

**Contagion and the Spread of the Recent Global Crisis to Asia:
The Effect of the Transmission on Equity Markets**

by

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A dissertation submitted to the Faculty of Claremont Graduate University in
partial fulfillment of the requirements for the degree of Doctor of Philosophy in
Economics

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This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Nan Zhang as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Economics.

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ABSTRACT

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This study discusses the spread of the recent financial crisis from the United States to the Asian economies. While traditional analysis suggests that international financial markets are getting more integrated, some argue that Asia has been decoupling from economic and financial developments in the US. These conflicting views are investigated with respect to the behavior of equity markets. We investigate the comovements of equity returns between the Asian economies and the US with correlation analyses including simple correlations, HP filter detrended correlations, and dynamic correlations (DCC-GARCH), and examine the magnitudes of impacts of different factors on Asian equity markets with multi-factor analyses including panel least squares fixed effect estimations and the dynamic method of VAR analyses.

The major findings of this study are that the comovements of equity returns of Asian economies and the US increased substantially in the recent financial crisis, and global factors, especially the US equity market, played significant roles in the transmission and impacted Asian equity markets with larger magnitudes than in previous periods. The results of this study suggest that it is too soon to conclude that the Asian economies have decoupled from the US.

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Chapter 1. Introduction

1.1 Background

The recent global financial crisis distinguishes itself by its severity and breadth. After the collapse of the housing bubble in early 2006, the US banking system experienced a tremendous liquidity shortfall which in turn caused the collapse of large financial institutions, downturns in equity markets, and then the deterioration in macroeconomic performances in the US. According to the 2010 International Monetary Fund (IMF) World Economic Outlook report (IMF, 2010a), the US output growth rate continuously turned down to a negative number of -2.6 percent in 2009 from 0 percent in 2008, and 1.9 percent in 2007. The crisis has been so severe that the global economy overall has been influenced negatively. In 2009, world output dropped from the already low growth of 2.8 percent in 2008 to a negative growth rate of -0.6 percent. Many developed economies as well as emerging market economies followed the deteriorating trend. The output of the developed economies decreased deeply from 0.2 percent to -3.2 percent in 2009 and though many emerging and developing economies still kept positive output growth, they experienced a large downturn from 6.0 to 2.5 percent within one year. The recent crisis has been generally considered the worst financial crisis since the Great Depression of the 1930s (Business Wire, 2009).

The recent global financial crisis is to an important different extent from the crises of previous decades. Beginning from the Mexican crisis in 1994-95, the Asian crises in 1997-98, and the Russian Crisis in 1998, through crises in Argentina (1999-2002) and Turkey (2001-02) in the beginning of the new

millennium, the epicenters of most financial crises in recent decades are emerging market economies. The recent crisis, however, started in one of the most developed countries, the United States. Before the crisis, the US output was around 21 percent of the world total and the US stock market capitalization was about 33 percent of the world market capitalization. Thus it makes sense that a decline in US macroeconomic performance and equity market would affect other economies dramatically through various real and financial linkages.

The severe and wide spread of the recent crisis from the most developed country - the US - has resulted in an outpouring of research and analysis on the contagion. Many questions about the recent crisis have been raised. For example, how tightly do other economies follow US' economic movements? What are the magnitudes of the contagion from the US through different transmission channels? Are the economies of some emerging markets decoupling or recouping from that of US in the process of the recent crisis? These questions are of considerable interest to economists and policy makers as there have been conflicting views and debates that emerging economies are decoupling from the advanced economies while traditional views suggest that international financial markets are getting more integrated. The answers to these questions also help the economies to better understand and limit the transmission of the global financial crisis from the advanced economies.

In the recent crisis, the Asian economies are of particular interest due to their special experiences in economic growth among the affected markets. After the end of 1997-98 Asian crises, the Asian economy overall has had relatively

stable growth. Especially, China and India stand out by keeping their relatively high growth rates for decades. Contrary to the high interdependence view, some argue that emerging Asia economies are well protected by their low exposure to US subprime loans and their strong ability to implement countercyclical macroeconomic policies (Kose et al., 2008) and are decoupling from the US. Under this circumstance, it is interesting to know how the Asian economies are affected by the US and to find if Asia has truly decoupled from the advanced economies.

Much research pays attention to the contagion of the recent crisis on the real economy, which provides understanding of the behavior of macroeconomic performance. Contagion in equity markets is also of important and worth more investigation. There are several reasons for this. First, the equity market indices are one of the principal financial indicators of economic activities, and the financial linkages are one of the most important channels in transmitting shocks between the US and other countries (Bayoumi and Swiston, 2007). Study of the topic for equities helps us better understand the nature of international financial interdependence during periods of stress. In addition, the movement of the stock markets could eventually affect the real economy. Much literature suggests that the prices change of the equity markets have wealth effects in the real economies in both advanced economies and emerging market economies (Bertaut, 2002; Funke, 2004; and IMF, 2008). Last, as equity prices represent the future economic outlook of investors, they are among the most sensitive indicators of economic shocks and thus could reflect immediate effects of the crisis.

1.2 Purpose of the Study

This dissertation focuses on the spread of the recent global crisis to Asian economies in equity markets and examines the movements of equity prices in the Asian economies vs. the US, investigating patterns of comovements and analyzing magnitudes of impacts of different factors, especially the US equity market, on Asian equity markets in different phases of the crises, adding more empirical evidences to the decoupling debates for the recent global crisis.

1.3 Contribution of the Study

This study contributes to the literature in two respects. First, the study adds to the literature on contagion to Asian economies in equity movements with more updated empirical evidences based on a longer period than the earlier research for the recent financial crisis. The findings of this study help provide insight on how significantly the recent crisis in the US affects the financial markets in a relatively stable-growing region and provide more updated evidence on the decoupling debates. Second, this study applies dynamic methods to provide more robust results for the contagion literature. Much traditional research only adopts a static analysis on contagion. For example, some research calculated constant correlation for each of the research periods. However, it is not robust enough as correlations might change from time to time in the real world, especially in the financial markets which are always characterized with high volatility. Without an adjustment for the non-constant variance, the magnitude of the cross-market correlations might be biased, thereby potentially leading to false

conclusions about the existence of contagion across economies (Forbes and Rigobon, 2002). Besides the static methods, this study adopts the dynamic method originally developed by Engel (2002), namely the Dynamic Conditional Correlation (DCC) - GARCH, to evaluate the correlations of equities of Asian economies and the US, and uses the dynamic method of VAR analysis, with customized applications for Asian economies, to investigate the magnitudes of impacts of different factors on Asian equity markets for the recent financial crisis.

1.4 Limitations of the Study

As the subject of the study - the recent financial crisis - is an on-going process as the research is being conducted, the empirical results of the study are limited by the availability of the data. In addition, the access to data sources is limited, so some proxies are made by choosing from the best accessible data. Last, due to the scope of the study, only main influencing factors of equity markets are included in the multi-factor analysis, but this doesn't mean others are not relevant. Future updates can be made as more data become available. This research serves as the base frame work of the further analysis for the recent financial crisis.

1.5 Structure of the Study

The rest of this dissertation is organized as follows: First, to give a detailed background of the recent crisis, Chapter 2 discusses the origins of the recent crisis and the spread of the crisis to the world, and the Asian economies.

Chapter 3 provides a literature review on contagion including concepts of contagion, its main channels, and its empirical tests and results, and introduces the decoupling debates. In Chapter 4, this study analyzes quantitatively the transmission of the US financial crisis to selected Asia economies with correlation analyses. The research first uses a set of constant correlation analyses (simple and Hodrick-Prescott filter detrended correlations) and then the dynamic conditional correlations (DCC-GARCH) to investigate the patterns of the comovements of equity returns for different phases of the crises. Chapter 5 conducts multi-factor regression analyses on equity returns using panel least squares fixed effect estimations and dynamic multivariate VAR analyses respectively to find how significantly different factors or contagion channels, especially the global factors influence the Asian equities in different periods. Last, Chapter 6 concludes and provides suggestions on limiting the occurrence of the future financial crisis and the future research.

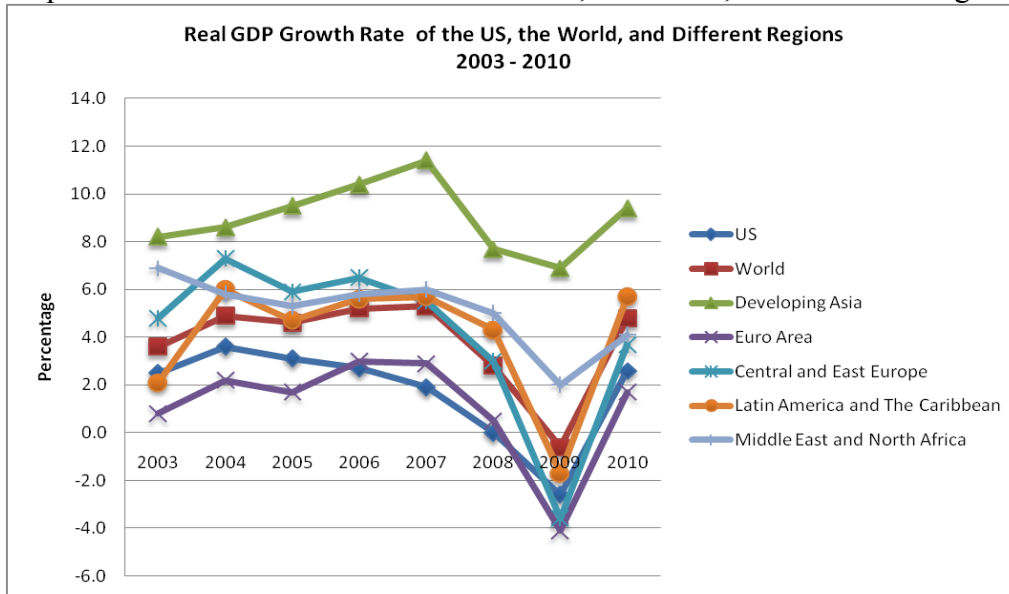
Chapter 2. The Origins and Spread of the Recent Financial Crisis

The financial crisis of 2007 to 2009 and on has made a tremendous impact on the global economy and has been considered the worst financial crisis spread since the Great Depression of the 1930s. Originated from the collapse of US housing market, the recent crisis has caused massive declines in consumers' wealth, deterioration in many financial institutions, damages in the credit system, hitting the real economy of the world significantly.

The 2010 IMF WEO reported that GDP growth in many regions decreased dramatically in the year of 2008 and worsened further in 2009 (IMF, 2010a). In particular, in the year of 2009 when the recession worsen, the US turned its GDP growth to a negative number of -2.6 from zero percent in 2008 for the first time, and most regions experienced the trough of negatives for their first time too (Graph 2-1). The Euro area had the lowest growth of -4.1 percent followed by Central and Eastern Europe of -3.6 percent, and Latin America and the Caribbean of -1.7 percent. Only two regions showed positive growth, namely, the Middle East and North Africa with a growth rate of 2.0 and developing Asia with a growth rate of 6.9 percent. Though the Asia growth was high in 2009 compared with other regions, it actually experienced a big GDP growth drop from the high rate of 11.4 percent in 2007 and 7.7 percent in 2008 to 6.9 percent in 2009. For the year of 2010, the IMF estimated that GDP would bounce back in all regions. The projections of the GDP growth for most regions were above their 2008 growth levels except for Middle East and North Africa, but below their 2007 levels except for the US which was expected to outperform its 2007 level.

Developing Asia was expected to reach a 9.4 percent growth rate in 2010 and remained the highest growth region.

Graph 2-1. Real GDP Growth Rate of the US, the World, and Different Regions



Note: The 2010 data are projections.

Data Source: IMF World Economic Outlook (October, 2010)

How did this severe recent financial crisis start and spread to the world?

What are the key factors that caused this crisis? As a region with highest economic growth among other regions, how have the Asian economies been impacted by the recent crisis? To provide a background on the contagion from the US to the Asian economies, this chapter discusses the origins and spread of the recent financial crisis to the world, explains the causes of the recent crisis, and discusses the spread of the crisis to the Asian economies.

2.1 The Origins and the Spread of the Recent Financial Crisis to the World

2.1.1 The Origins of the Recent Crisis

There have been many analyses of the origins of the crisis. This section gives a brief summary of key points.

The recent global crisis started from the housing market in the US. The housing market in the US had been continuously expanded for a long term due to the low interest rate and easy credit environment. More specifically, the price of the typical American house increased by 124% from year 1997 to 2006 (The Economist, 2007). As part of the housing and credit booms, the number of financial innovations such as mortgage-backed securities (MBS) and collateralized debt obligations (CDO) increased greatly. These innovations tied their value to real estate pricing and the increasing housing price prompted many investors to invest in assets including the subprime assets. According to CNN Money (2007), subprime loans amounted to about 20 percent of the nation's mortgage lending in 2006 and lenders made nearly twice the level in subprime loans at \$640 billion than three years earlier. The speculative housing bubble became unsustainable and began to burst in 2006. The US Home Construction Index decreased over 40% as of mid-August 2006 compared to a year earlier. Many mortgage companies as well as major financial institutions that had invested heavily in subprime mortgage-backed securities experienced significant losses.

The losses in the financial sectors reduced the liquidity in the economy and limited investment in other sectors of the economy. At the same time, the wealth of consumers was hurt by the fall of the house prices as many homes worth less than the mortgage loan and had to go through foreclosure. This

influence on consumers also eroded the financial strength of the banking institutions as well as the demand in the overall economy. Losses in real estate related investments by financial institutions brought their liquidities and solvency into question. The market for short term credit seized up and a full financial crisis developed. In summary, the origination of the recent financial crisis contributed to the further collapse of the housing market, which led to the damage of the wealth of direct participants in mortgage markets, the financial sectors, and eventually the real economy of the US and the world.

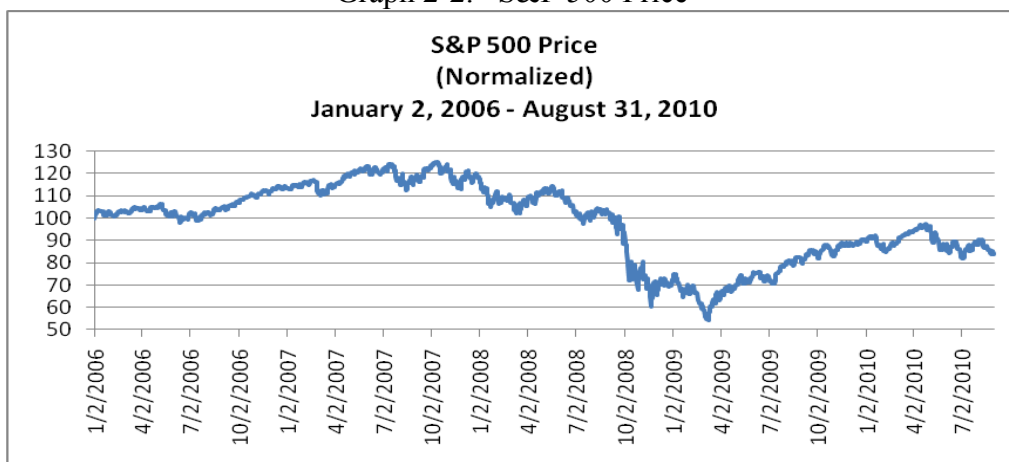
2.1.2 The Spread of the Recent Crisis to the World

Many experts or regulators believed initially the recent crisis would remain largely within the housing sector, or at least within the US. However, due to the strong financial interconnection that had developed, it disappointed these wishful thinks and spread to the whole economy in a global scale.

As early as 2006, the economy began to show negative impact from the collapse of the housing market. Some mortgage companies experienced huge losses and a number filed for bankruptcy. There were initially varying perception on the severity of the crisis. In this beginning stage, some economists such as Nouriel Roubini already foresaw and warned about a coming US housing bust, sharply declining consumer confidence and ultimately a deep recession (Roubini, 2007). Financial institutions such as J. P. Morgan and Goldman-Sachs also attempted to reduce their exposure to subprime mortgages in fall and winter of 2006 respectively. However, some other institutions seemed to take the warning

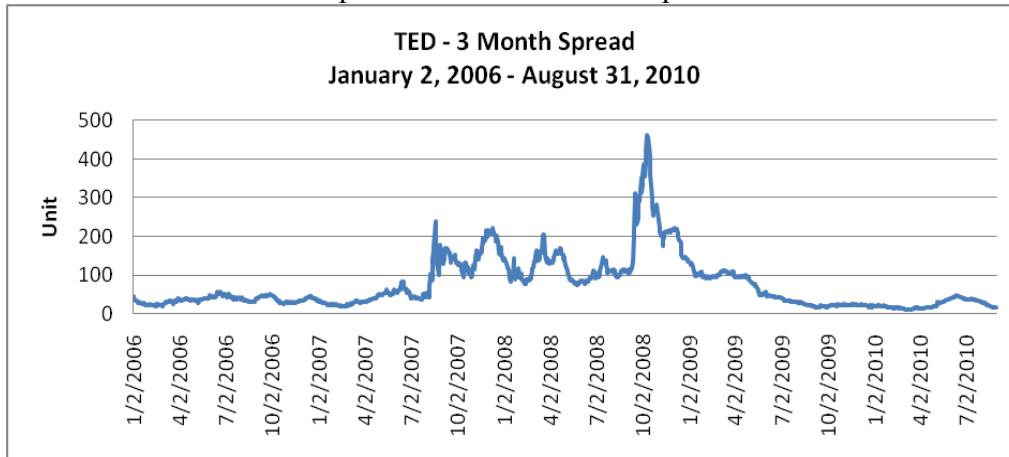
signs indifferently and bet on the return of the housing market. Bear Stearns, Lehman Brothers, and Merrill Lynch, for example, remained their high leverage structure. In particular, Merrill Lynch's kept its leverage in a high level doubling from 16 in 2001 to 32 in 2007 (Liang, Willett, and Zhang, 2010). Those indifference attitudes might contribute to the fact that warning signs were not much and strong enough at this begging stage. The US stock market only showed downturns of price in mid 2006 and rose again in the later part of the year (Graph 2-2). The TED Spread - the spread between euro currency and US Treasury bill rates and a widely used measure of the degree of perceived credit risk in the general economy - showed a stable trend in year 2006 (Graph 2-3).

Graph 2-2. S&P 500 Price



Data Source: Bloomberg

Graph 2-3. TED - 3 Month Spread



Data Source: Bloomberg

In 2007, housing prices continued to fall and the crisis began to spread both within and outside the US. The S&P/Case-Shiller house price index experienced its first year-to-year decline in the first quarter. The subprime industry worsened as several large US subprime lenders such as New Century Financial and the Countrywide Financial declared bankruptcy or announced significant losses in the first half year of 2007. At this point, however, there was still a wide spread belief that the loss from the subprime crisis would be very limited and primarily within the US. As shown in the stock markets, the Dow Jones Industrial Average closed above 14,000 for the first time in its history on July 19, 2007. Ben Bernanke, the Fed Chairman, thought there was "no broader spillover to banks or thrift institutions from the problems in the subprime market" (Tett, 2009). However, as Bear Stearns announced the closure of its two trouble hedge funds that were heavily into subprime mortgage related securities in mid July, the broader financial systems began to pay much attention.

The subprime crisis spread within and outside the US quickly. In October, Merrill Lynch announced a \$5.5 billion loss and revised this to an 8.4 billion loss from the subprime crisis later in the same month. A major Germany bank – the IKB Deutsche Industriebank - found trouble on one of its special investment funds in July and was provided a guarantee of liquidity to protect the bank against 1 billion euro of loss resulting from subprime investments. In August, the large French investment bank - French bank BNP Paribus - froze redemptions from three of its investment funds that invested in subprime mortgage debt. Furthermore, in September, Britain’s Northern Rock experienced a bank run after having had to approach the Bank of England for a loan facility. More ominously, rumors began to circulate in London that one or more large European banks were about to collapse. Those negative signs led to unusually large injections of liquidity by the European Central Bank (ECB). For example, after the BNP Paribus bank’s announcement itself, the European Central Bank injected 95 billion euros into the European banking market. By this time the volatility of stock markets and the TED spread had begun to increase beginning from second half year of 2007 as shown in Graph 2-2 and Graph 2-3. The evolution of the problem shattered the widespread assumption that the crisis would be limited just to the housing market itself and to the US (Liang, Willett, and Zhang, 2010).

In 2008, the most dramatic episode of the recent financial crisis occurred during the month of September when Lehman Brothers collapsed. In the beginning of that year, the first signs of trouble appeared at the giant insurer American International Group (AIG) which found “material weakness” in its low

level of reserves against its sale of credit default swaps (CDS). Earlier in March, Bear Stearns experienced a bank run and was acquired by JPMorgan Chase of which the deal was backed by the Federal Reserve which provided up to \$30 billion to cover possible losses. This bank run on Bear Stearns was taken as an important event in the recent crisis. As an investment bank, Bear Stearns did not take deposits, but was highly dependent on short-term borrowing to finance longer-term investments. When it had a bank run, other financial institutions reduced their willingness to lend to Bear Stearns, even short-term, and began to require greater collateral when they would lend. This definitely was a heavy hit for an investment bank like Bear Stearns. Tense negotiations in March led to the takeover of Bear Stearns by JPMorgan Chase and this limited the amount of immediate fallout on the financial system.

