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ESSAYS ON THE EQUITY PRICING AND CAPITAL STRUCTURE OF FINANCIAL
INTERMEDIARIES

by

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A Thesis submitted in fulfilment of the requirements for the degree of

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at the

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To my parents and family...

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DECLARATION

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ABSTRACT

The thesis investigates the risk-related behaviours of financial institutions across the global financial markets and provides reasonable explanations for the empirical results. The thesis has a few conclusions and contributions to the existing literature. It investigates various risks to which financial institutions are exposed, particularly capital risk, real estate risk and valuation risk. The importance of capital adequacy had drawn public and regulators attention in the recent financial turmoil, especially when financial institutions face unexpected credit and liquidity shocks in the financial markets. The thesis shows that banking organizations show little pecking order behaviour in capital structure. Banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. Therefore, the debt structure in banking is different from non-financial firms. For the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because the taxpayers funds deposit in the bank. The thesis also finds that despite of the regulatory minimum capital requirement, the banking organizations target capital level is linearly and collectively influenced by bank-specific, macroeconomic and country-specific variables.

In addition, the thesis adopts bivariate GARCH framework and finds significant evidences that with the development of mortgage loans issuance and related derivatives, financial institutions are increasingly exposed to real estate markets, and there is a significant and positive cross-volatility spillover from real estate sector to banks, and the co-movement is in the same direction. It is also crucial that financial institutions and fund managers can predict the expected portfolio returns more accurately.

The thesis also finds that zero-beta CAPM significantly improve the expected returns, represented as average predicted returns in the month ahead when comparing with three-factor model, which has difficulty explaining small and growth portfolios returns. We show that market risk is composed of two components, average market returns and cross-sectional market volatility.

The findings of the thesis not only contribute and extend the existing literature, but also have important implication for regulators, risk and asset managers as well as investors at both company and public policy levels. The regulators and financial institution managers can monitor banks targeted capital structure more closely based on the bank-specific, macroeconomic and country-specific variables discussed in the thesis. When there is any changes in these determinant variables, institution managers should make relevant adjustments in the targeted capital structure.

Moreover, regulators should be aware the influence of real estate market over financial institutions, especially any significant volatility changes in real estate as it can spillover into financial institutions. As financial institutions are increasingly exposed to real estate market, any significant changes in real estate market can also have influential impact on the capital adequacy in bank organisations. Therefore, it is suggested institutional managers need to control the real estate exposure in their financial assets and include real estate factor in the stress testing.

Furthermore, it is also important that financial institution and fund managers can estimate the expected returns more accurately, so that they can make correct collection of assets for required risk and return. In the thesis we find that the zero-beta CAPM outperforms the traditional asset pricing model, particularly three-factor model, by providing better prediction on portfolio expected returns. Therefore, the fund managers can adopt the zero-

beta ZCAPM framework along with other asset pricing framework when predicting portfolio returns. As high returns often come with high risk, predicting returns more accurately means we can predict and monitor risk more precisely. The financial institution managers can also apply zero-beta CAPM on their institutional asset holdings to monitor whether the institutions are exposed to higher risk assets. The regulators can use the framework to control the financial intermediaries risk and return behaviour to maintain the financial market stability. By identifying and quantifying the risk and return behaviours of financial intermediaries, stakeholders can assess and improve their management and investment performances. The empirical findings also help the regulatory bodies to make effective and suitable policies for financial sectors to ensure a stable, prosperity and sustainable growth of financial market.

CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Financial institutions are highly regulated institutions that facilitate the flow of funds and exchange of information due to market imperfections. They provide financial products and services to the economy, which are different from other industries due to the specialness in functions. The major special functions of financial institutions are the brokerage services and asset transformations. Financial Institutions act as agents for the savers by providing information and transaction services at reduced cost because of the economy of scale. As asset transformers, financial institutions purchase the financial claims issued by corporations as primary securities that are financed by selling financial claims in other forms as secondary securities to investors. The financial risks are thus in turn transformed from the primary securities to secondary securities. Another specialness of financial institutions is their key roles as transmitters of monetary policy from the central bank to the rest of the economy due to high liquid nature of bank and depository institutions which have resulted in their acceptance by their public as the most widely used medium of exchange in the economy. Other special functions of financial institutions include credit allocation as sources of financing and time intermediation for savers to transfer wealth across generations.

The types of financial institutions are categorised by the roles in facilitating the flow of funds from individual surplus unit, usually known as investors, to deficit units. One stream of funds shows that deposits from surplus units are transformed by depository institutions into loans for deficit units. Another stream is purchasing of securities and shares issued by

finance and investment companies which are then transformed into finance company loans or used by investment companies to purchase debt and equity securities of deficit units. The third stream of funds flow is from institutional investors, such as insurance companies and pension funds. Last but not least, security companies acting as brokers that are responsible for executing transactions between financial institutions and deficit units, during which funds flow directly from surplus to deficit units.

The first financial intermediary can be dated back to 2000 years ago, originating from rich cities, such as, Florence, Venice and Genoa. They were money changer, situated usually at a table in the commercial district of a city, aiding traveller by exchanging foreign coins for local money or discounting commercial notes for a fee in order to supply other merchants with working capital¹. The banking industry gradually spread from the classical civilization of Greece and Rome into northern and western Europe, and later into the New World, North and South America where colonies were established. Since then, United States has gradually established its influential role in the global financial market. From the early 1980s through the early 2000s, deregulation allows different types of financial institutions to expand the types of services they offer and capitalize on economies of scope. As a result, consolidation within financial industries was prevalence, and such a financial conglomerate is expected to be less exposed to risks of decline in customer demand for any single financial service. In addition, financial institutions have expanded globally, especially to emerging market, to capitalize on their expertise. By combining specialized skills and customer bases, the expanded financial institutions are capable of offering more services to clients with an international customer base.

¹ Peter S. Rose and Sylvia C. Hudgins, Banking Management and Financial Services, 6th Edition, McGraw-Hill Publisher, ISBN 007-123931-6.

The recent financial turmoil has drawn regulators and public attention on the deficiencies in the financial industry. As the financial market becomes increasingly interconnected, the financial industry is more vulnerable to financial shocks than ever before across all types of financial institutions, and the spill-over effect is dramatic internationally. Therefore, in order to provide more efficient regulatory policy on financial institutions and to prevent financial market failure, this thesis provides detailed research in identifying and quantifying the risks faced by the financial institutions, understanding the risk management practice currently implemented by financial institutions, evaluating on the efficiency of the existing regulatory framework and assessing the effectiveness of different asset pricing frameworks. In the following sections, we will discuss the objectives, contributions and implications of this thesis to the current literature. In the last section, we provide a summary discussion of the general layout of the thesis.

1.2 OBJECTIVES OF THE THESIS

The objective of the thesis is to empirically examine the relationship between major risk factors exposed by the financial institutions, particularly capital risk, real estate risk and valuation risk.. The thesis tries to identify and quantify the risks, review risk management practice, evaluate the efficiency of the regulatory framework and assess the effectiveness of various asset pricing frameworks.

We start the thesis by reviewing the current literature on financial institutions from risk and regulatory aspects. We discuss the formation of financial market and reasons that make the financial institutions special in chapter two. We then go on to evaluate the impact of major risks that financial institutions are facing, and how the risks are measured and controlled by the financial institutions. As there is a large shift of financial institution loan portfolios and

development of real estate backed financial instruments, financial institutions are increasingly exposed to real estate related risk. We review current research on the real estate factor influence on the financial institutions and the topic is further examined across US, UK and Japanese markets in the later part of the thesis. The recent financial crisis has raised the discussion of regulatory deficiencies in controlling capital adequacy. This chapter reviews the development of Basel policy and the potential impact of Basel III on the financial market. We assess measures of the Basel III policy on improving quantity and quality of the capitals by increasing the capital ratios and introducing additional capital buffers. Basel III also extends the previous policy by emphasizing on the leverage ratio, counterparty risk and liquidity management. The potential overall impact of the new policy on the economy is unclear. However, capital and liquidity regulation affect economic activity via an increase in the cost of bank intermediation. In order to meet the regulation criteria, banks increase the capital by deleveraging and increasing their lending spread. This will result in a decline in steady state output and welfare consumption.

In response to the observed regulation deficiencies from recent financial crisis, Basel Committee introduces Basel III aiming to increase the quality and quantity of capital. Further measures of recent Basel reforms also include: tightening the definition of common equity; limitation on qualification as Tier 1 Capital; introduction on a set of system-wide prudential filters to address systemic risk within the global financial system; and the enhancement of transparency and market discipline through new disclosure requirements. In order to monitor the capital adequacy, it is important to understand the factors that affect the bank capital structure. The thesis examines the extent of pecking order behaviour in the banking organizations and finds that banks show little pecking order behaviour. We then evaluate the factors that can affect the capital level from bank-specific, macroeconomic and country-specific regulation aspects for a panel data for fourteen countries over period from

1991 to 2011. The results show that all bank-specific, macroeconomic and country-specific variables collectively make a significant linear contribution in explaining banking organization target capital level.

The traditional risk factors faced by financial institutions have already been extensively examined in the literature, such as market risk and interest rate risk. In this thesis, we show similar results as in previous literature that the market risk is positive and significant for financial institution returns, while the interest rate effect is not very significant. As the increasing in the mortgage loans and rapid expansion in real estate related financial instruments since 1980s, movements in the real estate market can have a spillover effect into financial institutions. This thesis investigates the return sensitivity and volatility spillover of banks upon changes in the real estate market illustrated by returns of Real Estate Investment Trusts by using bivariate GARCH. We compare the return and volatility behaviour of banks returns across three markets, US, UK and Japan from year 1999 to 2011. Our findings indicate that the real estate factor has a significant impact on the bank return generating process for all three countries, and bank stock returns are more sensitive to real estate sector when the economy is booming. The results of significant and positive cross-volatility factor show that there is a volatility spillover from real estate sector to banks, and the co-movement is in the same direction.

The last issue addressed in the thesis is how to better estimate the expected stock and portfolio returns. It is also crucial that financial institutions and fund managers can predict the expected portfolio returns more accurately. The thesis investigates the influences of the cross-sectional market volatility on the portfolio returns, especially financial institution portfolio returns, based on zero-beta CAPM. We find that the zero-beta CAPM provides a better approximation of expected stock returns than traditional CAPM and Fama-French approaches. We used the iterative estimation method to initially obtain convergent binary

latent variables that indicate the positive and negative market volatility effects. We then use Fama-MacBeth procedure to run rolling window time series regression to obtain factor loadings and run out-of-sample cross-sectional regressions for each factor. We apply the procedure on eight portfolios in total which include a combination of common stocks and, particularly, financial institution stocks. We find out the results of widely used Fama-French three- and four-factor models are less significant. However, the effect of cross-sectional market volatility of zeta-risk is very significant and robust to different estimation periods in the first pass regressions and out-of-sample periods in the second pass regression. We also apply the ZCAPM specification on the financial institution portfolios, the results also suggest the cross-sectional zeta risk is highly related to both financial institution and common stock portfolios. The thesis finds that zero-beta CAPM significantly improve the expected returns, represented as average predicted returns in the month ahead when comparing with three-factor model, which has difficulty explaining small and growth portfolios returns .

1.3 CONTRIBUTIONS AND IMPLICATIONS

The contributions of this thesis not only extend the existing literature, but also have important implication for regulators, risk and asset managers as well as investors at both company and public policy levels. The regulators and financial institution managers can monitor banks targeted capital structure more closely based on the bank-specific, macroeconomic and country-specific variables discussed in the thesis. When there is any changes in these determinant variables, institution managers should make relevant adjustments in the targeted capital structure. In addition, regulators should be aware the influence of real estate market over financial institutions, especially any significant volatility changes in real estate as it can spillover into financial institutions. As financial institutions

are increasingly exposed to real estate market, any significant changes in real estate market can also have influential impact on the capital adequacy in bank organisations. Therefore, it is suggested institutional managers need to control the real estate exposure in their financial assets and include real estate factor in the stress testing. Furthermore, it is also important that financial institution and fund managers can estimate the expected returns more accurately, so that they can make correct collection of assets for required risk and return. In the thesis we find that the zero-beta CAPM outperforms the traditional asset pricing model, particularly three-factor model, by providing better prediction on portfolio expected returns. Therefore, the fund managers can adopt the zero-beta ZCAPM framework along with other asset pricing framework when predicting portfolio returns. As high returns often come with high risk, predicting returns more accurately means we can predict and monitor risk more precisely. The financial institution managers can also apply zero-beta CAPM on their institutional asset holdings to monitor whether the institutions are exposed to higher risk assets. The regulators can use the framework to control the financial intermediaries risk and return behaviour to maintain the financial market stability. By identifying and quantifying the risk and return behaviours of financial intermediaries, stakeholders can assess and improve their management and investment performances. The empirical findings also help the regulatory bodies to make effective and suitable policies for financial sectors to ensure a stable, prosperity and sustainable growth of financial market.

The contribution of the first literature chapter of the thesis is to provide an overall review of current literature on risk management and regulatory impact of financial institutions. Apart from the traditional risks faced by financial institutions, such as interest and foreign exchange risk etc., the thesis particularly reviews the current literature that study on the real estate impact of the financial institution. It has been noticed that financial institution returns have been directly and indirectly influenced by the underlying real estate market. In

addition, the recent financial crisis has unveiled the regulatory deficiency in the capital adequacy requirements. Capitals of financial institutions are in significant stress during the crisis, which leads to a chain effect of the credit crisis in the overall financial market. This thesis reviews frameworks and critics of former Basel capital adequacy policies. The revised new Basel III proposal continues assessing the definition of risk-weighted asset, and emphasizing on improving the quality and quantity of capital by increasing the capital ratio requirement and introducing an additional capital conservation and countercyclical buffer. The thesis also reviews the literature on the importance of leverage ratios, counterparty risks and liquidity management. Studies show that financial institutions with better leverage ratio and liquidity management are less vulnerable to unexpected financial shocks. This provides supporting evidence for Basel III proposal which sets guidelines for international active financial institutions to manage leverage ratio, counterparty risks and liquidity monitoring.

In the next three empirical chapters, the thesis provides empirical evidences from three perspectives. In chapter three, the thesis examines the determinants of bank capital structures for 358 large banking organisations from 1991 to 2011 across 14 countries. The contribution of this paper to the literature is that we extend the methodology used in non-financial firm in examining the extent of pecking order behaviour to banking organizations, and we found both financial and non-financial organizations share certain similar behaviour. The results of pecking order theory show that we have not found strong evidence for the existence of pecking order in banking organizations. The thesis also adds value in the current range of literature by providing results including most recent sample period in the analysis of factors influencing banking organization capital structure. In addition, we extend the conventional framework of capital structure determinants by including variables related to country-specific macroeconomic and public regulatory variables. The results indicate that bank-specific, regulatory and public policy variables collectively make a significant

contribution in explaining banking organizations' target capital level. We found that if the greater proportion of a country's financial system is bank-based, banks within the country tend to maintain less capital since they have a greater influence on the financial industry and are able to access to easier and cheaper finance within a short period. Changes in capital ratio tend to be higher in countries with better provisions for prompt corrective action, better external governance, and greater emphasis on explicit regulatory requirements regarding the amount of capital banks must maintain relative to specific guidelines. The findings also show public policy and regulatory variables affect changes in the capital ratio linearly since the results of including interactive variables provide weak evidences and dramatically reduce both the statistical and economic significance of the macroeconomic and standalone public policy and regulatory variables.

The next chapter uses bivariate GARCH framework to study the impact of real estate market on banks returns across three international markets, United States, United Kingdom and Japan over a period of thirteen years between 1999 and 2011. The paper contributes to the current literature in three ways. Firstly, more recent period is used in the thesis, and it allows the comparison between current bank return behaviours with those in previous periods in the literature. Secondly, three sub-periods are examined separately, which allows to compare the return behaviours of banks and REITs under different economic cycle. Thirdly, the paper extends the previous studies by comparing the impact of real estate factor to bank stock return across three different international financial markets. The results show that there is a significant volatility spillover effect from real estate sector to financial institutions. When comparing between different countries and sub-periods, we notice the level of sensitivity of all factors varies, which indicated the banks return and volatility behaviours are influenced by the countries and economic cycle factors.

The last empirical chapter examines the impact of cross-sectional market volatility on the portfolio returns by using zero-beta CAPM model. We test eight portfolio sets in total that include a combination of common and financial institution stocks. The study contributes to the current range of literature in four ways. Firstly, it provides further empirical evidence on the influence of upside and downside volatility on asset returns into consideration. Secondly, we apply the ZCAPM particularly on the financial institution stocks which have not been examined before. The results suggest the cross-sectional zeta risk is highly related to the financial institution portfolios returns as shown in common stock portfolios. Thirdly, we extend our data range from January 1964 to December 2012 comparing with previous studies that have a shorter period. Despite difference data range, we continue to find that the cross-sectional market volatility is consistently significant at high level. The results show that the ZCAPM does not depend on the period of the sample. Furthermore, we find evidence that ZCAPM provide better expected portfolio returns than the well-known three- and four-factor models. We compare the predicted realized excess returns versus actual excess returns for the combined common stock portfolios, the results show that average fitted excess returns for the ZCAPM spread out and fall fairly closely to average realized excess returns. On the other hand, the average fitted excess returns from three-factor model bunch up into a smaller range of values than that of average realized excess returns, and it is expected that the Fama-French model has difficulty explaining small and growth portfolios from literature. We see this result as market risk is composed of two components, average market return and cross-sectional market volatility. Therefore, in order to access the impact of market risk, we need to include both components in the analysis. Therefore, the results show that ZCAPM significantly improve the expected returns, represented as average predicted returns in the month ahead. Therefore, the major advantages of zero-beta CAPM in this chapter is that it can provide better prediction on portfolio expected returns than other traditional asset pricing model. The result also explains the unexplained return

behaviour from previous studies when only average market returns are included. Therefore, we conclude that the cross-sectional market volatility is indeed a significant factor in explaining the cross-sectional expected portfolio returns and zero-beta CAPM model can provide better prediction on portfolio expected returns than other traditional asset pricing model

1.4 LAYOUT OF THE THESIS

There are six chapters within the thesis with each of them concentrating on one aforementioned research question. Chapter one is the general introduction of the thesis which discusses the objectives, implications and contributions of the thesis. Chapter two is a survey chapter that reviews current literature on financial institutions from risk and regulatory perspectives. The following three chapters are empirical chapters which focus on different areas of risk, regulation and return behaviour of financial institutions. Chapter three examines the determinants of bank capital structures across fourteen countries. The results indicate that bank-specific, regulatory and public policy variables collectively make a significant contribution in explaining banking organizations target capital level. In chapter four, the thesis investigates the return and volatility spillover from real estate market to financial institutions across major markets and quantifies their magnitudes before and after the financial turmoil. The last empirical chapter five examines the influence of cross-sectional market volatility on the portfolio returns by using zero-beta CAPM model. The study shows that the cross-sectional market volatility is indeed a significant factor in explaining the cross-sectional expected financial institutional stock returns and should be included in estimating the expected returns. Finally, chapter six concludes the thesis by providing an overview of the research and general summary of issues examined.

Furthermore, the chapter discusses and identifies issues of risk management and return estimation of financial institutions that worth future investigation.

CHAPTER TWO

OVERVIEW OF FINANCIAL INSTITUTIONS RISK MANAGEMENT

2.1 INTRODUCTION

Financial market is a market in which financial instruments can be purchased and sold, which facilitates the flow of funds and transfer funds from those who have excess funds to those who need funds. If financial market were perfect, all information would be continuously and freely available to investors; all securities would be broken down into any size desired by investors, and securities transaction costs would be non-existent. Under these conditions, financial intermediaries would not be necessary. However, because markets are imperfect, investors do not have full access to information. In this case, financial institutions are needed to facilitate the exchange of information and resolve the problems caused by market imperfections.

Financial institutions provide products and services to the economy, which are different from other industries due to the specialness in functions. The risks of financial institutions are also closely associated with their special functions. There are two major functions of financial institutions in the world in terms of flow of funds. One is the brokerage services, in which financial institutions acts as an agent for the saver by providing information and transactions services. The financial institution plays an important role by reduction imperfections, such as information and transaction cost, due to economies of scale between households and corporations. The other major function is as asset transformers. Asset transformation function is that a financial institution issues financial claims that are more

attractive to household customers than the claims directly issued by corporation². To act as asset transformers, financial institutions purchase the financial claims issued by corporations as primary securities, such as equities, bonds and other claims. These purchases are financed by selling financial claims in other forms to household investors and other sectors. Financial institutions generate secondary securities by issuing the financial claims which are backed by the primary securities issued by commercial corporations investing in real assets. The financial risks are then transformed from the primary to secondary securities. Other special aspects of financial institutions include the transmission of monetary policy, credit allocation, time intermediation, payment services and denomination intermediation. Financial institutions play a key role in the transmission of monetary policy from the central bank to the rest of the economy ([Saunders and Yourougou 1990](#)). One possible example of the transmission is that the liabilities of depository institutions are a significant component of the money supply that impacts the rate of inflation. Therefore, the depository institutions are the conduit through which monetary policy actions impact the rest of the financial sector and the economy in general. Financial institutions act as credit allocators due to the fact that they are often viewed as a major and only source of financing for some particular sector of the economy. The time intermediation nature of financial institutions is demonstrated as the ability of saver to transfer wealth across generations. This function is especially encouraged in pension funds and life insurances by giving special tax relief and other forms of benefits. Due to the special services financial institutions provide, they are regulated by special regulatory policies. We will discuss the special regulatory policies imposed on the financial institutions later.

The major objective of financial institution management is to increase the returns for its shareholders; however, the increase of returns sometimes comes with the increase of the

² Saunders, A. and Cornett, M. M. 2008, Chapter 1, Financial Institutions Management: A Risk Management Approach, 6th Edition, McGraw-Hill Publisher, ISBN 978-007-126704-5.

risks. Financial institutions can be classified into different types by its main functions and business activities; however the risks faced by them are more or less similar because of the main function as financial intermediaries. Types of financial institutions are outlined as following:

Depository Institutions³: they are financial institutions that take deposits and make loans. They control the largest proportion of financial assets. This category includes commercial banks, savings institutions (savings banks and savings and loans associations), and credit unions. Their primary financial liabilities are deposits.

Finance Companies: similar to depositories in the financial assets that they specialize in loans to businesses and consumers. Their financial liabilities are different from those of depositories. They acquire most of their funds by selling commercial paper and bonds and by borrowing from their rivals, commercial banks.

Contractual Intermediaries: this category is consisting of insurance companies, both life insurance and property insurances companies, and pension funds, which together are considered as contractual savings institutions, because they operate under formal agreements with policyholders or pensioners who entrust their funds to these firms.

Investment Companies: include mutual funds, money market funds, and REITs.

Securities Firms: they assist customers with purchasing and selling stocks, bonds, and other financial assets. According to their activities, this industry is divided into investment banking and brokerage. Investment bankers assist in the creation and

³ Mona J. Garden, Dixie L. Mills and Elizabeth S. Cooperman, Managing Financial Institutions – An Asset-Liability Approach, 4th Edition, Harcourt College Publisher, ISBN 0-03-022054-8

issuance of new securities. Brokers assist in transfers of ownership of previously issued securities.

The remaining sections of this paper are structured as following: Section Two discusses the different types of risks of financial institutions. We review the previous literature on interest rate risk, market risk, credit and default risk, foreign exchange risk and liquidity risk separately in detail; Section Three discusses the impact of real estate factor on the financial institutions through two ways, direct and indirect real estate investments. Direct real estate investments affect the financial institutions through on-balance sheet and indirect real estate investments affect the financial institutions through off-balance sheet. In Section Four, we review the importance of capital adequacy and development of Basel frameworks. We continue with the discussion on the Basel III framework, and review the literature on the potential impact on the financial institutions and the overall economy. We conclude the chapter in Section Five.

2.2 RISK OF FINANCIAL INSTITUTIONS

There are several risks that are commonly faced by the financial institutions. Widely known risks are interest risk, market risk, credit risk, foreign exchange and liquidity risk. Another important risk is off-balance sheet risk, which is the risk incurred as the result of activities related to the contingent assets and liabilities held off the balance sheet. Financial institutions also face the risk of default by itself and particular countries. Insolvency risk is the risk that a financial institution may not have enough capital to offset a sudden decline in the value of its assets. Sovereign risk is the risk that repayments to foreign lenders or investors may be interrupted because of restrictions, intervention, or interference from foreign governments. Finally, financial institutions also face operational risk due to

malfunction or break down of support system and technology risk when technological investments do not produce anticipated cost savings. In the following sections, we will identify and review the recent literature of significant risks in more details.

2.2.1 INTEREST RATE RISK

[Dinenis and Staikouras \(1998\)](#) discuss there are at least three reasons that financial institution stocks should be affected by the interest rate changes. Firstly, market portfolio should be approximated by both equity and debt return due to risky debt instruments ([Stone 1974](#)). Secondly, [Flannery and James \(1984b\)](#) introduce an explanation based on the maturity mismatch. The equilibrium returns for financial institution assets and liabilities are based on certain expectation of interest rate. Unexpected fluctuation in interest rate will change duration match, and financial institutions would suffer significant income fluctuations so that equity returns will be affected. Finally, financial institutions equities can be considered as a call option on assets and, as a result, their stock returns should be affected by changes in interest rates ([Galai and Masulis 1976](#)). The primary interest rate risk comes from the special function of financial institutions as asset transformer of which financial institutions buy primary securities or assets and issue secondary securities or liabilities to fund asset purchases. The primary and secondary securities often have different maturities and this mismatch of assets and liabilities results in interest rate risk. One of the most familiar engagements of financial institutions involving in asset transformation is that financial institutions borrow from economic agents with excess funds and lend to agents with liquidity constraints. Both borrowing and lending contracts are determined based on the interest rate; therefore, interest rate risk occurs when financial institutions mismatch maturity and liquidity characteristics of rate-sensitive assets and liabilities. When financial institutions have more rate-sensitive liabilities than assets, they are exposed to refinancing

risk; therefore a rise in these short-term rates would lower their net interest incomes since financial institutions have more rate-sensitive liabilities than assets. Conversely, if they have more rate-sensitive assets than liabilities, the positive gap exposes them to reinvestment risk, in that a drop in rates over this period would lower the net interest income. In addition, financial institutions are also exposed to interest rate risk that is passed through from market risk when interest rate changes. This is because when interest rate increases, the discounted rate increase; therefore the market value the underlying assets and liabilities decreases, which is based on the discounted present value of future and current cash flows.

In order to hedge the interest rate exposure, financial institutions use several models and measures to monitor the interest rate risk. The first simple approach is the repricing model, which is analysing the repricing gap between the interest income earned on assets and interest expenses paid on liabilities over a particular period. The assets and liabilities are classified into different buckets according to maturity, and reported at their historic values or cost. Under repricing model, the interest rate changes affect only income statement rather than the market value of assets and liabilities on the balance sheet. Therefore, one of the critics of the repricing model is that it ignores the market value effect of interest rate changes, as in reality the present value of all assets and liabilities changes as interest rate changes. Another critic about repricing model is over aggregation across a range of maturities ignoring information regarding the distribution of assets and liabilities. In addition, repricing model only includes the assets and liabilities listed on the balance sheet.

While repricing model ignores the market value of balance sheet items, more comprehensive duration model presents a market value-based model of managing interest rate risk. The duration concept was first introduced in [Samuelson \(1945\)](#). In his work, he proposes that if weighted average duration of liabilities is greater than weighted average duration of assets, an increase in interest rates will adversely affect the financial institution's net worth

position. Under the duration model, financial institutions try to match the duration of their interest sensitive assets and liabilities and evaluate the overall interest rate exposure by measuring the duration gap on its balance sheet. The critics of the duration model have often claimed that it is difficult to apply in a real-world situation. The immunization aspect of the duration model was initially discussed in [Redington \(1952\)](#). It shows that the cash flows of a bond with a specific duration are immunized against an instantaneous change in interest rate. However, interest rates can change at any time over the holding period and at a different rate. This requires the portfolio manager to rebalance the portfolio continuously to ensure that the duration of the investment portfolio exactly matches the investment horizon. Matching duration and restructuring the balance sheet of a large and complex financial institution can be both time-consuming and costly. Therefore, there is a trade-off between perfectly immunized and costs, and most portfolio managers only seek to be approximately dynamically immunized against interest rate changes by rebalancing at discrete intervals. The duration model does not provide a complete protection against the interest rate risk when there are large interest rate changes due to the convexity. Duration model is able to measure the price sensitivity of fixed-income securities for small changes in interest rate. When a change is large, duration model is less accurate to measure the interest rate sensitivity. Under duration model, the expected relationship between interest rate and price changes is proportional to the duration. However, when experiencing large interest rate increases, the duration model over-predicts the fall in bond price, and under-predicts the rise in bond price for large interest rate decreases. This is a result of convexity nature of bond price-yield relationship rather than linearity as assumed in the duration model. Curvature of price-yield curve is favourable by financial institutions as it is similar to buying partial interest rate risk insurance. In order to predict the price of fixed-income instrument more accurately, financial institution managers also incorporate convexity into duration model. Furthermore, the increased involvement in off-balance sheet activities in financial

institutions creates significant exposure to risks not captured accurately by the duration model. Some of interest rate risks arise from the option embedded in assets, liabilities and off-balance sheet positions, such as loan repayment or guaranteed insurance contracts. This impact on interest rate risk from embedded option is studied in [Lee and Stock \(2000\)](#). The study shows both asset and liability durations decline when embedded options are present, and liability duration declines more substantially. Thus, the duration mismatch arises. When interest rates rises, the equity value of the financial institution decreases, and vice versa. In the sophisticated model incorporating the convexity, [Lee and Stock \(2000\)](#) show that a simple convexity hedging strategy with puttable assets and callable liabilities reducing the interest rate risk substantially. Moreover, duration matching approach does not take into account the default or credit risk of assets. [Drehmann et al \(2010\)](#) derive a comprehensive and consistent stress testing framework to measure the integrated impact of both risks. The study takes account the fact that both credit and interest rate risks are driven by a set of common macroeconomic risk factors. The result shows that credit and interest rate risks have an impact on the FIs equity value, and interaction is quantitatively significant. A shock of a significant increase in interest rate may lead to serious credit failure as macro condition deteriorates. Based on the above critics, the duration gap analysis does not provide a complete strategy to shelter interest rate risk, and the approach is also complicated because of the lack of consistent information available.

For less condition constraint approach, the previous academic literature analyse the effect of interest rate change on the capitalised value of a financial institution's future cash flow by applying market efficiency and equity market data to capture the interest rate sensitivity of financial firms' equity prices. The equity measure approach was gradually introduced with the development of the portfolio theory asset pricing studies. [Stone \(1974\)](#) is the first few study on two-index asset pricing and it extends the market model by including the debt

factor which captures the influence of unexpected development in the yield curve on asset price. The coefficient of debt factor is treated as the interest rate exposure beta. The significant relationship between interest rate and equity price particularly implies that asset-liability composition transmits interest rate fluctuation to the market as signals of changing in earning prospects. Since the study of [Stone \(1974\)](#), the asset pricing approach has become increasingly popular as it can be directly used for pricing the asset or liability whose value is linked to nominal rather than a real term. Many literature, such as, [Fama and Schwert \(1977\)](#) and [Fogler et al \(1981\)](#), has demonstrated the empirical significance of including interest rate factor to a single factor model. The Stone's model was later applied by [Lloyd and Shick \(1977\)](#) on two samples of securities over 1969-1972 period, 60 large commercial banks and 30 firms included in the Dow Jones Industrial Average. Long-term corporate bond index is used to represent interest rate effect. The results show that only a relatively small proportion of the sample exhibits significant coefficients and banks are only marginally significant to the bond index fact. The reason is that the bond index factor used in the study is long-term rather than short-term rate, and banks should be more sensitive to changes in short-term rate. Although the interest rate effect is not as strong as expected, it is still more significant than the market portfolio factor in the banking sectors. [Gultenkin and Rogalski \(1979\)](#) challenge the approach and results in [Lloyd and Shick \(1977\)](#) by using the same set of data. [Gultenkin and Rogalski \(1979\)](#) show that they are unable to duplicate the two-index model result due to a possible discrepancy in the bond index data used in [Lloyd and Shick \(1977\)](#). They also suggest that, in fact, Stone's model related to returns as a function of covariances, and [Lloyd and Shick \(1977\)](#) are actually testing for the existence of covariances. [Chance \(1979\)](#) also points out the deficiency in the conclusion drawn from [Lloyd and Shick \(1977\)](#) due to deficiencies concerning their data, statistical tests and misinterpretation of results. [Chance and Lane \(1980\)](#) emphasize the lack of appropriate return generating model which explains the mechanism through which interest rate movement is transmitted through the

financial institution stock return performance. Contrary to the previous result which shows the importance of interest rate effect on financial institutions, [Chance and Lane \(1980\)](#) show that of 119 banks tested, less than 2 percent of stocks exhibit significant interest rate sensitivity, suggesting that the interest rate factor should not be significant in explaining the returns. [Yourougou \(1990\)](#) shows that interest rate risk is priced by the capital markets. However, it failed to show the importance of interest rate risk premium, and the result further indicates that the failure is due to insufficient sensitivity rather than from inadequate interest rate volatility.

[Lynge and Zumwalt \(1980\)](#) include short- and long-term interest factors into two and three index models for 57 commercial banks. The results show that although the level of sensitivity is different among sample periods, a significant percent (ranging from 24 to 74 percent) of commercial banks exhibit significant interest rate coefficients. [Booth and Officer \(1985\)](#) extend the previous studies by employing a pooled cross-section time-series model with longer period sample. They also consider the effect of investors' expectation by using [Meiselman-type \(1962\)](#) error model of the term structure. The results support the findings in [Lynge and Zumwalt \(1980\)](#) by showing significance of interest rate. It further shows that banks show stronger sensitivity to anticipated and unanticipated changes in short-term interest rates, and financial institution securities are more interest rate sensitive than non-financial securities.

Although both sides of results have been shown, there is a common deficiency of empirical research as there is no particular hypothesis on the reason of interest rate movements on financial institution stock returns. [Flannery and James \(1984a\)](#) introduce the theory based on the empirical evidence to relate the interest rate sensitivity of stock returns to the maturity composition of the firms' nominal asset and liability. The findings show that the stock returns are highly correlated with interest rate changes. The size of the maturity difference

between the bank's asset and liability is positively related to the co-movement of stock returns with changes in interest rate. Cross-sectional variation in the interest rate sensitivity measure is significantly related to the maturity mismatch of the bank asset and liability. [Scott and Peterson \(1986\)](#) follow the study of [Flannery and James \(1984a\)](#) by employing seemingly unrelated regression procedures on hedged (commercial banks and life insurance companies) and unhedged (savings and loans) financial institutions. Life insurance firms were for the first time studied in the literature, and as expected, their behaviours are affected similarly to those banks by unexpected interest rate changes. Financial institutions, such as commercial banks and insurance companies that traditionally well-hedged against interest rate risk by duration matching are not as substantially affected by interest rate changes as less hedged financial institutions like savings and loans.

[Bae \(1990\)](#) re-examines the interest rate sensitivity of common stock returns and investigates the effect of three interest rate indices of different maturities, short-, intermediate-, and long-term. The study shows that current and unanticipated interest rate change is found to affect negatively financial institution stock returns with stronger sensitivity for a longer-maturity interest rate index. Bae interprets the reason of significance of current interest rate changes due to a large portion of the changes corresponds to unanticipated changes. Most financial and nonfinancial companies are not sensitive to anticipated interest rate changes since it is expected in an efficient market, anticipated changes should be already embedded in stock prices. The only exception is that saving and loan and REIT stock return is highly sensitive to anticipated interest rate changes in intermediate-term rates. Similar to the findings in [Scott and Peterson \(1986\)](#), less-hedged financial institutions are more sensitive to interest rate changes than better-hedged financial institutions like finance companies.

The effect of interest volatility on financial institutions is also studied in the literature. [Aharnoy et al \(1986\)](#) employ an event study on the impact of 1979 monetary policy regime

change on the bank stock returns. It finds that, after decomposing the abnormal return of stocks during the change of regime into unanticipated interest rate changes, the bank stock returns are related negatively to unexpected interest rate changes and volatility. The adverse relationship between returns and interest rate changes support the findings in previous literature. The negative link between return and interest rate volatility reflects the fact that an increase in rate variability may be at the cost of closure expense and regulatory tax considerations of any favourable call and put options. [Saunders and Yourougou \(1990\)](#) also incorporate the interest rate volatility into the model as an additional risk factor; however, the volatility factor exhibits a mix of results depending on the period employed. They find evidence as in previous studies that savings and loans are more sensitive than commercial banks. They also show that companies from commercial industry do not exhibit interest rate sensitivity, thus, they propose a possibility of eliminating the separation of banking from commerce to facilitate efficiency in financial institutions. Most of the literature on interest rate and its volatility effect are focusing on the US data. [Dinenis and Staikouras \(1998\)](#) study the relationship by employing a three-index model on UK financial institutional equities. The data reveals a significant negative relationship between stock returns and interest rate changes as expected. Additionally, under UK data, the interest rate volatility has a positive effect on both financial institutional and industrial equity returns.

2.2.2 MARKET RISK

Market risk is the risk related to the uncertainty of a financial institution's earnings on its trading portfolio caused by changes in market conditions, such as, price of an asset, interest rates, market volatility and liquidity, etc⁴. As previously discussed, interest rate can affect

⁴ Saunders, A. and Cornett, M. M. 2008, Chapter 10, Financial Institutions Management: A Risk Management Approach, 6th Edition, McGraw-Hill Publisher, ISBN 978-007-126704-5.

market risk, however, in general, market risk refers and focuses on the risk of financial institution's trading portfolios, which is the asset and liability that actively trade rather than holding for long-term purposes on both on- and off-balance sheet. With an increase in securitization of bank loans, more and more assets have become liquid and tradable and incomes from trading activities increasingly taking over incomes from traditional activities. Market risk impact on the financial institution has been extensively studied in the literature. [Sharpe \(1964\)](#) was the first to constructively include market risk premium into asset pricing model. [Bae \(1990\)](#) investigates the effect of the market return on different types of financial institutions, such as commercial banks, savings and loans, insurance companies, finance companies as well as REITs. The results show that the market return has positive significant impact on all financial institution portfolios. [Akella and Chen \(1990\)](#) and [Choi et al \(1992\)](#) obtain similar results by using the same multi-index CAPM framework. Although different data frequency is used, the significant impact of the market return to bank return remains the same. Apart from market risk premium, the market volatility effect on financial institutions has also been studied in recent literature. Variable conditional variance methodologies, such as GARCH framework, are increasingly adopted ([Elyasiani and Mansur 1998, 2003, 2004](#) and [Elyasiani et al 2007](#)). Without any doubt, results of later studies all show that financial institutions are sensitive to the changes of the general stock market. [Elyasiani et al \(2007\)](#) show that the market beta for financial institutions is to be size-dependent, with larger financial institutions displaying greater market beta values. The difference in the market beta may be because larger financial institutions tend to be highly leveraged, less liquid and more orientated towards no traditional banking activities such as exotic derivatives, which can be highly risky. Furthermore, different types of financial institutions have different market risk exposure ([Allen and Jagtiani 1997](#)). Security firms have the lowest market risk premium with most market risk exposure.

There are studies on various ways that financial institutions use to monitor market risk exposure internally. Most widely-discussed measures are RiskMetrics and Value-at-Risk models, including Historical and Monte Carlo Simulation. RiskMetrics was first introduced by J.P. Morgan based on the Value-at-Risk (VaR) concept. Since then, RiskMetrics has become increasingly popular for measuring market risk exposure. The RiskMetrics approach is a member of ARCH/GARCH family that uses the exponential smoothing model in which today's volatility forecasts is a weighted average of yesterday's volatility forecast and actual volatility. RiskMetrics approach broadly tracks day-to-day volatility changes, and it focuses on the recent rather than distant returns (McMillan and Kambouroudis 2009). Another benefit of RiskMetrics is that it requires little data to be stored and contains only one unknown parameter, which is a significant benefit in large portfolios. Despite that RiskMetrics is widely used, there have been discussions on the reasonableness of the method. One of the critics is the unrealistic assumption of normally distributed returns, which does not take into account the presence of fat tail in most of financial data distribution; thus, the model underestimates the risk. In addition, Johansson et al (1999) find that because of the normal distribution assumptions, financial institutions with small undiversified portfolios will significantly underestimate their actual risk exposure if using RiskMetrics, while RiskMetrics produces reasonable estimates of downside risk for financial institutions with highly diversified portfolios,. Furthermore, RiskMetrics model ignores the payments of accrued interest on debt securities; thus, it will underestimate the true probability of default and the appropriate level of capital to be held against this risk (Kupiec 1999). On the other hand, It is usually found that RiskMetrics performs satisfactorily well given the unrealistic assumption. This is because the effect of fat tails is minor when one calculates Value-at-Risk at commonly 95 percent. If higher significance level is used, fat tails in the distribution of return will make RiskMetrics underestimates risks (Pafka and Kondor 2001). McMillan and Kambouroudis (2009) assess whether the RiskMetrics model can

provide sufficient forecasts of volatility comparing to GARCH models. They find that using mean error forecast metric the RiskMetrics model outperforms all other models. However, the result suggests similar results as previous literature that the RiskMetrics model is sufficient in providing volatility forecast when calculating the 5 percent Value-at-Risk for all markets, and GARCH model is generally superior when calculating the 1 percent Value-at-Risk forecasts.

Because of the criticism discussed above about RiskMetrics, majority of financial institutions monitoring market risk compute Value-at-Risk of their trading portfolio. Value-at-Risk model measures the downside market risk of a portfolio of financial assets and estimates how much the value of a portfolio could decline over a given period with a given probability ([Hendricks 1996](#)). Value-at-risk model aggregates several components of price risk into a single quantitative measure of the potential loss of portfolio value. The most common VaR model is equally weighted, exponentially weighted and historical simulation approached. Historical simulation analysis is a procedure for predicting Value-at-Risk by constructing the cumulative distribution function of asset returns over time. The main idea of historical simulation is to take the current market portfolio of assets and revalue them on the basis of actual returns that existed on those assets yesterday, the day before and so on. The empirical performance of historical simulation based method for computing VaR has been examined by [Hendrick \(1996\)](#) and [Beder \(1995\)](#). The advantages of historical simulation are that it is relatively easy to implement; it does not assume any distribution on the asset return, and it does not require calculation on correlations or standard deviations of asset returns. However, the disadvantage of historical simulation is that it imposes a restriction on the estimation assuming assets returns are independent and identically distributed. In reality, it is not the case since asset returns usually exhibit pattern of volatility clustering that large changes tend to be followed by large changes and small changes tend to be followed by

small changes ([Mandelbrot 1963](#)). The second disadvantage is that traditional historical simulation applied equal weight to all returns over the entire period considered, and it is not realistic as there is diminishing predictability of data that is further away from the present. This shortcoming can be overcome by using weighted historical simulation to give higher weight to the more recent past observations, and semi-parameter filtered historical simulations ([Barone-Adesi et al 1999](#)), which introduces additional terms to account for time-varying correlations and the additional refinement is assumed to be independent and identically distributed rather than actual asset returns. Another limitation of historical simulation is that there may be a limited number of actual historical observations. To overcome this limitation, financial institutions usually generate further observations by using a Monte Carlo simulation to reflect the probability occurred in recent historical periods.

[Hendricks \(1996\)](#) studies and compares twelve approaches to VaR model and tends to produce risk estimates that do not vary greatly in the average size. However, the results show the historical approach to be superior to others. [Hull and White \(1998\)](#) use weighted average historical simulation and incorporate a volatility updating scheme such as GARCH for calculating value at risk. The results show that the simulation appears to provide better estimates of daily returns and show substantial improvement at eliminating bunching of tail events. [Pritzker \(2006\)](#) also adopts historical simulation based method for computing VaR, and examines the way to test the problems associated with historical simulation. He shows that back testing is not successful to detect the problem with historical simulations. The filtered historical simulation method provides better results; however, the method for choosing the length of the historical data series and augmenting additional extreme observations needs further investigated.

2.2.3 CREDIT AND DEFAULT RISK

Credit risk is defined as the potential degree of fluctuation in the value of debts and derivative instruments due to changes in the underlying credit quality of counterparties. The development in credit risk modelling has been rapid over the past twenty years, and it has become a key component of financial institution risk management. There is a wide variety of credit risk models that differ in their fundamental assumptions such as the definition of credit losses as mentioned both in Federal Reserve System Task Force on Internal Credit Risk Models ([FRSTF 1998](#)) and Basel Committee on Banking Supervision ([BCBS 1998](#)). Apart from the difference, the general purpose of these models is to forecast the probability distribution function of losses that may arise from a bank's credit portfolio. Since the credit default or rating change is not common events, and debt instruments have set payments that limit the possible returns, the loss distribution is generally not symmetric and skewed toward zero with a long right-hand tail ([Lopez and Saidenberg 2000](#)). There are increasingly proposals from many financial associations argue that credit risk models should also be used to determine formally risk-adjusted regulatory capital requirement. However, the development of corresponding regulatory standard for credit risk model is much more challenging than for market risk model. One of the major difficulties of credit risk modelling is the small number of forecasts available with which to evaluate the model's forecast accuracy. While the VaR model for market risk can generate more than 200 forecasts within one year, the credit risk model can only produce one forecast per year due to longer planning horizon. Furthermore, due to the nature of credit risk data, only a limited amount of historical data on credit losses is available and certainly not enough to cover some credit cycles ([Lopez and Saidenberg 2000](#)).

The development of credit risk management starts relying on subjective analysis on borrower characters to assess the credit risk on issuing loans. The key factors included in the

assessment are borrower-specific and market-specific factors. Borrower-specific factors are specific characters to an individual borrower. Market-specific factors are those that have an impact on all borrowers at the time of the credit decision⁵. These subjective judgmental decisions are often referred as expert systems. Borrower-specific factors include borrower reputation, capital structure, volatility of earnings and collateral. Market factors include economic business cycle and level of interest rate. However, as a result of inefficiency of banker expert system, financial institutions have increasingly moved away from subjective system towards more objective based system ([Altman and Saunders 1998](#)). More advanced quantitative models are developed in recent year, such as accounting based credit scoring system. The credit-scoring models are quantitative models that use observed loan applicants' characteristics either to calculate a score representing the applicants' probability of default or to sort borrowers into different default risk classes. Credit-scoring models include four types of approaches: linear probability models, logit models, probit models and discriminant analysis models. In order to apply credit-scoring models, the credit manager must identify objective economic and financial measure of risk for any particular class of borrowers. Unlike the previous less quantitative and judgmental based expert system, credit-scoring models enable credit issuers predict a borrower's performance more accurately without having to use more resources. The probability and logit models use a set of accounting variables to predict the probability of borrower default. The discriminant model divides borrowers into high or low default risk classes contingent on their observed characteristics, and both accounting and market variables that maximize the variance between two risk types while minimizing within group variances. [Altman and Saunders \(1998\)](#) have reviewed the literature in credit risk management models, and conclude the most widely used model is discriminant analysis model. [Martin \(1977\)](#) uses both logit and

⁵ Saunders, A. and Cornett, M. M. 2008, Chapter 11, Financial Institutions Management: A Risk Management Approach, 6th Edition, McGraw-Hill Publisher, ISBN 978-007-126704-5.

discriminant models to predict banks failures in 1975-1976 period, and similar results are obtained in terms of risk classification. [West et al \(1985\)](#) and [Lawrence et al \(1992\)](#) both use the logit model on assessing the probability of default of financial institutions and home loans respectively. They find that payment history is the most important predictor of default. [Altman et al \(1977\)](#) examine the reliability of seven variables in predicting default risk under discriminant analysis, of which the seven-variable discriminant analysis model is usually called ZETA model. [Scott \(1981\)](#) compares several empirical credit models, and concludes that the ZETA model provides the best forecast to the theoretical bankruptcy construct.

Although the credit-scoring models provide a good result in forecasting default risk, there are many criticisms. The first criticism is that the majority of credit-scoring models are based on the accounting data which fail to include capital market data that reflects the fast-moving changes in borrower's conditions. Furthermore, the linearity assumption of the model does not forecast actual market non-linear property accurately. Therefore, there are a few new approaches have been developed in assessing the credit risk in the literature. The first class is bankruptcy models of default risk, such as option models. The option pricing models in [Black and Scholes \(1973\)](#) and [Merton \(1974\)](#) are similar to the risk of default in many aspects. In the option pricing model, the probability of a firm going default depends crucially on the beginning period market value of that firm's asset relative to its outside debt, as well as the volatility of market value of firm's asset ([Altman and Saunders 1998](#)). The utilisation of option pricing model gains increasing popular such as in [KMV \(1993\)](#) and [Kealhofer \(1996\)](#) models. The underlying theoretical relationship between credit risk and option pricing model and can be viewed as a call option on the value of a firm's asset, which reflects the relationship between the observable volatility of a firm's equity value and its unobservable asset value volatility. However, as in any model, the option pricing model approach in

assessing credit risk has criticism. Firstly, there are concerns on the accuracy of using volatility of a firm's stock price as a proxy to derive the expected or implied variability in asset value. Secondly, as some of the borrowers are non-public companies, there is a concern on the efficiency of using public company information as comparable. Another quantitative approach is capital market based mortality rate model by [Altman \(1988 and 1989\)](#) and the aging approach model by [Asquith et al \(1989\)](#). These models try to derive actuarial-type probability of default from past bond default data by credit grade and year to maturity. Again, given for the potentially extended use of the mortality rate model, it has been criticized by the lack of sufficient loan default data. [McAllister and Mingo \(1994\)](#) show that in order to develop very stable estimate of default probability, financial institutions would need to have 20,000-30,000 data points. However, in reality, few financial institutions can achieve this sample size.

With the development of increasing variety of loans within a particular portfolio, financial institutions have realised the importance of measuring credit concentration risk. The credit concentration risk is the overall spread of the bank's outstanding accounts over a number of borrowers. Earlier approaches on the concentration risk focus on the expert judgemental decision on the maximum percent of loans to be allocated to the economic sector or geographic location and on limiting exposure in the area to a certain percent of capital. Financial institutions also use migration analysis, such as CreditMetrics™ 1997⁶ approach, to measure the transition probability of relatively homogenous loan moving from current to any number of possible default states ([Altman and Saunders 1998](#)). The aim of CreditMetrics™ is to create a benchmark for credit risk measurement; promote credit risk transparency and better risk management tool leading to improve market liquidity;

⁶ CreditMetrics™ 1997 is the first readily available portfolio model for evaluating credit risk developed and introduced by J.P. Morgan in 1997. The CreditMetrics™ approach enables a company to consolidate credit risk across its entire organization, and provides a statement of value-at-risk (VaR) due to credit caused by upgrades, downgrades and defaults.

encourage a regulatory capital framework that more closely reflects economic risk; and complement other elements of credit risk management decisions⁷. Moreover, in recent years, the application of modern portfolio theory (Markowitz 1959) to loans and fixed income instruments has been increasingly recognized. Although not many studies have been found in the literature, there are still some have made good attempts. Chirinko and Guill (1991) use a macro-econometric model of US economy to generate future possible states of the world and industry sector loan payoffs. Mean, variance and covariance are then calculated from the loss distribution and efficient loan portfolio is constructed.

2.2.4 FOREIGN EXCHANGE AND LIQUIDITY RISK

With the globalization of the financial industry, financial institutions are increasingly exposed to foreign exchange risk. There are several ways through which financial institutions are exposed to foreign exchange risk. Firstly, financial institutions are affected through foreign currency trading. Foreign exchange market is one of the largest world financial markets. According to BIS survey in 2010, the average daily turnover was \$3.98 trillion. Of all participants, Deutsche Bank is the main player followed by Citi, with market share of 15.18% and 14.90% in 2013⁸. Barclays and UBS have similar market share of 10.24% and 10.11% respectively. There are four major FX trading activities. In the first two activities, financial institution acts as an agent of its customers for a fee but does not assume the foreign exchange risk itself: purchase and sale of foreign currencies to allow customers to complete international commercial trade transactions and to take position in foreign real and financial investments. The third activity is the purchase and sale of foreign currencies for hedging purposes to offset customer or institution exposure in any given currency. The

⁷ J.P. Morgan release, Introduction to CreditMetrics™ 1997.

⁸ Source: Euromoney FX survey 2013: The Euromoney FX survey is the largest global poll of foreign exchange service providers.

fourth activity is directly taking speculative trade in the sight of anticipating future movement in foreign exchange rate so that foreign exchange risk exposure is essentially related to open unhedged positions taken as a principle by the financial institution. In addition, the second way of foreign exchange exposure results from any mismatch between foreign financial asset and liability portfolios. Financial institutions usually control the foreign currency exposure in both on- and off-balance-sheet hedging. Many literatures have investigated the foreign exchange influence on firms ([Allayannis and Ofek 2001](#), [Brown 2001](#) and [Chamberlain et al 1997](#)). Studies particular on the financial institutions are relatively less. [Choi et al \(1992\)](#) show that exchange rate factor is significant to bank stock returns, especially returns of money-centre banks. However, there is no strong evidence to show to what extent that banks have hedged their foreign currency positions. [Wetmore and Brick \(1992\)](#) show support for [Choi et al \(1992\)](#), and find as interest rate risk declines, foreign exchange risk increases. They find evidences that that foreign exchange risk is positively related to foreign or less developed country loan exposure and negatively related to off-balance sheet exposure, which implies foreign exchange risk is explained by unhedged foreign loan activity.

Liquidity is another significant risk that all financial institutions face, especially during any major economic crisis in history. Liquidity risk arises from both liability and asset sides of financial institutions. Liquidity risk occurs when a liability holder, such as depositor or insurance beneficial, seeks to cash in its financial claim immediately, so that financial institutions need to borrow additional funds or even sell assets to meet the withdrawal. Asset side liquidity risk arises including the ability to fund the exercise of off-balance sheet loan commitment, which allows a customer to borrow fund on immediate liquidity demand. The liquidity risk is closely related to liquidity buffers requirement in the Basel III to enhance the resilience to shocks of the financial system under a broad range of market conditions. Issues related to capital structures are discussed in the later section in the paper

in more detail. [Cifuentes et al \(2005\)](#) show the importance of liquidity stability as a forced sale of the asset may feedback on market volatility and produce a downward spiral in asset price, which in turn will affect adversely other financial institutions. Their findings show that liquidity buffer plays an important role similar to the capital buffer and more effective than capital buffer in forestalling systematic effect. To keep an adequate liquidity level is even more vital in the period of the economic downturn. [Cornett et al \(2011\)](#) assess the liquidity risk management and credit supply during the financial crisis of 2007-2009. During the period, liquidity dries up because of the collapse of asset- and mortgage-backed securities and freezing in the interbank market, especially in the fourth quarter of 2008 after the failure of Lehman Brothers and AIG bailout. They find that banks with more illiquid asset portfolios increased their holding of liquid asset and decreased lending. Off-balance sheet liquidity risk materialized as borrowers took loan commitments, which constrained new credit origination even further. Therefore, the finding supports that liquidity risk exposure plays a vital role and can explain bank credit production during the crisis.

2.3 REAL ESTATE INFLUENCE ON FINANCIAL INSTITUTIONS

Since 1980s, there is a large shift of loan portfolios into real estate in banking firms in United States, and it has been observed as a trend in the banking industry worldwide. The banking industry has changed substantially since the saving-and-loan crisis of the 1980s. Before the crisis, there are a large number of small and specialized firms, and traditional banking industry was fragmented. Since 1980s, segmented banking firms are consolidated, and a new financial service industry was gradually formed. One of the significant reforms is commercial banks shifted their product and asset portfolios into consumer lending, which was traditionally a specialty of thrifts and credit unions. The number of real estate banks, which hold more than 40% of loans secured by real estate, has increased from 1,724 in 1989

to 2,835 in year 1996 ([Blaško and Sinkey 2006](#)). On the other hand, the total number of banks has dropped from 12,702 to 9,529 in 1996.

Real estate has been considered as a relatively high average return investment relative to its risk. Institutional investors have favoured to include real estate in their portfolio as a good diversification instrument since 1980s. Real estate returns are as predictable as the stock returns, and performs well in an asset-liability framework. In addition, the chance of experiencing a large loss on real estate in the long term is very small ([Chun et al 2004](#)). The changes in the real estate returns reflect the changes in the property values, and it can have greater effects on bank risk and profitability ([He et al. 1996](#)). Therefore, real estate returns should have an explanatory power on the risk and return of the financial institution stocks.

Although the importance of real estate has drawn many researchers' attention, there are not much literature on the study of the sensitivity of financial institution stocks to real estate returns. The early research on the impact of real estate loans can be found in [Eisenbeis and Kwast \(1991\)](#), in which they study the economic viability of the financial institution concentrating on real estate loans for period 1978-1988. They classify the banks into two groups: one group containing banks with 40% or more real estate loans, and the other group with 40% or more real estate loans for five or more years. This classification is later adopted in [Blaško and Sinkey \(2006\)](#). The results show that banks with longer real estate loan history have higher returns with less risk than more diversified banks over the period 1978-1988, and those high return banks exhibit substantial flexibility in their ability to adjust their real estate loan holdings.

[Mei and Lee \(1994\)](#) find the presence of a real estate factor, in addition to both stock and bond factors in asset pricing, which addresses the importance to include real estate exposure in asset portfolios. [Allen et al \(1995\)](#) first explicitly introduce the idea of the impact of real

estate market condition on the banking industry. They argue that for bank stocks to be significantly related to the real estate market they have to have significant exposure to the real estate, i.e. the amount of real estate holdings and the effectiveness of real estate market impact on the holdings. They use the seemingly unrelated regression framework to estimate a three-factor index model on bank stock returns to market, interest rate and real estate over 1979-1992. The findings show that, apart from market and interest rate, stock returns on large and medium size bank portfolios are positively and significantly related to the level of returns on real estate. Also, the sensitivity of bank returns to a real estate index has increased over time, which reflects a shift to real estate investment over the period in 1980s.

Similarly, [He et al \(1996\)](#) use the same method, and he compares the results when different proxies of return series are used. He uses six proxies for the real estate returns: equally-weighted indices of monthly and weekly returns on all tax qualified REITs, equity REITs and mortgage REITs. He divides the bank holding company portfolios into 18 segments according to the feature of the loan, e.g. constructions, farmland or residential. Different combinations of portfolio returns and proxies are analysed by the three-factor model. The results show that mortgage and all value REIT returns have better performance. Among all the combinations, the most appropriate proxies of market returns, interest rates and real estate returns are equally weighted market index, the unexpected changes in yields on long-term government bonds, and the MREITs returns respectively. He also notes that banks with a large proportion of loan investments are more sensitive than those with a smaller proportion. However, farm loans do not experience sensitivity on the bank stocks returns.

In his later research, [He et al \(1997\)](#) further test how different types and quality of real estate loans affect the sensitivity of bank stocks to real estate returns by using the most appropriate proxies obtained in [He et al \(1996\)](#). The quality of real estate loans is tested according to the nature of loans. The results confirm the previous studies on the bank real estate sensitivity.

Different from the results before, he shows that farmland loans have a negative impact on bank real estate return, of which could perform as diversification role in terms of reducing bank real estate return sensitivity. As for the quality of real estate loans, when using mortgage REITs returns, charge-off real estate loans have a negative impact on the bank stock returns to real estate returns, however, the impact of recovery real estate loan is positive.

[Mei and Saunders \(1995\)](#) use the GMM approach to test the multi-factor model restriction on the returns of five portfolios, including general stock market, bond, real estate, and bank stock portfolios. The bank stock returns are divided into a money centre bank group and a non-money centre bank group, and two return series on equally-weighted bank stock portfolios are used. The model allows flexibility of the influencing factors on the bank stock return by not restricting particular factors. They find that the time variation in bank risk premiums has been partly determined by interest rate and real estate market conditions. Real estate return has been most important for large nonmoney center banks. [Mei and Saunders \(1997\)](#) extend the study by including real estate investment data of savings and loan associations and life insurance companies along with bank stock returns. When estimating the real estate returns, they not only use equally weighted equity REITs as in [Mei and Saunders \(1995\)](#), but also they include the equally weighted returns on real estate company stocks and mortgage REITs. They argue that mortgage REITs returns offer a particularly good proxy to the underlying returns on financial institution's real estate loan portfolios since from investment perspectives, the 'payoff' structure of the real estate loan portfolio of the financial institution is similar to underlying the mortgage loan asset portfolio of mortgage REIT. The study discovers a trend-chasing behaviour that the real estate investment made by US commercial banks and saving and loans have been driven by ex post real estate returns as well as ex post market returns.

[Ghosh et al \(1997\)](#) examine the event study on financial institution stock price behaviour from a different aspect. They analyse the stock price behaviour around the announcement of declining real estate values during the crisis late 1980s and early 1990s. They show that financial institutions have significant negative stock price reaction to the announcement of adverse real estate news. The study further supports the indication of real estate impact on the financial institution stock returns. In [He \(2002\)](#), monthly percentage change in median sale price of the new house sold is used as a proxy for the real estate return. The results show that a common set of variables is useful in explaining the return of commercial banks, insurance companies and diversified financial institutions. He also shows that the inclusion of real estate market factor in the model can significantly raise its explanatory power. Therefore, it suggests that the real estate market factor indeed represents a systematic risk and plays an important role in explaining the returns on financial institution stocks. He also finds real estate market factor has very stable significant coefficients, except for two sub-periods in the 10 year periods, 1978-1987, which reflects the dramatic bank deregulation and unprecedented interest rate volatility. This supports the assumption that real estate market experiences similar but less pronounced cycle as stock and bond markets.

