Volatility in financial markets: The impact of the global financial crisis

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Ph.D. Thesis

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To my parents

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I would like to thank all the people who have supported me and contributed in some way in the development of this thesis.

Four years ago I decided to start the PhD programme, while working full time outside the University. When I took this decision I knew that there would be moments of all kinds, some harder and some easier. Certainly, difficult times have arisen during this period, making hard to continue with the thesis. In those moments, I have felt the unconditional support of my parents and my thesis supervisor, Helena Chuliá.

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Natàlia Valls Ruiz

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Chapter 1

Introduction

1.1 Introduction

This dissertation focuses on volatility in financial markets, with a special concern for: (i) volatility transmission between different financial markets and asset categories and, (ii) the effect of macroeconomic announcements on the returns, volatility and correlation of stock markets. These issues are analysed taking into account the phenomenon of asymmetric volatility and incorporating the period of financial turmoil caused by the Global Financial Crisis. The study focuses the attention on the emerging markets of the region of Southeast Asia.

1.2 Volatility

The analysis of financial assets volatility is important to academics, policy makers, and financial market participants for several reasons. First, prediction of financial assets volatility is crucial to economic agents because it helps them make rational portfolio risk management decisions. Volatility is critically important to economic agents because it represents a measure of risk exposure in their investments.

Furthermore, from a theoretical perspective, volatility occupies a central stage in pricing of derivative securities. For example, to price an option we need to know, as a risk measure, the volatility of the underlying asset from now until the option expires. Moreover, in a market risk context, it is vital to know the volatility of an asset in order to calculate the Value-at-Risk of a portfolio selection. Finally, volatility is important for the economy as a whole. Policy makers often rely on market estimates of volatility as a barometer for the vulnerability of the financial markets and the economy. All these reasons have sparked an enormous interest in modelling the conditional variance and a large number of volatility models have been developed since the seminal paper of Engle (1982) [see Poon and Granger (2003) for an extensive review].

In the financial literature there are two well-known stylized features about volatility. First volatility responds asymmetrically to bad and good news and second, the existence of volatility spillovers between different financial markets and asset categories.

The asymmetric behaviour of volatility refers to the empirical evidence according to which a negative return shock (unexpected drop in the value of the stock) generates an increase in volatility higher than a positive return shock (unexpected increase in the value of the stock) of the same size. In the financial literature two explanations of the asymmetric effect of news on stock return volatility have been put forward.

The first one is based on the leverage effect hypothesis. According to this explanation, a drop in the value of the stock (negative return) increases financial leverage, which makes the stock riskier and increases its volatility [Black (1976) and Christie (1982)]. The second explanation is known as volatility *feedback* hypothesis. This explanation maintains that the asymmetry in volatility responds to the fact that returns could simply reflect the existence of time-varying risk premiums. If volatility is priced, an anticipated increase in volatility raises the required return on equity, leading to an immediate stock price decline [Campbell and Hentschel (1992), Pindyck (1984), French *et al.* (1987)]. This hypothesis relies on two basic tenets. Firstly, volatility is persistent and secondly, there exists a positive inter-temporal relation between expected returns and conditional variances.

If we consider these two principles, it is possible to observe what happens when news arrives at the market. Firstly we will consider the case of bad news, for example a large piece of bad news about future dividends. Large piece of news tend to be followed by other large piece of news (volatility is persistent), so these piece of news increases future expected volatility, which in turn increases the required rate of return on stock and lowers the stock price, amplifying the negative impact of the dividend news. Now consider a large piece of good news about future dividends. Once again, the stock price falls because higher volatility raises the required rate of return on stock and lowers the stock price, but now the volatility effect dampens the positive impact of the dividend news. Therefore, volatility increases more after bad news than after good news.

Finally notice the two theories on asymmetric volatility propose reversal causality. According to the leverage effect, the return shocks lead to changes in conditional volatility; whereas according to the volatility *feedback* hypothesis return shocks are caused by changes in conditional volatility.

Which effect, leverage effect or volatility *feedback* effect, is the main determinant of asymmetric volatility, remains an open question. Those studies that focus their analysis on the leverage *hypothesis* [Christie (1982) and Schwert (1989)], show that this effect is too small to explain the full asymmetry. On the other hand, authors like Braun *et al.* (1995), Bekaert and Wu (2000) and Wu (2001) find clear evidence in favour of the volatility *feedback* effect as the main cause of the asymmetric behaviour.

The second stylized feature about volatility is that volatility is often observed to move together over time across assets and markets. The study of volatility transmission has long been a challenge to both academic and practitioners. Transmission mechanisms between volatilities of different markets and assets are important for a number of reasons. First, transmission mechanisms may be useful for portfolio management, where knowledge of return spillover effects may be useful for asset allocation or stock selection. Second, information about volatility spillover effects may be useful for applications in finance that rely on estimates of conditional volatility, such as option pricing, portfolio optimization, Value-at-Risk calculation and hedging.

1.3 Asian markets

In recent years, the interrelations between the US and the Asian markets have raised due to the increasing financial relations. One typical portfolio diversification strategy consists of investing in similar asset classes in multiple markets (international diversification). In order to make appropriate risk management strategies it is vital to know the characteristics of the markets of the different geographical areas and how the markets co-move. Likewise, it is very important to analyse which factors can influence the behaviour of the assets in the financial markets.

Within Asian markets, this thesis distinguishes between mature and emerging countries. Japan represents the mature market and the emerging economies are divided into three groups: the Asian Tigers (tigers hereafter), the Asian Tiger Cub (cubs hereafter) economies and, finally, China.

Japan is one of the largest economies in the world in terms of nominal GDP and purchasing power parity. During the Meiji period from 1868, Japan expanded economically, founding at the time many of today's enterprises, emerging as the most developed nation in Asia. In the 1990s the growth slowed significantly, after the Japanese asset price bubble. The Government made efforts with little success to revive the economic growth. The economy showed strong signs of recovery in 2005, with a great GDP growth. Nowadays, Japan is the third largest economy in

the word, after the United States and China, in terms of nominal GDP. The Tokyo Stock Exchange is the largest stock exchange in Asia and the second largest stock exchange in the world by aggregate markets capitalization of its listed companies, which is mainly represented by the Nikkei 225 Index.

The tigers refer to the economies of Hong-Kong (old British colony nowadays belonging to China), Singapore, South Korea (Korea hereafter) and Taiwan. The tigers emerged between the years 1945 and 1990, and were notable for maintaining exceptionally high growth rates sustained over decades and rapid industrialization, with a wide range of characteristics similar to other Asian economies, such as China and Japan. These economies experienced a great growth, not only in quantity, but also in quality of their products, with a low price, reaching the international markets. All four markets have developed into advanced and high-income economies, specializing in areas of competitive advantage, so that Hong-Kong and Singapore have become world leading international financial centres and Korea and Taiwan are world leaders in manufacturing and information technology. Prior to the 1997 Asian Financial crisis, the growth of these economies has been attributed to export-oriented and strong development policies. These four economies were commonly referred as to "The Asian Miracle". The economic success of these markets have turned into models for other developing countries, especially the Asian Tiger Cub economies. In 1997 the tigers experienced their first major setback, the Asian financial crisis. While Singapore and Taiwan were relatively unhurt, Hong-Kong

suffered intense speculative attacks in the stock and currency markets and Korea performed a great stock market crash. However, in the years after the crisis all these four economies rebounded robustly, offering high levels of growth again.

Currently, Hong-Kong is one of the world's leading international financial centres. It is noteworthy that Hong-Kong is a city-state and is a Special Administrative Region of People's Republic of China, hence within the group of tigers, is distinguished as a separate market from China, as it has been a British colony until 1997, and nowadays maintains an independent economic, administrative and judicial system. The Hong-Kong Stock Exchange (represented by the Hang Seng Index) is the Asia's second largest stock exchange in terms of market capitalization behind the Tokyo Stock Exchange, and the sixth largest in the world behind Euronext.

Singapore, officially the Republic of Singapore, is a sovereign city-state and island-country in Southeast Asia. It is the third most densely populated country in the world after Monaco, another city-state, and Macau. Singapore has a highly developed trade-oriented market economy and its economy has been ranked as the most open in the world, less corrupt and most pro-business with low tax rates, having the world's third highest GDP per capita. Besides, this country is one of the world's major commercial hubs, with the fourth biggest financial centres and one of the five busiest ports. Its globalised and diversified economy strongly depends on trade, especially manufacturing. The Singapore Exchange was formed in December

1999 as a holding company, becoming in November 2000 the second exchange in Asia-Pacific. Its main stock exchange benchmark is the Straits Time Index.

South Korea, officially the Republic of Korea, constitutes the southern part of the Korean Peninsula. It is one of the world's wealthiest nations, being a member of the G-20 major economies. It was one of the world's fastest growing economies from the early 1960s to the late 1990s, and it is still one of the fastest growing countries in the 2000s, along with the other three tigers. South Korea is ranked twelfth in the Human Development Index, while in terms of average wage, it has the Asia's highest income and the world's tenth highest income. It ranks highly in education, quality of healthcare, rule of law, ease of doing business, government transparency, job security, tolerance and inclusion. The South Korean economy is heavily dependent on international trade, being among the top ten largest exporters and importers in the world. Its exportations are driven by high-tech multinationals as a world leader in innovation as it is. The Korea Exchange is the sole securities exchange operator in South Korea and its mainly representative benchmark is the Kospi Index.

Finally, the last tiger is Taiwan, a state located in East Asia. Since 1945, the island of Taiwan has been under the political system of the Republic of China, the state that governed entire China until the end of the civil war. Since then, the old Chinese regime has remained on the island of Taiwan, leading to a complex legal and

diplomatic situation, although in practice it is an independent partially recognized state. After the quick industrialization and rapid growth of this country during the latter half of the 20th century, which has been called the "Taiwan Miracle", Taiwan has developed an advanced and capitalist industrial economy with great position in the ranking of world economic growth. Taiwan is highly ranked in terms of health care, public education, economic freedom and human development. The stock exchange in this country is represented by the Taiwan Stock Exchange Index.

The cubs include Philippines, Indonesia, Malaysia and Thailand. The cubs achieved their industrialization later, following the same export-driven model of economic development pursued by the tigers. These markets became the newly industrialized countries that, following the steps of the tigers, are considered the rising tigers. In consequence, these economies have suffered, in general, in a less painful way the 1997 Asian financial crisis. Afterwards, all these countries have managed to keep high rates of industrialization and evolution, becoming important destinations for foreign investment. Within the cubs, Indonesia and Philippines are the ones with the major rapid industrialization and large population. Moreover, overseas Chinese entrepreneurs (residents with Chinese roots living outside of the People's Republic of China that keep business ties with China), contributed to the economic growth of private sectors from the cubs by establishing a business network between Southeast Asia and the Greater China (China, Hong-Kong, Taiwan and Macau).

The Philippines, officially known as the Republic of Philippines, is a sovereign island country in Southeast Asia. The Philippines is the seventh most populated country in Asia and the twelfth in the world. Its economy has been growing steadily over decades, but it is not part of the Group of 20 (G-20) nations. The Philippine economy has been transitioning from one based on agriculture to one based more on services and manufacturing. It is a newly industrialized country that has a high dependence on the United States, as a former American colony, thus has a large presence of US companies in the country. Its major trading partners include the United States, Japan, China and the Asian Tigers, among others. The Philippine Stock Exchange is one of the oldest stock exchanges in Southeast Asia and its main index is the Philippine Stock Exchange Composite Index.

The large economy of Indonesia (officially the Republic of Indonesia) is the largest economy in Southeast Asia and a member of the G-20 major economies, classified as a newly industrialized country. It has a market economy in which both the private sector and the government, through ownership of state-owned enterprises and the administration of prices of a range of basic goods (including fuel, rice and electricity), play significant roles. The industry sector is the economy's largest, accounting almost half of its GDP, followed by increasing services and agriculture. Indonesia was the country hardest hit by the Asian financial crisis of 1997, suffering sudden capital outflows leading the Indonesian rupiah into free fall. Afterwards, the rupiah stabilised and economic growth accelerated. In addition, it is noteworthy that

corruption has been a persistent problem in Indonesia. For example, Transparency International ranked Indonesia below 100 in its Corruption Perceptions Index. However, since 2007, due to an improvement in banking sector and domestic consumption, national economic growth has revitalised, performing strongly during the Global Financial crisis. Regarding the Indonesian Stock Exchange, the Jakarta Composite Index is the main benchmark index of all stocks.

Malaysia is a federal constitutional elective monarchy in Southeast Asia, consisting of thirteen states and three federal territories. Malaysia has a newly industrialised market economy, which is relatively open and also state-oriented. The state plays a significant, but declining, function in conducting the economic activity through macroeconomic policies. Malaysia has had one of the best economic records in Asia in terms of average GDP annual growth. Since 1980 the industrial sector, with a high level of investment, has led the country's growth and the economy began a transition towards a more multi-sector economy. Malaysia recovered from the Asian financial crisis earlier than its neighbours, but economic inequalities still exist between different ethnic groups. International trade and manufacturing are the key sectors of this country. Furthermore, Malaysia is an exporter of natural and agricultural resources, and petroleum is a major export. Bursa Malaysia, previously known as Kuala Lumpur Stock Exchange, operates as a fully integrated exchange, with the FTSE Bursa Malaysia Kuala Lumpur Composite Index as the main index.

Thailand, officially the Kingdom of Thailand, is a monarchy in Southeast Asia and is also a newly industrialized country, with a heavily export-dependent economy (the exports account more than two-thirds of its GDP). Despite its low gross national income per capita, the nation is recognized by the World Bank as "one of the great development success stories". After experiencing the world's highest growth rate from 1985 to 1996 (averaging 12,4% annually), increasing pressure on Thailand's bath, its currency, in 1997, led to a crisis that provoke a great financial sector weakness. Thailand's economy started to recover in 1999, thanks to strong exports. Major exports include Thai rice, textiles and footwear, fishery products, rubber, jewellery, cars, computers and electrical appliances. Rice is the most important crop in the country (Thailand has long been the world's number 1 exporter of rice, nowadays stays behind both India and Vietnam). Concerning the stock exchange, The FTSE SET Shariah Index is one of the main indexes of the Thailand Stock Exchange.

In general, the region of Southeast Asia has an elevated population growth rate, political instability and a great economic boom. On the other hand, the Southeast Asian economies are quite vulnerable to the economic decisions taken abroad, since they have a small internal market and a high dependence on foreign energy and technology.

The Southeast Asian region makes an interesting case study as both tigers and cubs are growing economies that offer major opportunities for international industry. As developing countries, they are following the lead set by China, the motor of growth in Asia, and, in recent decades, the financial and commercial ties established with the US have been strengthened considerably, since these countries are making an increasing contribution to global economic development while establishing themselves as key players in international industrialization.

Finally, China is included in the study due to its spectacular growth performance over the last two decades. It is a country that cannot be missed when analysing the Asian market. This economy, considered the engine of growth for Asia in general, is not included within the tigers because the concept of tiger obeys to emerging small country with great growth. China does not meet the characteristic of a small country. The People's Republic of China is a sovereign state governed by the Communist Party and it is the most populous country in the world. As of 2013, China has the world's second largest economy in terms of nominal GDP, after the United States. China has been among the world's fastest growing economies in the last decades, relying basically on investment and export-oriented economy. Its high productivity, low labour costs and relatively good infrastructure have made it a global leader in manufacturing, permitting having spectacular economic growth rates. However, the Chinese economy is very energy-intensive and inefficient. In the past decades this country has pursued an impressive course of creating a market-

based financial system and opening it up to international financial markets. Nevertheless, the openness of its financial market towards the rest of the world is still limited. The Shanghai Stock Exchange (mainly represented by the Shanghai A-Share Stock Price Index) is one of the two stock exchanges operating independently in the People's Republic of China (the other one is the Shenzhen Stock Exchange). The Shanghai Stock Exchange is the world's sixth largest stock market by market capitalization. Unlike the Hong-Kong Stock Exchange, the Shanghai Stock Exchange is still not entirely open to foreign investors due to tight capital account controls exercised by the Chinese mainland authorities.

In global, Asia's share of worldwide GDP was around 28% in the past decade. Currently, Asia accounts for 58% of world population with 20% of total land. Analysts forecast that the population will double from 3 billion in 2010 to 6 billion by 2050. In short, the focus is now on Asia given the growth prospect of many Asian countries, which are growing above 6%. Furthermore, inter and intra-regional trade with Asia will increase to 50% of world trade in the very near future, driving the demand of financial services and stimulating further financial innovations in Asia.

Overall, one cannot think about Asia without questioning how important this big continent will become and which role in finance will Asia play in the future. It is

crucial to highlight the potential of Asia, becoming a very important and interesting phenomenon to follow and to study.

1.4 Objectives and structure of the thesis

The objectives of this thesis are threefold. First, to explore volatility spillovers and the time-varying behaviour of the correlation between the US and the Asian stock markets. Second, to analyse how the macroeconomic events in the US affect the Asian stock market returns, volatility and correlation. Finally, to investigate volatility spillovers between equity and currency markets in Asia.

Throughout these analyses, this dissertation aims to establish behaviour patterns depending on the level of development of the emerging country analysed. Furthermore, the sample period used in the analyses incorporates the period of the recent financial turmoil originated by the subprime mortgage market in the United States in the summer of 2007, with the aim of studying the effect of the Global Financial crisis on the patterns found.

The document is structured as follows. The second chapter of this dissertation, entitled "Volatility transmission and correlation analysis between the US and Asia" explores the volatility spillovers and the behaviour of conditional correlations between the US market and the ten Asian markets considered, taking into account

the effect of the Global Financial crisis. As mentioned before, this analysis allows assessing if conditional correlations behaviour and volatility transmission patterns between the US and the Asian markets are different depending on the country's level of development and if they have changed since the beginning of the Global Financial crisis.

The third chapter is entitled "Asian market reactions to US macroeconomic news surprises" and examines if the arrival of US macroeconomic announcements affects the returns and volatility of the ten Asian financial markets analysed and their correlations with the US market. Moreover, this chapter also explores if there exists an asymmetric effect of news, so that the surprise (the difference between the real data and the expected data of the macroeconomic announcement), affects differently the returns, volatility and correlations depending on its sign. Finally, again, this analysis explores if the pattern observed changes after the onset of the recent financial crisis.

The fourth chapter of the dissertation is entitled "Volatility transmission between the stock and currency markets in emerging Asia" and investigates the nature of the relationship between stock prices and exchange rate movements in the ten Asian markets under study in this thesis. In the financial literature, there is no consensus on the causal link between equity and currency markets and the relation might be different depending on the direction of the volatility transmission considered.

Throughout this analysis it is possible to explore volatility spillovers between the equity and currency markets of the Asian economies, studying if it is possible to establish behaviour patterns depending on the level of development of the market analysed. Again, this analysis permits to inspect if the volatility transmission patterns found have changed since the beginning of the Global Financial crisis.

Finally, the dissertation ends with some concluding remarks in the fifth chapter.

Chapter 2*

Volatility transmission and correlation analysis between the US and Asia

2.1 Introduction

Among the effects of globalisation, it is likely to notice a raise of the permeability of the emerging economies to international crises, such as the Asian financial crisis of 1997 or the dot-com bubble crisis at the beginning of the current century. Increasing global financial integration translates into increased spillovers from global shocks on return and volatility to regional markets.

One typical portfolio diversification strategy consists of investing in similar classes of assets in multiple markets (international diversification). While this strategy have solid theoretical justification and there exists strong empirical evidence regarding the benefits[1], if markets exhibit higher co-movement during turmoil periods[2], then the

* This chapter has been published in the Global Economic Review. This journal is a peer-reviewed journal by Routledge and it is currently indexed in the Social Sciences Citation Index under the subject "Economics". The complete reference is:
Valls, N. and Chuliá, H. (2012). Volatility Transmission and Correlation Analysis between the USA and Asia: The Impact of the Global Financial Crisis. Global Economic Review, 41(2), 111-129

[1] See Grauer and Hakansson (1987), De Santis and Gerard (1997) and Ang and Bekaert (2002), among others.

[2] King and Wadhwani (1990), Lee and Kim (1993) and Longin and Solnik (1995), among others.

risk-sharing motive behind diversification may fail to deliver the desired benefits in periods when they are most needed.