The summer of 2008 passed without major disasters but still involved changes for many financial institutes and the governments. In July, Indymac Bank - a large saving and loan association and mortgage originator in the US - was placed into the receivership of the FDIC. On September 7, the Federal took over Fannie Mae and Freddie Mac, which at that time owned or guaranteed about half of the US's 12 trillion mortgage market and were effectively normalized. On September 14, Merrill Lynch was sold to Bank of America because of fears of a liquidity crisis.

The fallout from the above institutions was fairly mild, however, compared with that of the failure of Lehman Brothers soon after. On September 15, 2008, as one of the big global financial services and primary dealers in the US

Treasury securities market, Lehman Brothers filed for bankruptcy protection as it had held on to large positions in subprime and other low-rated mortgage tranches. This filing marked the largest bankruptcy in US history. Right after the September 15 collapse of Lehman, AIG's credit ratings were downgraded by Moody's and Standard and Poor on concerns over continuing losses to mortgage-backed securities and the Federal Reserve lent \$85 billion to AIG to avoid bankruptcy. There have been considerable debates about the reasons that the US government did not save Lehman Brothers as it did with AIG, but there is no question that the effects of it combined with the huge government bailout of AIG generated a deep phase of the crisis. The confidence in the financial system dropped dramatically at this time. In October, the Dow Jones Industrial Average recorded its worst week with the highest volatility day recorded in its 112 year history by then. Following the declines in the US' stock market, many other major national stocks in the world decreased sharply. To save the economy, the US created a \$700 billion Emergency Economic Stabilization Act (EESA) and announced a \$250 billion injection of public money into the US banking system in October and pledged \$800 billion more to help revive the financial system in November. Central banks in the US, Canada, Sweden, Switzerland, England, the European Central Bank, and China cut interest rates in a coordinated effort to aid the world economy.

2009 experienced the continued severe impact of crisis in the first several months of the year and then the milder crisis in the later time of the year. During the first two months, the S&P 500 dropped 18.62%, which was the worst start to a

year. By March 9, the Dow Jones Industrial Average Index had fallen with a percentage decline exceeding the pace of the market's fall during the Great Depression to a level which the index had last seen in 1996. To avoid economic breakdowns, some governments took action. For example, the Bank of England cut its interest rate to 1.5%, the lowest level in its 315-year history in January. In the spring, expectations began to turn around. In the beginning of May, mortgage demand rose in the first quarter for the first time since early 2007. And the stress test results of the Supervisory Capital Assessment Program (SCAP) for the 19 largest US banks such as JPMorgan Chase and Goldman Sachs were also more encouraging than anticipated. Global stocks and oil prices rose in response to the optimistic stress test results. In particular, the MSCI emerging markets index gained 38 percent from February to May 2009, compared with a 24 percent gain in the world markets index during the same period. The IMF WEO in its October report (IMF, 2009) confirmed that though output declined substantially during the first half of 2009, the monetary and fiscal policy interventions helped stabilize housing and financial markets, which pointed to renewed moderate growth in the second half of 2009.

From the beginning of 2010 up to August 2010, the economies of both the US and the world had shown signs of recovery. Especially, during the first half of 2010, the US economic recovery continued to strengthen. The S&P 500 increased in general since the mid of 2009 to April 2010. Other regions also saw recovery growth of different degree with Asia in the lead and Europe and other emerging economies staying stronger. However, financial conditions were still weak,

especially in the second half of the year. The European sovereign debt turmoil in the second quarter added to existing worries about the sustainability of the recovery and caused a broader decline in the international stock markets. As stated in the October 2010 Global Financial Stability Report (IMF, 2010b), “the financial system remains vulnerable to downside risks because capital and liquidity buffers are insufficient to support market confidence under renewed stress.” The real economy showed signs of recovery in this period. For example, the US would raise its growth to 2.6 percent (vs. 2.7 percent in 2006) and the world economy would go up to 4.8 percent (vs. 5.2 percent in 2006) in 2010. As many agree, the world economy had been on the way of recovery from the recent crisis from then on, but it still needed a long process to reach a completed recovery.

2.2 The Causes of the Recent Crisis

Many factors have explanatory power on the occurrence of the recent financial crisis. The main factors are including but not limited to interest rate incentives and the housing bubble, the imbalance of the current account, the increasing independency among the world economies, defective mental models and incomplete information, regulatory failures on financial innovations and credit rating, and excessive leverage and vulnerable credit. The details of the causes of the recent financial crisis are discussed in the following.

A. Interest rate incentives and the housing bubble

In order to soften the effect of the collapse of the dot-com and prevent the expected risk of deflation, the US Federal Reserve Bank kept low interest rate for a long time before the crisis. The excessively low interest rate promoted huge amount of investment on assets such as housing. The continuously rising house price led to a building boom. When there was a surplus of housing assets due to the low interest rate and easy credit, the housing bubble collapsed eventually and triggered the recent financial crisis.

B. Imbalances in current accounts

The US has been having large current account deficits and large capital inflows. Those growing amounts of foreign capital flowed into the US created additional demand for various types of financial assets lowering interest rates and raising prices of assets including the housing prices, which triggered the occurrence of the subprime crisis.

C. Increasing interdependency among the world economies

Under the trend of globalization, many economies have built more interdependencies. Especially, the US has becoming the main partner of investment and trade mainly in export for many advanced and emerging countries. The increasing interdependency with the US in finance and real economy added broadness and depth of the spread of the crisis into the world economy. On the other hand, however, increasing interdependence within regions such as the Asian

economies could help cushion some of the negative effect from the US when the shock came.

D. The defective mental models and incomplete information

The defective mental frameworks and the incomplete information due to market imperfection contributed to the origins of the recent crisis. Perceiving long periods of low real interest rate, continuously rising housing prices, and low economic volatility, people hold unrealistic beliefs that the value of real estate would never fall and more sophisticated, the modern financial engineering had conquered risk (Willett, 2009) and economy would always grow stably. These defective mental models affected broad segments of the private financial institutions, the public, and regulators. Those wrong mental models created excessive optimism before the crisis and ignorance of the warning signs of the deteriorated credit market and caused the failure in evaluating the amount of risk and solving the problems built up in the system in time.

It is also the result of defective mental models and extreme lack of information about how overextended many financial systems had become lead to the slow motion with which the crisis was recognized (Willett, 2009; Liang, Willett, and Zhang, 2010). Keeping wishful thinks, the private and public sectors continued to engage in poor managerial oversight and control until huge damages had been made in the real sector later on. The slow motion of the recognition of the recent crisis could be reflected in the adjustments in IMF's losses estimation which continuously rose to higher numbers during the crisis. For example, in

April 2008, the IMF estimated that the global financial system would lose close to \$1 trillion, with about half of this being due to direct exposure to the US subprime mortgage market. These estimates were progressively raised as the crisis deepened, reaching a high number of \$4.1 trillion, four times of the previous estimation one year later.

E. Regulatory failures on financial innovations and credit rating

The regulatory failures on the emerging financial innovations and credit rating system played an important role in the occurrence of the recent crisis. As the demand in asset market increased, the usage of financial innovations expanded dramatically in the years leading up to the crisis. The examples of the innovations include the mortgage-backed securities, collateralized debt obligations, credit default swaps, and so on. While the massive financial innovations of the past decade had led to considerable diversification of risk and made the financial system more resilient to some shocks, the degree of the resulting risk reduction had been greatly exaggerated as the over-extended financial innovations might seed the problem of credit without prudent regulatory and managerial practice.

One of the most blatant examples of regulatory and management failure was the treatment of credit default swaps. The CDSs were essentially insurance contracts that would pay off in the event of a default, thus allowing investors to hedge against the risk of default on assets they had purchased. In themselves these CDSs were a quite useful financial innovation. The problem was that unlike the sales of traditional insurance where regulators require capital to back

insurance sales, it was ruled against economic logic that CDSs were not legally insurance and not subject to regulation. In the non-crisis period, selling CDSs could be quite profitable. But it might be disaster when crisis hits. In the case of AIG, senior management didn't manage its financial position well and issued hundreds of billions of CDS contracts for which little provision for payouts was set aside. As the crisis progressed, AIG generated such huge losses that more than offset the solid performance of all of AIG's traditional business (Liang, Willett, and Zhang, 2010).

Another example of the regulatory failure was the inaccuracy of the credit rating system. A credit rating evaluated a potential borrowers' ability to repay debt. In the case of the recent crisis, credit rating agencies gave investment-grade ratings on securities such as MBS or CDO. The rating of these kinds of securities had been a large business accounting for just under half of Moody's total rating revenue in 2007 and was quite profitable. As rating agencies competed with each other to rate particular MBS and CDO securities issued by investment banks, they produced lower rating standards. In the same time, critics alleged that the rating agencies had conflicts of interest as they were paid by investment banks and other firms that organized and sold structured securities to investors (The Economist, 2008). Under this circumstance, many risky securities were rated with safe grades. Without these high rates, demand for the subprime securities would have been considerably less and the damage should have been reduced – by September 2008, bank writedowns and losses on those investments totaled \$523 billion (Smith, 2008).

F. Excessive leverage and vulnerable credit

One key to why the recent financial crisis had so much greater effect on the real economy than the tech bubble crash is not that the initial loss of wealth in some mortgage companies in this crisis was larger, but that the leverage was so much heavier in many of the financial institutions and the damage done to the operation of the credit system was so much greater (Liang, Willett, and Zhang, 2010).

The monetary policy ease combined with lax financial regulation allowed financial institutions to increase leverage greatly. Debt taken on by financial institutions rose from 63.8% of US' GDP in 1997 to 113.8% in 2007 (Blackburn, 2008). Being allowed by the SEC to issue substantially more debt through purchases of mortgage-backed securities, the top five US investment banks in the fiscal year of 2007 reported over \$4.1 trillion in debt, about 30% of USA nominal GDP for that year. This high leverage and dependence on short-term borrowing to finance illiquid long-term investments helped the financial institutions to reduce capital requirements and “enhanced” their returns from asset-backed securities and other new financial instruments. However, since the highly leveraged investment structure was based on extremely faulty assessment of risk throughout the system, the financial institutions were highly exposed and vulnerable in downturns of the liquidity. When the housing market collapsed, some highly leveraged institutions experienced significant loss.

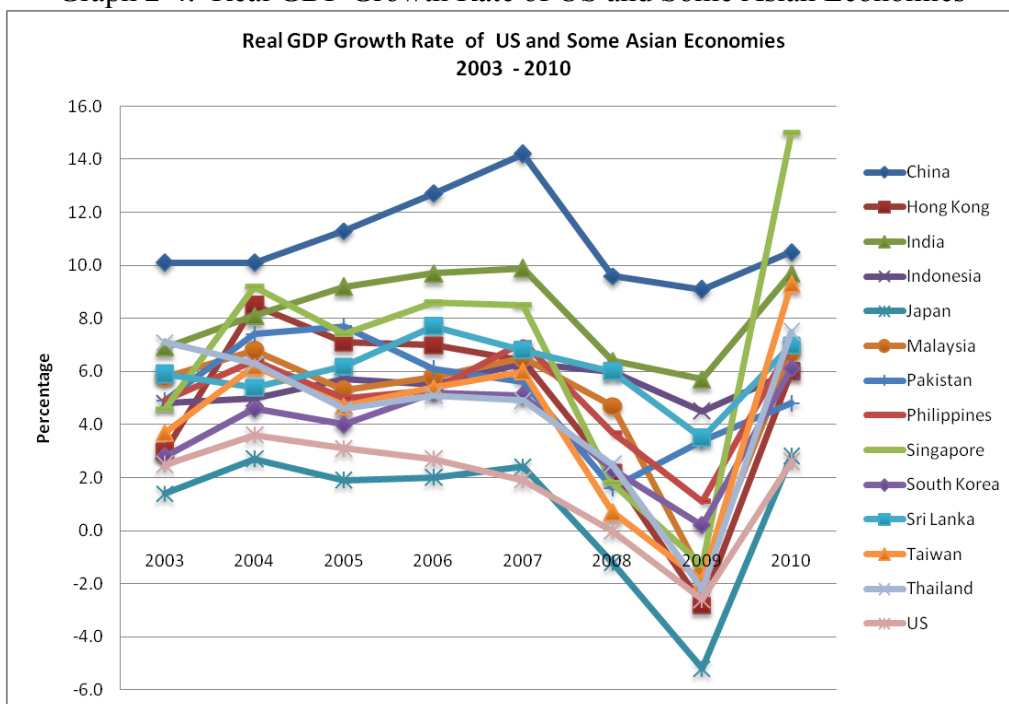
The losses on hedge funds and bankruptcies of some mortgage companies began to sow seeds of distrust throughout the credit system where a relatively small set of initial problems would heavily damage the network of trust on which the credit system operated. The TED spread (Graph 2-3) shows that there was an increasing degree of perception on credit and liquidity risks since mid 2007. Under conditions of uncertainty, market participants became extremely risk averse and a number of types of credit markets virtually ceased to function. This led to limitations on credit availability to the real sectors, which in turn led to recession (Liang, Willett, and Zhang, 2010).

2.3 The Spread of the Recent Financial Crisis to Asian Economies

After the 1997-98 Asian crises, the Asian economies have better prepared themselves to economic shocks. The region as a whole entered the recent financial crisis with a relatively sound set of pre-crisis conditions of economic and financial fundamentals, which enabled it to keep the leading role in growth among other regions even during the recent crisis. However, much adverse impact could be seen in the region. As shown in Graph 2-4, GDP growth in many individual Asian economies dropped dramatically during the year of 2008. The economies that experienced the biggest decreases in their growth rates were Singapore with a drop of 6.7 percent, Taiwan 5.3 percent, China 4.6 percent, and Hong Kong 4.2 percent from 2007 to 2008. In 2009, Japan continued its negative GDP growth beginning from 2008 and some Asian economies such as Hong Kong, Thailand, Taiwan, and Singapore showed negative growth for the first time in their recent

history. In 2010, the estimated GDP growth by the IMF projected that the growth of the economies would rise significantly. All the negatives would turn into positives and many would return their real growth to pre-crisis level or even higher.

Graph 2-4. Real GDP Growth Rate of US and Some Asian Economies



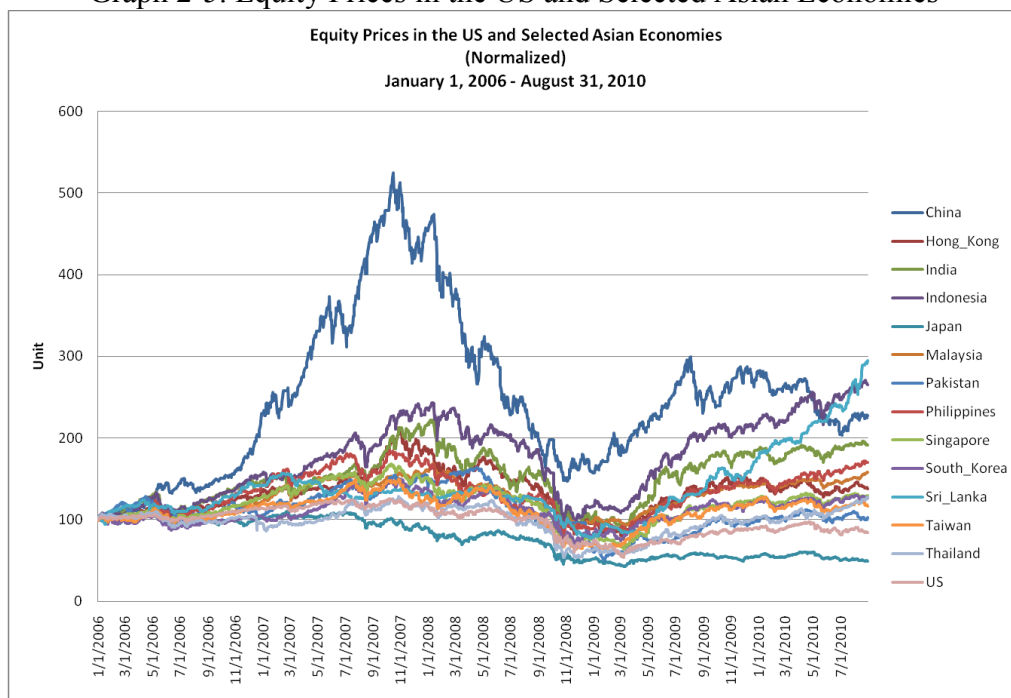
Note: The 2010 data are projections.

Data Source: IMF World Economic Outlook (October, 2010)

The region as a whole entered the recent financial crisis with a sound set of pre-crisis condition of financial and economic fundamentals. In the financial aspect, banking systems were generally healthy due to favorable economic condition and conservative bank regulations. In most economies, reported capital adequacy exceeded 10% of total risk-weighted assets, and non-performing loan ratios were low and declining secularly across the region. Loan-to-deposit ratios were less than 100% in most economies. The major Asian national equity prices

were in a stable and rising status until later 2007(Graph 2-5). Especially, China's stock market continued to boom up to October 2007. This was probably due to the continuous high growth rate of above 10 percent, high saving rates, and few available investment opportunities. In the macroeconomic aspect, inflation was well behaved. The rate of price change was low and stable in countries such as Korea, Malaysia, the Philippines, and Thailand. Government fiscal positions were healthy in most economies. China, Hong Kong, Korea, New Zealand, Singapore and Thailand enjoyed budget surpluses in 2007, and debt was falling as a percentage of GDP in all regional economies. Official reserves were generally thought to be ample. By mid-2007, reserve levels exceeded 100% of short-term external debt in most economies in the region.

Graph 2-5. Equity Prices in the US and Selected Asian Economies



Data Source: Bloomberg

From later 2007 when the US' subprime problems developed to September 2008 when Lehman Brothers collapsed, Asian economies were mildly affected. As stated in research by the Bank for International Settlements (Filardo et al., 2010), the toxic assets themselves had little direct impact on Asian banks as their exposure to them was quite small. For example, in Thailand, the CDOs held by banks only presented 0.04% of their balance sheets. And most Asian banks were generally much less leveraged than those in the US and Europe. So the banks were less vulnerable to a collapse in the credit products. But the subprime turmoil did show effects on the Asian economies. The equity prices of the Asian economies began to decline in 2008 (Graph 2-5). As the risk appetites of global investors declined, the low - grade borrowers such as those from India, Indonesia, and the Philippines, lost access to markets. The high-grade borrowers with large external financing requirements faced much high funding costs over time. In early 2008, portfolio investment appeared to reverse and there were large outflows in Hong Kong, Japan, and Korea. However, as Asian economies were still in the motion of high growth, and were under inflation pressure as food and energy price rose, the downside risk for economic activities and the upside risk of the inflation tended to balance each other during the middle of 2008 (Filardo et al., 2010). The relative resilience of the overall Asian economies led to views that the region might decouple from the developed countries such as the US which had already began to slow in early 2008. But some of the decoupling view swung to recoupling when the US entered a more serious crisis period later on.

After the collapse of Lehman Brothers in September 2008 to the beginning of 2009, the Asian economies saw larger impacts from the recent crisis. The sharp deterioration of the US financial sectors decreased market confidence greatly. The CDS spread of many Asian banks jumped immediately after mid-September 2008. Many major national Asian equities including China's stock also dropped dramatically, quit following the pattern of US' stock (Graph 2-5). As regional investors sought to reduce exposure to risk assets, borrowers struggled to roll over debt. The shortage of liquidity in the region limited the market to be funded intermediately and smoothly. This market stress caused further regional financial contagion. The real economy got affected as trade activity fell rapidly. By December 2008, aggregate exports from Asia went down 18% year on year, with imports declining at a similar rate (Filardo et al., 2010). For the highly open Asian economies such as Hong Kong and Singapore, the effects of the fall in trade on the broad economy were particularly severe. As mentioned previously, GDP growth in many Asian economies turned down dramatically with several economies such as Japan, Hong Kong, Thailand, Taiwan, and Singapore experiencing negative growth in 2009.

To prevent further losses in this special period, many Asian governments took action. To restore market confidence, the Asian governments expanded liquidities by various measures such as extending maturity of financing and bordering eligibility of collateral, injecting capital into banks, and offering guarantees for the liabilities of financial institutions. Some Asian economies also received bilateral swap facilities with the US, and discussed additional bilateral

swaps within the region. Monetary policy rates and required reserve ratios were cut sharply. Central banks in all Asian economies aggressively eased the stance of monetary policy and policy rates were at record lows in Indonesia, Korea, and the Philippines by March 2009. The reserve requirements were also lowered in China, India, Indonesia, and the Philippines. Governments announced aggressive fiscal stimulus. For example, the fiscal stimulation amounted to approximately 1% of GDP in Malaysia and Thailand, and 13% of GDP in China in the later period of 2008. And new fiscal plans were announced across the region in the beginning of 2009 with 5% of GDP in Japan and 8% in both Malaysia and Singapore. Towards the end of the first quarter of 2009, some tentative signs emerged that the region's economies were no longer in freefall.

From the beginning of 2009 and on, though the macro-economy was still weak, signs of recovery appeared in the Asian economies as the situation in the US began to get better. Asian sovereign CDS spreads continued to fall from the October 2008 peaks, meaning the perceived riskiness of the overall economy was decreasing, and the stock markets rose widely in March 2009. Equity inflows returned back faster in Asia than in other emerging markets and the corporate issuances began to provide a partial substitute for bank lending which remained inadequate in the region. Though there was a slowdown in portfolio inflows to the region due to the spike in global risk aversion in early 2010 following worries on the Euro area sovereign credit, flows have recovered rapidly in later period of 2010 (IMF, 2010a). The real economy also improved during this period. The monthly exports increased in China, Hong Kong, Japan, Korea, Malaysia, the

Philippines, and Singapore in April 2010. Japan's industrial output surged the most in 56 years then. The IMF estimated that in the year of 2010, the Asian economies would return to the positive GDP growths of the pre-crisis period with, for example, 15 percent in Singapore, 10.6 percent in China, 9.7 percent in India, and 2.8 percent in Japan.