In the recent literature, more studies have been focusing on relaxing the time-constant restrictions on the estimation process. [He and Reichert \(2003\)](#) use Flexible Least Square method on a three-factor Fama-French model to determine the returns of financial institution stocks for period 1972-1995. The study includes an index of overall financial institution performance, and indices for bank stocks and insurance companies to examine any difference in the return behaviour among sectors. The results find evidences that the real estate sensitivity of FI stock returns was statistically significant during most of the period 1972-1995. However, there are only two short sub-periods, 1972-73 and 1979-80 in

which the real estate market factor did not play a significant role in explaining risk premium of financial institutions.

Since most literature on financial institution stocks has been focusing on the more matured United States market, and [Lu and So \(2005\)](#) are the first few studying the real estate impact on the bank stocks in Asia. They study the return relationships between listed banks and real estate firms in seven Asian countries before and after the Asian financial crisis in 1997, including Hong Kong, Indonesia, Japan, Malaysia, Singapore, South Korea and Thailand. They use a three-factor model to capture the impact of general stock market, interest rate and real estate returns on bank stock portfolios over 1995-1999. The Grange-Causality results between real estate and bank stock returns show that the real estate returns do have an explanatory power in the bank stock returns in the Asian market; however, the reverse relationship is not established. In addition, Asian banks are exposed to the real estate risk both before and after the crisis like those in United States, and risk increases in the post-crisis period, which implies the underlying collateral on the bank real estate lending process is recognized.

2.4 CAPITAL ADEQUACY OF FINANCIAL INSTITUTIONS

2.4.1 DETERMINANTS OF CAPITAL STRUCTURE

Financial institutions need to protect against the risk of insolvency and shield it from the risk sufficiently large to cause the institution to fail. The mean of protection is the capital of financial institutions. Capitals in financial institutions extend beyond the role to perform a number of functions related to ensure the long-run viability of the organizations ([Valentine](#)

1999)⁹. In general, the first function of capital is to absorb unanticipated losses with enough margins to inspire confidence and enable the financial institution to continue as going concern. In addition, capital protects uninsured depositors, bondholders and creditors in the event of insolvency and liquidation. The capital of a financial institution also offers protection to insurance funds and the taxpayers who bear the cost of insurance fund insolvency. It also protects the industry from larger insurance premiums. Furthermore, capital is an important source of financing for a financial institution to fund the branches and other real investments necessary to provide financial services¹⁰.

There is extensive literature in studying the determinants and optimal capital structure of financial institutions (Modigliani and Miller 1958, Berger et al. 1995, Stolz 2002, Santos 2001). The starting point of all modern research on capital structure is from Modigliani and Miller (1958), which shows in a frictionless world of full information and complete market, a firm's capital structure cannot affect its value. This result is in contrast with the intuitive notion that a firm with risk-free debt could borrow at an interest rate below the required return on equity, reducing its weighted average cost of financing and increasing its value by substituting debt for equity. If depositors are perfectly informed about the bank's investment strategies, they will demand deposit rates that fully reflect the bank's risk. Hence, shareholders cannot exploit their controlling position, and maximizing the share value is equivalent to the maximization of the bank's total value (Modigliani and Miller 1958). Under this framework, the value maximizing portfolio and social optimal risk levels are always chosen, and the market value of a bank is independent of its capital structure, and hence, there would be no need for regulation. Therefore, under Modigliani and Miller

⁹ Valentine, T. J. and Ford, G. (1999) Readings in Financial Institution Management: Modern Techniques for A Global Industry, St. Leonards, NSW: Allen & Unwin Publisher, ISBN: 186448747X.

¹⁰ Saunders, A. and Cornett, M. M. 2008, Chapter 20, Financial Institutions Management: A Risk Management Approach, 6th Edition, McGraw-Hill Publisher, ISBN 978-007-126704-5.

(1958)'s assumption of frictionless world, the market prices will compensate for any leverage decision by the firm. When the leverage is higher, so is the risk to shareholders, increasing the cost of equity so that the weighted average cost of financing remains constant. However, banks differ from other non-financial firms in two important respects that affect their capital structures according to Berger et al (1995). The first feature is the presence of regulatory safety net that protects the safety and soundness of banks and the likely lower bank capital. The second aspect is the regulatory capital requirement that raises the capital of some banks. Capital regulation influences the bank's decision by acting as a constraint to their optimization. The bank's market capital requirement is defined as the ratio of equity to assets that maximizes the value of the bank to distinguish it from regulatory capital requirements (Berger et al 1995). The safety net for banks, which includes federal deposit insurance, unconditional payment guarantees, access to the discount window, and other bank safety regulations, possibly lowers market capital requirements by insulating banks from potential market discipline. Berger et al (1995) shows during 19th to 20th century, there is a continuous drop in the capital ratio, during which the capital ratio of banks in the United States drops from 50% in 1840 to 7% in 1990s. The constant decrease in the equity to asset ratio over the year may be as a result of banks' safety net, capital requirement and regulations since banks generally have the lowest equity to asset ratio of firms in any industry. Apart from the impact of capital requirements and regulation, factors like taxes, expected cost of financial distress, transaction cost, signalling behaviour, agency cost arising from asymmetric information between shareholders and creditors and between owners and managers can also influence the banks' capital structure. In addition, banks may have an incentive to increase portfolio risk due to moral hazard resulting from incomplete contracting and together with the safety net, such as limited liability and deposit insurance (Thies and Gerlowski 1989, Wheelock 1992). Under the deposit insurance, depositors do not incur any risk by depositing their funds with a bank under full cover. Their pay-off is

deterministic and independent of the riskiness of the banks' assets, and they lose any incentive to monitor banks behaviour. [Wheelock \(1992\)](#) shows that the balance sheet of insured banks reflecting greater risk-taking, and insured banks are more likely to fail than non-insured banks. [Demirgüç-Kunt and Detragiache \(2006\)](#) find evidence that during 1980-1997, explicit deposit insurance tends to increase the likelihood of banking crisis. The impact is stronger where bank interest rates are deregulated, and institutional environment is weaker, which shows higher moral hazard due to deposit insurance.

Another factor influence the capital structure is charter value and reputation of a financial institution. In a dynamic framework, banks that go bankrupt are likely to suffer losses related to future payoffs, such as, reputation, financial regulations, and charter value ([Suarez 1994](#)). The higher the bank's charter value, the higher is the bank's private cost of portfolio risk and leverage. In addition, financial liberalization tends to increase the intensity of competition between financial institutions while financial institutions are given greater flexibility to allocate assets and to determine interest rates. If the competition erodes the charter value, then the bank will increase leverage and risk. As a consequence, they tend to engage in higher risk activity in order to pursue higher profit ([Hellman et al. 2000](#)). [Keeley \(1990\)](#) shows empirical evidence that the increase in competition causes bank charter value to decline. He argues the decline in charter value will increase the default risk through increase in asset risk and reduction in capital.

All of the above discussions are from shareholders' aspects. We assume shareholders control the financial institutions and the managers act fully in the shareholders' interest. However, in many situations, manager may have preference diverging from shareholders' interest ([Stolz 2002](#)). [Saunders et al. \(1990\)](#) discuss the conflict of interests between shareholders and bank managers, and show that agency problem arising from the conflict of interests between shareholders and managers may also impact the bank capital structure. Furthermore, the

recapitalization of capital-constrained banks is found to have an impact on the bank capital structure. [Furlong and Keeley \(1989\)](#) examine the difference in stock price reaction after voluntary capital injection by commercial banks and involuntary recapitalization required to meet regulatory capital requirement, and find evidences of a significant drop in the share price of capital-constrained banks after recapitalization. However, if banks have high capitalization rate, the stock price does not show a significant response and less decrease in magnitude. [Cornett and Tehranian \(1994\)](#) also support the drop in share price after recapitalization. [Berger et al \(2008\)](#) found banks that would face a lower cost of raising equity at short notice tend to hold significantly more capital. Therefore, shareholder and banks managers need to take into account of the recapitalization cost and effect on the share price when making decision on their capital position.

2.4.2 BASEL CAPITAL ADEQUACY FRAMEWORK

The conclusions of the study on whether regulatory capital requirements in the banking industry are the first order determinant of banks are mixed. It is widely considered that FIs would retain less capital as it is more costly for banks than other types of funding. And it is a common view that capital regulation reduces moral hazard, as there is an incentive for financial institutions to take on excessive risk with high leverage level. However, there are some studies show that banks are more often willing to hold positive levels of capital well above the regulatory minimum, that the actual capital holdings tend to vary independently of regulatory changes internationally ([Allen et al 2010](#), [Flannery and Rangan 2008](#), [Ashcraft 2001](#), [Alfon et al 2004](#), [Barrios and Blanco 2003](#), [Gropp and Heider 2010](#)). Although the capital holding ratio is well above the regulatory minimum and continues to increase over the past few decades, the financial crisis that started in 2007 raised the question of whether banks were, in fact, undercapitalized. Banking crisis associated with sudden changes in asset

quality and value are often systemic in nature, arising from the interconnectedness of financial arrangement (Blundell-Wignall and Atkinson 2010). From historical experiences, banking crises have been associated with major economic disruptions and recessions. Therefore, policy makers regulate the amount of capital that banks are required to hold, and require high standards of corporate governance, such as liquidity management, accounting, audit and lending practices (Blundell-Wignall and Atkinson 2010). The most significant regulatory affecting the banking industry perhaps is the capital adequacy framework for internationally active banks. In this section, we will present an overview of the third Basel Capital Accord, known as Basel III, and its potential impacts on the banking industry and the overall economy which have been discussed in the current literature. Studies have shown that the 2008 global financial crisis was triggered and aggravated as a result of insufficient level of capital and inadequate level of quality capital. Therefore, Basel III is a direct response to the global financial crisis and to revise the shortcomings of Basel I and Basel II in addressing the capital requirements of internationally active banks. In the following section, the paper starts with a discussion on the previous capital adequacy framework, Basel I and Basel II, and their criticism associated with the each framework.

2.4.2.1 BASEL I AND BASEL II FRAMEWORKS

Basel I - 1988

The basic theory in the financial industry is asset transformation, in which financial institutions, especially banks, borrow from the market and depositors and lend to borrowers. The Basel Committee on Banking Supervision was formed in 1974 to advise national financial regulators on common capital requirements for internationally active banks. During later 1980s and 1990s, there is a worldwide deregulation in banking and

financial industry. Financial institutions fiercely compete for larger market share both domestically and internationally at the cost of institution capital bases. Internationally active banks take advantages of different national standards in the treatment of asset, capital and risk level. Due to perceived failings of deregulation, Basel Committee introduced Basel I in 1988 in the hope to set out a global standard for guidance on the proper capital levels for internationally active banks. As summarized in [King and Tarbert \(2011\)](#), Basel I consists of three main components. Firstly, it standardizes the minimum regulatory ratio for internationally active banks¹¹. Covered banks are required to hold at least 8% capital of their total risk-weighted assets. Secondly, it provides a basic definition on qualifying regulatory capital, which is consist of Tier 1 and Tier 2 capital. Tier 1 capital generally includes the highest quality capital, such as common equity and preferred stocks. Tier 2 capital is lower quality and riskier instruments, such as subordinated term debt and certain hybrid instruments. Basel I requires that at least half of bank's regulatory capital is Tier 1 capital. Thirdly, Basel I introduce a risk-weighted asset measure to account for the different risk levels inherent assets. Risk-weighted assets categorize different assets according to their credit risk, and assets in the same category are given the same weighting. However, the risk-weighted categories have been largely criticized by the uniform bucket weighting regardless of the credit standing of individual assets. It facilitates the banks chase higher yield at greater risk without necessarily incurring additional capital. Another criticism on Basel I is its failure to form a concise definition of Tier 1 and Tier 2 capital, which results in banks to rely on the instrument of questionable quality as part of their capital cushion ([King and Tarbert 2011](#)).

¹¹ Basel Committee on Banking Supervision, Bank For International Settlements, Publication: International Convergence of Capital Measurement and Capital Standard (July 1988, updated to April 1998); Available on <http://www.bis.org/publ/bcbasc111.pdf>

Basel II - 2004

Improving from the criticism in Basel I, the Basel Committee issues a more comprehensive and risk-sensitive capital regulation approach known as Basel II in 2004. Basel II includes three pillars: minimum capital requirements, supervisory review process and market discipline. The first pillar focuses on the maintenance of regulatory capital. In Basel I, only credit risk of assets is considered when calculating risk-weighted assets. In Basel II, operation risk and market risk are added in risk-weighted asset calculation. There is also an improvement in the asset weighting system. In order to give more accurate weighting to match the riskiness of its assets, Basel II provides three methods of evaluating credit risk: a basic standardized approach and two variants of an internal rating-based approach—foundational and advanced ([King and Tarbert 2011](#)). The standardized approach allows banks to calculate risk-weighted assets by reference to both Basel I's elementary buckets and external credit ratings, such as Standard & Poor, Moody and Fitch Ratings. The other two internal rating-based approaches allow banks to use more sophisticated their own risk management models to calculate their risk-weighted assets and capital needs. There is an obvious improvement in Basel II framework comparing with Basel. However, the global financial crisis in 2008 had demonstrated the limitations of Basel II in a number of areas. Firstly, although the definition of RWA and Tier 1 has significantly improved, the financial crisis still demonstrates the ambiguities in the definition. The loose definition gives banks opportunity to structure financial products to comply with Basel II with lower cost of capital when the actual equity capital holding is as little as 1 percent. Secondly, there are concerns on the way banks structure their liabilities. Thirdly, there are critical deficiencies in the risk management models used by internationally active banks and rating agencies. Fourthly, the financial crisis has shown that Basel II is inefficient in capturing major on- and off-balance sheet risks and derivative related exposures.

2.4.2.2 BASEL III FRAMEWORK

In response to the observed regulation deficiencies from recent financial crisis, Basel Committee aims to increase the quality and quantity of capital that banks must hold, and Basel III is officially endorsed by member states of the Group of Twenty in November 2010. Additional measures of recent Basel reforms also include: a tightening of the definition of common equity; limitation on qualification as Tier 1 Capital; introduction on a set of system-wide prudential filters to address systemic risk within the global financial system; and the enhancement of transparency and market discipline through new disclosure requirements (Ojo 2010). The revised Basel framework has addressed criticism raised from Basel I and II substantially. In the following section, we will discuss the Basel III framework and improvement from Basel II in further details.

2.4.3 SPECIAL CHARACTERS OF BASEL III FRAMEWORK

QUALITY AND QUANTITY OF CAPITAL

After the financial crisis, the highest priority of Basel committee needs to strengthen the quality, consistency and transparency of the regulatory capital base¹². Therefore, the new Basel III in general requires the capital base of every internationally active bank is backed by a high-quality buffer that can absorb losses during periods of economic distress. Blundell-Wignall and Atkinson (2010) show that the crisis is, in fact, due to the insufficient quality of capital rather than to the lack of capital. In Basel III, it continues to maintain the requirement that the total capital must be at least 8 percent of risk-weighted assets as in Basel I and II. However, Basel III increases the Tier 1 capital percentage within the total capital from 50 percent to 75 percent, and only up to 25 percent of total capital consisting of Tier 2 capital.

¹² Basel Committee on Banking Supervision, Bank For International Settlements, Publication: Strengthening The Resilience Of The Banking Sector – Consultative Document 13 (2009); Available on <http://www.bis.org/publ/bcbssc164.pdf>

Comparing with previous Basel framework, Basel III breaks down Tier 1 into two categories, Common Equity Tier 1 and Additional Tier 1. Within Tier 1 capital, Common Equity Tier 1 capital is required to take at least 75 percent of total Tier 1 capital, and up to the remaining 25% is Additional Tier 1 capital. Therefore, in proportion, Basel III requires at least 6 percent of risk-weighted assets as Tier 1 capital, which is consist of at least 4.5 percent of RWAs as Common Equity Tier 1 and up to 1.5 percent of RWAs as Additional Tier 1 capital. Within total 8 percent Total Capital, Tier 2 capital should be no more than 2 percent of total RWAs.

Basel III strengthens the definition of Tier 1, including Common Equity Tier 1 and Additional Tier 1, and Tier 2 capital. In general, Common Equity Tier 1 consists of the bank's common stock and any common stock surplus, such as share premium or additional paid-in capital. Basel III strictly establishes criteria for shares to be classified as common equity. Criteria include that instruments at issue must represent the most subordinated claim in the liquidation of a bank; have a perpetual principal; not be bought back, redeemed or cancelled; have dividend features that are not entirely discretionary at the option of the bank; be recognized under applicable accounting standards as equity; and be issued as part of an arms-length transaction with a third party (King and Tarbert 2011). Thus, Additional Tier 1 capital includes various types of preferred stocks and additional paid-in capital that do not otherwise satisfy the standards of Common Equity Tier 1 as discussed above. Apart from these, Additional Tier 1 capital also includes instruments issued by consolidated subsidiaries of a bank held by third parties. Furthermore, as Tier 1 capital is to provide banks with an equity cushion as going-concern, Tier 2 capital is usually referred as 'gone-concern' to provide loss absorption for junior equity and liabilities. Therefore, Tier 2 includes capitals which can not be classified as Tier 1, such as, preferred stock with non-perpetual and debt-like feature, as well as various types of subordinated debt.

ADDITIONAL CAPITAL BUFFER – CAPITAL CONSERVATION

The experiences of financial services have shown that some banks continued to distribute dividends and bonuses which further weakened capital reserves to absorb further losses. Therefore, Basel III sets new requirements for two additional buffers as further capital cushion against future losses. The first one is capital conservation buffer. The capital conservation buffer will require banks to retain an additional 2.5 percent of Total Capital in the form of Common Equity Tier above the minimum 4.5 percent, which effectively brings the Common Equity Tier 1 requirement to 7 percent of RWAs. In a period of stress, Basel III temporarily allows banks to go below 7 percent ratios, however, banks must rebuild the buffer through reduction of discretionary distributions, such as, share buybacks and employees bonuses distribution.

ADDITIONAL CAPITAL BUFFER – COUNTER CYCLICAL BUFFER

Another additional buffer under Basel III is the countercyclical buffer, which is introduced to achieve as a second pool of additional capital accumulated during periods of high credit growth. It requires banks to build up extra buffer when supervisors are aware of excessive credit in the system. This is because when there is excessive credit in the market, loans are built up, and price increased leading to asset bubbles. When the bubbles eventually burst, prices drop and loans are left unpaid. Banks start to reduce lending which pushes down asset prices even further, thus, the level of defaults ([Hannoun 2010](#)). Therefore, the countercyclical buffer aims to act as a brake on the credit availability in the event of the economic downturn with restricted credit after the excessive credit growth ([King and Tarbert 2011](#)). Basel III requires national authorities to monitor the level of credit growth in the system, and the buffer should range from additional zero to 2.5 percent of RWAs on top of previous Tier 1 capital ratio. Therefore, after accounting for both additional buffers, the

potential maximum capital ratio required by Basel III is 13 percent of RWAs. [Cosimano and Hakura \(2011\)](#) show that the excess credit growth could have a significant countercyclical impact on the developed countries' economies, and suggest such measure should be closely coordinated with monetary policy decision-making to avoid an excessive policy-tightening.

There are arguments over the Basel III, and one of them is on the calculation of risk-weighted assets RWAs. Basel III does not revise the methodology of risk weighting on complex instruments. [Ennis and Price \(2011\)](#) argue the reason is lack of clear alternative with a clear superior track record. They argue that the influence of increasing minimum capital requirement under Basel III is still unknown. The potential benefits of large capital buffer are to against losses and provide better incentives for controlled risk-taking, and thus fewer bank failures and less potential for systemic crises. [Demirguc-Kunt et al \(2010\)](#) compare behaviour of banks with different capital ratios before and during the financial crisis in 2008. They find that differences in capital ratio do not have an impact on bank stock returns when the market is stable. However, during the crisis, banks with stronger capital position have better stock market performance. They also find a positive association with subsequent stock return is stronger for higher quality capital, particularly Tier 1 and tangible common equity. The results in [Demirguc-Kunt et al \(2010\)](#) support the development of Basel III policy for the importance of stronger capital position and greater emphasis on higher quality capital in the form of Tier 1 capital and tangible equity.

On the other hand, apart from the costs of raising Tier 1 capital, instead of issuing new equity, banks may reduce lending or even liquidating bank-specific productive assets, which will result in constrain in the credit market [Ennis and Price \(2011\)](#). [Cosimano and Hakura \(2011\)](#) estimate that the large banks worldwide on average would raise their lending rates by on average 16 basis points in order to increase their equity-to-asset ratio by 1.3 percentage points needed to achieve the Basel III regulation of 7 percent equity to RWAs. The result also

suggests that banks in different countries show variations with respect to changes in loan rates due to variations in capital constraints, the net cost of raising equity and elasticity of loan demand. Another critic of the countercyclical buffer measure is using a single global risk factor that ignores the country economic differences. [Blundell and Atkinson \(2010\)](#) show that idiosyncratic credit risk and security market portfolio risk associated with individual borrowers in different business and regions is not well catered under Basel III that may undue reliance on cumbersome supervisory override as in the past Basel framework.

LEVERAGE RATIO

In addition to the extra buffers, Basel III also recognises the importance of the leverage ratio in monitoring the healthiness of financial institutions. The introduction of the leverage ratio is intended to avoid the build-up in excess leverage that can lead to a deleveraging credit crunch in a crisis ([Blundell and Atkinson 2010](#)). However, a financial institution with strong capital ratio still suffers from excessive leverage especially during the financial crisis. Basel III introduces the leverage ratio by comparing the proportion of Tier 1 capital to total exposure instead of RWAs. It requires the leverage ratio to be at least 3 percent, which means the Tier 1 capital should be at least 3 percent of total exposure. The key issue in the leverage ratio is the clear definition of total exposure. The discussion on what should be accounted in the total exposure is still in progress. The introduction of a minimum leverage ratio to supplement minimum risk-adjusted capital requirements is supported by [Demirguc-Kunt \(2010\)](#), as they find during the crisis stock returns of large banks are more sensitive to the leverage ratio than the risk-adjusted capital ratio. [Blundell and Atkinson \(2010\)](#) show that the leverage ratio has a negative relationship with losses in the crisis because of high risk-taking due to capital arbitrage under the Basel weighting of assets and banks willingness to take on more risk. If the leverage ratio is set too high, bank will have an

incentive to arbitrage the weights to ensure they do not hold any more capital than needed. However, [Blundell and Atkinson \(2010\)](#) argue that the introduction of leverage ratio is only a limited measure to enhance risk coverage of counterparty and off-balance exposure, and further development is needed.

COUNTERPARTY RISKS

Apart from strengthening the capital adequacy of financial institutions themselves, Basel Committee also makes several proposals on mitigating counterparty risk. This aims to capture on and off balance sheet risk ([Blundell and Atkinson 2010](#)). Two major concerns of Basel Committee are counterparty credit risk, and external rating and cliff effects. Basel Committee proposes several measures in controlling counterparty credit risk. The first potential measure is the stress testing of default risk, in which banks are required to calculate their default risk capital charge using a stress calibration as part of the exposure calculation. In addition to the capital default, Basel Committee proposes that banks should hold capital against marked-to-market losses arising from a decline in counterparty creditworthiness. Another measure to improve counterparty credit risk evaluation is the identification and mitigation of wrong-way risk. The wrong-way risk arises when a bank's exposure to a counterparty increases as the counterparty's creditworthiness declines. Further measures include assessing asset value correlation for large organisations to account for the potential systemic risk arising from the default of large market players; and a variety of measures to improve collateral calculation and management ([King and Tarbert 2011](#)). Basel Committee also emphasizes the improvement of quality of counterparty risk assessment procedures and practices, and particularly the operation of these functions in times of market turbulence. It also requires banks to regularly and extensively carry out stress testing on the counterparty exposures and risks in a timely manner ([King and Tarbert](#)

2011). The second counterparty risk mentioned in Basel III is the risk of external ratings. Basel III allows banks to assess risk by using both external and their own internal risk assessment measures. Bank may be over reliant on external rating organizations, which could lead to cliff effects when there is a sudden credit downgrading. Angelini et al (2011) study the impact of the adoption of countercyclical capital buffers on economic fluctuations. They show that the adoption of countercyclical capital buffers could have a sizeable dampening effect on output volatility that is consistent with expectations of Basel Committees. The size of dampening effect is sensitive to a number of factors: the types of shocks hitting the economy; the parameters included in the model; and the details of the prudential rule itself.

LIQUIDITY MANAGEMENT

It has been widely acknowledged that liquidity is as important as capital in the assessment of healthiness of a financial institution and stability of the financial sector. This is because the tightening ability to access short-term funding by financial institutions usually comes with difficulty in readiness of converting assets into cash. Together with a significant decline in the illiquid asset during any financial crisis, the weak liquidity status leads to erosion in capital levels.

In response to these issues, Basel III introduces two new liquidity standards, the liquidity coverage ratio and the net stable funding ratio. The liquidity coverage ratio is the ratio of bank's stock of high-quality liquid assets to the total net cash outflow over the next 30 calendar days. It aims at promoting banks' short-term resilience to potential liquidity disruptions (Ojo 2010). The liquidity ratio is required to be at least 100 percent, which means the high-quality liquid assets is at least equal to its total net cash outflow for the next 30 days, and in order to ensure that an internationally active bank has sufficient high-quality

asset to potential sudden net cash outflow under a month-long acute stress scenario that includes both systemic and institution-specific shocks¹³. High-quality assets are required to be unencumbered assets with low credit and market risk that can be convertible into cash at little or no loss under financial stress. Another liquidity buffer proposed by Basel III is the net stable funding ratio. The net stable funding ratio is proposed, in addition to liquidity coverage ratio, to address the mismatches between the maturity of a bank's assets and liabilities, and to promote medium- and long-term funding by establishing minimum amounts of liquidity based on the bank's assets and activities including off-balance sheet commitments over a one-year period of extended stress ([King and Tarbert 2011](#)). The net stable funding ratio is calculated as the ratio of the available amount of stable funding (ASF) to required amount of stable funding (RSF). The available stable funding is defined as the total amount of the bank's regulatory capital along with preferred stocks and liabilities with a maturity of a year or more, and deposits and funding with maturity of less than a year but would be expected to stay with the institution longer during the stress period. Required stable funding is based on the liquidity of risk profiles of a bank's assets and off-balance sheet exposure, which is calculated as the total amount of assets and off-balance sheet activity multiplied by its RSF factor. The RSF factor is used to approximate the amount of assets and off-balance sheet commitments that could not be readily converted into liquidity. Another importance of liquidity is its interconnectedness with risk-taking behaviour. [Borio and Zhu \(2012\)](#) discuss that lower perceptions of risk and greater risk tolerance weaken external funding and transferability constraints. On the other hand, weaker constraints can support higher risk-taking.

Increase in capital and liquidity level will strengthen banks' ability to absorb losses, however, it will not fully protect financial institutions from systemic risk posed by

¹³ Basel III Framework

institutional interconnectedness, so-called 'too-big-to-fail' (King and Tarbert 2011). A number of literature has discussed the measures and suggested solutions on the 'too-big-to-fail' risk. Hart and Zingales (2011) explain the too-big-to-fail problem arises from a combination of economic and political problem: the cost of bankruptcy on systemic obligations is too large to bear, and the government sacrifices the long-term effect on incentives to avoid the short-term costs of a possible collapse. Hart and Zingales (2011) examine a new approach to capital requirement for large financial institutions. They show that the financial institution should maintain an equity and long-term bond cushion sufficiently large so that their own credit default swap price stays below the threshold level to ensure the solvency of financial institutions. In order to address this risk, Basel Committee develop a series of measures, such as capital and liquidity surcharges, tighter large-exposure restrictions, mandatory recovery and resolution plans, and contingent capital and bail-in debt requirement. One of the important proposals is Basel III requires all non-common Tier 1 and Tier 2 instruments contain terms that ensure the instruments must be written-off prior to any infusion of capital from the public sector. These requirements aim to make the pooling of risk less likely and reduce the chance of 'too-big-to-fail' risk.

2.4.4 BASEL III IMPLEMENTATION AND POTENTIAL INFLUENCE

Basel III is designed to improve the safety and healthiness of financial institutions. However, as the potential impact on the financial system of implementing Basel III is still unclear, and the global economy is still recovering from the crisis, regulators plan to implement Basel III gradually with cautions. Increasing capital level is one of the most critical challenges as it is expensive. Especially, in order to adapt to Basel III, banks around the world need to change their business models, which can also be very costly. The original plan for implementation of Basel III starts in January 2013 and aims to fully implemented by January 2019. However,

due to the recent stress in the global economy, the initial implementation date from January 2013 has been delayed. The original plan from Basel Committee firstly starts with the leverage ratio in January 2013 with 'parallel run period' till 31 December 2016, during which banks are required to calculate the leverage ratio and its components will be tracked and disclosed publicly. The minimum leverage ratio of 3 percent will become in force on January 2017. As for capital requirement, the minimum capital requirements start to gradually phase-in from 2014, and by 2015, banks are required to achieve common equity Tier 1 ratio of 4.5 percent and an overall Tier 1 capital ratio of 6 percent. The conservation buffer is required to phase in from 2016 and become fully implemented by 2019. The timeline of implementing liquidity ratio is still in discuss, and the proposed introduction of liquidity coverage ratio and net stable funding ratio will occur in 2015 and 2018 respectively, with full achievement of 100 percent ratios by 2019.

Capital and liquidity regulation affect economic activity via an increase in the cost of bank intermediation. In order to meet the regulation criteria, for existing amount of assets, banks increase the capital by deleveraging. In addition, banks need to increase their lending spread when the cost of funding increase for the same required return on equity and cost of debt. [Angelini et al \(2010\)](#) assess the impact of higher capital and liquidity requirement on long-term economic performance from two aspects: steady state output and welfare. The results show a loss of output and welfare is linearly related to the increase in capital and liquidity requirement. This implies that the decline in steady state output and welfare consumption is to be expected if the capital requirements are increased by one percentage point. If the liquidity ratio increases by 25 and 50 percent, the estimated state output will reduce by 0.08 and 0.15 percent respectively. They interpret the 0.08 reduction in output proxies for the adoption of the NSFR accounting for the synergies between capital and liquidity. As for the impact on economic fluctuations, [Angelini et al \(2010\)](#) show that tighter capital rules induce

a decline in output volatility. A one percentage point increase in the capital-to-asset ratio reduces the standard deviation of output by 1 percent, and tighter liquidity requirements of 25 percent increase liquidity ratio will reduce the standard deviation of output by a further 1 percent.

2.5 CONCLUSIONS

Financial institutions are financial intermediaries that facilitate the exchange of information, and provide products and services to the economy which are different from other industries due to their special functions, asset transformation and brokerage services. The risks of financial institutions are closely associated with their special functions. We discuss types of risks faced by financial institutions and relevant literature on each of the risks. Interest rate risk is studied most extensively in the literature. The financial institutions are exposed to interest rate risk because of three reasons. Firstly, financial institutions possess debt instruments whose returns are associated with the interest rate; secondly, the equilibrium returns for FI's assets and liabilities are based on certain expectation of interest rate. Any unexpected fluctuations in interest rate will change financial institutions duration match and equity return will be affected. Thirdly, financial institution equity can be considered as a call option on assets and their stock returns should be sensitive to the interest rate changes. Another risk faced by financial institutions is the market risk. Market risk is the risk related to the uncertainty of a financial institution's earnings on its trading portfolio caused by changes in market conditions. A family of Value-at-Risk models are commonly used by financial institutions in monitoring market risk exposure. The historical or Monte Carlo simulation is usually used to generate additional observations. In addition, credit risk is defined as the potential level of fluctuation in the value of debt and derivative instruments due to changes in the underlying credit quality of counterparties. Credit risk management

starts with relying on subjective analysis on borrowers' characters to evaluate the credit risk on issuing loans. More advanced quantitative models are developed in recent year, such as accounting based credit scoring systems, including four types of approaches, linear probability models, logit models, probit models and discriminant analysis models. Due to the criticism of credit scoring systems on failure to capture capital market data and linearity assumption, bankruptcy models based on option pricing models are adopted by researchers. Apart from credit risk, the increasing variety of loans within a particular portfolio has made it important to measure the overall spread of financial institutions' outstanding accounts over the number of variety of borrowers, known as credit concentration risk. Furthermore, the expansion of financial services industry worldwide has made financial institutions expose to foreign exchange risk through foreign currency trading for the purpose of agents, hedging and direct speculation. Liquidity risk is another significant risk all financial institutions face which arises from both liability and asset sides of financial institutions. After the recent financial crisis, regulator has imposed liquidity buffer requirement in the proposed Basel III to enhance the resilience to shocks of financial systems under a broad range of market conditions.

Financial institutions have observed a trend of increasing exposure of real estate sector worldwide since 1980s. Comparing with traditional debt instruments, real estate has been considered as a relatively high average return investment relative to its risk. Therefore, real estate has been appealing to institutional investors as a good diversification instrument. From the literature research, we find that there are two ways real estate have been included in the financial institution investment portfolios. One way for financial institutions investing in real estate is through the traditional real estate loan. Studies show that banks with longer real estate loan history had higher returns with less risk than more diversified banks, and those high return banks exhibited substantial flexibility in their ability to adjust their real

estate loan holdings. The other way of investing in real estate is through indirect investments, such as real estate stocks, derivative instruments and Real Estate Investment Trusts. There is an increasing trend of investing in Real Estate Investment Trusts in recent years. REITs stocks can be viewed as a form of securitized indirect real estate investment representing claims on real property or mortgage. However, the view on to what extent REITs reflect the return to their underlying assets is mixed. Some studies show that the behaviours of REITs returns are very similar with private real estate after valuation parameter adjustments. In other literature, the relationship between REITs and their underlying real estate property is weak, and some even show they are not correlated. However, there is an increasing number of recent literature have used REITs as a real estate indirect exposure measure due to its readily accessible market information than direct real estate property investments especially for international real estate investments.

Financial institutions need to protect against the risk of insolvency and shield it from the risk sufficiently large to cause the institution to fail. One of the most important protections of the financial institution is their capitals. Therefore, the most significant regulatory policy affecting the banking industry is the capital adequacy framework for internationally active banks. The Basel Committee on Banking Supervision was formed in 1974 to advise national financial regulators on common capital requirements for internationally active banks. Due to perceived failings of deregulation, Basel Committee introduced Basel I in 1988 in the hope to set out a global standard for guidance on the proper capital levels for internationally active banks. Later in 2004 the Basel Committee issued a more comprehensive and risk-sensitive capital regulation approach known as Basel II. Basel III proposed in 2010 by Basel Committee is a direct response to the global financial crisis and to revise the shortcomings of Basel I and Basel II in addressing the capital requirements of internationally active banks.

Basel III enforces a higher standard of quality and quantity capital requirements, corporate governance, such as liquidity and leverage ratio management.

There are extensive literature in studying the determinant and optimal capital structure of financial institutions. Findings in the previous studies show that financial institution capital structure can be affected by institutional specific, macroeconomic and regulatory specific factors, such as the size of total assets, return of assets, credit risk exposure, GDP, level of external governance and degree of independence of countries' supervisory authorities etc. There is also evidence showing that financial institutions require around four to five years to be adjusted to the target required capital equilibrium. The discussion on whether regulatory capital requirement in financial institutions is the first order determinant is mixed. It is widely considered that financial institutions would retain less capital as it is more costly than other types of funding. However, studies have shown financial institutions tend to hold a capital buffer well above the minimum requirement.

Basel III is designed to improve the safety and healthiness of financial institutions, however, the possible influence of the implementation on economy is uncertain. Several studies have shown there is a potential of increase in cost of funding and decline in state output and welfare consumption. Therefore, implementing Basel III requires policy maker to take careful consideration in terms of the extent and time frame so that financial market and economy can have a buffer period to gradually adjust themselves to the changes.

CHAPTER THREE

AN EMPIRICAL STUDY OF BANK CAPITAL STRUCTURE DETERMINANTS

3.1 INTRODUCTION

The objective of the thesis is to empirically examine the relationship between major risk factors exposed by the financial institutions, particularly capital risk, real estate risk and valuation risk. This chapter specifically examines the capital risk and the determinants of bank capital structures for a sample of 358 large banking organisations from 1991 to 2011 from major financially influential countries, including, Austria, Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherland, South Korea, Sweden, Switzerland, United Kingdom and United States etc. The contribution of this chapter to the current literature is that we extend the methodology used in non-financial firms to banking organizations, and we found both financial and non-financial organizations share some similar behaviors. The results of pecking order theory show that we have not found strong evidence for the existence of pecking order in banking organizations. One concern of testing the pecking order theory on banks is that banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. The term deposit is used by the banking industry in financial statements to describe the liability owned by the bank to its depositor, and not the funds that bank holds as a result of the deposit, which are shown as assets of the bank. When taxpayers put funds into the bank, it is recognized as an asset by the bank. On the other hand, the bank credits a liability account for the same amount to show as a liability owed by the bank to its customer. Therefore, the debt structure in banking is different from non-financial firms. For the same level of financial deficit, a

bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because the taxpayers funds deposit in the bank.

The study also adds value to the current range of literature by providing results including empirical evidence in the analysis of factors influencing banking organizations' capital structure using most recent sample period. In addition, we extend the conventional framework of capital structure determinants by including variables related to country-specific macroeconomic and public regulatory variables. The results indicate that bank-specific variables collectively make a significant contribution in explaining banking organizations' target capital level. When country-specific macro-economic and public policy variables are included in the analysis, a series of results are found. The results show that if the larger proportion of a country's financial system is bank-based, banks within this country tend to maintain less capital since banks have a large impact on the financial industry, and they are more accessible to cheaper financing within a short period. The rate of changes in capital ratio tends to be higher in countries with better provisions of prompt corrective action, better external governance, and a greater emphasis on explicit regulatory requirements regarding the amount of capital banks must maintain relative to specific guidelines. The coefficients on supervisory authority independence and the difference between control rights and cash flow rights variables are negative and significant. The moral hazard of depository insurance has a positive impact on the capital structure level but not statistically significant. The indicator of government ownership of banks variable is negatively correlated with the change of the leverage ratio, which shows the higher degree of government ownership of banking organizations, the slower the change of leverage ratio. The statistics indicate that the regulatory and public policy variables collectively make a significant contribution to explaining changes in banking organizations' leverage ratio. The results of lagged capital ratio coefficients indicate that the average banking organization

requires around four to five years to be adjusted to the target equilibrium. The findings also indicate public policy and regulatory variables affect changes in the capital ratio linearly since the results of including interactive variables provide weaker evidences and dramatically reduce both statistical and economic significance of the macroeconomic and stand-alone public policy and regulatory.

We begin the chapter from the literature review of current findings from literature and background information on the capital structure theories and variables influencing the capital level. We then discuss the possibility of applying theory and framework developed from non-financial firm to financial organizations. We follow on with discussions of the framework used to examine the pecking order behaviour and capital structure determinants of banking organizations in this paper in Methodology section. In addition, we provide descriptive results of the data sample in section Data and Descriptive Statistics. We continue with discussions on the Empirical Results in the following section. Finally, we provide a summary of the Conclusion of the empirical findings.

3.2 LITERATURE REVIEWS ON CAPITAL STRUCTURE

Capital is important in business organizations to acquire the physical assets that are necessary for commence and expanding operations. Capitals in banks and other deposit-taking institutions extend beyond this role to perform a number of functions in ensuring the long-run viability of the institutions [Valentine \(1999\)](#)¹⁴. Firstly, capital provides a temporary cushion against the risk of failure. Bank capital is used to absorb unexpected losses arising from the risks incurred in the business of banking, and acts as the final line of defence

¹⁴ Valentine, T. J. and Ford, G. (1999) Readings in Financial Institution Management: Modern Techniques for A Global Industry, St. Leonards, NSW: Allen & Unwin Publisher , ISBN: 186448747X.

against insolvency behind current profits and provisions. This function is achieved by enabling a bank to meet claims against its external liabilities during periods where unexpected losses force the writing down of the value of some assets. The regulatory minimum capital requirement is implemented to reduce the risk of insolvency. Secondly, capital promotes public confidence in the banking system. Since banks act as financial intermediaries, it is obvious that only a relatively small proportion of funds are available at any one time to meet the deposit withdrawals. Therefore by ensuring that a bank can operate at the same level of capacity, capital acts to promote public confidence in the banking system to meet unexpected deposit withdrawals during the economic downturn. Last but not least, capital serves as a regulator of bank growth. A bank that increases its risk exposure is required to increase its capital base. This means the buffer provided by capital against unexpected losses is aligned with increases in a banks' risk exposure. Investors can restrict the banks' expansion by either not providing additional capital or by only providing it at less attractive terms to the banks.

There are extensive literatures in studying the determinants and optimal capital structure of both non-financial and financial firms ([Modigliani and Miller 1958](#), [Berger et al 1995](#), [Stolz 2002](#), [Santos 2001](#), etc.). The beginning of all modern research on firms' capital structure is from [Modigliani and Miller \(1958\)](#), which shows that a firm's capital structure cannot affect its value in a frictionless world of full information and complete markets. This result is in contrast with the intuitive notion that a firm with risk-free debt could borrow at an interest rate below the required return on equity, reducing its weighted average cost of financing and increasing its value by substituting debt for equity ([Modigliani and Miller 1958](#)). If depositors are perfectly informed about the bank's investment strategies, they will demand deposit rates that fully reflect the bank's risk. Hence, shareholders cannot exploit their controlling position, and it shows that maximizing the share value is equivalent to the

maximization of the bank's total value. Under this framework, the value maximizing portfolio and social optimal risk levels are always chosen, and the market value of a bank is independent of its capital structure, and hence, there would be no need for regulation. Therefore, under [Modigliani and Miller \(1958\)](#) assumption of frictionless world, the market prices will compensate for any leverage decision made by the firm. When leverage is higher, so is the risk to shareholders. Therefore, increase the leverage also increase the cost of equity so that the weighted average cost of financing remains constant.

However, banks differ from other non-financial firms in two important respects that affect their capital structures according to [Berger et al \(1995\)](#). The first feature is the presence of the regulatory safety net that protects the safety and soundness of banks and a possible lower bank capital. The second aspect is the regulatory capital requirement that raises the capital of some banks. Capital regulation influences the bank's decision by acting as a constraint to their optimization. The bank's market capital requirement is defined as the ratio of equity to assets that maximize the value of the bank to distinguish it from regulatory capital requirements. The safety net for banks, which includes federal deposit insurance, unconditional payment guarantees, access to the discount window, and other bank safety regulations, possibly lowers market capital requirements by insulating banks from potential market discipline. [Berger et al \(1995\)](#) show during 19th to 20th century, there is a continuous drop in the capital ratio, during which the capital ratio of banks in the United States drops from 50% in 1840 to 7% in 1990s. The constant decrease in the equity to asset ratio over the year may be as a result of banks' safety net, capital requirement and regulations, since banks usually have the lowest equity to asset ratio of firms in any industry. Apart from the impact of capital requirements and regulations, factors like taxes, expected cost of financial distress, transaction cost, signalling behaviour, agency cost arising from asymmetric information between shareholders and creditors and between owners and managers can also impact the

banks' capital structure. In addition, banks may have an incentive to increase portfolio risk due to moral hazard resulting from incomplete contracting and together with the safety net, such as a limited liability and deposit insurance (Thies and Gerlowski 1989, Wheelock 1992). Agency problem arising from conflicts of interest between shareholders and managers may also influence the bank capital structure (Saunders et al. 1990). Competition also plays a role via its impact on bank rents (Hellman et al. 2000, Keeley 1990). In the following sections, we discuss the factors which impact banks' capital structure, and regulation issues faced by the financial institutions.

The primary purpose of the risk regulations is to prevent systematic risk or the risk of the collapse of the entire system due to interconnections between financial firms. However, controlling systematic risk raises difficult challenge and dilemmas.¹⁵

3.2.1 COMPETITION AND REGULATION

Regulation and competition might be conflicting, since regulations limited the scope of operations of banks, interfering directly with free competition. On the other hand, new rules may create unpredictable behaviours to bypass constraints. There is a long-standing argument for providing more freedom to financial firms and avoiding too many regulations. The unfair competition resulting from non-economic rules combined with competition among players motivated the deregulation, and the barriers to competition are progressively lifted. Deregulation dramatically widens the range of products and services offered by the banks since 1970s¹⁶. Most credit institutions diversify their operations out of their original businesses. The pace of creation of new products remains constantly high, especially for those acting in the financial markets, such as derivatives. As a result, the risk in the banks

¹⁵ Joël Bessis, Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

¹⁶ Joël Bessis, Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

increases because of new competitions, new product innovations, shift from financial intermediation by banks to capital markets, and the disappearances of old barriers. However, relying on “code of conduct” rather than rules, implies relying on self-discipline or self-regulation, which is not likely to inspire trust in the financial system.

There are a number of rules aiming at limiting risks in banks, and the main pillar of new regulations is capital adequacy. While the insurance depositor system on banks is passive risk control, the capital requirement regulation is pre-emptive measure to control their risks within acceptable bound. By enforcing a capital level in line with risks, regulators focus on limiting the risk of failure. Since the capital serves for protecting banks against unexpected losses, banks should maintain a sufficient amount of capital to absorb unexpected losses.

Guidelines are defined by regulators in Basel at the Bank of International Settlement (BIS), therefore, the name of regulation on bank capital requirement is called “Basel” Accord. The first accord to be implemented focuses on credit risk, with famous “Cook Ratio”. The “Cook Ratio” sets up the minimum required capital as a fixed percentage of assets weighted according to their nature in 1988.¹⁷ The scope of regulations extends progressively later. The extension to market risk is a major step for market risk in 1996-1997 because Value-at-Risk model is used for assessing capital charge for market risk ([Santos 2001](#)). The New Basel Accord, or the Basel II Accord enforced in January 2007 considerably enhanced the credit risk regulation. The Basel II Accord sets new rules for marketing credit risk capital charges more risk sensitive, recognizing various forms of credit risk mitigation, providing various enhancements to the former Basel I Accord credit risk measure, adding capital requirements to operational risk, and detailing the supervision and market discipline pillar¹⁸. It treats interest rate risk of the banking book under supervisory review process rather than

¹⁷ Joël Bessis, Chapter 19 Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

¹⁸ Joël Bessis, Chapter 20 Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

imposing capital requirement. The new accord provides a more risk-sensitive framework that should considerably reduce distortions between standard capital charges of Basel I and the actual credit risk of counterparties and facilities. It also differentiates the risk according to the credit standing of borrowers and the transaction-specific guarantees. The timeline of successive capital regulations enforce in the past is as following:

- 1988: Current Basel I Accord published
- 1996: Market Risk Amendment allowing usage of internal models.
- 1999: First Consultative Package on the New Accord.
- 2007: Implementation of the Basel II Capital Accord.

3.2.2 MORAL HAZARD

The depositor insurance, providing protection of bank depositors, generates moral hazard since there is no penalty for taking risks because of the insurance. The insurance mechanism can be seen as an incentive for risk taking because the depositors cannot impose real discipline on banks. A few literatures suggest that the theory of [Modigliani and Miller \(1958\)](#) is not applicable to banks. They argue that under the assumption of frictionless and complete markets, there would not be a need for financial intermediaries. [Sealey \(1983\)](#) shows that the lack of applicability is due to particular features distinguish financial institution operation from non-financial firms. He argues that when intermediaries accept deposit financing, they must produce services such as liquidity and convenience at considerable expense of real resources. In addition, the introduction of intermediation is likely to be accompanied by incomplete markets so that shareholder unanimity is not valid in general. If the information is not equally distributed, and the depositors cannot interfere

into the bank's activity, interest rates fail to fully reflect the risk of bankruptcy. Banks will have an incentive to increase leverage and risk, and moral hazard arises.

Under the deposit insurance, there exists moral hazard since depositors do not incur any risk by depositing their funds with a bank under full cover. Their pay-off is deterministic and independent of the riskiness of the banks' assets, and they lose any incentive to monitor banks behaviour. [Thies and Gerlowski \(1989\)](#) and [Wheelock \(1992\)](#) examine the US market and find deposit insurance has a positive impact on bank failure rates. [Wheelock \(1992\)](#) shows that the balance sheets of insured banks reflecting greater risk-taking, and insured banks were more likely to fail than non-insured banks. [Demirgüç-Kunt and Detragiache \(2006\)](#) find evidence that during 1980-1997, explicit deposit insurance tends to increase the likelihood of banking crisis. The influence is stronger where bank interest rates are deregulated, and institutional environment is weaker, which shows higher moral hazard due to deposit insurance.

On the other hand, the results from [Gropp and Vesala \(2001\)](#) are in contrast to most of the previous empirical literature. They find evidences that the establishment of explicit deposit insurance significantly reduces the risk taking of European banks, hence moral hazard. The results support the hypothesis that, in the absence of deposit insurance, European banking systems have been characterized by strong implicit insurance operating through the expectation of public intervention at times of distress. The results also show that, after the introduction of explicit deposit insurance, banks with lower charter values and more subordinated debt reduce risk taking further, which implies that charter values and subordinated debt may mitigate moral hazard. However, [Gropp and Vesala \(2001\)](#) find that large banks do not change their risk taking in response to the introduction of deposit insurance, which suggests that the introduction of explicit deposit insurance does not mitigate "too-big-to-fail" problems.

3.2.3 CHARTER VALUE AND REPUTATION

The traditional theoretical approach to the moral hazard problem in banking has been based on static models of bank behaviours (Furlong and Keeley 1989). Under risk-insensitive deposit insurance, higher mean-preserving portfolio risk and leverage are to the benefit of bank shareholders and to the detriment of the deposit insurance agency as show in Furlong and Keeley (1989). Banker's lowest payoffs are bounded at zero since they are protected by limited liability. However, in a dynamic framework, banks that go bankrupt are likely to suffer losses related to future payoffs, such as, reputation, financial regulations, and charter value (Suarez 1994). The higher the bank's charter value, the higher is the bank's private cost of portfolio risk and leverage.

In addition, financial liberalization tends to increase the intensity of competition between financial institutions while financial institutions are given greater flexibility to allocate assets and to determine interest rates. If the competition erodes the charter value, then the bank will increase leverage and risk. As a consequence, they tend to engage in higher risk activity in order to pursue higher profits (Hellman et al. 2000). Keeley (1990) shows empirical evidences that the increase in competition causing bank charter values to decline. He argues the decline in charter value will increase the default risk through increase in asset risk and reduction in capital. Furthermore, Hellman et al. (2000) study two potential instruments of prudential regulation, capital requirements and deposit-rate control. They show that the capital requirement is costly because they force banks to hold expensive capital. However, the minimum capital requirements have adverse incentive effect because increased financing through expensive capital lowers the profit and banks, therefore, banks will lose less charter value when going bankrupt. Therefore, capital requirement can only eliminate moral hazard for financial institutions that give less weight to periods more distant in the future. Hellman

[et al. \(2000\)](#) argue that a combination of capital requirement and deposit-rate control is more favourable.

3.2.4 OWNERSHIP STRUCTURE

All of the above discussions are from shareholders' aspects. We assume shareholders control the financial institutions and the managers act fully in the shareholders' interests. However, in many situations, managers may have preferences diverging from shareholders' interests ([Stolz 2002](#)). [Saunders et al. \(1990\)](#) discuss the conflict of interests between shareholders and bank managers, and show that during 1979-1982 period of relative deregulation; shareholder-controlled banks exhibit significantly higher risk taking behaviour than managerially controlled banks. They point out that the risk taking incentives of bank managers will depend on the degree to which their best interests or preference are tied to those of value-maximizing shareholders. The managers' wealth is mostly in non-diversified human capital form; therefore, managers tend to act in risk-averse rather than a value-maximizing manner to lower the risk of default. This also suggests that high bank charter values can mitigate moral hazard of shareholders. [Saunders et al \(1990\)](#) also examine the influence of the ownership structure, regulatory environment and other bank specific variables. Their results suggest there is an agency problem, that is, bank loan portfolios are found to be less risky when the bank managers also hold capital of the bank other than outside shareholders.

3.2.5 RECAPITALIZATION

In the previous discussion, we have shown the effects of moral hazard, charter value, capital regulation on bank capital and risk-taking behaviours of managers and shareholders. The

recapitalization of capital-constraint banks is found to have impact on the bank capital structure. [Furlong and Keeley \(1989\)](#) examine the difference in stock price reaction after voluntary capital injections by commercial banks and involuntary recapitalization required to meet regulatory capital requirement on US bank holding companies during 1975-1986. He finds evidences of a significant drop in the share price of capital-constrained banks after recapitalization. However, if banks have high capitalization rate, the stock price does not show a significant response and less decrease in magnitude. [Cornett and Tehranian \(1994\)](#) find different results during 1983-1989 in their study. In addition to the reduction in stock price after both types of recapitalization, they find the stock price experiences greater decrease during voluntary common stock issue. The results also show that the stock price reaction is negatively related to the size of the offering and positively related to managerial ownership structure prior to the security issue. This means the higher the insiders' holding, the smaller the decline. Although different results are obtained in the two studies, a drop in share price after recapitalization is captured in both papers. [Berger et al. \(2008\)](#) find that banks would face a lower cost of raising equity at short notice tend to hold significant more capital. Therefore, shareholder and banks managers need to take into account of the recapitalization cost and effect on the share price when making any decision on their capital position.

3.2.6 REGULATORY CAPITAL REQUIREMENTS

The discussion on whether bank capital requirements are the first order determinant of banks capital position has been long. A common justification for capital regulation for banks is the reduction of bank moral hazard. With high leverage level, there is an incentive for banks to take on excessive risk. It is widely considered that equity capital is more costly for banks than other types of funding; therefore, many studies analyze the binding relationship

between bank regulation and capital adequacy. [Allen et al \(2011\)](#) show that banks are more often willing to hold positive levels of capital well above the regulatory minimums, which indicates the actual capital holdings tend to vary independently of regulatory changes. Similar findings have been found in many recent literature. By comparing the actual capital holdings to regulatory requirements in the United States, [Flannery and Rangan \(2008\)](#) find that banks' capital ratio increased substantially in the last decades, with banks holding capital level that were 75% in excess of the regulatory minimums in early 2000. [Ashcraft \(2001\)](#) shows that, during 1980s, the increase in the banks' capital holding ratio is independent of changes in regulatory requirement. The weak relationship between capital holdings and regulatory capital requirement is also found in countries other than the United States. The banks' capital ratio in the United Kingdom increased in the last decade despite a reduction in capital requirement with an average capital buffer of 35%-40% ([Alfon et al 2004](#)). Similar trend is also observed in countries like Spain. [Barrios and Blanco \(2003\)](#) argue that Spanish banks' capital ratios in period 1985-1991 were primarily driven by the pressure of market forces rather than regulatory constraints. Furthermore, the results from [Gropp and Heider \(2010\)](#) show that they did not find a first-order effect of regulation on banks' capital holdings.

Although the capital holding ratio is well above the regulatory minimum and continues to increase over the past few decades, the financial crisis that started in 2007 raises the question of whether banks are, in fact, undercapitalized. However, there is no universal conclusion on how much capital that banks should hold relative to the ideal social-welfare-maximizing level. [Flannery \(1994\)](#) examines the capital structure of financial intermediary firms, commercial banks, savings and loans, finance companies and some insurance companies. The paper evaluates the optimal means of financing a portfolio of bank-type loans. He argues that because bank asset portfolios are unusually fluid, standard debt-contracting

mechanism cannot control leveraged investment distortions as successfully as they control those of non-financial firms. The results show that banking firms' illiquidity risk is not caused by the transaction nature of their deposits. Policy concerns about financial firms' liquidity can be distinguished from concerns about payment-system stability. However, he argues that regulations separating illiquidity from the payment system would not eliminate illiquidity risk from the economy but would only transfer that risk to institutions that are not directly involved in the payment system. These results suggest capital requirements are not the first order determinants for the financial institution capital structure. [Diamond and Rajan \(2000\)](#) study the determinants of optimal bank capital structure by modeling the essential functions banks perform and identifying the role capital plays. The results show three areas affected by bank capital are bank safety, the ability to refinance at low cost and the ability to liquidate the loans. The paper also suggests that the influence of regulatory capital requirements and deposit insurance is overlooked over the last two centuries.

The above literature provides theoretical discussion and evidence on the determinants of bank capital structure. In addition, there are many studies empirically examine the factors influences the banks' capital structure. [Berger et al \(2008\)](#) find empirical evidences that US banks hold significantly more equity capital than required by their regulators. The paper adopts partial adjustment non-linear regression approach by using the data of period 1992-2006 for publicly traded US bank holding companies. They examine the two possible reasons for the high capital ratio. One possibility is the pecking order view of capital structure, which states when banks are profitable they retain those earnings, and, as a result capital ratios passively rise. Another possibility is that large banks actively target high capital ratio because market conditions make them optimal. [Berger et al \(2008\)](#) find that, during the year 1992-2006, banks either partially or fully offset new share issuance with existing share repurchases, and in six of those years banks repurchased enough existing

equity to fully offset the new share issuance plus offset a portion of retained earnings. These patterns indicate that banks actively managed their capital ratios freely by repurchasing shares to offset other additions to equity capital. The study also finds strong evidence that target capital ratios decrease with bank size and increase with bank retail deposit franchises. The capital target ratios also decline with banks' market-to-book values because cheap access to capital reduces large banks' demand for a precautionary capital. Apart from the findings that large banks have the higher than the required capital ratio, capital ratios at the average banks are relatively close to the targets, and any deviation from their target capital ratios are found to be adjusted quite rapidly. [Brewer et al \(2008\)](#) extend the literature on bank capital structure by modeling capital structure not only as a function of bank specific variables, country macro-economic conditions and country level financial characteristics, but also important public policy and bank regulatory characteristics of home country. They argue that these forces affect the capital structure of banks by affecting the intensity of competition in the banking sector, the extent of any bank safety-net, the extensiveness of capital standards, and the ability of bank regulators to intervene promptly and effectively in troubled banks. The findings show that, bank capital ratios are significantly affected by most of the bank-specific variables. In addition, [Brewer et al \(2008\)](#) also find there is a difference in the capital ratio between banks from different countries. Banks maintain higher capital ratios in home countries in which the banking sector is relatively smaller and in countries that practice prompt corrective actions more actively, have more stringent capital requirements, and have more effective corporate governance structures. The observed differences in capital ratios across countries may be partially explained by the public policy and regulatory regimes the countries themselves put in place.

The above discussions have shown that there are many factors which can contribute to the differences in the capital level which firms or banking organizations wish to maintain.

However, except for these determinants, researchers have identified some relationships and interaction between capital level, equity, deficit and even timing. In the following section of this paper, we will discuss the most popular capital structure theories in the literature.

TRADE-OFF THEORY

According to the trade-off theory, capital structure is determined by a trade-off between the benefits and the costs of debt. The benefits and costs can be obtained in a variety of ways. One perspective is “tax-bankruptcy” trade-off of which firms tend to balance the tax benefits of debt against the deadweight costs of bankruptcy. Another perspective is to discipline managers, and mitigate agency problems of free cash flow since debt must be repaid to avoid bankruptcy (Jensen 1986). However, the using of debt proposes other conflicts of interests between shareholders and debt holders (Stulz 1990).

There are also a few discussions of capital structure based on the interaction between product and factor market (Harris and Raviv 1991). These theories have explored the relationship between capital structure and either product market strategy or characteristics of products. The results show that oligopolists tend to have more debt than monopolists or firms in competitive industries (Brander and Lewis 1986) and the debts tend to be long term (Glazer 1989). It is also found that firms producing unique or high quality products and services are expected to have less debt (Titman 1984).

PECKING ORDER THEORY

The pecking order theory refers to the preference that firms finance new investment. Retained earnings are considered as a better source of funds than outside (Myers and Majluf

1984). If retained earnings are inadequate, debt financing will be used. Equity is only used as a last resort. This is because of the asymmetric information between investors and insiders. If investors are less well-informed than current firm insiders about the value of the firms' asset, then equity may be mispriced by the market. If firms are required to finance new projects by issuing equity, underpricing may be so severe that new investors capture more than the NPV of the new project, resulting in a net loss to existing shareholders (Myers and Majluf 1984). So, it is also the reason that, in some cases, the project will be rejected even if the NPV is positive. The underinvestment can be avoided if the firm can finance through securities that are not so severely undervalued by the market, e.g. internal fund and debt. Therefore, capital structure will be driven by firms' desire to finance, firstly from internal retained earnings, then with low-risk debt, and finally with equity only as a last resort (Myers and Majluf 1984).

MARKET TIMING THEORY

The market timing theory explains that in term of financing managers look at current conditions in both debt and equity market. If they need financing, they use whichever market currently looks more favorable. If neither market looks favorable, finance managers may defer issuances. Alternatively, if current conditions look unusually favorable, funds may be raised even if the firm has no need for funds currently (Frank and Goyal 2009). Many literatures have found various evidences of market timing theory. Graham and Harvey (2001) find that firms tend to issue equity following a stock pick-up. Baker and Wurgler (2002) show that capital structure is best understood as the cumulative effect of past attempts to time the market. All of these results suggest that stock returns and debt market conditions play an important role in capital structure decisions.

3.3 RELATION BETWEEN FINANCIAL AND NON-FINANCIAL INSTITUTIONS

Banks are private corporations that are subject to pervasive government regulation in all countries. [Brewer et al \(2008\)](#) argue that banks that use equity capital to fund its operations should be determined by the same set of factors that influence other non-financial firms together with the combined impact of any government safety net policies and capital regulations. [Gropp and Heider \(2010\)](#) use the empirical evidences on non-financial firms to explain the capital structure of large and publicly traded banks. The results show that there are considerable similarities in capital structures between financial and non-financial institutions. They also find evidences that most of the banks seem to be optimizing their capital structure in much the same way as other firms, except when their capital comes close to the regulatory minimum.