This chapter analyses volatility linkages and correlation between the US market and 10 Asian markets during the global financial turmoil. Specifically, we want to explore if the inter-relationships between the US and Asian markets have changed during the crisis. We focus on these markets because, even the financial crisis originated by the subprime mortgage market in the United States became global, economic growth in Asia-Pacific region has remained high and, year by year, accounted for increasing shares in the growth of the global economy. The region has generated huge savings and accumulates prosperity and the international capitals take into account this reality for their operations. Furthermore, commercial relations between the US and the Asian countries have increased substantially and it could be reflected in stronger linkages between their financial markets.

A priori, there are three reasons why spillovers to emerging Asian economies could be relatively limited. First, the regional financial institutions have relatively small direct exposure to US subprime mortgages and structured credit products. Second, strong growth prospects have continued to support investor confidence in the regional economies. Third, Asian financial crisis a decade and a half ago left improvements in financial and continued prudence in most emerging economies which help to mitigate the impact of external shocks. These positive factors do not,

however, guarantee the complete isolation of the emerging financial markets and systems from global financial turbulence.

Within Asian markets, this analysis distinguishes between mature and emerging countries. As mentioned in the Introduction of this dissertation, Japan represents the mature market and, the emerging markets are divided into three groups: the tigers (Taiwan, Singapore, Hong-Kong and Korea), the cubs (Philippines, Indonesia, Malaysia and Thailand) and China. Therefore, the volatility and correlation analysis is carried out with a global mature market, the US market, compared to an Asian developed market, which is Japan, and to the aforementioned Asian emerging markets. Throughout this analysis it is also possible to explore if the conditional correlation between the US and the Asian markets is different depending on the country's level of development.

Understanding and careful estimation of the time varying nature of volatilities and correlations is essential to capture changes in risk and identify the nature of co-movement between markets. Accurate estimates and good forecasts of asset return volatility and correlation are required in most financial applications including asset pricing, capital allocation, risk management, derivatives pricing and hedging. Traditionally, correlation has been modelled as a constant and unconditional variable. Over the years, practitioners have come to realize that correlation actually varies through time and several researchers have provided empirical evidence to

support this view (see Koch and Koch, 1991; Erb et al., 1994 and Longin and Solnik, 1995).

In the financial literature there are many studies that analyse volatility transmission and dynamic correlations between developed countries (see Hamao, 1990; Karolyi, 1995; Koutmos and Booth, 1995; Karolyi and Stulz, 1996 and Bessler and Yang, 2003 among others). As interest in emerging stock markets grows, a number of studies have emerged in the literature investigating linkages between developed and emerging markets. Some of these papers focus their analysis on Asian economies. For example, Ng (2000) investigates the magnitude and changing nature of the return and volatility spillovers from Japan and the US to the Pacific–Basin markets and finds that both the US and Japan influence volatility in the Pacific-Basin region. Miyakoshi (2003) investigates how the Asian stock markets are influenced by the main regional market, which is the Japan stock market, as well as the main global market, which is the US stock market. He finds that the volatility of the Asian market is influenced more by Japan than by the US. Wang and Firth (2004) test for return and volatility transmissions across four Asian emerging markets and New York, London and Tokyo. Their empirical findings indicate that there exist bidirectional volatility spillover effects between the developed and the emerging markets.

In addition to analysing volatility transmission and dynamic correlations between countries, papers such as Sheng and Tu (2000), Ratanapakorna and Sharma (2002), Jang and Sul (2002), Yang et al. (2002), Kim (2005), Click and Plummer (2005), Caporale et al. (2006) and Beirne et al. (2009) among others, also explore the impact of several financial crisis on information transmission across markets. However, most of these papers analyse the Asian financial crisis of 1997.

The main contributions of this analysis are to explore volatility spillovers and analyse the behaviour of conditional correlations between the US and the Asian markets taking into account the effect of the Global Financial crisis. In order to do this, a multivariate asymmetric generalized autoregressive conditional heteroskedasticity (GARCH) model is used. This analysis allows assessing if conditional correlations behaviour and volatility transmission patterns are similar for all the Asian markets with the US and if they have changed during the crisis.

Results show that there exist volatility spillovers between the US and the Asian markets. It is also observed that volatility transmission patterns have hardly changed during the crisis. Regarding the behaviour of conditional correlations, results indicate that the level of correlations depends on the country's grade of development. Japan exhibits the highest correlation with the US, followed by the four tigers, and the four cubs going after. China presents low correlation with the US, due to the still closed financial sector of this great country. Nevertheless, there

exist some exceptions, such as Philippines and Korea. Concerning Philippines, the correlation with the US is greater than expected. This seems to be due to the big number of US companies in this Asian country as long as it had been an American colony between 1901 and 1935. Regarding Korea, the correlation found with the US is lower than expected, probably owing to the late development of this country as a tiger, between 1975 and 1999. Since the Korean War finished in 1953, the investments of the US and Japan in Korea permitted the great economic growth of this country.

The chapter is organised as follows. Section 2 discusses the data employed in the analysis. The econometric method used to estimate volatility spillovers and correlation dynamics is outlined in Section 3. Section 4 deals with the results. The chapter ends with some concluding remarks.

2.2 Data

The data consist of the benchmark indexes in the 11 markets covered and include developed and emerging markets. The S&P500 Index and the Nikkei 225 Index represent the US and the Japanese markets, respectively. Within the Asian emerging markets, the tigers are made up of South Korea (Kospi Index), Taiwan (Taiwan Stock Exchange Index), Hong-Kong (Hang Seng Index) and Singapore (Straits Time Index). The cubs include Malaysia (FTSE Bursa Malaysia Kuala Lumpur

Composite Index), Thailand (FTSE SET Shariah Index), Indonesia (Jakarta Composite Index) and Philippines (Philippine Stock Exchange Index). Finally, the Shanghai A-Share Stock Price Index represents the Chinese stock market.

To sum up, there are the following groups:

<table>
<tr><td rowspan="2">Mature markets</td><td colspan="3">US</td></tr>
<tr><td colspan="3">JAPAN</td></tr>
<tr><td rowspan="9">Emerging markets</td><td rowspan="8">Southeast Asia</td><td rowspan="4">Asian Tigers</td><td>HONG-KONG</td></tr>
<tr><td>SOUTH KOREA</td></tr>
<tr><td>SINGAPORE</td></tr>
<tr><td>TAIWAN</td></tr>
<tr><td rowspan="4">Asian Tiger Cubs</td><td>PHILIPPINES</td></tr>
<tr><td>INDONESIA</td></tr>
<tr><td>MALAYSIA</td></tr>
<tr><td>THAILAND</td></tr>
<tr><td>Other</td><td colspan="2">CHINA</td></tr>
</table>

Therefore, the sample contains eleven markets, which will be analysed pair-wise, thus having 10 pairs, the US with the other markets.

The data has been extracted from Bloomberg and encompasses the period 1 January 2003 to 3 March 2010 (375 observations). Thereby, the dot-com crisis is not included in the sample. To take into account the Global Financial crisis, a dummy variable is introduced in the model, which is equal to 1 from 15 August 2007 until the end of the sample period and 0 otherwise.

Many financial analysts have fixed the beginning of the Global Financial crisis in August 2007 as during this month the Governments and central banks of some countries responded to the collapse of the economy with unprecedented fiscal stimulus, monetary policy expansion, and institutional bailouts. At the beginning of August 2007, the collapse of a global housing bubble rapidly spread into a global economic shock, resulting in a number of European bank failures, declines in various stock indexes, and large reductions in the market value of equities and commodities. On August 10, Central banks coordinate efforts to increase liquidity for first time since the aftermath of the September 11, 2001 terrorist attacks. The following days until August 15, stock indexes continue to fall and The United States Federal Reserve (Fed), the European Central Bank (ECB), the Bank of Japan and the central banks of Australia and Canada continue injecting liquidity to the system. Because of these reasons and since this study uses Wednesday closing prices to carry out the analysis, the beginning of the crisis is fixed in August 15, 2007.

Weekly data is used to partially overcome the potential problem of non synchronous data, which may arise because there are instants in which markets are closed in one country and open in another (Burns and Engle, 1998 and Lo and MacKinlay, 1990) study the effects of this problem). The returns are computed as log differences using Wednesday to Wednesday closing index prices to avoid any potential day of the week biases (see Brailsford, 1995 and Griffin et al., 2007 among others). If a

particular Wednesday happens to be a non-trading day, then closing values are recorded on the previous trading day.

We begin testing for the presence of a unit root in each of the series using the Augmented Dickey-Fuller (1981) test that has the unit root process as the null hypothesis (i.e. the series as I(1) against I(0)). Dickey and Fuller (1981) use the following regression equation:

$$\Delta Y_t = \alpha + \beta t + \rho Y_{t-1} + \sum_{j=1}^{p} \gamma_j \Delta Y_{t-j} + \varepsilon_t \qquad (2.1)$$

The test for a unit root in the series is a test of the null hypothesis that $\rho = 0$. If the hypothesis cannot be rejected the series is assumed to be non-stationary. The results in Table 2.1 shows that based on the ADF test, all price series have a single unit root.[3]

[3] When the ADF test is applied to the first difference of individual time series, the null of unit root process is strongly rejected in all cases.

Table 2.1. Unit Root tests

	Augmented Dickey-Fuller test (1981)	
	Price series	**Return series**
US	-1.711936 (0.4244)	-19.36494 (0.0000)
Japan	-1.416932 (0.5744)	-18.97376 (0.0000)
Hong-Kong	-1.560919 (0.5016)	-20.01315 (0.0000)
Korea	-1.447353 (0.5593)	-15.86237 (0.0000)
Singapore	-1.570158 (0.4969)	-19.57558 (0.0000)
Taiwan	-1.954937 (0.3070)	-19.40887 (0.0000)
Philippines	-1.440076 (0.5629)	-19.82506 (0.0000)
Indonesia	-0.795737 (0.8188)	-9.434649 (0.0000)
Malaysia	-1.426571 (0.5696)	-17.23884 (0.0000)
Thailand	-2.448210 (0.1293)	-19.33012 (0.0000)
China	-0.969605 (0.7649)	-18.83529 (0.0000)

Note: p-values displayed as (.). Critical value at 5% significance level of MacKinnon (1991) for the Augmented Dickey-Fuller test (process with intercept but without trend) is -2.86.

As it is shown in Table 2.2, the distributional properties of the return series generally appear to be non-normal. All the return series have negative skewness and are leptokurtic (the Kurtosis coefficient exceeds three). The Jarque-Bera test rejects normality of the returns. These characteristics have been well documented by a number of other studies in the financial literature.

Table 2.2. Summary statistics.

	Mean	Standard Deviation	Skewness	Kurtosis	Normality
US	0.001	0.024	-1.067	10.897	1042.691 (0.000)
Japan	0.000	0.032	-0.835	9.108	624.805 (0.000)
Hong-Kong	0.002	0.035	-0.348	6.572	206.4242 (0.000)
Korea	0.003	0.035	-0.278	7.871	374.591 (0.000)
Singapore	0.002	0.030	-0.157	8.075	402.861 (0.000)
Taiwan	0.001	0.033	-0.287	5.336	90.177 (0.000)
Philippines	0.003	0.033	-0.434	5.188	86.34322 (0.000)
Indonesia	0.005	0.039	-1.165	10.859	1047.005 (0.000)
Malaysia	0.002	0.021	-0.173	5.760	120.569 (0.000)
Thailand	0.002	0.034	-0.643	8.619	517.862 (0.000)
China	0.002	0.039	-0.201	3.703	10.215 (0.006)

Note: p-values displayed as (.).

Table 2.3 shows the unconditional correlation matrix. Focusing the attention on the correlation between the US market and Asian markets it is observed that the highest correlations are those with Japan, Hong-Kong and Singapore (around 0.6). This result makes sense due to their condition of mature market and tigers, respectively. The correlation with Korea and Taiwan, the other two tigers, is around 0.45 and the correlation with the cubs is around 0.4. Therefore, as it was expected, correlation

with the US market increases with the country's level of development. Finally, it is remarkable the low correlation between US and China (0.19).

The Japanese market returns exhibit relatively robust pair-wise correlations with Southeast Asian emerging markets (between 0.6 and 0.7), usually being higher with the four tigers. Again, the pair-wise correlation with China is relatively modest (0.21). Finally, the correlation within the tigers and the cubs is strong.

Table 2.3. Unconditional correlation matrix

	US	Japan	Hong-Kong	Korea	Singapore	Taiwan	Philippines	Indonesia	Malaysia	Thailand	China
US	1										
Japan	0.572	1									
Hong-Kong	0.604	0.701	1								
Korea	0.438	0.702	0.706	1							
Singapore	0.620	0.741	0.835	0.686	1						
Taiwan	0.461	0.598	0.660	0.658	0.642	1					
Philippines	0.377	0.519	0.525	0.519	0.581	0.491	1				
Indonesia	0.410	0.615	0.670	0.644	0.686	0.549	0.591	1			
Malaysia	0.399	0.562	0.637	0.563	0.682	0.539	0.591	0.640	1		
Thailand	0.432	0.592	0.625	0.626	0.633	0.542	0.559	0.663	0.557	1	
China	0.190	0.213	0.392	0.255	0.325	0.274	0.296	0.318	0.378	0.243	1

2.3 Methodology

To analyse volatility transmission between the US market and the Asian countries a bivariate VAR-GARCH process is used. Hence, 10 bivariate models are estimated.

The conditional mean equations are defined as a VAR(6) process:

$$R_{1,t} = \mu_1 + x_1 D_t + \sum_{p=1}^{6} d_{11,p} R_{1,t-p} + \sum_{p=1}^{6} d_{12,p} R_{2,t-p} + \varepsilon_{1,t}$$

$$R_{2,t} = \mu_2 + x_2 D_t + \sum_{p=1}^{6} d_{21,p} R_{1,t-p} + \sum_{p=1}^{6} d_{22,p} R_{2,t-p} + \varepsilon_{2,t} \qquad (2.2)$$

where $R_{1,t}$ and $R_{2,t}$ are the US and the Asian market returns, respectively, μ_i, x_i and $d_{ij,p}$ for i,j=1,2 are the parameters to be estimated and D_t is the dummy series for the Global Financial crisis. Finally, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the innovations. The VAR lag has been chosen following the AIC criterion.

To model the conditional variance-covariance matrix we use an asymmetric version of the BEKK model [Baba *et al.* (1989), Engle and Kroner (1995) and Kroner and Ng (1998)].[4]

[4] Asymmetric volatility refers to the empirical evidence according to which a negative shock increases volatility more than a positive shock of the same size. In the financial literature, two explanations of the asymmetries in equity markets have been put forward: The *leverage* effect and the volatility *feedback* effect. Which of the two effects is the main determinant of asymmetric volatility remains an open question.

As in the mean equations, we introduce a dummy series to take into account the Global Financial crisis.

The compacted form of this model is:

$$H_t = C'C + B'H_{t-1}B + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + G'\eta_{t-1}\eta_{t-1}'G + V\varepsilon_{t-1}\varepsilon_{t-1}'VD_t \qquad (2.3)$$

where *C, B, A, G* and *V* are matrices of parameters to be estimated, being *C* upper-triangular and positive definite, H_t the conditional variance-covariance matrix in *t* and D_t the dummy variable taking into account the crisis.

In the bivariate case, the BEKK model is written as follows:

$$\begin{bmatrix} h_{11t} & h_{12t} \\ \cdot & h_{22t} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}' \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ \cdot & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} +$$
$$+ \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \cdot & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}' \begin{bmatrix} \eta_{1,t-1}^2 & \eta_{1,t-1}\eta_{2,t-1} \\ \cdot & \eta_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} +$$
$$+ \begin{bmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \cdot & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{bmatrix} D_t \qquad (2.4)$$

where c_{ij}, b_{ij}, a_{ij}, g_{ij} and v_{ij} for all *i,j=1,2* are parameters, ε_{1t} and e_{2t} are the innovation series coming from equation (2.2), $\eta_{1,t} = \max[0, -\varepsilon_{1,t}]$ and $\eta_{2,t} = \max[0, -\varepsilon_{2,t}]$ are the Glosten *et al.* (1993) dummy series collecting a negative asymmetry from the shocks and, finally, $h_{ij,t}$ for all *i,j=1,2* are the conditional second moment series. Similarly to

$\eta_{i,t}$, the variable D_t is the dummy series for the crisis. It takes the value 0 until 15 August 2007 and 1 otherwise.

Equation (2.4) allows for both own-market and cross-market influences in the conditional variance, therefore enabling the analysis of volatility spillovers between both markets. Moreover, the BEKK model guarantees by construction that the variance-covariance matrix will be positive definite. This equation is estimated using the Quasi-Maximum Likelihood method. Bollerslev and Wooldridge (1992) show that the standard errors calculated using this method are robust even when the normality assumption is violated.

The estimation of the model is implemented in two steps. First, the US univariate equations have been estimated, and then the results are imposed on the individual countries in 10 bivariate regressions. Therefore, the estimates of the US coefficients in the conditional mean and variance are restricted to be the same in all countries.[5]

[5] A range of starting values was used to ensure that the estimation procedure converged to a global maximum. The estimations were repeated with random restarts of the starting values. None of the estimation results indicated any local maximum. The results also seem robust to alternating convergence criterions and optimizing methods. Consequently we are confident that we have found a global maximum.

2.4 Empirical results

2.4.1 Estimation results

Table 2.4 displays the estimated BEKK model of equation (2.4). It is necessary to distinguish own effects and cross-market effects. Coefficients a_{11}, b_{11}, g_{11} and v_{11} show the US own effects. All coefficients are significant indicating that S&P500 volatility is affected by its own past shocks (a_{11}) and by its own past volatility (b_{11}). Coefficient g_{11} is also significant indicating that negative shocks affect market volatility more than positive shocks. Finally, the coefficient v_{11} is significant suggesting that S&P500 shocks increase volatility more since the beginning of the crisis.

The estimated "own-market" coefficients of the conditional variances (a_{22} and b_{22}) are statistically significant for all Asian markets indicating that volatility of Asian markets is affected by its own past shocks and volatility. Concerning the asymmetric volatility response, the coefficient g_{22} is significant for all Asian markets but two, Hong-Kong and Indonesia. Finally, the coefficient v_{22} is significant for Japan, Singapore, Taiwan, Philippines and Thailand, suggesting that volatility in these markets is more affected by their own news since the beginning of the crisis. Therefore, the crisis has increased the response of the volatility in the case of the Asian mature market (Japan), two tigers (Singapore and Taiwan) and two cubs

(Philippines and Thailand). The coefficient for Thailand is significant at the 10% level and Philippines, as an American ex-colony, is very dependent on the US.

Regarding cross-effects, it must be highlighted that the coefficient a_{12} is always significant, indicating that shocks coming from the US increase the volatility of all Asian markets. The coefficient a_{21} indicates that shocks coming from the Asian markets affect the volatility of the US (except for Indonesia).[1]

The coefficient b_{12} is always significant except for China, that is, the volatility of US has an effect on almost all Asian markets volatility. However, only past volatilities from Japan (mature market), Singapore and Taiwan[2] (tigers) and China affect the US volatility.

While examining asymmetric cross-market effects, coefficients g_{12} and g_{21}, it is observed that US negative shocks increase the volatility of all Asian markets more than positive shocks (except for Hong-Kong and China). However, only negative news from Korea, Malaysia and Thailand increase the US volatility more than positive news.

[1] The coefficient for Philippines is significant at the 10% level.
[2] The coefficient for Taiwan is significant at the 10% level.

Finally, results suggest that since the beginning of the crisis, US shocks increase more the volatility of Japan, Taiwan and Philippines (coefficient v_{12}). However, shocks from the Asian market have the same effect on the US volatility before and after August 2007 (coefficient v_{21}). Therefore, volatility transmission patterns have not changed since the beginning of the crisis with few exceptions.