As showed above, the recent financial crisis has affected the world and Asian economies dramatically. The next chapter reviews the literature on contagion which provides foundations on further investigation of the spread of the recent crisis to the Asian economies in equity.

Chapter 3. Literature Review

To understand the spread of the recent financial crisis comprehensively, this chapter provides a literature review on concepts and channels of contagion, and empirical literature with the related empirical test methods and results on contagion, and discusses briefly the decoupling debates.

3.1 The Concepts of Contagion

There are many different versions of definitions on contagion in the literature. The concept of contagion can be either broad or specific. The World Bank defines one general and two restricted types of contagion based on literature research. For the general view, some research puts the definition of contagion as simple as “when A gets in trouble because B does” (Hernández and Valdés, 2001). Some think that “contagion is best defined as a significant increase in cross-market linkages after a shock” (Dornbusch, Park, and Claessens, 2000). The World Bank defines the broad concept of contagion as the cross-country transmission of shocks or general cross-country spillover effects. For the specific view, some research takes the role of “fundamentals” into consideration where the fundamentals refer to normal interdependence such as financial linkages and trade linkages. For example, Baig and Goldfajn (2001) defined contagion as “comovements in financial variables in excess of those that can be explained by comovements of fundamentals”. Favero and Giavazzi (2000) considered contagion as a change in the way shocks were transmitted across countries that was not caused by changes in fundamentals. The World Bank provides the concept of this restricted version of contagion as the transmission of shocks to

other countries or the cross-country correlation, beyond any fundamental link among the countries and beyond common shocks. This definition is usually referred to as excess comovement, commonly explained by herding behavior.

Another version of the specific view considers the change of correlations for different periods of the shock. For example, many researchers think contagion exists when there is a significant increase in correlation, either before or after adjustments for significance (Forbes and Rigobon, 2001). For this specific version of contagion, the World Bank defines contagion as occurring when cross-country correlations increase during “crisis times” relative to correlations during “tranquil times.” This definition addresses more the overall changes of the correlation for crisis and non-crisis periods. For the purpose of this study, we use this definition of the World Bank in our data analysis (The World Bank, 2010).

As discussed above, there is no definitive concept of contagion and there is no one best concept for all purposes. The question is how well the concepts are chosen to explain a certain aspect of the shocks in the real world.

3.2 The Channels of Contagion

The transmission channels of contagion can be categorized in several ways. One of the representatives is the categorization made by Dornbusch, Park, and Claessen (2000). They divided the causes of contagion into two main categories: the normal interdependence and investor behavior. The normal interdependence contagion means shocks can be transmitted to other economies through financial and real linkages. This normal interdependence type was also

termed by Calvo and Reinhart (1996) as fundamentals-based contagion. According to the research, fundamental causes include common shocks, trade links, and financial links (Dornbusch, Park, and Claessen, 2000). The common shock is the global shock that can trigger market adjustments in an international context. For example, a change in US interest rates could influence capital flows to some of the emerging market countries and thus could be considered a common shock. The trade linkage reflects connections between trading partners. When a crisis occurs in one country, its high-bilateral trading partners could be negatively affected due to the fall of demand in the crisis country. The financial linkage reflects connections between countries in equity or loan portfolios (Kaminsky and Reinhart, 2000). When a country is in crisis, its financial transactions in capital flows abroad, for example, may be reduced and thus influence the financial strength of other countries. The investor behavior contagion refers to the transmission that happens not because of macroeconomic or other fundamentals but the behavior of investors or other financial agents not based on fundamentals. Investor behaviors are influenced by information asymmetries and the incentive and coordination problems. Examples of this type of contagion include financial panic, herding behavior, increased risk aversion, and so on.

Other categories that have been offered are different but in a similar fashion. For example, Bazedresch and Werner (2000) divided the types of contagion into three kinds: common shocks, interdependence, and shifts in markets sentiment unexplained by macroeconomic fundamentals which were considered as “pure contagion”. Some other categories put contagion channels

into the trade channel, rational financial channel, and a channel due to market imperfections (Willett, Liang, and Zhang, 2011). Addressing the differences between crisis and non-crisis factors, Forbes and Rigobon (2001) divided the channels into crisis channels and non-crisis channels, where the crisis channels included multiple equilibria, endogenous liquidity, and political economy considerations and the non-crisis channels included trade, policy coordination, country reevaluation and learning, and common shocks. Kaminsky and Reinhart (2000) categorized the contagion channels to a common lending channel, a liquidity channel, and a trade channel.

3.3 The Empirical Literature on Contagion

The empirical literature provides many methodologies to measure and test contagion. The common methods include analyses of correlations, volatility spillovers GARCH models, VAR models, probability models, principle components analyses, and so on. Some have also suggested a focus on the effects on changes in levels. According to the methods used, we classify the empirical literature into roughly two broad categories: bilateral analysis, mainly the correlation or comovement analysis, and the multi-factor analysis. Sometimes both can be used. The correlation analysis measures the comovement or interdependence of two indicators, and the multi-factor analysis examines the influencing factors or channels of the contagion.

3.3.1 The Correlation Analysis

As for correlation analysis, defining contagion as a significant rise in the correlation among asset returns, many researchers such as King and Wadhvani (1990), Baig and Goldfajn (2001), and Bazdresch and Werner (2001) found the existence of contagion during various financial crises. In particular, King and Wadhvani (1990), for example, found there was a significant increase in correlation between stock returns of Japan, UK, and the US equity market after the stock market crash of 1987. Baig and Goldfajn (1999) tested for evidence of contagion between the financial markets of some Asian countries (Thailand, Malaysia, Indonesia, Korea, and the Philippines) and found correlations for currency and sovereign spreads increased significantly during the 1997-98 Asian crises period, while the equity market correlations offer mixed evidence. Angkinand, Barth, and Kim (2010) investigated comovements of national stock markets using OLS and Generalized Method of Moments (GMM) in the US and some advanced economies from 1973 to 2009 and found an increase in interdependence between national stock market returns over time and the spillover effects from the United States to other industrial countries were greatest after the summer of 2007, especially after the collapse of Lehman Brothers in 2008.

One important concept was provided by Forbes and Rigobon (2001, 2002). They criticized the simple correlation test by suggesting that simple correlation was biased because of the presence of heteroscedasticity in market returns. When stock market volatility increases, unadjusted estimates of cross market correlations will be biased upward, thereby potentially leading to false conclusions about the existence of contagion. Correcting for the

heteroskedasticity problem, they tested comovements in stock returns in the Mexican crisis in 1994 to 95, Asian crises in 1997, and the US stock market crash in 1987 by adjusting correlations with a VAR model and calculating unconditional cross-market correlations, and found virtually no evidence of significant contagion during the crises examined. They concluded that the greater degree of comovement of the stock market during the crisis period might simply reflect a continuation of the trend in market interdependence. However, their methodology has some limitations. In particular, they assumed that the interdependence or correlation across economies didn't change over the period based on which the correlation was calculated. This is not the necessary case in the real world as the correlations might be time varying. Also some argue that the increase in variance is a normal part of a crisis and so adjusting for these when testing significance may not be appropriate (Baig and Goldfein, 2001).

Engle (2002) developed the method of Dynamic Conditional Correlation GARCH and compared it with other constant conditional correlations and found the DCC-GARCH outperforms others in robustness since it takes heteroscedasticity into account. This method has then been widely used in the later research. For example, Wang and Thi (2006) used it to examine the impact of the 1997-98 Asian financial crises on the Chinese Economic Area (CEA) and found positive correlation coefficients of stock returns. Hesse, Frank, and González-Hermosillo (2008) adopted this method and examined the linkages between market and funding liquidity pressure during the recent subprime crisis and found that the interaction between market and funding illiquidity increased

sharply during the recent financial turbulence up to the beginning of 2008. Burdekin and Siklos (2010) calculated dynamic conditional correlations for the stock returns of some Asian economies and the US and found consistent and strengthening ties between Shanghai and other Asian markets but weaker ties with the S&P500 during the recent financial crisis. The IMF in its 2008 Global Financial Stability Reports (IMF, 2008) used DCC-GARCH to analyze the comovements in stock markets between the US and some global emerging market regions as a whole and found varied but overall increasing correlation levels during the past several years. As in the recent crisis, correlations of the equity markets can change rapidly, we consider the DCC-GARCH model a competitive choice to measure contagion in correlations for this financial episode. We use this method in Chapter 4 to examine how equity prices of individual Asian economies co-moved with those of the US.

3.3.2 The Multi-Factor Analysis

As for the multi-factor analysis, there are some empirical studies on contagion. Lin and Cheng (2008), for example, used a logistic model to identify the economic determinants of the stock markets, and to assess the comovements across international stock markets from 1994 to 2004. They found that both the volatility of stock market returns and the rate of change in the exchange rate affect the contagion of those stock markets, and interest rate differentials played an increasingly important role after the financial crisis. Calculating through a logit model, Collins and Gavron (2004) argued that the most significant channels of

financial contagion included inflation rates and financial liquidity. They also stated that neither fundamental links nor investor behavior alone caused contagion. Rather, a combination of each of these channels catalyzed the spreading of financial crises. Beirnea et al. (2009) examined global and regional spillovers in local emerging stock markets from 1990s to 2008 using a tri-variate VAR GARCH-in-mean model for 41 emerging market economies and suggested that spillovers from regional and global markets were present in the vast majority of emerging market economies.

Built on Hoffmaister and Roldos (2001) and Genberg (2005), the IMF in its WEO report (IMF, 2007) examined the spillover of the US to other economies in GDP. In particular, the analysis set two blocks for the determinants of GDP: the foreign block (US, Euro area, and Japan) and the country-specific block. In the dynamic method of VAR analysis, it assumed elements in foreign block were interrelated given the linkages among them (for example, shocks to US growth contemporaneously affected growth in the Euro area and in Japan) but were not significantly affected by developments in the country-specific block. One of the findings was that the US had significant impacts in newly industrialized economies and ASEAN-4 in growth, but disturbances in Japan had a smaller impact on these economies. The dynamic method of VAR analysis measures the spillover effect dynamically by allowing interactions across economies and fits the scenario of the recent crisis with better specification. For this reason, we use the dynamic method of VAR estimations to analyze the factors or channels of the contagion between the US and Asia in equity prices in Chapter 5.

In order to get a better understanding of factors that influence contagion in equities, we investigate the literature on determinants of equity prices. The capital asset pricing model (CAPM) developed by Sharpe (1964) and Lintner (1965), for instance, considered the risk-free return and volatility of the risk-free return to market return as the determinants of asset prices (Somoye, Akintoye, and Oseni, 2009). Chen, Roll and Ross (1986) found that industrial production, risk premium, yield curve, and unanticipated inflation could help explain expected returns during periods of high volatility. Hasan and Nasir (2008) suggested that interest rates, exchange rates and money supply had significant long run effects on equity prices while industrial production, oil prices and inflation were not statistically significant in determining equity prices in the long run.

The IMF (2008) in its Stability Report categorized the factors influencing equity prices as global factors and domestic factors and investigated the spill-over effects in equity market from January 2011 to May 2008. The study first employed fixed effect panel data analysis covering 30 EM economies including some economies in Asia.¹ The global factors included global excess liquidity (the difference between broad money growth and estimates for money demand in the Euro area, Japan, and the United States), credit risk premium (the level of the 10-year US dollar swap spread), and market risk premium (the implied volatility of the S&P 500 index). The domestic factors included economic growth (the change of the monthly consensus forecast for annual GDP growth rate), the differential between domestic and global interest rates (the spread between the one-year

¹ The Asian Economies included China, Hong Kong, India, Indonesia, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Thailand, and Vietnam.

domestic and the six month US treasury rates), the forward exchange rate (the log change in forward exchange rates), the inflation differential (the difference between the domestic and the US monthly inflation rates), and equity market capitalization (equity market capitalization-to-GDP ratio). The estimation Asian equity markets suggested that the global factors were statistically significant: equity prices were positively associated with global excess liquidity and negatively with credit and market risk prime. As for domestic factors, GDP growth, an expected exchange rate appreciation, and an increase of market capitalization had positive effects on equity prices, and interest rate differential had negative effect on equity prices. The study then ran the dynamic method of eight-variable VAR for several individual economies. The eight variables were partitioned into an exogenous foreign block (global excess liquidity, credit and market risk premia in the United States) and a country specific block (GDP growth, the forward exchange rate, the interest rate and inflation rate differentials, and the market capitalization) of variables. The study found that in the VAR estimations, most individual equity price responded to global shocks in the same direction as in the panel regression, and smaller countries had slightly larger responses overall (IMF, 2008). This IMF analysis provided a comprehensive framework of analysis for both common and individual factors. For our factor analysis in Chapter 5, we follow the categories of global and domestic factors and methods of panel fixed effect estimation and the dynamic method of VAR analysis used the IMF studies (2007 and 2008) to examine the factors in equity price contagion. Using different set of factors for Asian economies, we add to the

literature of multi-factor analysis on contagion in equity markets for the recent financial crisis.

3.4 The Decoupling Debates

To provide background for the implications of our empirical results, we introduce briefly the decoupling debates.

Economists offered structural definitions concerning the overall economy. For example, decoupling is often viewed as growth in one area becoming less dependent on growth in another area (Rossi, 2008). As decoupling implies a break in a relationship that was previously closely linked, this definition lends itself naturally to discussions of changes in patterns of correlations or influences, especially in discussions of equity markets.

There have been debates recently that emerging markets including Asian economies are decoupling from the advanced economies. Actually, the history of the decoupling debates could be traced to decades ago. In the 1970s, the increased global interdependence (highlighted by the breakdown of the Bretton Woods system, the oil shocks, and emergence of stagflation in a global scale) was getting more attention by people in most economies. By the 1980s, discussions of the desirability of international economic policy coordination and global growth were popular (Willett, Liang, and Zhang, 2011). The 1997-98 Asian financial crises reinforced recognition of global interdependence.

As emerging economies such as China and India continued to grow at high rates after the US and Europe sank into recession since early 2000s,

however, the decoupling theory became “a popular theme in Asian policy circles in the first decade of the new millennium” (Athukorala and Kohpaiboon, 2009). Even after the slowing of US growth followed by the early signs of the US subprime crisis, many researchers addressed decoupling. As Vanessa Rossi (2008) suggested, “up to mid-2008, the emerging markets remained strong- ‘decoupling did work’”. The IMF (2007) also concluded that “most countries should be in a position to ‘decouple’ from the U.S. economy and sustain strong growth if the U.S. slowdown remains as moderate as expected.”

However, discussions of recoupling began to replace the decoupling as 2008 progressed. In a study of the spread of the global crisis, Dooley and Hutchison (2009) considered May 2008 the latest time that any plausible decoupling view could be held for stock markets. The recoupling views were not unusual as most economies were hit by the US subprime crisis and showed downward trend following the US’ economy then.

The recoupling view was only temporary, however – the decoupling view quickly returned in 2009 when the US continued to show signs of contraction while some developing economies such as China and India quickly rebounded. The decoupling view was, once again, a hot topic (Willett, Liang, and Zhang, 2011). As El-Erian (2009) suggested in August 2009, “with the ongoing normalization of the financial system, the decoupling camp is again in strong ascension today.”

In the following chapters, we conduct the correlation analyses and multi-factor analyses, and discuss implications of the results, providing further

empirical evidences for the decoupling debates for Asian equity markets in the recent financial crisis.

Chapter 4. The Comovements of Equity Returns – Correlation Analyses

In this chapter, we calculate correlations of equity returns between the Asian economies and the US using both constant and dynamic methods, and investigate how closely Asian economies follow US equity movements during different phases of the crises.

4.1 Data

We include the US and 13 selected Asian economies which are either among the top 30 rank of stock market capitalization or smaller Asian markets used in past studies on contagion (Chiu & Mackay, 2009). The Asian economies are China, Hong Kong, Indonesia, India, Japan, Malaysia, Pakistan, the Philippines, Singapore, South Korea, Sri Lanka, Taiwan, and Thailand. For each market, a representative equity index is chosen to proxy for the broad market. The equity data are collected from Bloomberg. For the purpose of comparison, we also include regional indices for overall Asia, Europe and Latin America. In particular, we use the MSCI international equity indices developed by the former Morgan Stanley Capital International to represent the regional equity markets in Asia, Europe, and Latin America.² All the equity indices are calculated based on

² The MSCI indices are MSCI-Asia, MSCI – Europe and MSCI – Latin America. They are the free float-adjusted market capitalization weighted indices that are designed to measure the equity market performance of the markets. As of June 2007, the MSCI-Asia (MSCI AC Pacific Index) consisted of the following 12 developed and emerging market countries: Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore, Taiwan, and Thailand; the MSCI - Europe Index consisted of the following 16 developed market country indices: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom; the MSCI – Latin America (MSCI EM Latin America) Index consisted of the following 5 emerging market country indices: Brazil, Chile, Colombia, Mexico, and Peru.

local currencies (so that they exclude the effect of changes of exchange rates).

Table 4-1 lists the representative equity indices of the selected Asian economies and MSCI's.

Table 4-1. The Selected Economies and their Representative Equity Indices

	Economy	Name of the Equity Index	Symbol in Bloomberg
Individual			
	United States	S&P 500	SPX
	China	Shanghai Se Composite	SHCOMP
	Hong Kong	Hang Seng	HSI
	India	BSE Sensex 30	SENSEX
	Indonesia	Jakarta Composite	JCI
	Japan	Topix	TXP
	Malaysia	FTSE Bursa Malaysia KLCI	FBMKLCI
	Pakistan	Karachi 100	KSE100
	Philippines	PSEI Philippine Se	PCOMP
	Singapore	Straits Times	FSSTI
	South Korea	Korea Composite KOSPI	KOSPI
	Sri Lanka	Sri Lanka Colombo	CSEALL
	Taiwan	Taiwan Taix	TWSE
	Thailand	Stock Exchange of Thailand	SET
Regional			
Asia	Asia – Developed and Emerging Markets	MSCI-Asia	
Europe	Europe – Developed Markets	MSCI - Europe	
Latin America	Latin America – Emerging Markets	MSCI - Latin America	

The data runs from January 1991 to August 2010 monthly. The research time period makes it possible to compare the 1997-98 Asian financial crises and the recent global financial crisis. The monthly data does not reflect the high frequency of volatility as would daily data, but helps capture the medium-term

movements and also limit the problem of missing values of non-trading dates in the daily data.

We first perform a stationary test on the equity prices. The Augmented Dickey-Fuller unit-root test shows that the levels of equity prices are not stationary but the first differences of the equity prices - the equity returns - are. Table 4-2 illustrates the t-statistics of the unit root test for equities returns of US, the individual Asian economies, and MSCI. The t-values in each economy are much smaller than the 1% critical value of -3.47 (-3.5 for Singapore) and thus reject the hypothesis that there are unit roots in the data.

Table 4-2. T-Statistics of the Augmented Dickey-Fuller Unit-root Test for Equity Returns
January 1991 – August 2010

Economy	T-Statistic	Economy	T-Statistic	Economy	T-Statistic
US	-13.93	Malaysia	-14.23	Taiwan	-14.72
China	-15.72	Pakistan	-13.49	Thailand	-15.10
Hong Kong	-14.15	Philippines	-14.96	MSCI - Asia	-13.87
India	-14.20	Singapore	-9.93	MSCI - Europe	-13.43
Indonesia	-11.76	South Korea	-14.19	MSCI - LA	-12.68
Japan	-13.58	Sri Lanka	-10.70		

As the equity returns are stationary series, we use them for further analysis. The statistical summary of the equity returns is shown in Table 4-3.

Table 4-3. Statistical Summary for Equity Returns
January 1991 - August 2010

Variable	Obs	Mean	Std. Dev.	Max	Min	Skewness	Kurtosis
US	236	3.05	45.41	132.16	-197.61	-0.91	5.18
China	236	10.64	215.21	789.33	-1082.99	-0.77	9.73
Hong Kong	236	74.20	1085.27	4210.11	-4425.52	-0.51	6.73
India	236	71.71	655.21	3222.00	-3072.37	-0.49	10.67
Indonesia	236	11.29	86.09	296.46	-575.80	-1.28	13.76
Japan	236	-3.94	72.74	249.39	-256.53	-0.03	3.82
Malaysia	236	3.88	58.70	278.87	-208.44	-0.01	5.77
Pakistan	236	39.08	494.32	1512.67	-3322.09	-2.43	18.45
Philippines	236	12.34	171.53	873.01	-618.56	-0.04	6.75
Singapore	132	5.79	140.72	408.80	-564.71	-0.95	5.88
South Korea	236	4.43	73.07	191.07	-335.00	-0.43	5.11
Sri Lanka	236	22.35	119.01	548.96	-370.25	1.11	7.64
Taiwan	236	13.08	510.74	1716.66	-1431.84	0.03	3.53
Thailand	236	1.27	66.81	372.90	-189.40	0.73	8.40
MSCI-Asia	236	-0.04	4.87	12.80	-18.98	-0.57	4.25
MSCI-Europe	236	2.95	48.16	138.98	-176.99	-0.98	5.06
MSCI-LA	236	30213.45	215276.70	609604.50	-1403481.00	-1.39	12.73

Note: The equity returns of all economies in the table start from January 1991 except for Singapore for which the data are available starting from September 1999.