Based on the theories of capital structures for the general corporations, [Brewer et al \(2008\)](#) identify that banks share the same pattern with firms that capital positions are determined by the trade-off between the benefits and costs of debt financing ([Fama and French 2002](#)). The benefits of debt financing include any tax shield provided by debt but not by equity, and reductions in the cost of agency conflicts between firms' owners and manager. The costs of debt financing include higher expected costs of financial distress and increases in the greater cost of agency conflicts between the firm's owners and its creditors ([Fama and French 2002](#)). Another theory of capital structure from non-financial firms is also adopted by [Brewer et al \(2008\)](#). The short-run costs of adjusting a firm's capital structure exceed the benefits of capital structure changes over wide ranges. Firms change their capital structure in a predetermined pecking order, retained earnings, issuing debt, and then issuing equity ([Myers and Majluf 1984](#)). Firms issue new equity to fund remaining projects only if the marginal costs of issuing additional debt exceed the costs of issuing equity. Therefore, under this pecking order, the firm's capital ratio at any moment of time can vary over potentially

wide ranges. Furthermore, the standard cross-sectional determinants of firms capital structures also apply to large and publicly traded banks in the US and Europe, except for banks close to the minimum capital requirement [Berger et al. \(2008\)](#). However, [Berger et al. \(2008\)](#) also find the consistency between non-financial firms and banks does not extend to the components of leverage, i.e. deposit and non-deposit liabilities. From time to time, banks have financed their balance sheet growth entirely with non-deposit liabilities, which implies that the composition of banks total liabilities has shifted away from deposits. It is also observed, in a dynamic framework, bank capital structure and target leverage are time-invariant and specific to individual bank.

Many literatures have identified the impact of government policies in many aspects ([Flannery 1994](#), [Berger et al. 1995](#), [Marshall and Prescott 2001](#) etc.). Firstly, the government provides under-priced guarantees, e.g. explicit deposit insurance and implicit guarantees of deposit and other liabilities ([Berger et al. 1995](#)). The effect of under-priced liability guarantee is to reduce the marginal benefit of higher private capital and, thus, reduce bank's use of equity capital. Secondly, regulators may also change banks' capital structure by increasing the costs associated with capital level the regulators seem inadequate. If the regulatory requirements are higher than the bank's optimal ratio and the costs of violating the requirements are sufficiently high, then banks would maintain capital levels exactly at supervisory minimums. This is the trade-off theory with binding regulation ([Marshall and Prescott 2001](#)), where capital regulation overrides the optimal capital structures as seen in corporate firms. This suggests that there should be little cross-sectional variation in the leverage ratio of those banks falling under the Basel regulatory, since it prescribes an uniform capital ratio. Many literatures have discussed banks tend to hold less bank capital than is required by the regulatory authorities because of the high costs of holding capital. Therefore, in this case, the amount of bank capital is determined by the bank capital

requirements. However, if the costs of adjustment are not large enough to prevent adjustments in a bank's capital positions, then the impact of capital adequacy regulation would depend on whether the supervisor's requirements were above or below the individual bank's value maximizing level. If the regulatory capital requirements are less than the bank's optimum capital ratio, the regulations will have no effect, the trade-off theory of bank capital determination with non-binding regulation. [Flannery \(1994\)](#), [Myers and Rajan \(1998\)](#) and [Allen et al. \(2009\)](#) study the optimal bank capital structure and find that capital requirements are not necessarily binding. From market aspects, banks' capital structures are the outcome of pressures from shareholders, debt holders and depositors.

In addition, if both the cost of adjustment and the cost of falling below the regulatory standard are high, banks would seek to maintain capital in excess of the regulatory minimum. [Berger et al. \(2008\)](#) and [Brewer et al \(2008\)](#) observe that the level of bank capital is much higher than the regulatory minimum. They show that banks optimize their capital structure like non-financial firms, which would relegate capital requirement to second-order importance. In this case, banks maintain a capital buffer above the minimum required ratio. The size of the buffer depends on the costs of falling below the supervisory minimums, on the distribution of potential adverse shocks to capital, and on the changes in the retained earnings. [Wall and Peterson \(1987\)](#) are the first few papers to introduce a capital buffer factor in their empirical analysis of the impact of regulatory factors on bank capital determination. [Peura and Keppo \(2006\)](#) model the trade-off of banks' capitalization decision based on the buffer stock role of bank capital, and find that there is a significant fraction of the cross-sectional variation in bank capital ratios. The buffer effect is also examined in countries other than the United States. [Ayuso et al \(2004\)](#) estimate the relationship between the Spanish business cycle and the capital buffers held by Spanish commercial and saving

banks over the period 1986-2000. They find significant negative relationship between the position in the cycle and capital buffers.

3.4 METHODOLOGY

In this paper, we will examine whether the capital level of banking organizations follows the pecking order theory and what factors can influence the level and change of capital ratio that banks wish to maintain.

In the real world, company operations and the associated accounting structures are more complex than the standard pecking order representation. This implies that the aggregation should be used in order to test the pecking order. In this paper, we adopt the methodology from the corporate finance theory and applied to the financial institution sector. One concern of testing the pecking order theory on banks is that banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. The term deposit is used by the banking industry in financial statements to describe the liability owned by the bank to its depositor, and not the funds that bank holds as a result of the deposit, which are shown as assets of the bank. When taxpayers put funds into the bank, it is recognized as an asset by the bank. On the other hand, the bank credits a liability account for the same amount to show as a liability owed by the bank to its customer. Therefore, the debt structure in banking is different from non-financial firms. For the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because the taxpayers funds deposit in the bank.

To test the pecking order theory, we adopt and borrow the methodology developed in the studies in [Shyam-Sunder and Myers \(1999\)](#) and [Frank and Goyal \(2003\)](#), and we define the notation as follows:

DIV_t Cash dividends in year t;

I_t Net investment in year t (i.e., I_t = capital expenditures + increase in investments + acquisitions + other use of funds – sales of PPE – sales of investment);

ΔW_t Change in working capital in year t (i.e., ΔW_t = change in operating working capital + Change in cash and cash equivalents + change in current debt);

C_t Cash flow after interest and taxes (i.e., C_t = income before extraordinary items + depreciation and amortization + extraordinary items and discontinued operation + deferred taxes + equity in net loss – earnings + other funds from operations + gain (loss) from sales of PPE and other investments);

R_t Current portion of the long-term debt in year t;

ΔD_t Net debt issued in year t, (i.e., ΔD_t = long-term debt issuance – long-term debt reduction);

ΔE_t Net equity issued in year t (i.e., ΔE_t = sales of common stock minus stock repurchases).

According to the rational of accounting cash flow, we can aggregate the above notation as following:

$$DEF_t = DIV_t + I_t + \Delta W_t - C_t \quad (1)$$

[Shyam-Sunder and Myers \(1999\)](#) argue that under the pecking order hypothesis, after IPO equity issues are only used in extreme circumstances. Therefore,

$$\Delta D_{it} = a + b_{po}DEF_{it} + e_{it} \quad (2)$$

Where e_{it} is a well-behaved error term.

If the [Shyam-Sunder and Myers \(1999\)](#) pecking order hypothesis follows, the coefficient $\alpha = 0$ and $b_{po} = 1$. Despite for the accounting definition, [Shyam-Sunder and Myers \(1999\)](#) and [Frank and Goyal \(2003\)](#) include the current portion of long-term debt as part of the financing deficit beyond its role in the change in working capital. The flow of funds deficit is defined as

$$DEF_t^{SSM} = DIV_t + I_t + \Delta W_t + R_t - C_t \quad (3)$$

The hypothesis is examined in the [Shyam-Sunder and Myers \(1999\)](#) and [Frank and Goyal \(2003\)](#), they try both approaches and find that empirically the current portion of long-term debt does not appear to belong in the definition of DEF_{it} . On the other hand, cash and cash equivalents are included with changes in working capital in our aggregation formula. This is consistent with the previous work, as in [Frank and Goyal \(2003\)](#). [Frank and Goyal \(2003\)](#) show that although including changes in cash balance could arise in debt and equity issues, the conclusion results are not affected.

In order to control for the size differences of financial institutions, the variables in the equation (2) are usually scaled by size factors, e.g. net asset, total book asset, sum of book debt plus market equity, and sales. Although, algebraically, dividing right- and left- hand side by the same value does not change the equality of the equation, if the scaling is by a variable correlating with the variables in the equation, the estimated coefficient can be seriously affected. However, in the findings of [Frank and Goyal \(2003\)](#), they show that using the different scaling factor in the estimation does not affect the results of the pecking order. In this paper, we replicate all the tests by all scaling factors, and we found the results are very similar and do not affect our conclusions.

Another issue we need to take into consideration is that the pecking order theory treats the finance deficit as exogenous. However, as financing deficit includes investment and

dividend, many of previous studies have studied the determinants of these factors; therefore, it may not appropriate to consider finance deficit as pure exogenous. If finance deficit is regarded as endogenous variables, the equation (2) is misspecified. If a model is misspecified, a small change to the specification may lead to large changes in the estimated coefficients, and the model is likely to be unstable across periods. Such instability would be an indicator of the failure of the model. [Frank and Goyal \(2003\)](#) use two steps to tackle the concerns. Firstly, they take robustness check on all tests. They show that most of the findings are robust. Secondly, the ability to predict debt issues by a holdout sample of firms is examined directly to address the concern that the model may perform well within the sample but it cannot be generalized out of the sample.

In order to test the pecking order theory, we aggregate the accounting data as in equation (1)-(3). There may be information in the finance deficit that helps account for changes in equity issuance, but not in the subject to the pecking order theory. Therefore, to check the reasonableness of the aggregation, we will test the equation on a disaggregated basis, and then check whether the data satisfies the aggregation step. The pecking order test implicitly makes different exogeneity assumptions and uses different information sets that are conventional in empirical research on leverage and leverage-adjusting behaviour. Similar approach has been tested in [Frank and Goyal \(2003\)](#).

Consider the following framework,

$$\Delta D_{it} = a + b_{DIV}DIV_t + b_I\Delta W_t + b_C C_t + e_{it} \quad (4)$$

Under the framework in equation (4), a unit increase in any of the components, DEF_{it} must have the same unit impact on ΔD_{it} . If the pecking order holds the coefficients should satisfy the equality $b_{DIV} = b_I = b_W = b_C = 1$, and the equation (4) is justified. If the significance is

only driven by some of the individual component, then alternative coefficient patterns are possible.

However, the pecking order theory cannot give a complete justification on the factors that considered by the banking organizations when deciding the capital level, especially when considering financial institutions, such as banks. This is because that banks are different in terms of leverage relative to non-financial firms. Therefore, in order to examine the determinants of capital level, we need to adopt a more conventional approach. The conventional set of explanatory factors for leverage has survived many tests and has traditional interpretations. Excluding such variables from consideration is potentially significant omission. The traditional leverage regression is intended to explain the level of leverage, while the pecking order regression is intended to explain the change rather than the level. As long as the shocks are uncorrelated across year, we can equally run the conventional specification in first differences.

In the conventional capital structure empirical analysis, a regression of leverage is on four factors: tangibility of asset (T), market-to-book ratio (MTB), log sales (LS), and profitability (P). In [Frank and Goyal \(2003\)](#) study, they include the finance deficit factor (DEF), and all the factors are made to the first differences between years. The primary hypothesis examined in the paper is that country-specific economic and public policy factors can help to explain cross-country differences in bank capital ratios. The regulatory policy influence is examined empirically in the relationship between changes in the capital ratios of banks in addition to the variables that explain banks' capital structure by bank specific factors and country specific economic variables.

As used in [Marcus \(1983\)](#) and [Brewer et al \(2008\)](#), we adopt the methodology of relating bank target equilibrium capital ratio CR to a set of explanatory variables, X . In the paper, we

use three sets of explanatory variables, including bank-specific, country-specific economic and regulatory variables.

$$CR^* = \gamma_0 + \gamma X \quad (5)$$

3.4.1 BANK-SPECIFIC FACTORS

The empirical corporate finance literature has identified a set of variables that are reliably related to the leverage of non-financial firms as discussed in [Titman and Wessels \(1988\)](#), [Rajan and Zingales \(1995\)](#) and [Frank and Goyal \(2004\)](#). From previous literature, they find evidence that, in general, the leverage is related to the size, collateral, profits, market-to-book ratio and dividends. When considering bank capital structures, we have shown that the behaviour of bank capital structure shares some similar characteristics with the general non-financial institutions ([Brewer et al 2008](#), [Gropp and Heider 2010](#) and [Berger et al. 2008](#), etc). The standard view is that capital regulation constitutes an additional factor influencing the bank capital structure. Commercial banks have deposits that are insured to protect depositors and to ensure financial stability. In order to mitigate the moral-hazard of this insurance, commercial banks are required to hold a minimum amount of capital. Therefore, under the compulsory requirement, the standard corporate finance determinants should, therefore, have little or no explanatory power relative to regulation for the capital structure of banks in our sample. Another theory on the bank capital structure is the existing of capital buffer, or discretionary capital, above the regulatory minimum in order to avoid the cost of issuing equity at short notice, as discussed in [Ayuso et al \(2004\)](#) and [Peura and Keppo \(2006\)](#). Under the buffer concept, [Gropp and Heider \(2007, 2010\)](#) and [Shrieves and Dahl \(1992\)](#) have analysed the determinants of bank optimal capital structure. They found that the bank asset-size is negatively related to the capital ratio, i.e. the larger the bank size, the

lower the capital-to-asset ratio. They explain it is because larger banking organizations typically have better-diversified asset portfolios than smaller banks, which reduces their risk exposure and capital needs. Larger banks may also be viewed as more likely to be “too-big-to-fail” and thus require less private capital to remain in operation. In addition, bank risk exposure is found to be positively correlated with the bank capital arrangement. Profitability also influences banks target capital ratio. [Gropp and Heider \(2001, 2010\)](#) find that more profitable banks tend to have more capital relative to assets. This finding is consistent with the predicted pecking order theory of capital structure that firms tend to firstly rely on their retained earnings to fund new projects. Dividend paying banks are found to have higher leverage ratio, and this is consistent with the influence of bank profitability. This is because profitable and dividend paying banks can be expected to face lower costs of issuing equity since they are either better known to the outsiders, and they can obtain a better price. Moreover, an increase in the banks risk exposure increases its target capital ratio because it increases the probability of insolvency and the cost of bankruptcy for any given capital ratio.

3.4.2 COUNTRY-SPECIFIC MACROECONOMIC FACTORS

A country’s business cycle and economic growth rates and the extent to which its financial system is bank-based are important determinants of the capital structure of banking organizations headquartered in that country ([Brewer et al 2010](#)). The impact of higher economic growth rate on capital ratio is unclear. Higher growth rate in any given year may be associated with greater growth possibility in the banking sector and higher target capital ratio to accommodate the possibility. On the other hand, higher growth rate may be associated with lower capital ratios under the pecking order theory if assets grow faster than internally generated capital. [Schaeck and Cihak \(2009\)](#) show that banks tend to hold higher capital ratios when operating in a more competitive environment. [Brewer et al \(2008\)](#) also

find evidences that in countries when the economy is bank-based, the competitions from capital markets are less than the market-based economy, thus less risk of bank insolvency. Bank-based financial system makes regulatory easier to capture the movement in the capital structure in the banks. In an economy where banks are important, the impact of bank safety-net is more intensive, and private capitalization of banks is lower.

3.4.3 COUNTRY-SPECIFIC PUBLIC POLICY FACTORS

[Brewer et al \(2010\)](#) find evidences that government policies influence capital both directly and indirectly through their impact on market discipline. Banking organizations are likely to increase their target capital ratios when they perceive that the regulatory authorities would impose a significant penalty on them for not being adequately capitalized. In addition, bank size may also impact supervisory capital requirements to the extent large banks are able to exercise greater political influence on bank supervisors. [Baumann and Nier \(2003\)](#) show that higher level and better governance tend to lead to higher profit because it suggests a higher degree of outside monitoring that encourage banks to be both more efficient and more heavily capitalized. Furthermore, better governance in banks also tends to have higher capital ratios and more protection against unexpected losses.

The discussion above show that banks optimize their capital structure in a similar way as non-financial firm as shown in many literature and plus a number of bank specific factors ([Gropp and Heider 2010](#), [Brewer et al 2008](#), etc.). The target equilibrium capital ratio (CR^*) for bank i can now be written as following:

$$\begin{aligned}
CR_{i,c,t}^* = & \gamma_o + b_0 \text{Bank Specific Variables} \\
& + c_0 \text{Country Specific Economic Variables} \\
& + d_0 \text{Country Specific Public Policy Variables} + f_0 \text{Controls} \\
& + \text{Time Fixed Effects}
\end{aligned} \tag{6}$$

However, in reality we cannot observe the target equilibrium ratios in any period directly. Instead, the change in the bank capital ratios between periods and ratios of prior periods can be observed directly. Therefore, the target equilibrium ratio can be seen as a combination of bank capital ratios from previous periods and change in the ratios. In the studies of [Shrieves and Dahl \(1992\)](#) and [Wall and Peterson \(1995\)](#), they found that the observed changes in bank capital ratios at any time can be decomposed into two components, a discretionary adjustment to its targeted equilibrium ratio and an adjustment caused by exogenous current event. The same algorithm is shared in the study of [Brewer et al \(2008\)](#).

$$\Delta CR_{i,c,t} = \Delta^d CR_{i,c,t} + \varepsilon_{i,c,t} \tag{7}$$

Where $\Delta CR_{i,c,t}$ is the actual change in the capital ratio, $\Delta^d CR_{i,c,t}$ is the desired discretionary change in the capital ratio and $\varepsilon_{i,c,t}$ is an exogenously determined random shock.

However, the banking organizations may not be able to adjust to its target equilibrium capital ratio instantly in the same period; therefore, the discretionary change in capital can be assumed to consist of another two components, the unobserved target equilibrium in period t and the observed capital ratio in the previous period $t - 1$. Therefore, the change in the capital ratio can be shown as

$$\Delta CR_{i,c,t} = \phi (CR_{i,c,t}^* - CR_{i,c,t-1}) + \varepsilon_{i,c,t} \tag{8}$$

As in equation (6), the unobserved target equilibrium capital is a function of bank-specific and country-specific variables; therefore, the change in the capital ratio can be represented as:

$$\begin{aligned} \Delta CR_{i,c,t} = & \phi\gamma_o + \phi(b_0 \text{Bank Specific Variables}_{i,c,t-1} \\ & + c_0 \text{Country Specific Economic Variables}_{c,t-1} \\ & + d_0 \text{Country Specific Public Policy Variables}_c + f_0 \text{Controls}_{c,t}) \\ & + \text{Time Fixed Effects} - \phi CR_{i,c,t-1} + \varepsilon_{i,c,t} \end{aligned} \quad (9)$$

Explanatory bank specific variables used in this paper in examining the bank capital structure include log of total asset (SIZE); return on asset (ROA), which is the bank net income divided by the average on-balance sheet assets; bank credit risk exposure (RISK), which is proxied by dividing bank Basel I risk-weighted assets by its total on-balance sheet asset, and it is estimated that the greater is this ratio, the greater is the bank portfolio credit risk exposure, and dividend paid to shareholders (DIV). The country economic independent variables are including the growth rate of real domestic product (RGDP), which is computed as the annual percentage change in a country annual rate of real GDP. Another country specific economic variable is the degree to which a country's financial system is bank-based (BANK), which is calculated by taking the total assets of the banking system dividend by the country's GDP. As for the country specific policy factors, we adopt the variables used in Brewer et al (2008), which include the level of external governance (EGOVERN), the extend of explicit regulatory requirements for the amount of capital that a bank must maintain relative to various guidelines (CSTAND), the degree to which a country's supervisory authorities are independent (INDEP), the existence of a law establishing predetermined levels of the bank solvency deterioration that forces effective automatic enforcement actions by regulators (PROMPT), the extent of deposit insurance system (MHI), the proportion of banks in the country owned more than 50% by the

government (GOVCONT50), the extent of country's ownership structure influence on bank capital ratio (CONTROLCF). The control variable used in this paper is the accounting standard adopted by the banks (ACCT).

Therefore, the partial adjustment model for the change in capital ratio can be developed as,

$$\begin{aligned} \Delta CR_{i,c,t} = & \beta_0 + \beta_1 CR_{i,c,t-1} + \beta_2 SIZE_{i,c,t-1} + \beta_3 ROA_{i,c,t-1} + \beta_4 RISK_{i,c,t-1} \\ & + \beta_5 DIV_{i,c,t-1} + \beta_6 RDGP_{c,t-1} + \beta_7 BANK_{c,t-1} + \beta_8 PROMPT_c \\ & + \beta_9 EGOVERN_c + \beta_{10} MHI_c + \beta_{11} CSTD_c + \beta_{12} INDEP_c \\ & + \beta_{13} GOVCONT50_c + \beta_{14} CONTROLCF_c + \beta_{15} ACCT_c + \varepsilon_{i,c,t} \end{aligned} \quad (10)$$

3.5 DATA AND DESCRIPTIVE STATISTICS

The data we use in this chapter are banking institutions data from year 1991 to 2011, which are obtained from CRSP, Bankscope and Bloomberg database. We construct a sample of large banking organisations that may expose to large economic and financial forces. We identify 358 largest banks by total book assets of financially matured developed countries, including, Austria, Australia, Belgium, Canada, France, Germany, Italy, Japan, Netherland, South Korea, Sweden, Switzerland, United Kingdom and United States etc. Banks with cooperative or government ownership are excluded as these banks' objective function is likely to include more maximizing long-run shareholder value and they may be subject to broader safety net and other government guarantees. Since the data for each bank may not be available in every year, the same banks are not included in each year, and the sample is an unbalanced panel. All financial statement data for the banks in the sample are obtained

from CRSP, Bankscope and Bloomberg database. Data on additional country specific and control variables are obtained from IMF *International Financial Statistics*.

There are two different measures of bank capital ratios are specified as the dependent variables. The first dependent variable is the common equity ratio, which is the ratio of a banking organization's book value of equity to the book value of total on-balance sheet asset. The second dependent ratio variable is the Tier 1 capital ratio, which is bank's book value of Tier 1 capital to the book value of Basel I risk-weighted on and selected off-balance sheet asset. US regulations set minimum requirements for both the risk-based ratio and for a leverage ratio where the capital measure primarily consists of equity. European capital regulations usually rely exclusively on the risk-based capital ratio. Another dependent variable we use when testing especially for the pecking order of bank organizations is the net debt issued during the year.

In terms of independent variables, from the cash flow statement, we obtain amount of cash dividend paid, DIV_t ; net amount of investment made during the year, I_t ; any change in the working capital in the year, ΔW_t ; cash flow after interest and taxes, C_t . We also obtain the variables, total book assets, $SIZE$ and current liability. All the cash flow related variables we use to test the pecking order theory are scaled by the net asset, which is calculated as total asset minus current liability in order to eliminate any bias in different sizes between banks. Explanatory variables used in examining the banks' capital structure include bank specific variables, log of total asset ($SIZE$); return on asset (ROA), which is the bank net income divided by the average on-balance sheet assets; bank risk credit risk exposure ($RISK$), which is proxied by dividing bank Basel I risk-weighted assets by its total on-balance sheet asset, and it is estimated that the larger is this ratio, the greater is the bank's portfolio credit risk exposure and dividend paid to shareholders (DIV). Countries economic independent variables include the growth rate of real domestic product ($RGDP$), which is computed as

the annual percentage change in a country annual rate of real GDP. Another country economic variable is the extent to which a country's financial system is bank-based (BANK), which is calculated by taking the total assets of the banking system dividend by the country's GDP. The country specific economic information is obtained from the IMF International Financial Statistics database. All the bank specific and country economic variables are lagged by one period.

The third set of independent variables is country specific public policy variables. Most of the variables are selected according to the response of relevant questions from the World Bank Survey¹⁹. In the following section of the paper, I will discuss the relevant variables used in the analysis, and how the variables are selected and constructed. The first public policy variable is EGOVERN to capture the degree of external governance. As discussed in Barth et al (2007), we construct the level of external governance using three sets of questions from the World Bank survey on the strength of external audit, the transparency of financial statements and the use of external credit rating and reliance on credit monitoring.²⁰ It is expected that a higher level of external governance should lead to higher capital ratios as risks would be both recognized and managed more efficiently. There are two way to construct the index of the policy explanatory variables. Dummy variables are used for both methods. If the answer to the survey question is yes, then it is counted as 1, and 0 otherwise. One way to construct the index is to add up all the dummy variables, and the resulted sum is the policy index. Another way is to use principle component analysis method on the

¹⁹ Bank Regulation and Supervision Survey by World Bank. This project includes the first comprehensive, cross-country survey of how banks are regulated and supervised, including requirements and regulatory powers regarding bank entry, ownership, capital, powers and activities, auditing, organization, liquidity, provisioning, accounting and disclosure, incentives for supervisors, deposit insurance, and disciplining powers including bank exit. The goal of this research is to draw conclusions for policy makers on key priorities in making their regulatory and supervisory framework more robust.
<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSitePK:469382,00.html>

²⁰ The questions we selected from the survey for the degree of external governance are question 5.1, 5.1.2, 10.3, 10.4, 10.4.1, 10.5 and 10.7.

dummy variables to construct the index. We have examined the results based on both measures, and there is no significant difference in terms of results. Only the results using the principle component analysis is reported in this paper.

The second policy variable is CSTD, which is used to capture whether a country has explicit regulatory requirements for the amount of capital that a bank must maintain relative to various guidelines. This index is obtained through the responses of five questions from the World Bank survey²¹ (Barth et al 2002): whether the country has a minimum capital-to-asset ratio that conforms to the Basel standards; whether the minimum capital-to-asset ratio varies with market risk; whether the market value of loan losses is deducted from reported accounting capital; and whether unrealized losses in the security portfolio or from foreign exchange operations are deducted from reporting accounting capital. It is expected that higher index value indicates greater capital stringency, which is associated with greater capital maintained by banks. In addition, variable INDEP measures the degree to which a country's supervisory authorities is independent. An independent supervisory agency reduces political capture of the regulatory authorities and should enhance the governance of banking organizations in the country (Barth et al 2002 and 2007). According to Barth et al (2002 and 2007), a higher level of regulatory governance should lead to increase supervisory discipline, which can lead to either higher bank capital requirements or, to the extent that the market perceives the greater supervisory discipline to be effective with lower capital ratios. We use the response of three questions²² from World Bank survey about how is the head of supervisory agency and directors are appointed; to whom are the supervisory bodies responsible; and how the head of the supervisory agency and other directors are removed. Another policy variable is PROMPT, which measures the existence of a law establishing predetermined level of the bank solvency deterioration which forces effective

²¹ The questions we selected from the survey for CSTD are 3.1.1, 3.3, 3.9.1, 3.9.2, and 3.9.3.

²² The questions we selected from the survey for INDEP are 12.2, 12.2.1 and 12.2.2.

automatic enforcement actions by regulators. We used the response of seven questions to aggregate the law establishment index in this paper²³ (Barth et al 2002): whether the supervisory authorities can force a bank to change its internal organizational structure; whether failure to abide by a cease-desist type order can lead to the automatic imposition of civil and penal sanctions on the directors and managers of a banking organization; whether the supervisory authorities can order a bank's director or managers to increase provisions to cover actual or potential losses; and whether the supervisory authorities can suspend the directors' decision to distribute dividends, bonuses or management fees. It is estimated that the greater the cost of poor performance imposed by regulators, the greater the capital banks wish to hold as protection.

As discussed in the previous sections, moral hazard is resulted as the system of depositor insurance which provides protection for bank depositors since there is no penalty for taking risks because of the insurance. It is suggested that deposit insurance has a positive impact on bank failure rates (Thies and Gerlowski 1989) and balance sheets of insured banks reflecting greater risk-taking. Insured banks were more likely to fail than non-insured banks (Wheelock 1992). Therefore, in order to examine the significance of moral hazard due to deposit insurance, moral hazard index variables are included in the analysis. We adopt the method used in Demirgüç-Kunt and Detragiache (2002) to construct the moral hazard index (MHI) by principle component analysis. The index includes indicators of co-insurance, broadness of scope, coverage of foreign currency and interbank deposits, extend of explicit coverage, type and source of funding, management, and nature of membership. It is expected that the higher value of the index, a broader safety-net that provides for greater opportunity for moral hazard behaviour of banks. As a consequence, countries with a higher

²³ The questions we selected from the survey for PROMPT are 6.1, 11.1, 11.2, 11.3.1, 11.3.2, 11.3.3 and 11.8.

chance of moral hazard behaviour are more vulnerable to the banking crisis because of the potential lower capital ratios.

Furthermore, another country specific variable is GOVCONT50, which proxies for the fraction of banks in a country that is government owned. We use the response of question 3.8.1 from World Bank survey used in [La Porta et al \(2002\)](#), which demonstrates the percentage of the top ten banks in which the government owns more than 50% of the stock. The high level of government ownership should be associated with lower private capital ratios. The extent to which a country's ownership structure influences its bank capital ratio is measured by variable CONTROLCF, which measures the spread or difference between the country average control rights and cash flow rights. As in [Brewer et al \(2008\)](#), we use the data from [Caprio et al \(2007\)](#) on control rights that reflect controlling shareholders' ownership and on cash flow rights that reflect the fraction of the firm's cash flow owned by its controlling shareholder. [Caprio et al \(2007\)](#) argue that a large value of the control spread may reflect both an owner's ability and incentives to expropriate bank resources, and it is more likely to be associated with greater risk taking by the banks with lower capital ratio. There is also an accounting standard control variable ACCT to denote whether the bank is using local GAAP or IFRS. If the bank is using local GAAP, it is recorded as dummy variable 0; if the bank is using IFRS, we record it as dummy variable 1. It is expected that the difference in accounting standard may vary capital ratios that banks hold.

From the capital market, we have observed that companies do not issue much equity after the IPO. The following Figure.1 shows the year-by-year trends of the change of net long-term debt and net equity relative to the financing deficit over net assets for the full period from 1991 to 2011. If banking organizations follow the pecking order, we will expect that the debt would track the financing deficit more closely than equity. The correlations between deficit and net debt and equity are relatively low, 0.29 and 0.02 respectively. The correlations

show that the net debt is more closely linked to the financing deficit than the net equity, which supports the pecking order theory. The link of financing deficit can also be seen from Figure.1. From the graph, between 1995 and 2008, banking organizations issue more debt than equity to financing. The trend reversed significantly between 2008 and 2012, in which more equity financing is used due to tightening lending market since the subprime and European debt crisis. The initial results show that banking organizations follow the pecking order theory more than non-financial firms (Shayam-Sunder and Myers 1999). In Frank and Goyal (2003) and Graham (2000) study, they show that non-financial firms use debt conservatively, and more external financing takes the form of equity. Since there is a regulatory capital ratio requirement, it is expected that banking organizations use debt financing cautiously, and except for the equity, banks finance themselves mainly from retained earnings.

Figure.1

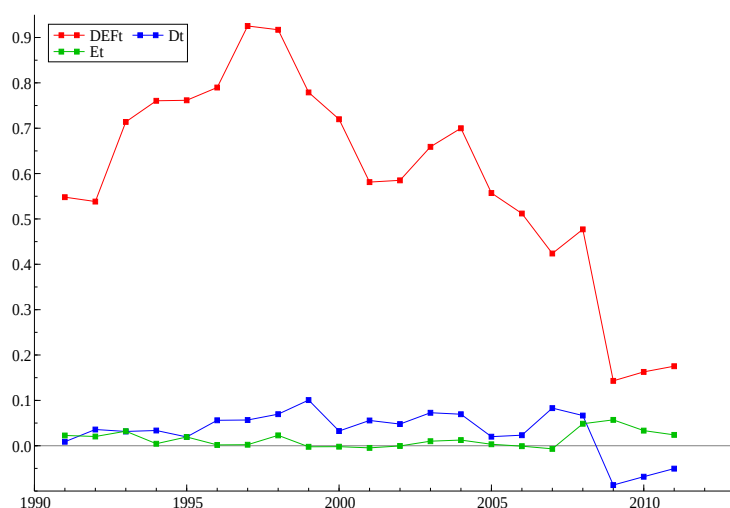


Figure.1 shows the year-by-year trends of the change of net long-term debt and net equity relative to the financing deficit over net assets of companies for the full period from 1991 to 2011. **DEFt** is the net deficit over net assets; **Dt** is the net long-term debt over net assets; and **Et** is the net equity over net assets.

The summary statistics for variables used in examining the capital structure are presented in Table.1. Due to data availability, the period used in testing the capital structure is from 1999 to 2011. The average equity and Tier 1 capital ratios are 8.6% and 11.3% respectively, which are higher than the Basel II bank capital ratio requirements. The average change in equity and Tier 1 capital ratio is small, with mean 0.08% and 0.28% respectively. However, the standard deviations for both ratios are significant which shows there are substantial variations in the equity and Tier 1 ratios. The Tier 1 capital ratio changes over time. From the Figure.2 we notice that from year 1998 to 2011, the capital ratio is above 10.5%, with fluctuation around its average 11.3%, which is well above the regulatory requirement 6%. The Tier 1 capital ratio decreases from 11.8% in 1998 to 11.0% in 2000 and to 10.5% in 2007, with a slight rebound of capital ratio to 11.4% in 2003. The results show that banks tend to increase the leverage level and take on more risk when the economy is booming until the economy breaks down. The two troughs in the capital ratio occur at two recent financial crises in 2000 and 2007 respectively. The financial and credit tension in the economic market has driven many banks and firms bankrupted. The inter-bank lending is increasingly tight during the financial crisis and banking organizations increase the capital holding in the case of freezing credit market. This can be shown on the graph that there is a rebound of capital ratio after each crisis. The average capital ratio increases sharply after the breakout of the subprime crisis in 2007, the capital ratio increased from 10.5% to 14.6% in 2011. The trend shows banking organizations in recent year have increased the capital holdings to hedge the liquidity risk and to be in compliance with the tightening regulations.

Figure.2

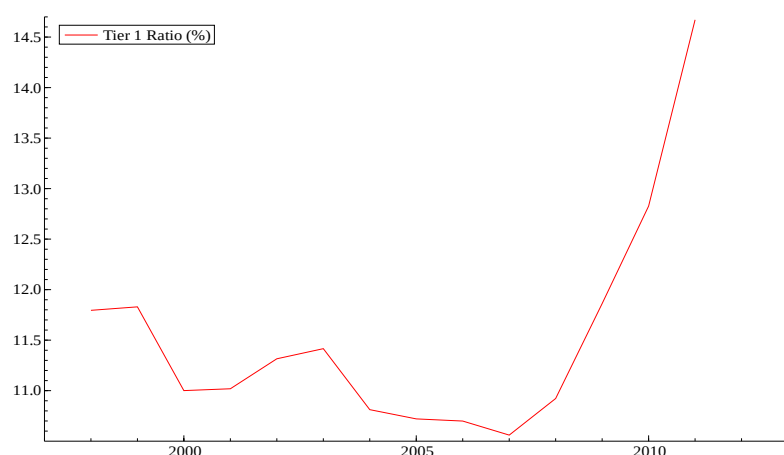


Figure.2 shows the changes of Tier 1 capital ratio over period from 1998 to 2011. Over the entire period, the capital ratio is above 10.5%, with fluctuation around the average 11.3%, which is well above the regulatory requirement 6%.

The average log total asset is 8.64 with standard deviation 2.05. The mean return on average asset is 0.65%, but the return is very volatile with unconditional volatility of 1.26%. Since 1998, the return on average assets decreases significantly from peak 1.19% around 2002 to 0.35% in 2011. The returns are lowest in 2008 and 2009 of 0.03% and -0.19%, which reflects the huge impact on the banking profitability and industry as a whole after the subprime crisis. The banking industry is still struggling since the 2008, and the situation escalates after the breakout of European debt market. The average percentage change in real GDP is 0.01% with unconditional volatility of 0.02%. In terms of country-specific policy factors, from the World Bank survey we notice that countries such as Canada, Switzerland and Germany have a high degree of external governance than US, UK and Spain. There is more regulatory requirement for the amount of capital that a bank must maintain in UK and France than in Belgium and Ireland. In addition, countries with more developed banking industry, such as UK, Germany and United States, have less independent supervisory authorities. The extent of country's safety net shows that Norway, Italy and United States have higher moral hazard index than Switzerland, Germany and Sweden. Larger extent of safety-net means there is a high chance for the moral hazard to occur since banks are likely to take the higher

risk because of the deposit insurance system. The level of government ownership of banking organizations varies across different countries. Germany has the highest level of government ownership of all others with 39.9% of top 10 banks owned by government for more than 50%, followed by Portugal, 18.8% and Switzerland with 11.5%. On the other hand, countries with no top 10 banks owned directly by the government for more than 50% are United State, Canada, Australia, Belgium, Netherland, Spain and Sweden. It is expected that a high level of government ownership should be associated with lower private capital ratios.

The correlations between dependent and explanatory variables are shown in Table.2. The change in leverage and Tier 1 capital ratios are less closely correlated with bank and country specific variables than the ratios themselves. The bank specific variables are less correlated with themselves than with country specific variables. Moreover, country-specific variables are more correlated with economic and regulatory policy variables. However, the correlations between dependent and explanatory, and within explanatory variables are relatively small.

Table 1 Descriptive statistics for period 1999-2011

This table shows the descriptive statistics for dependent and independent variables over period from 1999 to 2011. **LEVERAGE** is the ratio of a banking organization's book value equity to the banking organization's book value total asset; **TIER 1** is the ratio of a banking organization's book value Tier 1 capital to the banking organization's book value Basel I risk-weighted assets, RWA. **SIZE** is the log of total assets; **RISK** is the banking organization's Basel I risk-weighted asset (RWA) divided by its total assets; **ROA** is the banking organizations's net income divided by the average of its on-balance sheet assets at the beginning and end of the year; **DIV** is the dividend paid out dummy variable; **RGDP** is the percentage change in real gross domestic product; **BANK** is the bank assets to nominal gross domestic product; **PROMPT** is the prompt corrective action variable; **EGOVERN** is a version of the external governance index; **MHI** is the moral hazard index; **CSTAND** is the overall capital stringency variable; **INDEP** is the degree of independence of supervisory authority variable; **GOVCONT50** is the share of the assets of the top ten banks in a given country controlled by the government at the 50% level variable; **CONTROLCF** is the difference between control rights and cash flow rights; **ACCT** is the accounting standard dummy variable, taking value of 1 if the bank is reporting in a standard other than its local GAAP, zero otherwise.

Variable	Notation	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Dependent variables and bank-specific, country macroeconomic factors, and country policy factors									
Dependent variables									
Change in equity ratio	Δ LEVERAGE	0.0899	0.0360	87.7510	-23.5944	3.1118	17.7222	467.9934	27,039,411
Change in Tier 1 capital ratio	Δ TIER1	0.2856	0.1000	88.8800	-25.6100	3.5263	15.0737	376.8475	17,490,072
Bank-specific variables									
Lagged equity ratio	LEVERAGE _{t-1}	8.6778	8.4226	46.6764	-1.8912	3.5510	2.6498	20.4373	41,297
Lagged Tier 1 ratio	TIER1 _{t-1}	11.3093	10.8100	47.1000	-1.4400	3.4125	2.1452	14.5766	18,952
Log total assets	SIZE	8.6477	7.9443	15.1102	5.3212	2.0505	1.3393	4.0162	1,021
Return on average assets	ROA	0.6569	0.9027	5.5896	-21.0998	1.2668	-5.3138	55.9898	363,161
Risk-weighted assets to total assets	RISK	0.6889	0.7203	1.4812	-0.7842	0.1778	-1.1495	7.8910	3,632
Dividend paid out	DIV	0.9119	1.0000	1.0000	0.0000	0.2835	-2.9056	9.4427	9,360
Country macroeconomic factors									
Percentage change in real gross domestic product	RGDP	0.0158	0.0191	0.0632	-0.0835	0.0219	-1.4289	4.5714	1,322
Bank assets to nominal gross domestic product	BANK	0.8076	0.6213	8.8936	0.0285	0.7927	5.1699	37.4630	160,963
Country policy factors									
Prompt corrective action index	PROMPT	1.9695	2.1641	2.3380	0.0000	0.6057	-2.7819	8.9449	8,243
External governance index	EGOVERN	0.3448	0.2111	1.6421	0.2111	0.3761	2.5159	7.4729	5,635
Moral hazard index	MHI	2.9549	3.1323	8.1686	0.0000	0.8797	-0.0067	11.7080	9,428
Capital standard Index	CSTAND	1.7998	1.7572	2.9173	1.0000	0.2690	2.0794	12.0248	12,277
Independence of supervisory authority index	INDEP	1.9501	2.0000	3.0000	1.0000	0.3180	-1.0792	9.3127	5,534
Share of the assets of the top 10 banks controlled by the government at the 50% level	GOVCONT50	0.0080	0.0000	0.3999	0.0000	0.0438	7.0275	57.3009	391,169
Control rights divided by cash flow rights	CONTROLCF	1.1240	0.7000	39.5000	0.0000	3.1265	8.2408	75.9473	695,390
Accounting standard	ACCT	0.0982	0.0000	1.0000	0.0000	0.2976	2.7006	8.2932	7,111

Table 2 Correlation coefficients of variables used in the regression analysis.

The first part of the table reports the correlation coefficients between dependent variables and explanatory variables, and the second part of the table reports the correlation coefficients of explanatory variables. **LEVERAGE** is the ratio of a banking organization's book value equity to the banking organization's book value total asset; **TIER1** is the ratio of a banking organization's book value Tier 1 capital to the banking organization's book value Basel I risk-weighted assets; **RWA**, **SIZE** is the log of total assets; **RISK** is the banking organization's Basel I risk-weighted asset (**RWA**) divided by its total assets; **ROA** is the banking organization's net income divided by the average of its on-balance sheet assets at the beginning and end of the year; **DIV** is the dividend paid out dummy variable; **RGDP** is the percentage change in real gross domestic product; **BANK** is the bank assets to nominal gross domestic product; **PROMPT** is the prompt corrective action variable; **EGOVERN** is a version of the external governance index; **MHI** is the moral hazard index; **CSTAND** is the overall capital stringency variable; **INDEP** is the degree of independence of supervisory authority variable; **GOVCONT50** is the share of the assets of the top ten banks in a given country controlled by the government at the 50% level variable; **CONTROLCF** is the difference between control rights and cash flow rights; **ACCT** is the accounting standard dummy variable, taking value of 1 if the bank is reporting in a standard other than its local GAAP, zero otherwise.

	Δ LEVERAGE	Δ TIER1	LEVERAGE ₁	TIER1 ₁										
Correlation coefficient between the capital ratios used in the regression equations														
Δ LEVERAGE	1.00	0.84	-0.20	-0.10										
Δ TIER1	0.84	1.00	-0.17	-0.22										
LEVERAGE ₁	-0.20	-0.17	1.00	0.54										
TIER1 ₁	-0.10	-0.22	0.54	1.00										
Correlation coefficients of the independent variables with the capital ratios														
SIZE	-0.03	0.00	-0.34	-0.30										
RISK	0.05	0.03	0.21	-0.08										
ROA	0.14	-0.01	0.07	0.07										
DIV	-0.11	-0.13	0.11	0.07										
RGDP	0.04	-0.07	0.01	0.04										
BANK	-0.02	0.02	-0.26	-0.03										
PROMPT	0.01	-0.00	0.26	0.14										
EGOVERN	-0.02	0.01	-0.35	-0.16										
MHI	0.00	-0.00	0.28	0.09										
CSTAND	-0.00	0.01	-0.19	-0.10										
INDEP	0.00	-0.02	0.10	0.07										
GOVCONT50	-0.01	-0.00	-0.18	-0.09										
CONTROLCF	-0.01	-0.01	-0.11	0.00										
ACCT	-0.02	0.00	-0.26	-0.15										
	SIZE	RISK	ROA	DIV	RGDP	BANK	PROMPT	EGOVERN	MHI	CSTAND	INDEP	GOVCONT50	CONTROLCF	ACCT
SIZE	1.00													
RISK	-0.36	1.00												
ROA	-0.06	0.03	1.00											
DIV	-0.04	0.05	0.17	1.00										
RGDP	-0.09	0.02	0.35	0.01	1.00									
BANK	0.55	-0.41	-0.12	-0.12	-0.14	1.00								
PROMPT	-0.52	0.32	0.08	0.13	0.11	-0.44	1.00							
EGOVERN	0.61	-0.39	-0.08	-0.11	-0.07	0.63	-0.60	1.00						
MHI	-0.38	0.29	0.05	0.09	-0.02	-0.49	0.22	-0.66	1.00					
CSTAND	0.32	-0.23	-0.01	-0.14	-0.00	0.31	-0.26	0.52	-0.27	1.00				
INDEP	-0.25	0.17	0.04	0.11	0.13	-0.09	0.56	-0.27	-0.10	-0.38	1.00			
GOVCONT50	0.32	-0.23	-0.05	-0.07	-0.04	0.23	-0.33	0.40	-0.02	0.36	-0.22	1.00		
CONTROLCF	0.20	-0.17	-0.03	-0.08	-0.03	0.49	-0.08	0.35	-0.34	0.24	0.25	0.34	1.00	
ACCT	0.56	-0.34	-0.10	-0.14	-0.12	0.59	-0.71	0.62	-0.39	0.39	-0.28	0.41	0.33	1.00

3.6 EMPIRICAL RESULTS

The pecking order behaviour of banking organizations is examined from period 1991 to 2011. We follow the similar approach of [Shyam-Sunder and Myers \(1999\)](#) and [Frank and Goyal \(2003\)](#) of reporting results separately for net debt issued and change in debt ratio. We also examine different restrictions on the data. One of the restrictions requires banks to report continuously on a variety of other variables. We collect a subset of the sample to only include banks with complete observations from year 1991 to 2011. The resulted sub-sample is balanced sample and includes 630 bank-year observations with no gaps. There are 30 banks included in this sub-sample, and since these banks cover the full period, they can be considered as more matured and well-established banking organizations. The list of these banks is not represented in this paper, but it is available upon request. Furthermore, we relax the continuity restriction, and include banking organizations with more than 15 years of data, which give us a sample of larger sample size.

The results in Table.3 start with net debt issues as the dependent variables in the full period sample without any restrictions. As reported in column (1) of Table.3, the estimated coefficient for this sample is 0.048 with R^2 0.11. When using change in debt ratio as dependent variables, the estimated coefficient is -0.01 with R^2 0.07. Both coefficients are significant under 5% and 10% significant level respectively. The positive coefficient shows that the amount of debt issued increases when the financing deficit increases, indicating the existence of pecking order. The negative coefficient shows the debt issued decreases while the financing deficit increases, which indicates there is no potential pecking order exists and the change in debt does not reflect the deficits. If the more restricted condition is used requiring banks with more than 15-year information, in column (3) of Table.3, the R^2 increases slightly to 0.11 for net debt issued as dependent variable. The coefficient is still positive and significant, but the magnitude does not vary much. The coefficient of deficit

when using change in debt ratio as the dependent variable changes from negative to positive, but insignificant under more restricted sample. Furthermore, if we apply the continuity condition with complete observation from 1991 to 2011, it results in a balance sample. There is nothing in the pecking order theory that requires the use of balanced panel data. However, if we compare the results of columns (5)-(6) with column (1)-(4), we notice that requiring banks to have completed and no reporting gaps have a nontrivial impact on the results. Both the estimated coefficient on the financing deficit and the R^2 increase considerably when complete continuous sample than the broader population of banking organizations is examined over the period 1991-2011. With balanced sample, the R^2 increases to 0.14 and 0.09 in column (5) and (6) respectively, which shows 14% and 9% of the sample can be explained by the model. The coefficients of financing deficits also increase from 0.0434 and 0.0001 to 0.0553 and 0.0245 for net debt issued and change in debt ratio respectively. Both coefficients are positive and significant in restricted sample when considering only banking organizations that traded continuously over period 1991-2011. The difference in the results for different samples indicates that the degree of development of the banking organizations and the time period play a major role in the pecking order theory.

From the comparison of results, we find that the results for more matured and well-established banks are better and show stronger indication of pecking order than the broader population. In the previous discussion we predict that if a firm or banking organization follows the pecking order theory, the amount of changes in the net debt issued equals the same amount of changes in the financing deficits. Therefore, the coefficient of financing deficit in the estimation should be equal or close to unity. However, in our results, the coefficients are between 0.04 and 0.05 for net debt issued, which are significantly lower than unity. Moreover, the results are still weaker if we compare the results of non-financial firms.

In Frank and Goyal (2003), the estimated coefficient for financing deficit in the complete continuous sample is 0.75 for net debt issued and 0.43 for change in debt ratio with R^2 of 0.71 and 0.27 respectively during period 1971-1989. However, they find that the results vary when different sample periods are used. Frank and Goyal (2003) carried out the same test for period 1990-1998, both the coefficient and R^2 are uniformly lower than in period 1971-1989. However, both results are still larger and stronger than our results for banking organizations. Therefore, the above results show that the banking organizations show that, although the degree of development of the banking organizations and the period play a relative major role in the pecking order theory, there is a weaker indication of pecking order behaviour than the non-financial firm in general. One of the interpretations of this result is that banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. When taxpayers put funds into the bank, it is recognized as an asset by the bank. On the other hand, the bank credits a liability account for the same amount to show as a liability owed by the bank to its customer. Therefore, the debt structure in banking is different from non-financial firms.

Table 3 Pecking order tests for period from 1991 to 2011

This table reports the pecking order behaviour of banking organizations for period from 1991 to 2011. We report results separately for net debt issued and change in debt ratio. Three samples of data are examined. Column (1) and (2) include data for the full sample period; Column (3) and (4) include banks with more than 15 years of observations; Column (5) and (6) include banks with complete continuous observations with no gaps throughout period 1991-2011. The dependent variables are net debt issued for column (1), (3) and (5); and change in debt ratio for column (2), (4) and (6). The independent variable is financing deficit. All variables are scaled by net asset. t-statistics are reported in parentheses.

	Institutions with full period data		Institutions with more than 15 years data		Institutions with continuous 21 years data	
	Net debt issued (1)	Change in debt ratio (2)	Net debt issued (3)	Change in debt ratio (4)	Net debt issued (5)	Change in debt ratio (6)
Constant	0.0027 (0.7944)	0.0068** (2.1745)	0.0068 (1.6393)	0.0032 (0.8750)	-0.0002 (-0.0267)	-0.0112*** (-1.7552)
Financing deficit	0.0487*** (12.1483)	-0.0091** (-2.0395)	0.0434**** (8.5029)	0.0001 (0.0056)	0.0553*** (5.0017)	0.0245 (2.0091)**
N	4280	2262	2692	1375	630	630
R²	0.1092	0.0747	0.1142	0.0730	0.1403	0.0904
Adj. R²	0.1048	0.0694	0.1073	0.0642	0.1106	0.0504

*** 1% significant level

** 5% significant level

* 10% significant level

The aggregation of financing deficit used in this paper is based on the framework developed from non-financial firms in [Shyam-Sunder and Myers \(1999\)](#). In their study, they find that the pecking order is supported by the aggregation during 1971-1989. The results were later challenged by [Frank and Goyal \(2003\)](#), in which they have found the results are different if different samples are considered. In order to test whether the aggregation can be justified in the banking organization, we examine the aggregation according to different samples as used in testing the pecking order. The results are shown in Table.4. From the results, we notice that the aggregation is supported if continuous with no gap in cash flow data is used over time from 1991-2011. When we include banks that do not have complete records over the entire period, the sample becomes much larger, and the observed coefficients change. The evidence moves further away from supporting the pecking order aggregation hypothesis. In addition, we look at the estimated coefficients individually. When net debt issues are considered, the coefficient of the cash dividend is positive under full sample with no gaps. This support the fact that dividend-paying firms issue less long-term debt, but they also redeem less when compared to non-dividend paying firms. However, if larger sample is included, the coefficients become negative, which contradicts the conventional predictions. The pecking order theory predicts a positive sign and a unit coefficient on investments in both fixed assets and working capital. According to the theory, after controlling for internal cash plans, investments in fixed assets and working capital should be matched by increases in debt issues. The results in Table.4 show the coefficients of investment and change in working capital are all positive and significant under net debt issues. However, the magnitudes, ranging from 0.05 to 0.08, are far less than unity, which indicates the results on factor investment and working capital provide weak support for the pecking order aggregation. Furthermore, the coefficients of internal cash flow for all samples are negative and significant under both dependent variables. According to large numbers of literature, internal cash flow does lead to some reduction in debt issues, and there is a negative

relationship between leverage and profitability. Therefore, our results on internal cash are in line with the predictions. From the above discussion, we may conclude the result may provide some weak evidence on the pecking order aggregation; especially the signs of coefficients on investment, working capital and internal cash flow are like what we expected from pecking order theory. However, this is not the only expectation from pecking order. The tradeoff theory also predicts a positive relationship between investments and debt. [Frank and Goyal \(2003\)](#) argue that higher investment increases tangible assets in general, which in turn increases debt capacity. The positive relationship between changes in working capital and net debt issues may also be a result of time issues. Banks receive cash when issuing long-term debt, of which they can put into bank accounts or other short-term investments. As a result, working capital will be increased. Therefore, we have not found supportive evidence for the presence of pecking order in banking organizations. This may also support our expectation that banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. Therefore, for the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because of the taxpayers funds deposited in the bank.

Table 4 Aggregation of flow of funds deficit for period from 1991 to 2011

This table reports the results of aggregation of financing deficit of banking organizations for period from 1991 to 2011. We report results separately for net debt issued and change in debt ratio. Three samples of data are examined. Column (1) and (2) include data for the full sample period; Column (3) and (4) include banks with more than 15 years of observations; Column (5) and (6) include banks with complete continuous observations with no gaps throughout period 1991-2011. The dependent variables are net debt issued for column (1), (3) and (5); and change in debt ratio for column (2), (4) and (6). The independent variables are the amount of cash dividend, total investment, changes in working capital and internal cash flow. All variables are scaled by net asset. t-statistics are reported in parentheses.

	Institutions with full period data		Institutions with more than 15 years data		Institutions with continuous 21 years data	
	Net debt issued (1)	Change in debt ratio (2)	Net debt issued (3)	Change in debt ratio (4)	Net debt issued (5)	Change in debt ratio (6)
Constant	-0.0360*** (-7.0283)	-0.0199*** (-4.2515)	-0.0411*** (-6.5521)	-0.0224*** (-4.0361)	-0.0483*** (-3.4169)	-0.0131 (-1.1233)
Cash dividend	-0.3114** (-2.0760)	-0.5892*** (-4.0392)	-0.2845* (-1.6960)	-0.4893*** (-3.0513)	0.0122 (0.0304)	-0.0993 (-0.2652)
Investment	0.0577*** (13.7311)	-0.0097** (-2.0496)	0.0532*** (9.8381)	0.0053 (0.8589)	0.0848*** (7.1331)	0.0392*** (2.8299)
Δ Working capital	0.0613*** (5.0838)	0.0088 (0.5502)	0.0704*** (4.2527)	0.0147 (0.7696)	0.0066 (0.1935)	-0.0036 (-0.0977)
Internal cash flow	-0.2735*** (-7.2908)	-0.0232 (-0.6000)	-0.2686*** (-6.0789)	-0.1171** (-2.5292)	-0.5175*** (-5.4737)	-0.2636** (-2.0651)
R²	0.1293	0.0826	0.1359	0.0872	0.1964	0.1145
Adj. R²	0.1243	0.0760	0.1281	0.0764	0.1645	0.0661

*** 1% significant level

** 5% significant level

* 10% significant level

The pecking order theory is a competitor to more conventional empirical leverage specifications. Even if debt level of banking organizations does not follow the pecking order, it could be still useful to study the traditional leverage and capital structure regression. In the traditional leverage regression, the capital structure of firms is considered to be determined by a number of factors, including asset ratio, tangibility, sizes and profitability etc. However, due to the special feature as financial institutions, the capital structure of banking organizations may be influenced by other specific variables. As we have discussed in the previous section, we adopt the framework used in [Brewer et al \(2008\)](#), to include country-specific economic and public policy factors in addition to the conventional bank-specific factors as shown in equation (10). The framework is estimated for a pooled cross-section time series panel of 358 very large banking organizations headquartered in 24 developed countries from year 1999-2011. Because the specific banking organization included each year varies due to changes in bank size, merger or missing information, the panel is unbalanced. In this paper, two measures of capital are specified. One is the simple leverage (common equity) ratio, and the other is Basel I risk-based Tier 1 capital ratio. The regression results are shown in column (1)-(4) of Table.5 for the leverage ratio and in column (5)-(8) for the Tier 1 ratio. Column (1) and (5) show the results for a basic model that specifies each capital measure only as a function of four bank-specific factors plus year-fixed effect. We progressively expand the analysis to include country fix-effects in column (2) and (6), and then to include variables of country-specific macro-economic variables in column (3) and (7). We finally include the rest of country-specific public policy and regulatory variables in column (4) and (8). The impact of the public policy and regulatory variables across countries can be quantified by comparing the results of the expanded specifications with the baseline models. All the bank-specific and country-specific macro-economic variables are lagged by one period.

The estimations of the basic model including only bank-specific variables are shown in column (1) and (5) of Table.5. The results show that the changes in both capital ratios are negatively related with the lagged logarithm of total assets, but the results are only significant for the Tier 1 capital ratio. Bank risk is positively and significantly related to the change in the leverage ratio. The coefficient of bank risk is negative under dependent variable Tier 1 capital ratio, and the coefficient is insignificant. The difference in the different results of bank risk reflects that the risk-weighted asset appears in both the numerator of our risk measure and in the denominator of the Tier 1 capital ratio. The profitability of the bank is represented by return on asset. The coefficients of return on asset for both capital ratios are positive and significant at 10% for the leverage ratio and at 1% for Tier 1 ratio. The magnitude of the coefficient under Tier 1 capital ratio is larger than that under equity leverage ratio. The coefficient for dividend dummy variable for both dependent capital ratios is negative and significant under 1% significant level. The result supports the expectations that dividend-paying firms issue less long-term debt, and thus negatively related to the leverage ratio. The coefficient on the lagged capital ratio which captures the rate of adjustment towards the target capital ratio is also examined in the framework. Both coefficients are significant at 1% level and positive, with values of 0.17 and 0.27 respectively for equity leverage ratio and Tier 1 capital ratio. The result indicates that the average banking organization moves only 17% and 27% respectively of the way towards their target on average in a given year and requires around four years to adjust to the target equilibrium. The rate of adjustment is similar but slightly quicker to the results found in [Wall and Peterson \(1988\)](#), [Marcus \(1983\)](#) and [Brewer et al \(2008\)](#), in which they find it would take banks around five years to adjust to the target equilibrium capital ratio. The F-test is also used to test whether the bank-specific variables collectively make a significant contribution to explaining the banking organizations' target capital level. The F-statistics are 14.32 and 22.24 under leverage ratio and Tier 1 capital ratio respectively, which are both

significant at 1% significant level. The F-tests indicate that the bank-specific variables collectively make a significant contribution in explaining banking organization target capital level.

If the country fixed effects is added to the specifications to the previous basic framework, we obtain the results of estimations in the column (2) and (6). The results in column (2) and (6) are qualitatively similar to those in column (1) and (5). The largest difference in the results is under country fixed effect, the coefficient of the logarithm of total asset is positively related to the change in equity leverage and Tier 1 capital ratios, and both coefficients are significant. Bank risk under country fixed effects shares the same estimation results as the basic model. The risk is positively and significantly related to the change in the leverage ratio, but negative under Tier 1 capital ratio. As discussed before the difference in the results reflects that the risk-weighted asset appears in both the numerator of our risk measure and in the denominator of the Tier 1 capital ratio. Return of Assets (ROA) is positively correlated with changes in both capital ratios, but only coefficient under Tier 1 capital ratio is statistically different from zero. The dividend dummy variables are negative and significant for both capital structures as before, which indicates that dividend-paying firms issue less long-term debt, thus less leverage. The results of control variable ACCT, indicating the accounting policy used by the each bank, are negative for both frameworks, except for the Tier 1 capital ratio under country fixed effects, in which the coefficient of accounting control variable is positive, but it is not significantly different from zero. The F-statistics are 2.07 and 2.39 for equity leverage ratio and Tier 1 capital ratio, and they are both significant under 1% significant level. The results indicate that collectively the country binary variables make a significant contribution in explaining the target capital ratio in addition to bank-specific factors.

After testing for the primary and country fixed effects for the bank-specific variables, we expand the specifications by including two lagged country macroeconomic variables, the annual percentage change in real DGP (RGDP) and the ratio of aggregate bank assets to nominal GDP (BANK). The results are represented in column (3) and (7) of Table.5. The coefficients on the change of capital in real GDP are positive, but they are not statistically significant related to either measure of capital ratios. However, the impact of real GDP may be partially captured by the time fixed effects. The variable BANK measures the extent to which a country's financial system is bank-based. The coefficient on BANK is negative for equity leverage ratio, and it is significantly different from zero under 10% significant level. The result is in line with the expectations that if the larger proportion of a country's financial system is bank-based, banks within this country tend to maintain less capital since banks can easily access to cheap finance within short time period. The coefficient of BANK is positive but insignificant when Tier 1 capital ratio is examined as dependent variable. We also notice that after adding the country-specific macroeconomic variables in the framework, the bank-specific variables still show expected results as discussed before. The coefficients of logarithm of total asset and dividend dummy variables are negative and significant for both capital ratios. The coefficients of return on asset are still significantly positive, which shows if the bank is more profitably, it is more likely to retain higher capital ratio as a result of more retained earnings. The bank risk shows positively related to the change in equity leverage ratio and negatively related to the Tier 1 capital ratio as shown before. The coefficients of lagged capital ratio are both positive and significant at 1% level, and magnitudes are the same as the basic framework, which shows on average it takes banks around four years to adjust to the target equilibrium capital ratio. The values of R^2 increase slightly compared with results in column (1) and (5), but decrease from the value in column (2) and (6). This suggests that the country effects in column (2) and (6) capture more than just these two macroeconomic variables. This may reflect that these banking organizations

tend to operate in countries besides their home country. The F-test statistics are significant at 1% significant level for both capital ratios, indicating country-specific macroeconomic variables do have contribution to the change of capital ratios.

