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THE GLOBAL FINANCIAL CRISIS AND CONTAGION OF ITS EFFECTS ON EMERGING MARKET ECONOMIES

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ÖZ

GLOBAL FİNANSAL KRİZ VE GELİŞMEKTE OLAN PİYASALARA BULAŞMA ETKİSİ

Bu çalışmanın amacı, ABD ve seçilen 15 gelişmekte olan piyasalara ait borsalar için küresel krizin bulaşma etkilerini belirlemek ve ayrıca ABD ve hedeflenen borsalar arasındaki koşullu korelasyonun belirleyicilerini ve bulaşma kanallarını araştırmaktır. Çalışma 03.01.2000 – 29.07.2016 periyodu olmak üzeri uzun bir süreyi kapsamaktadır. Ekonomideki bulaşma etkisine dair çalışmaların literatür taramasından sonra, gelişmekte olan piyasa ekonomilerine ait borsaları ve küresel finansal krizin sonuçlarını inceleyen bir çerçeve oluşturulmuştur. Ekonomi açısından, 2 hiyerarşiyi içeren ekonomik ve sosyal göstergelerin, gelişmekte olan piyasaların ortak ve farklı karakterlerini yakalayabildiğine ilişkin 31 gösterge göz önünde bulundurulmuştur. Borsa açısından, 4 boyutlu ve 9 göstergeli iki seviyeli bir hiyerarşi çerçevesi oluşturulmuştur. Daha sonra, bulaşma etkisini ve kanallarını belirlemek için farklı yöntemler uygulanmıştır. Öncelikle uzun dönemli ilişkinin varlığını göstermek amacıyla, 1. seviyede bütünleşik olan Johansson Eş bütünleşme testi uygulanmış fakat birçok market için uzun dönemli bir ilişkinin varlığı tespit edilememiştir. İkinci olarak, borsalar arasındaki kısa vadeli korelasyonu incelemek için, çok değişkenli VAR modeli, Granger-Nedensellik testi ve etki-tepki ve varyans ayrıştırması yöntemleri günlük hisse senedi getirilerine uygulanmıştır. Farklı borsalar arasında Granger nedensellik korelasyonları, eşgüdüm ve karşılıklı bağımlılık tespit edilmiştir. Ek olarak, coğrafi konsantrasyona dair güçlü kanıtları bulunmuştur. Daha da önemlisi, Temmuz 2000 - 016 döneminin tamamını kriz öncesi, kriz ve kriz sonrası olmak üzere üç alt döneme ayırarak günlük hisse senedi getirilerine göre DCC-GARCH modeli kullanılmıştır.

DCC-GARCH modelinden tahmin edilen dinamik koşullu korelasyonu (DCC) analiz etmek için t-testi kullanılmış, seçilen tüm borsalara ABD'den bulaşma etkileri tespit edilmiştir. Ayrıca, dış şokların DCC'ler üzerindeki etkilerini araştırmak için kukla değişkenler eklenerek DCC tahmin edilmiştir ve küresel finansal krizden kaynaklanan bulaşma etkisinin varlığı ikinci kez onaylanmıştır. DCC'nin belirleyicilerini ve kanallarını incelemek amacıyla, hem temel hem de finansal perspektiften kapsamlı bir çalışma gerçekleştirilerek bulaşma kanallarına dair literatür boşluğu doldurulmuştur. DCCX-GARCH modeli VIX, CDS ve TED dışsal değişkenler eklenerek günlük verilere uygulanmıştır. TED ve DCC arasında negatif ilişki varken, VIX'teki artışın DCC artışına neden olduğu tespit edilmiştir. Ancak, CDS'in anlamlılığı borsadan borsaya farklılık göstermektedir. İhracat, ithalat, enflasyon, faiz oranı ve sanayi üretimi gibi değişkenlere ait aylık verilerle temel bulaşma kanalları incelemek için panel veri analizi uygulanmıştır. Sonuçlar ihracat, enflasyon, endüstriyel üretim ve faiz oranlarının temel bulaşma kanallarını etkileyen önemli ekonomik faktörler olduğunu göstermektedir. Araştırma sonuçları, varlık tahsisini yönetmek ve potansiyel riskleri önlemek için politika yapıcılar ve yatırımcılar için anlamlıdır.