4.2 Methodologies and Results

To discover the patterns of comovements in the equity markets, a set of correlations (Asian economies vs. the US) are calculated, namely the simple correlation, correlation of deviation from the Hodrick-Prescott filter series (both of them are considered as constant or static correlations), and the dynamic conditional correlation (DCC-GARCH) to test for robustness. Stata is used for the calculation of simple correlation and HP filter detrended correlation and Matlab is used for the calculation of the DCC-GARCH correlation.

4.2.1 The Simple Correlations

The simple correlation or Pearson's correlation measures the dependence between two variables by dividing the covariance of the two variables by the product of their standard deviations. The correlation coefficients show the degree of positive or negative dependency between two variables in a straight forward way. Though the simple correlation might produce a biased result in the analysis of contagion as it tends to rise when the volatility is high as suggested by the literature, it provides an intuitive overview on how the series co-move and serves as a good bench mark for the more complicated correlation analyses.

For the simple correlation, we divide the research period into several sub-periods based on the time of occurrence of some significant economic events. The sub-periods are 1/1991-6/1997, 7/1997-12/1999, 1/2000-6/2007, 7/2007-8/2008, and 9/2008-8/2010 respectively. The last sub-period is further divided as the analysis goes on. The first period is set for the pre 1997-98 Asian crises, the second is the time during the 1997-98 Asian crises, the third period is set for before the global financial crisis but after the previous Asian crises, the fourth period is for the time after the beginning of the recent crisis to Lehman Brother's collapse in September 2008, and the last period is for the recent financial crisis since September 2008 up to the end of the research period. There are many alternative ways to set the sub-periods in the literature, especially for the recent crisis, but most are similar in using significant events to set dividing points. We take the collapse of Lehman Brothers in September 2008 as one of the breaking points since this event influenced the financial market significantly - many

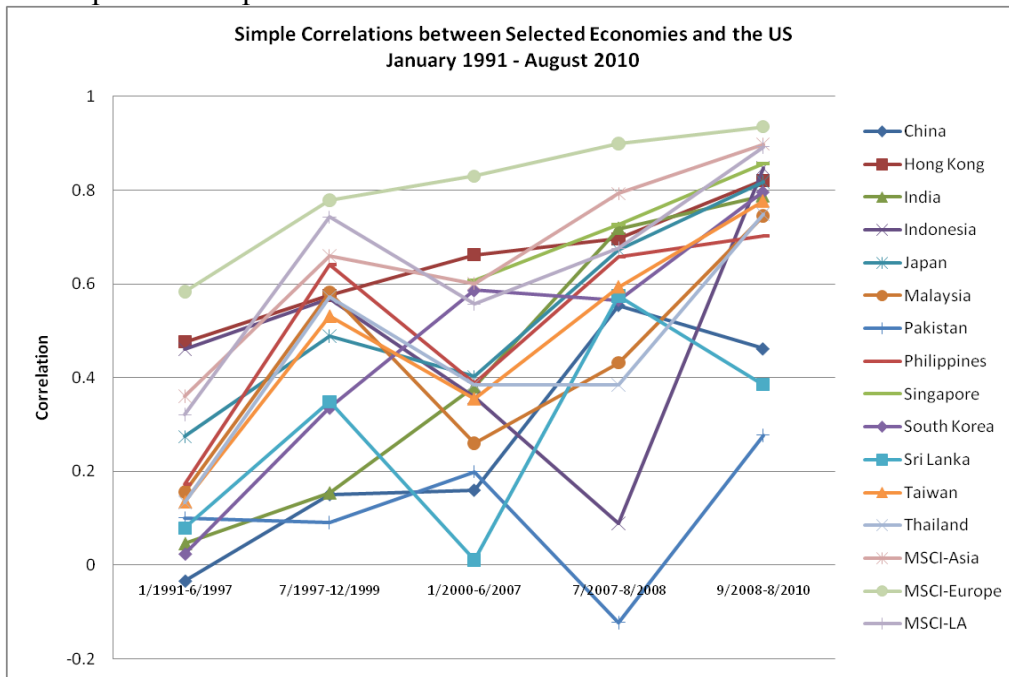
financial indicators such as the TED spread and equity indices of the US and many economies changed dramatically during this event. Using those sub-periods, we calculate the simple correlations between equity returns of the US and other economies. The results of correlations for Asian economies and the MSCI's vs. the US are listed in Table 4-4 and Graph 4-1.

Table 4-4. Simple Correlations between Equity Returns of Selected Economies and the US

	1/1991- 6/1997	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2010
China	-0.0337	0.1509	0.1601	0.5543	0.4616
Hong Kong	0.4762*	0.5753*	0.6622*	0.6959*	0.8205*
India	0.0457	0.1539	0.3799*	0.7179*	0.7873*
Indonesia	0.4611*	0.5686*	0.3579*	0.0887	0.847*
Japan	0.2742	0.488*	0.4024*	0.6721*	0.8179*
Malaysia	0.1556	0.582*	0.2596	0.4316	0.7452*
Pakistan	0.1004	0.0914	0.1993	-0.1224	0.2771
Philippines	0.1734	0.6415*	0.3876*	0.6583	0.7014*
Singapore			0.607*	0.7266*	0.8562*
South Korea	0.0241	0.3354	0.5862*	0.5655	0.7962*
Sri Lanka	0.079	0.3484	0.0111	0.5745	0.3851
Taiwan	0.1347	0.5308*	0.3547*	0.5934	0.7764*
Thailand	0.1333	0.5726*	0.3853*	0.3849	0.7489*
MSCI-Asia	0.3604*	0.6599*	0.6009*	0.7926*	0.8979*
MSCI-Europe	0.583*	0.7782*	0.8297*	0.8993*	0.9352*
MSCI-LA	0.321*	0.7425*	0.5566*	0.6761*	0.8919*

Note: The * indicates statistical significance at level of 1% and less.

Graph 4-1. Simple Correlations between Selected Economies and the US



From the above table and graph, we find that among the geographical regions, the developed market in Europe had the highest correlations with US in the whole period. Asia's correlations with the US were lower than Latin America in the 1997-98 Asian financial crises but became higher afterwards. Among the individual Asian economies, Singapore, Hong Kong, and Japan had relatively higher correlations, and Pakistan, Sri Lanka, and China had relatively lower correlations with the US over the whole period. The lower correlations of China make sense as China has outperformed the world economy for a long period and has retained capital controls. Compared with their own historical correlations, most economies showed higher correlations during the crises periods (the Asian crises of 7/1997-12/1999 and the recent crisis of 9/2008-8/2010) than the pre-crisis period (the pre Asian crises periods of 1/1991-6/1997 and the pre recent

crisis period of 1/2000-6/2007) respectively, except for Pakistan, Indonesia, South Korea, and Thailand. However, the correlations of those four countries rose again to their highest levels in the recent crisis period of 9/2008-8/2010 though those for Pakistan always remained fairly low. This phenomenon of higher simple correlations during the crisis confirms the theory in the literature that the simple correlation tends to rise in the crisis periods as the volatility is usually high then. The correlations with the US increased substantially for most economies in the period of 9/2008-8/2010 as the recent crisis developed after the collapse of Lehman Brothers. The only exceptions were China and Sri Lanka, for which the correlations decreased from 0.55 to 0.46 and from 0.57 to 0.38 respectively. Among the individual economies, India's correlations with the US continuously increased during the whole period, reflecting in part its liberalization.

In summary, the results of the simple correlations show that Asian economies didn't move as closely with the US as the European economy over all, but many individual economies tended to move closely with the US, especially in the later period of the recent financial crisis than before. There were some exceptions as some economies reduced their correlations in the most recent period of the recent crisis. They included either high growth rate countries such as China or less developed economies such as Sri Lanka. We then further calculate correlations using a commonly used detrending technique, the Hodrick-Prescott filter, to evaluate the comovement of the Asian equity markets with the US.

4.2.2 The Hodrick-Prescott Filter Detrended Correlations

The HP filter is a data-smoothing technique that is widely used to remove short-term fluctuations and reveal long-term trends. The HP filter produces a non-linear presentation with a procedure of squared error minimization. Given a chosen positive value of λ , there is a trend component that will minimize

$$\sum_{t=1}^T (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2$$

where the time series y_t is composed of a trend component τ and a cyclical component c ($y_t = \tau_t + c_t$). The first term of the minimization formula penalizes the cyclical component and the second term of the formula penalizes variations in the growth rate of the trend component. Depending on the values of λ , the HP filter is thus able to produce a smoothed trend to a certain level. The correlations of deviations from the HP trend reveal the correlations of the residuals from the trend which are not realized in the simple correlation and help capture the comovements of the “irregular” changes, including those caused by the crises.

One of the drawbacks of the HP filter is the end-point problem in which the calculation puts more weight on the observations at the end of the series (Marinheiro, 2005). But since we have relatively large numbers of observations and we focus on mostly the middle points, the biases are limited. As some economists have suggested, although the HP filter may be only optimal in special cases, the shortcomings and undesirable properties are not particularly compelling (Ravn and Uhlig, 2002).

We run the HP filter for each of the variables and find the residuals from the HP trends. Then we calculate the correlations between the residuals of other economies and the US using the same sub-periods as in the simple correlations. Following the practice in the literature, we set the parameter of λ as 129000 as we use monthly data. The results of the HP filter detrended correlations are shown in Table 4-5.

Table 4-5. Hodrick-Prescott Filter Detrended Correlations between Equity Returns of Selected Economies and the US

	1/1991- 6/1997	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2010
China	-0.0413	0.1517	0.1467	0.5469	0.4725
Hong Kong	0.4845*	0.5893*	0.6536*	0.6910*	0.8218*
India	0.0599	0.1694	0.3537*	0.7126*	0.7861*
Indonesia	0.4659*	0.5801*	0.3361*	0.0789	0.8458*
Japan	0.2767	0.5113*	0.3907*	0.6706*	0.8204*
Malaysia	0.1879	0.5973*	0.2443	0.4243	0.7427*
Pakistan	0.1404	0.0936	0.1833	-0.1323	0.2804
Philippines	0.2142	0.6461*	0.3720*	0.6586	0.6995*
Singapore			0.5907*	0.7245*	0.8557*
South Korea	0.0545	0.3518	0.5842*	0.5597	0.7951*
Sri Lanka	0.1064	0.3512	-0.0058	0.5598	0.3769
Taiwan	0.1168	0.5374*	0.3438*	0.5899	0.7750*
Thailand	0.2019	0.5764*	0.3878*	0.3759	0.7499*
MSCI-Asia	0.3702*	0.6771*	0.5933*	0.7919*	0.8992*
MSCI- Europe	0.5577*	0.7812*	0.8284*	0.8992*	0.9354*
MSCI-LA	0.3070*	0.7538*	0.5421*	0.6720*	0.8928*

Note: The * indicates statistical significance at level of 1% and less.

The HP filter is calculated based on the period of 1/1991-8/2010 for all economies except for Singapore of which the HP filter is based on the period of 1/2000-8/2010 due to its data availability.

As we can see from the above table, the results of the HP filter detrended correlations are very similar to that of the simple correlations we calculated

previously. The differences between these two calculations are small (Table 4-6). Among the 78 cases of differences, only one has an absolute value of the differences higher than 0.05 (Thailand in the first period of 1/1991 – 8/1997). The average absolute value of the differences is only around 0.01. So the results of the HP filter detrended correlations tell the similar story as that of the simple correlations. That is, for the irregular changes from the long-term trend, the comovements between the US and most Asian economies increased during the crises, especially for the second period (9/2008-8/2010) of the recent crisis.

Table 4-6. Differences between Simple Correlations and HP Filter Detrended Correlations

	1/1991- 6/1997	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2010
China	0.01	0.00	0.01	0.01	-0.01
Hong Kong	-0.01	-0.01	0.01	0.00	0.00
India	-0.01	-0.02	0.03	0.01	0.00
Indonesia	0.00	-0.01	0.02	0.01	0.00
Japan	0.00	-0.02	0.01	0.00	0.00
Malaysia	-0.03	-0.02	0.02	0.01	0.00
Pakistan	-0.04	0.00	0.02	0.01	0.00
Philippines	-0.04	0.00	0.02	0.00	0.00
Singapore			0.02	0.00	0.00
South Korea	-0.03	-0.02	0.00	0.01	0.00
Sri Lanka	-0.03	0.00	0.02	0.01	0.01
Taiwan	0.02	-0.01	0.01	0.00	0.00
Thailand	-0.07	0.00	0.00	0.01	0.00
MSCI-Asia	-0.01	-0.02	0.01	0.00	0.00
MSCI-Europe	0.03	0.00	0.00	0.00	0.00
MSCI-LA	0.01	-0.01	0.01	0.00	0.00

As mentioned previously, both the simple and HP filter detrended correlations assume constant correlations for each of the periods examined. However, equity prices always change rapidly in the real world and so do their correlations. We introduce in the next section the analyses using DCC-GARCH which fits the characteristics of the equity markets better and produces dynamic time-varying correlations.

4.2.3 The Dynamic Conditional Correlations – GARCH

The Dynamic Conditional Correlation - GARCH model was developed by Engel and Sheppard (2001). The model not only takes the volatility or heteroscedasticity, and autocorrelation of the variables into account as does the general ARCH model, but also is superior to the constant conditional correlations by using a dynamic mechanism to produce a time-varying correlation. This model has shown to be more robust than the constant correlation models, especially in the financial industry, as it is often characterized with high volatility.

Based on Engel (2002), the DCC-GARCH model is estimated in a two-stage procedure. First, univariate GARCH models are fitted for each of the variables in the specification. Second, using transformed residuals resulting from the first stage, the dynamic conditional correlation estimators are estimated.

As specified by Engel (2002) and summarized by Hesse, Frank, and González-Hermosillo (2008), the DCC-GARCH model is characterized by the following set of equations:

$$r_t | \zeta_{t-1} \sim N(0, D_t R_t D_t)$$

$$D_t = \text{diag}\{\sqrt{h_{i,t}}\}$$

$$D_t^2 = \text{diag}\{\omega_i\} + \text{diag}\{\kappa_i\} \circ r_{t-1}r'_{t-1} + \text{diag}\{\lambda_i\} \circ D_{t-1}^2$$

$$\varepsilon_t = D_t^{-1}r_t$$

$$Q_t = S \circ (u' - A - B) + A \circ \varepsilon_{t-1}\varepsilon'_{t-1} + B \circ Q_{t-1}$$

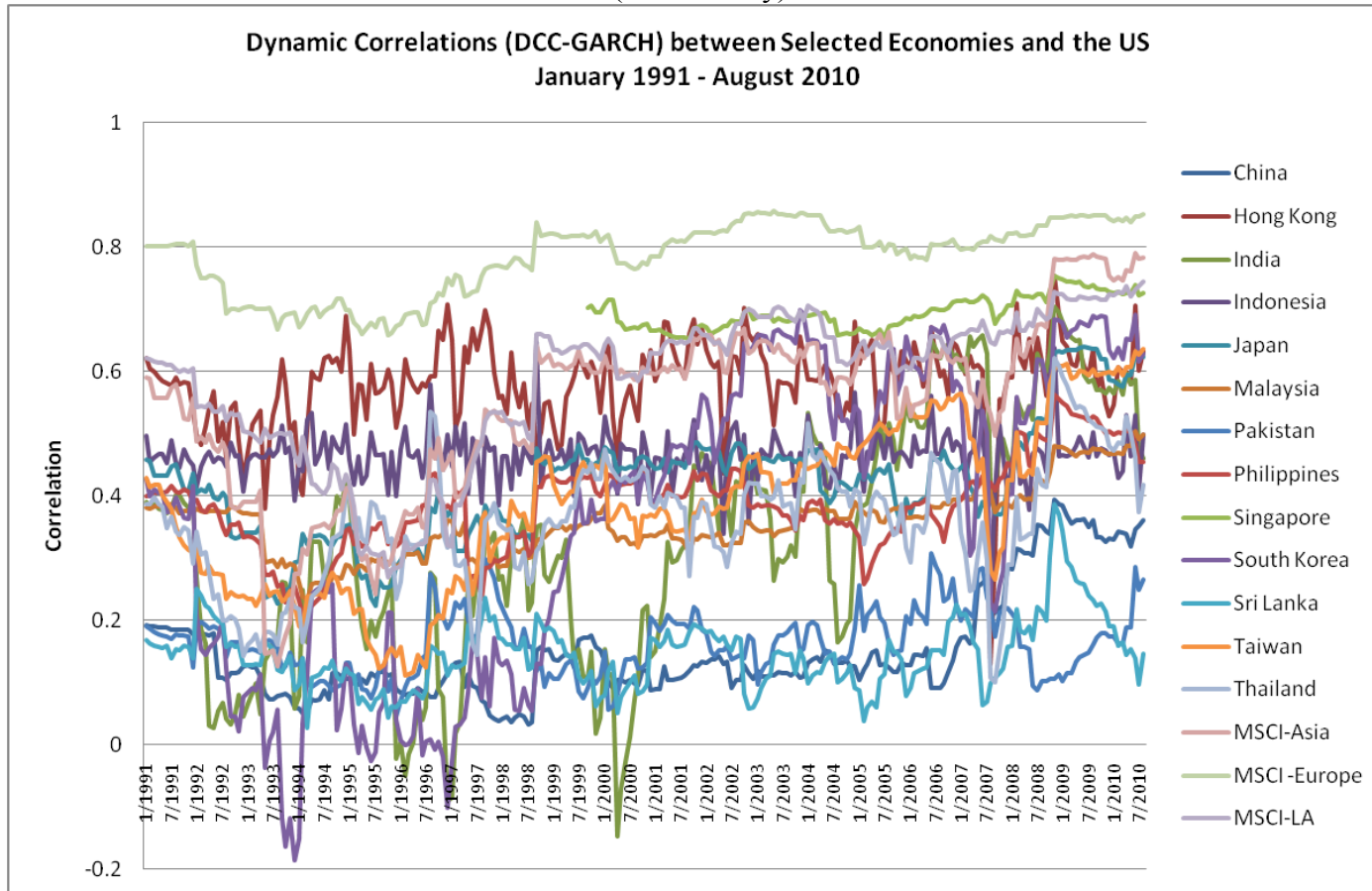
$$R_t = \text{diag}\{Q_t\}^{-1}Q_t\text{diag}\{Q_t\}^{-1}$$

$$S = E[\varepsilon_t\varepsilon'_t]$$

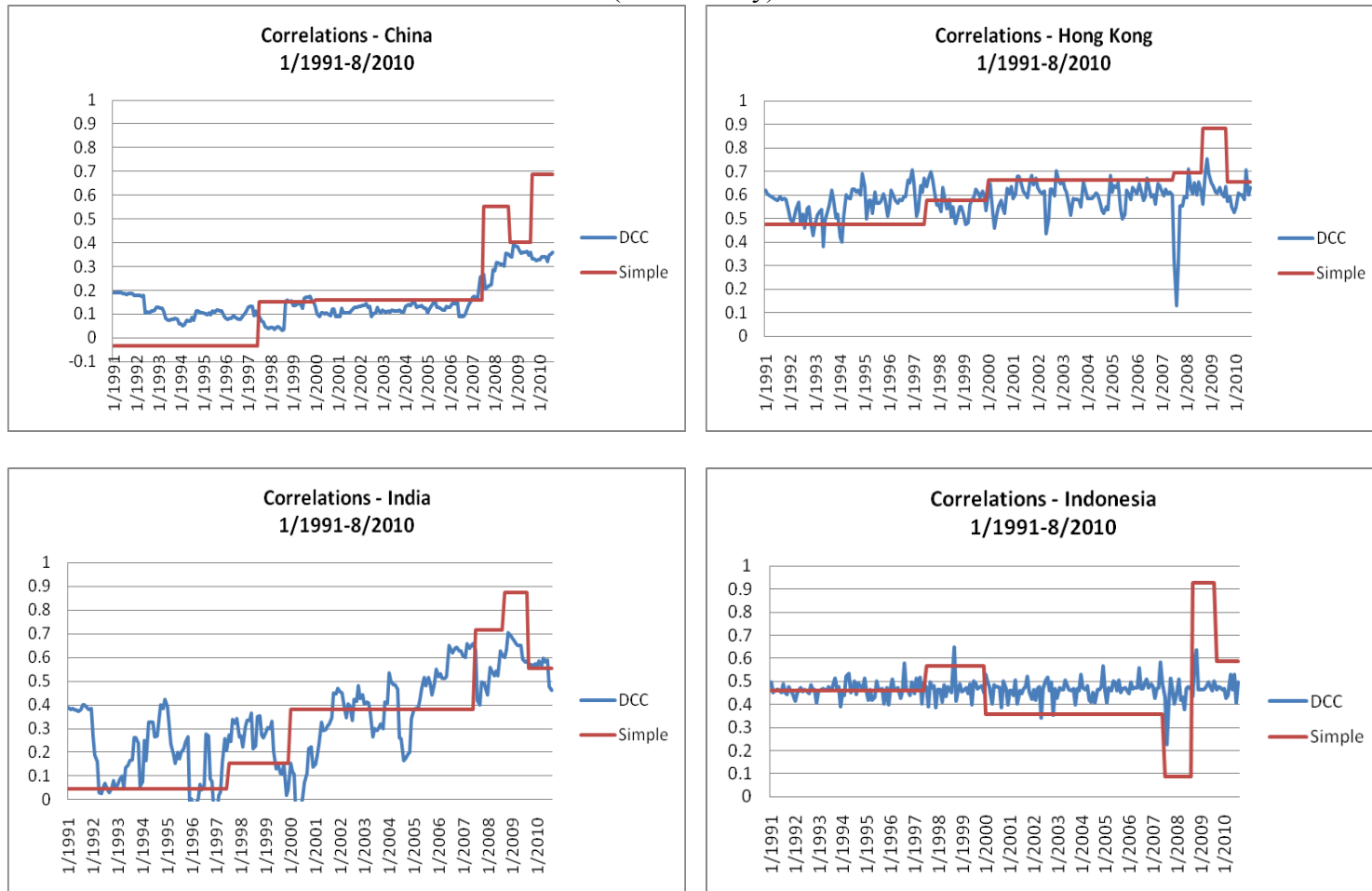
In the specifications, r_t denotes an $n \times 1$ vector of asset returns which have a mean of zero and the following time-varying covariance. D_t is defined as a diagonal matrix comprised of the standard deviations implied by the estimation of univariate GARCH models, which are computed separately, whereby the i^{th} element is denoted as $\sqrt{h_{i,t}}$. R_t is the time dependent correlation matrix and is a function of Q_t , which is the covariance matrix. k_i is the parameter associated with the squared lagged asset returns and λ_i is a weight parameter with the contributions of D_{t-1}^2 declining over time. S is the unconditional correlation matrix of the residuals ε_t of the asset returns r_t . In the matrix Q_t denotes a vector of ones, A and B are square, symmetric and \circ is the product (Hesse, Frank, and González-Hermosillo, 2008).