Table 2.4. Estimates of the BEKK model

	US	Japan	Hong-Kong	Korea	Singapore	Taiwan	Philippines	Indonesia	Malaysia	Thailand	China
c_{11}	0.000010* (0.0000)										
c_{12}		0.005267 (0.1846)	0.00188 (0.8657)	0.000057 (0.9918)	0.000008 (0.9848)	0.000010 (1.0000)	0.003227 (0.5598)	0.000006 (0.9991)	0.000012 (0.9832)	0.002652 (0.7078)	0.016300* (0.0003)
c_{22}		0.000006 (0.9999)	-0.000153 (0.9980)	0.000000 (0.9987)	0.000003 (0.9982)	-0.000000 (1.0000)	-0.009306* (0.0020)	-0.000001 (0.9985)	-0.000000 (0.9997)	0.000001 (0.9999)	-0.000004 (0.9998)
a_{11}	0.078600* (0.0000)										
a_{12}		0.492984* (0.0000)	0.490554* (0.0000)	0.568300* (0.0000)	0.571794* (0.0000)	0.481823* (0.0000)	0.056573* (0.0193)	0.481552* (0.0004)	-0.260012* (0.0000)	0.255601* (0.0003)	-0.270017* (0.0005)
a_{21}		0.149219* (0.0000)	-0.101207* (0.0462)	0.167700* (0.0000)	0.135274* (0.0000)	0.207373* (0.0000)	0.125820 (0.0818)	0.080715 (0.6981)	-0.134626* (0.0003)	0.082675* (0.0000)	-0.112459* (0.0005)
a_{22}		-0.147177* (0.0209)	0.218926* (0.0000)	-0.166500* (0.0046)	-0.263036* (0.0000)	-0.062495* (0.0046)	0.136659* (0.0351)	0.066398* (0.0000)	-0.167025* (0.0000)	-0.228078* (0.0000)	0.217714* (0.0046)
b_{11}	0.839900* (0.0000)										
b_{12}		0.126089* (0.0000)	0.120897* (0.0000)	0.172200* (0.0000)	0.040614* (0.0000)	-0.040145* (0.0000)	0.152811* (0.0000)	0.138399* (0.0000)	-0.039055* (0.0003)	0.156587* (0.0000)	-0.015562 (0.3861)
b_{21}		0.139834* (0.0000)	-0.005187 (0.94157)	0.146500 (0.4907)	0.105994* (0.0000)	0.124786 (0.0980)	0.021184 (0.2279)	0.164739 (0.7817)	0.137572 (0.1055)	-0.007690 (0.4655)	0.175294* (0.0000)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

Table 2.4. Estimates of the BEKK model (continued)

	US	Japan	Hong-Kong	Korea	Singapore	Taiwan	Philippines	Indonesia	Malaysia	Thailand	China
b_{22}		0.793502* (0.0000)	0.915112* (0.0000)	0.717000* (0.0000)	0.883459* (0.0000)	0.934576* (0.0000)	0.877172* (0.0000)	0.715066* (0.0000)	0.984681* (0.0000)	0.922589* (0.0000)	0.937049* (0.0000)
g_{11}	-0.026094* (0.0000)										
g_{12}		0.029264* (0.0412)	0.007650 (0.9084)	-0.181200* (0.0000)	-0.285395* (0.0000)	0.245668* (0.0000)	-0.536533* (0.0000)	-0.135757* (0.0058)	0.228033* (0.0000)	0.404106* (0.0000)	0.014664 (0.9268)
g_{21}		0.002613 (0.8306)	-0.016885 (0.8435)	-0.029700* (0.0000)	0.021692 (0.4301)	0.004446 (0.7590)	-0.085886 (0.2629)	-0.175859 (0.3443)	-0.194368* (0.0000)	0.113074* (0.0005)	0.030429 (0.8586)
g_{22}		-0.273379* (0.0000)	0.121456 (0.1746)	0.418500* (0.0000)	-0.171488* (0.0000)	-0.347576* (0.0000)	0.184191* (0.0026)	0.190800 (0.1874)	0.291768* (0.0000)	-0.007954* (0.0359)	0.126017* (0.0001)
v_{11}	-0.050884* (0.0000)										
v_{12}		0.202722* (0.0001)	0.207321 (0.3552)	-0.143700 (0.3070)	-0.002773 (0.9294)	-0.042744* (0.0316)	-0.032939* (0.0341)	-0.224264 (0.1079)	0.059245 (0.7564)	0.099997 (0.1809)	0.056935 (0.5837)
v_{21}		0.006904 (0.5925)	0.013734 (0.3867)	-0.006688 (0.5298)	0.033635 (0.4295)	-0.006540 (0.5642)	-0.000148 (0.9901)	0.003983 (0.8084)	-0.000932 (0.9157)	0.021206 (0.3031)	-0.033688 (0.1076)
v_{22}		0.043316* (0.0448)	0.054812 (0.7278)	0.018600 (0.7855)	-0.224430* (0.0000)	-0.090475* (0.0415)	0.062726* (0.0245)	0.419623 (0.6471)	-0.083146 (0.7403)	-0.166243 (0.0561)	-0.216235 (0.1728)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

Table 2.5 shows the standardized residuals analysis. It can be observed that the standardized residuals appear free from serial correlation (with the exceptions of Korea, Indonesia and China) and heteroskedasticity.

Table 2.5. Summary statistics for the standardized residuals of the model

	$\varepsilon_{i,t} / \sqrt{h_{ii,t}}$	
	Q(12)	**ARCH(12)**
US	12.84229 (0.381)	11.25274 (0.507)
Japan	8.96172 (0.706)	9.02760 (0.701)
Hong-Kong	13.12281 (0.360)	10.690144 (0.556)
Korea	22.20354 (0.035)	7.65465 (0.812)
Singapore	12.50207 (0.406)	14.81953 (0.251)
Taiwan	6.56060 (0.885)	19.84697 (0.070)
Philippines	14.87421 (0.248)	8.4388 (0.750)
Indonesia	24.79154 (0.016)	13.54134 (0.331)
Malaysia	20.14805 (0.064)	16.45555 (0.171)
Thailand	6.78450 (0.872)	18.33273 (0.106)
China	21.81884 (0.040)	10.78603 (0.547)

Note: Q(12) is the Ljung-Box test for twelfth order serial correlation in the standardized residuals. ARCH(12) is Engle's test for twelfth order ARCH, distributed as $\chi^2(12)$. The p-values of these tests are displayed as (.).

2.4.2 Volatility and conditional correlation dynamics

Figures 2.1a-2.1d show the estimated conditional volatilities. It is observed that all volatilities follow a similar pattern and start to rise in August 2007, showing a sharp spike in September 2008 when the bankruptcy of Lehman Brothers took place. It is noteworthy that even though volatility in all markets increases during the crisis, volatility in Asian markets tends to raise more.

Figure 2.1a. Japanese and US annualized market volatility

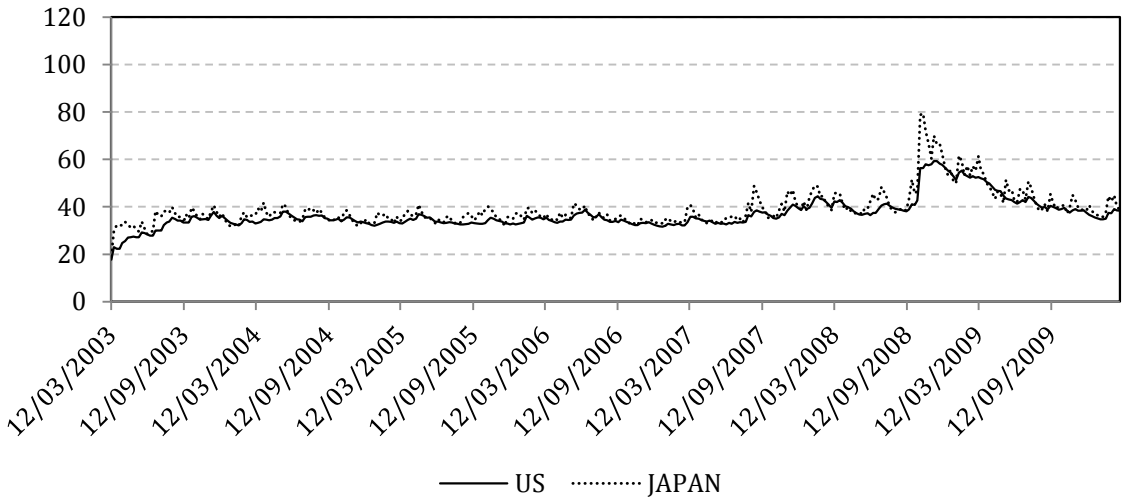


Figure 2.1b. US and Asian Tigers annualized market volatility

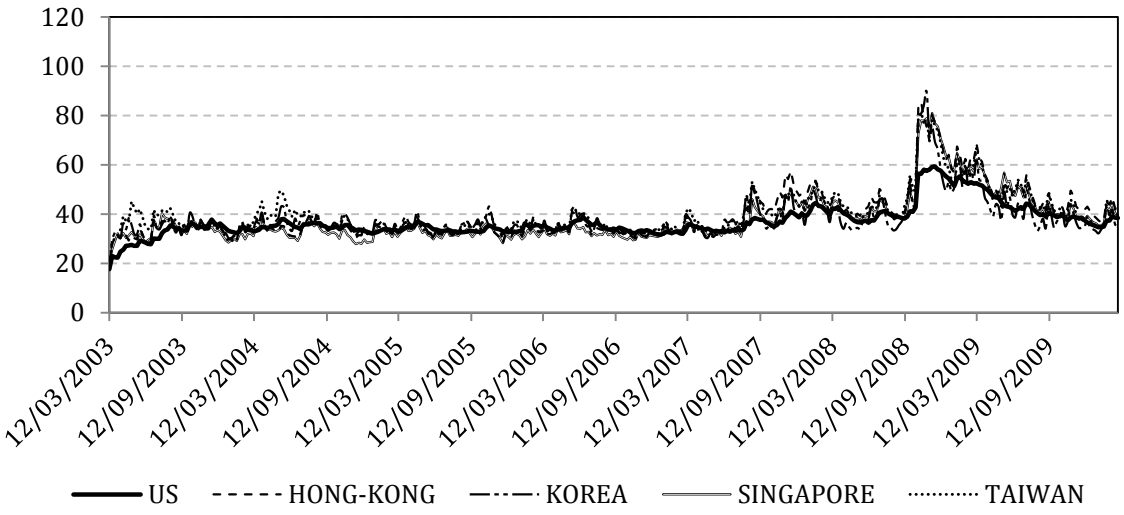


Figure 2.1c. US and Asian Tiger Cubs annualized market volatility

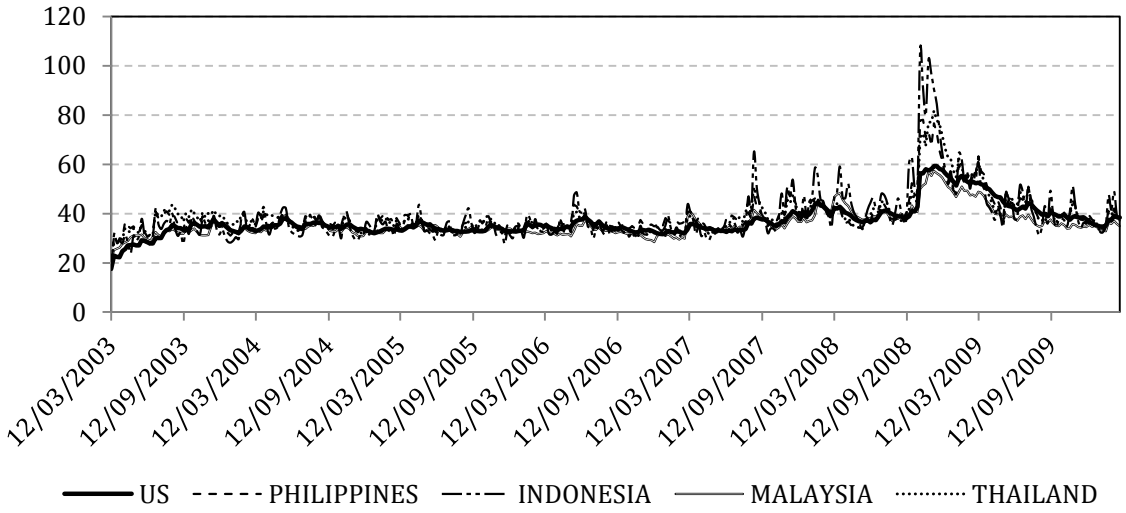
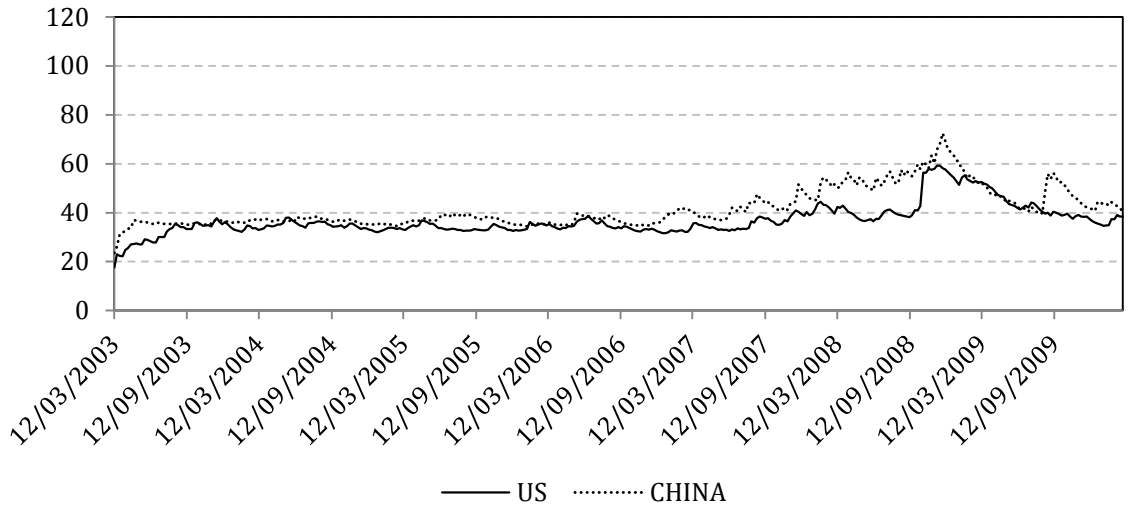
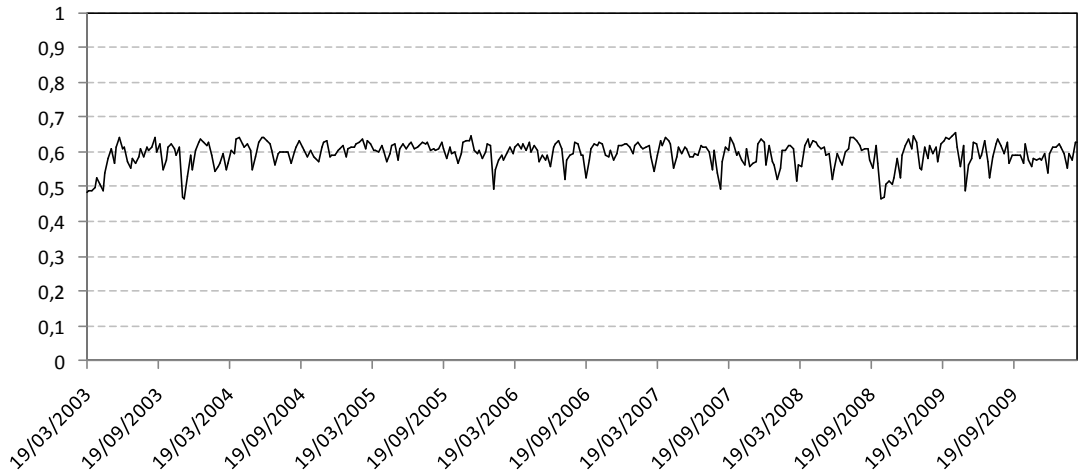


Figure 2.1d. Chinese and US annualized market volatility



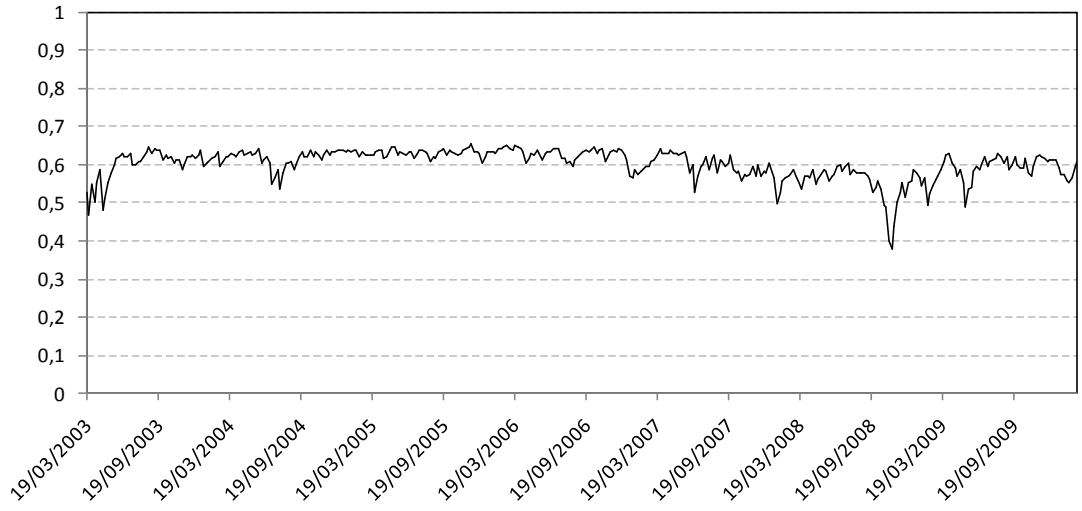
Having established the existence of volatility spillovers between the US and the Asian markets, a further issue is to analyse the correlation between markets. Figure 2.2 shows the conditional correlation between the US and the Japanese market. The correlation between both markets has been stable during the sample period. It is observed that around September and October 2008 (Lehman Brothers bankruptcy) the correlation decreases until 0.47 but it still remains at high levels.

Figure 2.2. Conditional correlation between Japan and US



In October 2008, the correlations between the US and Hong-Kong, Singapore and Taiwan decrease to 0.37, 0.29 and 0.32, respectively (Figures 2.3, 2.4 and 2.5). However, correlation between the US and Korea (Figure 2.6) diminishes to 0.11 in November 2008. Therefore, the correlations of the four Asian Tigers with the US follow a similar pattern except Korea.[8]

Figure 2.3. Conditional correlation between Hong-Kong and US



[8] This fact could be due to the Korean Government's announcement of an economic stimulus plan. After this announcement, Kospi index returns raised while S&P500 index returns decreased.