Last but not least, we add seven country-specific policy and regulatory variables to the framework: PROMPT, EGOVERN, MHI, CSTD, INDEP, GOVCONT50 and CONTROLCF, and the results are shown in column (4) and (8). The coefficients estimated on the previously bank-specific and country-specific economic variables, lagged capital ratios, SIZE, ROA, RISK, RGDP and BANK are qualitatively similar to those in regressions reported in column (3) and (7). As in column (3), changes in the leverage ratio in column (4) are positively correlated with both RISK and ROA and negatively associated with DIV, dividend dummy, and all the coefficients are significantly different from zero. The coefficient of SIZE is positive in column (4), which is different from the sign in column (3), but the coefficient is statistically insignificant. Similarly, compared with column (7) results, changes in Tier 1 capital ratio in column (8) are negatively correlated with RISK, SIZE and DIV and positively correlated with ROA. However, only coefficients of ROA and DIV are significant at 1% significant level. Coefficients of RGDP and BANK for both capital ratios are not significant, and the signs follow the same as in column (3) and (7). As for the country-specific policy and regulatory variables, five variables are statistically significant for the leverage ratio in column (4). Changes in the leverage ratio tend to be higher in countries with better provision for prompt corrective action, better external governance, and a greater emphasis on explicit regulatory requirements regarding the amount of capital banks must maintain relative to specific guidelines. The coefficients on supervisory authority independence and the difference between control rights and cash flow rights variables are negative and significant. The moral hazard index variable is positive but not statistically significant. The indicator of government ownership of banks variable GOVCONT50 is

negatively related with the change of the leverage ratio, which shows the higher degree of government ownership of banking organizations, the slower the change of leverage ratio. Similar to the leverage ratio, the signs of country-specific regulatory variables are the same under Tier 1 capital ratio with only three variables, PROMPT, INDEP and GOVCONT50, are statistically significant. The results are presented in column (8). Variables EGOVEN and CSTD are still positive associated to the Tier 1 capital ratio, but the t-statistics show that they are not significant to the change in the Tier 1 capital ratio. Moral hazard index still shows a positive relationship to capital ratio, and it is still insignificant. Both of the F-statistics are significant with values 9.74 and 14.75 for changes in leverage and Tier 1 capital ratio respectively. The statistics indicate that the regulatory and public policy variables collectively make a significant contribution to explaining changes in banking organizations' leverage ratio.

Table 5 Results of regression of estimating the relation between changes in capital ratio and determinant factors over period 1999-2011

This table reports the regression results of estimating the relation between changes in the capital ratios and a set of bank-specific, country macro and country policy and regulatory factors over the period 1999-2011. **LEVERAGE** is the ratio of a banking organization's book value equity to the banking organization's book value total asset; **TIER 1** is the ratio of a banking organization's book value Tier 1 capital to the banking organization's book value Basel I risk-weighted assets, RWA. **SIZE** is the log of total assets; **RISK** is the banking organization's Basel I risk-weighted asset (RWA) divided by its total assets; **ROA** is the banking organizations's net income divided by the average of its on-balance sheet assets at the beginning and end of the year; **DIV** is the dividend paid out dummy variable; **RGDP** is the percentage change in real gross domestic product; **BANK** is the bank assets to nominal gross domestic product; **PROMPT** is the prompt corrective action variable; **EGOVERN** is a version of the external governance index; **MHI** is the moral hazard index; **CSTAND** is the overall capital stringency variable; **INDEP** is the degree of independence of supervisory authority variable; **GOVCONT50** is the share of the assets of the top ten banks in a given country controlled by the government at the 50% level variable; **CONTROLCF** is the difference between control rights and cash flow rights; **ACCT** is the accounting standard dummy variable, taking value of 1 if the bank is reporting in a standard other than its local GAAP, zero otherwise.

	ΔLEVERAGE				ΔTIER1			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CONSTANT	2.0332 (5.5990)***	2.0078 (0.9401)	2.0060 (5.2946)***	1.5428 (1.6504)*	5.6606 (9.3449)***	2.7963 (1.1326)	5.5890 (8.9268)***	5.5919 (4.9539)***
CR₁	0.1731 (10.5120)***	0.5178 (16.2061)***	0.1730 (10.5039)***	0.1774 (10.5780)***	0.2715 (13.6372)***	0.5321 (16.9794)***	0.2715 (13.5009)***	0.2739 (13.4802)***
Bank Specific								
SIZE	-0.0310 (-0.9460)	0.3944 (1.6497)*	-0.0161 (-0.4745)	0.0071 (0.1952)	-0.1017 (-2.6366)***	0.5780 (2.1425)**	-0.1025 (-2.5509)**	-0.0937 (-2.1858)
RISK	1.0107 (5.8348)***	0.6001 (1.1203)***	0.9720 (5.5567)***	1.0174 (5.7139)***	-0.4771 (-1.2653)	-0.1780 (-0.2868)	-0.4673 (-1.2146)	-0.5369 (-1.3514)
ROA	0.0940 (1.7780)*	0.0207 (0.3395)	0.0936 (1.7686)*	0.0901 (1.6856)*	0.2292 (3.8931)***	0.2355 (3.5117)***	0.2300 (3.9009)***	0.2317 (3.8920)***
DIV	-0.8150 (-4.1745)***	-1.3072 (-5.0515)***	-0.8462 (-4.3148)***	-0.9028 (-4.4579)***	-0.9532 (-4.3023)***	-1.3113 (-4.4793)***	-0.9542 (-4.2852)***	-0.9697 (-4.2467)***
Country Macro								
RGDP			2.9541 (0.4388)	5.4460 (0.7046)			3.7837 (0.4480)	8.4873 (0.8675)
BANK			-0.1457 (-1.6534)*	-0.1246 (-1.1876)			0.0076 (0.0737)	0.0458 (0.3761)
Country policy and regulatory								
PROMPT				0.1046 (1.6172)*				0.2372 (2.2089)**
EGOVERN				0.1594 (-2.5235)**				0.0200 (0.0591)
MHI				0.0762 (0.7718)				0.0726 (0.6437)
CSTAND				0.0113 (-2.0409)*				0.0884 (-0.2833)
INDEP				-0.0638 (-3.2346)**				-0.3384 (-3.1033)**
GOVCONT50				-1.5312 (-0.9526)				-1.3761 (-1.7662)*
CONTROLCF				0.0146 (1.6124)*				0.0050 (0.1897)
Controls								
ACCT	-0.6065 (-2.8001)***	-0.5362 (-0.6197)	-0.4633 (-1.9916)**	-0.2080 (-0.6781)	-0.6391 (-2.6184)***	0.0857 (0.0852)	-0.6420 (-2.4455)**	-0.3105 (-0.8675)
Country fixed effects	No	Yes	No	No	No	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R ²	0.0730	0.1147	0.0733	0.0728	0.1124	0.1447	0.1118	0.1107
F-statistics	14.3248***	2.0718***	13.0415***	9.7446***	22.2494***	2.3963***	20.0229***	14.7578***

*** 1% significant level

** 5% significant level

* 10% significant level

In the above specification, we assume public policy and regulatory variables affect changes in the capital ratio linearly. However, the public policy and regulatory variables may also affect desired bank capital ratios nonlinearly and depend on the values of other independent banks or country-specific macroeconomic variables. For example, regulatory monitoring and enforcement of capital standards may be stronger for riskier banks, for whom failure is more likely, or weaker for banks in countries in which the banking system is relatively more important, so that the banks may retain greater political power and capture regulatory agencies more easily. Therefore, we expand the model developed in the previous section to

incorporate public policy variables with other independent variable. We include all seven public policy variables interactively with country-specific macroeconomic variables, RISK and BANK. The results of specifications are shown in Table.6. The results of previously discussed variables are similar as before. The bank-specific variables, SIZE and dividend dummy, are negative related to the changes in capital ratio, and most of them are significant under 1% and 5% significant levels. The RISK is positive under changes in the leverage ratio and negative for Tier 1 capital ratio, but neither of them is significant. The difference in the different results of bank risk reflects that the risk-weighted asset appears in both the numerator of our risk measure and in the denominator of the Tier 1 capital ratio. The profitability variable, ROA, is positive and significant for both capital ratios as expected. The country-specific macroeconomic variables, the change of capital in real GDP and BANK, are positive but insignificant for bank risk under Tier 1 capital ratio. The country policy variables have similar results as before. The results of interactive variables show that few of the interactive variables are statistically significant. Only variables $PROMPT \times BANK$, $INDEP \times BANK$ and $GOVCONT50 \times BANK$ are statistically different from zero. We have also noticed that the introduction of interactive variables tends to dramatically reduce both the statistical and economic significance of the macroeconomic and standalone public policy and regulatory variables estimated in the previous models. The coefficients of most of the interactive variables are negative. Therefore, the results of including interactive variables in the model indicate that this specification may not provide helpful and meaningful contribution to the estimation of capital ratios.

Table 6 Results of models of changes in capital ratio with interactions over period 1991-2011

This table reports the regression results of estimating the relation between changes in the capital ratios and a set of bank-specific, country macro and country policy and regulatory factors and interactions over the period 1991-2011. **LEVERAGE** is the ratio of a banking organization's book value equity to the banking organization's book value total asset; **TIER 1** is the ratio of a banking organization's book value Tier 1 capital to the banking organization's book value Basel I risk-weighted assets, RWA. **SIZE** is the log of total assets; **RISK** is the banking organization's Basel I risk-weighted asset (RWA) divided by its total assets; **ROA** is the banking organizations's net income divided by the average of its on-balance sheet assets at the beginning and end of the year; **DIV** is the dividend paid out dummy variable; **RGDP** is the percentage change in real gross domestic product; **BANK** is the bank assets to nominal gross domestic product; **PROMPT** is the prompt corrective action variable; **EGOVERN** is a version of the external governance index; **MHI** is the moral hazard index; **CSTAND** is the overall capital stringency variable; **INDEP** is the degree of independence of supervisory authority variable; **GOVCONT50** is the share of the assets of the top ten banks in a given country controlled by the government at the 50% level variable; **CONTROLCF** is the difference between control rights and cash flow rights; **ACCT** is the accounting standard dummy variable, taking value of 1 if the bank is reporting in a standard other than its local GAAP, zero otherwise.

	Δ LEVERAGE	Δ TIER1
CONSTANT	0.0342 (0.01)	-5.9379 (-1.01)
CR₁	-0.2036 (-10.95)***	-0.2407 (-11.67)***
Bank Specific		
SIZE	-0.0127 (-0.33)	-0.0857 (-1.90)**
RISK	4.5990 (0.68)	-6.5578 (-0.86)
ROA	0.1038 (1.92)**	0.3385 (5.74)***
DIV	-0.9171 (-4.49)***	-1.1177 (-4.83)***
Country Macro		
RGDP	5.5081 (0.68)	0.4233 (0.12)
BANK	0.4219 (0.25)	5.2436 (2.88)***
Country policy and regulatory		
PROMPT	0.2384 (0.27)	0.9688 (0.97)
EGOVERN	1.1790 (0.62)	0.0709 (0.03)
MHI	0.1770 (0.30)	0.0841 (0.12)
CSTAND	0.4413 (0.28)	1.0024 (0.53)
INDEP	-1.2180 (-0.73)	-5.2600 (-2.93)***
GOVCONT50	-2.4443 (-0.55)	-7.7482 (-1.57)
CONTROLCF	0.0046 (0.07)	-0.0111 (-0.14)
Controls		
ACCT	-0.3252 (-0.74)	-1.4601 (-3.15)***
Interactions		
PROMPT x RISK	-0.2508 (-0.23)	-1.5053 (-1.20)
EGOVERN x RISK	-0.0669 (-0.02)	-3.8587 (-1.47)
MHI x RISK	-0.1387 (-0.20)	-0.5815 (-0.67)
CSTAND x RISK	-0.7574 (-0.45)	1.0527 (0.49)
INDEP x RISK	-1.2733 (-0.66)	-1.5620 (-0.72)
GOVCONT50 x RISK	1.0642 (0.09)	-5.8993 (-0.43)
CONTROLCF x RISK	0.0212 (0.20)	0.0170 (0.13)
PROMPT x BANK	0.3178 (1.81)*	1.2317 (3.08)***
EGOVERN x BANK	0.3454 (0.46)	0.1764 (0.20)
MHI x BANK	-0.1394 (-0.54)	0.2660 (0.95)
CSTAND x BANK	-0.1105 (-0.18)	-0.8142 (-1.19)
INDEP x BANK	-0.3916 (-0.60)	-2.3688 (-3.40)***
GOVCONT50 x BANK	0.5842 (2.08)**	-0.3761 (-0.61)
CONTROLCF x BANK	-0.0132 (-0.42)	0.0013 (0.04)
Adj. R²	0.0737	0.0889
F-statistics	6.8356***	11.0472***

*** 1% significant level

** 5% significant level

* 10% significant level

As discussed before, since our observations are limited by data availability to annually, if there is an adjustment during the year, we cannot observe them. Therefore, in addition to equation (10), we carry out a robustness check to test the model under the assumption that the adjustment is faster and for annual observations the banks are always at their target capital level. In this case, we substitute the actual capital level at time t for the target ratio instead of the change of capital ratio. The results of robustness test are shown in Table.7.

$$\begin{aligned}
 CR_{i,c,t} = & \gamma_0 + \gamma_1 SIZE_{i,c,t-1} + \gamma_2 ROA_{i,c,t-1} + \gamma_3 RISK_{i,c,t-1} + \gamma_4 DIV_{i,c,t-1} \\
 & + \gamma_5 RDGP_{c,t-1} + \gamma_6 BANK_{c,t-1} + \gamma_7 PROMPT_c + \gamma_8 EGOVERN_c \\
 & + \gamma_9 MHI_c + \gamma_{10} CSTDAND_c + \gamma_{11} INDEP_c + \gamma_{12} GOVCONTROL_c \\
 & + \gamma_{13} CONTROLCF_c + \gamma_{14} ACCT_c + \varepsilon_{i,c,t}
 \end{aligned} \tag{11}$$

The level of both measures of capital ratios is more completely explained than when using changes of capital ratios. The most of bank-specific variables for both leverage and Tier 1 capital ratio show the expected signs and statistically significant. SIZE and dividend dummy variables are negatively related to the capital ratios, which show the capital ratio decreases as the increase of total asset and if banks pay out dividend. Profitability measure ROA is positively correlated. RISK is positively related to the leverage ratio, and negatively related to the Tier 1 capital ratio. Compared with annually adjustment specification, the level measure of capital ratio model has more significant bank-specific variables. The country macroeconomic variables are also more statistically significant for both capital ratios. The level of capital decreases as BANK, which is in line with expectations. However, both capital ratio measures show that if macroeconomic variables are included alone, the capital ratio decreases as the percentage change of GDP increases, and this is against our expectation. However, the sign changes when country public policy variables are included, which give the expected predicted direction as shown in column (4) and (8) of Table. 7. The results may

indicate that including country public policy variables help to increase the explanatory power of the specifications. In terms of country specific regulatory and public policy factors, six out of seven policy variables are significant for the leverage ratio, and three variables are significant for Tier 1 capital ratio. Majority of variables are at 5% level of statistical significance. The level of the leverage ratio is statistically significantly higher in countries that have regulatory prompt corrective action, better external corporate governance, and greater emphasis on explicit regulatory requirement regarding the amount of capital their banks must maintain relative to specific guidelines. The leverage ratio is also negatively related to the degree of supervisory authority independence, government ownership, and the difference between control right and cash flow right as discussed in the change in the leverage ratio. Similar movement direction of variables to Tier 1 capital ratio is experienced as well. However, the number of significant variables for Tier 1 capital ratio is less than the leverage ratio. For Tier 1 capital ratio only PROMPT and EGOVERN are positively significant, and INDEP is negatively significant. The rest of variables are not statistically significant, however, they show the same hypothesis direction between variables and capital ratio. The R^2 and F-test statistics are substantially higher in the level regressions. Therefore the level regression result suggests that country regulatory and public policy variables are even more significant determinants of bank capital ratios than for the changes in capital ratios.

Table 7 Results of robustness test between changes in capital ratio and determinant factors over period 1999-2011

This table reports the robustness test between changes in the capital ratios and a set of bank-specific, country macro and country policy and regulatory factors over the period 1991-2011. **LEVERAGE** is the ratio of a banking organization's book value equity to the banking organization's book value total asset; **TIER 1** is the ratio of a banking organization's book value Tier 1 capital to the banking organization's book value Basel I risk-weighted assets, RWA. **SIZE** is the log of total assets; **RISK** is the banking organization's Basel I risk-weighted asset (RWA) divided by its total assets; **ROA** is the banking organizations's net income divided by the average of its on-balance sheet assets at the beginning and end of the year; **DIV** is the dividend paid out dummy variable; **RGDP** is the percentage change in real gross domestic product; **BANK** is the bank assets to nominal gross domestic product; **PROMPT** is the prompt corrective action variable; **EGOVERN** is a version of the external governance index; **MHI** is the moral hazard index; **CSTAND** is the overall capital stringency variable; **INDEP** is the degree of independence of supervisory authority variable; **GOVCONT50** is the share of the assets of the top ten banks in a given country controlled by the government at the 50% level variable; **CONTROLCF** is the difference between control rights and cash flow rights; **ACCT** is the accounting standard dummy variable, taking value of 1 if the bank is reporting in a standard other than its local GAAP, zero otherwise.

	LEVERAGE				TIER1			
	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
CONSTANT	8.1410 (17.5772)***	5.6628 (2.5623)**	8.2699 (17.0761)***	6.8589 (5.4973)***	17.3547 (36.3317)***	13.3411 (5.4200)***	17.2612 (34.3530)***	18.2725 (14.6232)***
Bank Specific								
SIZE	-0.3640 (-8.3765)***	0.3853 (1.5476)	-0.34576 (-7.6436)***	-0.2513 (-5.1399)***	-0.5124 (-11.8443)***	-0.0151 (-0.0546)	-0.5786 (-12.9123)***	-0.5647 (-11.6107)***
RISK	5.4769 (27.2185)***	0.8525 (1.5288)	5.4517 (26.7659)***	5.5303 (27.0031)***	-1.3050 (-5.4155)***	-1.2725 (-1.9851)**	-1.1115 (-4.5749)***	-1.0874 (-4.4364)***
ROA	0.6305 (9.1576)***	0.2925 (4.8030)***	0.6351 (9.2105)***	0.6209 (8.9819)***	0.1753 (2.5170)**	-0.0999 (-1.4468)	0.1745 (2.5152)**	0.1704 (2.4362)**
DIV	-0.4368 (-1.6539)*	-1.0121 (-3.7659)***	-0.4726 (-1.7816)*	-0.5589 (-2.0552)**	-0.5827 (-2.1973)**	-0.8123 (-2.6910)***	-0.4451 (-1.6779)***	-0.4300 (-1.5801)
Country Macro								
RGDP			-6.9270 (-1.7604)**	13.2251 (2.2736)***			-2.0677 (-0.2061)	7.0390 (2.6045)***
BANK			-0.1647 (-2.3800)***	-0.0243 (-0.1730)			0.6403 (5.3684)***	0.7490 (5.3042)***
Country policy and regulatory								
PROMPT				0.3392 (2.4892)***				0.2262 (2.9764)***
EGOVERN				0.8826 (-2.1590)**				0.3899 (-1.9608)**
MHI				0.3255 (0.0140)**				0.0068 (0.0509)
CSTAND				0.0108 (-0.0290)				0.2000 (-0.5372)
INDEP				-0.6430 (-1.7619)**				-0.7263 (-1.9802)**
GOVCONT50				-4.7240 (-2.1890)**				-0.1513 (-0.0706)
CONTROLCF				0.0638 (1.9918)**				0.0085 (0.2665)
Controls								
ACCT	-1.2766 (-4.3622)***	-0.8565 (-0.9507)	-1.1274 (-3.5858)***	-0.0812 (-0.1969)	-0.8316 (-2.8601)***	0.3436 (0.3405)	-1.4430 (-4.6378)***	-1.0252 (-2.4352)**
Country fixed effects	No	Yes	No	No	No	Yes	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adj. R ²	0.3066	0.6080	0.3067	0.3099	0.1528	0.3946	0.1602	0.1554
F-statistics	80.1823***	13.8647***	71.8866	52.9602***	33.1271***	6.3782***	31.4211***	22.1729***

*** 1% significant level

** 5% significant level

* 10% significant level

3.7 CONCLUSIONS

In this chapter, we examine the extent of pecking order behaviour in the banking organizations and determinants of bank capital structures. We extend the methodology from non-financial firm to banking organizations and found both financial and non-financial organizations share some similar behaviour. The results of pecking order theory show that the coefficients of net debt issued are between 0.04 and 0.05, which are significantly lower than unity of perfect pecking behaviour than those of non-financial firms found in [Frank and Goyal \(2003\)](#). This indicates that we have not found strong evidence for the existence of pecking order in banking organizations. The magnitude of coefficient increases when smaller and continuous samples are used, which suggests that the degree of development of the banking organizations and the time period play a major role. We interpret this result as banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. The term deposit is used by the banking industry in financial statements to describe the liability owned by the bank to its depositor, and not the funds that bank holds as a result of the deposit, which are shown as assets of the bank. When taxpayers put funds into the bank, it is recognized as an asset by the bank. On the other hand, the bank credits a liability account for the same amount to show as a liability owed by the bank to its customer. For the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because of the taxpayers funds deposited in the bank.

We continue to examine the determinants of bank capital structure from year 1999 to 2011 due to data restrictions. The results show that the effects of lagged logarithm of total assets vary on changes in both capital ratio measures. Bank risk shows persistently positive and significant impact on changes in the leverage ratio, and negative for changes in Tier 1 capital ratio. Similar positive and significant behaviours are seen for return on asset. The

coefficients of dividend dummy variable for both dependent capital ratios are negative and significant, which supports the expectations that dividend-paying firms issue less long-term debt, and thus negatively related to the leverage ratio. The results indicate that bank-specific variables collectively make a significant contribution in explaining banking organizations target capital level. When country specific macro-economic and public policy variables are included in the analysis, the coefficients on the change of capital in real GDP are positive, but they are not statistically significant related to either measure of capital ratios. The coefficient on BANK, measuring the extent to which a country's financial system is bank-based, is negative and significant for equity leverage ratio. The result is in line with the expectations that if the larger proportion of a country's financial system is bank-based, banks within this country tend to maintain less capital since banks have a large impact on the financial industry and easy and cheap to finance within short time period. The country specific public policy factors show significant influence on either change in the leverage ratio or Tier 1 capital ratio or both. Changes in capital ratio tend to be higher in countries with better provisions for prompt corrective action, better external governance, and a greater emphasis on explicit regulatory requirements regarding the amount of capital banks must maintain relative to specific guidelines. The coefficients on supervisory authority independence and the difference between control rights and cash flow rights variables are negative and significant. The moral hazard index variable is positive but not statistically significant. The indicator of government ownership of banks variable is negatively related with the change of leverage ratio, which shows the higher degree of government ownership of banking organizations, the slower the change of leverage ratio. The statistics show that the regulatory and public policy variables collectively make a significant contribution to explaining changes in banking organizations' leverage ratio. The results of lagged capital ratio coefficients indicate that the average banking organization requires around four to five years to adjust to the target equilibrium.

The results above are under the assumption that public policy and regulatory variables influence the capital ratio linearly. However, the results when including non-linear combination of country-specific macroeconomic and public policy variables are not statistically significant. We have also noticed that the introduction of interactive variables tends to dramatically reduce both the statistical and economic significance of the macroeconomic and standalone public policy and regulatory variables estimated in the previous models. Therefore, the results of including interactive variables in the model indicate that the nonlinear specification may not provide helpful and meaningful contribution to the estimation of capital ratios.

CHAPTER FOUR

RETURN AND VOLATILITY SPILLOVER EFFECT OF REAL ESTATE IN FINANCIAL INSTITUTIONS

4.1 INTRODUCTION

The objective of the thesis is to empirically examine the relationship between major risk factors exposed by the financial institutions. The previous chapter specifically examines the capital risk. In this chapter, we will examine the real estate risk exposure by the financial institutions. Financial institutions are highly regulated institutions that provide financial services for its clients or members. In recent decades, the financial services industry is transforming itself in unpredictable and often contradictory ways. In the study of [Crane and Bodie \(1996\)](#)²⁴, they explain the reasons of financial services landscape changing so much: increased competition from non-traditional organizations, new information technologies and declining processing costs, the erosion of product and geographic boundaries, and less restrictive governmental relations have all played a role. Despite the realities of a completely changed marketplace and the need for efficiency by financial institutions, regulations have not changed fast enough to meet these realities²⁵. In United States, organizations and regulators frustrated with the slow development in recognized standards have initiated changes by re-interpreting vague legal language, putting pressure on Congress for legal change. Large banks, in particular, have responded to the increased competition in traditional lending markets by becoming diversified financial services firms. These

²⁴ Dwight B. Crane and Zvi Bodie, 1996, Harvard Business Review. The article is included in the book: Tom Valentine and Guy Ford, Readings in Financial Institution Management: Modern Techniques for a Global Industry, 1st Edition, 1999, Allen and Unwin Publisher, ISBN 1-86448-747-X.

²⁵ Mona J. Garden, Dixie L. Mills and Elizabeth S. Cooperman, Managing Financial Institutions – An Asset-Liability Approach, 4th Edition, Harcourt College Publisher, ISBN 0-03-022054-8

phenomena are likely to have strengthened the interdependence of banking sectors across these countries, heightened bank sensitivity to outside shocks, and exposed the international banking system to greater risks (Elyasiani and Mansur 2003).

The first financial intermediary appearing on the earth is banking services, which can be dated back to 2000 years ago, originating from rich cities, such as, Florence, Venice and Genoa. They were money changers, situated usually at a table in the commercial district of a city, aiding travellers by exchanging foreign coins for local money or discounting commercial notes for a fee in order to supply other merchants with working capitals²⁶. The banking industry gradually spread from the classical civilization of Greece and Rome into northern and western Europe. The development of new overland trade routes and improvements in navigation in the 15th, 16th and 17th centuries gradually shifted the centre of the world commerce from the Mediterranean region toward Europe and British. The early banks in Europe were places for safekeeping of valuables as people came to fear loss of their assets due to war, theft or expropriation by government. When colonies were established in North and South America, Old world banking practices were transferred to the New World. At first the colonists dealt primarily with established banks in the countries from which they had come. Later, state governments in the United States began chartering banking companies. The US federal government becomes a major force in banking during the Civil War. Despite the long history and success of banking, fierce financial services competitors have emerged over the past century to challenge bankers at every turn. Life insurance companies were the oldest competitors, and the first life insurance company was chartered in Philadelphia in 1759. Property-casualty insurers emerged at roughly the same time, led by the famous Lloyds of London in 1688, underwriting a wide range of risks to persons and property. Another type of organizations offering small savings deposits to individual are the

²⁶ Peter S. Rose and Sylvia C. Hudgins, Banking Management and Financial Services, 6th Edition, McGraw-Hill Publisher, ISBN 007-123931-6.

savings and loans association, appeared in the Midwestern US during the 1930s, encouraging household savings and financing the construction of the new homes. Credit Unions were first chartered in Germany during the same era, providing savings accounts and low-cost credit to industrial workers and customers left out by most of banks. Mutual funds, one of banking's most successful competitors over the past two decades, appeared in Belgium in 1822. Hedge funds appeared to offer investors a less regulated and riskier alternative to mutual fund. These aggressive financial institutions attract a huge volume of deposits away from the banks and ultimately helped to bring about government deregulation of the banking industry.

In this paper, we mainly concentrate on the banking industry, and we examine the real estate factor effect on United States, United Kingdom and Japanese banks. As suggested in [Elyasiani and Mansur \(2003\)](#) and [Allen and Santomero \(2001\)](#), banking sectors of different countries do not respond similarly to various shock because of the dissimilarity in terms of structure and regulatory constraints. The US financial system is the largest and most advanced in the world. It also has the greatest diversity of institutions, the widest variety of instruments and the most highly developed derivative markets²⁷. It is also one of the most idiosyncratic financial systems in the world, characterized by an oddly parochial set of laws and regulations that both pair the competition and shield inefficiency. The British financial system has a dual structure with two parallel financial systems since it is both the national system of the United Kingdom, but also one of the world's major international financial centres and hosts the largest component of the Euro and bond markets²⁸. The Japanese financial system has relied extensively on negotiated financial transactions with implicit

²⁷ George G. Kaufman, *Banking Structures in Major Countries*, Kluwer Academic Publishers, ISBN: 0-7923-9136-5.

²⁸ George G. Kaufman, *Banking Structures in Major Countries*, Kluwer Academic Publishers, ISBN: 0-7923-9136-5.

pricing, and less on open-market transactions with explicit pricing, than has been the case in the United States. In the mid-1970s, however, new economic and technological forces generated pressure on the Japanese financial system to increase the role of open-market-based financial transactions. As a result, the financial system is now more open and more competitive in terms of price competition than before. [Elyasiani and Mansur \(2003\)](#) argue that the extent of product diversification and organizational structure, within which a bank operates, can potentially exert a significant degree of influence on the bank's profitability and risk exposure.

4.2 FACTOR AFFECTING FINANCIAL INSTITUTION EQUITY RETURNS

In recent years, the role of financial institutions as risk intermediaries has come into greater play in the discussion of their role in the economy. In turn, serving as risk-taking intermediaries, financial institutions need to manage their own risks strategically. Risks are broadly defined as uncertainties potentially resulting in adverse variations of profitability or losses²⁹. Most of financial institutions have a great deal of financial risks in their normal operations. The various types of risks are differentiated according to the source of losses, market movements or default on payment obligations of borrowers, etc. Since most of the financial institutions are highly leveraged, hence there is a potential capital risk (the risk of not being able to cover losses against equity and becoming insolvent³⁰). For many financial institutions, their financial assets also generally tend to be long-term or intermediate-term asset that are financed by short-term debt. Hence by the nature of their operations they have significant credit risk (the risk of default on financial assets) and interest rate risk (the risk of rates on interest revenues and interest expenses not moving together), and market risk (as

²⁹ Joël Bessis, *Risk Management in Banking*, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

³⁰ Mona J. Garden, Dixie L. Mills and Elizabeth S. Cooperman, *Managing Financial Institutions – An Asset-Liability Approach*, 4th Edition, Harcourt College Publisher, ISBN 0-03-022054-8

risk of a fall in the value of financial assets and the market value of equity) with unfavourable interest rate or equity market changed. Other risks are also part of their standard operations including liquidity risk, the risk of not being able to meet upcoming obligations, particularly for depository institutions like banks and saving and loans, with possible deposit withdrawals. With globalization, large financial institutions operating in many different countries face additional risks including foreign exchange risk (the risk of loss on foreign exchange transactions). On the other hand, except for financial risks, financial institutions also face other types of risks. Operational risk is not financial to the extent that it arises from internal malfunctions of processes, and it is subject to a capital charge under the risk regulations. Technology risk is also another type of nonfinancial risk, and with the advent of internet transactions, financial institutions face serious fraud and criminal risk as well. Since the recent subprime crisis and thereafter European debt crisis, there is an increasing country or sovereign risk, the risk of expropriation, and cultural risks, the risk of cultural norms. Ethical and regulatory risk exist as well, such as in the Enron scandal, where large financial institutions assisted corporations to hide their liabilities in complex off-balance-sheet schemes. In our paper, we use bivariate GARCH framework to study risks that the financial institutions face. More specifically, we examine the interest rate, market risk and the risk of real estate sector to banks. There are extensive literatures have shown the significance of interest risk and market risk to the commercial banks ([Stone 1974](#), [Choi et al 1992](#), [Dinenis and Sotiris 1998](#), [Wetmore and Brick 1994](#), and [Flannery et al 1997](#)). However, the literatures on real estate factor effect are few, with some main papers such as , [Allen et al \(1995\)](#), [Mei and Lee \(1994\)](#), [Mei and Saunders \(1995, 1997\)](#), and [Elyasiani et al. \(2010\)](#), etc.

4.2.1 MARKET FACTOR

Market risk is the risk of adverse deviations of the market-to-market value of the trading portfolio, due to market movements, during the period required to liquidate the transactions.³¹ The period of liquidation is critical to assess such adverse deviations, the longer the period, the longer the deviation from the current market value. Earnings for the market portfolio, the portfolio of assets held for trading over a period, are the variations of the market value. Any decline in value results in a market loss. It is possible to liquidate tradable instruments or to hedge their future changes of value at any time. When liquidity is high, the adverse deviations of prices are much lower than in poor liquidity environment³².

In the literature, the impact of the market factor to financial institutions has been studied extensively. [Bae \(1990\)](#) finds the stock market return is sensitive to financial institutions stock in general during 1974-1985. He further investigates the effect of market return to different types of financial institutions, such as commercial banks, savings and loans, insurance companies, finance companies as well as REITs, and the results shows market return has positive significant impact on all financial institution portfolios. The research of [Akella and Chen \(1990\)](#) and [Choi et al \(1992\)](#) obtain similar results by using the same framework, multi-index CAPM, and period of data, from 1970s to 1980s. The difference between their work is different data frequency used; however, the significant impact of market return to banks return remains the same. Later periods, from 1980s to 2000s, are also covered with many literatures, and most importantly, variable conditional variance methodologies, such as GARCH framework, are increasingly adopted ([Elyasiani and Mansur 1998, 2003, 2004](#) and [Elyasiani et al 2007, etc.](#)). Without any doubt, the results of later

³¹ Joël Bessis, Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

³² Joël Bessis, Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

studies all show that financial institutions are sensitive to the changes in the general stock market.

With our most interest of this paper, we try to investigate the real estate effect to the financial institution stock behaviours. While a number of papers in the literature, although in very small proportion, have shown the significant impact of real estate effect to financial institutions, the general market return still has found to be significant to financial institution return after counting the real estate risk. [He and Reichert \(2003\)](#) use a three-index model on US quarterly data from period 1972-1995, and they find the systematic stock market factor has the most important, significant and stable impact on the risk premium of financial institutions, banks and insurance companies. While interest rate factor is useful in assessing bank current conditions, the equity stock market factor is useful in predicting future bank holding company performance ([Flannery 1998](#)). [He et al \(1996\)](#), by using monthly and weekly, value-weighted and equally-weighted indices, find that the market beta for banks is less than unity in US market, which shows the banks are generally less risky than the overall market stocks.

Market beta for financial institutions is to be size-dependent, with larger financial institutions displaying greater market beta values ([Elyasiani et al 2007](#)). The difference in the market beta may be to the fact that larger financial institutions tend to be highly leveraged, less liquid and more orientated towards no traditional banking activities such as exotic derivatives, which can be highly risky. Furthermore, different types of financial institutions have different market risk exposure ([Allen and Jagtiani 1997](#)). Securities firms have the lowest market risk premium with most market risk exposure. All financial firms, particularly insurance companies, reduced their market risk exposures after the 1979 change in monetary targets. Despite tighter regulations and the restriction of governmental forbearance, both depository institutions and insurance companies increased their market

risk exposure during the late 1980s and the early 1990s. The reason behind the general higher market risk exposure of commercial banks is because of the argument of moral hazard; that is, banks take on more risk to take advantage of government guarantees as their charter value decline.

4.2.2 INTEREST RATE FACTOR

The interest rate risk is the risk of declines of net interest income, or interest revenue minus interest cost, due to the movement of interest rate. Most of the loans and receivables of the balance sheet, and terms of saving deposits, generate revenue and cost that are driven by interest rates. Because interest rates are not stable, the earnings are unstable either. Borrowers and lenders with variable rate are subject to interest rate risk. In addition, loans and debts on fixed rate are also subject to interest rate risk because fixed rate lenders could lend at higher than their fixed rate if the rate increases, and borrowers could pay a lower interest rate when the rate decreases³³. Implicit or explicit options in banking products are other sources of interest rate risk. Optional risks are indirect interest rate risks because they do not depend only on the changes of interest rate, but also result from the behaviour of customers.

The early study of financial institution stock can be dated back to [Stone \(1974\)](#). Many earlier literature on the interest rate sensitivity impact on the bank stock return focused on the period 1976-1985, and interest rate was volatile and were at unprecedented high level ([Wetmore and Brick 1994](#)). [Stone \(1974\)](#) find that interest rate risk is inherent risk and cannot be either captured by market risk beta or diversified away. The two-factor model is, on the other hand, more efficient in explaining the interest rate risk by including equity market and

³³ Joël Bessis, Risk Management in Banking, 3rd Edition, Wiley Publisher, ISBN: 978-0-470-01912-2.

bond market information. [Bae \(1990\)](#) extends [Stone \(1974\)](#)'s study by examining both the current interest rate and anticipated interest rate monthly changes covering the period from 1974 to 1985. When estimating the expected current interest rate, he applies eight-lag autoregressive model and polynomial distributed lag model with the optimal lag of six periods, and the residual term is used to capture the unanticipated interest rate change factor. His results not only supports [Stone \(1974\)](#)'s finding that interest rate has an impact on the financial institution stock, but also he finds that both current and unanticipated interest rate changes are found to adversely affect financial institution stock returns. The current interest rate changes have less impact than the unanticipated interest rate changes, and it can be considered as changes correspond to unanticipated changes. Furthermore, he discovers that the sensitivity of financial institution stock return increases for a longer-maturity interest rate index. [Akella and Chen \(1990\)](#) also come to the same conclusion that long-term interest rate return is positively associated with bank stock return, and they further noted that the short-term return is ambiguous on the sensitivity of bank stock return. The study further points out that the estimation of the bank stock sensitivity appears to be affected by the period of study as well as by the methods estimation procedure.

The two-factor model is also supported by a number of studies. [Song \(1994\)](#) uses the same method over the same period 1979-1982 as in [Akella and Chen \(1990\)](#); however, he is the first to argue that since the market and interest rate risks depend on the conditioning information, the measure of betas on the conditional covariance and conditional variances of two factors, they are potentially time varying. Therefore, he applies an ARCH modelling process to the two-factor model, and the resulting two-factor ARCH model is estimated by generalized method of moments, GMM. The significant changes in the risk exposure of deposit institution are captured by the ARCH model, which corresponds to the dramatic

changes in banking regulations and economic environment in 1980s. This enforces the importance of modelling the time-varying beta in the market model for bank stock returns.

The idea of time-dependent bank stock return generating process is further supported in the study of [Flannery et al. \(1997\)](#), [Elyasiani and Mansur \(1998\)](#), [Kane and Unal \(1988\)](#) and [Kwan \(1991\)](#), and they all express that the return should be modelled to capture the feature. Instead of [Song \(1994\)](#)'s ARCH model, [Flannery et al. \(1997\)](#) apply generalized GARCH-M estimation process on two-factor model on the bank stock return generating process. [Elyasiani and Mansur \(1998\)](#) use the same GARCH-M process based on the multi-factor model to introduce the volatility of interest rate into the bank stock return generating process and allow for volatility to vary with time and relate the risk premium to the bank stock return volatility. The results support the previous studies that bank stock returns vary with time, and the long-term interest rate is significant with a negative impact on the bank stock return. The results also suggest that interest rate volatility is an important determinant of the bank stock return volatility and bank stock risk premium.

Similarly, [Brewer et al. \(2007\)](#) apply the same GARCH-M to life insurance stock returns rather than bank stock returns for period 1975-2000. They categorize the sample and form portfolios based on the high-beta and low-beta firms as well as different size of the insurance firms. The results show that the returns of insurance firms are sensitive to the long-term interest rate as shown in the bank stock returns, and the interest rate sensitivity of insurance firms is negatively related to changes in the interest rate. The study particularly notes that insurance firms with low market betas exhibit significant interest rate sensitivity, and equity returns of smaller life insurance firms are more sensitive to movements of the stock market than to the movement of interest rates.

The previous studies on volatility have been using univariate GARCH model, and [Elyasiani and Mansur \(2004\)](#) adopt a multivariate GARCH model to test the relative sensitivities of

bank stock returns to both short-term and long-term interest rates. In the later work, [Elyasiani and Mansur \(2007\)](#) apply the same method to examine the return interdependence and risk transmission across banks, securities firms and insurance companies. The findings suggest that bank stock returns are sensitive to the interest rate, and the direction of the effect is negative, with the magnitude depending on the portfolio- and model-specific characteristics. Long-term interest rate has a stronger impact on the bank stock returns, and the volatility of long-term and short-term interests have an important influence in determining the bank equity return and volatility. There is interdependency among three financial industries, and the relationship is size sensitive. Larger institutions show stronger volatility spillover effect than smaller organizations.

4.2.3 REAL ESTATE FACTOR

Since 1980s, there has been a large shift of loan portfolios into real estate in banking firms in the United States, and it has been observed as a trend in banking industry worldwide. The banking industry has changed substantially since the savings-and-loan crisis of the 1980s. Before the crisis, there are a large number of small and specialized firms, and traditional banking industry was fragmented. Since 1980s, segmented banking firms are consolidated, and a new financial service industry is gradually formed. One of the significant reform is commercial banks shifted their product and asset portfolios into consumer lending, which was traditionally a specialty of thrifts and credit unions. The number of real estate banks, which hold more than 40% of loans secured by real estate, has increased from 1,724 in 1989 to 2,835 in year 1996 ([Blaško and Sinkey 2006](#)). On the other hand, the total number of banks has dropped from 12,702 to 9,529 in 1996.

Real estate has been considered as a relatively high average return investment relative to its risk. Institution investors have favoured to include real estate in their portfolio as a good diversification instrument since 1980s. Real estate returns are predictable as the stock returns, and perform well in an asset-liability framework. In addition, the chance of experiencing a large loss on real estate in long term is very small ([Chun et al 2004](#)). The changes in the real estate returns reflect in changes in the property values, and it can have greater effects on bank risk and profitability ([He et al. 1996](#)). Therefore, real estate returns should have an explanatory power on the risks and returns of the financial institution stocks.

Although the importance of real estate has drawn many researchers' attentions, there are not many literatures on studying of the sensitivity of financial institution stocks to real estate returns. An early study on the impact of real estate loans can be found in [Eisenbeis and Kwast \(1991\)](#), in which they study the economic viability of the financial institution concentrating on real estate loans for period 1978-1988. They classify the banks into two groups: one group containing banks with 40% or more real estate loans, and the other group with banks with 40% or more real estate loans for five or more years. This classification is later adopted in [Blaško and Sinkey \(2006\)](#). The results show that banks with longer real estate loan history have higher returns with less risk than more diversified banks over the period 1978-1988, and those high return banks exhibit substantial flexibility in their ability to adjust their real estate loan holdings.

[Mei and Lee \(1994\)](#) find the presence of a real estate factor, in addition to both stock and bond factor in asset pricing, which addresses the importance to include real estate exposure in asset portfolios. [Allen et al \(1995\)](#) first explicitly introduce the idea of the impact of real estate market conditions on the banking industry. They argue that for bank stocks to be significantly related to the real estate market they have to have significant exposure to the

real estate, i.e. the amount of real estate holdings and the effectiveness of real estate market impact on the holdings. They use the seemingly unrelated regression framework to estimate a three-factor index model on bank stock returns to market, interest rate and real estate over 1979-1992. The findings show that, apart from market and interest rate, stock returns on large and medium size bank portfolios are positively and significantly related to the level of returns on real estate. And the sensitivity of bank returns to a real estate index has increased over time, which reflects a shift to real estate investment over the period in 1980s. .

Similarly, [He et al. \(1996\)](#) use the same method, and he compares the results when different proxies of return series are used. They use six proxies for the real estate returns: equally-weighted indices of monthly and weekly returns on all tax qualified REITs, equity REITs and mortgage REITs. They divide the bank holding company portfolios into 18 segments according to the feature of the loans, e.g. construction, farmland or residential. Different combinations of portfolio returns and proxies are analysed by the three-factor model. The results show that mortgage and all value REITs returns have better performance. Among all the combinations, the most appropriate proxies of market returns, interest rates and real estate returns are equally weighted market index, the unexpected changes in yields on long-term government bonds, and the mortgage REITs returns respectively. They also note that banks with a large proportion of loan investments are more sensitive than those with a smaller proportion. However, farm loans do not experience sensitivity on the bank stocks returns.

In his later research, [He et al. \(1997\)](#) additional test how different types and qualities of real estate loans affect the sensitivity of bank stock to real estate returns by using the most appropriate proxies obtained in [He et al. \(1996\)](#). The quality of real estate loans is tested according to the nature of loans. The results confirm the previous study on the bank real estate sensitivity. Different from the results before, he shows that farmland loans have a

negative impact on bank real estate return, of which could perform as diversification role in terms of reducing bank real estate return sensitivity. As for the quality of real estate loans, when using mortgage REITs returns, charge-off real estate loans have a negative impact on the bank stock returns to real estate returns, however, the impact of recovery real estate loans is positive.

[Mei and Saunders \(1995\)](#) use the GMM approach to test the multi-factor model restriction on the returns of five portfolios, including general stock market, bond, real estate, and bank stock portfolios. The bank stock returns are divided into a money centre bank group and a nonmoney centre bank group, and two return series on equally-weighted bank stock portfolio are used. The model allows flexibility of the influencing factors on the bank stock return by not restricting particular factors. They find that the time variation in bank risk premiums has been partly determined by interest rate and real estate market conditions. Real estate return has been most important for large nonmoney centre banks. [Mei and Saunders \(1997\)](#) extend the study by including real estate investment data of savings and loan association and life insurance companies along with bank stock returns. When estimating the real estate returns, they not only use equally-weighted equity REITs as in [Mei and Saunders \(1995\)](#), but also include the equally-weighted returns on real estate company stocks and mortgage REITs. They argue that mortgage REITs returns offer a particularly good proxy to the underlying returns on financial institution's real estate loan portfolios since from an investment perspective, the "payoff" structure of the real estate loan portfolio of financial institutions is similar to underlying the mortgage loan asset portfolios of mortgage REITs. The study discovers a trend-chasing behaviour that the real estate investment made by US commercial banks and saving and loans have been driven by ex-post real estate returns as well as ex-post market returns.

[Ghosh et al \(1997\)](#) examine the event study on financial institution stock price behaviour from a different aspect. They analyse the stock price behaviour around the announcements of declining real estate values during the crisis late 1980s and early 1990s. They show that financial institutions have significant negative stock price reactions to announcements of adverse real estate news. The study further support the indication of real estate impact on the financial institution stock returns. In [He \(2002\)](#), monthly percentage changes in median sale prices of new houses sold are used as a proxy for the real estate returns. The results show that a common set of variables is useful in explaining the returns of commercial banks, insurance companies and diversified financial institutions. He also shows that the inclusion of real estate market factor in the model can significantly raise its explanatory power. Therefore, it suggests that the real estate market factor indeed represents a systematic risk and plays an important role in explaining the returns on financial institution stocks. He also finds real estate market factor has very stable significant coefficients, except for two sub-periods in the 10 year periods, 1978-1987, which reflects the dramatic bank deregulation and unprecedented interest rate volatility. This supports real estate market experiences similar but less pronounced cycle as stock and bond markets.

In the recent literature, more studies have been focusing on relaxing the time-constant restrictions on the estimation process. [He and Reichert \(2003\)](#) use Flexible Least Square method on a three-factor Fama-French model to estimate the return of financial institution stocks for period 1972-1995. The study includes an index of overall financial institution, and indices for bank stocks and insurance companies to examine any differences in the return behaviour among sectors. The results find evidence that the real estate sensitivity of financial institution stock returns is statistically significant during most of the period 1972-1995. However, there are only two short sub-periods, 1972-73 and 1979-80 in which the real

estate market factor does not play a significant role in explaining risk premiums for financial institutions.

Since most of literature on financial institution stocks has been focusing on the United States market, and [Lu and So \(2005\)](#) are the first of few that study the real estate market impact on the bank return behaviours in Asia. They study the return relationships between listed banks and real estate firms in seven Asian countries before and after the Asian financial crisis in 1997, including Hong Kong, Indonesia, Japan, Malaysia, Singapore, South Korea and Thailand. They use a three-factor model to capture the impact of market, interest rate and real estate returns on bank stock portfolios over 1995-1999. The Grange-Causality results between real estate and bank stock returns show that the real estate returns do have an explanatory power in the bank stock returns in the Asian market; however, the reverse relationship is not established. In addition, Asian banks like those in United States are exposed to the real estate risk both before and after the crisis, and risk increased in the post-crisis period, which implies the underlying collateral on the bank real estate lending process is recognized.

4.2.4 REAL ESTATE FACTOR SELECTIONS

From previous discussions, we have seen that many studies have found evidences that real estate factor has a significant effect on the financial institution returns. However, there are different proxies of real estate factors have been employed in the literature. [Blaško and Sinkey \(2006\)](#) and [Chun et al \(2004\)](#) have used the size and proportion of real estate loans in the bank asset portfolios to represent the real estate factor. In addition, the sale price of real estate property has also been used in the research as shown in [He \(2002\)](#). There is an increasing trend of using Real Estate Investment Trusts (REITs) in the recent literature (as

seen in [Allen et al 1995](#), [Mei and Saunders 1995, 1997](#), etc.). The reasonableness of using REITs to represent its underlying real estate has been examined in many studies, and mixed results have obtained. In the following section, we will discuss the different findings of using REITs to represent real estate factor from the literature.

REIT stocks can be viewed as a form of securitized real estate representing claims on real properties or mortgages. However, when considering REITs as possible investment opportunities, investor should understand to what extent REIT stocks reflect the returns of their underlying real estate assets. If REITs returns do not reflect the returns to their underlying assets, investors can not use them as a convenient way to add a real estate component to their portfolio. In the literature, there is no consensus on the issue of whether the REITs stock market and the real estate property market are integrated. Strictly speaking, the two markets are said to be integrated if their risk premiums are the same or at least similar.³⁴

Some researchers find that the REIT pricing is very similar to that of other common stocks or that there is no evidence of market segmentation, suggesting that the two markets are integrated ([Li and Wang 1995](#)). [Giliberto and Mengden \(1996\)](#) find that return behaviours of REITs stock and private real estate are very similar after adjusting for differences in valuation parameters used in the two markets. [Ghosh et al \(1996\)](#) show that, during the period 1985-1996, REITs stocks have become less comparable to average stocks in recent period, and behave more like unsecuritized real estate. A positive contemporaneous relationship exists between REITs returns and real estate stock returns supporting a fundamental relationship between them ([Myer and Webb 1994](#)). After accounting for the lag in returns relative to REITs return, the returns to REITs are similar to the returns to real

³⁴ Su Han Chan, John Erickson, Ko Wang, Chapter 10 The Performance of REITs, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

estate. These findings could suggest that the market for REITs stocks and unsecuritized real estate shares similar fundamentals.

In some literature, they find evidences that a special real estate risk-factor premium affecting REITs returns and there is a relationship between the capitalization rate and REITs returns ([Mei and Lee 1994](#), and [Liu and Mei 1992](#), etc.). They argue that if the capitalization rate used to value real property affects the return to REITs, then it provides strong evidence that REITs stock returns can be partially affected by the movement of property values in the property market. [Lieblich et al \(1998\)](#) find weak long-run statistical relationship between the total returns of securitized and unsecuritized real estate, but no short-run relationship.

There are also evidences found by some researchers that the property market and the REITs stock market are not correlated. [Glascock et al \(2000\)](#) find that over the period 1972-1996, securitized and unsecuritized real estate markets are not cointegrated. [Ambrose et al \(1992\)](#) show that REITs stock market is integrated with general stock market over the long run. However, REITs may not be a good proxy for the returns of unsecuritized real estate because of their stock-like characteristics. Similar results are also seen in [Scott \(1990\)](#), in which he reports REITs stock prices do not always track real estate market fundamentals, therefore, REITs prices may not serve as reliable indicators of fundamental values for real estate.

The evidences of use REITs as a proxy of real estate factor are mixed, however, it seems there is an increasing number of recent studies have been used REITs represent the real estate factor influence. They conclude that there is some basic relationship between the markets for unsecuritized and securitized real estate. The differences of mixed views of the relationship between REITs and unsecuritized real estate are because of many reasons. One reason is due to the different data periods employed in the papers. It has been found

although the risk return characteristics of REITs stocks may have been more like non real estate common stocks in the past, in recent years REITs stocks have behaved more like unsecuritized real estate.³⁵

4.2.5 REITs – REAL ESTATE INVESTMENT TRUSTS

A traditional Real Estate Investment Trust (REIT) is essentially a closed-end fund created exclusively for holding real properties, mortgage-related assets, or both³⁶. This investment vehicle was created by the US Congress in 1960 for the express purpose of providing investors with an opportunity to invest in real estate properties and, at the same time, to enjoy the same benefits provided to shareholders in investment trusts. In order to make REIT a more attractive investment, Congress waives the corporate-level income tax on REITs, if they meet the requirements set by tax laws governing them. Among them, one of the most core conditions is that REITs must be widely held and they must distribute most of their taxable income as dividends to shareholders. With the creation of REITs, it is possible for investors to trade properties in the stock market since they are now in a form of a corporation or trust, and it also makes possible for small investors to invest in real estate. The stockholders of a REIT also receive economic benefits from the production of income through commercial real estate ownership. It can provide greater diversification by investing in a portfolio of properties rather than a single property.

There are two major ways in which institutional investors can invest in real estate³⁷: direct (private) and indirect (public). Direct real estate is acquired by investing directly or through

³⁵ Su Han Chan, John Erickson, Ko Wang, Chapter 10 The Performance of REITs, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

³⁶ Su Han Chan, John Erickson, Ko Wang, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

³⁷ Su Han Chan, John Erickson, Ko Wang, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

property pools, commingled real estate funds (CREFs), syndications or separate accounts managed by real estate professionals. The second category, indirect real estate, involves the purchase of securitized real estate, such as, REITs. The key difference between the traded securities, such as property companies and REITs, and direct market and private funds real estate investment is concerned with the basis of valuation. The direct market and private funds are valued according to valuation estimates, with expectations playing a limited role. On the other hand, traded securities such as property companies and REITs are priced primarily in relation to general equity markets, and the market expectation plays a key role. REITs have become popular financial products since it was first introduced in United States in 1960. REITs have changed the way of real estate investment from direct to indirect investment. It has been found that many institutional investors prefer to take larger positions in more liquid assets like REITs stocks than private real estate equities because REITs can provide more flexibility in liquidity ([Ciochetti et al. 2010](#)).

The regulations on REITs are passed on country level, and REITs from different countries may vary differently. However, in general, REITs are a tax efficient real estate investment vehicle giving them perceived advantages over conventional corporate vehicles. Tax efficiency means that the dividend payments of the firm are exempt from corporation tax. A regular corporation pays taxes on the entire profit, and then the after-tax profits are allocated between dividend and reinvestment. However, REITs can distribute all or almost all of their profit as dividend and avoid corporate income tax ([Peterson and Hsieh 1997](#)). To qualify as a REIT, a real estate company has to meet the following criteria³⁸:

- Pay out a minimum of 90% of its taxable income to its shareholder every year.
- Be an investor in real estate rather than a broker.

³⁸ Su Han Chan, John Erickson, Ko Wang, Chap. 2 The Origins and Evolution of Real Estate Investment Trusts, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

- Be a corporation, business trust or association managed by a board of trustees or director.
- Have at least 100 shareholders with no more than 5 of these owning more than a combined 50% of the trust's outstanding shares.
- Derive at least 90% of its gross income from rent and interest income, gains on the sale of property or shares of other trusts, and other real estate sources.
- Derive a minimum of 75% of its gross income from real property interest, gain on the sale of property or shares of other trusts, and other real estate sources
- Have at least 75% of total assets in real estate properties or mortgages, cash and government securities.

The success of the REIT structure in the US has led to the development internationally. Australia has introduced REITs (LPTs) since 1985. In recent years, a number of Asian markets have also pursued a REIT like structure, e.g. Japan, Singapore etc. European markets were slightly later to join the REIT markets. By the end of December 2011, the total number of companies listed under REITs is 616 worldwide³⁹. The following Table.8 lists 22 major REITs countries, and information on the year in which the country joined the REIT markets, the number of REITs by the end of year 2011, and its global market share:

³⁹ Source from Bloomberg and EPRA European Public Real estate Association Annual Global REITs Survey (<http://www.epra.com/>)

Table 8 Global REITs market share

This table reports the information regarding to the year of introduction, number of REITs products, market capitalization and percentage share of global REITs.

Country	REITs Name	Enacted Year	No. of REITs	Market Cap € billion	% of Global REITs
USA	US-REIT	1960	192	313.3	54.80%
Australia	LPT	1985	57	56.4	9.90%
France	SIIC	2003	43	50.3	8.80%
United Kingdom	UK-REIT	2007	21	30.9	5.40%
Japan	J-REIT	2001	34	29.5	5.20%
Canada	MFT	1994	35	26.7	4.70%
Singapore	S-REIT	1999	24	22.5	3.90%
Hong Kong	HK-REIT	2003	8	11.8	2.10%
Netherlands	FBI	1969	7	8.4	1.50%
Belgium	SICAFI	1995	14	5.5	1.00%
South Africa	PUT, PLS	2009	5	4.2	0.70%
Malaysia	Unit Trust	2002	14	2.8	0.50%
New Zealand	PIE	2007	8	2.4	0.40%
Turkey	REIC	1995	19	2	0.40%
Taiwan	Taiwan REIT	2003	8	1.7	0.30%
Germany	G-REIT	2007	4	1.3	0.20%
Mexico	FIBRAS	2004	1	0.6	0.10%
Greece	REIC	1999	2	0.4	0.10%
Italy	SIQ	2007	1	0.4	0.10%
Thailand	PFPO	1992	6	0.4	0.10%
Bulgaria	SPIC	2004	19	0.2	0.00%
South Korea	REIC	2001	4	0.2	0.00%

* Source: EPRA European Public Real estate Association Annual Global REITs Survey (<http://www.epra.com/>)

In general, North America, which includes United States and Canada, plays a dominating role in the global REITs market. It has the largest market share of global REITs market, 59.5%, with total market capital of €340bn. Asia Pacific region (Australia, Japan, Singapore, Hong Kong, Malaysia, New Zealand, Taiwan, Thailand and South Korea) has the second largest REITs market, with market capital €127.7bn, which takes 22.4% of global REITs market. European region is relative new joiner of the REITs market, with France and United Kingdom are the main players. The total market capital of European region is €97.4bn, which takes up 17.1% of global REITs market.

If we look at the country individually, the United State REITs market has the largest number of REITs, 179 companies. The US REITs dominated the global REITs market with market capital €313.3bn and market share of 54.8%. Besides US, no other country has market share more than 10%. Australia REITs is the second largest market in terms of number of REITs, 57 REITs, and market share of 9.9% (€56.4bn). In Europe, France has the largest number of REITs, 43 companies with market capital €50.3bn and market share of 8.8%, and third largest

globally. UK REITs follows the France REITs, with market share of 5.4% (€30.9bn). However, the total number of REITs companies in UK is 18, which is less than the number of REITs in Japan, 34 companies, with market share of 5.2% (€29.5bn). This represents that the average size of REITs in UK is larger than that in Japan. Canada REITs come to at the fifth place, with a total number of REITs of 35 and market share of 4.7% (€26.7bn). Furthermore, Singapore and Hong Kong REITs takes 3.9% (€22.5bn) and 2.1% (€11.8bn) of global REITs market. The total REITs market capital share percentage for the rest of countries is 5.2%, with each market share less than 1%.

REITs generally can be classified into three groups: equity REITs, mortgage REITs and hybrid REITs, which include both equity and mortgage REITs. Equity REITs focus on the ownership of income-generating real estate properties and invest heavily in commercial properties, such as retails, office buildings and industrial facilities. Mortgage REITs mainly invest in long-term and short-term construction loans, and residential and commercial mortgages, but they do not usually own or operate real estate. Therefore, it is expected that mortgage REITs may be more sensitive to interest rate changes than others in general, since they primarily held mortgages with long durations ([Liang et al 1995](#)). The total number of REITs companies is 616 by the end of 2011 worldwide as shown in Table.9. 90% of REITs products currently are equity REITs, with fewer than 10% are mortgage REITs. Table.9 is a classification of REITs products by their investment categories, and the information is obtained from Bloomberg. It shows REITs specialize in Industrial and Office have the largest number of REITs products of 179, followed by Retail REITs of 110, Diversified REITs of 99 and Residential REITs of 76. REITs specialize in mortgage lending has only 51 REITs, which occupies 8.27% of total REITs worldwide. It also reconfirms that equity REITs play a much larger role than mortgage REITs. There is a total of 192 US REITs, and 49 out of 192 US REITs products are mortgage REITs. REITs specialize in Retail and Industrial and Office are

33 respectively, followed by Specialty REITs (26) and Residential REITs (21). In UK, there are a total of 21 REITs products in UK. The number of REITs specializing in Industrial and Office and Retail is 9 and 7, followed by 3 in Diversified REITs and 2 in Specialty REITs. In Japan, over 50% of REITs products are Industrial and Office REITs (16 out 34 REITs). Residential REITs are the second largest REITs categories in Japan (8), followed by Diversified and Retail REITs of 4 REITs respectively.

Table 9 REITs Categories by Country

This table reports the number of REITs by categories worldwide, and particularly in US, UK and Japan.