Based on the above algorithms, we use the DCC-GARCH tool box developed by Sheppard and run the dynamic correlations for all the economies in this study. Graph 4-2 and Graph 4-3 show the results of the time-varying correlations for the selected Asian equities and the regional MSCIs both collectively and individually (Graph 4-3 also includes simple correlations for the comparison).

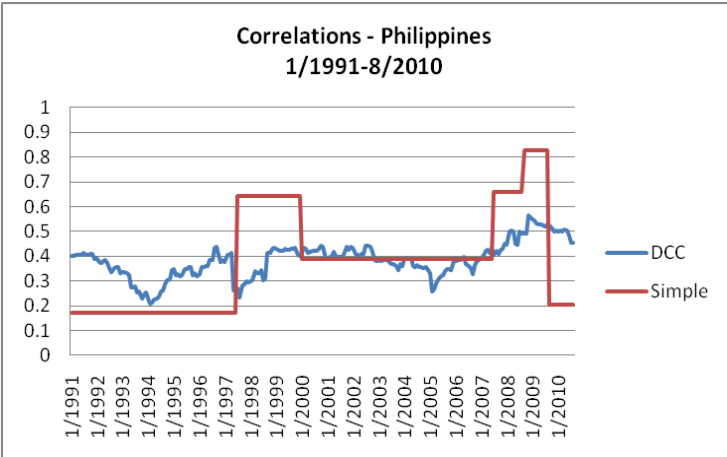
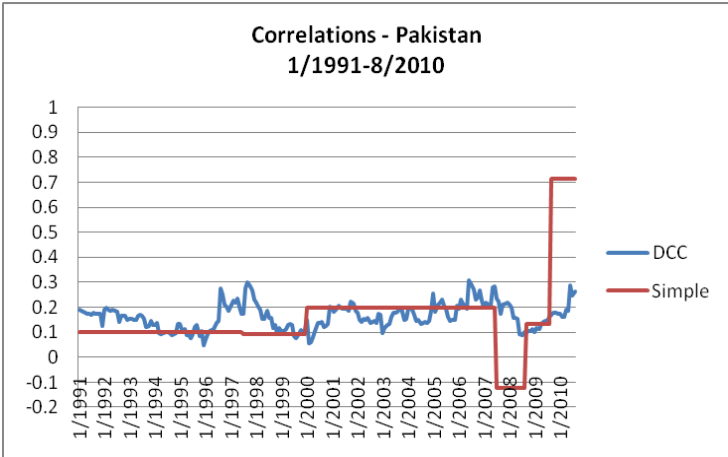
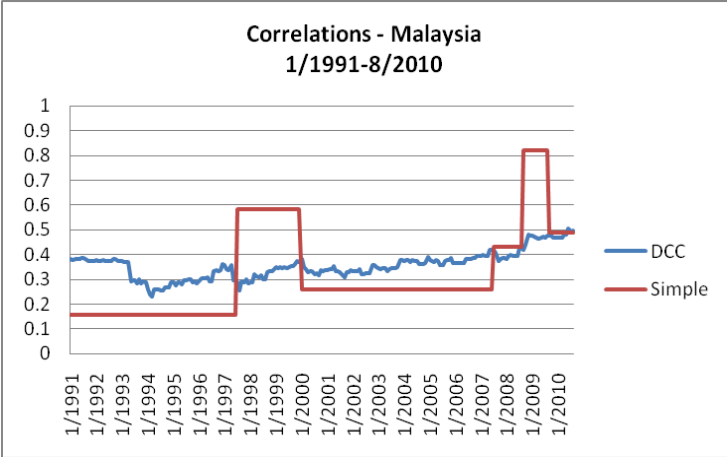
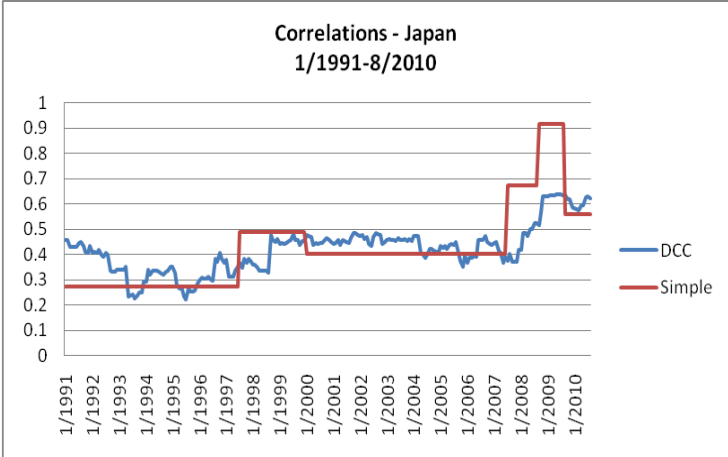
Graph 4-2. Dynamic Correlations (DCC-GARCH) between Selected Economies and the US
(Collectively)



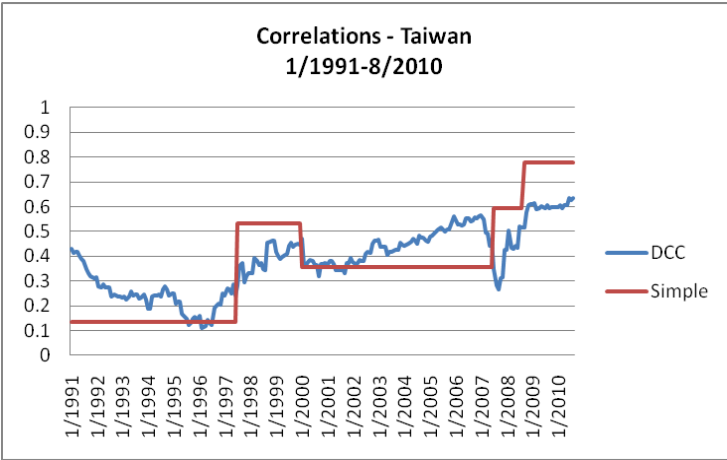
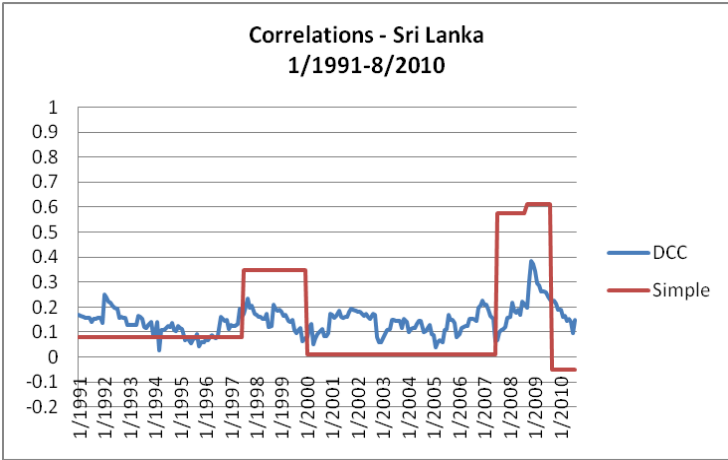
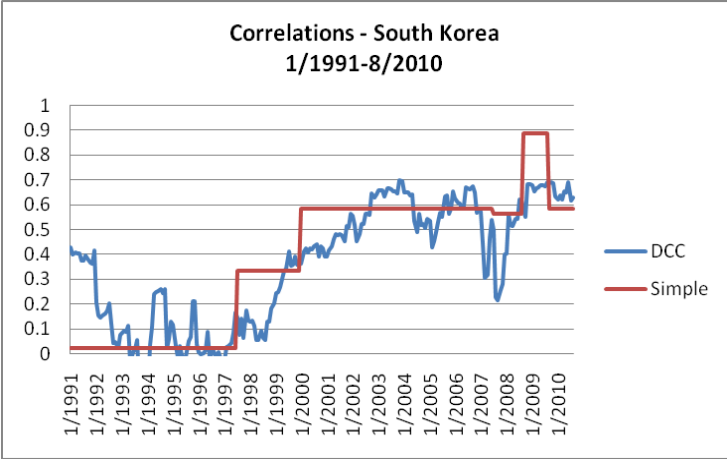
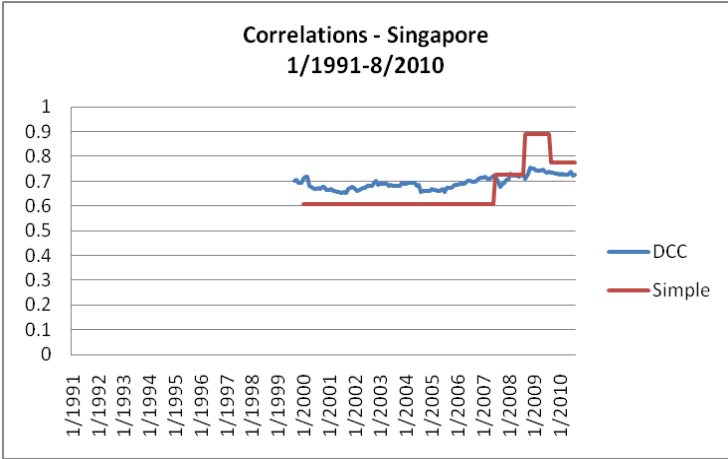
Graph 4-3. Dynamic Correlations (DCC-GARCH) and Simple Correlations between Selected Economies and the US (Individually)



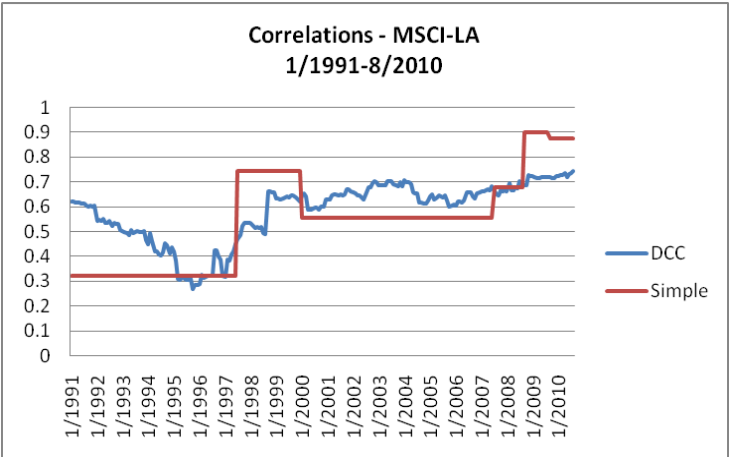
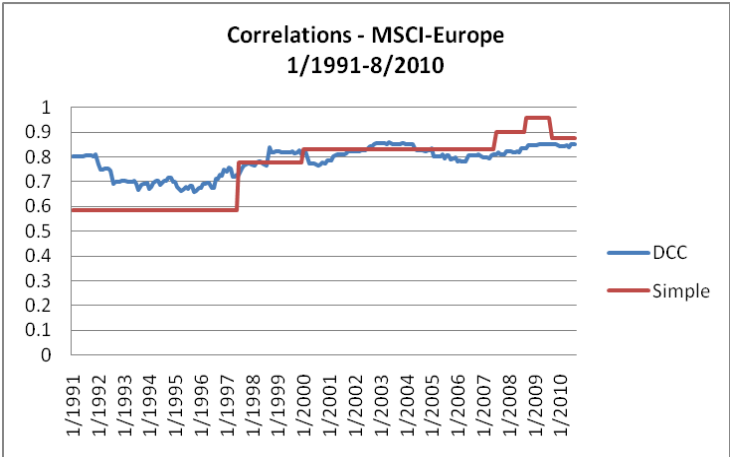
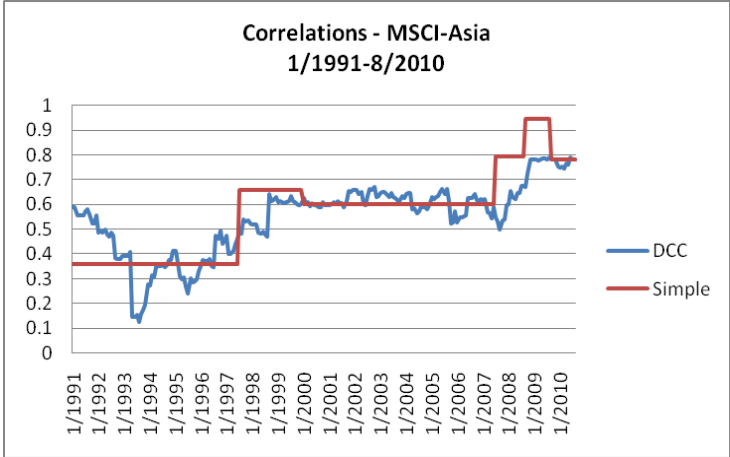
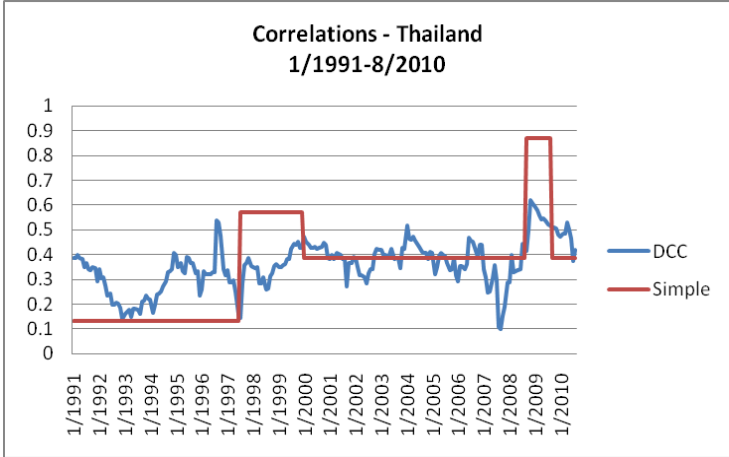
Graph 4-3. (Continued)



Graph 4-3. (Continued)



Graph 4-3. (Continued)



For dynamic correlations in Graph 4-2 and Graph 4-3, we see that for the regional correlations, Europe again showed the highest and relatively stable correlations over all the period from 1/1991 to 8/2010. Asia's correlations with the US were far below Europe's since the year of 1993, but caught up closer with Europe in the recent crisis, especially since 2008. Latin America's correlations were slightly higher than Asia most of the time, but became lower in the recent crisis since around 2008. Among the individual Asia economies, as we should expect, Singapore and Hong Kong had relatively high correlations, and China, Pakistan, and Sri Lanka had relatively low correlations for the whole period. In the 1997-98 Asian crises' period, Asian economies showed mixed changes of correlations with the US. For example, China and Thailand exhibited lower correlations while South Korea showed a higher correlation with the US. However, in the recent crisis, many economies had more substantial increases from 2008 on than in previous periods. Examples of these economies included China, India, Japan, Philippines, South Korea, and Thailand. There also appeared to be more of increases of correlations for the Asian economies in the 2008-2009 period than in the 2009-2010 period in which some economies showed a small tendency for the correlations to decline as the crisis loosened. To illustrate this better, we calculate the average of dynamic correlations for the period 9/2008-8/2010 with two sub-periods (Table 4-6). The dividing point is decided based on the trend of the dynamic graphs for a better comparison, which reflects the advantage of the dynamic correlations that the calculation doesn't depend on the predetermined dividing points as does the simple or HP filter detrended

correlations and thus can provide more robust results. Most Asia equity markets declined in correlations with the US in the second sub-period (9/2009-8/2010) from the first sub-period (9/2008 – 8/2009) except for Malaysia, Pakistan, and Taiwan.

Table 4-6. Average of Dynamic Correlations (DCC-GARCH) between Equity Returns of Selected Economies and the US
(Sub-Periods)

	Sub-Period 1 (9/2008-8/2009)	Sub -Period 2 (9/2009-8/2010)	Difference (2nd over 1st)
China	0.3642	0.3378	-0.0264
Hong Kong	0.6408	0.5926	-0.0482
India	0.6411	0.5577	-0.0834
Indonesia	0.4952	0.4708	-0.0243
Japan	0.6198	0.6059	-0.0139
Malaysia	0.4658	0.4788	0.0130
Pakistan	0.1238	0.1981	0.0743
Philippines	0.5297	0.4952	-0.0345
Singapore	0.7403	0.7289	-0.0113
South Korea	0.6572	0.6515	-0.0057
Sri Lanka	0.2862	0.1707	-0.1155
Taiwan	0.5925	0.6077	0.0152
Thailand	0.5444	0.4777	-0.0667
MSCI-Asia	0.7680	0.7690	0.0011
MSCI-Europe	0.8484	0.8475	-0.0008
MSCI-LA	0.7144	0.7271	0.0127

To see if there are some consistencies regarding the declined correlations for simple correlations in the above sub-periods, we calculate simple correlations again and find that most Asian equity markets decreased their correlations with the US in the second sub-period (9/2009-8/2010) from the first sub-period (9/2008 – 8/2009). The exceptions were China, Pakistan, and Taiwan (Table 4-7). The results show that simple correlations and dynamic correlations are consistent

in suggesting that correlations between the Asian economies and the US increased a lot in the period of 9/2008 to 8/2009 and decreased in the period of 9/2009 to 8/2010.

Table 4-7. Simple Correlations between Equity Returns of Selected Economies and the US
(Sub-Periods)

	Sub-Period 1 (9/2008-8/2009)	Sub -Period 2 (9/2009-8/2010)	Difference (2nd over 1st)
China	0.4041	0.6863	0.2822
Hong Kong	0.8814	0.6561	-0.2253
India	0.875	0.555	-0.3200
Indonesia	0.9297	0.5894	-0.3403
Japan	0.9182	0.5586	-0.3596
Malaysia	0.8203	0.4897	-0.3306
Pakistan	0.1327	0.7156	0.5829
Philippines	0.8277	0.2032	-0.6245
Singapore	0.8899	0.7763	-0.1136
South Korea	0.8868	0.584	-0.3028
Sri Lanka	0.6126	-0.0498	-0.6624
Taiwan	0.777	0.7777	0.0007
Thailand	0.8691	0.3856	-0.4835
MSCI-Asia	0.9433	0.7802	-0.1631
MSCI-Europe	0.9557	0.877	-0.0787
MSCI-LA	0.8989	0.8754	-0.0235

To further compare the results of the dynamic and the simple correlations, we add the updated simple correlations to Graph 4-3. Graph 4-3 shows that the simple correlations tended to go above the value of DCC-GARCH correlations during crises periods for most economies and regions. For example, for both the 1997-98 Asian crises period and most period of the recent financial crisis (7/2007-8/2009), the simple correlations were higher than dynamic correlations in most Asian economies and regions except for India, Indonesia, Pakistan, Singapore,

and MSCI-Europe. However, all of those exceptional economies and regions showed higher simple correlations in at least one of the crisis periods.

To illustrate the differences of the simple correlations and the dynamic correlations quantitatively, we calculate the average of dynamic correlations (Table 4-8) and the differences between simple correlations and the averages (Table 4-9). The results confirm that the simple correlations tended to produce higher estimates during crisis periods – the sum of differences between the simple correlation and DCC-GARCH correlations are positive in the previous Asian crises period (with a positive number of 1.54 in 7/1997-12/1999 vs. the negative number of -1.53 in 1/1991-6/1997) and the recent crisis (with positive numbers of 1.57, 3.59, and 0.74 in 7/2007-8/2008, 9/2008-8/2009, and 9/2009-8/2010 respectively vs. the negative number of -0.46 in 1/2000-6/2007). The percentages of cases where the simple correlation is greater than the dynamic correlation are relatively high (around 80 percent in the 1997-98 Asian crises, and 88 percent, 100 percent, and 63 percent in sub-periods of the recent financial crisis) in the crisis periods and relatively low (0 percent and 38 percent respectively) in the non-crisis periods.