Figure 2.4. Conditional correlation between Singapore and US

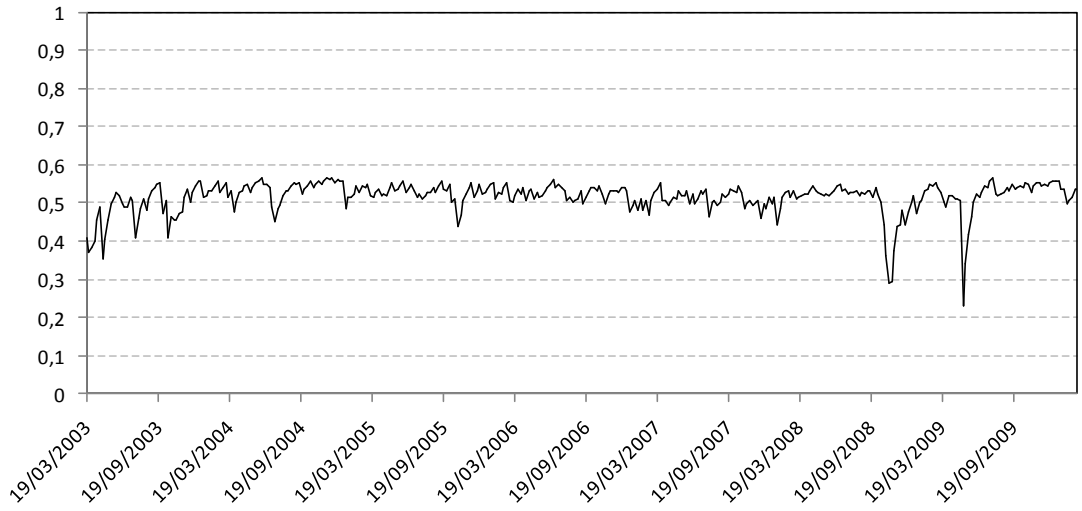


Figure 2.5. Conditional correlation between Taiwan and US

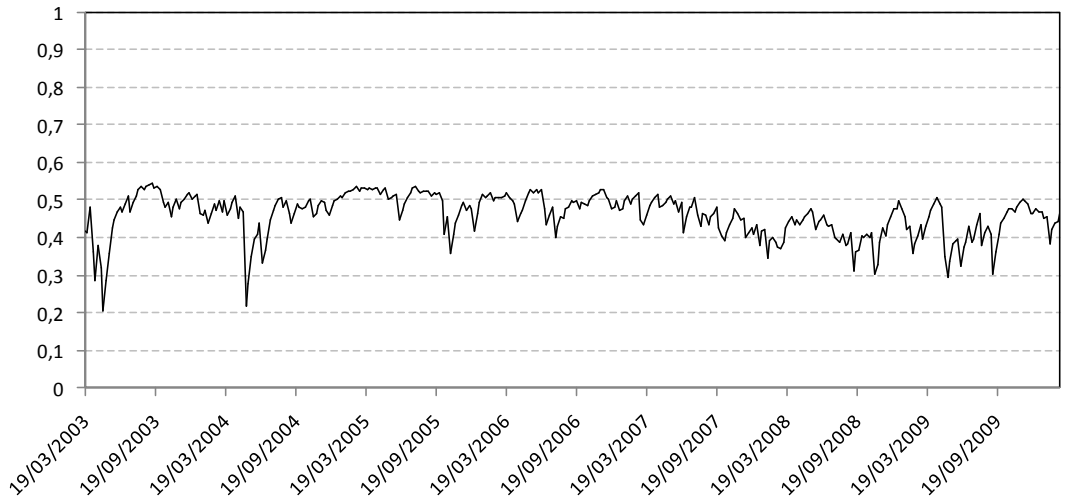
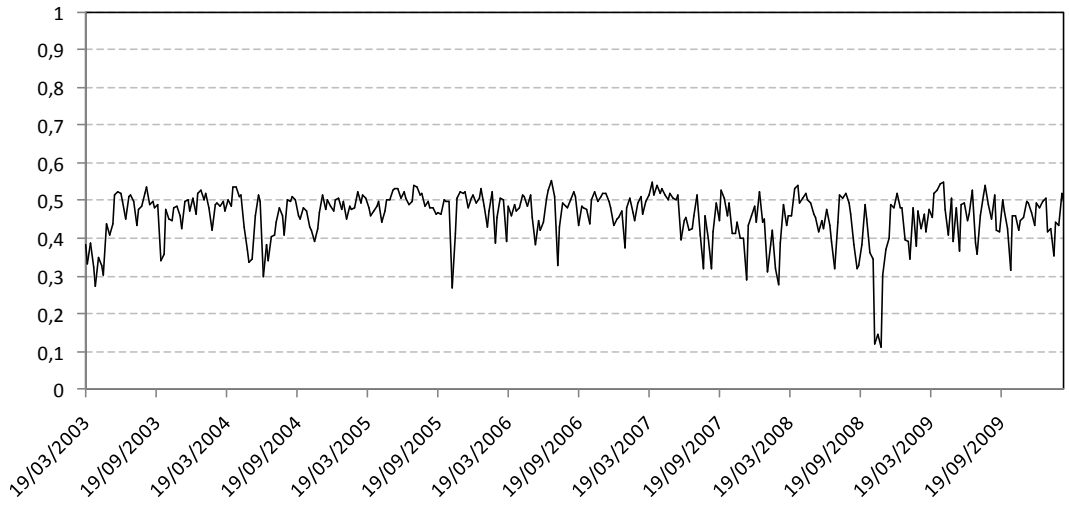


Figure 2.6. Conditional correlation between Korea and US



Regarding the correlations of the four cubs with the US, it is observed that they diminish after the Leman Brothers bankruptcy to 0.26, 0.18, 0.15 and 0.16 in the case of Philippines, Indonesia, Malaysia and Thailand, respectively (Figures 2.7-2.10). The correlation between Philippines and the US decreases less than the other correlations due to its dependency with the US mentioned before. In general, the cubs show a similar behaviour among them and suffer a stronger drop in correlations with the US than the tigers, owing to their lower level of development. The correlation between China and the US (Figure 2.11) decreases to 0.13, because despite being a big country and growing by leaps and bounds, its financial sector, as already mentioned above, is still quite closed.

Figure 2.7. Conditional correlation between Philippines and US

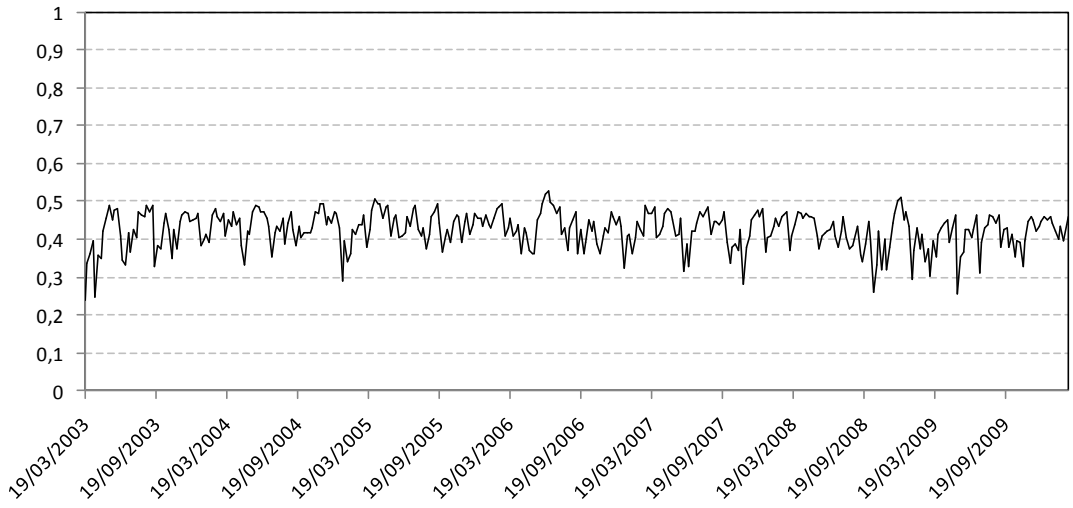


Figure 2.8. Conditional correlation between Indonesia and US

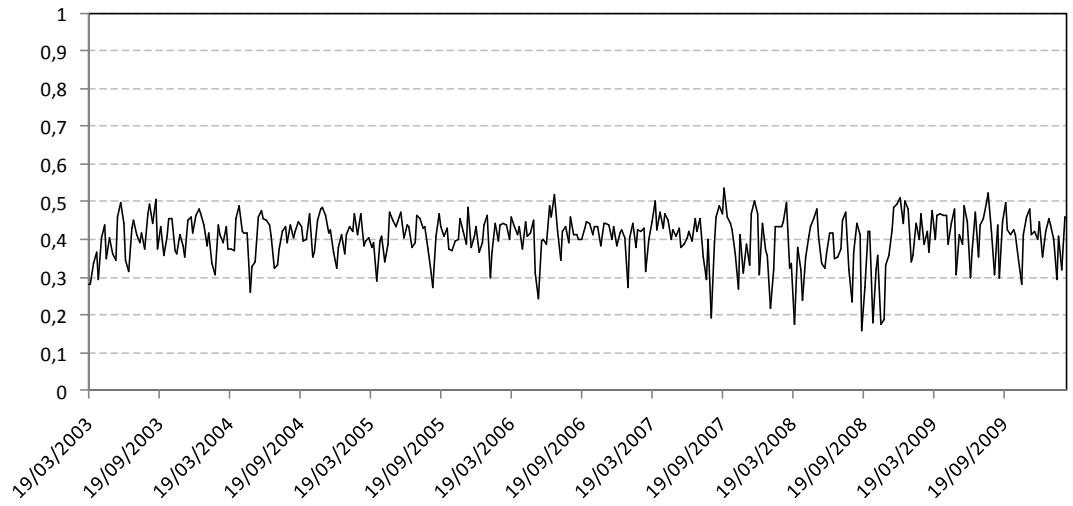


Figure 2.9. Conditional correlation between Malaysia and US

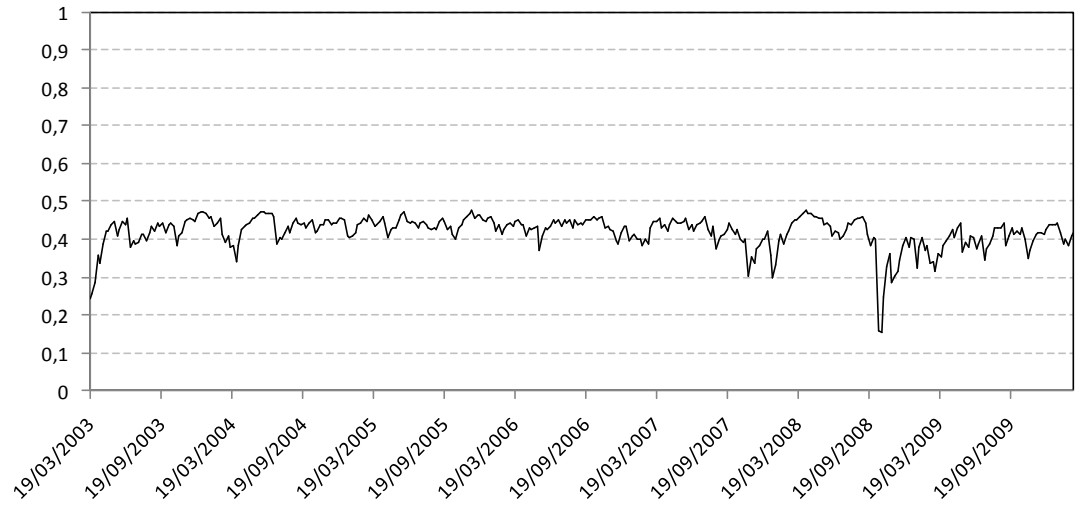


Figure 2.10. Conditional correlation between Thailand and US

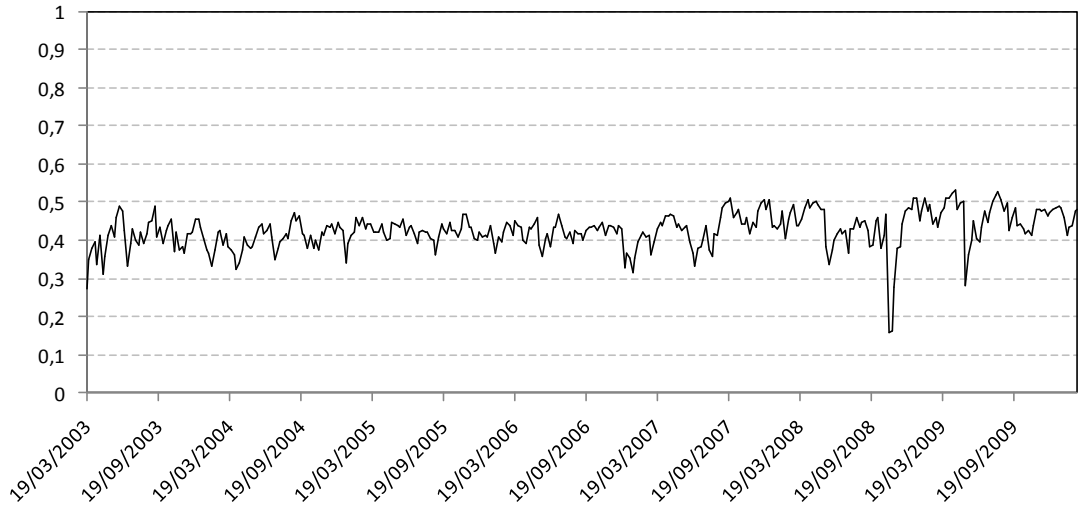
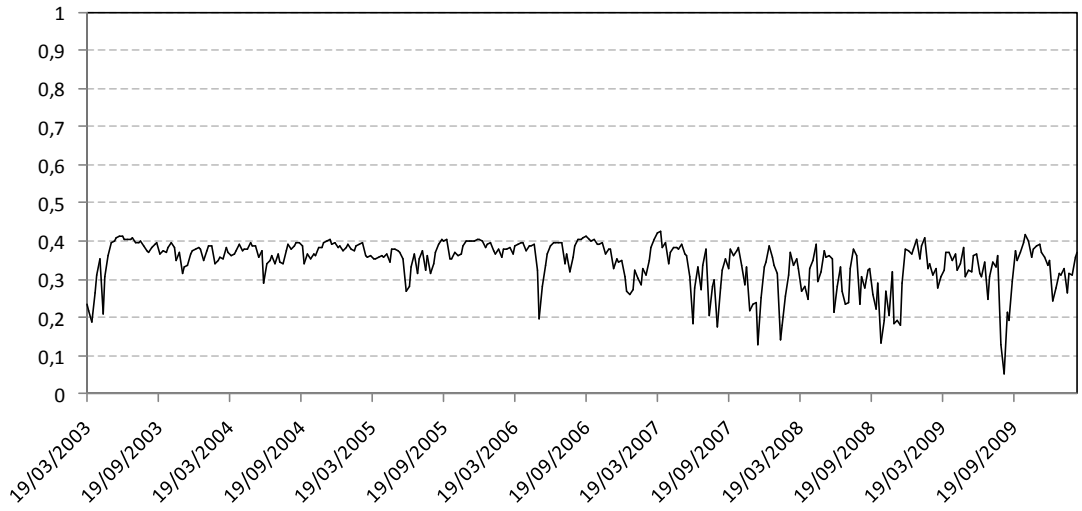


Figure 2.11. Conditional correlation between China and US



On the whole, results suggest that correlation between the US and the Asian countries have been stable around their unconditional level during the sample period. However, they diminish during the crisis, especially after the Lehman Brothers' failure, but the lower the country's development level, the greater the decline.

2.5 Conclusions

The main objective of this study is to examine the nature of interrelationships in terms of volatility spillover effects and the conditional correlation behaviour between the US market and the Asian markets, bearing in mind the Global Financial crisis. Within the Asian markets this analysis distinguishes between mature and emerging markets. To carry out it, a VAR-GARCH model is estimated taking into account the asymmetric

volatility phenomenon. The GARCH model estimation is pair-wise, having the US as the main market analysed with the rest of the markets.

The analysis provides a number of interesting insights. In particular, it suggests that all the markets are affected by their own past shocks and volatility. Most markets respond asymmetrically to news, so that bad news increases volatility more than positive news. Furthermore, volatility spillover analysis shows that past shocks and volatility from the US market do influence the dynamics of conditional variances of returns in the ten Asian markets analysed. However, in general, only shocks from these last markets increase the volatility of the US. Moreover, the results also find that the financial crisis has barely changed volatility transmission patterns.

After the Lehman Brothers failure conditional variances increased in all markets although the rise was higher in emerging economies. Regarding the behaviour of conditional correlations, results indicate that the level of correlations depends on the country's level of development. Japan exhibits the highest correlation with the US followed by the four tigers and the four cubs going after. China presents low correlation with the US. In the past decades this country has chased a remarkable progression of creating a market-based financial system and opening it up to international financial

markets. However, the openness of its financial market towards the rest of the world is still limited.

Chapter 3[+]

Asian market reactions to US macroeconomic news surprises

3.1 Introduction

Interrelations between the US and Asian markets have strengthened in recent years due to their developing financial relations. However, before investing, good portfolio managers need to know the characteristics of a geographical area, and should analyse the factors that can influence the behaviour of assets in a given financial market. Traditionally, one of the factors that can affect the behaviour of the equity markets are macroeconomic news announcements. This study analyses the impact of US macroeconomic news releases in several Asian countries, primarily the emerging markets of Southeast Asia.

[+] This analysis has been published as a chapter in the Handbook of Asian Finance entitled "Financial Markets and Sovereign Wealth Funds" edited by David Lee and Greg Gregoriou. The complete reference is:
Valls, N. and Chuliá, H. (2014). Asian Market Reactions to US Macroeconomic News Surprises. In: Financial Markets and Sovereign Wealth Funds, Eds: D. Lee and G. Gregoriou, Elsevier, 2014.

The specific Asian countries examined are again the ones aforementioned: first, Japan, representative of the mature Asian market; second, the emerging economies of Southeast Asia divided into two groups – the tigers, made up of Taiwan, Singapore, Hong-Kong and Korea, and the cubs, comprising Philippines, Indonesia, Malaysia and Thailand; and third, China, a growing economy with a great influence worldwide.

Although investors on non-U.S. stock markets are interested in US news releases, their general importance can be expected to vary across economic regions as a result of differences in dependence on international trade, size of the market, foreign ownership and the industrial and economical structures.

The domestic impact of US macroeconomic news announcements has been widely studied in the financial literature [see Bomfim, (2003), Bernanke and Kuttner (2005), Boyd, Jagannathan and Hu (2005), Christiansen and Ranaldo (2007), Andersen et al., (2007), Zebedee et al., (2008), Brenner, Pasquariello and Subrahmanyam (2009), Chuliá, Martens and van Dijk (2010) and Wongswan (2006), among others]; however, the effect of US news releases on the emerging Asian economies has not been as extensively discussed. For example, Kim (2003) explores the spillover effects of US and Japanese scheduled announcements in the advanced Asia-Pacific stock markets of Australia, Hong-Kong and Singapore between the years 1991 and 1999. His results show that both US and Japanese news releases significantly impact on the returns of the other markets.

Similarly, Wongswan (2006) finds a significant transmission of information from the US and Japan to Korean and Thai equity markets. Using high-frequency intraday data, this author finds a significant relation between emerging-economy equity volatility and trading volume and developed-economy macroeconomic news announcements at short-time horizons. Finally, Vrugt (2009) studies the impact of US and Japanese macroeconomic news announcements on stock market volatility in Japan, Hong-Kong, Korea and Australia. He finds that overnight conditional variances are significantly higher on announcement days and significantly lower on days before and after announcements, especially for US releases.

This chapter analyses whether the release of US macroeconomic news announcements affects the returns and volatility of the ten Asian financial markets analysed and their correlations with the US market. Moreover, this analysis also studies whether there is an asymmetric effect of news, so that the surprise (computed as the difference between the observed and the expected data) affects the returns, volatility and correlation differently depending on its sign (good or bad). Finally, the chapter examines whether the pattern observed changed following the onset of the financial crisis in August 2007.

This study makes a number of contributions to the relevant literature. First, we explore the entire emerging region of Southeast Asia, grouping countries with similar characteristics to determine if they present any differences in behaviour. Second, the

sample period incorporates the recent global financial crisis. Third, we also look at the effect of US news announcements on the correlations between the respective markets while the previous literature has focused solely on returns and volatility.

Following Brenner, Pasquariello and Subrahmanyam (2009), the methodology for testing the effect of US macroeconomic news announcements on conditional returns, return volatility and the correlation between the US and the Asian markets is based on the Dynamic Conditional Correlation (DCC) multivariate model of Engle (2002). Our main findings can be summarized as follows. First, our results indicate significant heterogeneity in the impact of the release of "good" and "bad" news announcements on Asian market returns and volatility. Second, there appears to be a relation between the response shown by returns and volatility and a country's level of development. Third, our evidence suggests that the co-movement between the US and the Asian markets is unchanged when US news announcements are released. Finally, we find that the financial crisis has not changed the response of Asian market returns, volatility and correlations to US macroeconomic news announcements.

The remainder of the chapter is organized as follows. Section 2 describes our data. Section 3 outlines the methodology we use. Section 4 discusses the empirical results and, finally, Section 5 concludes.