REITs Category	Worldwide	Number of REITs		
		US	UK	Japan
Diversified	99	14	3	4
Hotel and Lodging	35	16	0	2
Industrial and Office	179	33	9	16
Mortgage	51	49	0	0
Residential	76	21	0	8
Retail	110	33	7	4
Specialty	66	26	2	0
Total	616	192	21	34

* Source: The information, on the different REITs categories classification and the number of REITs in each category and country, is from Bloomberg database.

4.2.6 RISK AND RETURN CHARACTERISTICS OF REITs

From previous literature, there is a basic relationship between the markets for unsecuritized and securitized real estate, especially in the long run. It is also suggested that including REITs stocks in a portfolio possess certain advantages because of its unique characteristics, e.g. liquidity.

REITs have been studied as portfolio diversifiers in a multi-asset portfolio ([Glascock 2000](#) and [Stevenson 2009](#)). There is a significant positive correlation between REITs and equities, especially small capitalization and value stocks ([Niskanen and Falkenback 2010](#)). It is also found that the diversification benefits for equities decrease with increasing volatility. REITs correlation to fixed income securities is found to be negative; therefore fixed income assets

provide an increased hedge. REITs have become more popular among institutional investors, and more research studies have increasingly used REITs to represent the real estate effect on the financial institution stocks ([Mei and Saunders 1995, 1997](#); [Elyasiani et al. 2010](#)).

Similar with most common stocks, the returns on REIT securities have fluctuated significantly over time. From literature, empirical results show that REITs perform differently over different time periods against the stock market. Generally speaking, the evidence indicates that over the long term, portfolios of REITs have not outperformed the stock market. [Sanders \(1998\)](#) shows over 1978-1996, REITs perform slightly worse or no better than stock market indices on a risk adjusted basis. However, this performance varies over time. He also finds that REITs outperform long-term government and corporate bonds. [Chen and Peiser \(1999\)](#) show the similar results over the period 1993-1997. In addition, they find out REITs created after 1993 have the same performance with those created prior 1993. There are some difference in the performance between equity and mortgage REITs, and equity REITs tend to perform better than mortgage REITs ([Han and Liang 1995](#)). In general, REITs have lower systematic risk, with equity REITs having the lowest systematic risk ([Glascock and Hughes 1995](#)). However, REITs performance relative to stock market has varied significantly for different subperiods. [Sander \(1998\)](#) finds that during the period January 1978 to December 1986, equity REITs outperform the stock market indices, while for the period January 1987 to October 1990, equity REITs earn risk adjusted excess return below the stock market. In addition, for the most recent period from November 1990 through June 1996, REITs outperform the S&P 500 index but no better than the Wilshire index. He argues that the reason for the different performance of REITs to S&P 500 and Wilshire index is because REITs are small stocks and small stocks typically outperform large stocks, such S&P 500 index. [Han and Liang \(1995\)](#) find similar results for the period 1970-

1993, and they also find that the performance of larger REITs tend to be more stable than that of smaller REITs. They explain the reason is because the portfolios of larger REITs tend to be more diversified than those of smaller REITs in terms of the number of properties held. The unstable REITs return performance is consistent with the strong cyclical behaviour of property market, although the stock market cycles of REITs tend to precede cycles in property market.

Since REITs is publicly traded on the market, the price movement of REITs stocks is probably related to that of the general market, as evidenced by the fact that REIT stock prices, just like those of all other stocks, change on a continuous basis. Therefore, factors affecting the general stock market may have an impact on the REITs, such as stock and bond market and changes in interest rates and unexpected inflation⁴⁰. On the other hand, the value of a REIT should be determined by the value of its underlying real estate properties.

[Sander \(1998\)](#) suggests that REIT return behaviour can be best described in terms of the behaviour of a mixed-asset portfolio of stocks and bonds. He shows that REITs stock return behaviour is more directly related to high-risk corporate bond and small stocks than to other indices of portfolio returns. Since prior to the early 1990s, most of the REITs are relatively small market capitalization, therefore, the small-firm factor exist, as shown in [Chan et al \(1990\)](#), [Han and Liang \(1995\)](#) and [Peterson and Hsieh \(1997\)](#). However, the small market capitalization effect does not exist in the late 1990s. Similar with the returns of publicly traded non-REIT companies, REITs returns are shown to be negatively related to their market-to-book values, such that when a company has low market-to-book value, it has a higher return ([Peterson and Hsieh 1997](#)). Mei and Lee (1994) also find evidences that in

⁴⁰ Su Han Chan, John Erickson, Ko Wang, Chapter 10 The Performance of REITs, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

addition to the traditional bond and stock market factors, real estate market factor can also affect REITs returns.

There are plenty of evidences indicating REITs return is also sensitive to the changes in the interest rate ([Sander 1998](#), [Chen and Tzeng 1988](#)). Since REITs have high dividend payment ratios, REITs traditionally offer relatively stable cash flow streams that resemble the cash flows from fixed-rate bonds rather than those from stocks. Furthermore, it is expected that both equity and mortgage REITs return may be more sensitive than those of the average stock to changes in interest rates. [Sander \(1998\)](#) also shows that the level of sensitivity also depends on the rate used as a proxy for the movement of the interest rate. In addition, equity REITs tend to be less sensitive to variations in interest rates than mortgage REITs ([Chen and Tzeng 1988](#)). This is because the cash flows to equity REITs are more primarily from property leases, which are renewed on a more frequent basis, the average duration of cash flows from real property investment is shorter than that from mortgage securities. Therefore, equity REITs are less sensitive than mortgage REITs to changes in interest rates.⁴¹ [Allen et al \(2001\)](#) also show that the differences asset structure, financial leverage and management strategy could also affect REITs sensitivity to interest rate and market risk. Furthermore, interest rate sensitivity of REITs over time depends on the different interest rate environment ([Mueller and Pauley 1995](#)). When the interest rate increases, REITs prices usually tend to decline, while during periods of falling interest rate, REITs prices rise.

There are also classifications based on whether or not REITs can issue additional shares. If REITs can only issue shares to the public once and can only issue additional shares once approved by current shareholders, the REITs are closed-ended. On the other hand, open-ended REITs can issue new shares and redeem shares at any time. The closed-end REITs

⁴¹ Su Han Chan, John Erickson, Ko Wang, Chapter 10 The Performance of REITs, Real Estate Investment Trust, Oxford University Press, ISBN: 0-19-515534-3.

companies raise money through IPO, much like corporations raise money selling stock to the public. Money raised from the IPO is used to invest in various real estate projects. Share prices for closed-ended REITs are based on the supply and demand on the market at any given time, and the prices can change throughout the trading day. The open-ended REITs, like most of mutual funds, do not have a fixed number of shares. When investing in open-ended REITs, new shares are created and funds are added to the investment pool. When selling share, the investment pool shrinks by the value of the share sold. The share price of open-ended REITs is based on the REITs net assets value.

The close- and open-ended REITs may have different risk and return behaviours due to different pricing characteristics, and close-ended REITs are more resemble to the common stock behaviour than open-ended REITs. In the current market, close-ended REITs dominate the REITs market. [Myer and Webb \(1993\)](#) study the time series properties of the REITs returns and intertemporal relationship between REITs and real estate returns, and the results show mixed behaviour. They show that in a distributional and time series sense, equity REIT returns appear to be much more like those in common stocks and close-ended funds than those on unsecuritized real estate. Intertemporally, REIT returns are much more strongly related to unsecuritized real estate than stocks or close-ended funds.

4.3 LITERATURE REVIEWS ON METHODOLOGY

4.3.1 CAPITAL ASSET PRICING MODEL – SHARPE (1964)

In the following section, we will discuss the estimation procedures that have been widely used in the literature (He et al 1996, Ross and Zisler 1991, Chen and Tzang 1988 and Liang et al. 1995). The first model has been adopted by the researchers in analysing the asset and portfolio returns is the Capital Asset Pricing model. The CAPM is a model for pricing an individual security or a portfolio first introduced by William Sharpe (1964) by building on the earlier work of Harry Markowitz on the modern portfolio theory on diversification. From Sharp's study, it shows the expected return depends on the risk free rate of interest and market premium or risk premium. The formula is as following:

$$E(R_i) = R_f + \beta_i(E(R_m) - R_f) + \epsilon_i$$

Where $E(R_i)$ is the expected return on the capital asset; R_f is the risk-free rate of interest such as interest arising from government bonds; β_i is the sensitivity of the expected excess asset returns on the expected excess market returns, $\beta_i = \frac{Cov(R_i, R_m)}{Var(R_m)}$, $E(R_m)$ is the expected return of the market; $E(R_m) - R_f$ is sometimes known as the market premium or risk premium, which is the difference between the expected rate of return and the risk-free rate of return.

Stone (1974) and Bae (1990) use the CAPM in estimating the interest rate sensitivity on the bank stock returns. Stone (1974) argues that single-factor CAPM model produces noise and instability on interest rate effects in estimating beta. He further studies the effects of bond and equity market by using the two-factor model under the assumption investors hold well-diversified portfolios with the aim to maximize a single-period mean variance expected utility function. Allen et al (1995), Mei and Lee (1994) and He et al. (1996, 1997) use multi-

variant CAPM model in studying the real estate sector influence on the bank stock return. However, Sharpe's one-factor CAPM model can explain only about 70% of the returns of the stock market, but when two additional factors were considered; about 90% - 96% of the variability of returns of a diversified portfolio can be explained.

In the early study of real estate risk and returns, CAPM and multi-index model have been used as an estimating procedure for the assessing the relationship between REITs returns and the market and interest rate indices. [Ross and Zieler \(1991\)](#) use two-index CAPM to find that that real estate risk lies plausibly midway between that of stocks and bonds, in the 9 percent to 13 percent range. [Chen and Tzang \(1988\)](#) examine both the interest rate and market effect on the REITs returns, and show that both equity and mortgage REITs are sensitive to changes in the long-term interest rates and changes in expected inflation in 1973-1979. In period 1980-1985, both REITs are sensitive to long-term as well as short-term interest rates. The changes in the interest rate sensitivity are due to the change in the Federal Reserve operating procedure in October 1979, shifting from interest-rate targeting toward money-supply targeting. They also analyse the impact of expected inflation rate and expected real rates of interest, and find that Equity REITs are sensitive to changes in the expected inflation and Mortgage REITs are sensitive to both changes in expected inflation and real rate of interest. Market factor is still an important factor in explaining the return generating process of REITs, with mortgage REITs are marginally riskier with greater estimated coefficient. In addition, the coefficients are larger in period 1973-1979 than period 1980-1985 for both REITs, which show REITs have lower market risk in 1980-1985. [Liang et al \(1995\)](#) use the same method for similar period 1973-1989, and instead of examining the expected interest rate and inflation, the study more focus on the impact of market risk and long-term interest rate risk on different REITs portfolios. They construct four equally weighted REIT portfolios: all-REIT portfolio, equity REIT portfolio, hybrid REIT portfolio,

mortgage REIT portfolio. The results support the findings in [Chen and Tzang \(1988\)](#), and all-REIT and hybrid REIT portfolio show similar return-generating process as shown in mortgage and equity REITs. It also shows that changes in policy can affect REITs performance. All REITs portfolios experience a significant shift in the return-generating process in 1976, 1980, 1983 and 1986, which are coinciding with important events, such as, tax reform and monetary regime changes.

The effectiveness of interest rate proxies for equity and mortgage REITs are studied in [He et al \(2003\)](#). The study examines REITs returns by two-factor index model, and FLS method is used to allow the analysis of changes that affect each factor of the return-generating process. FLS does not impose a time-constant restriction on coefficient estimates and analyse the relative stability of the regression coefficient by showing the changes of coefficients over time. It is suggested that mortgage REITs are sensitive to all proxies and equity REITs are significantly affected by only changes in yields on long-term US government bonds and high-yield corporate bonds. All interest rate sensitivities are time specific.

4.3.2 FAMA-FRENCH MODEL – FAMA AND FRENCH (1993)

[Fama and French \(1993\)](#) extended the Sharpe's CAPM model by including another two factors, size and price, to determine the factors describing the reason that there are differences among the returns of stock asset classes over a long period. The findings suggest that an investor's investment performance in comparison to the stock market depends almost entirely on the percentage of stocks (market factor) held in the portfolio, and more specifically, the amount of small stocks (size factor) and high book-to-market ratio stocks (value factor) held.

The model is described as follows:

$$r = R_f + \beta_i(K_m - R_f) + b_s \times SMB + b_v \times HML + \epsilon_i$$

K_m is the return of the whole stock market, and R_f is the risk-free rate of return. Term $K_m - R_f$ in the Fama-French three-factor model is the amount of exposure to the overall stock market or the market risk factor. The level of exposure to this market factor is determined by the amount of a portfolio invested in or exposed to stocks. The greater the exposure is, the higher the return is in comparison to the US Treasury bills.

The second risk factor, *SMB*, in the model is the level of exposure to small company stocks, which denotes the size factor. The size risk factor is determined by the amount of a portfolio that is invested in small company stocks. The greater the exposure, the higher the return in comparison to large company stocks. The small company is determined by the size of market capitalization. The market capitalization is calculated by multiplying the total number of shares times the market price per share. Stocks with small market capitalization are generally considered as riskier than large company stocks because small companies have fewer financial resources therefore more uncertainty than large companies. During the period of economic downturns, small companies are less able to survive. Even small companies have good track records, the records are not very long or stable, which makes small company stocks riskier. Therefore, the investors investing small company stocks expect higher returns. Over the last eighty years, the average returns of small cap company stocks have significantly outperformed large company stocks by 3.13% percent. However, in short term, small company returns do not always perform better than large companies.

The third factor, *HML*, in the model is the amount of exposure to stocks with low book-to-market ratio value. Book-to-market value is the ratio of book value and market value, which is used to identify undervalued or overvalued securities. Book value of a company is just an

accounting term for its net value, its assets minus liabilities. The market value of a company is its price per share multiple the numbers of shares outstanding on the market. Book-to-market value is referred as value factor or price factor. Exposure to the price factor is determined by the amount of a portfolio exposure level to the high book-to-market stocks. If a stock's book value is more than its market value, the ratio is greater than one, which gives high book-to-market stock. Stocks with high book-to-market value have low earnings and experience other signs of financial distress. Due to their poor performance, the market drives down their share prices in the market, this gives the market value less than its book value. Therefore stocks with high book-to-market value are riskier to investors. Stocks with low book-to-market value represent healthy growth and performance, therefore less risky to investors. Because the market perceives a value stock to be riskier, it drives down their price so that the expected return is high enough to make it worthwhile for investors to hold. As for investment, investors seeking for high returns are more favour to the stocks with high book-to-market, and subsequently need to bare more risk. Investors earned higher return by owning the stocks of companies that have poor performance.

The Fama-French three factor model can be extended by adding more deterministic factors. Two common factors for fixed income products are usually considered as influential. One of the factors is term risk factor. Term factor reflects the different rate of return by investing different fixed income product with different maturities. If investors keep terms of maturities short, they have more opportunity to capture much higher expected returns. Therefore, products with short maturity give a higher return than products with long maturity. Another factor is the default risk factor. It measures the difference between long-term corporate bonds and government bonds, since the long-term government bonds are considered less likely to default than corporate bonds. Portfolios with a high proportion of corporate bonds have higher returns than those with a lower proportion of corporate bonds,

since it bears higher default risk and investors expect a higher return to compensate the risk taken. After including these two factors, term risk factor and default risk factor, The Fama-French three-factor model can be extended into five-factor model.

A number of studies examine the REITs return process under Fama-French procedures. [Peterson and Hsieh \(1997\)](#) is the first to use Fama-French five-factor model on REITs returns. They show that equity REITs returns are significantly related to three stock market factors: market return, capitalization size HML and price factor book-to-market. Mortgage REITs returns are related to these stock market factors as well as two bond market factors, default risk and term risk factors. The inclusion of size factor and book-to-market factor in return can significantly reduce the abnormal performance of equity REITs found in previous studies. It is also noted that mortgage REITs on all five factors suggest that the mortgage REITs underperform by 6.8 percent per year on average during the sample period 1976-1992. In addition, [He and Reichert \(2003\)](#) use a three-factor Fama-French model to estimate the return of financial institution stocks for period 1972-1995. [He \(2002\)](#) uses six-factor Fama-French model after including the default risk and term risks. [Chiang et al \(2004\)](#) examine REITs return-generating process by using the Fama-French three-factor model for period 1972-2001. It tests the robustness of the asymmetric beta under a variety of asset pricing specifications and the findings show that the asymmetry in market beta in advancing and declining markets disappears when adding capitalization size and book-to-market variables in the estimation. To address the declining market beta of REITs found in some recent studies, [Chiang et al \(2005\)](#) show that there is a weak evidence for a decline in equity REITs beta based on a single factor model, and the declining trend disappears when Fama-French three-factor model is used. The stability of equity REITs risk exposure to market beta has implications for investor's decision on asset allocation and portfolio diversification. The Fama-French model is also used in the event study examining the performance of

acquisitions in the REITs around the announcement and in the long-run in [Sahin \(2005\)](#). [Lee and Chiang \(2008\)](#) examine the linkage between equity REITs and the underlying real estate and show that REITs returns reflect the performance of underlying real estate. Therefore, it supports the use of REITs as a proxy to capture the real estate exposure to the market. All these studies find strong evidence that Fama-French model provides a better estimation framework than the CAPM model.

4.3.3 GARCH FRAMEWORKS

Another model has been widely used in the literature is Autoregressive Conditional Heteroskedasticity model as shown in [Song \(1994\)](#). The ARCH models are used to characterize and model observed time series. It assumes that the variance of current error terms to be a function of the actual size of the error terms of prior periods.

For an estimation $y_t = a_0 + a_1 y_{t-1} + \dots + a_q y_{t-q} + \epsilon_t = a_0 + \sum_{i=1}^q a_i y_{t-i} + \epsilon_t$

Let ϵ_t denote the error term or return residuals, i.e. the series terms. Let

$$\epsilon_t = \sigma_t z_t$$

Where z_t is the stochastic term, $z_t \stackrel{iid}{\sim} N(0,1)$, and σ_t is the time-dependent standard deviation characterizing the typical size of the terms. For and ARCH(q) model, the series σ_t^2 modeled as

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \dots + \alpha_q \epsilon_{t-q}^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \epsilon_{t-i}^2$$

Where $\alpha_0 > 0$ and $\alpha_i \geq 0, i > 0$.

If an Autoregressive Moving Average model (ARMA model) is assumed for the error variance, the model is a generalized autoregressive conditional heteroskedasticity (GARCH). For a GARCH (p, q) model, the standard deviation is characterized as:

$$\sigma_t^2 = \alpha_0 + \alpha_1 \epsilon_{t-1}^2 + \dots + \alpha_q \epsilon_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \dots + \beta_p \sigma_{t-p}^2 = \alpha_0 + \sum_{i=1}^q \alpha_i \epsilon_{t-i}^2 + \sum_{i=1}^p \beta_i \sigma_{t-i}^2$$

The common feature of ARCH and GARCH is that they specify the conditional variance as a function of the past shocks allowing the volatility to evolve over time and to permit volatility shocks to persist. However, ARCH uses a limited number of lags in derivation of the conditional variance, while GARCH allows all lags to include the past value of the conditional variance itself and the past values of the squared error term.

There is a number of literatures using the GARCH based model to examine the volatility in the financial institution stocks, as seen in [Song \(1994\)](#), [Elyasiani and Mansur \(1998, 2003, 2007\)](#) and [Flannery et al \(1997\)](#). [Song \(1994\)](#) is the first study to employ the ARCH-type methodology in financial institution stocks. He finds that ARCH-type modelling is the appropriate framework for analysis of bank stock returns. According to his results, market and interest rate risk measures of banks do vary significantly over time. However, he shows the volatility does not change significantly around October 1979 in response to the shift in the monetary policy strategy; they increase around the end of 1982 when the Fed switch to targeting borrowed reserve. [Flannery et al \(1997\)](#) also find similar results by using GARCH-M, and except for the significant effect of stock market risk on financial institution stock returns, the market factor's volatility varies significantly through time, from 1973-1990. They also show, interest rate risk is reflected in the pricing of financial institution stock, as well as a broad class of securities. When sub-periods are considered, they show that the interest rate volatility is relatively low, except for 1979-1984 sub-period. They also find evidence that ARCH-M and GARCH-M model give better performance than the basic ARCH and

GARCH, and they argue that the reason for the better performance is due to the inclusion of the mean of return series as an explicit function of the conditional variance of the process. [Elyasiani and Mansur \(1998\)](#) use the same GARCH-M method to investigate the effect of interest rate and its volatility on the bank stock return generation process over 1979-1982 time periods. ARCH, GARCH and volatility are found to directly impact the first and second moments of the bank stock returns distribution. The degree of persistence in shocks is substantial for bank portfolios and sensitive to the nature of the bank portfolio and the prevailing monetary policy regime.

Univariate-GARCH model can be generalized into the multivariate-GARCH model. For the error term ϵ_t of an n-dimensional time series model we assume that the conditional mean is zero and the conditional covariance matrix is given by the positive definite (n×n) matrix σ_t^2 .

$$\epsilon_t = \sigma_t z_t$$

Where, $z_t \stackrel{iid}{\sim} N(0, I)$, I is the identity matrix.

A number of studies have used the multivariate-GARCH model as in [Elyasiani and Mansur \(2003, 2004, 2007\)](#). The advantage of using a multivariate framework is to provide an analysis of volatility and interlinkage between the assets concerned, and to allow an estimation of the time-varying covariance and correlations. [Elyasiani and Mansur \(2003\)](#) use bivariate GARCH framework to examine the bank stock sensitivity to market, interest rate, and exchange rate, and investigates the spillover effects of interest rate volatility and unsystematic risk among the banking sectors of the United States, Japan and Germany. The results show that the bivariate GARCH model is appropriate to represent the return generating process of financial institutions. In addition, banks are sensitive to market and exchange factor, but insignificant to interest rate factor. The volatilities in banks of the three countries are found to be interdependent. Furthermore, most importantly, the spillover

effects of interest rate uncertainty among three countries are found to be significant. When interest rate volatility shocks originate in the United State, it spreads to Japan and Germany market. In addition, [Elyasiani et al \(2007\)](#), they employ the multi-variate GARCH framework to investigate the risk and return relationship across US commercial banks, securities firms, and life insurance companies during 1991-2001period. They find evidences of significant linkage between these financial institutions, and the relationship depends on the size of the organizations. Larger organizations display stronger volatility transmission, while smaller organizations show return-related linkage. Furthermore, [Elyasiani et al \(2010\)](#) also use the bivariate GARCH model to examine the return and volatility spillover from real estate sector to three financial institutions in US, commercial banks, savings and loans, and life insurance companies. They show that the equity returns of the financial institutions considered follow a GARCH process and should be modelled accordingly. There is also evidence that the real estate factor has significant and positive influence on the financial institutions returns. The results on the volatility indicate that the volatility in the real estate sector does get transmitted into financial institutions. However, savings and loans institutions and life insurance companies experience greater volatility spillover from real estate sector than commercial banks.

Furthermore, in recent studies, there are a number of papers focusing on explaining the volatility of REITs return under GARCH framework. [Devaney \(2001\)](#) uses GARCH-M estimating procedure used in [Elyasiani and Mansur \(1998\)](#) on the monthly equally weighted returns on all individual publicly traded REITs from NAREIT from 1978 to 1998. He argues that monthly data is used since it is more manageable than higher frequency data for long horizons and monthly data avoids the settlement and clearing problems associated with daily returns. It finds that both ARCH and GARCH effects in the volatility equation are significant for mortgage REITs but not for equity REITs. The trade-off between the

conditional variance and excess returns is only significant for mortgage REITs, but positive for both REITs. It also shows that the impact of policy change is significant and negative for mortgage REITs but is insignificant for equity REITs. [Stevenson \(2002\)](#) examines the linkages of volatility and spillover between REITs and other capital market assets using both the GARCH and EGARCH specifications. Various REITs portfolios and market equity portfolios have been analysed in relation to US government bonds and T-bills. The adoption of various equity indices is to capture any differences in the relationship between REITs and different sectors of the broader capital markets. It is found that REITs are influenced more strongly by volatility in small cap stocks and firms classified as value stocks. The overall S&P 500 has inconsistent relationship with REITs. Comparing the GARCH and EGARCH specifications, EGARCH gives more intuitively justifiable findings. Within the REITs sectors, it shows that the equity REITs can influence the mortgage and hybrid REITs, and mortgage REITs behave similarly with other REITs. In addition, in terms of volatility, the market does not differentiate between the REITs sub-sectors and views the entire sector as a single market. In the later study, [Cotter and Stevenson \(2006\)](#) extend the study to examine REITs volatility in both method and data employed. Instead of univariate GARCH specification, a multivariate GARCH model, BEKK, is used. The study also includes a high frequency daily data and compares the results when different frequency data are used. The advantage of using a multivariate framework is not only to provide an analysis of volatility and interlinkage between the assets concerned, but also allow an estimation of the time-varying covariance and correlations. The findings show that the use of high frequency data would weaken the results when monthly data is used in relation to the links both within the REITs sector and between REITs and the broader equity market. Under daily data, equity market plays a stronger role and more influential when the linkage between REITs and related sector is less obvious.

4.4 METHODOLOGY

In this study, we adopt Bivariate GARCH framework on the financial institutions and REITs return generating processes as used in [Elyasiani et al \(2010\)](#). The financial institution return process is structured by the multifactor capital asset pricing model (CAPM). The REITs return generating process is tested by both the Fama-French three-factor and multifactor capital asset pricing model.

The frameworks used are as following:

Model.1:

$$R_{1,t} = \beta_{10} + \beta_{11}RM_t + \beta_{12}R_{2,t} + \beta_{13}\Delta I + \varepsilon_{1,t} \quad (12)$$

$$h_{1,t} = a_{10} + a_{11}\varepsilon_{1,t-1}^2 + b_{11}h_{1,t-1} + \gamma_{12}h_{2,t-1} \quad (13)$$

$$R_{2,t} = \beta_{20} + \beta_{21}RM_t + \beta_{22}SMB_t + \beta_{23}HML_t + \varepsilon_{2,t} \quad (14)$$

$$h_{2,t} = a_{20} + a_{22}\varepsilon_{2,t-1}^2 + b_{22}h_{2,t-1} \quad (15)$$

$$h_{12,t} = \rho_{12}h_{1,t}h_{2,t} (-1 < \rho_{12} < 1) \quad (16)$$

$$\varepsilon_{i,t} | \Omega'_{t-1} \sim N(0, h_{i,t}) \quad (i = 1, 2) \quad (17)$$

REITs return is estimated by Fama-French three-factor model as in equation (14).

Model.2:

$$R_{1,t} = \beta_{10} + \beta_{11}RM_t + \beta_{12}R_{2,t} + \beta_{13}\Delta I + \varepsilon_{1,t} \quad (18)$$

$$h_{1,t} = a_{10} + a_{11}\varepsilon_{1,t-1}^2 + b_{11}h_{1,t-1} + \gamma_{12}h_{2,t-1} \quad (19)$$

$$R_{2,t} = \beta_{20} + \beta_{21}RM_t + \beta_{24}\Delta I + \varepsilon_{2,t} \quad (20)$$

$$h_{2,t} = a_{20} + a_{22}\varepsilon_{2,t-1}^2 + b_{22}h_{2,t-1} \quad (21)$$

$$h_{12,t} = \rho_{12}h_{1,t}h_{2,t}(-1 < \rho_{12} < 1) \quad (22)$$

$$\varepsilon_{i,t}|\Omega'_{t-1} \sim N(0, h_{i,t}) \quad (i = 1, 2) \quad (23)$$

REITs return is estimated by multifactor CAPM model as in equation (20).

Where,

$R_{1,t}$, is the return of banks portfolio; three different countries are examined separately;

$R_{2,t}$, is the return of REITs index for each country;

RM_t , is the market return;

ΔI , is the change of interest rate for each country;

SMB_t , Small minus Big, size of market capitalization, Fama-French factor;

HML_t , High minus Low, value of book-to-market, Fama-French factor;

$\varepsilon_{1,t}$, error term of bank stock return generating process, following $N(0, h_{i,t})$;

$\varepsilon_{2,t}$, error term of REITs return generating process, following $N(0, h_{i,t})$;

$h_{1,t}$, conditional variance of bank stock return;

$h_{2,t}$, conditional variance of REITs return;

$h_{12,t}$, conditional covariance of bank and REITs returns.

In this framework, the error term $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are structured by the bivariate GARCH specification. Equation (12)-(13) and (18)-(19) are the same and represent the financial institution mean return⁴² ($R_{1,t}$) and the conditional volatility ($h_{1,t}$). The difference between the two models is the mean return of REITs ($R_{2,t}$). In Model.1, the REITs return ($R_{2,t}$) is estimated by the Fama French three factor model (RM_t, SMB_t, HML_t) in equation (14) as used in [Chan et al \(1990\)](#), [Chiang et al \(2004, 2005\)](#) and [Peterson and Hsieh \(1997\)](#). In Model.2, REITs return ($R_{2,t}$) is estimated by CAPM multifactor model ($RM_t, \Delta I$). Equation (15) and (21) estimates the conditional volatility ($h_{2,t}$) of REITs return. The conditional covariance between banks and REITs returns ($h_{12,t}$) is described by equation (5) and (11). The mean return spillover of REITs to bank return is estimated by the REITs return factor ($R_{2,t}$) in the financial institution mean equation (12) and (18). The volatility spillover of REITs to bank return is estimated by the conditional variance of REITs ($h_{2,t-1}$) in the bank conditional volatility ($h_{1,t}$) in equation (13) and (19). The market return is represented by RM_t and the interest rate return is represented by variable ΔI .

In equation (12) and (18), the mean equation of financial institution return is explained by the market risk RM_t , interest rate risk ΔI , and most important to our interest, real estate return factors $R_{2,t}$. RM_t is the return on the S&P 500 market index for US, FTSE All Share Price index for UK and NIKKEI 225 for Japan. ΔI is the change in long-term interest rate (10-year treasury bills) for three countries. The real estate factors are represented by the REITs returns, which are the return of NAREIT All REITs index⁴³ (US), EPRA UK REITs index⁴⁴ (UK) and TSE REITs index⁴⁵ (Japan). In the first model, REITs return is estimated by the

⁴² All return series used in the paper are excess returns. One month Treasury Bill rates in US, UK and Japan market are used as risk free rates.

⁴³ NAREIT: National Association of Real Estate Investment Trusts; NAREIT All REITS index is the weighted average index of all REITs companies (192 REITs) traded in the United State market.

⁴⁴ EPRA UK REITs index is the UK REITs index produced by European Public Real estate Association for all UK REITs (21 REITs) traded in the UK market.

⁴⁵ TSE REITs index is the index of all REITs (34 REITs) traded in the Tokyo Stock Exchange.

Fama-French three-factor model (equation 14). The model includes variables, the market risk RM_t , and two Fama-French factors, SMB, the difference between the returns on portfolios of small and big stocks, and HML, the difference between the returns on portfolios of high and low book-to-market ratio stocks. [Chiang et al \(2004\)](#) suggest that the growth style exposures of REITs are the aggregation of small growth and big growth exposures. The value stock exposure consistently represents a large component of equity exposure of REITs. [Chiang et al \(2004\)](#) conclude that Fama-French three-factor model is a proper return generating process of REITs. In the second model, REITs return is estimated by the CAPM. [Chen and Tzang \(1988\)](#) examine both the interest rate and market effect on the REITs returns, and show that both equity and mortgage REITs are sensitive to changes in the long-term interest rates and changes in market returns. All return series used in the paper are excess returns. One month Treasury bill rates in US, UK and Japan market are used as risk free rates.

The bivariate GARCH system model described above is estimated simultaneously for banks and REITs returns. The advantage of GARCH model is that they can release some restrictive assumptions in the conventional asset pricing models, such as, linearity, error independence, and constant conditional variance, homoscedasticity. GARCH models specify the conditional variance of return $h_{i,t-1}$ as a function of past shocks (lagged squared errors $\varepsilon_{i,t-1}^2, h_{i,t-1}, i=1,2$), allowing volatility to evolve over time and permitting volatility shocks to persist ([Elyasiani et al 2010](#)). The squared error terms specify in GARCH estimation shows that if the current shocks are larger in absolute value, future innovations are likely to be large as well. The magnitudes of ARCH and GARCH coefficients (a_{ii}, b_{ii}) determine the weights of lagged innovations. The sum of these parameters $(a_{ii} + b_{ii})$ determines the degree of persistence in the shocks. To ensure a well defined process, the ARCH and GARCH parameters must be non-negative and must satisfy the second order stationarity

conditions ($0 < a_{ii} + b_{ii} < 1$). If the sum of parameters is unity, the model is integrated of order 1 in variance, and the persistence of shocks to the system will never end.

4.5 DATA AND DESCRIPTIVE STATISTICS

In this study, weekly data are analysed for period from January 1999 to December 2011 for US market of total 673 observations. However, since UK and Japan introduced REITs in 2007 and 2001, that are much later than US REITs, which was introduced in 1960, the time periods for UK and Japan market are from 2007 to 2011 of total 257 observations and from 2003 to 2011 of total 453 observations respectively. The reason to use weekly data is because of the short period of data available for UK and Japan, especially in REITs, therefore, weekly data can provide more information than monthly data. Also, when estimating REITs return, compared to the monthly data, the weekly data always result in a higher level of significance for both the coefficients of most variables as suggested by [He et al \(1996\)](#). For US market, bank portfolios are constructed based on the standard industrial classification (SIC) code. Standard Industrial Classification code is a United States government system for classifying industries by a four-digit code. This classification is adopted in [Elyasiani et al \(2010\)](#). According to the classification, three financial institution portfolios are formed. The commercial banks portfolio consists of 323 banks which includes SIC 6021 (National Commercial Banks) and SIC 6022 (State Commercial Banks). In UK market, 35 banks which are actively traded in the UK stock market are selected according to the Bloomberg. In Japan market, 95 banks are selected, and all of them are actively traded in the Japanese stock market, and the historical prices are obtained from Bloomberg. The weekly returns are calculated as $\log(\frac{P_t}{P_{t-1}})$ for each banks stock return, and the bank portfolio return is constructed by the equally weighted average of the return of each individual bank. The

measure of real estate impact of real estate on the performance of financial institution is complex (He and Reichert 2003). Non-securitized measure of real estate return which using the actual real estate prices is one option to represent the real estate factor as shown in He (2002) and He and Reichert (2003). Blasko and Sinkey (2006) and Eisenbeis and Kwast (1991) use the proportion of real estate loan in bank loan book as an indication of real estate factor.

In most of the literature, REITs are used to as proxies of the real estate factors, and they have been shown as appropriate proxies to represent the influence of real estate on the financial institution stocks. Furthermore, depository institutions such as commercial banks and savings and loans have significant holdings on the residential and commercial real estate mortgages, therefore, REITs, especially mortgage REITs may be considered as an appropriate proxy to the real estate performance (Chen and Tzang 1988, Liang et al 1995 and He et al 2003 etc.). In addition, other financial institutions, like insurance companies and pension funds, own commercial real estate directly; therefore, equity REITs may be considered as a good proxy (Peterson and Hsieh 1997, Lee and Chiang 2008 and Chiang et al 2004 etc.). In this paper, we use NAREIT All REITs index⁴⁶ as a proxy for the US REITs returns, EPRA UK REITs index⁴⁷ as a proxy for the UK REITs returns, and TSE JREITs index⁴⁸ as a proxy for the Japanese REITs returns. NAREIT is the National Association of Real Estate Investment Trusts, which is the worldwide representative for REITs and publicly traded Real Estate companies with an interest in US Real Estate and capital markets. NAREIT is one of the most popular indexes used to analyse real estate market influence (Lee and Chiang 2008, Chiang et al. 2005, Cotter and Stevenson 2006, etc.). There are few literatures in studying the UK and Japanese REITs market due to the limited data

⁴⁶ NAREIT: National Association of Real Estate Investment Trusts; NAREIT All REITS index is the weighted average index of all REITs companies (192 REITs) traded in the United State market.

⁴⁷ EPRA UK REITs index is the UK REITs index produced by European Public Real estate Association for all UK REITs (21 REITs) traded in the UK market.

⁴⁸ TSE REITs index is the index of all REITs (34 REITs) traded in the Tokyo Stock Exchange.

availability, and our paper extends the literature range. All the REITs indices we adopted here mainly included close-ended REITs as this is more resemble to the common stock behaviours, and more close-ended than open-ended REITs in the market. Interest rate variable is represented by change in the 10 year Treasury Bills interest rate (ΔI) for all three countries. The market risk variable is represented by the S&P 500 index, FTSE All Share Price index and NIKKEI 225 index. S&P 500 index is one of the most used variables to represent market risk for US market (Cotter and Stevenson 2006). FTSE All Share Price index is used in many literatures to represent the UK stock market performance (Dinenis and Staikouras 1998). NIKKEI 225 index is used to represent the Japanese stock market performance as in Connolly and Wang (1998). All the above data are collected from Bloomberg and Datastream database. The Fama-French factors variables SML and HML for US and UK market are obtained from Kenneth R. French website⁴⁹ and UK Fama-French Xfi Centre source⁵⁰. The Fama-French factors are created by using CRSP database. The weekly returns are calculated as $\log(\frac{P_t}{P_{t-1}})$, and the interest rate return is calculated by first difference.

We separate the entire period 1999-2011 into three sub-periods: from January 1999 to December 2002; from January 2003 to December 2006; from January 2007 to December 2011. The rationale behind the first division of December 2002 is to reflect the impact of the collapse of the Dot-Com bubble in 2000, and especially after the 911 attack in September 2001, the overall decline in the financial market. In October 2000, Fannie Mae commits to purchase and securitize \$2 billion of Community Reinvestment Act eligible loans. Since then, the early 2000s recession begins and spurs government action to recover the economy. The second cutoff is January 2007 to reflect the recent subprime crisis. Since the first quarter in 2007, the home sales continue to fall. The subprime mortgage industry collapses, and a

⁴⁹ US Fama-French factors are collected from Kenneth R. French website:
<http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/>

⁵⁰ UK Fama-French factors are collected from Xfi Centre for Finance and Investment:
<http://xfi.exeter.ac.uk/researchandpublications/portfoliosandfactors/index.php>

surge of foreclosure activity and rising interest rates threatens to depress prices further as problems in the subprime markets spread to the near-prime and prime mortgage markets. The two financial crises in 21th century are both originated in US and subsequently spread into Europe and Asian market, and become a global economic recession. The two cutoffs in the paper represent the two financial crisis and economic cycles for the last decade.

The following graphs show the annual average returns of bank portfolio, stock market and REITs returns of US, UK and Japanese market. Figure.3 shows the percentage mean return of US market. For bank stock portfolio, in 1999 the mean return of bank stock is negative, -0.27%, and the return increases to -0.17% in 2000. In 2001, the return of bank stock becomes positive in 2001, 0.42%, and after a small fluctuation in 2002, the return reaches its highest point in 2003 to 0.63%. This return pattern represents the influence of Dot-Com bubble and 911 attack on the financial market in 2000, and the economic shows a sign of recovery in 2003. Since then, the return of banks decreases, however, the bank stock return is still positive from 2004 to 2006. The graph shows in US there is a huge increase in the REITs return reflects the influence of the government actions and booming economy, which peaks between 2005 and 2006. However, in the beginning of 2007, the S&P/Case-Shiller house price index records first year-over-year decline in nationwide house prices since 1991. The subprime mortgage industry collapses, and several subprime lenders declare bankruptcy, announcing significant losses, or putting themselves up for sale. The collapse of subprime mortgage market spreads to the near-prime and prime mortgage markets, and further to the whole financial market. The financial market has been experienced significant decline in all aspects as a result of the subprime crisis. There is a sharp drop of bank stock return since 2006, and the return is -0.59% in 2007. The return is lowest in 2008, -0.84%, which shows the recent subprime crisis has a significant impact in banks since 2007 and the situation is worst in 2008. The bank return increases from 2009, and reaches positive 0.14% in 2010, which

shows the bank stocks is recovering from 2009. However, from 2011, the US economy has experienced a fluctuation due to the debt crisis and unemployment rate, and the bank return again drops to -0.43%. The REITs and market returns experience the same fluctuation pattern as bank returns. However, in 1999 and 2000, REITs return experiences an increasing trend from -0.29% to 0.28%, and market return decreases from 0.34% to -0.21%. From the graph, we can also see that from 1999 to 2005, bank stocks experience highest returns, followed by REITs and general market returns. However, since 2005, bank stocks become the least profitable stocks with the lowest return, and REITs have the highest return.

Figure.3 US market annual returns

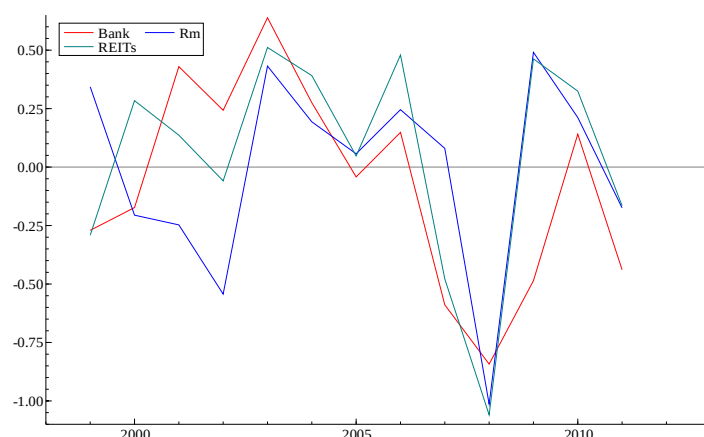


Figure.3 shows the annual mean returns of US market for bank, market and REITs portfolios. **Bank** is the commercial banks portfolio is consist of 323 banks which include SIC 6021 (National Commercial Banks) and SIC 6022 (State Commercial Banks). **Rm** is the market stock returns which is proxied by S&P 500 index. **REITs** is the returns of US NAREITs Index (National Association of Real Estate Investment Trusts, which is weighted average index of all 192 REITs companies traded in the United State market.

Figure.4 shows the percentage of returns in UK market, and since REITs was first introduced in 2007, our data adopted in our analysis is from 2007. From the graph, we can see that bank, REITs and market returns all experience a significant drop from 2007, 0.36%, -0.81% and 0.11% respectively, and only REITs return is negative. Similarly as in US market, all the returns reach their lowest point in 2008. Bank stock return is down to -2.08%, followed by REITs return of -1.70% and market return of -1.44%. Since 2008, all the returns increase in 2009 to a new high point in 2009 as in US with bank stock return of 0.60%, REITs

return of 0.12% and market return of 0.67%, which shows a recovery of the economy in 2009 since the subprime crisis. And after 2009, the returns continue to drop which reflects another economic turbulence in UK market due to the European debt crisis since 2010. If we compare the level of return for each portfolio, we can see in UK, general stock market has the highest return from 2007 to 2011 in general. REITs return is higher than the return of bank stock portfolio from 2007 to 2008 and from 2010 to 2011. In 2009, bank stock return outperforms REITs.

Figure.4 UK market annual returns

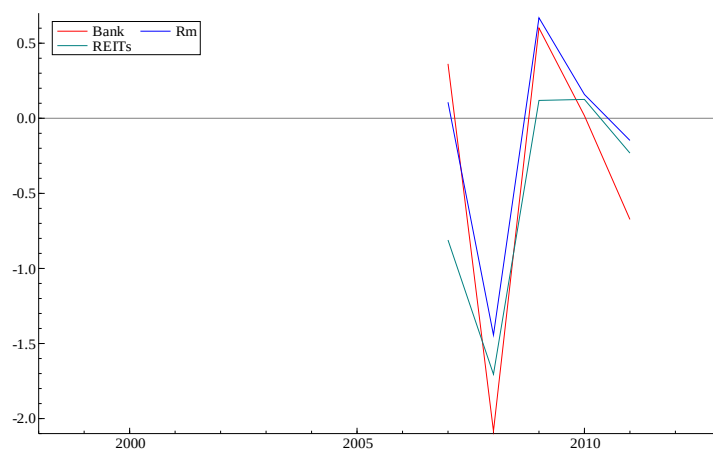


Figure.4 shows the annual mean returns of UK market for bank, market and REITs portfolios. **Bank** is the UK banks portfolio, which is consist of 35 banks that are actively traded in the UK stock market. **Rm** is the market stock returns which is proxied by FTSE All Share Price index. **REITs** is the returns of UK REITs which is the index produced by European Public Real Estate Association for all 21 UK REITs.

Figure.5 shows the percentage return of Japanese market. In our sample, the Japanese data starts from 2003. From the graph, we can see the highest return for all series is in 2003, with bank return of 0.56%, REITs return of 0.65% and market return of 0.97%. Since 2003, all the returns decrease, and reach the lowest return in 2008, which shares the same pattern with US and UK market. The market experiences a recovery from 2008 to 2010 with a positive return in 2010. Again, due to the European debt crisis and overall recession of the global market since 2010, all the returns decrease with negative returns in 2011.

Figure.5 Japanese market annual returns

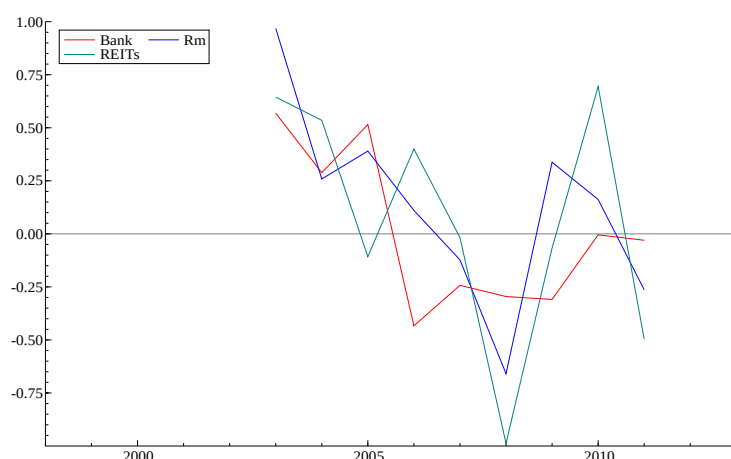


Figure.5 shows the annual mean returns of Japanese market for bank, market and REITs portfolios. **Bank** is the Japanese banks portfolio, which is consist of 95 banks that are actively traded in the Japanese stock market. **Rm** is the market stock returns which is proxied by NIKKEI 225 index. **REITs** is the returns of Japanese TSE JREITs index which include 34 REITs traded in the Tokyo Stock Exchange.

From the above analysis, we notice that US, UK and Japanese market share a similar pattern in terms of bank, REITs and market returns. In general, there is an increasing trend of returns from 2000 to 2003 which shows an increasing activity in the financial market since the Dot-Com bubble and 911 attack. All the returns reach the lowest point in 2008 to reflect the global financial subprime crisis since late 2007. The overall global market experiences a recovery from 2009 to 2010. However, due to the collapse of the European debt market and continuous defaults of European countries, the returns of financial market experiences another downturn from 2010 to 2011. The similarity of the return pattern of three portfolios in US, UK and Japanese market also confirms that there is a close relationship in the global market among each country. The financial condition in one country or region can significantly produce a spillover effect on another country or region. It supports the results from [Fraser and Oyefeso \(2005\)](#), which shows real stock prices of US and UK market are linked by a common stochastic trend and therefore they are perfectly correlated in the long-term. Short-term diversification gains may occur, however, it tends to be short-lived.

The descriptive statistics for each return series are described in Table.10. We include the descriptive statistics for the full sample period of US, UK and Japan Market. The descriptive results show that, for the full sample period, the average return of commercial banks is negative and between -0.30% and -0.02%. UK market has the lowest average return of -0.3%, followed by US banks of the average return of -0.1%. Japanese commercial banks have the highest average return with -0.02%. We can see that the returns of commercial banks, REITs and market fluctuate over the period. Commercial banks and REITs returns are all positive for the period 1999-2006; however, the sharp drop since 2007 significantly influences the overall average returns in the period from 1999 to 2007. The average returns of commercial banks are still negative over longer sample period from 1999 to 2011. The average returns of REITs range from -0.6% to 0.1%. Japanese REITs average return is the highest of 0.1%, followed by US REITs return of 0.05%. UK REITs show the lowest return of -0.6%. Results show that REITs portfolios exhibit higher unconditional volatility compared with commercial portfolios returns with a standard deviation of 3.5%, 6.0% and 3.5% for US, UK and Japan respectively. The finding is different from those found in [Elyasiani et al. \(2010\)](#) and [Cotter and Stevenson \(2006\)](#), in which REITs show lower unconditional volatility. The reason of the difference may be due to the long sample period in our study. [Elyasiani et al. \(2010\)](#) only study the period from 1972 to 2004, and our sample has included the most volatile period from 2007 to 2011, which may contribute to the difference. The overall market average returns of the three market is around 0.0%, with UK market return of -0.1% and Japan market of 0.1%. The unconditional volatility of general market is higher than commercial bank and lower than REITs for all countries, which shows that commercial banks are less volatile than the general market, and REITs is more volatile than the general market. The average interest rates of US and UK market are 4.33% and 4.15% respectively, which is higher than Japanese average interest rate of 1.40%. In addition, US interest rate is the most volatile with unconditional volatility of 98%, with highest interest rate of 6.78% and

lowest interest of 1.83%. The reason of the volatile interest rate is because, after the 911 attack, there is an overall decline in the financial market. The government takes a series of actions to boost the economy. Between 2000 and 2011, US Federal Reserve lowers Federal funds rate 11 times, from 6.5% (May 2000) to 1.75% (December 2001), creating an easy-credit environment that fuels the growth of US subprime mortgages. Skewness and kurtosis are significant for all series. The significant kurtosis values demonstrate leptokurtosis. The unconditional distributions of returns are non-normal since the Jarque-Bera statistics are significant. The Ljung-Box test statistics for the return series are significant for all series except for commercial banks return for Japanese market, which shows the Japanese commercial banks portfolios reject the null hypothesis of no autocorrelation. The findings are to be expected because the time period covers certain rather extreme economic situations of record high and low stock prices and interest rates (Elyasiani et al. 2010). The results of skewness, kurtosis, non-normality and serial correlation suggest that a GARCH-type process is appropriate for modelling financial institutions and REITs returns.

Table 10 Descriptive statistics of financial institutions and REITs returns												
Variables	Definition	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Q(8)	Q(16)	Q(24)
US Market												
BANK	Commercial Banks	-0.001	0.001	0.145	-0.149	0.024	-0.675	11.142***	1910.514***	15.752**	60.643***	78.356***
REITS	Real Estate Investment Trust	0.000	0.002	0.204	-0.192	0.035	-0.348***	11.076***	1842.699**	7.467	33.182***	53.856***
RM	Market (S&P 500)	0.000	0.001	0.114	-0.201	0.027	-0.769***	8.877**	1035.159***	19.174**	30.567**	35.502**
I	Long-term Interest Rate	4.326	4.269	6.765	1.833	0.980	0.009***	2.812***	0.994**	4777.4***	8565.4***	1158.5***
SMB	Small minus Big	0.098	0.090	6.270	-9.350	1.424	-0.455***	7.912***	699.928***	23.097***	41.886***	44.461***
HML	High minus Low	0.086	0.000	9.830	-6.950	1.545	0.480***	8.689***	933.595***	25.705***	47.822***	67.131***
UK Market												
BANK	Commercial Banks	-0.003	0.002	0.137	-0.260	0.049	-1.573***	10.831***	617.432***	16.513***	37.921***	51.789***
REITS	Real Estate Investment Trust	-0.006	0.001	0.177	-0.233	0.060	-1.022***	6.106***	119.912***	3.581	26.589**	42.992***
RM	Market (FTSE All Share Price)	-0.001	0.002	0.162	-0.269	0.043	-1.251**	10.781**	579.076***	13.824**	38.580***	43.237***
I	Long-term Interest Rate	4.150	4.040	5.547	2.866	0.714	0.067**	1.800***	12.628***	1679.1***	2769.5***	3336.1***
SMB	Small minus Big	-0.086	0.013	4.634	-2.957	1.106	0.926***	8.274***	270.903***	249.650***	253.390***	259.120***
HML	High minus Low	-0.111	-0.143	2.839	-1.869	0.770	1.384***	7.990***	282.316**	265.400***	309.500***	407.080***
Japan Market												
BANK	Commercial Banks	0.000	0.000	0.106	-0.127	0.028	-0.044***	4.506**	42.824***	7.811	19.027	29.573
REITS	Real Estate Investment Trust	0.001	0.001	0.189	-0.257	0.035	-0.779***	12.972***	1914.572***	19.817**	44.053***	56.616***
RM	Market (NIKKEI 225)	0.001	0.002	0.085	-0.216	0.029	-1.039***	9.273***	820.868***	4.037	21.484	34.789***
I	Long-term Interest Rate	1.404	1.406	1.994	0.455	0.274	-0.450**	3.711***	24.789***	2592.7***	3786.2***	4396.2***
Note: The US commercial banks portfolio is consist of 323 banks which includes SIC 6021 (National Commercial Banks) and SIC 6022 (State Commercial Banks). In UK market, 35 banks which are actively traded in the UK stock market are selected according to the Bloomberg. In Japan market, 95 banks are selected and all of them are actively traded in the Japanese stock market, and the historical prices are obtained from Bloomberg. The bank portfolio returns are constructed by the equally weighted average of the returns of each individual banks. US REITs index are obtained from NAREIT: National Association of Real Estate Investment Trusts, which is weighted average index of all REITs companies (192 REITs) traded in the United State market. UK REITs index is the REITs index produced by European Public Real estate Association for all UK REITs (21 REITs). Japan REITs index is the TSE JREITs index is the index of all Japanese REITs (34 REITs) traded in the Tokyo Stock Exchange. Market stock used is here is the return of S&P 500 index, FTSE All Share Price index, and NIKKEI 225 index. The variables on the SML and HML Fama-French factors for US and UK market are obtained from Kenneth R. French website and UK Fama-French Xi Centre source. Interest rate variable is represented by change in the 10 year Treasury Bills interest rate (ΔI) for all three countries. The weekly returns are calculated as $\log(P_t/P_{t-1})$ for each return series, and the interest rate return is calculated by first difference.												
*** 1% significant level												
** 5% significant level												
* 10% significant level												

The correlation coefficients are presented in Table.11.

Table 11 Correlation coefficients of variables used in the empirical testing						
US Market	BANK	REITS	RM	ΔI	SMB	HML
BANK	1.000					
REITS	0.563	1.000				
RM	0.572	0.534	1.000			
ΔI	0.233	0.218	0.292	1.000		
SMB	0.208	0.225	0.081	0.141	1.000	
HML	0.392	0.312	0.025	0.003	-0.234	1.000
UK Market	BANK	REITS	RM	ΔI	SMB	HML
BANK	1.000					
REITS	0.431	1.000				
RM	0.503	0.573	1.000			
ΔI	0.142	0.221	0.338	1.000		
SMB	0.121	0.218	0.153	0.056	1.000	
HML	0.198	0.202	0.175	-0.024	0.465	1.000
Japan Market	BANK	REITS	RM	ΔI		
BANK	1.000					
REITS	0.416	1.000				
RM	0.582	0.524	1.000			
ΔI	0.158	0.013	0.277	1.000		

Note: **BANK:** The US commercial banks portfolio is consist of 323 banks which includes SIC 6021 (National Commercial Banks) and SIC 6022 (State Commercial Banks). In UK market, 35 banks which are actively traded in the UK stock market are selected according to the Bloomberg. In Japan market, 95 banks are selected and all of them are actively traded in the Japanese stock market, and the historical prices are obtained from Bloomberg. The bank portfolio returns are constructed by the equally weighted average of the returns of each individual banks. **REITS:** US REITS index are obtained from NAREIT: National Association of Real Estate Investment Trusts, which is weighted average index of all REITs companies (192 REITs) traded in the United State market. UK REITS index is the REITs index produced by European Public Real estate Association for all UK REITs (21 REITs). Japan REITS index is the TSE JREITs index is the index of all Japanese REITs (34 REITs) traded in the Tokyo Stock Exchange. **RM:** Market stock used is here is the return of S&P 500 index, FTSE All Share Price index, and NIKKEI 225 index. The variables on the **SMB** and **HML** Fama-French factors for US and UK market are obtained from Kenneth R. French website and UK Fama-French χ^2 Centre source. ΔI Interest rate variable is represented by change in the 10 year Treasury Bills interest rate (ΔI) for all three countries. The weekly returns are calculated as $\log(P_t/P_{t-1})$ for each return series, and the interest rate return is calculated by first difference.

In US market, the correlation between commercial banks and general market (0.572) is higher than the correlations of other portfolios. This is followed by the correlation of 0.563 between banks and REITs returns. The pattern of correlations in US market among banks, REITs and market is the same with UK and Japanese market. The correlation between general market and REITs is 0.534 in US market. However, in UK, the correlation between general market and REITs (0.573) is higher than both the correlations between bank portfolio and REITs (0.431), and between bank portfolio and general market (0.503). In Japanese market, the correlation between REITs and general market is 0.524, which is lower than the correlation between bank portfolio and general market (0.582), and is higher than the correlation between bank portfolio and REITs (0.416). The correlations between interest rate return and other portfolios are lower than others for the three countries, which shows portfolios within the equity market are more correlated than with the bond market. These results are consistent with findings in the majority of literature.

4.6 EMPIRICAL RESULTS

The extended bivariate GARCH model of both Model.1 and Model.2 are presented by equation (12)-(17) and equation (18)-(23) respectively described in the methodology section. Each model framework is estimated simultaneously for commercial banks and REITs. Equation (12)-(13) and (18)-(19) represent the mean return and conditional volatility process for financial institution returns. Equation (14)-(15) and (20)-(21) represent the mean return and conditional volatility process for REITs. Asymptotic t-values are in parentheses. The estimation results for Model.1 are displayed in Table.12, and the estimation results for Model.2 are displayed in Table.13.

4.6.1 FACTORS AFFECTING BANK STOCK RETURNS

4.6.1.1 MARKET FACTOR

As shown in Table.12 and Table.13, the magnitude of market betas (β_{11}) for banks and REITs portfolios for all periods in Model.1 and Model.2 are less than 1.0. [He et al \(1996\)](#) find that the market beta for banks is less than unity in US market by using monthly and weekly, value-weighted and equally-weighted indices. Our results support the findings in [He et al \(1996\)](#), and the results also indicate that banks are less risky than the market portfolio in all our testing periods of all three countries: US, UK and Japan.

In Model.1, the market beta (β_{11}) for US market in full period from year 1999 to 2011 is 0.313. Within in the full sample period, we divide the thirteen years into three sub-periods. The market sensitivity to bank stock returns varies in different period. In the period 1999-2002, the market beta is 0.164, which is less than the market beta of the full period. This indicates that the bank stock return is less sensitive during 1999-2002 than during the longer period from 1999-2011. This is because the longer period from 1999 to 2011 includes two

extreme financial conditions, 2000 Dot-Com bubble and 2007 financial crisis; therefore, the market beta may be significantly compromised by the ups and downs of the financial market conditions. During the year 2003 to 2006, the market beta is 0.521, and during the year 2007 to 2011, the market beta is 0.353. The results show that the bank stock return is more sensitive to the market return during the economic booming during 2003-2006 than during the economic downturn in year 2007-2011, during which the world economy suffer from subprime and European debt crisis. [Elyasiani et al \(2007\)](#) show that market beta for financial institutions is to be size-dependent, with larger financial institutions displaying greater market beta values. They explain that the difference in the market beta may be to the fact that larger financial institutions tend to be highly leveraged, less liquid and more orientated towards non-traditional banking activities such as exotic derivatives, which can be highly risky. The argument is supported by our results of higher market beta (0.521) than other periods, which shows during the economic booming period 2003-2006, banks are highly involved in the exotic derivative in order to seek high profit, such as CDOs and CMOs, and banks during the period are extremely highly leveraged with little liquidity. Therefore, the banks return is highly sensitive to the general market performance. The high leverage of banks is also the underlying reason for the sub-prime crisis beginning in late 2007. In UK, since we only test the period from year 2007 to 2011, we cannot compare the market sensitive of different periods in UK. However, we notice that the market beta in UK for period 2007-2011 is negative and insignificant, -0.047. The negative market beta shows that banks are negatively related to the general market return during 2007-2011 in UK. In addition, when the general market return increases, the bank stock returns decrease.

In Model.2, similarly within Model.1, the market betas for US market are all positive and significant, and the magnitudes are slightly greater than the one in Model.1. The market sensitivity is 0.383 for full period 1999-2011, which is similar with the magnitude in Model.1.

The market beta for period 1999-2002 is 0.228, which is greater than the value in full period. Bank stock return is more sensitive to the general market during period 2003-2006 than during 1999-2002. The high sensitivity of banks to general market during the economic booming in 2003-2006 is because banks tend to engage in the high risk financial activities in order to pursue high profit, which has been discussed in the previous paragraph. However, in the second model, the market beta of US market is highest during period 2007-2011 of 0.619. The second framework is different from the trend in the first framework, in which market beta is greatest in period 2003-2006. This indicates when market is volatile during the subprime and European debt crisis during 2007-2011, the bank stocks are sensitive to the general market. As for UK market, the market beta is positive 0.659 and, again, insignificant. The market beta is negative in the first framework, and in our second model, the coefficient is positive. Japanese market is included in the second framework. The market betas in Japan are positive and significant. The greatest market beta is 0.745 in period 2003-2006. Since the market is globally connected, the prosperity of the economy in one country can be transmitted to another country. [Elyasiani and Mansur \(2003\)](#) show that stock volatilities in the banking sectors of US and Japan are found to be highly interdependent, so that the performance of the stock market in US can spillover to Japanese market. During 2003-2006, the Japanese banks actively invest in the high-risk high-profit financial products as US banks. Therefore, the bank stocks are highly sensitive to the general market performance. If we compare like-by-like the Japanese market with the US market, we notice that for the same period Japanese market beta is higher than the US market beta. This indicates that Japanese banks are more sensitive to the equity market with greater impact.