Anahtar kelimeler: Global Finansal Kriz'in Bulaşma Etkisi, DCC(X)-GARCH, Bulaşma Kanalları, VAR Tahminlemesi, Granger Nedensellik Testi, Etki-Tepki Analizi, Varyans Ayrıştırması, Panel Veri Analizi.

ABSTRACT

THE GLOBAL FINANCIAL CRISIS AND CONTAGION OF ITS EFFECTS ON EMERGING MARKET ECONOMIES

The global financial crisis (GFC) profoundly influenced almost all countries and markets in the world, and the consequences are persistent and immense. The financial contagion effect has become an essential and popular topic. This study identified the GFC contagion effects from the U.S to 15 selected emerging stock markets, and furthermore to investigate the contagion channels and determinants of the conditional correlation between the U.S. and selected emerging stock markets. It covers the period from 1/3/2000 to 7/29/2016. After the literature review of contagion studies, we established two frameworks consisting of different levels and the main economic and stock market indicators to review emerging market economies and the stock market. In addition, we examine the consequences of the global financial crisis. In terms of the economics, economic, social& welfare indicators that include two hierarchies, 31 indicators were considered to capture the common and different characters of the emerging market economies. In terms of the stock market, a two-level hierarchy framework was built that included four dimensions and nine indicators. It is meaningful to investigate how the financial crisis impacted on the different emerging markets, which vary from each other. After that, we applied different methods to identify the contagion effect and contagion channels. Firstly, considering the long term, we applied Johansson Co-integration to the stock price with integration in level one. However, there is no long term relationship for most of the selected stock markets. Secondly, to examine the short-term correlation between stock markets, we applied a Multivariate VAR model, a Granger-Causality test and impulse response function and variance decomposition analysis within a VAR model to the daily stock returns. We found Granger causality correlations, co-movement and interdependence among different stock markets. In addition, strong evidence of geographic concentration was observed. Importantly, to capture further time-variation in contagion effects and dynamic linkages among equity markets, a superior DCC-GARCH model was employed with the daily stock returns by dividing the entire period 1/3/2000-7/29/2016 into three sub-sample periods, namely: pre-crisis, crisis, and post-crisis.

By comparing the dynamic conditional correlation (DCC) estimated from DCC-GARHC model by t-test, we identified the contagion effects from the U.S. to all selected emerging stock markets. Furthermore, we analyzed DCCs by adding dummy variables to investigate how the external shocks impacted on the DCCs and confirmed the contagion effect from the global financial crisis. Furthermore, to examine the determinants and channels of the DCC, from financial and fundamentally two perspectives, we did a comprehensive study and filled the gap of the contagion channel study. We applied DCCX-GARCH model to daily stock return data, by simultaneously adding VIX, CDS spread, and TED spread as the exogenous variables. We found the rise of VIX leading DCC increase, while finding a negative relationship between TED and DCC. However, CDS is significant but varies between different stock markets. In parallel, Panel data analysis based on the monthly data was employed to examine the fundamental contagion channels by adding export, import, inflation, interest rate, and industrial production. The results show that exports, inflation, industrial production, and interest rate are essential economic factors which determine the fundamental contagion channels. Our research results are meaningful to policymakers and investors to adjust asset allocation and prevent potential risk.

Keywords: Global Financial Crisis Contagion, DCC(X)-GARCH, Contagion Channels, VAR Estimation, Granger Causality Test, Impulse Response Function, Variance Decomposition Analysis, Panel Analysis.