3.2 Data

3.2.1 Stock market data

We use daily data covering the period from January 1, 2003 until February 29, 2012.[9] The data has been obtained from Bloomberg. The S&P 500 Index and the Nikkei 225 Index are used as benchmarks for the US and Japanese markets, respectively. Among the emerging markets of Southeast Asia, the four tigers include South Korea (Kospi Index), Taiwan (Taiwan Stock Exchange Index), Hong-Kong (Hang Seng Index) and Singapore (Straits Time Index), and the four cubs are made up of Malaysia (FTSE Bursa Malaysia Kuala Lumpur Composite Index), Thailand (FTSE SET Shariah Index), Indonesia (Jakarta Composite Index) and Philippines (Philippine Stock Exchange Index). Finally, the Shanghai A-Share Stock Price Index represents China.

It should be stressed that trading in the US and Asian markets is non-synchronous, so when the US market is operating, the Asian markets are closed, and the latter start negotiating when the US market has already closed. Table 3.1 shows the time (Greenwich Mean Time) in the different countries included in this analysis, indicating that the trading times of the US and Asian markets do not overlap.

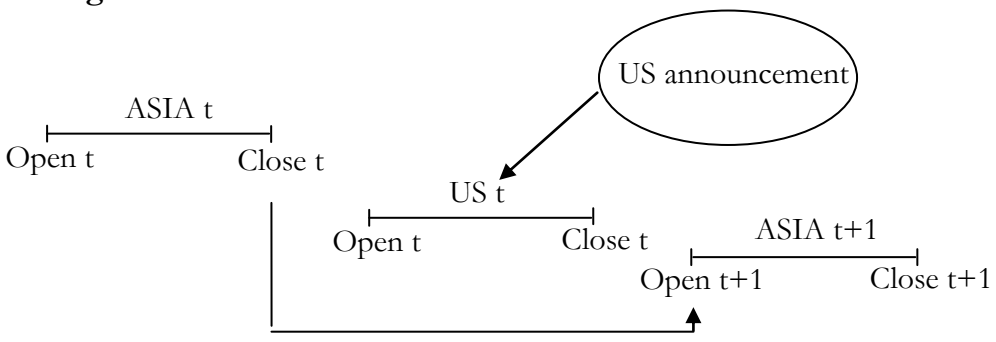
[9] The earliest data available for Indonesia and Thailand is 1 April 2004.

Table 3.1. GMT hours

Country	Time
US	GMT - 5:00
JAPAN	GMT + 8:00
HONG-KONG	GMT + 7:00
SOUTH KOREA	GMT + 8:00
SINGAPORE	GMT + 7:00
TAIWAN	GMT + 7:00
PHILIPPINES	GMT + 7:00
INDONESIA	GMT + 6:00
MALAYSIA	GMT + 7:00
THAILAND	GMT + 6:00
CHINA	GMT + 7:00

As the minimum time difference between any of the Asian countries and the US is eleven hours, when a news announcement is released in the US on calendar date t, the Asian markets are already closed. When the US market closes, therefore, the Asian markets open on calendar date t+1. As such, the opening price of the Asian markets on calendar date t+1 incorporates the information that was released in the US on calendar date t. We can therefore take the close-to-open (t to t+1) returns of the Asian markets to analyse the impact of US news releases on the returns, volatility and correlation of the Asian markets (spillover effects). The timeline described is shown in Figure 3.1.

Figure 3.1. Timeline of the US and Asian financial markets



The market returns that capture the impact of US macroeconomic news releases are calculated over the closing price on the calendar day before the announcements and the opening price one calendar day after for the Asian markets (overnight return on calendar date t+1, $\ln(P_{t+1}^{Open} / P_t^{Close})$).

The summary statistics of the overnight returns on the Asian markets are shown in Table 3.2. It can be seen that the means are fairly close to zero, that the return series are leptokurtic and the Jarque-Bera test rejects normality of the returns. These characteristics are typical of high frequency financial return series.

Table 3.2. Statistical properties of overnight stock market index returns

	Mean	Standard Deviation	Skewness	Kurtosis	Normality
Japan	0.0004	0.0078	0.4413	9.222	3932.348 (0.000)
Hong-Kong	0.0005	0.0117	-0.3703	10.307	5370.992 (0.000)
Korea	0.0008	0.0101	-0.5764	8.287	2915.454 (0.000)
Singapore	0.0004	0.0104	-0.5076	8.721	3361.635 (0.000)
Taiwan	0.0014	0.0101	-0.9036	11.584	7662.886 (0.000)
Philippines	0.0003	0.0063	0.5259	23.502	41966.590 (0.000)
Indonesia	-0.0002	0.0069	0.6405	36.383	96027.360 (0.000)
Malaysia	0.0001	0.0042	-1.0142	22.297	37492.150 (0.000)
Thailand	0.0008	0.0078	-1.0739	15.671	14210.930 (0.000)
China	-0.0010	0.0077	0.9681	27.279	59074.490 (0.000)

Note: p-values displayed as (.).

3.2.2 Announcement data

The announcement data have also been obtained from Bloomberg. For each macroeconomic announcement, we obtain a time series of the real values as well as of the market forecasts based on survey expectations. In line with the literature, the "surprise" is computed as the difference between the real value and the survey median. It should be stressed that, depending on the nature of the macroeconomic news announcement, the sign of the surprise will indicate either "good" or "bad" news. The information provided by the survey is traditionally taken to represent unbiased estimates of the anticipated portion of macroeconomic announcements.[10] Therefore, the survey data enable us to identify the unexpected component in the news when released to the public.

The macroeconomic news announcements that have been analysed concern the following fundamentals: Gross Domestic Product (GDP), the Consumer Price Index (CPI), the unemployment rate and the Federal Open Market Committee (FOMC) decisions on the federal funds target rate. The GDP is an aggregate indicator describing domestic production. It acquires particular relevance here, however, as the aggregate indicator of economic performance. A positive (negative) surprise indicates that the GDP has either increased (decreased) by a surprising amount or decreased (increased)

[10] See Balduzzzi, Elton and Green (2001) and Andersen *et al.,* (2003, 2007), among others.

surprisingly little with respect to the previous announcement, and so this is good (bad) news.

The CPI measures the change in prices of a basket of goods and services considered representative of the general consumption of the population. Controlling the CPI is particularly relevant since the price evolution of an economy has a direct influence on monetary policy decisions. A positive (negative) surprise means that the CPI has either increased (decreased) by a surprising amount or decreased (increased) surprisingly little with respect to the previous announcement, and so this is bad (good) news.

The unemployment rate indicates the number of unemployed out of a country's total labour force. As with the CPI announcement, a positive (negative) surprise means that the unemployment rate has either increased (decreased) by a surprising amount or decreased (increased) surprisingly little with respect to the previous announcement, and so this is bad (good) news.

Finally, the announcements of FOMC decisions on the federal funds target rate are analysed. The committee's decisions regarding the target rate have a major impact on international capital markets, since they provide a broad picture of the economic situation of the country and the expectations of its monetary authority. A positive (negative) surprise indicates that the FOMC announced either a surprisingly large rate increase (cut) or a surprisingly small rate cut (increase), and so this is bad (good) news.

Table 3.3 reports summary statistics for the macroeconomic news surprises. The number of surprises during the sample period is higher for announcements concerning the CPI and the unemployment rate. Good news announcements were more common regarding the unemployment rate (62% of releases), and bad news announcements were more frequent in the case of the GDP, the CPI and the FOMC decisions (72%, 52.5% and 70% of releases, respectively).

Table 3.3. Descriptive statistics of news announcement surprises

	Mean	Median	Max	Min	Standard Deviation	N
GDP	-0.700	-0.600	2.200	-3.200	1.165	36
GDP +	0.670	0.500	2.200	0.100	0.617	10
GDP-	-1.227	-1.100	-0.200	-3.200	0.852	26
CPI	0.044	0.100	0.700	-0.400	0.251	80
CPI +	0.236	0.200	0.700	0.100	0.186	42
CPI -	-0.168	-0.100	-0.100	-0.400	0.090	38
Unemployment rate	-0.029	-0.100	0.400	-0.400	0.186	77
Unemployment rate +	0.183	0.200	0.400	0.100	0.089	29
Unemployment rate -	-0.156	-0.100	-0.100	-0.400	0.082	48
Interest rate	-0.007	0.005	0.140	-0.229	0.076	30
Interest rate +	0.027	0.012	0.140	0.001	0.034	21
Interest rate -	-0.086	-0.072	-0.002	-0.229	0.090	9

Note: N is the number of observations for each macroeconomic announcement surprise. Max and Min are the maximum and minimum for the surprise, respectively. + (-) refers to positive (negative) surprises.

3.3 Methodology

Following Brenner, Pasquariello and Subrahmanyam (2009), the methodology for testing the effect of US macroeconomic news announcements on conditional returns, volatility and the correlation between the US and the Asian markets is based on the Dynamic Conditional Correlation (DCC) multivariate model of Engle (2002). The DCC model has the flexibility of univariate GARCH models but does not suffer from the "curse of dimensionality" as do multivariate GARCH models. The estimation consists of two steps. First, the conditional variance of each variable is estimated using a univariate GARCH procedure. Second, the standardized regression residuals obtained in the first step are used to model conditional correlations that vary over time.

To analyse the response of Asian markets to the arrival of US macroeconomic news, the evolution in the returns and volatility of country i is modelled as

$$\begin{aligned} r_t^i &= \mu_i^e + \rho_i r_{t-1}^i + sr_t^i + \varepsilon_t^i \\ \varepsilon_t^i &= \sqrt{h_t^i} e_t^i \,\big| F_{t-1} \sim \mathrm{N}(0,1) \\ h_t^i &= sh_t^i \left[\omega_i^e + \alpha_i^e (e_{t-1}^i)^2 + \beta_i^e h_{t-1}^i \right] \end{aligned} \qquad (3.1)$$

where r_t^i is the overnight return on calendar day t+1 of the Asian market i, F_{t-1} denotes the information set at time t-1, $sr_t^i = (\gamma_i^{+e} I_t^{+e} + \gamma_i^{-e} I_t^{-e}) S_t^e$ and $sh_t^i = 1 + (\delta_i^{+e} I_t^{+e} + \delta_i^{-e} I_t^{-e}) \big| S_t^e \big|$. In the above specification, I_t^{+e} (I_t^{-e}) is a dummy variable equal to one if a positive (negative) surprise macroeconomic event of type e occurred at

time t and equal to zero otherwise and, finally, S_t^e are news surprises. As standard in the finance literature, equation (3.1) specifies a first-order autocorrelation model to control for microstructure effects and gradual convergence to equilibrium.

The above specification enables us to identify the asymmetric effects of surprises on conditional returns and volatilities. The coefficient $\gamma_i^{+e}(\gamma_i^{-e})$ captures the impact of a positive (negative) surprise announcement on the mean returns. Similarly, the dummy coefficient $\delta_i^{e+}(\delta_i^{e-})$ proxies for the impact of positive (negative) absolute macroeconomic news surprises on conditional volatility.[11]

Finally, to analyse the impact of news announcements on conditional correlations the following exponential smoothing function is used:

$$q_t^{ij} = sq_t^i\left[\lambda q_{t-1}^{ij} + (1-\lambda)\eta_{t-1}^i\eta_{t-1}^j\right] \qquad (3.2)$$

where $sq_t^i = 1 + (\theta_{i,j}^{+e}I_t^{+e} + \theta_{i,j}^{-e}I_t^{-e})\left|S_t^e\right|$.[12] To deal with the problem identified by Forbes and Rigobon (2002) that shocks to the conditional covariance among asset returns in

[11] Following Brenner, Pasquariello and Subrahmanyam (2009), macroeconomic news announcement surprises enter the variance equation as absolute values.

[12] In order to estimate conditional correlations, the return and variance equations in (3.1) are also estimated for the US market. In this case, r_t^i refers to the over night return on calendar day *t* of the US market calculated as $\ln(P_t^{Open}/P_{t-1}^{Close})$.

proximity of certain macroeconomic announcements may be due to shocks to return volatility, the residuals are standardized as follows:

$$\eta_t^i = \frac{\varepsilon_t^i}{\sqrt{sh_t^i \cdot h_t^i}} \text{ and } \eta_t^i = \frac{\varepsilon_t^j}{\sqrt{sh_t^j \cdot h_t^j}} \qquad (3.3)$$

In equation (3.2), the coefficient $\theta_{i,j}^{+e}(\theta_{i,j}^{-e})$ captures the impact of a positive (negative) surprise announcement on the conditional covariance between any pair of standardized residuals (countries i and j).

The above model enables us to examine the effect of US news releases on the returns, volatilities and correlations of Asian markets. Moreover, we can also observe whether there exists an asymmetric effect, that is, if the impact of the news differs depending on whether the surprise is positive or negative.

In order to estimate the model a conditional normal distribution for the innovation vector is assumed and the quasi-maximum likelihood method is applied. Bollerslev and Wooldridge (1992) show that the standard errors calculated by this method are robust even when the normality assumption is violated.

3.4 Empirical results

Tables 3.4 to 3.7 display the estimation results. An inspection of the coefficients shows that, in general, the number of significant coefficients increases as the level of development of the country falls. Of the potentially significant values (16 coefficients for each country), Japan presents 1 significant coefficient, Hong-Kong 3, Singapore 5, Korea 6, Taiwan 7, Philippines 5, Indonesia 12, Malaysia 8, Thailand 10 and China 9. Given that tigers, cubs and China are more exposed to the global economy with exports representing a very high percentage of their GDP, these results could be explained by the fact that export-oriented firms weigh heavily in the Asia-Pacific market indexes.

Japan is only affected by announcements concerning GDP. Bad news in relation to GDP (lower than expected data) increases the volatility of the Nikkei 225. Japanese stock market returns and volatility remain indifferent to all other US news announcements. This result is in line with the findings reported by Kim (2003), who likewise finds that the response of Japan to US news announcements is not as great as that of Hong-Kong and Singapore.

Among the tigers, the news announcements that have most impact on Hong-Kong are primarily those that report signs of possible recession in the US. These include worse than expected GDP data (bad news), which increase the volatility of the Hang Seng

Index, or a higher than anticipated unemployment rate (bad news), which increase volatility in the Hong-Kong market. Good news, such as a lower than expected interest rate, increases the returns of the benchmark index in Hong-Kong. Korea and Singapore are more markedly influenced by news announcements in the US. In the case of news releases related to GDP, a higher than expected outcome (good news) decreases market volatility in both countries, while bad news about the US GDP has no impact. The volatility of both the Kospi and Straits Time Indexes falls after reports of a lower than expected inflation rate. Good news regarding the unemployment rate is well received, as market volatility in Korea decreases and the returns of the benchmark index in Singapore increase. Bad news about the unemployment rate increases the volatility of both markets. Lower than predicted interest rates (good news) increases returns and diminishes the volatility of the Korean market. Finally, Taiwan is the tiger that is affected by most events. Good news about US GDP reduces market volatility in Taiwan, and somewhat unexpectedly, bad news about US GDP also decreases the volatility of the Taiwanese economy. Good news about the CPI decreases the index returns and good news about the unemployment rate decreases its volatility. As for the interest rate, bad news increases both the returns and the volatility of the index, while good news decreases the market volatility.

In the case of the cubs, positive GDP news reduces the returns of the benchmark index while negative CPI news reduces index volatility in the Philippines. Bad news regarding

the unemployment rate increases financial market volatility whereas good news reduces it. Finally, lower than anticipated interest rates increase the volatility of the Philippine Stock Exchange Index. Twelve coefficients are found to be positive in the case of Indonesia. For example, both positive and negative news announcements concerning GDP and CPI increase market volatility, while negative news releases about these two macroeconomic variables reduce market returns. Negative and positive news releases about the unemployment rate affect the market volatility of the Jakarta Index. Good news about GDP reduces market volatility in Malaysia, while both good and bad news about inflation and unemployment affect the volatility of the benchmark index in this country. As for the interest rate, a lower than expected data improves market performance and reduces its volatility. Finally, in Thailand, announcements about US GDP, both positive and negative, increase market volatility. Additionally, both negative and positive news about inflation affect the returns and the volatility of this market. As for the unemployment rate, both good and bad news have an impact on financial market volatility. Finally, lower than expected interest rates reduce market volatility.

Table 3.4. Estimates of the DCC model for the GDP

	Impact on returns		Impact on variance		Impact on correlation	
	γ_i^{+e}	γ_i^{-e}	δ_i^{+e}	δ_i^{-e}	θ_i^{+e}	θ_i^{-e}
Japan	0.001270	0.000357	0.747520	0.185660*	-0.874121	1.192541
	(0.68)	(0.77)	(0.05)	(0.00)	(0.15)	(0.26)
Hong-Kong	-0.000300	0.000625	0.171500	0.179400*	(1.589632)	(0.896521)
	(0.94)	(0.66)	(0.52)	(0.02)	(0.65)	(0.81)
Korea	-0.002854	-0.000868	-0.239600*	0.050600	3.569003	0.122303
	(0.68)	(0.62)	(0.01)	(0.44)	(0.63)	(0.80)
Singapore	-0.001983	0.000074	-0.245600*	0.109400	-0.080853	0.269842
	(0.52)	(0.92)	(0.00)	(0.1)	(0.25)	(0.14)
Taiwan	-0.002945	-0.000218	-0.274100*	-0.179500*	-0.059647	0.098721
	(0.11)	(0.83)	(0.01)	(0.00)	(0.82)	(0.25)
Philippines	-0.004348*	-0.000897	-0.049400	-0.038000	0.012547	1.254863
	(0.00)	(0.36)	(0.71)	(0.33)	(0.89)	(0.48)
Indonesia	-0.000421	-0.001133*	5.714933*	0.100044*	-0.158725	0.048523
	(0.96)	(0.03)	(0.00)	(0.02)	(0.82)	(0.12)
Malaysia	-0.000303	-0.000231	-0.405600*	-0.003466	0.987235	0.542186
	(0.76)	(0.69)	(0.00)	(0.91)	(0.85)	(0.74)
Thailand	-0.002091	0.002041*	2.360752*	0.366151*	0.498532	0.215525
	(0.66)	(0.00)	(0.00)	(0.00)	(0.82)	(0.04)
China	0.003880*	-0.000988*	1.519956*	2.760999*	-0.869571*	0.596452*
	(0.00)	(0.11)	(0.00)	(0.00)	(0.00)	(0.00)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

US macroeconomic news releases also have an effect on the Chinese market. Announcements, both good and bad, regarding US GDP affect the volatility of the financial market. A higher than anticipated GDP outcome increases the returns of the Shanghai Index. Similarly, both good and bad news about inflation affect the returns and the volatility of the Chinese benchmark index. Finally, good news about the

unemployment rate and higher than expected interest rates increase the volatility of this market.

An examination of news release types shows that the response tends to vary across markets. Thus, the announcement that has the greatest impact on markets is a lower than expected (good news) interest rate, which causes a decrease in the volatility of six of the ten markets analysed (the tigers of Korea, Singapore and Taiwan and the cubs of Indonesia, Malaysia and Thailand). Similarly, a lower than expected interest rate increases the returns of five markets, three tigers (Hong-Kong, Korea and Singapore) and two cubs (Indonesia and Malaysia).

Table 3.5. Estimates of the DCC model for the CPI

	Impact on returns		Impact on variance		Impact on correlation	
	γ_i^{+e}	γ_i^{-e}	δ_i^{+e}	δ_i^{-e}	θ_i^{+e}	θ_i^{-e}
Japan	-0.0011	0.000869	-0.075800	0.205500	-1.387669	1.034019
	(0.75)	(0.82)	(0.82)	(0.56)	(0.56)	(0.11)
Hong-Kong	-0.003	0.001037	0.232500	0.024300	-0.3978631	3.187014
	(0.48)	(0.87)	(0.28)	(0.95)	(0.57)	(0.12)
Korea	0.0010	-0.006707	0.511000	-0.617000*	0.254125	0.154821
	(0.83)	(0.41)	(0.05)	(0.04)	(0.26)	(0.25)
Singapore	0.0018	0.003527	0.252700	0.169800	(0.318547)	0.985621
	(0.79)	(0.60)	(0.32)	(0.67)	(0.95)	(0.52)
Taiwan	-0.0027	-0.012100*	-0.060100	-0.331200	0.289641	0.364527
	(0.53)	(0.01)	(0.79)	(0.30)	(0.83)	(0.62)
Philippines	-0.0019	-0.005931	-1.076626*	-0.109816	0.564218	0.736212
	(0.34)	(0.05)	(0.00)	(0.65)	(0.39)	(0.25)
Indonesia	-0.006151*	-0.001938	0.476500*	0.678800*	0.269512*	0.821541
	(0.00)	(0.61)	(0.0)	(0.00)	(0.04)	(0.23)
Malaysia	-0.000550	-0.001534	-0.683700*	0.650000*	0.900235	0.062512
	(0.61)	(0.33)	(0.00)	(0.00)	(0.89)	(0.15)
Thailand	0.003641*	0.010923*	0.070975*	-0.378907*	0.492355)	1.018961
	(0.00)	(0.00)	(0.00)	(0.00)	(0.22)	(0.62)
China	0.002145*	0.009534*	-0.417172*	2.097830*	0.552321	0.864251
	(0.02)	(0.00)	(0.00)	(0.00)	(0.13)	(0.11)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

As regards news announcements concerning the GDP, negative surprises (i.e., the GDP has fallen by a surprising amount or increased only slightly with respect to the previously reported figure) increase the volatility of five markets (Japan, Hong-Kong, Indonesia, Thailand and China). Conversely, positive surprises reduce market volatility in three of the tigers (Korea, Singapore and Taiwan) and in one of the cubs (Malaysia).