4.6.1.2 INTEREST RATE FACTOR

The interest rate betas (β_{13}) for most of the portfolios are negative and small in magnitude but not statistically significant, except for US full period 1999-2011 in Model.1 (-0.007) and UK period 2007-2011 under both frameworks (-0.031). The findings on the interest rate variable in the extant literature are mixed but in general the magnitude of the interest rate effect is small and the direction of the effect is negative. According to [Elyasiani and Mansur \(2004\)](#), the sensitivity of bank stock returns to the changes in the interest rate is an indicator of the level of interest rate risk exposure of the banks. Banks curtail their interest rate risk exposure by limiting the duration gap between their assets and liabilities and taking positions in derivatives markets. These actions reduce the magnitude of the interest rate beta coefficient in the model. [Elyasiani and Mansur \(2004\)](#) study three portfolios, money centre, large and small banks by using daily data for period from January 1988 to December 2000 in US market and find out bank stocks are clearly interest rate sensitive, with the long rate demonstrating a bigger impact. In our results, when we use the US full period 1999-2011, the interest rate is negative and significant to the bank stock returns. There are few literature examining the interest rate sensitivity to bank stocks over the recent 10-year period. Our results show that in the recent period 1999-2011, US banks still are sensitive to the interest rate change as before (in period year 1988-2000 as in [Elyasiani and Mansur 2004](#)). On the other hand, the interest rates for all three sub-periods in US and all periods in Japan are all negative but insignificant in both frameworks. The negative coefficients indicate that financial institutions are generally effective in hedging their interest rate exposures ([Brewer et al. 2007](#)). [Elyasiani et al. \(2007\)](#) explain that banks tend to securitize much of their loans, thereby shifting their interest rate risk to institutional investors purchasing the securitized packages. While majority of literature, cited earlier in the literature review section ([Stone 1974](#), [Wetmore and Brick 1994](#), [Bae 1990](#), etc.), find that the interest rate exposure of

commercial banks is significant. The negative and insignificant of interest rate sensitivity to bank stock returns in US and Japanese market is supported by a few literatures. [Booth and Officer \(1985\)](#), [Chance and Lane \(1980\)](#) and [He et al \(1996\)](#) have found that interest rates have little impact on U.S. bank stock returns. [Elyasiani and Mansur \(2003\)](#) study the bank stock sensitivities to market, interest rate, exchange rate, and the spillover effects of interest rate volatility and unsystematic risk among the banking sectors of the United States, Japan and Germany for period of year 1986-1995. They found the interest rates are all negative and insignificant for US, Japan and Germany. They discuss that there are several factors contributing to the lack of significance of the interest rate. One reason is banks included in the data set may have conflicting sensitivities to interest rates due to duration gaps between assets and liabilities; the average interest rate sensitivity of the portfolio appears insignificant. Moreover, the hedging activity of the banks in the form of matching duration gaps, securitization, and holding positions in financial derivative may results in the insignificance of interest rate. Furthermore, banks in the sample are diversified organizations, and they are more likely to engage in both banking and non-banking activities whose banking business is focused on fee-based and off-balance sheet contracts, rather than the intermediation. Finally, the results on interest rate may differ from some of the existing literature because of the GARCH methodology adopted here. The interest rate sensitivity of the Japanese banks is also insignificant under both frameworks. This result is particularly interesting since it is expected that Japanese banks are sensitive to the interest rate change because these banks hold a substantial amount of government bonds. The reason is due to the low level and less volatile of interest rate which narrows the interest rate changes and makes them ineffective ([Elyasiani and Mansur 2003](#)). Our sample period for Japan is from year 2003 to 2011. From the descriptive statistics in Table.10, we notice that the average interest rate is 1.404%, which only fluctuates slightly between 0.445% (minimum) and 1.994% (maximum). Unlike US and Japanese market, the UK bank stocks show

significant sensitivities to the interest rate changes, with coefficients of -0.031 under both frameworks. [Dinenis and Staikouras \(1998\)](#) also use the weekly UK data and find that the coefficients on the interest rate are significant and negative for UK financial institution portfolios including banks for both one-month and three-month rate during period 1989-1995. They also find that the use of longer term interest rate can increase the interest rate sensitivity of the financial institution portfolios. Our results show that, following [Dinenis and Staikouras \(1998\)](#)'s work, interest rate sensitivity to UK bank stocks is still significant even over the most volatile subprime crisis 2007-2011. The long-term ten year Treasury bill rate used in this paper provides stronger interest rate sensitivity of the portfolios.

4.6.1.3 REAL ESTATE FACTOR

The effect of real estate returns on the FI return distribution is the most interesting issue in the study. [Elyasiani et al. \(2010\)](#) explain there are three channels through which the effect of real estate can be transmitted to the financial institutions. Firstly, when there is a boost in real estate, the level of credit risk exposed by the financial institutions falls because the value of mortgage loans and other real estate investment increases. Secondly, since financial institutions directly hold real estate properties, such as industrial and office buildings, when there is an increase in the value of the real estate, financial institutions gain greater profits. The third channel is from the increase in the wealth of borrowers, such as an increase in their revenue from rent.

The REITs Indices used in the paper (NAREITs, EPRA UK REITs and TSE REITs) measure the total return on a value weighted investment in publicly traded REITs. There are many discussions on the appropriate proxy to represent real estate market fundamentals. [Eisenbeis and Kwast \(1991\)](#), [Ghosh et al. \(1997\)](#) and [Blaško and Sinkey \(2006\)](#) use mortgage

loans and real estate properties holdings as percentage of total asset to examine effect of real estate factor to financial institution stocks. [He \(2002\)](#) and [He and Reichert \(2003\)](#) adopt median sale price index of commercial properties in the study to represent real estate influence on the bank holding companies. Since the introduction of REITs, REITs have become one of the most frequently used measures of real estate returns. [Chun et al \(2004\)](#) and [Mei and Saunders \(1995, 1997\)](#) present evidences to support the use of REITs returns as a real estate market proxy. [Allen et al \(1995\)](#) argue that the use of REIT returns is appealing because they represent market transactions, even though REITs prices are a secondary measure of real estate value.

The results show that most of REITs returns have positive and significant impact on all financial institution returns ($\beta_{12} > 0$) for all three countries. While each real estate coefficient varied with the model used, the real estate coefficient is consistently positive and significant, regardless of the model employed as shown in [Allen et al \(1995\)](#). The positive coefficients of REITs represent that the fluctuation of bank stock returns is moving in the same direction with the REITs returns. In terms of magnitude effect the coefficients of US REITs range from 0.556 to 1.469 for different time periods under Model.1. Over the full period 1999-2011, the coefficient of REITs return is 0.746, less than unity, which shows the bank stock is less risky than the REITs during 1999-2011 in general. When comparing among different sub-periods, we notice that REITs return gives the strongest sensitivity to bank stock return during period 2003-2006, with coefficient great than unity, 1.469. This is followed by the period 2007-2011 (0.985) and period 1999-2002 (0.556). During 2003-2006 there is a booming in the real estate section and global economy. The price of real estate property is rising in consecutive five years since 2002. The rising property prices have encouraged individual and institutional investors investing in real estate properties and related products. Individual investors take loans from banks and S&L institutions in order to invest in more

properties. Institutional investors heavily invest in high risky real estate related financial derivatives in order to gain greater profits. The booming real estate market has made investor wealthy, however, at the same time properties and real estate related financial products are significantly over-valued. This makes real estate products highly risky during the period. The large magnitude of REITs coefficient, 1.469 reflects the unstable situation during 2003-2011. [Allen et al \(1995\)](#) discuss the increase in bank exposure as measured by the proportional holding of real estate over time increase the shift in the sensitivity of bank portfolios to real estate. The coefficient is greater than unity, which shows REITs are more risky than the bank stocks during this period. [He et al \(1996, 1997\)](#) examine real estate sensitivity by using all REITs, equity REITs and mortgage REITs. They conclude that irrespective of different REITs used, the results all show significant sensitivity to the bank stock returns. However, they find out bank returns are most sensitive to mortgage REITs given higher coefficient. They explain this is because banks make more real estate loans during the period 1986-1991. This is consistent with [Mei and Saunders \(1995\)](#), in which they show there is an increase in the sensitivity of bank stock to real estate as banks expanded their loan portfolios in the real estate sector. Under Model.2, the coefficients of REITs are also positive and significant; however the magnitudes are smaller than the coefficients under Model.1. This shows Model.1 is stronger to represent the real estate REITs effect to bank stock returns than Model.2. In UK market, the REITs return is significant in Model.1, with magnitude of 0.738. The coefficient is smaller than that in US market from the same period, which indicates UK REITs have weaker influence on bank stock returns than US REITs during year 2007-2011. Under Model.2, REITs show insignificant influence to financial institutions. Japanese REITs are tested in Model.2. All coefficients are significant, with largest coefficient appearing during period 2003-2006. Since [Elyasiani and Mansur \(2003\)](#) show that stock volatilities in the banking sectors of US and Japan are found to be highly interdependent, so that the performances of stock market in US can spill over to Japanese

market. Therefore, the reason of higher coefficient in period 2003-2006 is similar with the US REITs as discussed before.

According to [Elyasiani et al. \(2010\)](#), the economic significant is examined by the impact of changes in standard deviation change of explanatory variable, REITs returns, over the explained variables, FI returns. In our paper, the magnitudes of economic significances are obtained by multiplying the standard deviation of an explanatory variable by its coefficient. From the Table.10, Table.12 and Table.13, a unit change in the standard deviation in REITs return results in a change of 2.61% on US banks return over full period 1999-2011, and a change of 4.43% on UK banks return during year 2007-2011 under Model.1. We find in Model.2 the economic significance of REITs is lower than that in Model.1 due to smaller magnitude of REITs coefficients. Under Model.2, a unit change in the standard deviation in REITs return results in a change of 1.02% on US banks return over full period 1999-2011 and a change of 0.50% on UK banks return during year 2007-2011. In Japan market, the economic significance is the lowest, and a unit change in the standard deviation in REITs returns results in a change of 0.40% on banks return over full period 2003-2011.

If we compare the magnitude of coefficients of REITs under Model.1 and Model.2, the coefficients of the first framework are generally greater than in the second framework for US and UK market. Japanese market is only examined in Model.2 due to the lack of Fama-French data. However, the coefficients of Japanese REITs are between 0.118 and 0.213, and the coefficients are smaller than US REITs but larger than the UK REITs on average. This shows Model.1 is stronger to represent the real estate REITs effect to bank stock returns than Model.2. Furthermore, US banks are most sensitive and closest related to the REITs returns, followed by the Japanese banks. UK shows the weakest link of bank stock to REITs returns during 2007-2011. The highest level of sensitivity of US banks is as expected. US banks, as a leader, invest heavily in real estate properties and related products over the last decade with

long established and matured REITs market. Japanese REITs market established in 2001, but it is more matured than the UK REITs market. UK banks are less aggressive compared with US banks, and the REITs history in UK is very recent, starting in 2007 with only 21 REITs products. The short history and less REIT products of Japan and UK may make it less influential and representative on the bank stock, especially in UK.

The results in the paper provide evidences to researchers and investors. Although the association between financial institutions and interest rate, general market and even foreign exchange has received much more attention in the literature, the effect of real estate sector on the financial institution has proven to be both statistically and economically significant. This calls increasing attention of banks, insurance funds, regulators as well as investors to carefully consider the real estate influence on the financial institution portfolios when making investment and regulatory decisions.

Coefficients variables	US				UK	
	1999-2011	1999-2002	2003-2006	2007-2011	2007-2011	2007-2011
β_{10}	-0.001 (-1.490)	0.001 (-0.961)	-0.001 (-0.881)	-0.003 (-1.520)	0.001 (0.374)	0.001 (0.374)
β_{11}	0.313 (12.860)***	0.164 (5.990)***	0.521 (4.920)***	0.353 (4.940)***	-0.047 (-0.438)	-0.047 (-0.438)
β_{12}	0.746 (40.700)***	0.556 (13.200)***	1.469 (63.900)***	0.985 (32.200)***	0.738 (10.500)***	0.738 (10.500)***
β_{13}	-0.007 (-1.921)**	-0.007 (-1.440)	-0.001 (-0.384)	-0.006 (-0.875)	-0.031 (-1.850)*	-0.031 (-1.850)*
β_{20}	-0.001 (-0.957)	-0.001 (-0.918)	0.002 (1.410)	-0.001 (-0.470)	-0.003 (-1.370)	-0.003 (-1.370)
β_{21}	0.800 (25.100)***	0.495 (12.600)***	0.649 (8.720)***	0.986 (17.000)***	1.091 (19.000)***	1.091 (19.000)***
β_{22}	0.006 (14.700)***	0.003 (6.740)***	0.003 (12.000)***	0.007 (9.170)	0.002 (0.835)	0.002 (0.835)
β_{23}	0.009 (22.800)***	0.006 (10.900)***	0.000 (0.882)	0.008 (13.500)	0.006 (2.070)**	0.006 (2.070)**
a_{10}	0.096 (1.383)	0.299 (1.341)	0.005 (0.923)	0.281 (1.684)***	0.041 (0.694)	0.041 (0.694)
a_{11}	0.281 (2.064)***	0.293 (2.865)***	0.026 (1.589)	0.407 (3.307)***	0.138 (2.079)**	0.138 (2.079)**
b_{11}	0.684 (4.756)***	0.393 (1.405)	0.959 (49.170)***	0.559 (4.689)***	0.801 (31.240)***	0.801 (31.240)***
γ_{12}	0.897 (13.560)***	0.545 (2.111)***	0.370 (1.473)	0.710 (3.779)***	0.861 (24.080)***	0.861 (24.080)***
a_{20}	0.440 (0.306)	1.517 (2.742)***	1.631 (1.463)	0.964 (1.767)*	0.007 (0.061)	0.007 (0.061)
a_{22}	0.144 (0.465)	0.245 (1.257)	0.042 (1.107)	0.348 (1.229)	0.12 (3.457)***	0.12 (3.457)***
b_{22}	0.758 (1.232)	-0.098 (-0.514)	0.382 (1.086)	0.558 (2.338)**	0.876 (46.860)***	0.876 (46.860)***
ρ_{12}	0.596	0.031	0.036	0.416	0.378	0.378

*** 1% significant level

** 5% significant level

* 10% significant level

The extended bivariate GARCH model of Model.1 is presented by equation (12)-(17) described in the text. The model is estimated simultaneously for each financial institution and REITs. Equation (12)-(13) represent the mean return and conditional volatility process for financial institution returns. Equation (14)-(15) represent the mean return and conditional volatility process for REITs. Asymptotic t-values are in parentheses:

Model.1: REITs return is estimated by Fama-French three-factor model as in Equation (14):

$$R_{1,t} = \beta_{10} + \beta_{11}RM_t + \beta_{12}R_{2,t} + \beta_{13}\Delta I + \varepsilon_{1,t} \quad (12)$$

$$h_{1,t} = a_{10} + a_{11}\varepsilon_{1,t}^2 + b_{11}h_{1,t-1} + \gamma_{12}h_{2,t-1} \quad (13)$$

$$R_{2,t} = \beta_{20} + \beta_{21}RM_t + \beta_{22}SMB_t + \beta_{23}HML_t + \varepsilon_{2,t} \quad (14)$$

$$h_{2,t} = a_{20} + a_{22}\varepsilon_{2,t}^2 + b_{22}h_{2,t-1} \quad (15)$$

$$h_{12,t} = \rho_{12}h_{1,t}h_{2,t} \quad (-1 < \rho_{12} < 1) \quad (16)$$

$$\varepsilon_{1,t}|\Omega_{t-1} \sim N(0, h_{1,t}) \quad (17)$$

Where, $R_{1,t}$ is the return of banks portfolio; three different countries are examined separately; $R_{2,t}$ is the return of REITs index for each country. RM_t is the market return; ΔI is the change of interest rate for each country; SMB_t is Fama-French factor Small minus Big, size of market capitalization; HML_t is Fama-French factor High minus Low, value of book-to-market; $\varepsilon_{1,t}$ is error term of bank stock return generating process, following $N(0, h_{1,t})$; $\varepsilon_{2,t}$ is error term of REITs return generating process, following $N(0, h_{2,t})$; $h_{1,t}$ is conditional variance of bank stock return; $h_{2,t}$ is conditional variance of REITs return; $h_{12,t}$ conditional covariance of bank and REITs returns.

Table 13 Model 2 Bivariate GARCH results of financial institutions and REITs returns

Coefficients	variables	US						UK		Japan	
		1999-2011	1999-2002	2003-2006	2007-2011	2007-2011	2007-2011	2003-2011	2003-2006	2007-2011	2007-2011
β_{10}	Constant	-0.001 (-1.510)	0.001 (1.280)	0.001 (2.090)**	-0.004 (-3.120)***	-0.003 (-1.240)	-0.001 (-0.964)	-0.001 (-0.964)	-0.001 (-1.230)	-0.001 (-0.968)	-0.001 (-0.868)
β_{11}	Rm	0.383 (14.600)***	0.228 (8.950)***	0.422 (10.900)***	0.619 (10.500)***	0.659 (7.470)	0.623 (16.400)***	0.623 (16.400)***	0.745 (13.700)***	0.527 (10.200)***	0.527 (10.200)***
β_{12}	REITs	0.292 (14.600)***	0.286 (6.750)***	0.152 (5.230)***	0.201 (5.540)***	0.084 (1.340)	0.118 (3.870)***	0.118 (3.870)***	0.213 (3.130)***	0.135 (3.700)***	0.135 (3.700)***
β_{13}	ΔI	0.002 (0.371)	-0.005 (-1.070)	0.000 (0.104)	-0.002 (-0.274)	-0.031 (-1.820)*	-0.011 (-0.765)	-0.011 (-0.765)	-0.018 (-0.969)	-0.022 (-0.924)	-0.022 (-0.924)
β_{20}	Constant	0.001 (0.551)	0.001 (0.523)	0.002 (1.630)	-0.001 (-0.366)	-0.004 (-1.790)*	0.000 (-0.147)	0.000 (-0.147)	0.002 (1.730)*	-0.001 (-0.465)	-0.001 (-0.465)
β_{21}	Rm	0.826 (21.000)***	0.233 (6.040)***	0.793 (10.600)***	1.227 (18.400)***	1.129 (21.100)***	0.742 (15.700)***	0.742 (15.700)***	0.383 (7.560)***	0.915 (13.500)***	0.915 (13.500)***
β_{24}	ΔI	0.009 (1.070)	0.007 (0.896)	-0.041 (-3.900)***	0.012 (0.793)	-0.019 (-1.080)	-0.088 (-3.910)***	-0.088 (-3.910)***	-0.039 (-2.080)**	-0.101 (-2.500)**	-0.101 (-2.500)**
a_{10}	Constant (Var)	0.096 (1.383)	0.299 (1.341)	0.005 (0.923)	0.281 (1.684)*	0.041 (0.694)	0.485 (2.296)**	0.485 (2.296)**	0.617 (1.579)	0.449 (1.375)	0.449 (1.375)
a_{11}	ARCH	0.173 (2.048)**	0.157 (2.635)***	0.024 (1.732)	0.413 (2.927)***	0.108 (1.936)**	0.147 (2.648)***	0.147 (2.648)***	0.285 (1.740)*	0.095 (1.294)	0.095 (1.294)
b_{11}	GARCH	0.612 (3.745)***	0.365 (1.398)	0.897 (9.287)***	0.486 (3.174)***	0.724 (20.117)***	0.714 (8.097)***	0.714 (8.097)***	0.514 (2.829)***	0.787 (5.918)***	0.787 (5.918)***
γ_{12}	Spillover	0.724 (5.481)***	0.385 (1.396)	0.962 (48.740)***	0.54 (4.311)***	0.877 (27.510)***	0.703 (6.915)***	0.703 (6.915)***	-0.001 (0.002)	0.823 (10.290)***	0.823 (10.290)***
a_{20}	Constant (Var)	0.338 (1.419)	1.775 (0.960)	0.247 (0.810)	1.131 (2.933)***	0.088 (1.109)	0.224 (2.014)**	0.224 (2.014)**	0.570 (1.732)*	0.332 (1.519)	0.332 (1.519)
a_{22}	ARCH	0.134 (1.766)*	0.352 (1.399)	0.000 (0.001)	0.597 (2.386)**	0.105 (3.791)***	0.135 (3.396)***	0.135 (3.396)***	0.087 (1.843)*	0.137 (2.648)***	0.137 (2.648)***
b_{22}	GARCH	0.811 (8.145)***	0.000 (0.000)	0.910 (8.741)***	0.382 (2.793)***	0.893 (54.240)***	0.834 (20.790)***	0.834 (20.790)***	0.720 (7.742)***	0.832 (17.340)***	0.832 (17.340)***
ρ_{12}	Correlations	0.553	-0.031	-0.367	0.360	0.441	0.519	0.519	0.063	0.548	0.548

*** 1% significant level

** 5% significant level

* 10% significant level

The extended bivariate GARCH model of Model 2 is presented by equation (18)-(23) described in the text. The model is estimated simultaneously for each financial institution and REITs. Equation (19)-(19) represent the mean return and conditional volatility process for financial institution returns. Equation (20)-(21) represent the mean return and conditional volatility process for REITs. Asymptotic t-values are in parentheses:

Model 2: REITs return is estimated by multifactor CAPM model as in Equation (20):

$$R_{1,t} = \beta_{10} + \beta_{11}RM_t + \beta_{12}R_{2,t} + \beta_{13}\Delta I + \varepsilon_{1,t} \quad (18)$$

$$h_{1,t} = a_{10} + a_{11}\varepsilon_{1,t}^2 + b_{11}h_{1,t-1} + \gamma_{12}h_{2,t-1} \quad (19)$$

$$R_{2,t} = \beta_{20} + \beta_{21}RM_t + \beta_{24}\Delta I + \varepsilon_{2,t} \quad (20)$$

$$h_{2,t} = a_{20} + a_{21}\varepsilon_{2,t}^2 + b_{21}h_{2,t-1} + b_{22}h_{1,t-1} \quad (21)$$

$$h_{12,t} = \rho_{12}h_{1,t}h_{2,t} \quad (-1 < \rho_{12} < 1) \quad (22)$$

$$\varepsilon_{1,t}|\Omega_{t-1}^* \sim N(0, h_{1,t}) \quad (23)$$

Where, $R_{1,t}$ is the return of banks portfolio; three different countries are examined separately, $R_{2,t}$ is the return of REITs index for each country, RM_t is the market return, ΔI is the change of interest rate for each country; SMB_t is Fama-French factor Small minus Big, size of market capitalization; HML_t is Fama-French factor High minus Low, value of book-to-market. $\varepsilon_{1,t}$ is error term of bank stock return generating process, following $N(0, h_{1,t})$; $\varepsilon_{2,t}$ is error term of REITs return generating process, following $N(0, h_{2,t})$; $h_{1,t}$ is conditional variance of bank stock return; $h_{2,t}$ is conditional variance of REITs return; $h_{12,t}$ conditional covariance of bank and REITs returns.

4.6.2 FACTORS AFFECTING REITS RETURNS

Under the two frameworks, Model.1 and Model.2, the REITs return is estimated simultaneously with the financial institution returns. The differences between the two frameworks are the ways in estimating the REITs return. Under Model.1, a Fama-French three factor methodology, as used in [Chiang et al. \(2005\)](#), is used to estimate the REITs returns; under Model.2, a two-index CAPM model is adopted as in [Chen and Tzang \(1988\)](#). In the following sections, we discuss the empirical results obtained under both frameworks.

4.6.2.1 MARKET FACTOR

The systematic market coefficient for the REITs returns is estimated, and the results are listed in Table.12 for Model.1 and Table.13 for Model.2. From the results, we notice the market coefficients for all periods and countries under both models are positive and significant under 1 percent significant level. This indicates a clear co-movement between REITs returns and systematic market risk. In US market, under Model.1, the magnitudes of market betas are all less than unity for all periods, between 0.495 and 0.986, indicating the average market risk of REITs is below market average during full period 1999-2003 as well as each sub-periods. In Model.2, the coefficients are still all positive, but the range of fluctuation is larger than in Model.1, between 0.223 and 1.227. It is noticed that the market beta in period 2007-2011 is greater than 1.0, which shows that REITs are riskier than the average market during the subprime crisis since 2007. The positive and significant relationship between REITs and general market performance has been examined in previous literature, and they all show evidences of a strong connection. [Chen and Tzang \(1988\)](#) and [Ross and Zisler \(1991\)](#) show market beta is sensitive to both equity and mortgage REITs with positive coefficients during year 1973-1985. Similarly, [Liang et al. \(1995\)](#) obtain a similar

result by using the same data period with another two indices, all REITs and hybrid REITs. [Peterson and Hsieh \(1997\)](#) use Fama-French model over period 1976-1992 and show that risk premiums on equity and mortgage REITs are significantly related to the risk premium on a market portfolio of stocks as well as to the returns on mimicking portfolios for size and book-to-market equity factors in common stock returns. [Chiang et al. \(2004, 2005\)](#) provide evidences of the positive relationship in return for a period covering year 1972-2002, and they also find on average that mortgage REITs are generally riskier than equity REITs with higher market beta.

In US market, over the three sub-periods, the magnitude of market beta (β_{21}) under both frameworks increases over the time with greatest value experienced in period 2007-2011. One explanation of the increasing sensitivity of REITs to general market over time is that REITs market is more matured and the proportion of equity REITs is increasing significantly over time. In the current global REITs market, over 90% REITs are equity REITs. The equity nature of equity REIT makes it more dependent on the general market. Another explanation of the increasing sensitivity is based on the findings in [Chiang et al. \(2004, 2005\)](#). [Chiang et al. \(2004, 2005\)](#) examine the market effect on REITs for period 1972 to 2002, with two sub-periods. They find that the market factor is generally larger in declining market than in advancing market. In our results, the largest market beta is shown in period 2007-2011. During this period all industries and market are in a serious recession, thus, declining and low growth market, because of the subprime crisis in 2007 and recent European debt crisis. The highest market beta experienced in this volatile period is supported by the conclusion in [Chiang et al. \(2004, 2005\)](#).

During 2007-2011, UK REITs are also significantly sensitive to general market factor, with positive coefficients of 1.091 and 1.129 under Model.1 and Model.2 respectively. By comparing to the US REITs of same period 2007-2011, we see that the market impact to UK

REITs under Fama-French framework is higher than to the US REITs with larger market beta. On the other hand, when using CAPM two-index model, market beta is slightly smaller for UK REITs than for US REITs. However, no matter which framework is used, the market betas of UK REITs are both greater than unity. The results show that UK REITs is riskier than the general market during period 2007-2011.

Similar results are shown in Japanese REITs. Market betas are all positive and significant for Japanese REITs, ranging from 0.383 to 0.915 for period 2003-2011 and two sub-periods. The magnitudes are less than unity, which shows the Japanese REITs are less risky than the general market stocks. Market beta in sub-period 2007-2011 is significantly greater than the sub-period 2003-2007, and the trend resembles the US market. As discussed in US REITs, the greater impact of the market factor on Japanese REITs is due to the low growth during the global financial downturn in period 2007-2011. If we compare with the US and UK market under Model.2, during period 2003-2007, general market has a weaker influence on Japanese REITs than on US REITs with smaller market beta. In addition, in period 2007-2011, Japanese REITs are still the least affected by the market factor, followed by the US REITs. UK REITs are the most influenced by the market returns since it has the greatest market beta in this period.

4.6.2.2 FAMA-FRENCH FACTORS

The coefficients of Fama-French factors, SMB and HML, are positive and significant for most of REITs returns in US and UK markets as shown in Table.12, and this is consistent with many literatures. SMB is the difference between the return on small-cap stocks and the return on large-cap stocks. HML is the difference between the return on high book-to-market stocks and the return on low book-to-market stocks. [Fama and French \(1992\)](#) find

that size of capitalization and book-to-market equity (BE/ME) explains the cross-section of average returns on US common stock, excluding ADRs, REITs and units of beneficial interest. [Fama and French \(1992\)](#) use the time-series regression approach to show that a market factor and mimicking portfolios for size and BE/ME factors in returns explain returns on stocks. [Peterson and Hsieh \(1997\)](#) argue that although factors like size and BM/ME have not direct connection to an asset pricing theory, it is possible these factors which affect the return to common share also affect returns on REITs shares. In US market, the coefficient of SMB ranges from 0.003 to 0.007 and the magnitude of SMB increases over time for the three sub-periods. It shows the sensitivity of SMB to REITs increases over time. The coefficients of HML of are also positive and significant for all periods, ranging from 0.006 to 0.009, however, the magnitude declines to zero in period 2003-2006. The HML is more powerful in explaining the REITs return behaviour over the full time period 1999-2011 and sub-periods 1999-2001 and 2007-2011 for greater magnitude of HML coefficient. However, during period 2003-2006, small size factor SMB has a stronger influence on the REITs returns. In UK market, the coefficients of SMB and HML are also positive, however, factor SMB is not significant. Similar with the US REITs in the same period, the coefficient of HML is higher than the SMB, which shows during period 2007-2011 the factor HML is more sensitive to the UK REIT returns.

There are many literatures have demonstrated SMB and HML influence on the REITs returns. However, since UK REITs market is very recent, majority of REITs literatures are focusing on the US REITs. [Peterson and Hsieh \(1997\)](#) studied the REITs return behaviour for period from year 1976-1992, and find REITs return is sensitive to the small size factor SMB and HML. They also discover that the small firm effect is less pronounced for equity REITs and mortgage REITs. They explain that the significant correlation with SMB and HML are consistent with the facts that many REITs are small firms and that many REITs have high

BE / ME ratios. Therefore, it is likely that the factors which drive the size and BE / ME effects in common stock returns also have the same effects in REITs returns. [Chiang et al. \(2005\)](#) examine the REITs return over year 1972-2002. It shows the SMB factor is more useful than the HML in equity REITs returns in period 1972-1983 and 1983-1991, and HML is more useful during period 1991-2002. [Lee and Chiang \(2008\)](#) use similar period of information in examining the sensitivity of SMB and HML effect on REITs returns. The findings indicate that the return sensitivities to SMB and HML increase substantially from 1992 to 2003, and the sensitivity of REITs returns to small cap stock increase with a decline to the large cap stocks. Therefore our results in Table.12, which show the increasing trend of SMB and HML sensitivity during the period 2007-2011, extend the previous literature of [Chiang et al. \(2005\)](#) and [Lee and Chiang \(2008\)](#) by indicating the REITs return is increasingly sensitive to the capitalization size and BE / ME factors of the general stock market.

4.6.2.3 INTEREST RATE FACTOR

While the interest rate sensitivity on bank stock returns has been discussed in the previous section, the interest rate effect on REITs returns is examined by the two-index CAPM Model.2, and the empirical results are displayed in Table.13. As suggested by many literatures ([Chen and Tzang 1988](#), [He et al 2003 etc.](#)), REITs return is sensitive to the return and change of interest rate.

[Chen and Tzang \(1988\)](#) investigate the effect of both the short-term (three-month 3MTB, six-month 6MTB and one-year 1YTB) and long-term (20-year 20YTB) US Treasury bills to REITs, especially equity and mortgage REITs returns over period 1973-1985. The results show that both short-term and long-term interest rates seem to be an additional factor in explaining the return generating process of REITs during period 1980-1985, with negative and statistically

significant interest rate coefficients. However, only long-term interest rate is significant for period 1973-1979. They argue that the difference of significance between two sub-periods may be attributed to the fact that the Federal Reserve changed its policy orientation towards reserves and the monetary aggregates in 1979. [He et al \(2003\)](#) extend previous studies by including a longer period from year 1972 to 1998 to test the effects of both the return and change of long-term interest rate on REITs returns (equity and mortgage REITs). [He et al \(2003\)](#) show that the equity REITs are insensitive to the monthly long-term interest rate, but sensitive to the monthly change of interest rate. On the other hand, mortgage REITs are sensitive to both return and change of interest rate, and more sensitive to the changes in interest rate. The results also show that during 1972-1998, the coefficients of significant interest rate changes are negative for both types of REITs. Furthermore, the results of [Mei and Lee \(1994, 1995 and 1997\)](#) also provide evidences that REITs, especially equity REITs, are sensitive to the changes in the interest rate, and the coefficients are negatively significant. The negative sign of interest rate coefficients suggests perverse inflation behaviour of REITs, and REITs generally perform well in hedging towards the changes in interest rate.

Our study contributes to the recent literature by including the most recent thirteen years (1999-2011) in our sample since majority of previous literature focusing on period 1980s-1990s. From the results shown in Table.13, similar behaviour of interest rate to REITs returns is found for period 1999-2011. The change in interest rate returns is negative and significant for UK REITs in period 2007-2011 and Japan REITs in period 2003-2011 as well as its two sub-periods. This shows that the both UK and Japanese REITs are sensitive to interest rate, and they are efficient in hedging toward the changes in the interest rate. The results of UK and Japanese REITs follow the same findings in of US REITs [He et al \(2003\)](#) and [Mei and Lee \(1994, 1995 and 1997\)](#), and we conclude that the UK and Japan REITs in 2003-2011 behave similarly with US REITs in 1980s-1990s. The magnitude of interest rate coefficient of

Japan REITs increases over sub-period 2003-2006 (-0.039) and 2007-2011 (-0.101), which shows Japan REITs are increasingly efficient in hedging the interest rate changes over time. During the same period in 2007-2011, the magnitude of UK REITs (-0.019) is smaller than Japan REITs (-0.101), and it indicates UK REITs are less volatile to the changes in interest rate.

As for US REITs, the change in interest rate is only significant during period 2003-2006, with negative coefficient -0.041. The magnitude is larger than that for Japan REITs, which shows US REITs perform better than Japan REITs to interest rate impact during 2003-2006. However, the interest rates for two sub-periods 1999-2002 and 2007-2011 are not significant but with positive coefficients. The results show during 1999-2002 and 2007-2011, there is a co-movement between US REITs return and interest rate. US REITs perform badly in hedging the interest rate changes. The reason of the positive relationship may be because of the volatile economy and market during 1999-2002 and 2007-2011. In 2000, the Dot-Com bubble bursts, and it drags down the whole US economy, as well as the global market, into a serious recession. In addition, the subprime crisis started in 2007 has damaged the global economy in all aspects. Moreover, despite a mild recovery in the economy in 2009, the collapse of European debt markets since 2010 gives the global economy another deadly shock. Therefore, the most probable cause for the usual REITs performance during these two sub-periods is for the increased volatility in all types of economic behaviour.

In [He et al \(2003\)](#), they separate the REITs into equity and mortgage REITs, and find mortgage REITs are more sensitive to changes in interest rates with larger magnitude of coefficients. They argue that the reason of the difference is that as fixed-income securities, both mortgage and bonds share many similar fundamentals in the return generating process. [Chen and Tzang \(1988\)](#) explain the phenomenon by using the effective duration of real estate, which is a function of the lease structure for equity and maturities of mortgage

for mortgage REITs. The difference is that for most of the equity REITs, lease terms are updated every three to five years to reflect changes in the market. However, for mortgage REITs, the mortgage maturities are usually fixed for more than ten years. Therefore, mortgage REITs should be more sensitive to the changes in the interest rates. Both equity and mortgage REITs use long-term liabilities as a source of financing, therefore, the duration of long-term liabilities can explain the sensitivity of REITs to changes in interest rates since interest rate on long-term government bonds do not have risk premium. The longer duration of long-term liabilities, the higher is the sensitivity to interest rate changes for REITs (He et al (2003)). However, in our study, we use NAREIT all REITs index, including all kinds of REITs, to represent the real estate market. Since over 90% of REITs are equity REITs worldwide, all REITs index are more likely to resemble the equity REITs behaviour. In addition, this provides a future research direction to examine the equity and mortgage REITs behaviour separately for period 1999-2011.

4.6.3 BIVARIATE GARCH VOLATILITY SPILLOVER

The results on the conditional volatility of financial institutions and REITs returns, described by equation (13) and (15) in Model.1 and equation (19) and (21) in Model.2, are also described in Table.12 and Table.13 respectively. The conditional volatility variables ($h_{i,t,i=1,2}$) measure the overall risk of banks and REITs returns. The conditional covariance between banks and REITs return is represented by $h_{12,t}$ in equation (16) and (22) under each framework. In the bivariate GARCH representation of banks and REITs return, the volatility ($h_{i,t,i=1,2}$) is explained as a function of ARCH factor ($\varepsilon_{i,t-1,i=1,2}^2$), representing a short-term shock to the return from the last period, and GARCH factor ($h_{i,t-1,i=1,2}$), representing a long-term memory effect of the shocks over all previous periods. Parameter γ_{12} captures the cross-volatility spillover effect from the real estate sector to the banks.

In US market, irrespective of which model used, the ARCH effect (short-term memory) to bank returns is significant for full sample period 1999-2011, as well as sub-period 1991-2002 and 2007-2011, which shows during these periods bank stock returns show a strong presence of ARCH effect. On the other hand, the results of both models suggest that the GARCH effect (long-term memory) to banks returns is significant for all periods except for first sub-period 1999-2002. It indicates that banks stock returns show a strong presence of GARCH effect except for period 1999-2002. The significance of ARCH and GARCH effect questions the findings derived from the basic conventional models which assume the linearity, independence and constant variances over time, which suggests a variable variance methodology is more appropriate in bank return generating process ([Elyasiani and Mansur 1998](#)). Furthermore, the study of [Stevenson \(2002\)](#) reveals that the volatility of REITs has a significant influence on other sub-sectors of the market. It also shows that a number of patterns emerge with regard to the influence of other asset classes. In all cases under both frameworks, the second order stationary conditions ($0 < a_{ii} + b_{ii} < 1$) are met. The sum of ARCH and GARCH coefficients means the persistent shock for the banks. From the results, the shock persistence varies from 0.686 to 0.985 under Model.1 and from 0.522 to 0.921 under Model.2, with period 2002-2006 exhibiting the highest persistence for the banks, and period 1999-2002 with the lowest. In UK market, the shock persistence is 0.939 under the first framework and 0.832 under the second framework. The Japanese bank stock is analysed under Model.2, with higher shock persistence in year 2007-2011, 0.882, and lower persistence in year 2003-2006, 0.799. The longevity of shocks in period 2007-2011 is because of the long-term duration of banks' mortgage portfolios. This is consistent with the high interest rate sensitivity of these banks in period 2007-2011 ([Elyasiani et al. 2010](#)). Interest rate and interest rate volatility are especially found to directly impact the first and the second moments of bank stock returns distribution respectively, as suggested in [Elyasiani and Mansur \(1998\)](#).

The ARCH and GARCH effect on REITs returns are generally significant but weaker than the bank stock return ([Devaney 2001](#)). Same as in bank stocks effect, the second order stationary conditions ($0 < a_{ii} + b_{ii} < 1$) are met for all portfolios. When REITs return is estimated under Fama-French three-factor model, only long-term memory GARCH is significant for period 2007-2011 for US REITs, with coefficient 0.558. On the other hand, when two-index CAPM model is employed, short-term ARCH effect is significant for full period 1999-2011 and sub-period 2007-2011. The long-term GARCH effect of US REITs is significant for most of periods except for period 1999-2011. In addition, UK and Japan REITs experience both ARCH and GARCH effects no matter which framework is used. The shock persistence of US REITs is more volatile when using Fama-French framework, ranging from 0.147 to 0.906, than using CAPM framework, 0.352-0.979. The persistence of UK REITs remains stable under both models. For Japan REITs, the persistence increases over time from 0.807 in 2003-2006 to 0.969 in 2007-2011.

The cross-volatility spillover (γ_{12}) is significant and positive over all periods and countries. This indicates there is a co-movement in the same direction between banks and real estate sector as represented by REITs in all periods and countries. The result here is inconsistent with the findings in ([Elyasiani et al. 2010](#)) for US market, which finds that the commercial banks are not responsive to the changes in volatility of REITs, but it shows the significant spillover of volatility from REITs to other financial institutions, such as savings and loans and life insurance companies. In US market, the coefficient of spillover effect increases from 0.545 to 0.710 continuously in Model.1 over three sub-periods. The magnitude of coefficient represents the strength of volatility spillover. This indicates the banks are increasingly influenced by the volatility from real estate sectors over time. However, under the CAPM model, the effect of real estate volatility spillover increases from period 1999-2002 (0.385) to 2003-2006 (0.962), and decreases in 2007-2011 (0.540). The stronger volatility spillover from

real estate to bank stocks in period 2003-2006 shows that during the booming economy the volatility of real estate sector has stronger influence on banks than other periods. This result is inconsistent with the finding in [Elyasiani et al. \(2010\)](#). [Elyasiani et al. \(2010\)](#) use real-estate cycle dummy variable to represent the up- and down-turn in economy, and they notice the real estate cycle does not exert a statistically significant influence on the risk of any of the financial institutions considered. The reason of the difference in the significance of volatility spillover is due to the different periods used in the study. In [Elyasiani et al. \(2010\)](#), they examine the a longer 33-year period of 1972-2004, including some extreme periods of economy, which may influence the sensitivity of volatility spillover from real estate sector to bank stocks. Furthermore, [Elyasiani et al. \(2010\)](#) use monthly data in the study, and we use more frequent weekly data. [Cotter and Stevenson \(2004 and 2006\)](#) suggest that the use of different data frequency could lead to different empirical findings. It is possible that the use of higher frequency data may mask more of these fundamental relationships with general market sentiment. As for UK market, there is also strong influence from REITs to bank stocks with positive significant influence. In addition, the magnitude of volatility spillover effect does not change when different framework is used. Moreover, in Japan, real estate volatility can be transmitted to banks in full period 2003-2011 and sub-period 2007-2011. However, during the first period 2003-2006 it does not show significant volatility influence from real estate to banks. The significant effect of volatility spillover from REITs to banks stocks demonstrates that the UK and Japan markets follow the same mechanism as US market, and similar market trend has been observed.

The statistical significance and the magnitude of the cross-sectional spillover effects should draw more attention to the financial regulators and investors to the developments in the real estate market. The difference in the volatility parameter values for different sample periods indicates real estate has a different level of risk impact on bank stock returns. In addition,

when considering the appropriate methodology of REITs return generating process, the significance of both ARCH and GARCH effects for REITs returns suggest that the second moment of REITs return distribution should be estimated accordingly.

4.7 CONCLUSIONS

This paper adopts bivariate GARCH methodology to examine the return behaviour of bank stocks and REITs, and the volatility spillover from REITs to bank stocks between January 1999 and December 2011. Weekly data is used in order to include more data points and increase the sensitivity of volatility. Three sub-periods, 1999-2002, 2003-2006 and 2007-2011 are used to examine the different return and volatility behaviours in different economic environment. The results show that the market risk is positive and significant for both bank stocks and REITs return, however, the interest rate effect is not always significant. In addition, the bank stock return is more sensitive to the market return during the economic booming in year 2003-2006 than during the economic downturn in year 2007-2011, in which the world economy suffered from the subprime and European debt crisis. The effect of real estate returns on the bank stock return distribution is the most interesting issue in the study. The results indicate real estate factor has a significant impact on the bank return generating process for all three countries. The positive coefficients of REITs represent that the fluctuation of bank stock returns is moving in the same direction with REITs returns. Moreover, US banks are most sensitive and closest related to REITs returns, followed by the Japanese banks. The highest level of sensitivity is shown in US banks as expected since US banks, as a leader, invest heavily in real estate properties and related products over the last few decades with long established and matured REITs market. Meanwhile, the bank stock return is most sensitive to real estate sector during 2003-2006 when the global economy is booming. As for REITs returns, the general common factors are also influential to the REITs

returns. The result indicates a clear co-movement between REITs returns and systematic market risk for all countries. Interest rate risk has only significant and negative impact to REIT returns over period 2003-2006 for US market, and all periods for Japanese market. The negative sign of interest rate coefficients suggests perverse inflation behaviour of REITs, and REITs generally perform well in hedging towards the changes in interest rate. Furthermore, the long-memory of GARCH and short-memory of ARCH effects to returns are significant for all periods in all countries except for first period 1999-2002 of US market. The ARCH and GARCH effects of REITs returns are usually significant but weaker than the bank stock returns. The cross-volatility spillover (γ_{12}) is significant and positive over all periods and countries. This indicates there is a volatility spillover from real estate sector to financial institutions, and the co-movement is in the same direction between banks and real estate sector in all periods and countries. However, the level of significance varies with different magnitudes depending on the periods and countries.

CHAPTER FIVE

AN EMPIRICAL STUDY OF TWO-SIDED MARKET CROSS-SECTIONAL VOLATILITY BASED ON ZERO-BETA CAPITAL ASSET PRICING MODEL

5.1 INTRODUCTION

The previous chapters empirically examine the relationship between major risk factors exposed by the financial institutions, particularly capital risk and real estate risk respectively. This chapter examines the influence of cross-sectional market volatility on the portfolio returns by using zero-beta ZCAPM model. We apply rolling-window Fama-MacBeth two-step procedure to examine the return estimation process under four frameworks, CAPM, zero-beta CAPM, Fama-French three-factor and four-factor models over the period from January 1964 to December 2012. We apply the procedure on eight sets of portfolios in total which include a combine of common stocks and, particularly, financial institution stocks.

This chapter contributes to the current range of literature in four ways. Firstly, it provides further empirical evidences on the impact of positive and negative volatility on asset returns by taking two-sided market volatility into consideration. We achieve this by specifying a signal variable D_{it} to denote positive and negative market volatility by taking value 1 and -1 respectively. Secondly, we apply the ZCAPM particularly on the financial institution stocks which have not been examined before. The results suggest the cross-sectional zeta risk is highly related to the financial institution portfolios similar as shown in common stock portfolios. Therefore, we have shown that the high significance of cross-sectional market volatility on asset returns in ZCAPM does not depend on the chosen test asset returns which overcome the problem of portfolio formation that is common to other asset pricing models.

Thirdly, we extend our data range from January 1964 to December 2012 comparing with previous studies which have a shorter period. Despite different data range, we still find the cross-sectional market volatility is consistently significant at high level. The results show that the ZCAPM does not depend on the period of the sample. Furthermore, we find evidences that ZCAPM provides better expected stock returns than the well-known three- and four-factor models. We see this result as market risk is composed of two components, average market returns and cross-sectional market volatility. Therefore, the fund manager can use zero-beta CAPM framework to better predict expected stock returns. We also use the Fama-MacBeth rolling window framework for the combined common stock portfolios using one-month ahead excess returns. These fitted one-month returns are compared to each portfolio's one-month ahead average actual excess returns under both Fama-French three-factor and ZCAPM models. The results show models can fit average realized excess returns to some extent. However, the average fitted excess returns from three-factor model bunch up into a smaller range of values than that of average realized excess returns, and it is expected that the Fama-French model has difficulty explaining small and growth portfolios from literature. On the other hand, average fitted excess returns for the ZCAPM spread out and fall fairly closely to average realized excess returns. Therefore, the results show that ZCAPM significantly improve the expected returns. Thus, in order to access the influence of market risk, we need to include both components in the analysis. The result also explains the unexplained return behaviour from previous studies when only average market returns are included. Therefore, we conclude that the cross-sectional market volatility is indeed a significant market factor in explaining the cross-section of expected stock returns and ZCAPM model can provide better estimation as an asset pricing model.

The rest of the chapter is set as following. We begin the study from the literature reviews on capital asset pricing for current findings and theories of zero-beta ZCAPM from literature.

We follow on with discussions of methodology used to examine the ZCAPM in the methodology section. In addition, we provide descriptive results of the data sample in section data and descriptive statistics. We present the results with discussions in the empirical results section. Finally, we provide a summary of results in the conclusion section.

5.2 LITERATURE REVIEWS ON CAPITAL ASSET PRICING

The beginning of modern portfolio theory can be dated back to the paper [Markowitz \(1952\)](#). In his paper, he introduces the theory of frontier of investment portfolios, such that each of them had the greatest possible expected rate of return for their given risk. The primary impact of MPT is on portfolio management because it provides a framework for the systematic selection of portfolios based on expected return and risk principles. Most portfolio managers today are aware of, and use to various degrees, the basic principles of MPT. Major mutual fund families employ the implication of MPT in managing their funds. Financial advisors use the principles of MPT in advising their individual investor clients. Many financial commentators use MPT terms in discussing the current investing environment and so forth.⁵¹ Prior to the dissemination of portfolio theory into the real world, argument on how the pricing of securities would be affected by using portfolio theory to invest in the portfolios on the frontier has been discussed in a wide range of literature. In order to address the issue, the Capital Asset Pricing Model was developed by [Sharp \(1964\)](#), [Lintner \(1965\)](#) and [Mossin \(1966\)](#) almost simultaneously. This model has become widely used in the real world to measure portfolio performance, value securities, make capital budgeting decision, and even regulate public utilities. However, the model is later questioned in [Roll \(1980\)](#) because he argues the model is impossible empirically to verify its

⁵¹ Charles P. Jones (2010) Chapter 7 Investments Principles and Concepts , 11th Edition John Wiley & Sons Inc. Publisher, ISBN: 9780470553077

single economic prediction. On the other hand, the Arbitrage Pricing Theory is being developed by Ross (1976). This theory argues that expected return must be related to risk in such way that no single investor could create unlimited wealth through arbitrage

From Sharp (1964)'s study, it shows the expected return depends on the risk free rate of interest and market premium or risk premium. The formula is as following:

$$E(\tilde{R}_i) = R_f + \beta_i(E(\tilde{R}_m) - R_f) + \epsilon_i \quad (24)$$

Where $E(\tilde{R}_i)$ is the expected return on the capital asset; R_f is the risk-free rate of interest such as interest arising from government bonds; β_i is the sensitivity of the expected excess asset returns on the expected excess market returns,

$$\beta_i = \frac{Cov(\tilde{R}_i, \tilde{R}_m)}{Var(\tilde{R}_m)} \quad (25)$$

$E(\tilde{R}_m)$ is the expected return of the market; $E(\tilde{R}_m) - R_f$ is known as the market premium or risk premium, which is the difference between the expected rate of return and the risk-free rate of return.

A number of simplifying assumptions lead to the basic version of the CAPM, the fundamental idea is that individuals are as alike as possible, with notable exceptions of initial wealth and risk aversion. The list of assumptions is generally used in deriving equation (24) that describes the necessary conformity of investors follows⁵²:

1. Investors cannot affect prices by their individual trades. This means that there are many investors, each with an endowment of wealth that is small compared with the total endowment of all investors. This assumption is analogous to the perfect competition assumption of microeconomics.

⁵² Zvi Bodie, Alex Kane and Alan J. Marcus, Essentials of Investments 6th Edition, McGraw-Hill Publication, ISBN-10 007-125445-5

2. Investors form portfolios from a universe of publicly traded financial assets, such as stocks and bonds. Investors may take a long or short position of any size in any assets, including the riskless asset. Any investor may borrow or lend at any amount he wants at the riskless rate of interest.
3. All investors attempt to construct efficient frontier portfolios; that is, investors choose portfolios that maximize their expected end-of-period utility of wealth, and all investors are risk averse. Every investor's utility function on end-of-period wealth increases at a decreasing rate as his wealth increases.
4. All investors analyse securities in the same way and share the same economic view of the world. They have the same opinions about the possibilities of various end-of-period values for all assets. Therefore, they have a common joint probability distribution for the returns on the available assets. They all end with identical estimates of the probability distribution of future cash flows from investing in the available securities. This means that given a set of security prices and the risk-free interest rate, all investors use the same expected returns, standard deviations, and correlations to generate the efficient frontier and the unique optimal risky portfolio.
5. The common probability distribution describing the possible returns on the available assets is joint normal or joint stable with a single characteristic exponent. And all investors plan for one identical holding period.
6. Investors pay neither taxes on returns nor transaction costs, e.g. commissions and service charges. In such a simple world, investors will not care about the difference between returns from capital gains and those from dividends.

There are several challenges of CAPM⁵³: The model assumes that the variance of returns is an adequate measurement of risk. This would be implied by the assumption that returns are normally distributed, or indeed are distributed in any two-parameter way, but for general return distributions other risk measures will reflect the active and potential shareholders' preferences more adequately. The model assumes that the probability beliefs of active and potential shareholders match the true distribution of returns. A different possibility is those active and potential shareholders' expectations are biased, causing market prices to be informationally inefficient. This possibility leads to a new study field of behavioural finance. The market portfolio consists of all assets in all markets, where each asset is weighted by its market capitalization. This assumes no preference between markets and assets for individual active and potential shareholders, and they choose assets solely as a function of their risk-return profile. The length of the period for which the model applies is not specified. The assumptions of the model are only held if the period is taken to be infinitesimal. For any finite period, the distribution of possible returns on an asset is likely to be closer to lognormal than normal. In particular, if the distribution of returns is normal, then there will be a finite probability that the asset will have negative value at the end of the period. The market portfolio should in theory include all types of assets that are held by anyone as an investment, such as real estate and human capital etc. In reality, such a market portfolio is unobservable, and people usually substitute a stock index as a proxy for the true market portfolio. However, [Ross \(1977\)](#) shows that this substitution is not innocuous and can lead to false inferences as to the validity of the CAPM. It is also noted that due to the difficulty in the observability of true market portfolio, the CAPM may not be empirically tested. One of the most restricted assumptions is the second assumption, in which an investor may take a long or short position of any size in any asset, including the riskless

⁵³ Zvi Bodie, Alex Kane and Alan J. Marcus, Essentials of Investments 6th Edition, McGraw-Hill Publication, ISBN-10 007-125445-5

asset, and any investor can borrow or lend any amount he wants at the riskless rate of interest. In fact, borrowing and investing in the capital market has restrictions, and the riskless asset may not be available. Therefore, the model would be changed substantially if this assumption is dropped.

This model has become widely used in the real world to measure portfolio performance, value securities, make capital budgeting decisions, and even regulate public utilities. However, the model was later questioned by many researchers such as [Black \(1972\)](#) and [Ross \(1977\)](#) because of the restricted assumptions. [Merton \(1972 and 1973\)](#) show a multivariable intertemporal CAPM model outperforms over traditional CAPM. [Fama and French \(1993, 1995, 1996a and 1996b\)](#) also suggest more than market betas are needed to explain expected stock returns, and they show a three-factor model is more suitable which captures size and value factors developed from stocks. The work from [Carhart \(1997\)](#) further proposes a four-factor model including size and value factors with a momentum factor.

In addition, the model also does not appear to explain adequately the variation in stock returns. Empirical studies show that low beta stocks may offer higher returns than the model would predict ([Carhart 1997](#)). The model assumes that given a certain expected return, active and potential shareholders will prefer lower risk (lower variance) to higher risk and conversely given a certain level of risk will prefer higher returns to lower ones. It does not allow for active and potential shareholders who will accept lower returns for high risk. Several early studies have suggested that the returns on securities do not behave like the simple capital asset pricing model as predicted. The work by Black, Jensen and Scholes in [Black et al \(1972\)](#) analyses the returns on portfolios of stocks at different levels of β_i , and reject the traditional CAPM. [Black et al \(1972\)](#) find that the average returns on these portfolios are not consistent with original CAPM. Their estimates of the expected returns on portfolios of stocks at low levels of β_i are consistently higher than predicted by CAPM, and

their estimates of the expected returns on portfolios of stocks at high levels of β_i are consistently lower than predicted by CAPM. They suggest a possible explanation for these empirical results is that the assumption of CAPM which can access unlimited riskless asset does not hold. They continue to give a suggestion on the possible behaviour of the portfolio in form of

$$\tilde{R}_i = \alpha_i + \beta_i \tilde{R}_m + (1 - \beta_i) \tilde{R}_z + \tilde{\varepsilon}_i \quad (26)$$

Where $\tilde{R}_z$ is the return on another factor that is independent of the market $\tilde{R}_m$. $\tilde{\varepsilon}_i$ is approximately mutually independent residuals. This model indicates that in periods when $\tilde{R}_z$ is positive, the low β_i portfolios should perform better than predicted by the traditional CAPM. The high β_i portfolios have worse performance than predicted by CAPM. When $\tilde{R}_z$ is negative, low β_i portfolios behave worse than expected, and high β_i portfolios give better performance. The finding of equation (26) leads to establishing a new CAPM model – zero-beta CAPM (Black 1972). We provide the derivation of the above zero-beta CAPM in Appendix A. In order to derive zero-beta CAPM, we start by assuming investors can take long or short positions of any size in any risky asset, but there is no riskless asset and that no borrowing or lending at the riskless rate of interest is allowed. However, in reality, this assumption is not valid since there is a restriction on shorting selling just as the restriction on riskless borrowing. We later introduce the riskless asset in our derivation, and we find that the introduction of riskless borrowing opportunities only changes the market equilibrium in terms of portfolio composition. In the presence of riskless assets, there are two kinds of efficient portfolios. The more risky efficient portfolios continue to be mixtures of portfolio m and z as when there is no riskless asset available. The expected return on portfolio z must now be greater than the return on the riskless asset. Therefore, we show that the empirical results are consistent with an equilibrium in which there is restricted borrowing at the riskless interest.

We find that if there is a riskless asset, the slope of the line relating the expected return on a risky asset to its beta must be smaller than it without riskless borrowing restriction. The risky portion of every portfolio is a weighted combination of market portfolio and minimum-variance zero-beta portfolio. The zero-beta portfolio has covariance with risky asset i proportional to $1 - \beta_i$. If there is a riskless asset, then the efficient portfolios that contain the riskless asset are all weighted combinations of the riskless asset and a single risky portfolio. The line relating the expected return on an efficient portfolio to its beta is composed of two straight line segments, where the segment for the lower-risk portfolios has a greater slope than the segment for the higher-risk portfolios. The above derivation is consistent with the arguments in [Shanken \(1985 and 1986\)](#), in which they find the true market portfolio can be constructed from any two efficient portfolios on the efficient frontier.

The quantitative derivation of zero-beta CAPM has been studied from the previous work as in Appendix A. In addition, there are many literatures such as [Roll \(1980\)](#) and [Kandel \(1986\)](#) have geometrically derived the properties of zero-beta CAPM in return-variance space. However, a new geometric approach has been studied in [Liu et al \(2012\)](#). The [Liu et al \(2012\)](#)'s approach begins with choosing any portfolio expected return $E(\tilde{R}_x)$ on the y-axis to tangent points on the superior and inferior curves of the symmetric mean-variance parabola. [Liu et al \(2012\)](#) conclude that these two tangent points on the parabola are the zero-beta CAPM portfolios I and ZI . This geometric approach is presented in Appendix B. Following from [Roll \(1980\)](#), in the return-variance space, we set the y-axis as expected return, and x-axis as variance. The minimum-variance portfolio is the one with the smallest variance on the efficiency frontier, and let denote this portfolio as G . For any given market index I on the efficient frontier, a line extending from and passing through minimum variance portfolio G to the y-axis gives the expected return on the zero-beta index $E(\tilde{Z}I)$. Using this expected

return as a reference point, the portfolio ZI can be located on the inferior part of the frontier. There are infinite pairs of these minimum variance portfolios I and ZI which can be identified in this way. Roll (1980) shows that the market portfolio can be replaced by any market index that is an efficient portfolio. The uniqueness is true only when the market index is mean-variance efficient. When the index is not efficient, there are zero-beta portfolios at all levels of expected return.

The traditional CAPM and Black (1972) zero-beta CAPM both assume that investors have homogeneous expectations about end-of-period asset values, and returns on all assets are jointly normal and investors are risk-averse with expectations to maximize their expected end-of-period wealth. However, there are some fundamental differences between these two models. Unlike the three-moment CAPM of Kraus and Litzenberger (1976) and Friend and Westerfield (1980), the ZCAPM focuses on cross-sectional rather than time-series market volatility and more importantly, posit two-sided as opposed to one-side directional market volatility effects. Literature has provided support for the zero-beta CAPM, such as Black (1972), Gibbons (1982) and Jobson and Korkie (1982). Black et al (1972) reject the traditional CAPM by examining the US stock returns in the period 1931-1961. They find that time series regression of excess returns reveals that high or low beta stocks have significant negative or positive intercepts, which supports the zero-beta CAPM. Stambaugh (1982) provides further evidences of significant zero-beta parameter for US stocks. However, no previous studies have conducted cross-sectional tests of the zero-beta CAPM due to the inability to estimate factor.

One of the differences is that zero-beta CAPM finds that the identification of the market portfolio M defined in the CAPM as the tangent portfolio with respect to a ray from the riskless rate to the efficient frontier is not a necessary condition for examining the CAPM. This is because the identification of any orthogonal pair of minimum-variance index

portfolios I and ZI on the mean-variance parabola is sufficient. The real market portfolio is the one consist of the weighted average of all individual portfolios on the market. Furthermore, different from traditional CAPM, zero-beta CAPM allows both long and short positions in assets to construct portfolios I and ZI .