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LIST OF ABBREVIATIONS

AIC	: Akaike information criterion
ASEAN	: Association of Southeast Asian Nations
CDS	: Credit Default Swap
DCC-GARCH	: Dynamic Conditional Correlation – Multivariate Generalized Autoregressive Conditional Heteroskedasticity
EME	: Emerging market economies
EMS	: Emerging stock markets
FPE	: Final prediction error
GFC	: Global financial crisis
HQ	: Hannan-Quinn information criterion
IRF	: Impulse response funcation
LM test	: Breush and Pagan Lagrangian multiplier test
SC	: Schwarz information criterion
VAR	: Vector autoregression

INTRODUCTION

The Global Financial Crisis was triggered when the U.S. mortgage bubble burst in 2007 and the U.S. housing market collapsed. A GFC has only happened four times in the last 200 years, but each time it has affected multiple regions around the world. The 2008 GFC (Global financial crisis) was seen as the worst crisis since the1930s, and it was unprecedented and severe, spreading rapidly from the US financial sector to other countries and also influenced the real economy significantly. The influence, ability and intensify was strong and still lingers. The US stock market dropped by 43% whereas the emerging markets declined by 50% and frontier markets by 60% (Boubaker, Jouini and Lahiani, 2016: 15).

There are huge costs and disastrous consequences of the GFC as a large number of financial institutions collapsed although national governments tried to bailout banks. Stock markets dropped worldwide, housing prices went down rapidly and immensely, resulting in evictions, foreclosures, and prolonged unemployment. No surprise that there was a real economic downturn and industry sectors slowed down, consumer wealth declined by trillions of US dollars and so on. The emerging financial market asset price return experienced the sharpest decline after the first phase of the crisis and entered a higher volatility period (Min and Hwang, 2012: 2069-2070). Only a few sectors were immune from it and but all developed and emerging markets were impacted significantly by the Global Financial Crisis.

The GFC contagion effects also spread to real economic sectors worldwide. The emerging country growth rates were -1.9% and -3.2% in the fourth quarter 2008 and the first quarter of 2009, respectively. It was roughly 10% below 2007 value during the similar period (Blanchard, Faruqee and Das, 2010: 263). The export demand for goods and services swiftly downturned sharply by 35% from peak through from July 2008 to February 2009 (Keat, 2009: 268).

There are questions as to why the GFC started from U.S. stock markets but spread worldwide and impacted intensively and severely on other stock markets and sections. From which channels did the contagion effect spread? What were the determinants for the conditional correlation? To answer these questions, therefore, contagion study has become an important and popular topic attracting research attention recently. That is why to understand the contagion phenomenon, to know why and when the contagion occurred, and how it happened, from which channels it spread, and how to mitigate the contagion level became important to the financial markets and for financial stability. To understand what researches had been done about contagion, where we stand now, what the problems are and what recent evidence indicates, and what directions should dominate future research and discussion are important matters to study.

This study will apply a variety of econometric models and quantitative analysis to investigate whether the global financial crisis had contagion effects on a selected number of emerging stock markets by taking into account the mechanisms and phases of transmission and the timing of the impact. Besides identifying contagion effects, finding the channels and mechanism of the contagion, understanding how transmission spread, synthesizing the methodology of measurements of financial contagion, finding the reasons why some countries were fragile and weak but others responded efficiently to the GFC are key areas.

The emerging countries and their stock markets in this study are Brazil (BOVE), China (SSEC), Colombia (A.IGBC), Hungary (BUX), India(BSESN), Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), Poland (WIG), the Philippines (PSI), South Africa (FTSE), Thailand (SETI) and Turkey (XU100) index, and US (S&P 500 index).They were selected from the common emerging countries among the IMF, MSCI, S&P and Dow-Jones lists[1] (Kenton, 2018).

[1] This link shows the different institution list for emerging market economy. https://www.investopedia.com/terms/e/emergingmarketeconomy.asp

Macroeconomic and financial determinant indicators that can be signals of a similar financial crisis in the future, in order to prevent it, have also been sought in this study. In addition, we try to point out differences among emerging market economies and regional vulnerabilities. Emerging market economies are classified based on their financial structure and their soundness levels and capabilities against financial crisis into different groups. Moreover, investigated specifically is whether financial diversity will help to mitigate the effects of financial crisis or not.