Bad news regarding the unemployment rate increases market volatility in three of the tigers (Hong-Kong, Korea and Singapore) and three of the cubs (Philippines, Indonesia and Malaysia) and good news reduces volatility in two of the tigers (Korea and Taiwan) and in three of the cubs (Philippines, Indonesia and Malaysia). Finally, news releases concerning the CPI have a varied and uneven impact across the countries.

An examination of the impact of US news announcements on correlations indicates that overall the co-movement between the US and the Asian markets is unchanged when the US news releases are made. In the case of Japan, our result is in line with the findings reported in and Stulz (1996) who also find that macroeconomic announcements do not significantly affect co-movements between US and Japanese share returns. In the case of the Asia-Pacific countries (i.e., those that are more exposed to the global economy), our results are more closely in line with Albuquerque and Vega (2009), who analyse the effects that real-time domestic and foreign news about fundamentals have on the co-movement between stock returns of a economy exposed to the global economy, Portugal, and a large economy, the United States. They find that US macroeconomic news does not affect stock market co-movements.

Finally, to determine whether the responses of the Asian markets to US macroeconomic news releases have changed after the global financial crisis, the sample was split into two subsamples. The first subsample covers the period January 1, 2003 until July 31,

2007 and the second subsample runs from August 15, 2007 until February 29, 2012. The results show that responses to macroeconomic news announcements have not changed notably.

Table 3.6. Estimates of the GARCH model for the Unemployment Rate

	Impact on returns		Impact on variance		Impact on correlation	
	γ_i^{+e}	γ_i^{-e}	δ_i^{+e}	δ_i^{-e}	θ_i^{+e}	θ_i^{-e}
Japan	-0.011100	0.002163	0.686800	0.296000	-0.638440	0.907516
	(0.24)	(0.71)	(0.30)	(0.57)	(0.25)	(0.49)
Hong-Kong	-0.017593	0.008899	1.130583*	-0.190983	0.424799	0.30545*
	(0.12)	(0.15)	(0.01)	(0.52)	(0.20)	(0.00)
Korea	-0.017029	0.000165	1.463060*	-0.973817*	-0.417070	0.61198*
	(0.25)	(0.97)	(0.00)	(0.00)	(0.41)	(0.00)
Singapore	-0.004297	0.014300*	0.937200*	-0.382300	-0.326841	0.841511
	(0.67)	(0.00)	(0.04)	(0.26)	(0.32)	(0.23)
Taiwan	0.006531	-0.001186	0.179100	-0.814000*	0.896512	0.524143
	(0.49)	(0.74)	(0.60)	(0.00)	(0.11)	(0.14)
Philippines	-0.003869	0.001297	3.654532*	-1.308812*	-0.348851	0.727411
	(0.60)	(0.37)	(0.00)	(0.00)	(0.25)	(0.23)
Indonesia	-0.002613	-0.001058	1.889536*	-1.690238*	-0.844275	-1.700112
	(0.77)	(0.28)	(0.00)	(0.00)	(0.11)	(0.44)
Malaysia	-0.007200	0.000322	4.196010*	-0.797554*	-0.30014*	0.258141
	(0.00)	(0.80)	(0.00)	(0.00)	(0.03)	(0.39)
Thailand	-0.007804	0.008466	-0.736383*	1.255180*	0.314785	0.992121
	-0.17	(0.35)	(0.00)	(0.00)	(0.71)	(0.59)
China	-0.001114	-0.003509*	0.516497	3.893653*	0.009821	0.965111
	(0.78)	(0.05)	(0.10)	(0.00)	(0.66)	(0.38)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

Table 3.7. Estimates of the GARCH model for the Interest Rate

	Impact on returns		Impact on variance		Impact on correlation	
	γ_i^{+e}	γ_i^{-e}	δ_i^{+e}	δ_i^{-e}	θ_i^{+e}	θ_i^{-e}
Japan	0.055479	0.037867	0.639483	-1.619943	0.826241	-1.402871
	(0.53)	(0.12)	(0.85)	(0.12)	(0.15)	(0.29)
Hong-Kong	-0.017274	0.099444*	-1.137140	-1.348582	0.252181	1.030454
	(0.73)	(0.00)	(-0.64)	(0.14)	(0.68)	(0.45)
Korea	0.051459	0.095780*	-3.851420	-2.110422*	-0.206874	-0.87451
	(0.32)	(-0.00)	(0.06)	(0.00)	(0.21)	(0.19)
Singapore	0.041635	0.074877*	-0.661143	-2.938556*	1.451691	-0.148989*
	(0.46)	(0.00)	(0.82)	(0.00)	(0.50)	(0.03)
Taiwan	0.085453*	0.055063	6.591156*	-2.269191*	0.09851	0.105141
	(0.00)	(0.11)	(0.00)	(0.00)	(0.18)	(0.31)
Philippines	0.044919	0.020911	0.512860	3.851027*	0.206981	-0.727154
	(0.13)	(0.39)	(0.79)	(0.00)	(0.39)	(0.62)
Indonesia	0.002350*	0.093844*	-7.142857*	-3.574224*	1.074554	-1.285211
	(0.00)	(0.00)	(0.00)	(0.00)	(0.45)	(0.99)
Malaysia	-0.009912	0.024525*	0.919318	-2.724842*	-1.267711	-0.032882
	(0.60)	(0.01)	(0.65)	(0.00)	(0.33)	(0.41)
Thailand	0.025715	0.045006	3.139486	-3.376319*	-1.191455	-0.011254
	(0.67)	(0.10)	(0.40)	(0.00)	(0.50)	(0.51)
China	-0.019703	0.017141	3.988248*	-1.139869	0.152210*	-0.480091
	(0.54)	(0.70)	(0.01)	(0.10)	(0.00)	(0.97)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

3.5 Conclusions

This chapter analyses the effect of US macroeconomic news releases on the returns volatility and correlations of several Asian countries, primarily the emerging economies of Southeast Asia, and their correlations with the US market. The study covers the period from January 2003 until February 2012, examining the impact of news releases concerning the gross domestic product, the consumer price index, the unemployment rate and the Federal Open Market Committee decisions on the target rate. To carry out this study, a Dynamic Conditional Correlation model is used, which incorporates the possibility that the response of returns, volatility and correlations might be asymmetric depending on the sign of the news item.

The results provide interesting insights into the effects of US macroeconomic news announcements on Asian markets. First, there appears to be a relation between the response shown by returns and volatility and a country's level of development. Japan, representative of a mature market, remains quite indifferent to US news arrivals. However, as the level of market maturity falls, the effect of US macroeconomic news announcements becomes greater; hence, the tigers are more strongly influenced by US news releases than Japan, while the cubs are even more susceptible to them. Finally, China is very strongly affected by US macroeconomic news releases. Given that the tigers, cubs and China are more susceptible to the vagaries of the global economy, their export earnings representing a very high percentage of their GDP, these results could be

explained by the fact that export-oriented firms weigh heavily in the Asia-Pacific market indexes.

The results also show that on average the conditional correlations do not change on news announcement days. Finally, we find that the financial crisis has not necessarily increased the sensitivity of Asian market returns, volatility and correlations to macroeconomic news releases. Market participants should be careful in picking markets in the emerging Asia as the results show that these markets are also dependent on the US economy.

Chapter 4

Volatility transmission between the stock and currency markets in emerging Asia

4.1 Introduction

A causal link is expected, in theory, between stock prices and exchange rate movements. However, there is little consensus on the nature, or even the direction, of this connection. According to the portfolio balance model (see Branson and Henderson, 1985, and Frankel, 1983, among others] a negative correlation exists because, at the macro level, as stock prices fall, domestic wealth also falls, leading to a reduction in domestic money demand that causes interest rates to drop. With investment in the domestic market no longer being attractive, capital outflows to foreign markets and the domestic currency depreciates (leading to a rise in the exchange rate). From the perspective of foreign investors with internationally diversified portfolios, when domestic stock prices fall, they are likely to revise their portfolio asset allocation. The resulting decline in demand for local assets brings about a similar fall in demand for domestic currency as investors seek foreign currency to buy international assets, which leads to a depreciation of the national currency.

In the opposite direction, the influence of the currency market on the stock market should a priori depend on the country's exposure to the exchange risk, that is, whether the country is a net exporter or importer (see Dornbusch and Fischer, 1980). If we assume that changes in the exchange rate affect a country's international competitiveness and trade balance, then if that country is chiefly an exporter, when the domestic currency depreciates its firms will become more competitive as their exports are cheaper. As a result, domestic firms increase their profit levels causing domestic stock prices to rise. However, if the country is chiefly an importer, a depreciation of the domestic currency reduces the competitiveness of its firms. The rise in price of imports in turn causes the profits of the domestic firms to fall and hence their stock prices tumble. Given this dependence on the level of exposure to the exchange rate risk, a country's exchange rate policies need to take this fact into careful consideration and remain aware of the consequences for the stock markets.

The interdependence of stock price returns and exchange rate changes has been extensively examined in the empirical literature with mixed findings on the directional causality (see Adler and Dumas, 1984; Booth and Rotenberg, 1990; Jorion, 1990; Sercu and Vanhulle, 1992; Smith 1992; Bodnar and Gentry, 1993; and Amihud, 1994; among others). Likewise, empirical evidence on the dynamic linkage between stock and currency market volatilities also provides conflicting findings. Early studies, such as Jorion (1990), suggested that exchange rate fluctuations do not affect stock return volatility, while others (see, for example, Dumas and Solnik, 1995; Roll, 1992) identified the existence of a strong linkage. More recently, Kanas (2000) has analysed volatility

transmission between stock and currency markets in the USA, the UK, Japan, Germany, France and Canada finding evidence of spillovers between stock returns and exchange rate changes for five of the six countries analyzed (with Germany being the exception). These results present evidence in favour of the portfolio balance model when formulated in terms of the second moments. Caporale et al. (2002) analysed the causal relationship in four East Asian countries using daily data from 1987 to 2000. Their results suggest that the causal structure is more complex than implied by the portfolio balance model. Yang and Doong (2004) investigated volatility spillovers between stock prices and exchange rates for the G-7 countries finding that stock markets play a relatively more important role than foreign exchange markets in the second moment interactions and spillovers. Mishra (2007) finds evidence of bidirectional volatility spillover between stock and foreign exchange markets in India. Finally, Walid et al. (2011) investigate the impact of exchange rate changes on stock market volatility in four emerging markets (Hong-Kong, Singapore, Malaysia and Mexico) between 1994 and 2009 and find that an increase in currency market volatility leads to an increase in stock market volatility.

Motivated by the impact of the recent crisis, which has renewed interest in understanding the nature of information transmission across markets, this study explores volatility linkages between stock and exchange rate markets. This analysis has important implications for both portfolio managers and policy makers. For the former, not only is it important to know the nature of the assets and the characteristics of the different geographical areas in which they might invest, it is also essential to identify the

factors that influence the behaviour of these assets. Given that a relation might exist between the equity and currency markets, it is vital to analyse this linkage in every economy before portfolio asset allocation. For policy makers, the linkage between stock and currency markets is crucial for maintaining financial stability. This chapter examines the nature of this relationship in ten primarily emerging Asian markets with increasing global importance, while taking into account the effects of the current financial crisis.

As in the rest of this dissertation, the Asian markets included are Japan, representative of the mature Asian market; the emerging economies of Southeast Asia divided into two groups – the Asian Tigers (tigers) of Taiwan, Singapore, Hong-Kong and South Korea (Korea), and the Tiger Cub countries (cubs), comprising the Philippines, Indonesia, Malaysia and Thailand; and, China, a growing economy with a great influence worldwide and Asia's engine of growth.

As already mentioned, Southeast Asia is characterized by its high population growth rate, political instability and the fact that it is enjoying a marked economic boom (of the countries analysed here, Indonesia and Singapore show the greatest development potential). However, the Southeast Asian economies remain vulnerable to economic decisions taken abroad, given that their domestic markets are small and they are heavily dependent on their exports and on foreign energy and technology. The tigers emerged between 1945 and 1990, and they present a broad range of characteristics that are similar to those found in the economies of China and Japan. The tigers' economies underwent great growth, not only in quantitative terms, but also in terms of the quality of the low

price products they were able to introduce into international markets. The cubs achieved industrialization at a later date, following a similar path to that taken by the tigers. Subsequently, all these countries have managed to maintain high rates of industrialization and development, becoming attractive destinations for foreign investment.

The Southeast Asian region makes for an interesting case study because tigers and cubs alike present great opportunities for international industry. Following the lead taken by China, these developing countries are gaining increasingly strong positions in international industrialization.

This study contributes to the literature in two ways. First, exploring volatility transmission between the equity and currency markets of these Asian economies provides a more complete picture of the links between these two markets and allows us to determine if any differences depend on the level of a country's development. Second, as the sample period covers that of the global financial crisis, we are able to examine if the volatility transmission patterns between the stock and currency markets have increased during the period of crisis.

The analysis conducted here, using a multivariate asymmetric generalized autoregressive conditional heteroskedasticity (GARCH) model, provides several important findings. First, we find more evidence of an asymmetric response of the volatility in stock markets than in currency markets. Second, we find bidirectional volatility spillovers between the

stock and currency markets independently of the country's level of development. Third, asymmetric volatility transmission is only observed in a few economies. Finally, we find a mixed effect of the global financial crisis on volatility transmission patterns. Thus, while in some countries there is an increase in volatility spillovers from the stock to the currency markets, in others the increase is observed from the currency to the stock markets. China is found to be an exception in this global analysis.

The rest of the chapter is organised as follows. Section 2 presents the data employed in the analysis. The econometric method used to estimate volatility spillovers is outlined in Section 3. Section 4 examines the results. The chapter ends with some concluding remarks.

4.2 Data

The data, obtained from Bloomberg, consist of daily closing stock prices and exchange rates for the ten Asian markets (see Table 4.1) between 1 January 2003 and 31 January 2014 (2.893 observations). The exchange rates are expressed in US dollars per local currency (direct quotation system), so that an increase (decrease) in the rate indicates a depreciation (appreciation) of the domestic currency. The stock market returns and the rate of change in exchange rates are computed as log differences of the daily closing prices and currency exchange rates, respectively.[13] A dummy variable – equal to 1 from

[13] The Augmented Dickey and Fuller (1979) (ADF), Phillips and Perron (1988) (PP) and Kwiatkowski et al. (1992) (KPSS) tests (not reported) show that both stock prices and exchange rates are integrated of order one (I(1)).

15 August 2007 until the end of the sample period and 0 otherwise – is introduced in the model to control for the global financial crisis.

As previously mentioned in chapter 2, many financial analysts date the onset of the global financial to August 2007 since it was in this month that various governments and central banks responded to the economic collapse with unprecedented fiscal stimuli, monetary policy expansions and institutional bailouts. At the beginning of that month, the bursting of the global housing bubble rapidly developed into a global economic shock, resulting in a number of European bank failures, declines in various stock indexes and sharp falls in the market value of equities and commodities. On August 10, the central banks took coordinated actions to increase liquidity for first time since the aftermath of the terrorist attacks of 11 September 2001. In the days that followed, stock indexes continue to fall and the US Federal Reserve (Fed), the European Central Bank (ECB), the Bank of Japan and the central banks of Australia and Canada continued injecting liquidity into the system. For these reasons, the onset of the crisis is fixed at 15 August 2007 (see Valls and Chuliá, 2012).

Table 4.1. Stock market indexes and exchange rates for each market covered

Type of market			Economy	Equity Index	Exchange Rate
Mature market			JAPAN	Nikkei 225 Index	Japanese Yen/US Dollar
Emerging markets	Southeast Asia	Asian Tigers	HONG-KONG	Hang Seng Index	Hong-Kong Dollar/US Dollar
			SOUTH KOREA	Kospi Index	South Korean Won/US Dollar
			SINGAPORE	Straits Time Index Exchange Index	Singapore Dollar/US Dollar
			TAIWAN	Taiwan Stock Exchange Index	Taiwanese Dollar/US Dollar
		Asian Tiger Cubs	PHILIPPINES	Philippine Stock Exchange Index	Philippine Peso/US Dollar
			INDONESIA	Jakarta Composite Index	Indonesian Rupiah/US Dollar
			MALAYSIA	FTSE Bursa Malaysia Kuala Lumpur Composite Index	Malaysian Ringgit/US Dollar
			THAILAND	FTSE SET Shariah Index	Thai Baht/US Dollar
	Other		CHINA	Shanghai A-Share Stock Price Index	Chinese Renminbi/US Dollar

Table 4.2 shows the descriptive statistics for the stock index returns and exchange rate changes. The mean returns are positive for all stock markets; however, the less developed countries (the cubs) present higher returns than those presented by the more developed markets (the tigers). Japan and China present the lowest returns. The mean returns of all the exchange rates are either very low or negative. All the return series (both the stocks and exchange rates) are leptokurtic and the Jarque-Bera (JB) test rejects the normality of all the series, as expected. These characteristics are well documented in a number of other studies elsewhere in the financial literature. Finally, note that almost all the return series exhibit serial correlation and heteroskedasticity.

[14] We differentiate Hong-Kong from China, as the former, being a British colony until 1997, retains to this day independent economic, administrative and judicial systems.