Table 4-8. Average of Dynamic Correlations (DCC-GARCH) between Equity Returns of Selected Economies and the US

	1/1991- 6/1997	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2009	9/2009- 8/2010
China	0.1156	0.1041	0.1250	0.2822	0.3642	0.3378
Hong Kong	0.5631	0.5716	0.6002	0.5370	0.6408	0.5926
India	0.1900	0.2481	0.3817	0.5194	0.6411	0.5577
Indonesia	0.4651	0.4655	0.4672	0.4324	0.4952	0.4708
Japan	0.3390	0.4085	0.4418	0.4449	0.6198	0.6059
Malaysia	0.3241	0.3246	0.3575	0.3977	0.4658	0.4788

Pakistan	0.1482	0.1567	0.1779	0.1746	0.1238	0.1981
Philippines	0.3390	0.3666	0.3854	0.4560	0.5297	0.4952
Singapore			0.6813	0.7112	0.7403	0.7289
South Korea	0.1128	0.2016	0.5436	0.4427	0.6572	0.6515
Sri Lanka	0.1293	0.1564	0.1326	0.1571	0.2862	0.1707
Taiwan	0.2429	0.3919	0.4449	0.4034	0.5925	0.6077
Thailand	0.2934	0.3494	0.3888	0.2877	0.5444	0.4777
MSCI-Asia	0.3900	0.5627	0.6117	0.5996	0.7680	0.7690
MSCI-Europe	0.7186	0.7953	0.8153	0.8195	0.8484	0.8475
MSCI-LA	0.4515	0.5812	0.6490	0.6697	0.7144	0.7271

Table 4-9. Differences between Simple Correlations and Average of Dynamic Correlations (DCC-GARCH)

	1/1991- 6/1997	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2009	9/2009- 8/2010
China	-0.15	0.05	0.04	0.27	0.04	0.35
Hong Kong	-0.09	0.00	0.06	0.16	0.24	0.06
India	-0.14	-0.09	0.00	0.20	0.23	0.00
Indonesia	0.00	0.10	-0.11	-0.34	0.43	0.12
Japan	-0.06	0.08	-0.04	0.23	0.30	-0.05
Malaysia	-0.17	0.26	-0.10	0.03	0.35	0.01
Pakistan	-0.05	-0.07	0.02	-0.30	0.01	0.52
Philippines	-0.17	0.27	0.00	0.20	0.30	-0.29
Singapore			-0.07	0.02	0.15	0.05
South Korea	-0.09	0.13	0.04	0.12	0.23	-0.07
Sri Lanka	-0.05	0.19	-0.12	0.42	0.33	-0.22
Taiwan	-0.11	0.14	-0.09	0.19	0.18	0.17
Thailand	-0.16	0.22	0.00	0.10	0.32	-0.09
MSCI-Asia	-0.03	0.10	-0.01	0.19	0.18	0.01
MSCI- Europe	-0.14	-0.02	0.01	0.08	0.11	0.03
MSCI-LA	-0.13	0.16	-0.09	0.01	0.18	0.15
Sum	-1.53	1.54	-0.46	1.57	3.59	0.74
Percentage	0.00	80.00	37.50	87.50	100.00	62.50

Note: The percentage refers to percentage of the number of records that simple correlation is greater than dynamic correlation in the single period.

In summary, in the DCC-GARCH correlations, Asian equity markets didn't move as closely with the US as European markets did over all, but they

tended to catch up to Europe, especially during the recent financial crisis. Asia's correlations with the US were slightly lower than that of Latin America in the beginning but higher during the recent crisis. Among individual Asian economies, Hong Kong and Singapore had relatively stable high correlations with the US during the whole period. Pakistan and China showed lower correlations overall but increased their correlations during the recent crisis. The Asian economies showed mixed changes in the 1997-98 Asian crises with the US, but in the recent crisis, many individual economies tended to move more closely with the US, with much higher correlations in the 2008 to 2009 period followed by somewhat lower correlations in the period of 2009 to 2010. Though the simple correlations tended to produce higher estimations than the dynamic correlations did, they were consistent with each other in showing the changes of correlations in the recent financial crisis.

4.3 Implications of the Results

The different levels of correlations among Asian economies have important implications. Examples of the high correlation economies with the US are Singapore and Hong Kong. The high correlations imply that those economies have been integrated with the advanced world market well. Examples of the low correlation economies with the US are Pakistan and China. The lower correlations reflect that the economies weren't highly integrated with the world market to begin with. In the case of China, the economy outperforms the world economy.

The changes of correlations for the Asian individual economies have some implications as well. Measuring the decoupling with changes in correlations, our results suggest that the Asian equity markets tended to show some signs of decoupling with the US in the beginning period of the recent crisis (7/2007-8/2008), signs of recoupling after the collapse of Lehman brothers up to late 2009 (9/2008-8/2009), and signs of decoupling again in the later period of the recent crisis (9/2009-8/2010).

As shown in the percentage changes of the average of dynamic correlations (Table 4-10), for example, the correlations in the period of 7/2007-8/2008 increased for some economies such as China and India, and decreased in some economies such as Thailand and South Korea. Compared with the percentage changes in the previous non-crisis period (1/2000-7-2007) when most economies had increased correlations over the previous period, this period of 7/2007-8/2008 tended to show more signs of decoupling for the overall Asian economies. Later on, the correlations in the period of 9/2008-8/2009 increased substantially (ranging from 3.5 to 89.3 percent) from the previous period for most of the Asian economies except for Pakistan. The dramatic increases in correlations suggest there were more interdependencies between some of the Asian economies and the US and that the Asian economies might recouple with the developed world. The correlations in the period of 9/2009-8/2010 decreased quite a bit (ranging from 0.1 to 40.4 percent) from the previous period for most Asian economies except for Pakistan, Malaysia, and Taiwan. Those decreases in correlations suggest that Asian economies were more independent by keeping the

momentums of their stable domestic growth. However, though the correlations in this period decreased, most of them were still higher than the correlations in other periods of and before the recent financial crisis. Thus, based on the overall pattern of changes in correlations, the decoupling view is not strongly supported in the recent financial crisis.

Table 4-10. Percentage Changes of the Average of Dynamic Correlations (DCC-GARCH)

	7/1997- 12/1999	1/2000- 6/2007	7/2007- 8/2008	9/2008- 8/2009	9/2009- 8/2010
China	-9.90	20.07	125.71	29.06	-7.24
Hong Kong	1.51	5.00	-10.53	19.33	-7.52
India	30.59	53.84	36.09	23.43	-13.01
Indonesia	0.07	0.36	-7.44	14.52	-4.91
Japan	20.51	8.16	0.70	39.31	-2.24
Malaysia	0.16	10.11	11.26	17.13	2.78
Pakistan	5.70	13.54	-1.85	-29.08	60.00
Philippines	8.13	5.13	18.33	16.15	-6.50
Singapore			4.39	4.09	-1.53
South Korea	78.73	169.66	-18.55	48.44	-0.87
Sri Lanka	21.02	-15.26	18.53	82.18	-40.36
Taiwan	61.32	13.53	-9.32	46.86	2.57
Thailand	19.09	11.28	-26.02	89.26	-12.25
MSCI-Asia	44.28	8.71	-1.98	28.07	0.14
MSCI-Europe	10.68	2.52	0.51	3.52	-0.10
MSCI-LA	28.73	11.66	3.19	6.68	1.78

We should not put too much weight on those correlations themselves, but they do suggest that we should not be too quick to accept the argument that the Asian economies have decoupled from the US. After all, we have entered a world that has characterized with more economic exchanges and interdependence.

Having identifying the comovements in equity returns between Asian economies and the US, we investigate the magnitudes of transmission of the recent crisis through different channels to the Asian equity markets in the next chapter.

Chapter 5. The Magnitudes of the Transmission in Equity Returns – Panel Least Squares Fixed Effect Estimations and Dynamic VAR Analyses

In this chapter, we investigate the magnitudes of transmission of the recent financial crisis in equities through different channels or factors. We include global factors such as US equities and European equities and domestic factors such as GDP growth, inflation, exchange rate, interest rate, political risk, and so on to run regressions on Asian equities using the panel least squares fixed effect estimations and the dynamic method of VAR analyses, revealing the magnitudes of transmission through different factors, especially the global ones, in the recent financial crisis.

5.1 Data

Based on data availability, we include 10 major Asian economies, namely, China, Hong Kong, Indonesia, India, Japan, Malaysia, the Philippines, Singapore, South Korea, and Thailand, and the US and the developed European economies into the analysis. Our research period runs from July 1997 to August 2010, which covers the time from the 1997-98 Asian crises into the recent global financial crisis.

We focus on the same major equity returns of the Asian economies as in the previous correlation analysis. For the influencing factors, we select major determinants of equity prices based on the empirical results of the related literature. As in the IMF research (2007 and 2008), we group the factors as the foreign block and the domestic block. The foreign block factors include equity

returns of the S&P500 index and the MSCI – Europe. The domestic block factors include the main factors of GDP growth rate, consumer price index, exchange rate, central bank interest rate and other economic or political factors for each of the Asian economies. Based on general economic view, the above factors are expected to affect equity prices in the following ways:

S&P 500 index and MSCI-Europe - The S&P500 index represents the broad equity market of the US; the MSCI-Europe represents the equity markets for the developed European economies and could be used as a proxy for equity markets for the rest of the developed economies in the world vs. the Asian economies. Both indices play the role of common shocks for the Asian equity markets and are expected to have a positive relationship with Asia's equity prices.

GDP growth - The GDP growth rate is a measure of overall economic activity and thus could affect equity markets through its influence on expected future economic outlooks and cash flows. A change in GDP growth could be expected to influence the equity prices positively in normal cases.

Consumer price index - The consumer price index measures the inflation rate and might have a mixed effect on equity prices. When consumer prices rise, the equity price could either increase as the overall price of the economy increases or decrease as inflation will ultimately translate to an increase of the nominal interest rate which results in reduction of the present value of cash flow.

Exchange rate - The exchange rate influences the competitiveness of an economy and could have a mixed effect on equity prices as well. On the one hand, the depreciation in home currency could increase exports and therefore

corporations increase their profits which ultimately raises equity prices in the short run; on the other hand, depreciation of the exchange rate could increase the current account and reduce capital inflows, which results in loss of corporate profits and decreases in equity prices.

Interest rate - The interest rate measures the cost of capital. On the one hand, an increase in interest rates leads to decrease in present value of future cash flows thus will reduce stock prices; on the other hand, higher interest rate can attract more capital inflows which will prompt demand for investment in the domestic economies and increase equity prices. Therefore, it is hypothesized that the interest rate has mixed relationship to equity market prices.

Among the main economic factors, we adopt the form of differentials vs. the US for the CPI and interest rate as did the IMF 2008 study, and used equity returns (difference of the equity prices) for S&P500 and MSCI-Europe indices. The exchange rate is in form of national currency per US dollar in our analysis. The expected influencing effects should remain the same as mentioned previously.

Additional economic or political factors are expected to contribute to the movement of the equity prices as well. To find the robust estimations on determinants of equity returns, we also include some other domestic factors such as international reserves, exports to the US, net direct investment, net portfolio investment³, and the ICRG political risk index⁴ to help explain the change in the equity markets.

³ The original data of the above factors are available in units. We transform them into ratios by dividing the value of the current period by the value of the previous period.

The equity returns are calculated as the first difference of equity prices collected from Bloomberg and the MSCI database; the data of most domestic factors are from International Financial Statistics and Balance of Payment of the IMF database; and the political risk index is from the PRS group ICRG database. All data are monthly data except for GDP growth, net direct investment, and net portfolio investment for which only quarterly data are available. To make them monthly, quarterly data are converted to monthly using one of the frequency conversion methods of Cubic – match last method in Eviews.⁵

5.2 Methodologies and Results

To find the magnitudes of the transmission factors in the Asian equity markets, two kinds of multi-factor analyses are performed. They are the panel least squares fixed effect estimation, and the dynamic method of VAR analysis for each Asia economy. Eviews is used to produce the quantitative results.

5.2.1 The Panel Least Squares Fixed Effect Estimations

⁴ The political risk index is from the International Country Risk Guide (ICRG) database developed by the PRS group. The Political Risk Rating includes 12 weighted variables covering both political and social attributes. The variables include Government Stability, Socioeconomic Conditions, Investment Profile, Internal Conflict, External Conflict, Corruption, Military in Politics, Religious Tensions, Law and Order, Ethnic Tensions, Democratic Accountability, and Bureaucracy Quality. The higher the index is, the lower the risk is.

⁵ The Cubic – match last method in Eviews assigns all intermediate points on a natural cubic spline connecting all the points of the low frequency data. A natural cubic spline has the following properties: each segment of the curve is represented by a cubic polynomial; adjacent segments of the curve have the same level, first derivative, and second derivative at the point where they meet; the second derivative of the curve at the two global end points is equal to zero.

The panel least squares fixed effect model is a statistical model that represents the observed quantities in terms of explanatory variables that are treated as non-random. The basic model is:

$$Y_{it} = \alpha + X'_{it}\beta_{it} + \delta_i + \gamma_t + \varepsilon_{it}$$

where Y_{it} is the dependent variable observed for individual i at time t , α is the overall constant in the model, X_{it} is the time-variant regressor, δ_i and γ_t represent cross-section or period specific effects, and ε_{it} is the error term. In the fixed effect model, the δ_i or γ_t is treated as a set of fixed (non-random) parameters. As the fixed effect method enables the control for more common characteristics of the individuals in the study and potentially reduces bias, we use this method (cross-section fixed effect) to estimate the influencing factors of the equity markets as the first cut.

Before running the regressions, we perform a stationary test for all variables. Several panel unit root tests methods such as Levin, Lin and Chu test, Breitung test, and Augmented Dickey-Fuller and Phillips-Perron unit root tests are used. Results show that equity return, GDP growth rate, CPI differential, interest rate differential, reserve, export to the US, net direct investment, and net portfolio investment are stationary⁶ in at least one of the stationary tests, while the exchange rate and political risk index are stationary in their first differences. We use these stationary data for the estimations.

Setting equity returns of Asian markets as the dependent variable, we use different sets of independent variables to run panel least squares fixed effect

⁶ As the reserve, export to the US, net direct investment, and net portfolio investment have been transformed to ratios earlier, they are stationary.

regressions for the whole research period of July 1997 to August 2010 for robust test. Table 5-1 shows the common coefficients of the panel regressions for Hong Kong, India, Indonesia, Japan, Philippines, Singapore, South Korea and Thailand (China and Malaysia are not included as quarterly GDP growth in China and monthly interest rates for Malaysia are not available at the time). The results suggest that for the whole period, both S&P500 and MSCI-Europe had significant positive effects on Asian equity returns, which is under the expectation. While not statistically significantly, GDP growth, direct investments, and political risk had positive relationships to the equity returns, exports to the US and net portfolio investment had negative effects, and the rest of the factors had mixed effects on equity returns. The relationships for most domestic factors are within expected range for either crisis or non-crisis case. The R-squared statistics show that regression 5 and regression 7 have the best fit. We use regression 5 and 7 for further analyses.

Table 5-1. Robust Test for Factors of Asian Equity Returns
 Panel Least Squares Fixed Effect Estimations
 July 1997 - August 2010

Dependent variable - Equity Returns of the Asian Economies							
Independent Variable	1	2	3	4	5	6	7
Global factors							
S&P 500	2.7043 ***		2.7077 ***	2.7180 ***	3.1415 ***	2.7180 ***	3.1486 ***
MSCI-Europe	2.8849 ***		2.8819 ***	2.8695 ***	2.9033 ***	2.8695 ***	2.8944 ***
Domestic factors							
GDP growth rate	1.9614	3.0961	1.8278	1.8958	0.4366	1.8958	0.5131
CPI differential	3.0301	5.7059	2.9163	2.8731	-0.2771	2.8731	-0.3088
Exchange rate	0.0467	-0.0151	0.0477	0.0437	0.0522	0.0437	0.0494
Interest rate differential	-3.0763	-7.7879	-3.0203	-3.0122	0.0553	-3.0122	0.0740
Reserve	-0.7230	9.0611					
Export to US	-0.0634	-0.4311					
Net Direct investment	0.0168	0.0160	0.0168	0.0171		0.0171	
Net portfolio investment	-0.0013	-0.0051					
Political risk index	9.2395	4.4581	9.4306		6.8278		
R-squared	0.2153	0.0103	0.2152	0.2149	0.2182	0.2149	0.2180
No. of Observations	156	156	156	156	156	156	156

Note: The *** means data is significant at 1% level, ** significant at 5% level, *significant at 10% level.

Using the suggested factors in regression 5 in Table 5-1 (variable set 1), we run panel regressions on Asian equity returns for the period of recent crisis as well as the period of 1997-98 Asian crises, and the period in between (namely, the ordinary period) for the purpose of comparison (Table 5-2).

Table 5-2. Factor Effects on Asian Equity Returns in Different Periods

Panel Least Squares Fixed Effect Estimations – Variable Set 1				
Dependent Variable - Equity Returns of the Asian Economies				
Independent Variable	Asian crises (7/1997- 12/1999)	Ordinary Period (1/2000-6/2007)	Recent Crisis (7/2007- 8/2010)	Whole Period (7/1997- 8/2010)
Global factors				
S&P 500	2.9378***	1.7483***	3.5569***	3.1415***
MSCI-Europe	1.8874**	2.2162***	4.9114***	2.9033***
Domestic factors				
GDP growth rate	-4.6230	4.3909	-3.0093	0.4366
CPI differential	-14.0747*	12.4943**	42.5154*	-0.2771
Exchange rate	0.0125	0.0367	0.3992	0.0522
Interest rate differential	16.5926	-3.4463	-54.4503	0.0553
Political risk index	-20.3809	15.0802	17.1995	6.8278
R-squared	0.1965	0.1725	0.3133	0.2182
No. of Observations	30	90	36	156

Note: The *** means data is significant at 1% level, ** significant at 5% level, *significant at 10% level.

The results in Table 5-2 show that the global factors of S&P500 and MSCI-Europe significantly influenced Asian equity markets with positive coefficients in all periods. The magnitudes of the effects of the global factors were the highest in the recent financial crisis. One unit of decrease in the US S&P500 equity returns, for example, would decrease the returns of the Asian equity markets by 3.56 units in the recent crisis, and by only 2.94 and 1.75 units in the 1997-98 Asian crises and the ordinary period respectively. One unit of decrease in the Europe's MSCI equity returns would decrease the returns of the Asian equity markets by 4.91 units in the recent crisis, and by only 1.89 and 2.22 units in the 1997-98 Asian crises and the ordinary period respectively. This implies that in the recent

financial crisis, the US and European played more important roles in the price changes of the Asian equity markets than in the previous periods. The larger coefficients of the European factor in the recent crisis doesn't necessarily mean that Europe had more effects on the Asian equity returns than the US did since the coefficients may also reflect the unit of the equity indices used for the US and Europe (equity returns in this case). However, the coefficients of the Europe equity did show slightly more increases (with an increase of 122 percent) in the recent crisis period from the ordinary period than the US did (with an increase of 103 percent). The results of the global factors in this panel analysis are consistent with the results of the IMF 2008 study where it used MSCI world equity as one of the global factors and found significant positive effects on Asian equities in the period 1/2001-5/2008.

For domestic factors, the inflation differential significantly influenced equity market returns positively in the recent crisis but negatively during the 1997-98 Asian crises. The results of the IMF study (2008) showed mixed results on inflation differential for the period of 1/2001 to 5/2008 as well. Different from the IMF study, our results here enable us to analyze both the crisis and ordinary periods individually. Our results imply that increases of domestic prices might reflect better economic outlooks and resulted in higher stock prices in the recent crisis while in the 1997-98 Asian crises, the increased prices lowered stock returns through other economic mechanisms such as lower real interest rates which produced more capital outflow.

Other domestic factors didn't show statistically significant effects on the Asian market returns but their signs provided some economic information. For example, the GDP growth rate had negative effects on equity returns in both the Asian crises and the recent crisis periods, but positive effects in the ordinary period. Those results are different from the IMF study (2008) which found significant positive effects of GDP growth on the Asian equity markets in the period of 1/2001-5/2008, but at the same time, our sign of the coefficients in the ordinary period is consistent with the IMF results since the IMF study period was mostly covered by our ordinary period (1/2000-7/2007). A possible interpretation on the negative effects of the crises periods is that good GDP reports during the crisis period might be considered as the beginning of the falling point when the corporate profits began to erode. In this case, a strong GDP report would have a negative effect on the equity markets.

The exchange rate showed positive effects of depreciation for all the periods which is consistent with the empirical evidences that exchange depreciation of an economy may increase its trade competitiveness and thus increase corporations' profits and their equity prices. The results of the IMF study (2008) suggested that an increase of the expected exchange rate increased the stock market prices. Both results are reasonable in the economic interpretations. The interest rate differential had negative coefficients in the recent crisis and the ordinary period but positive one in the 1997-98 period. The signs of the interest rate differential in both the recent crisis and ordinary period are consistent with the IMF study (2008) which found significant negative effects

in the period of 1/2001-5/2008. The negative effect of the interest rates on equity prices implies that the effect of value of future cash flow dominated in the recent crisis and the ordinary period. The positive role of interest rates in the Asian crises could then be explained by the situation that higher interest rates helped attract more capital inflows through the financial sector and thus increased stock prices. The political risk factor (higher the index value, lower the risk) also negatively influenced equity returns for the recent crisis and the ordinary period in the results, which represented the common consensus that more stable political environment would help boost the investment in equity markets. The negative sign of the political risk index in the 1997-98 case appeared to be counter-intuitive as it implied higher political risk produced higher equity returns. But this to some extent could be explained by the increasing high return driven investment behaviors under the unstable social environment.