This study investigates the GFC impacts on emerging markets economics. Firstly, a general research background and brief theoretical and empirical review will be given in Chapter 1 and 2. Secondly, we will review all selected countries' economics and examine how the GFC affected them in Chapter 3 and 4. Thirdly, it is investigated whether contagion effects exist or not from the U.S. stock market to the selected emerging stock markets in Chapter 5 and 6. Finally, in Chapter 7, we will examine how the contagion spread, from which channels, and what variables or financial indicators are the determinants of conditional correlation. We will give brief conclusion, implication, and limitation at the end of study.

This study covered a long time and 15 common consensus emerging economies, from long term and short term two aspects by applying various methods to identify the contagion effects and find out the determinants of the financial channels. The analysis from shallow to deeper, find the relationship first by applying Johansen co-integration and VAR, Granger causality, impulse response, variance decomposition method. Furthermore, an alternative superior method DCC-GARCH model applied to capture the time-varying dynamic conditional correlation. We found short term comovement and relationship among the US and the selected emerging market. It challenges the asset allocation benefit theory.

We also contributed to the financial channel studies in the empirical and literature perspective. A comprehensive study to investigate the financial channels from the financial and fundamental perspective is applied to the different models and data.

Especially, we established a model for panel analysis and connected the dynamic conditional correlation among countries with the macroeconomic factors for fundamental channels.

CHAPTER ONE

GENERAL RESEARCH BACKGROUND

1.1. The Significance Of Research

It is very meaningful to study the contagion of the financial crisis. We also learn lessons from history to warn and give guidance for the future. It is provide useful lessons for any future potential crisis. After we learn the timing, phases, channels and mechanisms of financial crisis transmission, we can take good actions when we face similar situations to minimize the loss from the crisis and mitigate the effects. It is especially important to the decision-makers, central banks and governments. Their decisions affect investors' confidence that directly influence the crisis result.

To have a sound and steady financial market and integration capital market is one of the most important aims of investors and decision markers. To know the financial market integration degree and the ability to avert risk is very useful to investors to balance their investment portfolio from diversification with less related assets (Hwang, 2014: 312). From this study, we will understand the contagion effect from the U.S stock market to the selected emerging stock markets, and it very helpful to policymakers to determine monetary and fiscal policies, in order to maintain macroeconomic stability and sustain economic growth (Moriyama, 2010: 14).

1.1.1. Global Financial Crisis Background And Consequences

Financial crises have happened many times in different countries and areas in history from the 19th century. Each crisis resulted in unavoidable loss for financial markets and economics. Financial sectors as a cause of economic fluctuations (Bernanke 1983: 258; Bernanke and Gertler 1989: 14) as a view increase the importance of the value of studying financial crises. Allen and Gale (2000: 2) state that: Financial crisis are important because the ultimately will lead low growth and recession periods in the real sector, and restrain the activities in the real sector due to the increasing cost of the intermediation and restrict credit.

The most notorious and worst depression and financial crisis in history is the 1929-1939 Great Depression. The following 1970s energy crisis, banking crisis in the UK, Latin American debt crisis known as “the lost decade”, then in the1980s, the early 1980 Recession, 1982 Chilean crisis, 1983 Israeli bank stock crisis, 1986-1992 Japanese asset price bubble, 1987 U.S. black Monday, moreover, The Early 1990s recession, 1991 India Economic crisis, 1991-93 Finnish banking crisis, 1994 Mexico economic crisis, 1997 Asian financial crisis, 1998 Russian financial crisis, 1998-99 Ecuador financial crisis, 1999-2002 Argentine economic crisis and 1999 Brazil Samba effect are all examples. The crises happened more often and the degree and scope of the impact was getting bigger.

Although each time the government, policy makers and investors learned lessons from crises, it seems that they could not cope with the crises and they intensified. In the 21st century with the development of globalization and internationalization and financial integration, the crises increased rapidly and widely beyond expectation. The early 2000s recessions like the 2000-02 Doc-com bubble, 2001 Turkish economic crisis, 2002 Uruguay banking crisis, and 2002-03 Venezuelan general strikes happened one after another or simultaneously.