Table 4.2. Summary statistics of the return series of stock prices and exchange rates

Market	Statistics	Stock prices	Exchange Rates
Japan	Mean	0.0002	-0.0001
	Std. Dev.	0.0151	0.0066
	Skewness	-0.5901	0.0789
	Kurtosis	11.573	7.148
	Normality (JB test)	2,076.667 (0.0000)	2,076.667 (0.0000)
	Q(12)	20.055 (0.0661)	14.164 (0.2904)
	ARCH(12)	247.682 (0.0000)	930.351 (0.0000)
Hong-Kong	Mean	0.0003	0.0000
	Std. Dev.	0.0152	0.0004
	Skewness	0.0364	-2.6175
	Kurtosis	13.164	44.743
	Normality (JB test)	12,448.070 (0.0000)	213,268.300 (0.0000)
	Q(12)	46.552 (0.0000)	20.093 (0.0653)
	ARCH(12)	164.223 (0.0000)	815.474 (0.0000)
Korea	Mean	0.0004	0.0000
	Std. Dev.	0.0141	0.0075
	Skewness	-0.4952	-0.7935
	Kurtosis	9.398	56.608
	Normality (JB test)	5,051.144 (0.0000)	346,603.000 (0.0000)
	Q(12)	82.935 (0.0000)	10.455 (0.5762)
	ARCH(12)	676.967 (0.0000)	696.995 (0.0000)
Singapore	Mean	0.0003	-0.0001
	Std. Dev.	0.0117	0.0034
	Skewness	-0.1970	0.0120
	Kurtosis	8.800	8.118
	Normality (JB test)	4,072.163 (0.0000)	3,156.308 (0.0000)
	Q(12)	35.943 (0.0000)	31.796 (0.0015)

Market	Statistics	Stock prices	Exchange Rates
Philippines	Mean	0.0006	-0.0001
	Std. Dev.	0.0131	0.0036
	Skewness	-0.6430	0.1370
	Kurtosis	10.755	4.536
	Normality (JB test)	7,445.578 (0.0000)	293.432 (0.0000)
	Q(12)	13.719 (0.3190)	70.120 (0.0000)
	ARCH(12)	333.121 (0.0000)	368.139 (0.0000)
Indonesia	Mean	0.0008	0.0001
	Std. Dev.	0.0142	0.0060
	Skewness	-0.6515	0.0525
	Kurtosis	9.880	17.886
	Normality (JB test)	5,907.782 (0.0000)	26,702.100 (0.0000)
	Q(12)	128.678 (0.0000)	55.999 (0.0000)
	ARCH(12)	367.096 (0.0000)	333.629 (0.0000)
Malaysia	Mean	0.0004	0.0000
	Std. Dev.	0.0075	0.0035
	Skewness	-1.0415	-0.2554
	Kurtosis	17.407	8.799
	Normality (JB test)	25,533.320 (0.0000)	4,083.054 (0.0000)
	Q(12)	15.737 (0.2306)	60.322 (0.0000)
	ARCH(12)	338.645 (0.0000)	161.812 (0.0000)
Thailand	Mean	0.0004	-0.0001
	Std. Dev.	0.0136	0.0032
	Skewness	-0.8677	0.2113
	Kurtosis	15.656	17.373
	Normality (JB test)	19,663.460 (0.0000)	24,916.190 (0.0000)
	Q(12)	35.554 (0.0004)	28.218 (0.0051)

	ARCH(12)	227.906 (0.0000)	781.723 (0.0000)		ARCH(12)	436.725 (0.0000)	334.353 (0.0000)
Taiwan	Mean	0.0002	0.0000	**China**	Mean	0.0001	-0.0001
	Std. Dev.	0.0128	0.0026		Std. Dev.	0.0158	0.0009
	Skewness	-0.3741	-0.2521		Skewness	-0.2469	-3.9514
	Kurtosis	6.440	7.958		Kurtosis	7.057	92.560
	Normality (JB test)	1,493.681 (0.0000)	2,993.230 (0.0000)		Normality (JB test)	2,012.999 (0.0000)	974,053.900 (0.0000)
	Q(12)	38.956 (0.0000)	23.991 (0.0204)		Q(12)	30.710 (0.0022)	24.912 (0.0152)
	ARCH(12)	167.925 (0.0000)	325.358 (0.0000)		ARCH(12)	1.009 (1.0000)	474.573 (0.0000)

Note: Q(12) is the Ljung-Box test for serial correlation of the returns at lag 12. ARCH(12) is Engle's test for twelfth order ARCH, distributed as $\chi^2(12)$. P-values of displayed as (.).

4.3 Methodology

To analyse the volatility spillovers between stock and currency markets in the ten Asian countries considered, a bivariate VAR-GARCH process was used. Hence, 10 bivariate models were estimated.

The conditional mean equations are defined as a vector autoregressive process of order 1 [VAR(1)] process:

$$R_{1,t} = \mu_1 + x_1 D_t + \sum_{p=1}^{6} d_{11,p} R_{1,t-p} + \sum_{p=1}^{6} d_{12,p} R_{2,t-p} + \varepsilon_{1,t}$$

$$R_{2,t} = \mu_2 + x_2 D_t + \sum_{p=1}^{6} d_{21,p} R_{1,t-p} + \sum_{p=1}^{6} d_{22,p} R_{2,t-p} + \varepsilon_{2,t} \qquad (4.1)$$

where $R_{1,t}$ and $R_{2,t}$ are the stock and the exchange rate returns, respectively, μ_i, x_i and $d_{ij,p}$ for i,j=1,2 are the parameters to be estimated and D_t is the dummy series for the global financial crisis. Finally, $\varepsilon_{1,t}$ and $\varepsilon_{2,t}$ are the innovations. The VAR lag was chosen by applying the Schwarz criterion.

To model the conditional variance-covariance matrix we used an asymmetric version of the BEKK model [Baba *et al.* (1989), Engle and Kroner (1995) and Kroner and Ng (1998)][15]. As in the mean equations, we introduced a dummy series to capture the global financial crisis.

The compact form of the model is:

$$H_t = C'C + B'H_{t-1}B + A'\varepsilon_{t-1}\varepsilon_{t-1}'A + G'\eta_{t-1}\eta_{t-1}'G + V\varepsilon_{t-1}\varepsilon_{t-1}'VD_t \qquad (4.2)$$

where C, B, A, G and V are matrices of the parameters to be estimated, C being an upper-triangular and positive definite matrix, H_t the conditional variance-covariance matrix in t and D_t the dummy variable taking into account the crisis.

In the bivariate case, the BEKK model is written as follows:

[15] As explained in chapter 2, asymmetric volatility refers to the empirical evidence according to which a negative shock increases volatility more than a positive shock of the same size. In the financial literature, two explanations of the asymmetries in equity markets have been put forward: The *leverage* effect and the volatility *feedback* effect. Which of the two effects is the main determinant of asymmetric volatility remains an open question.

$$\begin{bmatrix} h_{11t} & h_{12t} \\ \cdot & h_{22t} \end{bmatrix} = \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix}' \begin{bmatrix} c_{11} & c_{12} \\ 0 & c_{22} \end{bmatrix} + \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix}' \begin{bmatrix} h_{11,t-1} & h_{12,t-1} \\ \cdot & h_{22,t-1} \end{bmatrix} \begin{bmatrix} b_{11} & b_{12} \\ b_{21} & b_{22} \end{bmatrix} +$$
$$+ \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \cdot & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{bmatrix} + \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix}' \begin{bmatrix} \eta_{1,t-1}^2 & \eta_{1,t-1}\eta_{2,t-1} \\ \cdot & \eta_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} g_{11} & g_{12} \\ g_{21} & g_{22} \end{bmatrix} +$$
$$+ \begin{bmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{bmatrix}' \begin{bmatrix} \varepsilon_{1,t-1}^2 & \varepsilon_{1,t-1}\varepsilon_{2,t-1} \\ \cdot & \varepsilon_{2,t-1}^2 \end{bmatrix} \begin{bmatrix} v_{11} & v_{12} \\ v_{21} & v_{22} \end{bmatrix} D_t \qquad (4.3)$$

where c_{ij}, b_{ij}, a_{ij}, g_{ij} and v_{ij} for all $i,j=1,2$ are parameters, e_{1t} and e_{2t} are the innovation series derived from equation (4.1), $\eta_{1,t} = \max[0,-\varepsilon_{1,t}]$ and $\eta_{2,t} = \max[0,-\varepsilon_{2,t}]$ are the Glosten *et al.* (1993) dummy series collecting a negative asymmetry from the shocks and, finally, $h_{ij,t}$ for all $i,j=1,2$ are the conditional second moment series. Similarly to $\eta_{i,t}$, the variable D_t is the dummy series for the crisis. It takes a value of 0 until 15 August 2007 and 1 otherwise.

Equation (4.3) allows for both own-market and cross-market influences in the conditional variance, thus allowing us to analyse the volatility spillovers between the two markets. Moreover, the BEKK model guarantees by construction that the variance-covariance matrix will be positive definite. This equation is estimated using the Quasi-Maximum Likelihood method.[16] Bollerslev and Wooldridge (1992) show that the standard errors calculated using this method are robust even when the normality assumption is violated.

[16]A range of starting values was used to ensure that the estimation procedure converged to a global maximum. The estimations were repeated with random restarts of the starting values. None of the estimation results indicated any local maximum. The results also seem robust to alternating convergence criteria and optimizing methods. Consequently we are confident that we have found a global maximum.

4.4 Empirical results

Table 4.3 shows the estimated BEKK model of equation (4.3). Coefficients a_{ij} for i,j=1,2 show the effects of past shocks on volatility, while coefficients b_{ij} capture the persistence of this volatility. The asymmetric effect of volatility is captured by coefficients g_{ij}, and, finally, coefficients v_{ij} capture the impact of the global financial crisis. An interpretation of these results requires that we distinguish between own-market and cross-market effects.

4.4.1 Own-market effects

Coefficients a_{11}, b_{11}, g_{11} and v_{11} show the own stock market effects while coefficients a_{22}, b_{22}, g_{22} and v_{22} display the own currency market effects.

In the case of the stock markets, coefficients a_{11} and g_{11} are statistically significant[17] in all countries except Hong-Kong, indicating that the volatilities of almost all the Asian equity markets analysed are affected by their own past shocks and that they exhibit an asymmetric volatility response. Coefficient b_{11} is significant for all the economies analysed, indicating that the volatility of the Asian equity markets is influenced by their own past volatility. Finally, coefficient v_{11} is significant only for Japan, Singapore and Indonesia, suggesting that in these equity markets the effects of their own shocks on volatility are higher since the onset of the current financial crisis.

[17] Significance at the 5% level is considered.

In the case of the currency markets, the estimated own-market coefficients a_{22} and b_{22} are statistically significant for almost all the Asian markets. Therefore, we find evidence that in general the Asian currency markets are affected by their own past shocks and volatility. However, coefficient g_{22}, measuring the asymmetric response of volatility, is statistically significant only for Japan, Hong-Kong, Philippines and Thailand. Finally, coefficient v_{22} indicates that the volatility of the currency markets of Japan, Hong-Kong, Korea, Singapore[18], Philippines, Malaysia and China has been more strongly affected by their own shocks since the onset of the crisis.

4.4.2 Cross-market effects

As for the cross-market effects, coefficients a_{12}, b_{12}, g_{12} and v_{12} show the influence of the stock markets on the currency markets, whilst coefficients a_{21}, b_{21}, g_{21} and v_{21} show the impact of the currency markets on the stock markets.

If we focus on volatility spillovers from the stock markets to the currency markets, we find that coefficient a_{12} is significant for most of the Asian markets (Japan, the tigers and Indonesia), whereas coefficient b_{12} is only significant in the case of just three economies (Hong-Kong, Singapore and Indonesia). As for the asymmetric volatility response, coefficient g_{12} is significant for Singapore, Philippines, Indonesia and Thailand [19] indicating that in these countries negative shocks from the stock market generate greater volatility in their exchange rate markets than do positive shocks of a similar magnitude.

[18] Singapore is significant at the 10% level.
[19] Thailand is significant at the 10% level.

Thus, overall, we find statistically significant evidence of volatility transmission between the currency and stock markets in one mature market, four tigers and three cubs, suggesting that volatility transmission from the stock to the currency markets is independent of the country's level of development (with the exception of China). Finally, half the Asian economies analysed (Singapore, Taiwan, Philippines, Indonesia and Malaysia) exhibit significant coefficients v_{12}, indicating that in these countries the equity market has had a greater influence on the currency market following the onset of the global financial crisis.

In the case of volatility spillovers from the currency market to the stock market the coefficient a_{21} is statistically significant in practically all the economies considered (Japan, three of the tigers and three of the cubs[20]). As for coefficient b_{21}, the past volatility of the exchange rate of most of the countries (three tigers and three cubs) affects the volatility of the stock prices. The asymmetric reaction of the volatility (coefficient g_{21}) can be perceived in some economies (Japan, Hong-Kong, Malaysia[21] and Thailand), indicating that negative shocks from the currency market increase the volatility of equity markets more than positive shocks of the same magnitude. All in all, we find evidence for volatility spillovers between the two markets in all the countries, again with the exception of China. Hence, the currency market has a clear influence on the equity market of the Asian countries analysed, independently of the degree of development of

[20] Philippines is significant at the 10% level.
[21] Malaysia is significant at the 10% level.

the economy. Finally, coefficient v_{21} indicates that volatility transmission patterns have changed since the onset of the crisis in Hong-Kong, Philippines, Malaysia and China[22].

Overall, although cross-market volatility dependence varies in magnitude and sign across the ten countries, there are noticeable bidirectional volatility spillovers between the stock and currency markets. However, the asymmetric response of the volatility is only apparent in a few of the economies analysed. Our results paint a complex picture of the effects of the global financial crisis on the volatility transmission patterns. The crisis has only had an impact on half the countries studied and the effects are mixed. In this respect, China emerges as an exception. As expected, given the country's fixed exchange rate, together with the changes to its monetary system and the currency devaluations that have been implemented, we find no evidence of volatility spillovers from the stock prices to the exchange rates. Interestingly, our results show that cross-market effects are not statistically significant in either direction, indicating that the devaluations of the Chinese currency have had no effect on the volatility of the stock market either.

[22] China is significant at the 10% level.

Table 4.3. Estimates of the BEKK model

	Japan	Hong-Kong	Korea	Singapore	Taiwan	Philippines	Indonesia	Malaysia	Thailand	China
c_{11}	0.006501* (0.0000)	-0.008771* (0.0000)	0.008611* (0.0000)	-0.004957* (0.0000)	-0.001299* (0.0000)	0.002415* (0.0000)	-0.002800* (0.0001)	0.001082* (0.0091)	-0.002903* (0.0000)	0.001618* (0.0011)
c_{12}	0.000386 (0.7545)	0.000070* (0.0000)	0.000328 (0.3611)	-0.000320 (0.1374)	0.000081 (0.3366)	0.000072 (0.5610)	0.000148* (0.0162)	-0.000092 (0.0512)	0.000310* (0.0000)	-0.000574* (0.0000)
c_{22}	0.005350* 0.0000	-0.000112v 0.0017	0.000635* 0.0325	-0.002700* 0.0000	0.000387* 0.0000	-0.000478* 0.0000	0.001198* 0.0000	0.000000 1.0000	0.000415* 0.0006	0.000000 0.9995
a_{11}	-0.165690* (0.0142)	-0.045909 (0.5700)	-0.276190* (0.0028)	-0.310564* (0.0012)	-0.112346* (0.0019)	-0.257217* (0.0000)	0.178676* (0.0000)	-0.216824* (0.0222)	-0.225871* (0.0008)	0.200891* (0.0000)
a_{12}	0.096178* (0.0034)	0.003694* (0.0347)	-0.059489* (0.0010)	0.055316* (0.0040)	-0.006805 (0.0731)	0.000792 (0.8793)	0.013578* (0.0000)	-0.000135 (0.8724)	0.001336 (0.8331)	-0.000811 (0.6577)
a_{21}	0.671956* (0.0000)	-3.325312 (0.1942)	-0.287084* (0.0050)	-0.779207* (0.0065)	0.178925* (0.0320)	-0.329731 (0.0541)	-0.196395* (0.0000)	-0.250261* (0.0006)	-0.642427 (0.2113)	0.377182 (0.3637)
a_{22}	-0.057764 (0.2993)	0.570815* (0.0000)	-0.321707* (0.0000)	-0.200926* (0.0061)	-0.353684* (0.0000)	0.254483* (0.0000)	0.613203* (0.0000)	0.429211* (0.0000)	-0.171296 (0.3946)	-0.356399 (0.0609)
b_{11}	-0.701319* (0.0000)	-0.282594* (0.0000)	0.486796* (0.0000)	-0.545946* (0.0000)	0.963609* (0.0000)	0.924874* (0.0000)	0.923180* (0.0000)	0.948561* (0.0000)	0.901615* (0.0000)	0.969568* (0.0000)
b_{12}	-0.019946 (0.8047)	-0.018929* (0.0000)	-0.045427 (0.1192)	0.065733* (0.0000)	-0.001380 (0.2694)	-0.003705 (0.1559)	-0.011207* (0.0000)	-0.005510 (0.4866)	0.009956 (0.1107)	0.001971 (0.5126)
b_{21}	-0.055205 (0.3672)	2.610850* (0.0000)	-0.495607* (0.0000)	0.908560* (0.0000)	0.000960 (0.9789)	0.025667 (0.6538)	0.065045* (0.0000)	0.982220* (0.0000)	-0.122857* (0.0205)	0.452889 (0.6954)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

Table 4.3. Estimates of the BEKK model (continued)

	Japan	Hong-Kong	Korea	Singapore	Taiwan	Philippines	Indonesia	Malaysia	Thailand	China
b_{22}	-0.129479 (0.0565)	0.022950* (0.0033)	0.885648* (0.0000)	-0.112375* (0.0000)	0.921125* (0.0000)	0.936238* (0.0000)	0.785203* (0.0000)	-0.907187* (0.0000)	0.955591* (0.0000)	-0.535402* (0.0000)
g_{11}	0.358762* (0.0000)	-0.273643 (0.1022)	-0.585305* (0.0000)	0.606319* (0.0000)	0.283343* (0.0000)	0.326996* (0.0000)	0.394282* (0.0000)	0.275128* (0.0000)	0.384684* (0.0000)	-0.145939* (0.0001)
g_{12}	-0.064058 (0.2184)	-0.015388 (0.1522)	0.018127 (0.4434)	-0.054035* (0.0046)	-0.004955 (0.2151)	-0.025911* (0.0016)	-0.068319* (0.0000)	-0.003155 (0.2005)	-0.029130 (0.0545)	-0.005439 (0.2090)
g_{21}	0.440587 (0.0174)	13.583922* (0.0025)	0.070090 (0.2908)	-0.436998 (0.1083)	0.174364 (0.1592)	-0.429537 (0.2085)	-0.214724 (0.2573)	0.171918 (0.0713)	-0.350502* (0.0016)	-0.270606 (0.5151)
g_{22}	0.263243* (0.0190)	-1.484221* (0.0009)	0.048460 (0.2287)	0.061969 (0.2775)	0.118802 (0.0762)	0.201943* (0.0089)	0.047300 (0.6437)	-0.188725 (0.2107)	0.265383* (0.0049)	-0.191170 (0.1582)
v_{11}	0.090755* (0.0032)	0.003606 (0.1592)	-0.008019 (0.4945)	-0.041362 (0.0305)	-0.001518 (0.3239)	-0.002019 (0.4565)	-0.006025* (0.0000)	-0.003627 (0.6180)	-0.003143 (0.1261)	-0.001025 (0.3501)
v_{12}	-0.062822 (0.5212)	-0.208521 (0.2835)	-0.023968 (0.0975)	0.274173* (0.0000)	0.022794* (0.0012)	0.032769* (0.0048)	0.084144* (0.0000)	0.099781* (0.0000)	0.003912 (0.3209)	-0.003948 (0.4156)
v_{21}	0.013181 (0.8695)	0.040495* (0.0000)	0.001201 (0.9675)	-0.120327 (0.2928)	0.013679 (0.3622)	0.050745* (0.0406)	-0.015046 (0.2866)	0.072319* (0.0108)	-0.008099 (0.6489)	0.088516 (0.0508)
v_{22}	-0.512047* (0.0000)	-0.906863* (0.0007)	-0.257543* (0.0000)	0.306988 (0.0569)	0.074663 (0.3277)	0.138097* (0.0262)	-0.017174 (0.6796)	0.109276* (0.0212)	0.129665 (0.1368)	0.597978* (0.0000)

Note: * indicates significant coefficients at the 5% level. P-values displayed as (.).

4.5 Conclusions

This chapter has examined the causal relationship between stock price and exchange rate volatilities in ten, primarily emerging, Asian economies, drawing on daily data from January 2003 to January 2014. In so doing, we employed a methodology based on a bivariate VAR-GARCH process, using an asymmetric version of the BEKK model. Additionally, our approach has taken into account the effect of the onset of the global financial crisis.

The empirical results can be summarized as follows. As regards own-market effects, the volatilities of both the stock and the currency markets were, in general, affected by their own past shocks and past episodes of volatility. In the case of the stock markets, we find some evidence for an asymmetric response of the volatility; hence, a negative shock had a greater influence on volatility than a positive shock of a similar magnitude. However, this asymmetric effect was much less apparent in the exchange rate market. Our examination of the impact of the financial crisis revealed that the pattern of behaviour found in the stock markets only changed in a few countries after the onset of the crisis, whereas in the currency markets the earlier pattern changed in a greater number of economies.

As regards cross-market effects, our analysis has identified several important trends. First, we find empirical evidence for bidirectional volatility transmission between the

stock and the currency markets, independently of the country's level of development. Second, China emerges as an exception as it does not show any significant volatility transmission in either direction. The explanation for this would seem to lie in the fact that China operates a fixed exchange-rate system, which in recent years has been switched from the US Dollar to a basket of foreign currencies, and as a consequence it has experienced a number of devaluations. Third, in some cases we have found that the volatility transmission patterns are asymmetric.