There is extensive range of literature studying on market volatility, but few authors address two-sided risk effects. [French et al \(1987\)](#) examine the relationship between stock returns and stock market volatility and find evidence that the expected market risk premium is positively related to the predictable volatility of stock returns. They also find evidences that unexpected stock market returns are negatively related to the unexpected change in the volatility of stock returns. [Campbell and Hentschel \(1992\)](#) also support the volatility relation to stock returns by using modified GARCH. The results show that volatility feedback is more important when volatility is high for US stock market in period 1926-1988. Estimated volatility discounts on the stock market range from 1% in normal time to 13% after the stock market crashes in 1987. However, volatility feedback has little effect on the unconditional variance of stock returns. Furthermore, [Brown et al \(1988\)](#) find that following news of a dramatic financial event, both the risk and expected return of the affected companies increase systematically, and the price reacts more significantly to bad news than good. [Haugen et al \(1991\)](#) exhibit similar result that changes of expected returns to volatility appears to be an asymmetry in the market's reaction to volatility increase as opposed to volatility decrease. [Ang et al \(2006\)](#) extend the literature by exploring the pricing of aggregate volatility risk in the cross-section of stock returns. They find that stocks with high sensitivities to innovations in aggregate volatility, VIX – Chicago Board Options Exchange Market volatility index, have low average returns. [Ang et al \(2009\)](#) use a similar approach across 23 developed markets, and the difference in average returns between the extreme quintile portfolios sorted on idiosyncratic volatility is -1.31% per month after controlling for

geographical, size, and value factors. They also show that low returns earned by stock with high idiosyncratic volatility around the world have strong covariance with the idiosyncratic volatility effect in the United States, which makes diversification difficult. However, none of these literatures incorporates the two-sided risk effects into research. [Ang et al \(2006b\)](#) is one of the few paper investigating the two-sided risk effects. The findings show investors who place greater weight on the downside risk demand additional premium for holding stocks with high sensitivities to downside market risk.

5.3 METHODOLOGY

From the derivation of zero-beta CAPM in Appendix B, we find that It is almost impossible to calculate the real values of A , B and C with so many stocks in real practice. One problem is that the empirical estimation of the covariance matrix Σ is not well justified because its elements are time-dependent unobservation quantities. Another issue is that for large samples gathering sufficient observations to invert the covariance matrix is very difficult. Since the matrices have large dimension, we can use random matrix theory as in [Liu et al \(2012\)](#) which extracts their statistical properties. There are a few literatures have found that the empirical data for US common stocks is closely related to the correlation structure of stock prices predicted by random matrix theory. [Laloux et al \(1999\)](#) and [Rosenow et al \(2000\)](#) find that the statistics of most of the eigenvalues in the spectrum of the correlation matrix of the largest 1000 US stocks during year 1994-1995 agree with the predictions of random matrix theory. They also demonstrate that the correlation matrix shares universal properties with the Gaussian orthogonal ensemble of random matrices. The relationship found between empirical random matrices and Gaussian orthogonal provide sfurther supporting evidence on the random walk hypothesis in [Fama \(1965\)](#) and [Malkiel \(1973\)](#), except that [Lo](#)

and Mackinlay (1988) have found the random walk model is rejected for US stocks during 1962-1985.

According to the work in Liu et al (2012), we apply random matrix theory to study the asymptotic behaviour of A , B and C for large sample of assets as following,

$$A \approx \left(\frac{E(\tilde{R}_a)}{\frac{1}{\sigma_{ave}^2}} + E(\tilde{R}_a)\sigma_\sigma^2 \right) \frac{2n^{\frac{3}{2}}}{\pi} \quad (27)$$

$$B \approx \left(E(\tilde{R}_a)^2 + \sigma_a^2 \right) \left(\frac{1}{\frac{1}{\sigma_{ave}^2}} + \sigma_\sigma^2 \right) \frac{2n^{\frac{3}{2}}}{\pi} \quad (28)$$

$$C \approx \left(\frac{1}{\frac{1}{\sigma_{ave}^2}} + \sigma_\sigma^2 \right) \frac{2n^{\frac{3}{2}}}{\pi} \quad (29)$$

Where $E(\tilde{R}_a)$ is the average return of portfolio a with n assets, and σ_a^2 is the variance of portfolio a returns. $\frac{1}{\sigma_{ave}^2}$ and σ_σ^2 are mathematical terms from the derivation. In the limit for an infinite large sample n of assets,

$$\frac{A}{C} \approx E(\tilde{R}_a) \quad \sqrt{\frac{BC - A^2}{C^2}} \approx \sigma_a \quad (30)$$

Thus,

$$\begin{aligned} E(\tilde{R}_{I^*}) &\approx E(\tilde{R}_a) + \sigma_a \\ E(\tilde{R}_{ZI^*}) &\approx E(\tilde{R}_a) - \sigma_a \end{aligned} \quad (31)$$

Since $\frac{A}{C}$ is the expected return of global minimum-variance portfolio G , $E(\tilde{R}_G)$. Therefore, $E(\tilde{R}_G) \approx E(\tilde{R}_a)$, which shows that portfolio a lies in the return-variance space with the axis of symmetry at $E(\tilde{R}_G)$ that splits the parabola into halves. The portfolio a can also be market portfolio M , and the equal-weighted market return is not reasonable proxy as it represents

an estimate of $E(\tilde{R}_a)$ or $E(\tilde{R}_G)$. The same problem arises if we use a value-weighted return to construct portfolios as the standard deviations are both greater than σ_G . The above equations also show that the market volatility has two-sided, opposite effects in increasing $E(\tilde{R}_{I^*})$ and decreasing $E(\tilde{R}_{ZI^*})$ from the average market return $E(\tilde{R}_a)$. It also simplifies the computation in estimating $E(\tilde{R}_{I^*})$ and $E(\tilde{R}_{ZI^*})$ by only using the average return and standard deviation of returns for the n population assets in the market instead of covariance matrix. Many researchers have studied in extending traditional CAPM. [Kraus and Litzenberger \(1976\)](#) extend the capital asset pricing model to incorporate the effect of skewness on in return distributions. In the later study, [Friend and Westerfield \(1980\)](#) implement the same theory in [Kraus and Litzenberger \(1976\)](#) and incorporate bonds as well as stocks into the analysis. They find that investors may pay a premium for positive skewness in their portfolios.

When riskless assets exist in the market, there are three orthogonal assets I^* , ZI^* and f . The zero-beta CAPM from Appendix B derivation can be written as

$$\begin{aligned} E(\tilde{R}_i) &= \omega_{I^*}E(\tilde{R}_{I^*}) + \omega_{ZI^*}E(\tilde{R}_{ZI^*}) + \omega_{i,f}R_f \\ &= (\omega_{I^*} + \omega_{ZI^*})E(\tilde{R}_a) + (\omega_{I^*} - \omega_{ZI^*})\sigma_a + \omega_{i,f}R_f \end{aligned}$$

Thus,

$$\begin{aligned} E(\tilde{R}_i) - R_f &= (\omega_{I^*} + \omega_{ZI^*})[E(\tilde{R}_a) - R_f] + (\omega_{I^*} - \omega_{ZI^*})\sigma_a \\ E(\tilde{R}_i) - R_f &= \beta_{i,a}[E(\tilde{R}_a) - R_f] + Z_{i,a}\sigma_a \end{aligned} \tag{32}$$

Investors can both long and short positions in these assets, but the sum of weights equals to unity, $\omega_{I^*} + \omega_{ZI^*} + \omega_{i,f} = 1$. $\beta_{i,a}$ is beta risk measuring the sensitivity of the i th asset excess returns to average market excess returns, and the zeta risk coefficient $Z_{i,a}$ measures the

sensitivity of asset returns to market volatility. $\beta_{i,a}$ is used instead of $\beta_{i,M}$ because it does not measure the market beta associated with the market portfolio, but instead it is related to the average return on the portfolio of n assets in the market. The approach is consistent with the study in [Shanken \(1985 and 1986\)](#) and [Shanken and Weinstein \(2006\)](#), in which they show that the true market portfolio can be constructed from any two portfolios on the parabola. The intuition of the two-factor zero-beta CAPM model is that the factors are multivariate proxies for the unobservable equilibrium market portfolio.

5.3.1 PRELIMINARY TESTS OF TWO-SIDED MARKET VOLATILITY HYPOTHESIS

In order to test the existence of two-sided market volatility, we carry out the following procedure based on equation (32):

Firstly, we run an OLS time-series regression of the market model using a value-weighted stock market index to proxy the average return of assets in the market in month t :

$$\tilde{R}_{it} - R_{ft} = \alpha_i + \beta_{i,a}(\tilde{R}_{at} - R_{ft}) + \tilde{\varepsilon}_{it} \quad (33)$$

Where error term $\tilde{\varepsilon}_{it}$ is i.i.d. normal and uncorrelated with the average market premium.

We then using the residual terms, we estimate the following OLS zeta risk model,

$$|\tilde{\varepsilon}_{it}| = b_i + Z_{i,a}\tilde{\sigma}_{at} + \tilde{\mu}_{it} \quad (34)$$

Where the zeta risk parameter $Z_{i,a}$ measures the sensitivity of the absolute value of asset i market model residuals to market volatility over time, and error term $\tilde{\mu}_{it}$ shares the same properties as in equation (33). The absolute value of market model residual is used to capture two-sided market volatility effects. Therefore, if the estimated zeta risk coefficient is

significant, ZCAPM theory is supported. The term $\tilde{\sigma}_{at}$ represents a measure of market volatility and the zeta risk coefficient $Z_{i,a}$ captures its two-sided effect on excess returns.

5.3.2 TESTS FOR ZCAPM CROSS-SECTIONAL MARKET VOLATILITY

The ZCAPM equation (32) implies that there are two-sided market volatility effects on asset returns. This means the expected returns on portfolios I^* and ZI^* are

$$\begin{aligned} E(\tilde{R}_{I^*}) - R_{ft} &= \beta_{I^*,a}[E(\tilde{R}_a) - R_{ft}] + Z_{I^*,a}\sigma_a \\ E(\tilde{R}_{ZI^*}) - R_{ft} &= \beta_{ZI^*,a}[E(\tilde{R}_a) - R_{ft}] - Z_{I^*,a}\sigma_a \end{aligned} \quad (35)$$

Therefore, if σ_a increases, the expected return on I^* will increase but the expected return on ZI^* will decrease. In the ZCAPM, each period generates a different cross-sectional standard deviation of asset returns and asset excess returns can be differently affected by changes in the cross-sectional measure of market volatility. [Liu et al \(2012\)](#) propose an empirical methodology that takes into account for the first time two-sided market volatility on asset returns from period to period. For ith asset, the general empirical ZCAPM model is,

$$\tilde{R}_{it} - R_{ft} = \alpha_i + \beta_{i,a}(\tilde{R}_{at} - R_{ft}) + Z_{i,a}D_{it}\tilde{\sigma}_{at} + \tilde{u}_{it} \quad (36)$$

Where D_{it} is unobserved indicator variable, taking value 1 with probability p_i for positive market volatility effect, and -1 with probability $1 - p_i$ for negative market volatility effect. The probability of unobserved D_{it} is calculated by Bayes' rule.

Let

$$\hat{p}_{it} = P(D_{it} = 1 | \tilde{R}_{it}, \theta'_i) \quad (37)$$

Therefore, the expected D_{it} is

$$\begin{aligned}
\tilde{D}_{it} &= E(D_{it}|\tilde{R}_{it}, \theta'_i) = P(D_{it} = 1|\tilde{R}_{it}, \theta'_i) - P(D_{it} = -1|\tilde{R}_{it}, \theta'_i) \\
&= \hat{p}_{it} - (1 - \hat{p}_{it}) \\
&= 2\hat{p}_{it} - 1
\end{aligned} \tag{38}$$

The parameters in the empirical ZCAPM model in equation (36) can be denoted as $\theta_i = (\alpha_i, \beta_{i,a}, Z_{i,a}, \sigma_i^2, p_i)$. If the signal variable D_{it} is observable, the first four parameters can be estimated by running a least squares regression, and p_i can be estimated by computing the sample frequency of D_{it} taking value 1. However, since the signal variable D_{it} is the latent variable that is unable to be observed, we can not use the least square regression for empirical ZCAPM as normal. In order to make a valid inference, the latent variable distribution should be integrated out from the complete data likelihood. Therefore, we need to find other estimation methods which can take the unobserved latent variable into account. One way to estimate the parameters including latent signal variable D_{it} is to use expectation-maximization algorithm to compute the maximum likelihood estimate. EM iterates between an expectation-step and maximization-step until the iteration reaches the convergent point. The first step of EM algorithm is to calculate the conditional expectation of the complete data log-likelihood given the observed data and the estimates of the parameter. Then we maximize the conditional expectation obtained from the previous step until the estimates converge to the maximum likelihood estimate. We outline the general procedure of expectation-maximization algorithm in Appendix C.

Although we have achieved nice convergence properties of the estimation, it requires extensive computation iterations. Therefore, we implement an alternative procedure that requires less computational efforts to estimate the signal variable D_{it} with expected value $2\hat{p}_i - 1$.

- (1) The first step is to estimate the CAPM model for sample period $t = 1, \dots, T$. Initialize the value of $D_{it}^{(0)}$ as:

$$D_{it}^{(0)} = \begin{cases} 1; & \text{when } (\tilde{R}_{it} - R_{ft}) - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) \geq 0 \\ -1; & \text{when } (\tilde{R}_{it} - R_{ft}) - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) \leq 0 \end{cases} \quad (39)$$

In this step, we firstly initiate the initial value of signal variable $D_{it}^{(0)}$ based on the sign of residual terms under CAPM model.

- (2) We then used the estimated initial signal variable $D_{it}^{(0)}$ obtained from step (1) to estimate the empirical ZCAPM:

$$\tilde{R}_{it} - R_{ft} = \alpha_i + \beta_{i,a}(\tilde{R}_{at} - R_{ft}) + Z_{i,a}D_{it}\tilde{\sigma}_{at} + \tilde{u}_{it} \quad (40)$$

In this step, we obtained an estimated coefficients $\hat{\beta}_{i,a}$ and $\hat{Z}_{i,a}$.

- (3) We use the estimated coefficient $\hat{\beta}_{i,a}$ from step (2) to calculate the updated signal variable D_{it} . Let k denotes the k 's iteration, and the signal variable $D_{it}^{(k)}$ is defined as:

$$D_{it}^{(k)} = \begin{cases} 1; & \text{when } (\tilde{R}_{it} - R_{ft}) - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) \geq 0 \\ -1; & \text{when } (\tilde{R}_{it} - R_{ft}) - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) \leq 0 \end{cases} \quad (41)$$

- (4) We continue to repeat the step (2) and (3) until model converges to D_{it} value that will not change. We conclude the convergence of the iteration is achieved at this stage. This step minimizes the sum of the $|\alpha_i + \tilde{u}_{it}|$ conditional on the estimates of $\beta_{i,a}$ and $Z_{i,a}$. When convergence achieves, the corresponding estimated coefficients $\hat{\beta}_{i,a}$ and $\hat{Z}_{i,a}$ are the final estimates we obtain. [Liu et al \(2012\)](#) find this alternative iteration method gives almost identical average D_{it} to $2\hat{p}_i - 1$ obtained from EM algorithm, with similar estimates of both $\beta_{i,a}$ and $Z_{i,a}$.

5.3.3 FAMA-MACBETH ROLLING WINDOW FRAMEWORK

In order to compare the effectiveness of ZCAPM estimation with other standard methods, we compare the estimation results across four frameworks for each portfolio: CAPM market model, zero-beta CAPM model, Fama and French three-factor model and four-factor model. The Fama-MacBeth (1973) two-step procedure is used in all the estimations. This includes two separate steps:

- (1) The first step is carrying out time-series regressions of the respective factor model are fitted using daily returns in a 6- and 12-month period rolling window to estimate factor loadings. By rolling this process forward one month at a time, a set of estimated factor loadings is obtained for subsequent out-of-sample period from January 1964 to December 2012.
- (2) Then in the second step, in the subsequent out-of-sample month, a cross-sectional regression uses monthly excess returns in the out-of-sample month January 1964 to December 2012 as the dependent variable and factor loadings from the first pass regressions in the previous 6- and 12- month estimation period as independent variables for the entire sample period. By rolling this process forward one month at a time, a set of estimated factor prices of risk $\hat{\lambda}_k$ for the kth factor are generated.

The procedures are rolled forward one month at a time to enable cross-sectional regressions in each month from July 1964 to December 2012. We analyse the above four frameworks across eight different sets of portfolios: (A) 25 size B/M sorted portfolios; (B) 49 industry portfolios; (C) 25 beta-zeta sorted portfolios on all CRSP common stocks; (D) 25 size B/M sorted and 49 industry portfolios; (E) 25 size B/M sorted plus 49 industry and 25 beta-zeta sorted portfolios on all CRSP common stocks; (F) 4 financial institution industry sectors portfolios; (G) 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks; (H) 4

financial institution industry sectors and 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks.

5.4 DATA AND DESCRIPTIVE STATISTICS

We first provide an overlook of the descriptive feature of the data employed in the analysis. We then provide preliminary evidences in favour of the ZCAPM hypothesized two-sided market volatility effect. We later develop an empirical ZCAPM that takes into account two-sided market volatility and comparing ZCAPM to market CAPM, three- and four-factor asset pricing model.

We use S&P 500 index to proxy the general market return and use one-month Treasury bill as the risk-free rate. Both data are obtained from the Centre for Research in Security Prices (CRSP). We also obtained Fama-French size, value and momentum factors from Kenneth R. French data library⁵⁴. The size factor SMB is referred by small minus large firms' stock returns; the value factor HML is referred by high B / M minus low B / M firms' stock returns; the four-factor model is based on the three-factor model augmented with a momentum factor MOM that is proxied by high past return minus low past return firms' stock returns.

Five different sets of US stock portfolios are employed from period January 1964 to December 2012. For common stock portfolios, we use Fama and French 25 size and book-equity / market-equity (B / M) sorted portfolios; and 49 industry portfolios. The monthly and daily weighted average returns of both of the portfolios are obtained from Kenneth R. French data library⁵⁵. Another set of 25 common stock portfolios is created by sorting on all CRSP stock's estimated values of $\beta_{i,a}$ and $Z_{i,a}^*$ in the empirical ZCAPM equation ($\tilde{R}_{it} - R_{ft} =$

⁵⁴ Kenneth R. French data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

⁵⁵ Kenneth R. French data library: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

$\beta_{i,a}(\tilde{R}_{at} - R_{ft}) + Z_{i,a}^* \tilde{\sigma}_{at} + \tilde{u}_{it}$). This is constructed by using daily data series common stocks and financial institution stocks, and estimating the empirical ZCAPM for the six-month period from July 1963 to December 1963. We include 1000 common stocks and 951 financial institution stocks in our study, which have coverage of almost 75% to 78% of the total market capitalisation. The stock returns are obtained from the Centre for Research in Security Prices (CRSP). Estimated $\beta_{i,a}$ and $Z_{i,a}^*$ parameters are used to sort the stocks into portfolios, within each quintile rank of $\beta_{i,a}$, quintile ranks of $Z_{i,a}^*$ are formed. The value weighted average returns on these portfolios are computed in the next month in January 1964. The process is repeated by rolling forward one month at a time to generate a series of $\beta_{i,a}$ - $Z_{i,a}^*$ sorted portfolio returns from January 1964 to December 2012. For each individual stock, we requires at least 50 months of return observations in each sample period, as well as stock price more than \$1. To proxy for the market return and risk free rate, we use CRSP value weighted return of all stocks and one-month Treasury bill. To proxy the market volatility, we use cross-sectional standard deviation of assets return

$\tilde{\sigma}_{at} = \sqrt{\frac{n}{n-1} \sum_{i=1}^n a_{it-1} (\tilde{R}_{it} - \tilde{R}_{at})^2}$, where $\tilde{R}_{at}$ is the value weighted market return for all CRSP stocks; a_{it-1} is the weighted market value for asset i in month $t - 1$; and $\tilde{R}_{it}$ is the return of asset i in month t . [Liu et al \(2012\)](#) show that although the cross-sectional standard deviation of all assets return $\tilde{\sigma}_{at}$ is biased and consistent estimator of σ_{at} , the magnitude of the bias is a constant proportion of σ_{at} . Therefore we can use $\tilde{\sigma}_{at}$ as a reasonable proxy to the market volatility. Alternatively, another option to represent the market volatility is using implied volatility VIX index produced by Chicago Board Options Exchange Market as in [Ang et al. \(2006\)](#). They find that VIX provides a good proxy of market volatility. However, the VIX index only starts from year 1992, therefore, due to shorter data period compared with ours, we will not use this VIX index to represent market volatility in our paper.

In addition to the common stock portfolios, another two financial institution portfolios are also included in our analysis. The financial institution stocks are chosen and obtained from CRSP according to the SIC industry classification. The first set of financial institution portfolios includes four portfolios: the first asset class is the banking institutions with SIC code ranging from 6000 to 6199, including banks, saving institutions and credit unions etc; The second asset class is insurance companies with SIC code ranging from 6300 to 6411; The third portfolio is real estate financial companies with SIC code ranging from 6500 to 6611, including real estate developers, agents and operators etc; The last asset category is financial trading firm with SIC code ranging from 6200 to 6799, including security and commodity traders and brokers, Investment trusts and investment holding companies etc. The second set of financial institution portfolios is constructed in a similar way as in common stock $\beta_{i,a}$ - $Z_{i,a}^*$ sorted portfolios. Instead of using all CRSP stocks returns, we use only financial institutional stocks according to SIC classification of financial institutions from CRSP.

The descriptive data analysis is shown in the Table.14. In the sample period, the average monthly return on CRSP market stock return is 0.88 percent with standard deviation 4.49. The average monthly risk free rate is 0.42 percent with a standard deviation of 0.24. The mean SMB and HML are 0.25 and 0.38 percent respectively. All of the above variables are downloaded from Kenneth French website. The market volatility σ_a is computed from all CRSP stocks cross-sectional standard deviation of asset return

$\tilde{\sigma}_{at} = \sqrt{\frac{n}{n-1} \sum_{i=1}^n a_{it-1} (\tilde{R}_{it} - \tilde{R}_{at})^2}$ as discussed before. The average market volatility is 6.65 percent per month. The mean we computed here is similar with those computed in the literature.

Table.14 Descriptive statistics for the period January 1964 to December 2012

The variables presented in this table is monthly data in percentage terms. The variables are defined as following: R_a is the average market return which is value-weighted return of CRSP market index; R_f is riskless rate which is one-month US Treasury bill return; σ_a is the market volatility which is cross-sectional standard deviation of monthly value-weighted returns for all CRSP common stocks; SMB is the size factor which is Fama-French small minus big firms' stock returns; HML is the value factor which is high B/M minus low B/M firms stock returns. MOM is momentum factor which is Fama-French high past return stocks minus low past return stocks.

	R_a	R_f	SMB	HML	σ_a
Mean	0.88	0.42	0.25	0.38	6.65
Median	1.21	0.41	0.07	0.38	6.18
Maximum	16.61	1.35	22.00	13.84	23.42
Minimum	-22.64	0.00	-16.39	-12.60	3.23
Std. Dev.	4.49	0.24	3.12	2.89	2.29
Skewness	-0.49	0.66	0.54	-0.00	2.53
Kurtosis	4.88	4.17	8.51	5.48	13.38
Jarque-Bera	113.23	78.62	783.36	152.72	3,311.16

5.5 EMPIRICAL RESULTS

5.5.1 PRELIMINARY RESULTS OF TWO-SIDED MARKET VOLATILITY HYPOTHESIS

In order to test the presence of two-sided market volatility, we first run an OLS time-series regression of the CAPM market model using a value-weighted stock market index to proxy the average return of assets in the market in the month as shown in equation (33). We then estimate OLS zeta risk model by using the residual terms from equation (33) as dependent variable and market volatility as independent variable as in equation (34). The zeta risk parameter $Z_{i,\alpha}$ measures the sensitivity of the absolute value of asset i market model residuals to market volatility over time, and error term $\tilde{\mu}_{it}$ share the same properties as in equation (33). The absolute value of market model residuals is used to capture two-sided market volatility effects. Therefore, if the estimated zeta risk coefficient is significant, ZCAPM theory is supported. The term $\tilde{\sigma}_{at}$ represents a measure of market volatility and the zeta risk coefficient $Z_{i,\alpha}$ captures its two-sided effect on excess returns. We carried out a preliminary test on the existence of two-sided market volatility by using monthly data on five sets of portfolios from January 1964 to December 2012. The five portfolios are, Fama and

French's 25 B/M sorted all industry portfolios, 49 industry portfolios, 25 $\beta_{i,a}$ and $Z_{i,a}^*$ sorted portfolios on all common stocks, and another two financial institutional specific portfolios. One financial institutional portfolio includes four stock categories, banking, insurance, real estate and trading and investment holding portfolios sorted by SIC classification, the other is 25 $\beta_{i,a}$ and $Z_{i,a}^*$ sorted portfolios based on all financial institution stocks. We present the result in the following Table.15. From the results, we can see all the estimated $\beta_{i,a}$ and $Z_{i,a}$ are highly significant in all five portfolios at 1 percent level or less. The magnitude of the $Z_{i,a}$ coefficient ranges between 0.1 and 1.0 across all five portfolios as shown in the previous literature. This suggests that the sensitivity to market volatility differs considerably across industries and that most portfolios are significantly exposed to zeta market volatility risk. The average $Z_{i,a}$ coefficient is 0.44, which shows the zeta risk accounts for residual stock returns of approximately an average of 2.3 percent per month. The adjusted R^2 values for the first CAPM model range from 0.38 to 0.71 and the adjusted R^2 values for the second zeta risk model are much smaller than those under CAPM model, which is between 0.06 and 0.16. This shows that the market volatility explains some portion of the absolute value of market model residuals in all sets of portfolios. We interpret this preliminary results as evidences to support the ZCAPM's proposition that market volatility has two-sided and opposite effects on stock returns.

Table.15 Preliminary ZCAPM existence results for the period January 1964 to December 2012

This table reports the preliminary test on the existence of two-sided market volatility. The $Ra - Rf$ is the monthly value-weighted market excess return, where Ra is the monthly value-weighted market return and Rf is the risk-free rate presented as one-month Treasury bill. σ_a is the market volatility which is the cross-sectional standard deviation of monthly value-weighted returns for all CRSP common stocks.

We first run an OLS time-series regression of the CAPM market model shown in equation (33); we then estimate OLS zeta risk model of the residual terms and market volatility shown in equation (34):

$$R_{it} - R_{ft} = a_i + \beta_{i,a} (R_{at} - R_{ft}) + \varepsilon_{it} \quad (33)$$

$$|\varepsilon_{it}| = b_i + Z_{i,a} \sigma_{at} + \mu_{it} \quad (34)$$

Portfolio I is French's 25 B/M sorted all industry portfolios; Portfolio II is 49 industry portfolios; Portfolio III is 25 beta-zeta sorted all common stocks portfolios; Portfolio IV is the 4 sectors financial institution portfolios; Portfolio V is 25 beta-zeta sorted financial institutional stocks portfolios.

	a_i	$\beta_{i,a}$	Adj. R^2 (1)	b_i	$Z_{i,a}$	Adj. R^2 (2)
Portfolio I	-0.01 (-0.50)	1.07 (193.72)***	0.71	-0.46 (-9.32)***	0.38 (54.83)***	0.16
Portfolio II	0.09 (3.40)***	1.05 (168.46)***	0.49	0.14 (0.14)**	0.48 (57.36)***	0.10
Portfolio III	0.70 (20.93)***	0.97 (130.67)***	0.53	-0.26 (-3.89)***	0.46 (48.25)***	0.13
Portfolio IV	-0.01 (-0.20)	1.12 (59.41)***	0.59	-0.54 (-3.20)***	0.51 (21.27)***	0.16
Portfolio V	0.25 (5.43)***	0.85 (86.99)***	0.38	0.80 (8.17)***	0.38 (28.87)***	0.06

*** 1% significant level

** 5% significant level

* 10% significant level

5.5.2 RESULTS FOR ZCAPM CROSS-SECTIONAL MARKET VOLATILITY

In order to carry out cross-sectional tests of the empirical ZCAPM, we employ the Fama-MacBeth (1973) two-step approach. From the literature, the General Method of Moments (GMM) procedure is not adapted to a latent variable required in the iterative time-series regression model. The Fama-MacBeth two-step approach has been used in many literatures.

The first pass time-series regressions are used to estimate the factor loadings, such as, $\hat{\beta}_{i,a}$ and $\hat{Z}_{i,a}^*$ by using daily returns in the 6- and 12- month period from July 1963 to December 1963 for the first factor loading. By rolling this process forward one month at a time, a set of estimated factor loadings are obtained for subsequent out-of-sample period from January 1964 to December 2012. The second pass cross-sectional OLS regression uses monthly excess returns in the out-of-sample month January 1964 to December 2012 as the dependent variable and factor loadings from the first pass regressions in the previous 6- and 12- month estimation period as independent variables for the period from July 1963 to June 2012. By

repeating this process forward one month at a time, a set of estimated factor prices of risk $\hat{\lambda}_k$ for the k th factor are generated for 589 months from January 1964 to December 2012. In order to evaluate the performance of the empirical ZCAPM with the CRSP value-weighted index as the market factor, we conduct the same Fama-MacBeth (1973) two-step approach procedure for CAPM market model, Fama and French three-factor model, and a four-factor model with additional momentum factor. The factor series for SMB, HML and MOM are all obtained from Kenneth French website.

5.5.2.1 EMPIRICAL RESULTS UNDER 6-MONTH ROLLING WINDOW

We first conduct the cross-sectional empirical Fama-MacBeth (1973) two-step approach under the 6-month rolling windows in the first pass regressions. The results are shown in the Table.16 below. The market factor M is proxied with the CRSP value-weighted index; the volatility V factor is proxied by the cross-sectional standard deviation of CRSP stocks' returns; the size factor SMB is referred by small minus large firms' stock returns; the value factor HML is referred by high B/M minus low B/M firms' stock returns; the four-factor model is based on the three-factor model augmented with a momentum factor MOM which is proxied by high past return minus low past firm stock return. The riskless rate is proxied with one-month Treasury bill yield. We analyse the above frameworks across eight different sets of portfolios: (Panel A) 25 size B/M sorted portfolios; (Panel B) 49 industry portfolios; (Panel C) 25 beta-zeta sorted portfolios on all CRSP common stocks; (Panel D) 25 size B/M sorted and 49 industry portfolios; (Panel E) 25 size B/M sorted plus 49 industry and 25 beta-zeta sorted portfolios on all CRSP common stocks; (Panel F) 4 financial institution industry sectors portfolios; (Panel G) 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks; (Panel H) 4 financial institution industry sectors and 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks.

From the Table.16 results, we notice that all the estimated market volatility $\hat{\lambda}_v$ are significant, and particularly, most of them are consistently priced at 1 percent level. No other factor is consistently priced in these test assets. Under Panel A using the 25 size B/M sorted portfolios, the cross-sectional market volatility coefficient is 5.04 and significant at 1 percent level. Among all four frameworks in Panel A, excess market return is not significant. Although the rest of the excess markets return coefficients are not significantly priced, the estimated coefficients are a mix of positive and negative. The coefficients of size factor SMB under Fama-French three- and four-factor are both positive and significant at 1 percent level. The coefficients of value and momentum factor HML and MOM are not significant in either of the models under Panel A. The results in Panel B with 49 industry portfolios share similar behaviour as those under 25 size B/M sorted portfolios. The cross-sectional market volatility coefficient is still significant at 1 percent level, although the magnitude of the coefficient (1.51) is smaller than 25 size B/M sorted portfolios. Similar as in Panel A, the excess market return coefficient is not significant in under any of the frameworks. However, different from in Panel A, all the excess market return coefficients are positive in Panel B. This shows the 49 industry portfolio sets are more positively related to the general market movement. The size factor SMB is not significant in either three- or four-factor model, with negative coefficient -0.06 in three-factor model and positive coefficient 0.07 in four-factor model. Similar behaviour is shown for value HML factor, which is not significant in either of Fama-French three- and four- factor model. However, unlike in Panel A where momentum factors are is significant, MOM is significant in four-factor model at 10 percent level only. The momentum coefficient MOM is positive 0.17. We then move to look at the results by using the constructed 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on all common CSRP stocks. All coefficients under Panel C show more significant results than in previous portfolios. Excess market return coefficients in Panel C are all positively significant at 1 percent significant level. The

magnitudes of the excess market return coefficient range from 0.37 to 0.46, which are higher than the market coefficients in Panel B in general. This shows the 25 $\beta_{i,a} - Z_{i,a}^*$ sorted portfolios on all common CSRP stocks are more influenced by the market movement than the market influence on 49 industry sorted portfolios. Market cross-sectional volatility coefficient is positive 0.08, which is lower than that in Panel A and B. This observation shows that the 25 $\beta_{i,a} - Z_{i,a}^*$ sorted portfolios on all common CSRP stocks are less exposed to the market volatility. All the Fama-French size, value and momentum factors are significant at 1 percent level, except for MOM that is not significant. Size factor SMB is positive and both value and momentum factors HML and MOM are negatively related to the Panel C portfolio returns. The size factor SMB shares similar positive significant impact on the portfolio returns in Panel C as in Panel A. The negative significance of value factor is consistent with the Panel B 49 industry portfolio returns. On the other hand, the momentum factor MOM has a positive impact on the Panel C portfolio return, similar with the result shown in Panel B. In the next two Panel D and Panel E portfolios, we combine the portfolios sets of previous Panel A to Panel C portfolios together and we expect the combined portfolio sets have combined mixed behaviour. In Panel D, we examine the portfolio returns combining 25 size B/M sorted portfolios with 49 industry portfolios, resulting in a 74 portfolio sets of returns in Panel D. The results of Panel D shown in Table.16 show our expected behaviour, in which the coefficients show a mixed of behaviours when testing Panel A and Panel B individually. As in Panel A and B, the excess market return coefficient is not significant in any model, and the magnitude of the coefficient is smaller than that in Panel B and larger than in Panel A. The market cross-sectional volatility factor is still positively significant, and the magnitude (1.71) is in between of 5.04 from Panel A and 1.51 from Panel B. We can explain this as after combining the portfolio sets, the cross-sectional market volatility still has influence on the combined portfolio returns. The size, value and

momentum factors are only significant in the four-factor model. The coefficient of SMB and MOM are positive 0.12 and 0.16 respectively as shown in Panel B, whereas the value factor HML is negative -0.06 similar with that in Panel B as well. We noticed that the results of the combined portfolios Panel D share more similar behaviour with Panel B rather than with Panel A. We interpret this as that 49 out of 74 portfolio sets in Panel D are industry portfolios in Panel B, which takes 66% of the total Panel D portfolio returns. Therefore, the results in Panel D are more influenced by the behaviours of 49 industry portfolios presented in Panel B. We propose the question on how the results will behave if the size of portfolio sets difference is diluted by introducing another portfolio. We combine all the portfolios sets from Panel A, B and C together to form a portfolio of 94 return sets. The results of the pooled portfolios set are shown in Panel E. The coefficients of the excess market returns are all positively significant, which shows the movement of returns of pooled portfolios is in the same direction with the general market returns. The result is in line with our expectation as when the number of return sets increases, we include a greater proportion of market stocks into our portfolio; therefore, the behaviour of larger sample of stocks represents more resemble the general market behaviour. The cross-sectional market volatility in Panel E is still highly significant with coefficient 0.93, which is lower than individual result from either of the Panel A to Panel C. The size coefficient SMB is not significant in four-factor model as in Panel D, with much lower coefficient of 0.02. The value factor HML is significant for four-factor model and the coefficient is negative as shown in Panel D. Similarly, the momentum factor MOM is still significant in pooled portfolio Panel E, and the coefficient is positive. From the results of Panel E, the weighting influence of 49 industry portfolios is significantly diluted, and the results show a mixture of behaviours.

Apart from common stock portfolios, we also study the zero-beta CAPM behaviour when we use financial institution stocks and portfolios to see whether the cross-sectional market

volatility has a similar effect on the financial institution portfolios as in general common stock portfolios. The first portfolio (Panel F) we use in our test is the 4 return sets which are categorized according to the Standard Industry Code. The four financial institutional categories employed in this paper are banking, insurance, real estate and trading related sectors. Similar with the common stock portfolios, the cross-sectional volatility is still positively significant at 1 percent level related to financial institution portfolio return in Panel F. However, the magnitude of the coefficient is 2.59, which is higher than the cross-sectional market volatility in Panel B. The result suggests that financial institution portfolios returns are more extensively exposed to the cross-sectional market volatility than the overall general market. The Fama-French size factor SMB is not significant in either model. The value factor HML and momentum MOM factor are significant in four-factor model, with coefficient 0.61 and 1.23 respectively. However, despite the insignificance, all Fama-French factors are positive. In order to compare the behaviour of financial institutions results more closely with the general common stocks, we also construct a 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on financial institution stocks only in Panel G and try to compare the like-to-like with results in Panel C which is 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on common stocks. Almost all explanatory factors show significance in Panel G compared with other financial institution portfolios Panel F to H. This observation is consistent with all common stock portfolios in Panel A to E where the Panel C 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on all common stocks show the strongest significance among all the other portfolios sets. Excess market returns in Panel G are all significant and positive. If we revisit the market coefficient in Panel C, we can notice that the market return is more significant for beta-zeta sorted portfolios in ZCAPM model, although some of them are only significant at 5 percent level while others are significant at 1 significant level. This shows that the beta-zeta sorted portfolios are more closely related to the general market movement. The cross-sectional market return volatility in ZCAPM is

positively significant as usual, however, the magnitude of the coefficient is 0.26 which is less than that in Panel C on all common stock beta-zeta portfolios at only 5 percent significant level. This suggests that the financial institution portfolios are less influenced by the market volatility than the general common stock portfolios. The Fama-French factors SMB and HML are also seen as non-significant in both three- and four-factor models. However, the momentum factor MOM is highly significant at 1 percent level with positive coefficient 0.67. We then pool the two financial institution portfolios together to obtain a pooled portfolio set with 29 asset returns in Panel H. The pooled portfolio results are weakened by the portfolio including four sectors financial institution returns compared with the results in Panel G. The excess market return is significant in all models with positive coefficients. As expected the cross sectional market volatility is significant at 5 percent significant level with positive coefficient 0.21. The results of Fama-French factors under Panel H show the similar behaviour as in Panel G. Both SMB and HML Fama-French factors are not significant, but momentum factor MOM is highly significant at 1 percent level with positive coefficient 0.75. The magnitudes of coefficients are larger than Panel G results but less than those in Panel F.

Table.16 Fama-MacBeth cross-sectional regression results for factors in pricing common stocks in the period January 1964 to December 2012 for 6-month rolling windows

This table reports the price of risk estimates under four frameworks: CAPM market model, the empirical ZCAPM model, Fama and French three-factor model and four-factor model. The market factor **M** is proxied with the CRSP value-weighted index; the volatility **V** factor is proxied by the cross-sectional standard deviation of CRSP stocks' returns; the size factor **SMB** is referred by small minus large firms' stock returns; the value factor **HML** is referred by high B/M minus low B/M firms' stock returns; the four-factor model based on the three-factor model augmented with a momentum factor **MOM** which is proxied by high past return minus low past return firms' stock returns. The riskless rate is proxied with one-month Treasury bill yield. The Fama-MacBeth (1973) two-step procedure is used in all the estimations. The first step is carrying out time-series regressions of the respective factor model are fitted using daily returns in a 6-month period rolling window to estimate factor loadings; Then in the second step, in the subsequent out-of-sample month, a cross-sectional regression is run to estimate the out-of-sample factor prices of risk λ for each factor. The procedures are rolled forward one month at a time to enable cross-sectional regressions in each month from January 1964 to December 2012. We analyse the above four frameworks across eight different sets of portfolios: (A) 25 size B/M sorted portfolios; (B) 49 industry portfolios; (C) 25 beta-zeta sorted portfolios on all CRSP common stocks; (D) 25 size B/M sorted and 49 industry portfolios; (E) 25 size B/M sorted plus 49 industry and 25 beta-zeta sorted portfolios on all CRSP common stocks; (F) 4 financial institution industry sectors portfolios; (G) 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks; (H) 4 financial institution industry sectors and 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks.

Panel A: 25 Fama-French Size B/M Sorted Portfolios

Model	α	λ_M	λ_V	λ_{SMB}	λ_{HML}	λ_{MOM}	Adj. R ²
CAPM	0.44 (2.65)***	0.03 (0.18)					0.71
ZCAPM	0.33 (1.96)**	0.14 (0.80)	5.04 (4.42)***				0.80
Three-factor	0.65 (2.06)**	-0.40 (-1.27)		0.33 (3.30)***	0.17 (1.45)		0.73
Four-Factor	0.62 (1.90)*	-0.37 (-1.14)		0.34 (3.39)***	0.17 (1.46)	0.03 (0.11)	0.65

Panel B: 49 Industry Portfolios

CAPM	0.43 (3.76)***	0.14 (1.34)					0.10
ZCAPM	0.53 (4.84)***	0.06 (0.67)	1.51 (3.61)***				0.25
Three-factor	0.46 (3.39)***	0.12 (0.91)		-0.06 (-0.71)	0.07 (1.18)		0.08
Four-Factor	0.47 (3.34)***	0.08 (0.58)		0.07 (0.84)	-0.09 (-1.29)	0.17 (1.87)*	0.00

Panel C: 25 Beta-Zeta Sorted All Common Stocks Portfolios

CAPM	0.61 (5.51)***	0.43 (4.19)***					0.25
ZCAPM	0.66 (6.09)***	0.37 (3.80)***	0.08 (3.18)***				0.28
Three-factor	0.65 (4.77)***	0.41 (3.14)***		0.47 (3.57)***	-0.38 (-3.62)***		0.31
Four-Factor	0.60 (4.10)***	0.46 (3.19)***		0.55 (4.05)***	-0.43 (-3.93)***	0.21 (1.56)	0.56

Panel D: 25 Size B/M Sorted Plus 49 Industry Portfolios

CAPM	0.41 (4.42)***	0.13 (1.47)					0.30
ZCAPM	0.46 (5.13)***	0.10 (1.15)	1.71 (4.56)***				0.28
Three-factor	0.46 (3.88)	0.05 (0.44)		0.04 (0.61)	0.06 (1.11)		0.10
Four-Factor	0.47 (3.79)***	0.02 (0.23)		0.12 (1.92)*	-0.06 (-1.13)	0.16 (1.88)*	0.15

Table.16 Continue

Panel E: 25 Size B/M Sorted , 49 Industry Plus 25 Beta-Zeta Sorted All Stocks Portfolios							
CAPM	0.42 (5.81)***	0.24 (3.55)***					0.22
ZCAPM	0.47 (6.70)***	0.20 (3.05)***	0.93 (3.23)***				0.29
Three-factor	0.45 (4.99)***	0.22 (2.49)**		-0.05 (-1.04)	-0.03 (-0.61)		0.12
Four-Factor	0.48 (4.94)***	0.18 (1.98)**		0.02 (0.35)	-0.14 (-2.83)***	0.17 (2.35)**	0.26
Panel F: 4 Financial Institution Industry Portfolios							
CAPM	0.16 (0.41)	0.33 (0.84)					0.27
ZCAPM	0.19 (0.48)	0.34 (0.87)	2.59 (3.03)***				0.40
Three-factor	-0.12 (-0.24)	0.54 (1.10)		0.02 (0.06)	0.10 (0.32)		0.11
Four-Factor	-0.47 (-0.82)	0.65 (1.25)		0.41 (1.20)	0.61 (1.77)*	1.23 (2.86)***	0.06
Panel G: 25 Beta-Zeta Sorted Financial Institution Stocks Portfolios							
CAPM	0.41 (3.98)***	0.27 (2.32)**					0.27
ZCAPM	0.40 (3.94)***	0.25 (2.33)**	0.26 (2.64)**				0.51
Three-factor	0.27 (2.17)**	0.38 (2.91)***		0.07 (0.52)	-0.06 (-0.48)		0.32
Four-Factor	0.24 (1.91)*	0.36 (2.70)***		0.14 (1.01)	0.08 (0.65)	0.67 (4.09)***	0.43
Panel H: 4 Financial Industry Plus 25 Beta-Zeta Sorted Financial Institution Stocks Portfolios							
CAPM	0.39 (3.94)***	0.25 (2.27)**					0.22
ZCAPM	0.39 (3.90)***	0.23 (2.29)**	0.21 (2.52)**				0.31
Three-factor	0.25 (2.08)**	0.36 (2.85)***		0.05 (0.44)	-0.02 (-0.22)		0.17
Four-Factor	0.20 (1.62)	0.33 (2.65)***		0.17 (1.31)	0.16 (1.34)	0.75 (4.86)***	0.18

*** 1% significant level

** 5% significant level

* 10% significant level

5.5.2.2 EMPIRICAL RESULTS UNDER 12-MONTH ROLLING WINDOW

In order to compare whether the size of the rolling window has effect on the cross-sectional regression results, we conduct the same Fama and MacBeth two-step approach with one-month ahead returns by using 12-month rolling windows in the first pass regression, and the results are shown in Table.17. We first notice that the cross-sectional market volatility is still consistently priced at 1 percent significant level in all portfolios panels, and the results appear to be stronger than the 6-month regression results with higher factor prices and significance level. In Panel A, the excess market return is significant under all models except for ZCAPM. If we compare with the 6-month rolling windows results, the excess market return has more significant t statistics under 12-month rolling windows than the 6-month rolling windows. However, all significant results show negative estimated market return coefficients under 12-month rolling window, while, in 6-month rolling window, only Fama-French three- and four-factor models give negative coefficients. The cross-sectional market volatility factor is also significant at 5 percent level with positive coefficient 2.60. The results of Fama-French factors, when using 12-month rolling windows, show similar results as in Table.16, in which only size factor SMB is significant under both three- and four-factor models. We then look at the results under Panel B for 49 industry portfolios. The excess market return is not significant under any model. The cross-sectional market volatility is still highly significant with coefficient 2.27. The magnitude of cross-sectional volatility is lower than that in Panel A, and this has the same trend as the results in the 6-month rolling windows. We noticed that, in Panel B, none of the Fama-French factor is significant, whereas the momentum factor MOM is significant in the four-factor model under 6-month rolling windows. The results of using 49 industry portfolios are generally weaker under all models in Table.17 as in Table.16. We also test the constructed $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on all common stocks by using 12-month rolling windows. The results of 12-month rolling

window share similar behaviour as in 6-month rolling windows, and the Panel C results shows the strongest result in terms of significance of coefficients. The excess market returns of $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios are all positively significant at 1 percent significant level with coefficient between 0.34 and 0.46. The cross-sectional market volatility is 1.45 and significant at 5 percent level. The magnitude of the coefficient is lower than that in size B/M sorted portfolio but larger than that when using 49 industry portfolios. Both size factor SMB and value factor HML are highly significant under three- and four-factor models. The size factor SMB coefficients are positive 0.47 and 0.55, and value factor HML coefficients are negative -0.38 and -0.43 respectively. Similar as in 6-month rolling windows, the momentum factor MOM is positive and significant at 1 percent level and the coefficient is positive 0.21. As before, the Panel D consists of portfolios sets of 25 size B/M sorted portfolios and 49 industry portfolios. From the results from 6-month rolling window, we expect the results in Panel D is a mixed behaviour of Panel A and Panel B, with a stronger influence from the results of Panel B as two thirds of the portfolio sets within Panel D is from Panel B portfolios. As we expected, the results shown in Panel D in Table.17 experience similar trends as in Panel B. Excess market return coefficient is not significant under any framework, however, the coefficients are all negative. The cross-sectional volatility factor is highly significant under ZCAPM at 1 percent level with magnitude of 2.11. No other factors are significant in any other frameworks. The coefficient of the cross-sectional volatility is lower than 2.60 in Panel A and 2.27 in Panel B. The pooled 99 portfolios set is also analysed in Panel E. We notice that except for the cross-sectional market volatility factor, all other factors show slightly weaker results in 12-month rolling windows than those in 6-month rolling windows framework. In 12-month rolling windows, the excess market return factor is significant in CAPM and ZCAPM models, with coefficient 0.14 and 0.13 at 10 percent significant level in CAPM and ZCAPM. The estimated cross-sectional volatility coefficient is 0.92 at 5 percent significant level. Fama-French size factor SMB does not show significant

feature in either three- or four-factor model as in Panel A or Panel C. Furthermore, the value factor HML is negatively significant in Fama-French four-factor models with coefficient -0.12 and this result is same with Panel C under 12-month rolling window and Panel E results under 6-month rolling windows. The momentum factor MOM is significant at 10 percent level with coefficient 0.15

Moreover, we continue to examine on whether the change in the rolling window periods has impact on the cross-sectional market volatility on the financial institution portfolios as in general common stock portfolios. In Panel F, we still use the 4 financial industry portfolios returns. Similarly as under 6-month rolling window, the excess market return factor is not significant in any model. The cross-sectional market volatility factor is significant with a positive coefficient of 7.49 at 1 percent significant level. This shows, as usual, the financial institution portfolio is also influenced by the overall market volatility. The Fama-French factors are only significant in four-factor model, with estimated value factor coefficient 0.79 and estimated momentum coefficient 1.16 at 5 percent significant level. We also construct the 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on financial institutional stocks as in Panel G. The results in Panel G show stronger behaviour than in Panel F, and they are also similar with those using previous 6-month rolling windows. Excess market returns coefficients are positively significant in all models. The market cross-sectional return has a positive coefficient of 2.24 at 1 percent significant level. Size factor SMB is significant under both three- and four-factor models, and the momentum factor MOM is also positively significant (0.66) at 1 percent significant level in four-factor model. Both coefficients are positive. The value factor HML is still not significant in either model; however, the coefficient is positive 0.01 in three-factor model, and 0.11 in four-factor model. We also combine the four financial industry asset returns and the 25 $\beta_{i,a}-Z_{i,a}^*$ sorted asset returns on financial institutional stocks to create a pooled financial institution 29 returns sets portfolio in Panel H. The results experience

similar behaviour as in Panel G, with significant positive excess market return in Fama-French three- and four-factor models. It shows positive market volatility factor of 0.83 at 10 percent significant level, and positive significant coefficients on size factor SMB and momentum factor MOM. The resemble results of Panel H with Panel G are not surprising as the trend is the same when we using 6-month rolling window since 25 out of 29 asset returns in Panel H is the 25 $\beta_{i,a}-Z_{i,a}^*$ sorted portfolios on financial institutional stocks. In conclusion, the results of coefficients in any panel are consistent no matter which rolling window is used. However, we can see the results of cross-sectional market volatility show stronger behaviour when using 12-month rolling windows, while other factors do not have a significant difference under 6- and 12-month rolling window.

The obtained estimated coefficients under both 6-month and 12-month can be used to compare predicted realized excess returns versus actual excess returns of test assets. [Liu et al \(2012\)](#) review the results for the common stock combined portfolio including 25 B/M sorted and 49 industrial portfolios. As discussed before in Fama-MacBeth rolling window framework, using 6-month and 12-month first pass time-series regression with daily returns to estimate factor loadings, cross-sectional three-factor and ZCAPM models are estimated for the combined common stock portfolios using one-month ahead excess returns. Similarly this process is rolling forward one month at a time to generate cross-sectional regressions, the average of the estimated factor price of risk and the average estimated loading factors are used to compute average fitted expected excess returns in the next month for each portfolio. These fitted one-month returns are compared to each portfolio's one-month ahead average actual excess returns under both Fama-French three-factor and ZCAPM models. We compare the predicted realized excess returns versus actual excess returns for the 74 combined common stock portfolios, which are exogenous portfolios not constructed from the ZCAPM. The results show models can fit average realized excess returns to some extent.

However, the average fitted excess returns from three-factor model bunch up into a smaller range of values than that of average realized excess returns. From previous literature, it is well-known that the Fama-French model has difficulty explaining small and growth portfolios ([Fama and French 1996](#)). On the other hand, average fitted excess returns for the ZCAPM spread out and fall fairly closely to average realized excess returns. Therefore, the results show that ZCAPM significantly improve the expected returns, represented as average predicted returns in the month ahead. It is also noted that Fama-French three-factor model can not predicted exogenous industry portfolio returns ([Daniel and Titman 2012](#)). Therefore, the major advantages of zero-beta CAPM in this chapter is that it can provide better prediction on portfolio expected returns than other traditional asset pricing model.

Table.17 Fama-MacBeth cross-sectional regression results for factors in pricing common stocks in the period July 1964 to December 2012 for 12-month rolling windows

This table reports the price of risk estimates under four frameworks: CAPM market model, the empirical ZCAPM model, Fama and French three-factor model and four-factor model. The market factor *M* is proxied with the CRSP value-weighted index; the volatility *V* factor is proxied by the cross-sectional standard deviation of CRSP stocks' returns; the size factor *SMB* is referred by small minus large firms' stock returns; the value factor *HML* is referred by high B/M minus low B/M firms' stock returns; the four-factor model based on the three-factor model augmented with a momentum factor *MOM* which is proxied by high past return minus low past return firms' stock returns. The riskless rate is proxied with one-month Treasury bill yield. The Fama-MacBeth (1973) two-step procedure is used in all the estimations. The first step is carrying out time-series regressions of the respective factor model are fitted using daily returns in a 12-month period rolling window to estimate factor loadings; Then in the second step, in the subsequent out-of-sample month, a cross-sectional regression is run to estimate the out-of-sample factor prices of risk λ for each factor. The procedures are rolled forward one month at a time to enable cross-sectional regressions in each month from July 1964 to December 2012. We analyse the above four frameworks across eight different sets of portfolios: (A) 25 size B/M sorted portfolios; (B) 49 industry portfolios; (C) 25 beta-zeta sorted portfolios on all CRSP common stocks; (D) 25 size B/M sorted and 49 industry portfolios; (E) 25 size B/M sorted plus 49 industry and 25 beta-zeta sorted portfolios on all CRSP common stocks; (F) 4 financial institution industry sectors portfolios; (G) 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks; (H) 4 financial institution industry sectors and 25 beta-zeta sorted portfolios on all CRSP financial Institution stocks.

Panel A: 25 Fama-French Size B/M Sorted Portfolios							
Model	α	λ_M	λ_V	λ_{SMB}	λ_{HML}	λ_{MOM}	Adj. R^2
CAPM	0.78 (2.65)***	-0.34 (-1.86)*					0.80
ZCAPM	0.68 (3.74)***	-0.24 (-1.28)	2.60 (2.25)**				0.82
Three-factor	1.03 (2.94)***	-0.76 (-2.19)**		0.29 (2.88)**	0.18 (1.56)		0.69
Four-Factor	0.90 (2.49)**	-0.64 (-1.76)*		0.30 (2.95)***	0.16 (1.37)	0.06 (0.15)	0.68
Panel B: 49 Industry Portfolios							
CAPM	0.56 (4.63)***	0.01 (0.13)					0.19
ZCAPM	0.61 (5.11)***	0.01 (0.13)	2.27 (4.27)***				0.21
Three-factor	0.64 (4.32)***	-0.05 (-0.35)		-0.09 (-0.95)	0.11 (1.56)		0.06
Four-Factor	0.68 (4.26)***	-0.11 (-0.71)		0.02 (0.27)	-0.05 (-0.64)	0.15 (1.36)*	0.01
Panel C: 25 Beta-Zeta Sorted All Common Stocks Portfolios							
CAPM	0.57 (4.93)***	0.44 (4.06)***					0.33
ZCAPM	0.63 (6.09)***	0.34 (3.27)***	1.45 (2.17)**				0.26
Three-factor	0.67 (4.33)***	0.42 (3.12)***		0.43 (3.42)***	-0.33 (-3.52)***		0.35
Four-Factor	0.62 (4.12)***	0.45 (3.09)***		0.55 (4.02)***	-0.44 (-3.63)***	0.23 (1.57)	0.62
Panel D: 25 Size B/M Sorted Plus 49 Industry Portfolios							
CAPM	0.58 (5.93)***	-0.04 (-0.46)					0.27
ZCAPM	0.57 (5.92)***	-0.01 (-0.11)	2.11 (4.54)***				0.35
Three-factor	0.67 (5.09)***	-0.14 (-1.13)		0.01 (0.22)	0.09 (1.48)		0.13
Four-Factor	0.69 (4.87)***	-0.17 (-1.24)		0.08 (1.22)	-0.03 (-0.56)	0.14 (1.36)	0.16

Table.17 Continue

Panel E: 25 Size B/M Sorted , 49 Industry Plus 25 Beta-Zeta Sorted All Stocks Portfolios							
CAPM	0.51 (6.71)***	0.14 (1.89)*					0.28
ZCAPM	0.53 (7.03)***	0.13 (1.85)*	0.92 (2.39)***				0.32
Three-factor	0.54 (5.49)***	0.12 (1.28)		-0.09 (-1.59)	-0.01 (-0.04)		0.16
Four-Factor	0.60 (5.56)***	0.06 (0.62)		-0.03 (-0.58)	-0.12 (-2.16)***	0.15 (1.67)*	0.29
Panel F: 4 Financial Institution Industry Portfolios							
CAPM	0.39 (0.92)	0.10 (0.25)					0.22
ZCAPM	0.60 (1.39)	0.03 (0.07)	7.49 (2.41)**				0.45
Three-factor	0.29 (0.52)	0.10 (0.20)		0.01 (0.04)	0.22 (0.64)		0.12
Four-Factor	-0.23 (-0.36)	0.35 (0.61)		0.52 (1.42)	0.79 (2.01)**	1.16 (2.25)**	0.03
Panel G: 25 Beta-Zeta Sorted Financial Institution Stocks Portfolios							
CAPM	0.52 (4.81)***	0.21 (1.74)**					0.25
ZCAPM	0.44 (3.85)***	0.21 (1.80)**	2.24 (4.57)***				0.56
Three-factor	0.26 (1.80)**	0.37 (2.60)***		0.35 (2.00)**	0.01 (0.06)		0.29
Four-Factor	0.08 (0.58)	0.48 (3.32)***		0.59 (3.31)***	0.11 (0.65)	0.66 (2.90)***	0.45
Panel H: 4 Financial Industry Plus 25 Beta-Zeta Sorted Financial Institution Stocks Portfolios							
CAPM	0.51 (4.87)***	0.16 (1.44)					0.23
ZCAPM	0.48 (4.54)***	0.16 (1.45)	0.83 (1.77)*				0.34
Three-factor	0.29 (2.09)***	0.29 (2.15)**		0.25 (1.63)	0.06 (0.42)		0.16
Four-Factor	0.07 (0.53)	0.40 (2.92)***		0.54 (3.40)***	0.24 (1.56)	0.76 (3.64)***	0.23

*** 1% significant level

** 5% significant level

* 10% significant level

5.6 CONCLUSIONS

This chapter adopts rolling-window Fama-MacBeth (1973) two-step procedure to examine the return generating process under four frameworks, CAPM, zero-beta CAPM, Fama-French three-factor and four-factor models. Particularly, the result of zero-beta CAPM is of our great interest since ZCAPM examines the impact of cross-sectional market volatility on the portfolio returns. The ZCAPM model specifies asset returns as a function of the average return on all assets in the market and their cross-sectional standard deviation – volatility σ_a . According to ZCAPM, the market volatility can have two-sided and opposite effects on asset returns. Some asset returns are positively affected by an increase in market volatility, and on the other hand, some asset returns may be negatively affected by an increase in market volatility. Therefore, our study takes into account two-sided market volatility by specifying a signal variable D_{it} to denote positive and negative market volatility by taking value 1 and -1 respectively. Since the direction of market volatility effect on an asset is unknown at any given specific time, we use iterative regression method on a binary latent variable that iteratively estimates the probabilities of positive versus negative market volatility effect.

In the first step of Fama-Macbeth procedure, we carry out time-series regressions of the respective factor model are fitted using daily returns in a 6- and 12-month period rolling window to estimate factor loadings. Then in the second step, in the subsequent out-of-sample month, a cross-sectional regression is run to estimate the out-of-sample factor prices of risk λ for each factor. The procedures are rolled forward one month at a time to enable cross-sectional regressions in each month from January 1964 to December 2012. We apply the method on eight portfolios in total which include a combination of common stocks and, particularly, financial institution stocks. We find that cross-sectional market volatility premium is consistently significant at high level in all sets of portfolios. The results of cross-sectional market volatility are also robust to different estimation periods when applying to

6- and 12-month rolling windows in the first pass regressions and different out-of-sample period in the second pass regression. Another finding of our interest is that we also apply the ZCAPM specification on the financial institution portfolios. The results also suggest the cross-sectional zeta risk is highly related to the financial institution portfolios as shown in common stock portfolios. Therefore, we have shown that the high significance of cross-sectional market volatility on asset returns in ZCAPM does not depend on the chosen test asset returns which overcome the problem of portfolio formation that is common to other asset pricing models.

We find evidence that the cross-sectional market volatility is indeed a significant market factor in explaining the cross-section of expected stock returns and ZCAPM model can provide better estimation as an asset pricing model. We can explain this result as, in the ZCAPM, market risk is composed of two components, average market returns and cross-sectional market volatility. The previous studies on asset returns only focus on beta risk and exclude the unobserved risk from cross-sectional market volatility. We also find that the Fama-French size and B/M sorted portfolios are also closely related to zeta-risk and one-month-ahead average excess returns. The highly significance of cross-sectional market volatility on B/M sorted portfolios indicates that the size and value portfolios are explained by two-sided market volatility associated with zeta risk which is an unobserved component of market risk. Therefore, we conclude that the cross-sectional market volatility is indeed a significant market factor in explaining the cross-section of expected stock returns and ZCAPM model can provide better estimation as an asset pricing model.

The important application of the ZCAPM study is that the fund manager can use zero-beta CAPM framework to better predict expected stock returns. The Fama-MacBeth rolling window framework is used for the combined common stock portfolios using one-month ahead excess returns. This process is rolling forward one month at a time to generate cross-

sectional regressions, the average of the estimated factor price of risk and the average estimated loading factors are used to compute average fitted expected excess returns in the next month for each portfolio. These fitted one-month returns are compared to each portfolio's one-month ahead average actual excess returns under both Fama-French three-factor and ZCAPM models. We compare the predicted realized excess returns versus actual excess returns for the 74 combined common stock portfolios, which are exogenous portfolios not constructed from the ZCAPM. The results show models can fit average realized excess returns to some extent. However, the average fitted excess returns from three-factor model bunch up into a smaller range of values than that of average realized excess returns, and it is expected that the Fama-French model has difficulty explaining small and growth portfolios from literature. On the other hand, average fitted excess returns for the ZCAPM spread out and fall fairly closely to average realized excess returns. Therefore, the results show that ZCAPM significantly improve the expected returns, represented as average predicted returns in the month ahead. Therefore, the major advantages of zero-beta CAPM in this chapter is that it can provide better prediction on portfolio expected returns than other traditional asset pricing model.