Taking the political risk factors off and running regression 7 in Table 5-1 (variable set 2), we find similar results in Table 5-3 as in Table 5-2. The global factors of S&P500 and MSCI-Europe again positively influenced the Asian market in all different periods and the magnitudes of the influencing effects were highest and increased the largest in the recent crisis. The domestic factors also influenced the Asian economies in the similar way as in the previous estimation.

Table 5-3. Factor Effects on Asian Equity Returns in Different Periods
Panel Least Squares Fixed Effect Estimations - Variable Set 2

Dependent Variable - Equity Returns of the Asian Economies				
Independent Variable	Asian crises (7/1997- 12/1999)	Ordinary Period (1/2000-6/2007)	Recent Crisis (7/2007- 8/2010)	Whole Period (7/1997- 8/2010)
Global factors				
S&P 500	2.9216***	1.7648***	3.5842***	3.1486***
MSCI-Europe	1.9801**	2.2170***	4.8970***	2.8944***
Domestic factors				
GDP growth rate	-5.2348	4.3207	-2.9739	0.5131
CPI differential	-13.9645*	12.7295**	43.0904*	-0.3088
Exchange rate	0.0168	0.0185	0.3980	0.0494
Interest differential	16.6247	-3.4591	-55.0226	0.0740
R-squared	0.1939	0.1708	0.3131	0.2180
No. of Observations	30	90	36	156

Note: The *** means data is significant at 1% level, ** significant at 5% level, *significant at 10% level.

In summary, for the recent crisis, the results of panel least squares fixed effect suggest that Asian equity returns were influenced significantly by global equity markets including the US and European ones. The magnitudes of the influences from the US and the Europe in the recent financial crisis were greater than in the 1997-98 Asian financial crises and the ordinary period. Domestic factors such as inflation played a significant positive role on the Asian equity markets. Among other domestic factors, the GDP growth rate, exchange rate, interest rate differential, and political risk factor had negative effects, and exchange rate had positive effects of depreciation on Asian equity returns in the recent financial crisis. Using different set and forms of factors from the IMF research (2008), our results are mostly consistent with the empirical results of the

IMF (2008) which found significant positive effects in global equity factors, mixed effect in inflation differentials, and negative effects in interest rate differentials for the recent financial crisis.

The panel least squares fixed effect estimation is a relatively static analysis. It provides a general picture of the influences of the factors with simple interactions hold between the variables. In the real world, the factors that influence equity markets may associate with different degrees of endogeneity. That is, the shocks from one factor may not only affect the equity returns of the economy, but also affect other factors that determine the equity returns of that economy. To further investigate the magnitudes of the influencing factors of the Asian equity market in the recent financial crisis, we conduct a more dynamic method of the multi-factor estimation - the VAR analysis.

5.2.2 The Dynamic VAR Analyses

Vector autoregression (VAR) analyzes the dynamic impact of random disturbances and describes the evaluation of a set of endogenous variables in the system as a linear function of their past evolution. The reduced form presentation of the VAR model is as the following:

$$y_t = c + A_1 y_{t-1} + A_2 y_{t-2} + \dots + A_p y_{t-p} + e_t$$

where y_t is a set of k time series variables: $y_t = (y_{1t}, y_{2t}, \dots, y_{kt})'$, c is a $k \times 1$ vector of constants, the A s are $k \times k$ matrices of coefficients, p is the order or lag of the model, and e_t is a $k \times 1$ vector of error terms - the e_t s are serially uncorrelated but may be contemporaneously correlated. The VAR model enables

analyzing the effect of the innovational shocks allowing interactions among variables and provides more dynamic solutions to the estimates.

To investigate how the global factors, especially the shock in the US equity market, influenced the Asian equity markets dynamically, we estimate a seven-variable VAR for each of the Asian economies (China and Malaysia are not included due to the lack of data availability) using the same set of stationary variables used in the previous panel fixed effect estimations. The seven variables are the global factors of S&P 500 equity return and MSCI-Europe equity return, and the domestic factors of the interest rate differential, the CPI differential, exchange rate (in first difference), GDP growth rate and the major equity returns for eight Asian economies.

Based on common economic views and the literature (Genberg 2005; IMF, 2007; IMF, 2008), we make assumptions regarding the endogeneity of the variables in the recent financial crisis. The assumptions are, fluctuations in US equities are determined independently of fluctuations of both European and Asian equities; fluctuations in Europe equities depend on the US but not on Asian equities; and fluctuations in Asian equities are determined by the fluctuations of all the global and domestic factors. Based on empirical structural VAR specifications used by Genberg (2005) and IMF (2007), the interactions among factors can be described by the following general model:

$$\begin{pmatrix} A_0^{ii} & A_0^{iM} & A_0^{iU} \\ 0 & A_0^{MM} & A_0^{MU} \\ 0 & 0 & A_0^{UU} \end{pmatrix} \begin{pmatrix} x_t^i \\ x_t^M \\ x_t^U \end{pmatrix} = \begin{pmatrix} A^{ii}(L) & A^{iM}(L) & A^{iU}(L) \\ 0 & A^{MM}(L) & A^{MU}(L) \\ 0 & 0 & A^{UU}(L) \end{pmatrix} \begin{pmatrix} x_{t-1}^i \\ x_{t-1}^M \\ x_{t-1}^U \end{pmatrix} + \begin{pmatrix} \mu_t^i \\ \mu_t^M \\ \mu_t^U \end{pmatrix}$$

where x_t^U , x_t^M , and x_t^i represent variables in the US, other global economies (the “middle economies” - Europe here), and individual Asian economy i respectively.

A_0 and $A(L)$ represent structural coefficients and the error vector contains structural shocks to the equation. The triangular form of the matrices that multiply the vectors of endogenous variables reflects the assumed recursive nature of the interactions between them. That is, x^i are determined by global factors (x^U and x^M) and domestic factors (x^i). The “middle economies” (x^M) are assumed to depend on x^U and x^M but not significantly on x^i . And x^U are determined independently of both x^M and x^i . Furthermore, the VAR residuals are such that the error terms of the US are linear combinations of the elements of μ^U only, that the error terms of the middle economies are linear combinations of μ^U and μ^M , but not of μ^i , and that error terms of the individual Asian economies are linear combinations of all.

We conduct the Cholesky impulse functions and variance decompositions in the VAR estimations. The Cholesky process helps to capture the contemporaneous relationship mentioned in the assumption. The Cholesky order matters as it defines the degree of endogeneity of different factors in the VAR estimations. According to our assumption, the US’s equity return is the most exogenous variable and is put the first in the Cholesky order. Europe’s equity return is put the next as its fluctuation is assumed to affect the other domestic

factors but not the US. The individual Asian equity return is assumed to be affected by all the global and domestic shocks, so it is the most endogenous variable and is put the last. Other endogenous domestic factors are put in between the equity returns of Europe and those of Asian individual economies. In Cholesky order, those domestic factors are the interest rate differential, the CPI differential, exchange rate (in first difference), and the GDP growth rate. We order these domestic factors based on the macro economic logic that interest rate is usually decided first in an economy, then CPI and the exchange rate will change accordingly, and the GDP will be affected eventually. There are alternative ways to make orders based on different theories. Our order reflects the assumptions we make based on one of the common views in the literature.

We first run the seven-variable VAR for the recent financial crisis (7/2007-8/2010) and then for the ordinary period (1/2000-6/2007) to compare the effects of the shocks. Lags for the two periods are selected based on Schwarz information criterion.⁷ Graph 5-1 lists impulse functions for effects of shocks from the US and Europe to each of the eight Asian equity markets in the recent financial crisis. The Asian equity markets responded to the shock from the US in a similar fashion. The US had a positive effect to the Asian equities at the same time of the shock, then the responses of the Asian equity tended to fluctuate later on and the positive impacts of the shock from the US decreased overtime. The impacts from Europe were positive with some less degree than the US for most of the Asia economies. The results of the impulse functions in most Asian

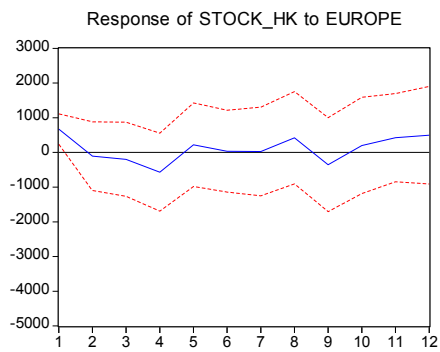
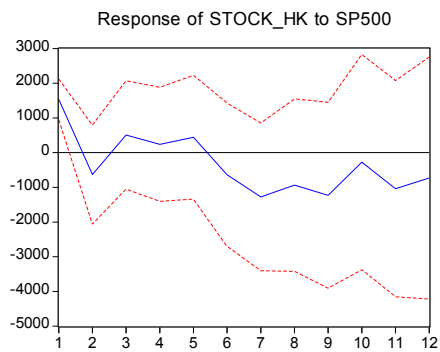
⁷ Lag of 4 is selected for each of the Asian economies (except for India and the Philippines of which lag of 3 is selected) during the recent financial crisis period (7/2007-8/2010); lag of 1 is selected for all the Asian economies during the ordinary period (1/2000-6/2007).

economies are consistent with the results in the previous panel least squares estimations in that changes in equity prices in the US and Europe had substantial positive effects on Asia's equity markets.

Graph 5-1. Impulse Functions on Effect of Shocks from the US and Europe in the Recent Financial Crisis
July 2007 – August 2010

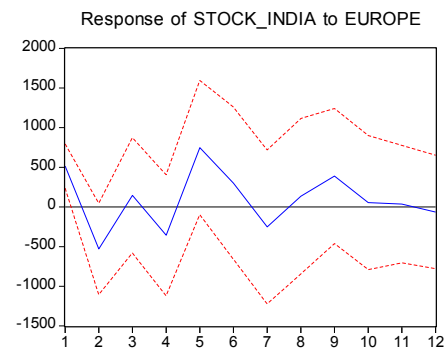
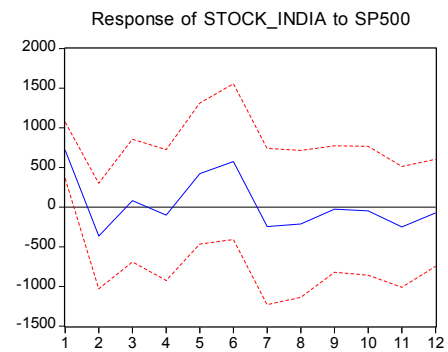
Hong Kong

Response to Cholesky One S.D. Innovations ± 2 S.E.



India

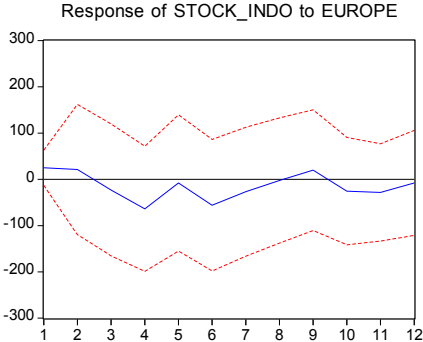
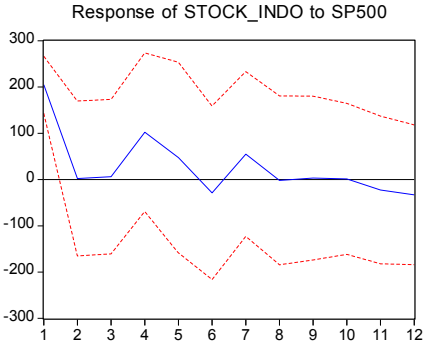
Response to Cholesky One S.D. Innovations ± 2 S.E.



Graph 5-1. (Continued)

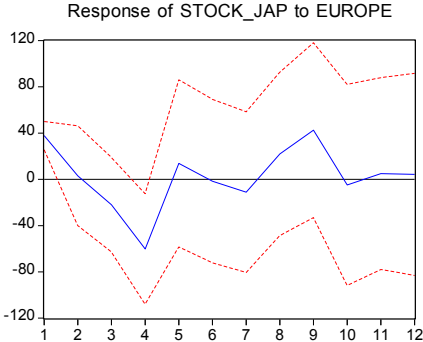
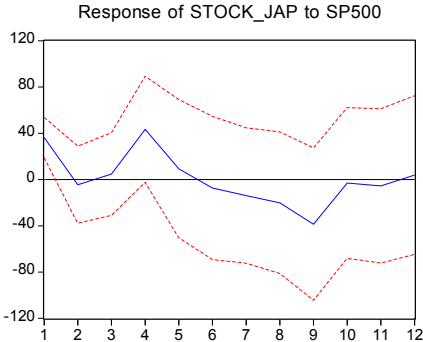
Indonesia

Response to Cholesky One S.D. Innovations ± 2 S.E.



Japan

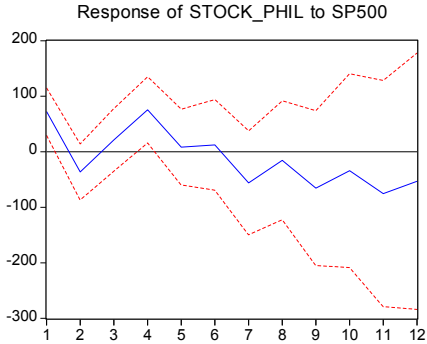
Response to Cholesky One S.D. Innovations ± 2 S.E.



Graph 5-1. (Continued)

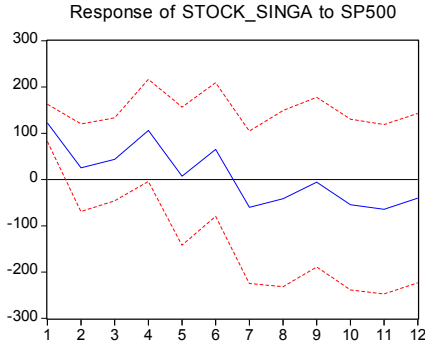
Philippines

Response to Cholesky One S.D. Innovations ± 2 S.E.

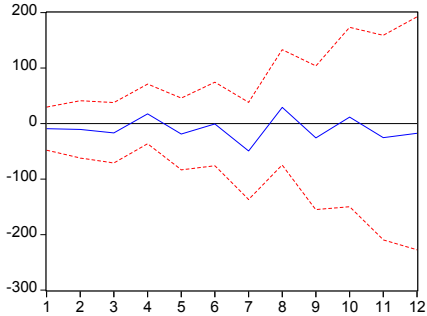


Singapore

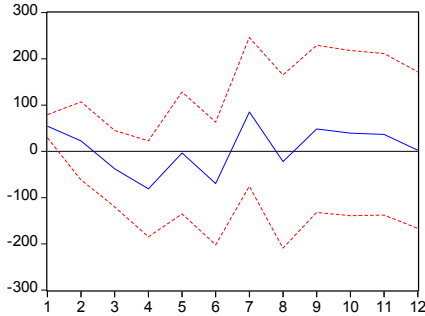
Response to Cholesky One S.D. Innovations ± 2 S.E.



Response of STOCK_PHIL to EUROPE



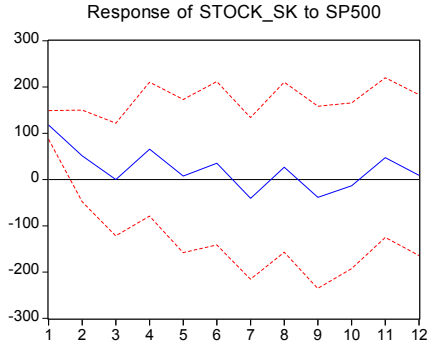
Response of STOCK_SINGA to EUROPE



Graph 5-1. (Continued)

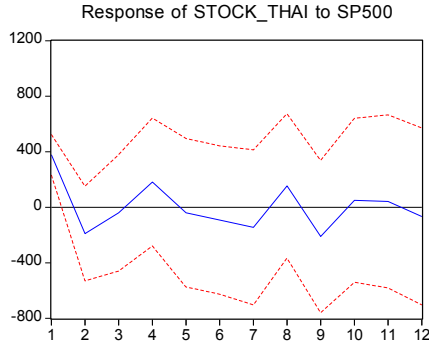
South Korea

Response to Cholesky One S.D. Innovations ± 2 S.E.

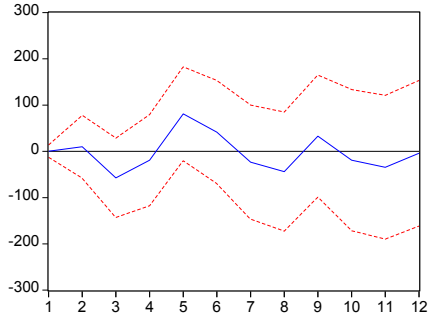


Thailand

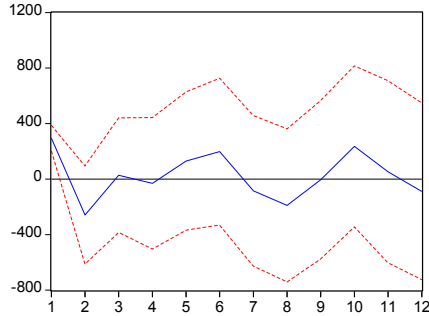
Response to Cholesky One S.D. Innovations ± 2 S.E.



Response of STOCK_SK to EUROPE

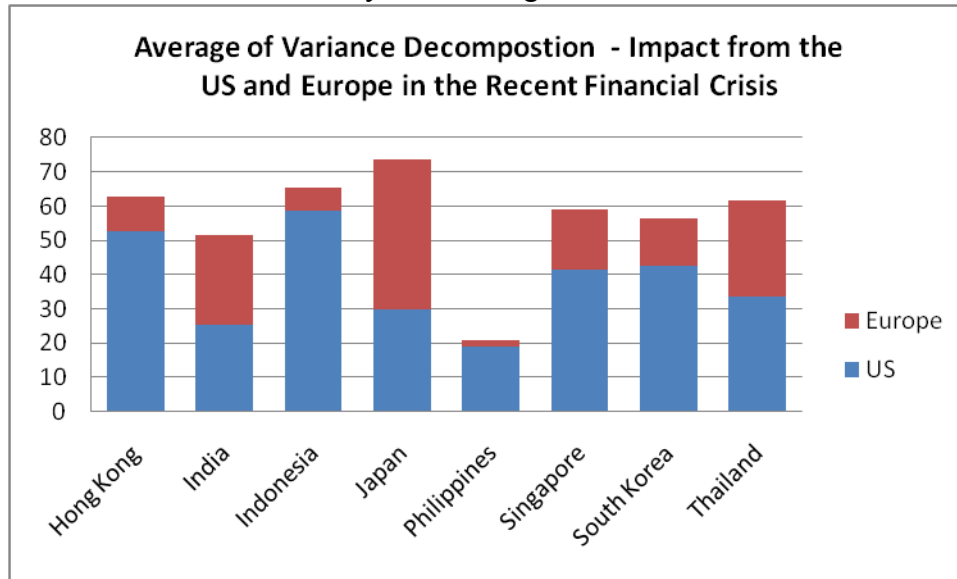


Response of STOCK_THAI to EUROPE



To find the magnitudes of the transmission of shocks from the US and Europe equity markets in the recent financial crisis, we perform Cholesky variance decomposition for the VAR estimations. Graph 5-2 shows the comparison of impacts from the US and Europe equity markets to Asian equity markets in the recent crisis based on the calculations of the average of variance decomposition (based on the first 12 periods). From the graph, we find that for the impact from the US, Indonesia was impacted the most, followed by Hong Kong, South Korea, and Singapore, and the Philippines was influenced the least among these Asian economies. For the impact from Europe, Japan, Thailand, and India got the highest impact, and the Philippines and Indonesia had the lowest. The results can be supported by the fact that equity markets of more developed Asian economies such as Hong Kong, South Korea, and Japan are more integrated with the global advanced markets while the less developed Asian economies such as the Philippines are relatively independent from the global market in their equity markets. The domestic factors collectively also played some roles in the equity markets.

