of the international securitized real estate market. Therefore, a thorough understanding of the dynamic movements and regime shifts affecting international securitized real estate are paramount, considering the dynamic and rapid change of the global economic and financial system. Thus, the aim of the thesis is to investigate the dynamics of securitized real estate market returns and their relationship with macroeconomic factors under a regime switching framework.

7.1 Summary of main findings

The prevalence of international securitized property as an alternative asset class, to achieve global diversification and greater real estate exposure, requires investors to understand the various risk-return performances of securitized property after accounting for state dependent regime movements. The empirical results suggest that the international securitized property in this study exists in one state (state 0) where the returns are low/negative and the variance is high, and in the other state (state 1) where the returns are high and the variance is low. The two regimes (low return-high

volatility; high return-low volatility) are persistent with differences observed in the expected duration and in the frequency of shifts between the states among the six international markets of the US, UK, Australia, Japan, Hong Kong and Singapore. However, the high return-low volatility (state 1) regime dominates in the six markets. This state dominants because it has a higher probability to stay and longer duration (see Table 4.4 and 4.5). The two crisis in 1987 and 1997 are specially discussed, not because state 0 dominants, but because these two crisis triggered the obvious regime switching in most of the markets. Moreover, there is also some evidence of change in correlations among some pairs of securitized property markets after the 1987 stock market crash and the 1997 Asian financial crisis. Additionally, common regime shift movement exists in the international markets. However, these co-movements do not relate to cointegration. The co-movements are short term relationships and behaviors, but cointegration is long term relationship. International investors' diversification benefits will be reduced but still can be achieved since the co-movement among the markets is not completely perfect and full synchronized.

The second chapter of this study relates the dynamic and regime-dependent securitized real estate expected returns with their domestic macroeconomic forces, as well as assesses the asymmetries of macroeconomic shocks to the securitized real estate expected returns. The dynamic and nonlinear structural behavior can help local and global real estate investors understand the differential relationship between securitized property expected returns and the domestic economic conditions after accounting for state dependent regime switching and would thus enable the investors

to adjust their asset allocation strategy, according to the changes of the local economy and regime shifts of securitized property market expected return.

Overall, the results indicate conclusively that securitized real estate expected returns are significantly related to domestic economic changes. However, the economic shocks to securitized real estate expected returns are state-dependent and asymmetric; with the macroeconomic factor shocks impacting the real estate expected returns in recession greater than in expansion. This suggests that the signs of better prospects for the economy are much more valuable in slump than in boom. Specifically, the inflation hedging ability of securitized real estate asset is regime dependent, which might explain why the empirical results on real estate inflation hedging are mixed and controversial. It shows that traditional linear models substantially underestimate the impacts as different and sometimes offset the effects of fundamental shocks across the economy states. The contributions of macroeconomic factor shocks on securitized real estate expected returns are also different under two regimes.

This chapter also investigates the nonlinear relationship between the securitized real estate expected returns and the global and regional macroeconomic factors as well as the asymmetric macroeconomic shocks to the securitized real estate markets, internationally and regionally. The international evidence of the nonlinear and asymmetric transmission channels of the economic shocks to real estate expected returns is insightful and useful for international investment. Global economic condition, together with domestic macroeconomic factors, impacts the international property

stock expected returns. Furthermore, in the global market, the macroeconomic factor shocks to securitized real estate expected returns are state-dependent and asymmetric, and the signs of better prospects of the economy are much more valuable in economic recession than in expansion. Inflation rate has greater impacts on real estate expected returns in the Asia Pacific region than that of the non-Asia Pacific region.

The final chapter is to investigate how do regime shifts affect the real estate asset allocation and develop a regime switching portfolio strategy for global securitized real estate markets. Strong evidence of asymmetric return structure is detected in international securitized property. The worldwide securitized real estate markets are more highly correlated with each other in bear markets than in bull times. Specifically, the return correlation coefficients are generally higher in regime 0 (recession) than in regime 1 (expansion), which causes different asset allocation strategies in different regimes. The results of out-of-sample tests illustrates the regime switching asset allocation strategy outperforms the unconditional and conventional strategies and general market, no matter from return, risk and risk-adjusted performance perspectives. It shows the regime switching strategy is advanced and dominant. Also could help investors to improve their portfolio performance.

7.2 Implications of the research

There are several implications arising from this study. The first implication is on the issue of international real estate portfolio diversification. Strong evidence of regime shifts is detected in the international securitized real estate market. Therefore,

the global diversification effect or benefit might vary with the diverse risk-return performance in different economic environments (e.g. bull and bear markets). Consequently, failure to consider changing behavior and time-varying correlations of the markets due to regime shifts might result in sub-optimal asset allocation and inaccurate portfolio performance measurement. Understanding the market specific regimes and the global common regimes would allow us to establish the appropriate regime-dependent and time-varying asset allocation strategy in order to reap the international real estate diversification benefit.

On the international real estate asset pricing issue, the domestic economic factors as well as the global factor would affect the securitized real estate expected return dynamically and asymmetrically. Hence, the expected real estate return is determined by not only the local economic risk factors, but also by the international risk factors. More importantly, the role of macroeconomic risks in affecting real estate security pricing is not stable across time. It is therefore necessary to consider the nonlinear pricing effect of potential macroeconomic risk factors on real estate expected returns in Asia and internationally.

The third issue is that international and domestic real estate investors can improve their investment performance in terms of real estate risk management and portfolio construction. Given the importance of securitized real estate as a real estate investment vehicle for institutional investors to gain worldwide real estate exposure, active portfolio management should be undertaken to consider regime changes domestically

and globally to add value in international asset allocation. Nevertheless, since the securitized real estate expected return responds to the macroeconomic news asymmetrically and the effects are more significant in recession than in expansion, real estate investors should be concerned with the changes of economic factors more during the economic downturn. Since economic agents make decisions based on the perception that high levels of volatility tend to cause the general erosion of the real estate investor's confidence, the accurate prediction of economic circumstances is highly important.

Finally, national policy and decision makers can also benefit from understanding the results of this study. In respective countries, the economic decisions would affect the property stocks' expected returns as well as the real estate investors' confidence. Policy makers can concentrate their efforts on attaining stability in macroeconomic fundamentals in order to reduce real estate market volatility and to minimize real estate investing uncertainty, in order to attract more international institutional real estate investors.

7.3 Limitations

This study has achieved all the objectives as set out in Chapter 1 and the findings are encouraging. However, some limitations might be noted. As a study on the international real estate market, one inherent limitation of the study is the sample size. The thesis only focuses on the Asia-Pacific real estate market by covering four major

markets in this area. Further studies might include more European countries and generate other profound results.

In this study, the samples of US and Australian real estate stocks are mainly composed of REITs and LPTs, which are subject to strict leverage and dividend payouts constraints. On the other hand, majority of the property stocks of the other four markets are property management and development listed companies. And those regulatory or institutional differences would have different impacts on their own securitized property markets. This factor is one of the limitations of the study.

7.4 Recommendations for further studies

This study concentrates exclusively on securitized real estate. Nonetheless, the whole real estate world, especially the direct real estate might also be subject to regime changes as well under dynamic economic and financial systems. In particular, the regime switching models can be employed to direct real estate investment and the housing market movements for further meaningful real estate research. In Chapter 4, this study employs two steps procedure to estimate the MS-VECM model. Further studies can incorporate the regime shifts into the co-integration process and present more robust estimation results.

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