CHAPTER SIX

CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

The thesis investigates the risk-related behaviours of financial institutions across the global financial markets and provides reasonable explanations for the empirical results. The thesis has a few findings and contributions to the existing literature. It investigates various risks to which financial institutions are exposed, particularly capital risk, real estate risk and valuation risk. The importance of capital adequacy had drawn public and regulators attention in the recent financial turmoil, especially when financial institutions face unexpected credit and liquidity shocks in the financial markets. The thesis shows that banking organizations show little pecking order behaviour in capital structure. Banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. Therefore, the debt structure in banking is different from non-financial firms. For the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because the taxpayers funds deposit in the bank. The thesis also finds that despite of the regulatory minimum capital requirement, the banking organizations target capital level is linearly and collectively influenced by bank-specific, macroeconomic and country-specific variables. Thesis also finds significant evidences that with the development of mortgage loans issuance and related derivatives, financial institutions are increasingly exposed to real estate markets, and there is a significant and positive cross-volatility spillover from real estate sector to banks, and the co-movement is in the same direction. It is also crucial that financial institutions and fund managers can predict the expected portfolio returns more accurately. The thesis finds that zero-beta CAPM significantly improve the expected returns,

represented as average predicted returns in the month ahead when comparing with three-factor model, which has difficulty explaining small and growth portfolios returns .

The findings of the thesis not only contribute and extend the existing literature, but also have important implication for regulators, risk and asset managers as well as investors at both company and public policy levels. The regulators and financial institution managers can monitor banks targeted capital structure more closely based on the bank-specific, macroeconomic and country-specific variables discussed in the thesis. When there is any changes in these determinant variables, institution managers should make relevant adjustments in the targeted capital structure. In addition, regulators should be aware the influence of real estate market over financial institutions, especially any significant volatility changes in real estate as it can spillover into financial institutions. As financial institutions are increasingly exposed to real estate market, any significant changes in real estate market can also have influential impact on the capital adequacy in bank organisations. Therefore, it is suggested institutional managers need to control the real estate exposure in their financial assets and include real estate factor in the stress testing. Furthermore, it is also important that financial institution and fund managers can estimate the expected returns more accurately, so that they can make correct collection of assets for required risk and return. In the thesis we find that the zero-beta CAPM outperforms the traditional asset pricing model, particularly three-factor model, by providing better prediction on portfolio expected returns. Therefore, the fund managers can adopt the zero-beta ZCAPM framework along with other asset pricing framework when predicting portfolio returns. As high returns often come with high risk, predicting returns more accurately means we can predict and monitor risk more precisely. The financial institution managers can also apply zero-beta CAPM on their institutional asset holdings to monitor whether the institutions are exposed to higher risk assets. The regulators can use the framework to control the financial intermediaries risk and

return behaviour to maintain the financial market stability. By identifying and quantifying the risk and return behaviours of financial intermediaries, stakeholders can assess and improve their management and investment performances. The empirical findings also help the regulatory bodies to make effective and suitable policies for financial sectors to ensure a stable, prosperity and sustainable growth of financial market.

The thesis starts with reviewing the current literature on financial institutions from risk and regulatory aspects. We discuss types of risks faced by financial institutions and relevant literature on each of the risks, such as interest rate risk, market risk, credit risk and foreign exchange risk. Financial institutions have observed a trend of increasing exposure of real estate sector worldwide since 1980s. From the literature research, we find that there are two ways real estate have been included in the financial institution investment portfolios. One way for financial institutions investing in real estate is through the traditional real estate loan. The other way of investing in real estate is through indirect investments, such as real estate stocks, derivative instruments and Real Estate Investment Trusts. There is an increasing trend of investing in Real Estate Investment Trusts in recent years. Furthermore, financial institutions need to protect against the risk of insolvency and shield it from the risk sufficiently large to cause the institution to fail. One of the most important protections of the financial institution is their capitals. We review the current literature on the initiation, implementation, limitation and development of Basel I, II and III regulation. Particularly, Basel III is designed to improve the safety and healthiness of financial institutions; however, the possible influence of the implementation on economy is uncertain. Several studies have shown there is a potential of increase in cost of funding and decline in state output and welfare consumption. Therefore, implementing Basel III requires policy maker to take careful consideration in terms of the extent and time frame so that financial market and economy can have a buffer period to gradually adjust themselves to the changes.

We then empirically investigate the risk factors that financial institutions are exposed to, including particularly capital risk, real estate risk and valuation risk. In chapter three, the thesis shows that financial institutions, especially banking institutions, are significantly exposed to capital risks. The recent financial turmoil has revealed the capital inadequacy of the financial institution when facing unexpected credit and liquidity shocks in the financial markets. Therefore, it is important to understand the factors that impact bank capital structures so that risk managers can efficiently monitor banks capital level and regulatory bodies can design suitable policies. The thesis examines the extent of pecking order behaviour in the banking organizations and finds that banks show little pecking order behaviour. One concern of testing the pecking order theory on banks is that banks are different in terms of leverage relative to non-banks, as taxpayers deposit subsidized debt relative to equity in banking. The term deposit is used by the banking industry in financial statements to describe the liability owned by the bank to its depositor, and not the funds that bank holds as a result of the deposit, which are shown as assets of the bank. When taxpayers put funds into the bank, it is recognized as an asset by the bank. On the other hand, the bank credits a liability account for the same amount to show as a liability owed by the bank to its customer. Therefore, the debt structure in banking is different from non-financial firms. For the same level of financial deficit, a bank may have higher debt level than non-financial firms. However, this is not due to pecking order but because the taxpayers funds deposit in the bank.

The results also show that all bank-specific, macroeconomic and country-specific variables collectively make a linear significant contribution in explaining banking organizations target capital level. The thesis finds that if the larger proportion of a country financial system is bank-based, banks within this country tend to maintain less capital since banks have a large impact on the financial industry, and it would be easier and cheaper for banks to finance

within short time period. The moral hazard index variable is positive but not statistically significant. The indicator of government ownership of banks variable is negatively related with the change of leverage ratio, which shows the higher degree of government ownership of banking organizations, the slower the change of leverage ratio. We have also noticed that the introduction of non-linear interactive variables tends to dramatically reduce both the statistical and economic significance of the macroeconomic and standalone public policy and regulatory variables estimated in the previous models. This indicates that the nonlinear specification may not provide helpful and meaningful contribution to the estimation of capital ratios.

In addition to the study on capital adequacy, we further empirically examine other risk factors that impact the financial institution returns. The results give similar results as in the existing literature that the market risk is positive and significant for financial institution equity returns, while the interest rate effect is not significant. With the development of mortgage loans issuance and related derivatives, financial institutions are increasingly exposed to real estate markets. We adopt bivariate GARCH framework to examine the return and volatility spillover of real estate market into financial intermediaries across three international markets, United States, United Kingdom and Japan over a period of thirteen years between 1999 and 2011. Comparing with previous studies, the thesis extends the period of the sample to most recent years and allows comparison across three international markets. The positive coefficients of REITs represent that the fluctuation of bank stock returns is moving in the same direction with REITs returns. Our findings indicate real estate factor has significant influence on the bank return generating process in all three countries. Moreover, US banks are most sensitive and closest related to REITs returns, followed by the Japanese banks. The highest level of sensitivity is shown in US banks as expected since US banks, as a leader, invest heavily in real estate properties and related products over the last

few decades with long established and matured REITs market. Furthermore, the bank stock return is most sensitive to real estate sector during 2003-2006, which indicates that bank stock returns are more sensitive to real estate sector when the economy is booming. The results of significant and positive cross-volatility spillover show that there is a volatility spillover from real estate sector to banks, and the co-movement is in the same direction. When comparing between different countries and sub-periods, we notice the level of sensitivity of all factors varies, which indicates the bank return and volatility behaviours are influenced by the country and economic cycle factors.

Furthermore, the last empirical chapter thesis investigates the influences of the cross-sectional market volatility on the portfolio returns, especially financial institution portfolio returns, based on zero-beta CAPM. The zero-beta CAPM framework provides further empirical evidences on the impact of positive and negative volatility on asset returns by taking two-sided market volatility into consideration. We especially apply the model to the financial institution equity returns, and results suggest the cross-sectional zeta risk is highly related to the financial institution portfolios as shown in common stock portfolios. We also extend the existing research by employing more recent periods, and find that the cross-sectional market volatility is consistently significant at high level. By comparing the zero-beta CAPM with other traditional asset pricing model, the results show that the zero-beta CAPM provides a better approximation of expected stock returns. We explain this result as that market risk is composed of two components, average market returns and cross-sectional market volatility. The implication of the findings is that in order to access the impact of market risk, we need to include both components in the analysis. The result also explains the unexplained return behaviour from the previous study when only average market returns are included. Therefore, we conclude that the cross-sectional market volatility is indeed a significant market factor in explaining the expected financial institutional stock returns.

The important application of the ZCAPM study is that the fund manager can use zero-beta CAPM framework to better predict expected stock returns. The Fama-MacBeth rolling window framework is used for the combined common stock portfolios using one-month ahead excess returns. This process is rolling forward one month at a time to generate cross-sectional regressions, the average of the estimated factor price of risk and the average estimated loading factors are used to compute average fitted expected excess returns in the next month for each portfolio. These fitted one-month returns are compared to each portfolio's one-month ahead average actual excess returns under both Fama-French three-factor and ZCAPM models. We compare the predicted realized excess returns versus actual excess returns for the 74 combined common stock portfolios, which are exogenous portfolios not constructed from the ZCAPM. The results show models can fit average realized excess returns to some extent. However, the average fitted excess returns from three-factor model bunch up into a smaller range of values than that of average realized excess returns, and it is expected that the Fama-French model has difficulty explaining small and growth portfolios from literature. On the other hand, average fitted excess returns for the ZCAPM spread out and fall fairly closely to average realized excess returns. Therefore, the results show that ZCAPM significantly improve the expected returns, represented as average predicted returns in the month ahead. Therefore, the major advantages of zero-beta CAPM in this chapter is that it can provide better prediction on portfolio expected returns than other traditional asset pricing model.

The findings of the thesis pave ways for future research as following. The thesis examines the bank capital structure determinants. Current literature has shown that despite for the specialness of financial institutions, banks that use equity capital to fund its operations should be determined by the same set of factors that influence other non-financial firms together with combined impact of any government safety net policies and capital regulation.

We find that target capital structure is influenced by all bank-specific, macroeconomic and country-specific factors. However, in the thesis, due to data limitation, the changes in capital structure behaviour during the financial crisis and later sovereign credit issues of European countries were not specifically revealed. Studies on the impact of unexpected financial and credit shock on bank capital structure is important in maintaining the stability of financial market for the financial institution and regulatory bodies. The financial institution can use the knowledge to predict and control of risk of capital failure, and regulatory bodies can design efficient and sustainable policies to maintain the stable capital and credit environment during the turmoil. In the future, we can extend the thesis results by examining capital structure changes before and after the financial crisis by using the event studies.

In addition, the thesis shows that there is a significant volatility spillover from real estate sector to banks, and the co-movement is in the same direction. In the study, we use REITs to illustrate the real estate risk factor, and it is based on the assumptions from result of existing literature that REITs return and unsecuritized real estate share similar fundamentals and behaviours. However, some researches show that REITs do not always reflect real estate market fundamentals which indicate REITs may not be a good proxy for the returns to unsecuritized real estate. Therefore, the future study can reassess the volatility spillover effect by using unsecuritized real estate returns. The only limitation of using unsecuritized real estate data is that it may not have adequate periods or frequencies required. There are also classifications based on whether or not REITs can issue additional shares. If REITs can only issue shares to the public once and can only issue additional shares once approved by current shareholders, the REITs are closed-ended. On the other hand, open-ended REITs can issue new shares and redeem shares at any time. The close- and open-ended REITs may have different risk and return behaviours due to different pricing characteristics. Although REITs traded in the market are mainly close-ended REITs, however, there are also open-

ended REITs available. The future research can focus on separating the close-ended REITs and open-ended REITs to see the difference of impacts on the results, and which type of REITs can represent the unsecuritized real estate market more closely.

Furthermore, the thesis also examines the superiority of zero-beta CAPM model over traditional asset pricing models by using a rolling window Fama-MacBeth two-step procedure. We find evidence that zero-beta CAPM provides better expected portfolio returns than the well-known three- and four-factor models, and market risk is composed of two components, average market returns and cross-sectional market volatility. The thesis uses monthly data for the Fama-MacBeth rolling window regression. In the future research, we can apply bootstrapping and stochastic asset models, such as, Monte Carlo simulation, to extend and simulate the sample over the period in order to review the superiority of the zero-beta CAPM approach.

In conclusion, the thesis investigates the risk-related behaviours of financial institutions across the global financial markets. It provides reasonable explanations for the empirical results. We investigate various risks to which financial institutions are exposed, particularly capital risk, real estate risk and valuation risk. The findings of the thesis not only contribute and extend the existing literature, but also have important implication for regulators, risk and asset managers as well as investors at both company and public policy levels. The regulators and financial institution managers can monitor banks targeted capital structure more closely based on the bank-specific, macroeconomic and country-specific variables discussed in the thesis. In addition, regulators should be aware the influence of real estate market over financial institutions, especially any significant volatility changes in real estate as it can spillover into financial institutions. It is suggested institutional managers need to control the real estate exposure in their financial assets and include real estate factor in the stress testing. Furthermore, the fund managers can adopt the zero-beta ZCAPM framework

along with other asset pricing framework when predicting portfolio returns. The regulators and financial institution managers can also apply zero-beta CAPM on their institutional asset holdings to monitor whether the institutions are exposed to higher risk assets to maintain the financial market stability. Overall, the financial intermediary stakeholders can benefit from the results in the thesis to improve their management and investment performances. The empirical findings also help the regulatory bodies to make effective and suitable policies for financial sectors to ensure a stable, prosperity and sustainable growth of financial market.

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APPENDIX A

ZERO-BETA CAPM WITH NO RISKLESS ASSETS

In order to derive zero-beta CAPM, we assume investors can take long or short positions of any size in any risky asset, but there is not riskless asset and that no borrowing or lending at the riskless rate of interest is allowed. However, in reality, this assumption is not valid since there is restriction on shorting selling just as the restriction on riskless borrowing. Followed by the original CAPM, the efficient sets of portfolios can be written as value-weighted combination of two basic portfolios, with different weights being used to generate the different portfolios in the efficient set. Let X_i be the proportion of asset i in the efficient portfolio corresponding to the parameter λ satisfies: $X_i = K_i + \lambda k_i$, where K_i and k_i are constant, which are the weights on the stocks in the two basic portfolios. K_i and k_i satisfy,

$$\sum_{i=1}^N K_i = 1; \sum_{i=1}^N k_i = 0 \quad (42)$$

Thus,

$$\sum_{i=1}^N X_i = \sum_{i=1}^N K_i + \lambda \sum_{i=1}^N k_i = 1 \quad (43)$$

Therefore, the sum of weights X_i is always equal to 1.

The beginning of modern portfolio theory can be dated back to the paper [Markowitz \(1952\)](#). In his paper, he introduces the theory of frontier of investment portfolios, such that each of them had the greatest possible expected rate of return for their given risk. The primary impact of MPT is on portfolio management because it provides a framework for the systematic selection of portfolios based on expected return and risk principles. Most portfolio managers today are aware of, and use to varying degrees, the basic principles of

MPT. Major mutual fund families employ the implication of MPT in managing their funds, financial advisors use the principles of MPT in advising their individual investor clients, many financial commentators use MPT terms in discussing the current investing environment and so forth.⁵⁶ Prior to the dissemination of portfolio theory into the real world, argument on how the pricing of securities would be affected by using portfolio theory to invest in the portfolios on the frontier was discussed in wide range of literature. In order to address the issue, the Capital Asset Pricing Model is developed by [Sharp \(1964\)](#), [Lintner \(1965\)](#) and [Mossin \(1966\)](#) almost simultaneously. This model has become widely used in the real world to measure portfolio performance, value securities, make capital budgeting decision, and even regulate public utilities. However, the model is later questioned in [Roll \(1978\)](#) because he argues the model is impossible to empirically verify its single economic prediction. On the other hand, the Arbitrage Pricing Theory is being developed by [Ross \(1976\)](#). This theory argues that expected return must be related to risk in such a way that no single investor could create unlimited wealth through arbitrage.

From the standard mean-variance portfolio, given the expected returns and matrix of covariances of returns for n assets, we need to find the set of optimal asset weights that minimizes the return variance for a given expected return. Followed from previous studies, an efficient portfolio is one that has maximum expected return for given variance, or minimum variance for given expected return. We want to show that every efficient portfolio consists of a weighted combination of two basic portfolios as follows. Using the notation similar to that used in [Black \(1972\)](#), the efficient portfolio held by individual k is obtained by choosing proportions $X_{ki}, i = 1, 2, \dots, N$, invested in the shares of each of the N available assets. Following [Markowitz \(1952\)](#), we minimize the portfolio's variance subject to the constraints of expected return, and constituent asset weights sum to one:

⁵⁶ Charles P. Jones (2010) Chapter 7 Investments Principles and Concepts , 11th Edition John Wiley & Sons Inc. Publisher, ISBN: 9780470553077

Minimize:

$$var(\tilde{R}_k) = \sum_{i=1}^N \sum_{j=1}^N x_{ki} x_{kj} cov(\tilde{R}_i, \tilde{R}_j); \quad (44)$$

Subject to:

$$E(\tilde{R}_k) = \sum_{j=1}^N x_{kj} E(\tilde{R}_j); \quad (45)$$

$$\sum_{j=1}^N x_{kj} = 1; \quad (46)$$

In order to minimize equation (44), we use Lagrange multiplier S_k and T_k , this can be expressed as minimizing,

$$\sum_{i=1}^N \sum_{j=1}^N x_{ki} x_{kj} cov(\tilde{R}_i, \tilde{R}_j) - 2S_k \left[\sum_{j=1}^N x_{kj} E(\tilde{R}_j) - E(\tilde{R}_k) \right] - T_k \left[\sum_{j=1}^N x_{kj} - 1 \right] \quad (47)$$

Differentiate equation (47) with respect to x_{ki} resulting,

$$\sum_{j=1}^N x_{kj} cov(\tilde{R}_i, \tilde{R}_j) - S_k E(\tilde{R}_i) - T_k = 0 \quad (48)$$

This set of equations for i determines the value of x_{ki} . If we take the inverse of covariance matrix as D_{ij} , then the equation (48) can be written as:

$$x_{ki} = S_k \sum_{j=1}^N D_{ij} E(\tilde{R}_j) + T_k \sum_{j=1}^N D_{ij} \quad (49)$$

Since k denotes the individual investor and it only appears in S_k and T_k on the right hand side of the equation, it shows every investor holds a linear combination of two basic portfolios, and every efficient portfolio is a linear combination of these two basic portfolios. In order to have sum of weighted equals to unity, we normalize these weights, and the equation (49) becomes,

$$x_{ki} = w_{kp}x_{pi} + w_{kq}x_{qi} \quad (50)$$

Where,

$$w_{kp} = S_k \sum_{i=1}^N \sum_{j=1}^N D_{ij} E(\tilde{R}_j); \quad (51)$$

$$w_{kq} = T_k \sum_{i=1}^N \sum_{j=1}^N D_{ij}; \quad (52)$$

$$x_{pi} = \frac{\sum_{j=1}^N D_{ij} E(\tilde{R}_j)}{\sum_{i=1}^N \sum_{j=1}^N D_{ij} E(\tilde{R}_j)}; \quad (53)$$

$$x_{qi} = \sum_{j=1}^N D_{ij} / \sum_{i=1}^N \sum_{j=1}^N D_{ij} \quad (54)$$

Therefore, if we sum x_{pi} and x_{qi} according to i , we get

$$\sum_{i=1}^N x_{pi} = 1; \quad (54)$$

$$\sum_{i=1}^N x_{qi} = 1; \quad (55)$$

$$\begin{aligned} w_{kp} + w_{kq} &= S_k \sum_{i=1}^N \sum_{j=1}^N D_{ij} E(\tilde{R}_j) + T_k \sum_{i=1}^N \sum_{j=1}^N D_{ij} \\ &= \sum_{i=1}^N \left[S_k \sum_{j=1}^N D_{ij} E(\tilde{R}_j) + T_k \sum_{j=1}^N D_{ij} \right] \end{aligned} \quad (56)$$

From equation (49), equation (56) equals,

$$w_{kp} + w_{kq} = \sum_{i=1}^N x_{ki}; \quad (57)$$

Since x_{ki} is the normalized weighting of individual assets, according to equation (46), the sum $\sum_{i=1}^N x_{ki} = 1$, therefore,

$$w_{kp} + w_{kq} = S_k \sum_{i=1}^N \sum_{j=1}^N D_{ij} E(\tilde{R}_j) + T_k \sum_{i=1}^N \sum_{j=1}^N D_{ij} = 1; \quad (58)$$

Equation (50) shows that the efficient portfolio held by any investor k consists of a weighted combination of the basic portfolios p and q . However, these two basic portfolios are not unique, therefore, we can transform the basic portfolios p and q into two different portfolios, for example, u and v . Let w_{up} , w_{uq} , w_{vp} and w_{vq} be the weights,

$$\begin{aligned}x_{ui} &= w_{up}x_{pi} + w_{uq}x_{qi}; \\x_{vi} &= w_{vp}x_{pi} + w_{vq}x_{qi};\end{aligned}\tag{59}$$

We solve the simultaneous equation (59) for x_{pi} and x_{qi} , and set the coefficients to be w_{pu} , w_{pv} , w_{qu} and w_{qv} . Therefore, we get

$$\begin{aligned}x_{pi} &= w_{pu}x_{ui} + w_{pv}x_{vi}; \\x_{qi} &= w_{qu}x_{ui} + w_{qv}x_{vi};\end{aligned}\tag{60}$$

If we substitute equation (60), we can obtain a linear combination of portfolio k , with basic portfolio u and v , with coefficients w_{ku} and w_{kv} , and the sum of these weights equal to unity.

$$\begin{aligned}x_{ki} &= w_{ku}x_{ui} + w_{kv}x_{vi}; \\w_{ku} + w_{kv} &= 1;\end{aligned}\tag{61}$$

Therefore, according to [Black \(1972\)](#), the basic portfolios u and v can be any pair of different portfolios that can be formed as weighted combinations of the original pair of basic portfolio p and q . Every efficient portfolio can be expressed as a weighted combination of portfolios u and v , but they do not have to be efficient themselves. However, portfolio p and q must have different betas, otherwise it will not be possible to generate every possible efficient portfolio as a weighted combination of these two portfolios. In addition, if portfolio p and q have

different betas, it will be possible to generate new basic portfolios u and v with different betas by choosing appropriate weights. In extreme case, we can choose,

$$\beta_u = 1 \text{ and } \beta_v = 0; \quad (62)$$

If we multiply equation (9) by factor x_{mk} of total wealth held by investor k , and summing over all the investors, with $k = 1, 2, \dots, L$. We obtain the weights x_{mi} of each asset in the market portfolio,

$$\begin{aligned} \sum_{k=1}^L x_{mk} x_{ki} &= \left(\sum_{k=1}^L x_{mk} w_{kp} \right) x_{pi} + \left(\sum_{k=1}^L x_{mk} w_{kq} \right) x_{qi} \\ \Rightarrow x_{mi} &= \left(\sum_{k=1}^L x_{mk} w_{kp} \right) x_{pi} + \left(\sum_{k=1}^L x_{mk} w_{kq} \right) x_{qi} \end{aligned} \quad (63)$$

Since the market portfolio is a weighted combination of portfolios p and q , and the beta of market portfolio is unity, the portfolio u must be the market portfolio because $\beta_u = 1$. Therefore, we can set portfolio u as portfolio m , and portfolio v as portfolio z , with beta $\beta_m = 1$ and $\beta_z = 0$, which are market portfolio and the zero-beta basic portfolio. The return on an efficient portfolio k as a weighted combination of the returns on portfolio m and z , the coefficient of the return on portfolio m must be β_k . Therefore, the return of portfolio k is:

$$\tilde{R}_k = \beta_k \tilde{R}_m + (1 - \beta_k) \tilde{R}_z \quad (64)$$

If we take the expected value of both side of equation (20), we get

$$\begin{aligned} E(\tilde{R}_k) &= \beta_k E(\tilde{R}_m) + (1 - \beta_k) E(\tilde{R}_z) \\ \Rightarrow E(\tilde{R}_k) &= E(\tilde{R}_z) + \beta_k [E(\tilde{R}_m) - E(\tilde{R}_z)] \end{aligned} \quad (65)$$

Therefore, the equation (65) shows that the expected return on an efficient portfolio k is a linear function of its β_k . If we compare equation (65) with [Sharp \(1984\)](#), the corresponding relationship when there is a riskless asset, and riskless borrowing and lending are allowed, we discover that the relation between the expected return on an efficient portfolio k and its β_k is the same no matter whether there is a riskless asset. If there is a riskless asset, the interception of the relationship is the return of riskless asset, R_f . If there is no riskless asset, the interception is expected return of zero-beta portfolio, $E(\tilde{R}_z)$. Therefore the equation (65) applies to individual securities, and the equation also applies to efficient portfolios. We show this conclusion as follows;

From equation (48), we let index i and j be to i and k , and j and k ,

$$\sum_{k=1}^N x_{kk} \text{cov}(\tilde{R}_i, \tilde{R}_k) - S_k E(\tilde{R}_i) - T_k = 0 \quad (66)$$

$$\sum_{k=1}^N x_{kk} \text{cov}(\tilde{R}_j, \tilde{R}_k) - S_k E(\tilde{R}_j) - T_k = 0 \quad (67)$$

Subtract equation (67) from equation (66), we get

$$\text{cov}(\tilde{R}_i, \tilde{R}_k) - \text{cov}(\tilde{R}_j, \tilde{R}_k) = S_k [E(\tilde{R}_i) - E(\tilde{R}_j)] \quad (68)$$

We substitute portfolio k by efficient market portfolio m , and portfolio j by zero-beta portfolio z . Given $\text{cov}(\tilde{R}_z, \tilde{R}_m) = 0$, the above equation (24) becomes

$$\text{cov}(\tilde{R}_i, \tilde{R}_m) = S_m [E(\tilde{R}_i) - E(\tilde{R}_z)] \quad (69)$$

Since $\beta_i = \frac{\text{Cov}(\tilde{R}_i, \tilde{R}_m)}{\text{Var}(\tilde{R}_m)}$, equation (25) becomes,

$$E(\tilde{R}_i) = E(\tilde{R}_z) + \beta_i [\text{var}(\tilde{R}_m) / S_m] \quad (70)$$

Substituting m for i and $\beta_m = 1$, we get

$$\frac{var(\tilde{R}_m)}{S_m} = E(\tilde{R}_m) - E(\tilde{R}_z) \quad (71)$$

Putting equation (71) into equation (70), we obtain

$$E(\tilde{R}_i) = E(\tilde{R}_z) + \beta_i [E(\tilde{R}_m) - E(\tilde{R}_z)] \quad (72)$$

Therefore, the expected return on every asset where there is no riskless asset or borrowing. If let $\beta_i = 0$, each portfolio with beta equals to zero must have the same expected return as portfolio z . It has been noted that the return on portfolio z is independent of the return on portfolio m , and the weighted combinations of portfolios m and z must be efficient, portfolio z must be the minimum-variance zero-beta portfolio.

Many researchers have tested and demonstrated the existence of zero-beta CAPM. [Black et al \(1972\)](#) reject the traditional CAPM by examining the US stock returns for the period 1931-1961. They find that time series regression of excess returns reveal that high or low beta stocks have significant negative or positive intercepts, which supports the zero-beta CAPM. [Stambaugh \(1982\)](#) provides further evidence of significant zero-beta parameter for US stocks. However, no previous studies have conducted cross-sectional tests of the zero-beta CAPM due to the inability to estimate factor. The above derivation of zero-beta CAPM is from analytical point of view. After the first introduction of zero-beta CAPM, studies such as [Roll \(1980\)](#) and [Kandel \(1986\)](#) have geometrically derive the properties of zero-beta CAPM in return-variance space.

ZERO-BETA CAPM WITH RISKLESS ASSETS

When there is riskless asset available, but investors are not allowed to take short positions in the riskless asset, the zero-beta ZCAPM share similar behaviour as when there is no riskless asset available. In the case of riskless asset, it is expected that the expected return on any asset i continues to be a linear function of its β . The efficient set of portfolios now has two parts. One part is consist of weighted combinations of portfolios m and z , and the other part includes weighted combinations of riskless asset with a single portfolio of risky assets. Since the restriction on short position is only on riskless asset, there is two kinds of efficient portfolios. One contains the riskless assets and the other one does not. For efficient portfolios that do not contain riskless asset, we can apply equation (47)-(62) from the previous section. Each efficient portfolio can be expressed as a weighted combination of portfolios u and v , where β_u is unity and β_v is zero. For those efficient portfolios that do contain the riskless asset, we extend equation (48) to $N+1$ assets. The covariance term for $j = N + 1$ equals to zero. Therefore, we have the following equation for $i=1,2,\dots,N$:

$$\sum_{j=1}^N x_{kj} cov(\tilde{R}_i, \tilde{R}_j) - S_k E(\tilde{R}_i) - T_k = 0 \quad (73)$$

Therefore, the risky portions of these investors' portfolios are weighted combinations of portfolios u and v as before. For the riskless portion of the portfolio $i = N + 1$, equation (73) becomes

$$-S_k R_f - T_k = 0 \quad (74)$$

Since the risky part of every investor's portfolio, whether he holds riskless asset or not, consists of a weighted combination of portfolios u and v . The sum of all investors' risky holdings, which is the market portfolio, must be a weighted combination of portfolios u and

v . As discussed in the previous section, the portfolio u must be the market portfolio, and portfolio v must be the minimum-variance zero-beta of risky assets. Since equation (73) is the same as equation (48), we can see equation (72) still applies to all risky assets even when there are riskless borrowing and investment opportunity.

Let w_{km} , w_{kz} , and w_{kf} be the weights on portfolio m , z and riskless portfolio f , and k be the efficient portfolio. Since the return on portfolio z is independent of return on portfolio m , the expected return and variance of portfolio k will be

$$E(\tilde{R}_k) = w_{km}E(\tilde{R}_m) + w_{kz}E(\tilde{R}_z) + w_{kf}R_f \quad (75)$$

$$var(\tilde{R}_k) = w_{km}^2 var(\tilde{R}_m) + w_{kz}^2 var(\tilde{R}_z) \quad (76)$$

The weights also satisfy

$$w_{km} + w_{kz} + w_{kf} = 1 \quad (77)$$

$$w_{kf} \geq 0 \quad (78)$$

If $E(\tilde{R}_z)$ is less than or equal to R_f , then we can increase w_{kf} and decrease w_{kz} by the same amount, and the variance of portfolio k changes accordingly. When portfolio k is the market portfolio, the weight w_{km} must be unity, and w_{kz} must be zero. If $E(\tilde{R}_z)$ is greater than or equal to $E(\tilde{R}_m)$, then we can decrease w_{km} by a very small amount and increase w_{kz} by the same amount, and variance of portfolio k will be change. In either situation, this means that portfolio is not efficient.

Therefore, the expected returns must satisfy the following inequality,

$$R_f < E(\tilde{R}_z) < E(\tilde{R}_m) \quad (79)$$

When w_{kf} is greater than zero, portfolio k is a mixture of portfolio risky and riskless asset. From equation (77), we get the presentation of w_{kf} in terms of w_{km} and w_{kz} . We get $w_{kf} = 1 - w_{km} - w_{kz}$. Substitute this into equation (75) and (76), we get

$$E(\tilde{R}_k - R_f) = w_{km}E(\tilde{R}_m - R_f) + w_{kz}E(\tilde{R}_z - R_f) \quad (80)$$

$$var(\tilde{R}_k - R_f) = w_{km}^2 var(\tilde{R}_m - R_f) + w_{kz}^2 var(\tilde{R}_z - R_f) \quad (81)$$

Since equation (80) and (81) hold for any portfolio containing riskless asset, they must hold for the efficient portfolio t . Since the efficient portfolio must maximize equation (80) subject to variance equation (81), which is equivalent to maximize,

$$\frac{E(\tilde{R}_k - R_f)}{\sigma(\tilde{R}_k - R_f)} \quad (82)$$

Where $\sigma(\tilde{R}_k - R_f)$ is the standard deviation.

If we plot on the graph with $E(\tilde{R}_k - R_f)$ on the y-axis, and $\sigma(\tilde{R}_k - R_f)$ on the x-axis, the value of k that satisfies the maximization is the value of k that maximizes the slope of a line drawn from the original to point k . So the efficient portfolio t is the tangent portfolio to the efficient set.

Therefore the introduction of riskless borrowing opportunity only changes the market equilibrium in terms of portfolio composition. In the presence of riskless asset, there are two kind of efficient portfolios. The less risky efficient portfolio is a mixture of portfolio t , which is a combination of portfolio m and z , and the riskless asset. The more risky efficient portfolios continue to be mixtures of portfolio m and z as when there is no riskless asset available. The expected return on portfolio z must now be greater than the return on the riskless asset. Therefore we show that the empirical results are consistent with an equilibrium in which there is restricted borrowing at the riskless interest.

We find that the expected return on any risky asset is a linear function of its beta regardless with the existence of restricted on riskless asset. If there is a riskless asset, the slope of the line relating the expected return on a risky asset to its beta must be smaller than it without riskless borrowing restriction. The risky portion of every portfolio is a weighted combination of market portfolio and minimum-variance zero-beta portfolio. The zero-beta portfolio has covariance with risky asset i proportional to $1 - \beta_i$. If there is a riskless asset, then the efficient portfolios that contain the riskless asset are all weighted combinations of the riskless asset and a single risky portfolio t . The portfolio t is the efficient portfolio of risk assets with the highest ratio of the expected difference between the return on the portfolio and the return on the riskless asset to the standard deviation of the return on the portfolio. The line relating the expected return on an efficient portfolio to its beta is composed of two straight line segments, where the segment for the lower-risk portfolios has a greater slope than the segment for the higher-risk portfolios. The above derivation is consistent with the arguments in [Shanken \(1985, 1986\)](#), in which they find the true market portfolio can be constructed from any two efficient portfolios on the efficient frontier.

APPENDIX B

SPECIAL FEATURE OF ZERO-BETA CAPM

Many papers have tested the existence zero-beta CAPM. There are a few fundamental differences between the basic CAPM and zero-beta CAPM. Zero-beta CAPM finds that identification of the market portfolio M defined in the CAPM as the tangent portfolio with respect to a ray from the riskless rate to the efficient frontier is not a necessary condition for examining the CAPM. This is because studies found that identification of any orthogonal pair of minimum-variance index portfolios I and ZI on the mean-variance parabola is sufficient. And the real market portfolio is the one consist of the weighted average of all individual portfolios on the market. Furthermore, different from traditional CAPM, zero-beta CAPM allows both long and short positions in assets to construct portfolios I and ZI .

According to zero-beta CAPM notation from [Liu et al \(2012\)](#), we rewrite minimization of portfolio variance subject to the constraints of expected return and asset weight,

$$\min_{\omega} \frac{1}{2} \omega' \Sigma \omega + \eta [E(\tilde{R}_p) - \omega' E(\tilde{R})] + \kappa (1 - \omega' e) \quad (83)$$

Where ω is the weights vector, e is a vector of ones, $E(\tilde{R}) = [E(\tilde{R}_1), E(\tilde{R}_2), \dots, E(\tilde{R}_n)]$ is the expected return vector for n assets. All of these vectors have dimension $n \times 1$. Σ is the covariance matrix for n assets with dimension $n \times n$.

Take the first order derivative with respect to ω, η and κ , we get the following equations:

$$\begin{aligned}\omega: \quad \Sigma \omega - \eta E(\tilde{R}) - \kappa e &= 0 \\ \eta: \quad E(\tilde{R}_p) - \omega' E(\tilde{R}) &= 0 \\ \kappa: \quad 1 - \omega' e &= 0\end{aligned}\tag{84}$$

The optimal weights ω^* from the above simultaneous equation is,

$$\omega^* = \frac{CE(\tilde{R}_p) - \alpha}{BC - \alpha^2} \Sigma^{-1} E(\tilde{R}) + \frac{B - \alpha E(\tilde{R}_p)}{BC - \alpha^2} \Sigma^{-1} e \equiv \phi + \psi E(\tilde{R}_p)\tag{85}$$

Where,

$$\begin{aligned}A &= E(\tilde{R})' \Sigma^{-1} e \\ B &= E(\tilde{R})' \Sigma^{-1} E(\tilde{R}) \\ C &= e' \Sigma^{-1} e \\ \phi &= \frac{B \Sigma^{-1} e - A \Sigma^{-1} E(\tilde{R})}{BC - A^2} \\ \psi &= \frac{C \Sigma^{-1} E(\tilde{R}) - A \Sigma^{-1} e}{BC - A^2}\end{aligned}\tag{86}$$

A, B and C are known scalars, and ϕ and ψ are known vectors with dimension $n \times 1$.

Therefore, the variance of the efficient portfolio P is

$$\sigma_P^2 = \frac{1}{C} + \frac{C \left[E(\tilde{R}_p) - \frac{A}{C} \right]^2}{BC - A^2}\tag{87}$$

In a return-standard deviation space, take derivative of equation (87) with respect to σ_p ,

$$\sigma_p = \frac{C \left[E(\tilde{R}_p) - \frac{A}{C} \right] \frac{\partial E(\tilde{R}_p)}{\partial \sigma_p}}{BC - A^2}$$

$$\frac{\partial E(\tilde{R}_p)}{\partial \sigma_p} = \frac{BC - A^2}{C \left[E(\tilde{R}_p) - \frac{A}{C} \right]} \sigma_p \quad (88)$$

Therefore for a line passing through the tangent point $[\sigma_M, E(\tilde{R}_M)]$ is

$$E(\tilde{R}_p) - E(\tilde{R}_M) = \frac{BC - A^2}{C \left[E(\tilde{R}_M) - \frac{A}{C} \right]} \sigma_M (\sigma_p - \sigma_M) \quad (89)$$

GEOMETRIC INTERPRETATION OF ZERO-BETA CAPM

We have shown the quantitative derivation of zero-beta CAPM from the previous work. In addition, there are many literatures have studied the geometrical presentation of the zero-beta CAPM. Following from [Roll \(1980\)](#), in the return-variance space, we set the y-axis as expected return, and x-axis as variance. The minimum-variance portfolio is the one with the smallest variance on the efficiency frontier, and let denote this portfolio as G . For any give market index I on the efficient frontier, a line extending from and passing through minimum variance portfolio G to the y-axis gives the expected return on the zero-beta index $E(\tilde{R}_{ZI})$. Using this expected return as a reference point, the portfolio ZI can be located on the inferior part of the frontier. There are infinite pairs of these minimum variance portfolios I and ZI which can be identified in this way. [Roll \(1980\)](#) shows that the market portfolio can be replaced by any market index that is an efficient portfolio. The uniqueness is true only when the market index is mean-variance efficient. When the index is not efficient, there are zero-beta portfolios at all levels of expected return.

The line passing through tangent point in Equation (89) is under return-standard deviation space. We continue to derive the notation for the return-variance space. We take derivative for both side of equation (88) with respect to σ_p^2 ,

$$1 = \frac{2C \left[E(\tilde{R}_p) - \frac{A}{C} \right]}{BC - A^2} \frac{\partial E(\tilde{R}_p)}{\partial \sigma_p^2} \quad (90)$$

Therefore,

$$\frac{\partial E(\tilde{R}_p)}{\partial \sigma_p^2} = \frac{BC - A^2}{2C \left[E(\tilde{R}_p) - \frac{A}{C} \right]} \quad (91)$$

For a given portfolio I at position $[\sigma_I^2, E(\tilde{R}_I)]$, the line passing through I and global minimum-variance portfolio G : $\left[\frac{1}{C}, \frac{A}{C} \right]$ is

$$E(\tilde{R}_p) - E(\tilde{R}_I) = \frac{E(\tilde{R}_I) - \frac{A}{C}}{\sigma_I^2 - \frac{1}{C}} (\sigma_p^2 - \sigma_I^2) \quad (92)$$

The expected return on portfolio ZI orthogonal to I is the intercept of equation (92) to y-axis,

$$\begin{aligned}
 E(\tilde{R}_{ZI}) &= E(\tilde{R}_I) - \frac{E(\tilde{R}_I) - \frac{A}{C}}{\sigma_I^2 - \frac{1}{C}} \sigma_I^2 \\
 &= E(\tilde{R}_I) - \frac{E(\tilde{R}_I) - \frac{A}{C}}{\frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2}} \left[\frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2} + \frac{1}{C} \right] \\
 &= E(\tilde{R}_I) - \frac{E(\tilde{R}_I) - \frac{A}{C}}{\frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2}} \left[\frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2} + \frac{1}{C} \right] \\
 &= \frac{A}{C} - \frac{1}{C} \frac{BC - A^2}{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} \tag{93}
 \end{aligned}$$

Substituting equation (93) into equation (87), we get the variance

$$\begin{aligned}
 \sigma_{ZI}^2 &= \frac{1}{C} + \frac{C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]^2}{BC - A^2} \\
 &= \frac{1}{C} + \frac{C \left[\left(\frac{A}{C} - \frac{1}{C} \frac{BC - A^2}{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2} \right) - \frac{A}{C} \right]^2}{BC - A^2} \\
 &= \frac{1}{C} + \frac{C}{BC - A^2} \times \frac{(BC - A^2)^2}{C^4} \times \frac{1}{\left(E(\tilde{R}_I) - \frac{A}{C} \right)^2} \\
 &= \frac{1}{C} + \frac{BC - A^2}{C^3 \left(E(\tilde{R}_I) - \frac{A}{C} \right)^2} \tag{94}
 \end{aligned}$$

Above discussion provide a presentation of [Roll \(1980\)](#) geometric approach for zero-beta CAPM. Many other studies have also provides geometric derivation of the properties of ZACPM in the return-variance space. [Kandel \(1986\)](#) has explored geometric relations among sample frontier, the maximum likelihood estimator, and two other estimators of the zero-beta return. It is also demonstrated that a partition of the portfolio space is determined by a family of parabolas; the zeros of each parabola are the maximum likelihood estimators associated all portfolios on the parabola.

However a new geometric approach has been studied in [Liu et al \(2012\)](#). The approach begins with choosing any portfolio expected return $E(\tilde{R}_x)$ on the y-axis to tangent points on the superior and inferior curves of the symmetric mean-variance parabola. [Liu et al \(2012\)](#) conclude that these two tangent points on the parabola are the zero-beta CAPM portfolios I and ZI . To prove this we start by using the same orthogonal portfolios portfolios I and ZI as in [Roll \(1980\)](#). The equation passing through tangent $[\sigma_I^2, E(\tilde{R}_I)]$ and y-axis intercepts $[0, E(\tilde{R}_x)]$, with gradient, the equation is as following,

$$E(\tilde{R}_p) - E(\tilde{R}_I) = \frac{BC - A^2}{2C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} (\sigma_p^2 - \sigma_I^2) \quad (95)$$

Setting $\sigma_p^2 = 0$, we get the presentation of $E(\tilde{R}_x)$ as

$$E(\tilde{R}_x) = E(\tilde{R}_I) - \frac{BC - A^2}{2C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} \sigma_I^2 \quad (96)$$

Substitute equation (87) into (96) for σ_I^2 , we get,

$$\begin{aligned}
E(\tilde{R}_X) &= E(\tilde{R}_I) - \frac{BC - A^2}{2C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} \times \left(\frac{1}{C} + \frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2} \right) \\
&= E(\tilde{R}_I) - \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C} \right]} - \frac{\left[E(\tilde{R}_I) - \frac{A}{C} \right]}{2} \\
&= \frac{\left[E(\tilde{R}_I) + \frac{A}{C} \right]}{2} - \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C} \right]} \tag{97}
\end{aligned}$$

In order to prove the new geometric approach also gives the orthogonal pair, we need to prove the tangent passing through portfolio ZI also intercept with y-axis at the same expected return $E(\tilde{R}_X)$. We get the tangent line at point $[\sigma_{ZI}^2, E(\tilde{R}_{ZI})]$ is,

$$E(\tilde{R}_P) - E(\tilde{R}_{ZI}) = \frac{BC - A^2}{2C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]} (\sigma_P^2 - \sigma_{ZI}^2) \tag{98}$$

Suppose the intercept is $[0, E(\tilde{R}_{X'})]$,

$$E(\tilde{R}_{X'}) = E(\tilde{R}_{ZI}) - \frac{BC - A^2}{2C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]} \sigma_{ZI}^2 \tag{99}$$

Substitute equation (93) and (94) into (99), we get,

$$\begin{aligned}
E(\tilde{R}_{X'}) &= E(\tilde{R}_{ZI}) - \frac{BC - A^2}{2C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]} \sigma_{ZI}^2 \\
&= \frac{A}{C} - \frac{1}{C} \frac{BC - A^2}{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} + \frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]}{2} \times \left[\frac{1}{C} + \frac{BC - A^2}{C^3 \left(E(\tilde{R}_I) - \frac{A}{C} \right)^2} \right] \\
&= \frac{A}{C} - \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C} \right]} + \frac{\left[E(\tilde{R}_I) - \frac{A}{C} \right]}{2} \\
&= \frac{\left[E(\tilde{R}_I) + \frac{A}{C} \right]}{2} - \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C} \right]} = E(\tilde{R}_X)
\end{aligned} \tag{100}$$

The equation (100) gives the same result as in equation (97), and $E(\tilde{R}_{X'}) = E(\tilde{R}_X)$, which shows the tangent passing through points I and ZI have the same intercept y-axis expected returns. Therefore we conclude that the new geometric approach gives the same pair of orthogonal I and ZI portfolios as those obtained in [Roll \(1980\)](#). The notation of two tangent lines is as following:

$$\begin{aligned}
I: \quad E(\tilde{R}_P) &= E(\tilde{R}_I) - \frac{BC - A^2}{2C \left[E(\tilde{R}_I) - \frac{A}{C} \right]} \left[\frac{C \left[E(\tilde{R}_I) - \frac{A}{C} \right]^2}{BC - A^2} + \frac{1}{C} \right] \\
ZI: \quad E(\tilde{R}_P) &= E(\tilde{R}_{ZI}) - \frac{BC - A^2}{2C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]} \left[\frac{C \left[E(\tilde{R}_{ZI}) - \frac{A}{C} \right]^2}{BC - A^2} + \frac{1}{C} \right]
\end{aligned} \tag{101}$$

If we extend two rays from the expected return of global minimum-variance portfolio $E(\tilde{R}_G)$ to the tangent points on the mean-variance parabola, the intercept of the tangents will be $\frac{A}{C}$, from equation(97) and (100), we get

$$\begin{aligned} \frac{\left[E(\tilde{R}_I) + \frac{A}{C}\right]}{2} - \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C}\right]} &= \frac{A}{C} \\ \frac{BC - A^2}{2C^2 \left[E(\tilde{R}_I) - \frac{A}{C}\right]} &= \frac{\left[E(\tilde{R}_I) - \frac{A}{C}\right]}{2} \\ \left[E(\tilde{R}_I) - \frac{A}{C}\right]^2 &= \frac{BC - A^2}{C^2} \end{aligned} \tag{102}$$

The solutions above give the expected returns of this special case of the zero-beta CAPM starting from minimum-variance expected return G .

$$\begin{aligned} E(\tilde{R}_{I^*}) &= \frac{A}{C} + \sqrt{\frac{BC - A^2}{C^2}} \\ E(\tilde{R}_{I^*}) &= \frac{A}{C} + \sqrt{\frac{BC - A^2}{C^2}} \end{aligned} \tag{103}$$

This is important because according to [Black \(1972\)](#) and [Roll \(1980\)](#) that examining the zero-beta CAPM does not require an exclusive pair of market index I and companion zero-beta index ZI .

To verify this, assume there a pair of market index and zero-beta index portfolio M and ZM that are the real market and zero-beta portfolio, and we can represent I and ZI by real market portfolio index M and ZM .

$$E(\tilde{R}_I) = \beta_{I,M} E(\tilde{R}_M) + (1 - \beta_{I,M}) E(\tilde{R}_{ZM})$$

$$E(\tilde{R}_{ZI}) = \beta_{ZI,M} E(\tilde{R}_M) + (1 - \beta_{ZI,M}) E(\tilde{R}_{ZM}) \quad (104)$$

Where $\beta_{I,M}$ and $\beta_{ZI,M}$ are the beta risks of portfolios I and ZI with respect to market portfolio M .

We can solve $E(\tilde{R}_M)$ and $E(\tilde{R}_{ZM})$ in terms of $E(\tilde{R}_I)$ and $E(\tilde{R}_{ZI})$, we get

$$\begin{aligned} E(\tilde{R}_M) &= \frac{1 - \beta_{ZI,M}}{\beta_{I,M} - \beta_{ZI,M}} E(\tilde{R}_I) + \frac{\beta_{I,M} - 1}{\beta_{I,M} - \beta_{ZI,M}} E(\tilde{R}_{ZI}) \\ E(\tilde{R}_{ZM}) &= \frac{\beta_{ZI,M}}{\beta_{ZI,M} - \beta_{I,M}} E(\tilde{R}_I) - \frac{\beta_{I,M}}{\beta_{ZI,M} - \beta_{I,M}} E(\tilde{R}_{ZI}) \end{aligned} \quad (105)$$

Therefore, for any $E(\tilde{R}_i)$ the zero-beta CAPM when there is no riskless asset can be written as

$$\begin{aligned} E(\tilde{R}_i) &= \beta_{i,M} E(\tilde{R}_M) + (1 - \beta_{i,M}) E(\tilde{R}_{ZM}) \\ &= \frac{\beta_{i,M} - \beta_{ZI,M}}{\beta_{I,M} - \beta_{ZI,M}} E(\tilde{R}_I) + \left(1 - \frac{\beta_{i,M} - \beta_{ZI,M}}{\beta_{I,M} - \beta_{ZI,M}}\right) E(\tilde{R}_{ZI}) \\ &= \beta_{i,I} E(\tilde{R}_I) + (1 - \beta_{i,I}) E(\tilde{R}_{ZI}) \end{aligned} \quad (106)$$

Equation (106) has shown that it is not necessary to identify the true market and zero-beta portfolios M and ZM when testing the zero-beta CAPM. Any pair of portfolio I and ZI on the mean-variance parabola can be identified, and an equivalent zero-beta CAPM can be specified.

When a riskless asset exists, given any efficient portfolio K consisting of some weights of orthogonal market and zero-beta portfolios M and ZM plus the riskless assets, the zero-beta CAPM is

$$E(\tilde{R}_k) = \omega_M E(\tilde{R}_M) + \omega_{ZM} E(\tilde{R}_{ZM}) + \omega_f R_f$$

$$\omega_M + \omega_{ZM} + \omega_f = 1 \quad (107)$$

Substituting equation (105) into (107), we obtain

$$E(\tilde{R}_k) = \omega_I E(\tilde{R}_I) + \omega_{ZI} E(\tilde{R}_{ZI}) + \omega_f R_f \quad (108)$$

Where ω_I and ω_{ZI} are combination of ω_M and ω_{ZM} , and $\omega_I + \omega_{ZI} + \omega_f = 1$ remains the same. This zero-beta CAPM deviation releases the constraint in [Black \(1972\)](#) $\omega_f \geq 0$ and $\omega_{ZI} > 0$, which shows under the zero-beta CAPM, ω_{ZI} can take negative to allow for short selling.

APPENDIX C

APPLICATION OF EXPECTATION-MAXIMIZATION ALGORITHM

The expectation-maximization algorithm is commonly used when the observed data are considered to be part of the complete data that include latent unobserved data. In general, the complete data likelihood has a simple expression but can not be used for valid statistical inference due to dependence on latent variables. In order to make valid inference, the latent variable distribution should be integrated out from the complete data likelihood. The EM algorithm has the advantage of avoiding such integration and still yields valid inference. The algorithm iterates between an expectation-step and maximization-step until the iteration reaches the convergent point. The first step of algorithm is to calculate the conditional expectation of the complete data log-likelihood given the observed data and the estimates of the parameter. Then we maximize the conditional expectation obtained from the previous step until the estimates converge to the maximum likelihood estimates.

Let $\{\tilde{R}_{it}, D_{it}\}$ be the complete data set, and the observed data set be $\{\tilde{R}_{it}\}$. The likelihood of the complete data set is

$$\mathcal{L}(\theta_i) = \prod_{t=1}^T P(\tilde{R}_{it}|D_{it})P(D_{it}) \quad (109)$$

Where

$$P(D_{it}) = p_i^{I(D_{it}=1)}(1 - p_i)^{I(D_{it}=-1)}$$
$$P(\tilde{R}_{it}|D_{it}) = \frac{1}{\sqrt{2\pi\sigma_i^2}} \exp \left\{ -\frac{(\tilde{R}_{it} - R_{ft} - \alpha_i - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) - Z_{i,a}D_{it}\tilde{\sigma}_{at})^2}{2\sigma_i^2} \right\} \quad (110)$$

The estimates of the parameter θ_i is $\theta'_i = (\alpha'_i, \beta'_{i,a}, Z'_{i,a}, (\sigma'_i)^2, p'_i)$. We then take log expectation of the equation (109), and get

$$Q_i(\theta_i, \theta'_i) = E[\log(\mathcal{L}(\theta_i)) | \{\tilde{R}_{it}\}, \theta'_i] \quad (111)$$

Let

$$\hat{p}_{it} = P(D_{it} = 1 | \tilde{R}_{it}, \theta'_i) \quad (112)$$

Therefore, the expected D_{it} is

$$\begin{aligned} \tilde{D}_{it} &= E(D_{it} | \tilde{R}_{it}, \theta'_i) = P(D_{it} = 1 | \tilde{R}_{it}, \theta'_i) - P(D_{it} = -1 | \tilde{R}_{it}, \theta'_i) \\ &= \hat{p}_{it} - (1 - \hat{p}_{it}) = 2\hat{p}_{it} - 1 \end{aligned} \quad (113)$$

Equation (111) can be written as

$$\begin{aligned} Q_i(\theta_i, \theta'_i) &= E[\log(\mathcal{L}(\theta_i)) | \{\tilde{R}_{it}\}, \theta'_i] \\ &= \sum_{t=1}^T \left\{ \hat{p}_{it} \log p_i + (1 - \hat{p}_{it}) \log(1 - p_i) \right\} - \frac{1}{2} \log(2\pi\sigma_i^2) \\ &\quad - \frac{(\tilde{R}_{it} - R_{ft} - \alpha_i - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) - Z_{i,a}\tilde{D}_{it}\tilde{\sigma}_{at})^2}{2\sigma_i^2} \\ &\quad - \frac{Z_{i,a}^2(1 - \tilde{D}_{it}^2)\tilde{\sigma}_{at}^2}{2\sigma_i^2} \end{aligned} \quad (114)$$

The next step of EM algorithm is obtain θ_i from maximizing $Max Q_i(\theta_i, \theta'_i)$. However, different initial values of α_i can generate different local maximization points of the likelihood function, which is not uniquely tracked by the model. Since ZCAPM assumes efficient market, which rules out mispricing of assets, we can set $\alpha_i = 0$ for all assets. The restriction $\alpha_i = 0$ does not appear to affect cross-sectional tests of asset pricing model.

Apply Bayes' rule to $\hat{p}_{it} = P(D_{it} = 1|\tilde{R}_{it}, \theta'_i)$ and get

$$\hat{p}_{it} = \frac{P(\tilde{R}_{it}|D_{it} = 1, \theta'_i)P(D_{it} = 1)}{P(\tilde{R}_{it}|D_{it} = 1, \theta'_i)P(D_{it} = 1) + P(\tilde{R}_{it}|D_{it} = -1, \theta'_i)P(D_{it} = -1)} \quad (115)$$

Where,

$$P(\tilde{R}_{it}|D_{it} = \pm 1, \theta'_i) = \frac{1}{\sqrt{2\pi(\sigma'_i)^2}} \exp\left\{-\frac{(\tilde{R}_{it} - R_{ft} - \alpha_i - \beta_{i,a}(\tilde{R}_{at} - R_{ft}) \mp Z_{i,a}\tilde{\sigma}_{at})^2}{2(\sigma'_i)^2}\right\} \quad (116)$$

Give an estimate of probability $\hat{p}_i$ related to signal variable D_{it} in sample period $t = 1, \dots, T$, we can rewrite the empirical ZCAPM as the following equation:

$$\tilde{R}_{it} - R_{ft} = \beta_{i,a}(\tilde{R}_{at} - R_{ft}) + Z_{i,a}^*\tilde{\sigma}_{at} + \tilde{u}_{it} \quad (117)$$

Where, $Z_{i,a}^* = Z_{i,a}(2\hat{p}_i - 1)$.

We list out the step-by-step procedure in the following section for applying the EM algorithm:

- (1) Initialize the set of parameter $\hat{\theta}_i^0 = (\hat{\beta}_i^0, \hat{Z}_{i,a}^0, (\hat{\sigma}_i^0)^2, \hat{p}_i^0)$ for the i th asset.

To begin, estimate the simple OLS regression with no mispricing error:

$$\tilde{R}_{it} - R_{ft} = \beta_{i,a}(\tilde{R}_{at} - R_{ft}) + \tilde{\varepsilon}_{it}, \quad t = 1, \dots, T \quad (118)$$

D is the signal variables, and set $D_{it}^0 = 1$ when $\tilde{\varepsilon}_{it} > 0$ or $D_{it}^0 = -1$ when $\tilde{\varepsilon}_{it} < 0$.

Compute the initial probability

$$\hat{p}_i^0 = \frac{1}{T} \sum_{t=1}^T 1(D_{it}^0 = 1) \quad (119)$$

Next, estimate the zero-beta CAPM regression to obtain $\hat{\beta}_i^0, \hat{Z}_{i,a}^0$ and the initial variance $(\hat{\sigma}_i^0)^2 = \frac{1}{T} \sum_1^T (\tilde{u}_{it})^2$:

$$\tilde{R}_{it} - R_{ft} = \beta_{i,a} (\tilde{R}_{at} - R_{ft}) + Z_{i,a} D_{it}^0 \tilde{\sigma}_{at} + \tilde{u}_{it} \quad (120)$$

Set these initials as the current estimates of the parameters, $\theta_i' = \hat{\theta}_i^0$.

(2) Compute:

$$\hat{p}_{it} = \frac{\eta_{it}^+ p_i'}{(\eta_{it}^+ p_i' + \eta_{it}^- (1 - p_i'))} \quad (121)$$

With

$$\eta_{it}^\pm = \exp \left\{ - \frac{(\tilde{R}_{it} - R_{ft} - \beta_{i,a} (\tilde{R}_{at} - R_{ft}) \mp Z_{i,a} D_{it} \tilde{\sigma}_{at})^2}{2\sigma_i^2} \right\} \quad (122)$$

(3) Solving the following linear equations to get updated estimates of $\hat{\beta}_{i,a}$ and $\hat{Z}_{i,a}$:

$$\begin{aligned} \left(\sum_{t=1}^T (\tilde{R}_{at} - R_{ft})^2 \right) \beta_{i,a} + \left(\sum_{t=1}^T \hat{D}_{it} (\tilde{R}_{at} - R_{ft}) \tilde{\sigma}_{at} \right) Z_{i,a} &= \sum_{t=1}^T (\tilde{R}_{it} - R_{ft}) (\tilde{R}_{at} - R_{ft}) \\ \left(\sum_{t=1}^T \hat{D}_{it} (\tilde{R}_{at} - R_{ft}) \tilde{\sigma}_{at} \right) \beta_{i,a} + \left(\sum_{t=1}^T (\tilde{\sigma}_{at})^2 \right) Z_{i,a} &= \sum_{t=1}^T \hat{D}_{it} (\tilde{R}_{it} - R_{ft}) \tilde{\sigma}_{at} \end{aligned} \quad (123)$$

Where $\hat{D}_{it} = 2\hat{p}_{it} - 1$ with $\hat{p}_{it}$ obtained from step (2).

(4) Compute the updated variance:

$$\hat{\sigma}_i^2 = \frac{1}{T} \sum_{t=1}^T \left\{ (\tilde{R}_{it} - R_{ft} - \hat{\beta}_{i,a} (\tilde{R}_{at} - R_{ft}) - \hat{Z}_{i,a} \hat{D}_{it} \tilde{\sigma}_{at})^2 + Z_{i,a}^2 (1 - \hat{D}_{it}^2) \tilde{\sigma}_{at}^2 \right\} \quad (124)$$

(5) Compute the updated probability:

$$\hat{p}_i = \frac{1}{T} \sum_{t=1}^T \hat{p}_{it} \quad (125)$$

(6) Define the vector

$$\Delta\theta = \left(\left| \frac{\hat{\beta}_{i,a} - \beta'_{i,a}}{\beta'_{i,a}} \right|, \left| \frac{\hat{Z}_{i,a} - Z'_{i,a}}{Z'_{i,a}} \right|, \left| \frac{(\hat{\sigma}_i)^2 - (\sigma'_i)^2}{(\sigma'_i)^2} \right|, \left| \frac{\hat{p}_i - p'_i}{p'_i} \right| \right) \quad (126)$$

We can declare convergence obtained when $Max(\Delta\theta) < 0.1\%$. If convergence is not achieved, update θ'_i to the recent value of θ_i obtained from step (3) to step (5), and repeat steps (2) to (5).