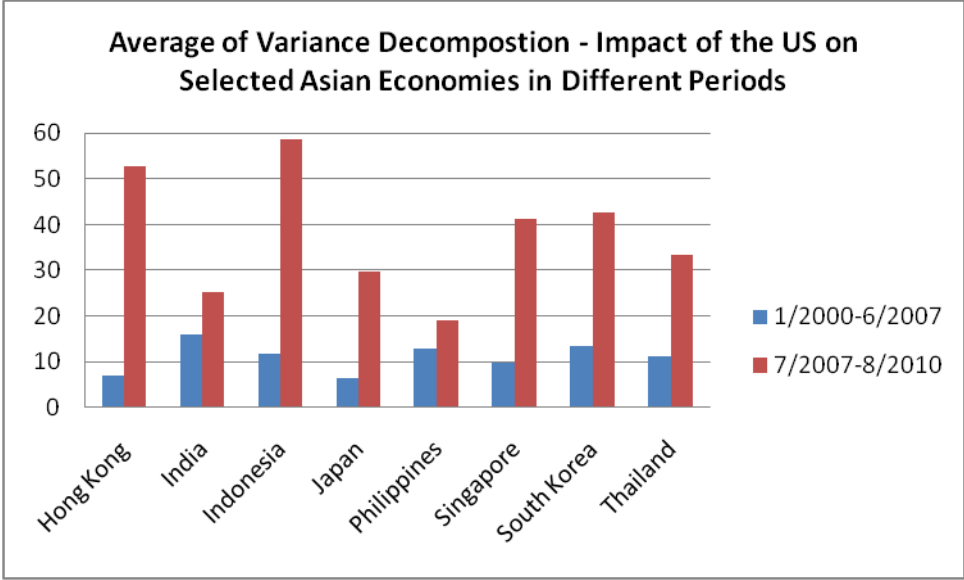
Graph 5-2. Average of Variance Decomposition – Impact of the US and Europe in the Recent Financial Crisis
July 2007 – August 2010



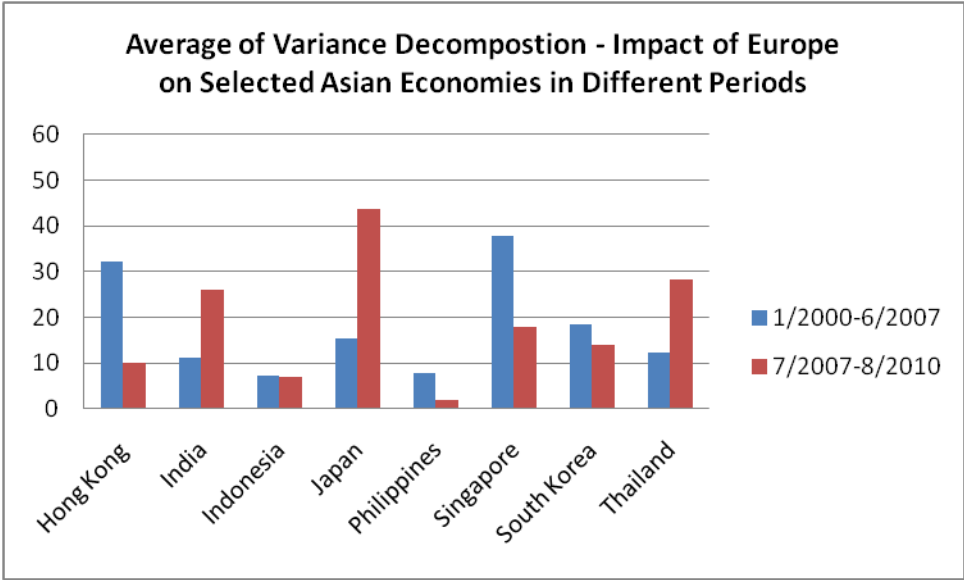
We further investigate the changes of impacts of the global factors in different periods, namely, the recent financial crisis period (7/2007 -8/2010) and the ordinary period (1/2000-6/2007). With the calculation of the average of variance decomposition, Graph 5-3 shows that all the selected Asian economies experienced a substantially bigger impact from the US in the recent crisis than in the ordinary period. This result is consistent with the result in the panel least squares fixed effect analysis in which US had higher coefficients in the recent financial crisis. Graph 5-4 shows that for the impact from Europe, three Asian economies (Japan, Thailand, and India) got higher impacts from Europe but four (the Philippines, Hong Kong, South Korea, and Indonesia) got lower impacts in the recent crisis than in the ordinary period. The comparison of Graph 5-3 and Graph 5-4 suggests that US's impact increased more than Europe's on Asian equity markets in the recent crisis. This is different from the result in the panel fixed effect analysis in which it find that Europe's impact increased more than the

US's in the recent financial crisis. The difference of the results suggests that endogenous consideration of the dynamic VAR method may help correcting for more of the effect of US on Europe in the recent financial crisis.

Graph 5-3. Average of Variance Decomposition – Impact of the US on Selected Asian Economies in Different Periods



Graph 5-4. Average of Variance Decomposition – Impact of Europe on Selected Asian Economies in Different Periods

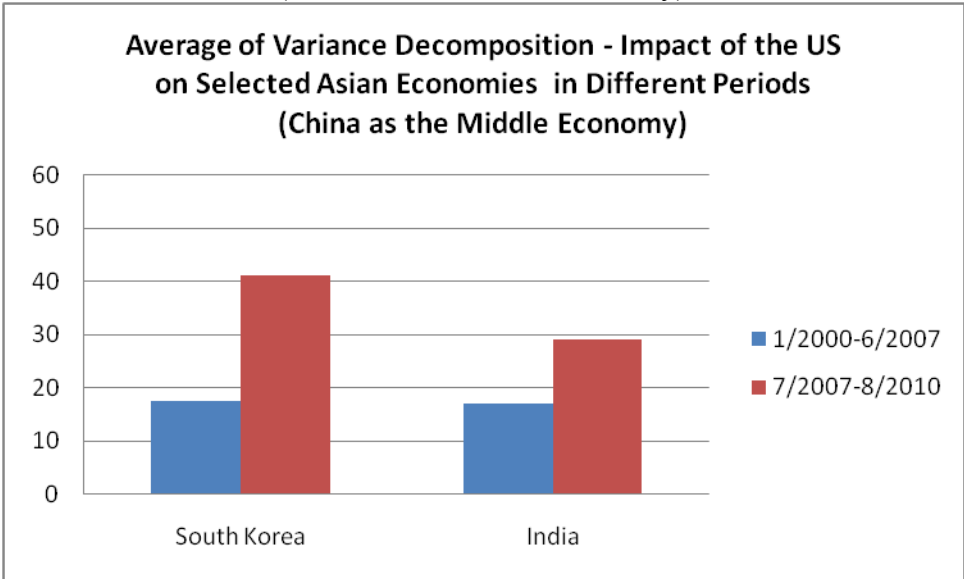


As China and Japan are two main economies in Asian area, we replace Europe with China and Japan respectively as the “middle economy” and investigate how China and Japan’s equity markets influence their neighbors’.

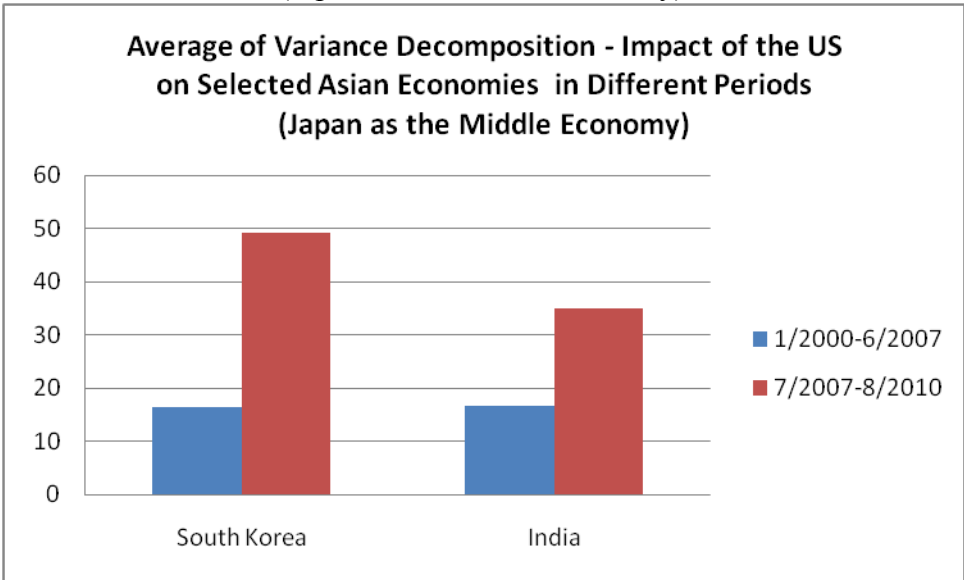
Taking South Korea and India as representatives of the developed and the developing Asian economies, we perform the same seven-variable VAR estimations for the Asian equity markets except for the selections of the middle economies. Graph 5-5 and Graph 5-6 show the comparison of the average variance decomposition for the cases using different middle economies of China and Japan in different periods. The results show again that US affected the selected Asian equity markets substantially and had bigger impact effect in the recent financial crisis (7/2007-8/2010) than in the ordinary period (1/2000-6/2007). Whichever middle economies are used among Europe, China, and Japan, US influenced the economies with similar magnitudes (with around 40 percent some for South Korea and around 30 percent for India in the recent financial crisis, for example). China and Japan, especially China, also impacted the selected Asian economies a great amount. At the same time, we find China’s equity markets had played more roles in both the developed (South Korea) and developing (India) Asian economy in the recent period than before (Graph 5-7). This is consistent with the findings of some research that the Shanghai stock market has grown enormously and integrated with other Asian economies and world markets with meaningful level (Burdekin and Siklo, 2010). Japan’s impact increased in the more developed Asian economy - South Korea and decreased in the developing one - India (Graph 5-8). Those results support the view that while

US played a stronger role in influencing Asian equity markets in the recent crisis, regional emerging economies such as China should also be taken into account as economies with increasing impacts.

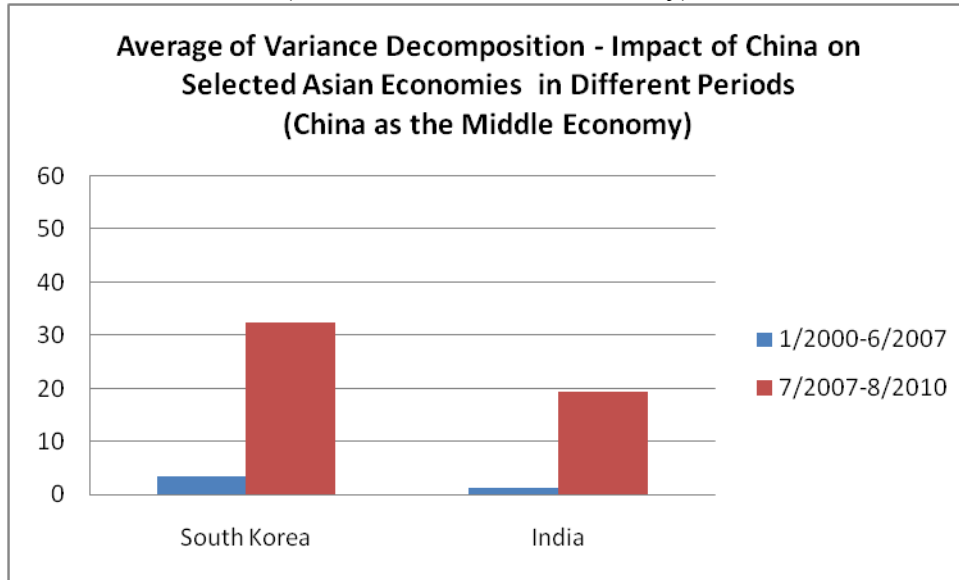
Graph 5-5. Average of Variance Decomposition – Impact of the US on Selected Asian Economies in Different Periods (China as the Middle Economy)



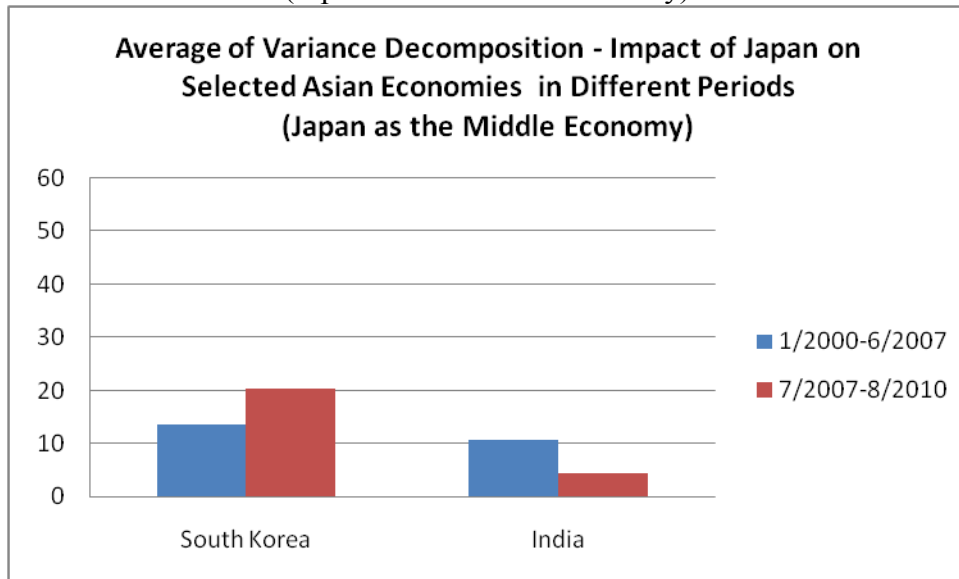
Graph 5-6. Average of Variance Decomposition – Impact of the US to Selected Asian Economies in Different Periods (Japan as the Middle Economy)



Graph 5-7. Average of Variance Decomposition – Impact of China on Selected Asian Economies in Different Periods (China as the Middle Economy)



Graph 5-8. Average of Variance Decomposition – Impact of Japan on Selected Asian Economies in Different Periods (Japan as the Middle Economy)



In summary, the dynamic method of VAR estimations suggest that the US equity market played a substantial positive role and increased their impact in

Asian equity markets in the recent crisis than before. This reflects the increasing financial interdependence between the Asian economies and the US. For the “middle economies”, other than Europe, some regional economies, especially China, also influenced Asian equity markets greatly and increasingly in the recent period.

5.3 Implications of the Results

After examining the magnitudes of the influencing factors of Asian equity markets through the multi-factor analyses, we find that among the global and domestic factors or channels, the US equity market played a significant role on the movements of Asian equities in the recent crisis. Among different periods, the magnitudes of the influences from the US were much greater in the recent financial crisis than in the previous periods. This indicates that for the equity markets, the Asian economies had substantial and more interdependencies with the US equity market in the recent period than in before. This may reflect the trend of the globalization in equity markets in Asia economies.

At the same time, the individual Asian economies showed different magnitudes of impact from the US in the recent crisis. Indonesia, Hong Kong, South Korea, and Singapore received high impacts and the Philippines had a low impact from the US. These differences of the impacts reflect at least in part the different degrees of development of the Asian individual equity markets. As the more developed economies of Hong Kong, South Korea, and Singapore have relatively bigger market capitalization and more open equity markets, they tend to

be integrated more with the US. Though Indonesia is not as developed as the above economies, its equity market is becoming more interdependent with the global markets. The Philippines has relatively less developed equity market and thus has had low impact from the US.

Other than the US, Europe, China, and Japan influenced other Asian equity markets substantially. China especially influenced the equity markets of neighbors greatly and increasingly. The interdependence among the Asian economies is far from being ignored.

Other than the global effect, domestic factors also influenced the movement of Asian equity markets. While the domestic macro vulnerability didn't impact equities as significantly as the global factors did in the recent financial crisis, it doesn't necessarily mean that they will be less important in future crisis. A highly developed economy with appropriate financial structure would provide better cushion for the stabilities of equity markets when the financial turmoil comes.

Based on the increasing amount of impacts from the US equity market, a simple conclusion that the Asian economies have been decoupling from the advanced economy does not hold for the recent crisis.

Chapter 6. Conclusions

The previous chapters discuss the origins and spread of the recent financial crisis to the Asian economies and the contagion literature, investigate comovements of the equity returns between the Asian economies and the US through correlation analyses, and identify the magnitudes of impacts of different factors especially the global factors through the multi-factor analyses. This chapter summarizes the major findings of our study and provides some suggestions for policy on preventing the occurrence of future financial crisis.

6.1 Conclusions

The major findings of this study are that the comovements of equity returns of Asian economies and the US increased substantially in the recent financial crisis. Global factors, especially the US equity market, played significant roles in the transmission of the financial crisis and impacted Asian equity markets with larger magnitudes in the recent financial crisis than in previous periods. Based on the increasing amount of correlations and magnitudes of impacts from the US equity market in the recent financial crisis, it is too soon to draw a conclusion that the Asian economies have been decoupling from the advanced economies.

In more detail, the correlation studies in Chapter 4 (the simple correlations, HP filter detrended correlations, and dynamic conditional correlations) find that although Asian equity markets didn't move as closely with US as the European markets did from the 1990s and on, their correlations with the

US tended to increase during the beginning period of the recent financial crisis and decreased a little in the later period of the financial crisis, though the correlation levels of the later period were still higher than in the pre-crisis period for most of the Asian economies. Among the individual Asian economies, Hong Kong and Singapore kept relatively stable high correlations with the US. China and Pakistan showed overall lower but increasing correlations during the recent crisis.

The multi-factor studies in Chapter 5 (the panel least squares fixed effect estimations and dynamic VAR analyses) provide further findings on the magnitudes of the contagion from the US. Chapter 5 finds that among different factors or contagion channels, the global factors, especially the US equities, played significant positive roles in the Asian equity markets. The magnitudes of impacts from the US increased for the Asian economies in the recent financial crisis. This is consistent with the results in Chapter 4 that correlations between the US and Asian economies were higher in the recent financial crisis than before.

In the panel fixed effect estimations, the magnitudes of the influences from the US in the recent financial crisis was greater than in other periods including the 1997-98 Asian financial crises period. Among domestic factors, inflation differentials positively and significantly influenced Asian equity returns. Other domestic factors or channels such as the GDP growth rates, interest rate differentials, exchange rates, and political risk factor also contributed to the movement of Asian equity prices. Among those factors, GDP growth rates, interest rate differentials, and political risk had negative effects and exchange rates had positive effects of depreciation on Asian equity markets.

In the VAR analyses, the magnitudes of the influences from the US in the recent financial crisis were greater than in the pre-crisis period of 1/2000-6/2007. Correcting for more of the effect of US on Europe in the recent financial crisis, the VAR analyses find that US's impact increased more than Europe's on Asian equity markets in the recent crisis. Domestic factors collectively also played a role in equity prices. Among Asian economies, equity markets in Indonesia, Hong Kong, South Korea, and Singapore received the most impacts from the US, and the Philippines had the least. This result is partially consistent with the findings in Chapter 4 which found higher correlations in Hong Kong and Singapore (and higher simple correlations in Indonesia) and lower correlations in Pakistan. The VAR analyses also suggest that some regional economies influenced Asian market greatly. Especially China's impact increased in both the equity markets of the developed Asian economy (South Korea) and developing Asian economies (India) in the recent crisis. This shows the importance of major regional emerging economies in financial contagion.

6.2 Suggestions for Policy

To prevent the occurrence of similar future financial crises in Asian economies, efforts could be made to limit the transmission of the crisis from the outside and to limit the generation of crisis from the inside. This practice is not only suitable for the Asian economies, but also for other emerging economies in the world.

The transmission of the crisis would be limited by being more alert to international signals and better preparing the domestic economics. For example, the Asian authorities should be alert to changes in economic indicators, especially the financial indices that reflect the negative impact of the deteriorating economic conditions of the advanced economies. Once potential triggers of the crisis are sensed, prevention actions could be planned or taken in view the response of the signals. For example, the individual economies could make timely prudential financial policies when they sense irregular financial volatility.

At the same time, while the Asian economies are developing more interdependence with the advanced economies in the world, stronger domestic fundamentals should be built to be able to balance off the negative impact when international economic shocks come. Policies should focus on promoting stable domestic economic growth with appropriate adjustments in inflation, interest rate, exchange rate, trade openness, capital flows, reserves, political environment, and so on. Especially, as the Asian economies experienced excessive capital inflows in the 1997-98 crisis, and the recent crisis was considered partially associated with the global savings glut and capital inflows, there is a need for extra caution and future research on dealing with global imbalances, surges and sudden stops of capital flows, and the reserves to be held against different types of capital flows (Liang, Willett, and Zhang, 2010).

The generation of financial crisis can be limited by building sound financial structures in a sound macroeconomic environment, keeping appropriate

leverage and credit risk standards, improving mental models, and making better international financial coordination.

To build a sound financial structure, for example, deeper and more liquid capital markets with diverse institutional investors should be fostered, which would help improve the resilience of national financial markets to withstand shocks (IMF, 2008).

Progress should also be made in prudential and regulatory financial policies. When a new financial instrument is introduced, for example, it should be properly sequenced with appropriate oversight (IMF, 2008). As the recent crisis was due partially to overextensions of leverage and excessive risk-taking in many markets in the US, greater emphasis needs to be put on finding the best leverage ratios and strengthening risk management. The rating companies should follow the standard precisely so that credit risks are better evaluated.

It is also important to improve mental models as many public and private sectors operated on the basis of seriously wrong mental models prior to the recent crisis. The housing bubble in the US, for example, was importantly affected by unrealistic expectations that housing prices would never fall. There was also an excessive faith that risks of the financial innovations developed in financial engineering had been substantially limited (Liang, Willett, and Zhang, 2010). These defective mental models provided a rich environment for the growth of the recent crisis and should be adjusted to a more objective direction to prevent reoccurrences. Especially, researchers need to put less faith in financial engineering that assumes fixed relationships among financial variables and more

faith in financial economics that acknowledges that relationships can vary enormously depending on the patterns of shocks (Willett, 2009).

Last but not least, as the global economy becomes more interdependent, there is a need for building better international or regional coordination to limit the occurrence of financial crisis by setting proper financial standards and implementing mutual financial cooperation.

Further research can be done when subsequent data is available for the US subprime global crisis. Adequate data enables us to evaluate contagion with more updated and comprehensive analyses to see if the decoupling holds. While this study focuses on the transmission from the US to the Asian economies, future study could investigate the impacts of the Asian economies within the region or on the US as the Asian markets are emerging in the world economy. It is a continuous task for Asian and the world economies to learn from the past to prevent the occurrence and limit the transmission of future financial crises as the world has entered an era of globalization.

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