Finally, volatility transmission patterns have experienced a change since the onset of turmoil in the world's financial markets in the summer of 2007. We find heterogeneous changes in half the markets analysed here.

The results of this study should be valuable for analysts, traders and practitioners that seek to diversify their portfolios at the international level and to invest in different assets, i.e., both stocks and exchange rates. When investing in the emerging economies of Asia, before constructing a portfolio it would clearly be beneficial to take into account volatility spillovers between stocks and currencies, as we have found empirical evidence of a bidirectional connection between these two markets. Likewise, policy makers could usefully take into account the relationship between stock prices and exchange rates before implementing their exchange rate policies.

Chapter 5

Conclusions

This dissertation has centred on three specific issues: (i) the analysis of the nature of volatility spillovers between the stock markets of US and certain economies of Asia (chapter 2); (ii) the effect of US macroeconomic announcements on the returns, volatility and correlations of Asian stock markets (chapter 3); and (iii) the analysis of the volatility transmission between the stock and the currency markets in Asian economies, always taking into account the effect of the Global Financial crisis. This concluding chapter seeks to provide a summary of the principal findings and implications of each separate study.

In the first part of the analysis, chapter 2, the main objective has been to examine volatility linkages and the conditional correlation behaviour between the US and the Asian stock markets. The results are a first approach to the nature of the relationship between mature and emerging stock markets during financial crises, nevertheless, the analysis provides a number of interesting discernments. From the volatility point of view, all markets are influenced by their own past shocks and volatility, most of them responding asymmetrically to news. Additionally, the study suggests that spillovers from the US market do influence the dynamics of conditional variances of returns in the

Asian markets analysed. Finally, the results also show that the Global financial crisis has scarcely changed volatility transmission patterns.

Regarding the links between the Asian countries analysed and the US, results indicate that the level of correlations depends on the country's level of development. Japan exhibits the highest correlation with the US, followed by the Asian Tigers, which are less correlated with the US, and, finally, by the Asian Tiger Cub economies. China, as an exception, presents low correlation with the US.

Chapter 3 has analysed if US macroeconomic announcements influence the Asian countries studied and whether this effect has an asymmetric impact, hence returns, volatility and correlation response depend on the news being good or bad. This study offers some interesting insights. Firstly, a specific behaviour pattern by groups of countries is found. As the level of development of the Asian market analysed is lower, the effect of US macroeconomic announcements is higher, thus, the tigers are more influenced by the US news than Japan and the cubs are even more susceptible to them. In fact, Japan remains quite indifferent to the new arrivals in the US. China, again as an exception, is severely affected by news occurring in the US.

Concerning the analysis of the effect of the Global financial crisis, results found in the periods before and after the onset of the destabilization of the equity markets worldwide

are not far from the results obtained in the total sample. Nevertheless, it is worth saying that after the financial turbulence occurred in recent years, the Asian markets seem to be more aware of what happens in the US.

The fourth chapter of this dissertation has examined the nature of the relationship between the stock and the currency markets in the Asian economies. Some remarkable findings have arisen from this analysis. Firstly, we have found empirical evidence for bidirectional volatility transmissions between both markets, independently of the country's level of development. Secondly, China, again, arises as an exception, since does not show significant volatility spillovers in either direction. The reason can remain on the fact that China operates a fixed exchange-rate system, which has been changed in the last years from the US Dollar to a fixed change based on a basket of foreign currencies, and has suffered some devaluations. Last but not least, considering the effect of the Global financial crisis, volatility transmission patterns have changed since the beginning of the world financial turmoil in the summer of 2007 in half of the markets analysed but in a heterogeneous way.

In general, the results of the three analyses of this dissertation show some interesting visions. While the volatility transmission pattern between the US and the Asian stock markets is mostly observed when the degree of development of the Asian country is

higher, the effect of US macroeconomic news releases on these Asian markets is greater as the Asian market analysed is less developed.

Therefore, Japan exhibits strong volatility spillovers with the US but is barely affected by the arrival of US macroeconomic announcements. The Asian Tigers show less volatility transmission with the US but are more influenced by the arrival of macroeconomic news in the US. The Asian Tiger Cubs display even less volatility spillovers but are more susceptible to macroeconomic announcements in the US. China, on its hand, is quite affected by news happening in the US. Finally, it is noteworthy that there is evidence for bidirectional volatility spillovers between the stock and the currency markets of the Asian economies analysed, independently of the development grade of the country.

It is worth mentioning that China arises as a general exception of the three analyses, performing in an independent way with respect to the other Asian economies analysed. The reason of this behaviour can be due, on the one hand, to the fact that in the past decades China has been reaching market-based financial system and has been trying to open it up towards the international financial markets. In spite of these efforts, its financial market is still not entirely open to other countries worldwide. Besides, it should be pointed out that this great country has a fixed exchange rate system that has suffered some changes in the last years.

All in all, the results suggest that emerging Asian financial markets have thus far suffered only limited impact from the Global Financial crisis. However, heightened risk perception and declining investor confidence could trigger a sudden reversal of financial flows from these region's capital markets, pushing down asset prices and intensifying financial market volatility.

The results of this dissertation may be useful for analysts, traders and portfolio managers. In an asset allocation framework, it is crucial to diversify the assets of a portfolio to diminish its risk. Considering international diversification, before composing a portfolio, it is very useful to know volatility spillovers across countries and asset classes. In this regard, it is vital to take into account the role of the currency market, not only because of the effect of exchange rate in foreign investments, but also for the relationship between the stocks in which to invest and the exchange rate of the related country. Likewise, macroeconomic news releases play a significant role in the stocks markets, hence it is very important to know the effect of the arrival of macroeconomic announcements on the returns, volatility and correlations of the stocks markets in which we want to invest. Finally, it is remarkable that the results of this thesis suggest that exchange rate policies should not be implemented without considering the repercussions on the stock market, and vice versa.

Bibliography

[1] Adler, M. and Dumas, B. (1984). Exposure to currency risk: Definition and measurement. Financial Management, 13, 41-50.

[2] Albuquerque, R. and Vega, C. (2009). Economic news and international stock market co-movements. Review of Finance, 13 (3), 401-465.

[3] Amihud, Y. (1994). Exchange rates and the valuation of equity shares. Exchange Rates and Corporate Performance, 49-59. Eds. Y. Amihud and R. Levich.

[4] Andersen, T.G., Bollerslev, T., Diebold, F.X., and Vega, C. (2003). Real-time price discovery in global, stock, bond, and foreign exchange markets. Journal of International Economics, 73 (2), 251-277.

[5] Andersen, T.G., Bollerslev, T., Diebold, F.X., and Vega, C. (2007). Micro effects of macro announcements: Real-time price discovery in foreign exchange. American Economic Review, 93 (1). 38-62.

[6] Ang, A., Bekaert, G. (2002). International asset allocation with regime shifts. Review of Financial studies, 15, 1137-1187.

[7] Baba, Y., Engle, R.F., Kraft, D.F. and Kroner, K.F. (1989). Multivariate simultaneous generalized ARCH, Mimeo, University of California at San Diego.

[8] Balduzzi, P., Elton, E.J. and Green, T.C. (2001). Economic News and Bond Prices: Evidence from the U.S. Treasury Market. Journal of Financial and Quantitative Analysis, 36 (4), 523-43.

[9] Beirne, J., Caporale, G.M., Schulze-Ghattas M. and Spagnolo, N. (2009). Volatility Spillovers and Contagion from Mature to Emerging Stock Markets. European Central Bank, Working Paper Series, 1113.

[10] Bekaert, G. and Wu, G. (2000). Asymmetric Volatility and Risk in Equity Markets. Review of Financial Studies, Society for Financial Studies, 13 (1), 1-42.

[11] Bernanke, B.S. and Kuttner, K.N. (2005). What explains the stock market's reaction to Federal Reserve policy? Journal of Finance, 60 (3), 1221-1257.

[12] Bessler, D. A. and Yang, J. (2003). The structure of interdependence in international stock markets. Journal of International Money and Finance, 22 (2), 261–287.

[13] Black, F. (1976). Studies of Stock Price Volatility Changes. Proceedings of the 1976 Meetings of the American Statistical Association, Business and Economical Statistics Section, 177-181.

[14] Bodnar, G.M. and Gentry, W.M. (1993). Exchange-rate exposure and industry characteristics: evidence from Canada, Japan and the US, Journal of International Money and Finance, 12, 29-45.

[15] Bollerslev, T. and Wooldridge, J.M. (1992). Quasi-maximum likelihood estimation and inference in dynamic models with time-varying covariances, Econometric Reviews, 11 (2), 143-172.

[16] Bomfim, A.N. (2003). Pre-announcement effects, news, and volatility: Monetary policy and the stock market. Journal of Banking and Finance, 27 (1), 133-151.

[17] Booth, L., and Rotenberg, W. (1990). Assessing foreign exchange exposure: Theory and applications using Canadian firms, Journal of International Financial Management and Accounting, 2, 1-22.

[18] Boyd, J.H., Jagannathan, R., and Hu, J. (2005). The stock market's reaction to unemployment news: Why bad news is usually good for stocks. Journal of Finance, 60 (2), 649-672.

[19] Branson, W.H. and Henderson, D.W. (1985). The specification and influence of assets markets, Handbook of International Economics, 2, Jones, R.W. and Kenen, P.B. (Eds.), Elsevier.

[20] Brailsford, T. J. (1995). An Empirical Test of the Effect of the Return Interval on Conditional Volatility. Applied Economic Letters, 2, 156-158.

[21] Braun, P.A., Nelson, D.B. and Sunier, A. M. (1995). Good News, Bad News, Volatility and Betas. The Journal of Finance 50 (5), 1575-1603.

[22] Brenner, M., Pasquariello, P., and Subrahmanyam, M. (2009). On the volatility and comovement of U.S. financial markets around macroeconomic news announcements. Journal of Financial and Quantitative Analysis, 44 (6), 1265-1289.

[23] Burns, P. and R. Engle (1998). Correlations and Volatilities of Asynchronous Data. Journal of Derivatives, 5 (4), 7-18.

[24] Campbell, J.Y. and Henstschel, L. (1992). No News is Good News: An Asymmetric Model of Changing Volatility in Stock Returns. Journal of Financial Economics 31 (3), 281-318.

[25] Caporale, G.M., Pittis, N. and Spagnolo, N. (2002). Testing for causality-in-variance: An application to the East Asian markets, International Journal of Finance and Economics, 7, 235-245.

[26] Caporale, G.M., Pittis, N. and Spagnolo, N. (2006). Volatility transmission and financial crisis. Journal of Economics and Finance, 30 (3), 376–390.

[27] Christiansen, C. and Ranaldo, A. (2007). Realized Bond-Stock Correlation: Macroeconomic Announcement Effects. Journal of Futures Markets, 27 (5), 439-469.

[28] Chuliá, H., Martens, M., and Dijk, D. (2010). Asymmetric effects of Federal Funds target rate changes on S&P100 stock returns, volatilities and correlations. Journal of Banking and Finance, 34 (4), 834-839.

[29] Click, R.W. and Plummer, M.G. (2005). Stock market integration in ASEAN after the Asian financial crisis. Journal of Asian Economics, 16 (1), 5–28.

[30] Christie, A.A. (1982). The Stochastic Behaviour of Common Stock Variances: Value, Leverage and Interest Rate Effects. Journal of Financial Economics 10 (4), 407-432.

[31] De Santis, G., Gerard, B. (1997). International asset pricing and portfolio diversification with time-varying risk. Journal of Finance 52 (5), 1881-1912.

[32] Dickey, D.A. and Fuller, W.A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. Journal of the American Statistical Association, 74 (366), 427-431.

[33] Dickey, D. A. and W. A. Fuller (1981). Likelihood Ratios Statistics for Autoregressive Time Series with a Unit Root, Econometrica, 49 (4), 1057-72.

[34] Dornbusch, R. and Fischer, S. (1980). Exchange rates and the current account. American Economic Review, 70, 960–971.

[35] Dumas, B. and Solnik, B. (1995). The world price of foreign exchange risk, Journal of Finance, 50, 445-477.

[36] Engle, R. F. (1982). Autoregressive Conditional Heteroskedasticity with Estimates of the Variance of UK Inflation, Econometrica, 50 (4), 987-1008.

[37] Engle, R. F. and K. F. Kroner (1995). Multivariate Simultaneous Generalized Arch, Econometric Theory, 11 (1), 122-150.

[38] Engle, R. (2002). Dynamic conditional correlation - a simple class of multivariate GARCH models. Journal of Business and Economic Statistics, 20 (3), 339–350.

[39] Erb, C.B., C.R. Harvey and E. Viskanta (1994). Forecasting international equity correlations. Financial Analysts Journal, 6, 32-45.

[40] Frankel, J. (1983). Monetary and portfolio balance models of exchange rate determination, Economic Interdependence and Flexible Exchange Rates, 84-114, Bhandari, J. and Putnam, B. (Eds.), MIT Press.

[41] French, K.R., Schwert, G.W. and Stambaugh, R. F. (1987). Expected Stock Returns and Volatility. Journal of Financial Economics 19 (1), 3-29.

[42] Glosten, L. R., Jagannathan, R. and Runkel, D.E. (1993). On the Relation between the Expected Value and Volatility of Nominal Excess Return on Stocks, Journal of Finance, 48 (5), 1779-1801.

[43] Grauer, R., Hakansson, N. (1987). Gains from international diversification: 1968-85 returns on portfolios of stocks and bonds. Journal of Finance, 42 (3), 721-739.

[44] Griffin, J. M., Nardari, F. and Stulz, R.M. (2007). Do Investors Trade More When Stocks Have Performed Well? Evidence from 46 Countries. Review of Financial Studies, 20, 905-951.

[45] Hamao, Y., Masulis, R.W. and Ng, V.K. (1990) Correlations in price changes and volatility across international stock market. Review of Financial Studies, 3, 281–307.

[46] Jang, H. and Sul, W. (2002). The Asian financial crisis and the co-movement of Asian stock markets. Journal of Asian Economics, 13 (1), 94–104.

[47] Jorion, P. (1990). The exchange rate exposure of the U.S. multinationals, Journal of Business, 63, 331-345.

[48] Kanas, A. (2000). Volatility spillover between stock returns and exchange rate changes: international evidence, Journal of Business, Finance and Accounting, 27, 447-467.

[49] Karolyi, G.A. (1995). A multivariate GARCH model of international transmissions of stock returns and volatility: the case of the United States and Canada. Journal of Business and Economic Statistics, 13, 11–25.

[50] Karolyi, G. A. and Stulz, R. M. (1996). Why do markets move together? An investigation of US-Japan stock return co-movements. Journal of Finance, 51 (3), 951–985.

[51] Kim, S. J. (2003). The spillover effects of US and Japanese public information news in advanced Asia-Pacific stock markets. Pacific-Basin Finance Journal, 11 (5), 611-630.

[52] Kim, S.J. (2005). Information leadership in the advanced Asia-Pacific stock markets: return, volatility and volume information spillovers from the U.S. and Japan. Journal of the Japanese and International Economies, 19 (3), 338–365.

[53] King, M.A., Wadhwani, S. (1990). Transmission of volatility between stock markets. Review of Financial Studies, 3, 5-33.

[54] Koch, P.D. and T.W. Koch (1991). Evolution in dynamic linkages across daily national stock indexes. Journal of International Money and Finance, 10, 231-251.

[55] Koutmos, G. and Booth, G.G. (1995). Asymmetric volatility transmission in international stock markets. Journal of International Money and Finance, 14, 747-762.

[56] Kroner, K. F. and V.K., Ng (1998). Modelling asymmetric comovements of asset returns, The Review of Financial Studies, 11 (4), 817-844.

[57] Kwiatkowski, D., Phillips, P.C.B., Schmidt, P. and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: how sure are we that economic time series have a unit root?, Journal of Econometrics, 54, 159-178.

[58] Lee, S.B., Kim, K.J. (1993). Does the October 1987 crash strengthen the co-movements among national stock markets? Review of Financial Economics, 3, 89-102.

[59] Lo, A. and MacKinlay, A.C. (1990). An Econometric Analysis of Nonsynchronous Trading. Journal of Econometrics, 45 (1-2), 181-211.

[60] Longin, F. and Solnik, B. (1995). Is the correlation in international equity returns constant: 1960-1990? Journal of International Money and Finance, 14, 3-26.

[61] MacKinnon, J. G., (1991). Critical Values for Cointegration Tests. In: Long-run Economic Relationships: Readings in Cointegration. (eds Engle R.F. and Granger, C.W.J.), Chapter 13. Oxford University Press, Oxford.

[62] Mishra, A.K., Swain, N. and Malhotra, D.K. (2007). Volatility spillover between stock and foreign exchange markets: Indian evidence. International Journal of Business, 12, 344–359.

[63] Miyakoshi, T., (2003). Spillovers of Stock Return Volatility to Asian Equity Markets from Japan and the US. Journal of International Financial Markets, Institutions and Money, 13 (4), 383–99.

[64] Ng, A., (2000). Volatility spillover effects from Japan and the US to the Pacific-Basin. Journal of International Money and Finance, 19 (2), 207-233.

[65] Phillips, P.E. and Perron, P.I. (1988). Testing for a unit root in time series regressions, Biometrika, 75, 335-346.

[66] Pindyck, R.S. (1984). Risk, Inflation and the Stock Market. American Economic Review 74 (3), 334-351.

[67] Poon, S.H. and Granger, C.W.J. (2003). Forecasting Volatility in Financial Markets: A Review . Journal of Economic Literature, 41 (2), 478-539.

[68] Ratanapakorn, O. and Sharma, S. (2002). Interrelationships among regional stock indices. Review of Financial Economics, 11 (2), 91–108.

[69] Roll, R. (1992). Industrial structure and the comparative behaviour on international stock market indices, Journal of Finance, 47, 3-41.

[70] Sercu, P. and Vanhulle, C. (1992). Exchange rate volatility, international trade, and the value of exporting firm, Journal of Banking and Finance, 16 (1), 152–182.

[71] Sheng, H. C. and Tu, A.H. (2000). A study of cointegration and variance decomposition among national equity indices before and during the period of the Asian financial crisis. Journal of Multinational Financial Management, 10 (3–4), 345–365.

[72] Smith, C. (1992). Stock markets and the exchange rate: a multicountry approach, Journal of Macroeconomics, 14, 607-629.

[73] Schwert, G.W. (1989). Why Does Stock Market Volatility Change Over Time?. The Journal of Finance 44 (5), 1115-1153.

[74] Valls, N. and Chuliá, H. (2012). Volatility transmission and correlation analysis between the US and Asia: The impact of the Global Financial Crisis, Global Economic Review, 41 (2), 111-129.

[75] Vrugt, E. B. (2009). U.S. and Japanese macroeconomic news and stock market volatility in Asia-Pacific. Pacific-Basin Finance Journal, 17 (5), 611–627.

[76] Walid, C., Chaker, A., Masood, O. and Fry, J. (2011). Stock market volatility and exchange rates in emerging countries: A Markov-state switching approach, Emerging Markets Review, 12, 272-292.

[77] Wang, S.S. and Firth, K. (2004). Do bears and bulls swim across oceans? Market information transmission between Greater China and the rest of the world. Journal of International Financial Markets, Institutions and Money, 14, 235-254.

[78] Wongswan, J. (2006). Transmission of information across international equity markets. Review of Financial Studies, 19 (4), 1157-1189.

[79] Wu, G. (2001). The Determinants of Asymmetric Volatility. The Review of Financial Studies 14 (3), 837-859.

[80] Yang, S. and Doong, S. (2004). Price and volatility spillovers between stock prices and exchange rates: Empirical evidence from the G-7 countries. International Journal of Business and Economics, 3, 139-153.

[81] Yang, J., Kolari, J.W. and Min, I. (2002). Stock market integration and financial crises: the case of Asia. Applied Financial Economics, 13 (7), 477–486.

[82] Zebedee, A.A., Bentzen, E., Hansen, P.R and Lunde, A. (2008). The Greenspan years: an analysis of the magnitude and speed of the equity market response to FOMC announcements. Financial Markets and Portfolio Management, 22 (1), 3-20.