Furthermore, the most incredible and catastrophic financial crisis is the 2007-2009 Global Financial Crisis (GFC), which is labeled according to the economic consequences, including Soros (2008: vii), Stiglitz (2010: 321), IMF (2008), as the worst financial crisis since the 1930s Great Depression. Our focus is this global financial crisis.

> "The financial market crisis that erupted in August 2007 has developed into the largest financial shock since the Great Depression, inflicting heavy damage on markets and institutions at the core of the financial system." -- International Monetary Fund, World Economic Outlook, (April 2008: 2)

Therefore, there are enough reasons to study the GFC. First, it is a part of history as the most severe financial crisis since the 1930s Great Depression. It is the key financial event at the beginning of the 21th century, it has wide reverberations that caused different crises for Europe and other places, and it directly slowed down the economic development speed for the rest of world, increased inequality and influenced global economic and political structure.

In addition, the GFC could happen again and the impacts and degree may increase next time. We need to prevent it in advance, at least know how to mitigate the impacts on the world. Hence, it is necessary to study it and understand it. Only by understanding why and how it happened, will next time we recognize it and see what the buildup looks like so we can take efficient actions.

1.1.2. The Importance Of Studying Contagion Effect

One important question is why the financial crisis happened in the U.S. but suddenly spread to almost the whole world and every sector and from where and how it impacted on others. Therefore, contagion effect study became a popular and important topic attracting research attention.

One more interesting point is that this global financial crisis was like a contagion disease and a crises fuse, causing a series of crises thereafter. The impact of this GFC is persistent and resilient. There are the 2008-10 US Automotive industry crisis, 2008-12 Icelandic financial crisis, 2008-10 Irish banking crisis, 2008-09 Russian financial crisis, 2008 Latvian financial crisis, 2009-10 Venezuelan banking crisis, 2008-16 Spanish financial crisis. Furthermore, even after the 2010s financial crises continued to spread in the world. Like the 2009 European Sovereign debt crisis, Greece government-debt crisis, 2010-14 Portuguese financial crisis, 2012 – Bolivarian Venezuelan crisis, 2013-14 Ukrainian crisis, 2014 Russian financial crisis, 2014-17 Brazilian economic crisis, and the 2015 Chinese stock market crash.

The term contagion was initially used in July 1997 (Seth and Sighania, 2017: 406) for the Asian Crisis that originated in Thailand then spread rapidly to Russia, Brazil and East Asia and to Europe and North America to developed markets. The number of empirical researches about contagion has grown extensively in the last few decades. Contagion has become attractive for scholars because there were a series of financial crises at the end of the 20th Century and they have some common characteristics that started from one place and spread to other markets in a short time.

For instance, the Exchange Rate Mechanism attacks of 1992, The Mexican peso crisis of 1994, Asian crisis in 1997, Russian collapse in 1998, the Brazilian devaluation of 1999, and Argentine crisis in 2001. Especially, then the most recent global shock, the 2008 U.S. global financial crisis emphasized the importance of understanding contagion again to the world. Based on the review work from Seth and Sighania (2017: 406), from 2000 contagion studies started to increase, reached a peak by 2005, and then decreased a little to 2008.

However, after the GFC, a new higher peak was reached and contagion became a very popular and important topic from 2009 until now. Seth & Sighania (2017:) did a literature review, which included 104 academic papers and official reports related to contagion. According to the research year, more than 60% of financial contagion research was carried out during the current period, especially 2014-2015 when 25 academic papers out of 104 emerged on this topic.

Globalization shortens the distance of markets, so one crisis or event that occurs in one part of the world can have tremendous impacts on many other markets far away. The fundamental factors could not explain adequately the timing, range, virulence of the current crisis, and why the crises spread to either developed and emerging markets.. All these issues raised the importance of contagion study.

There is another importance reason Lupu (2012: 35) gave for why we have to investigate contagion from the investors' perspective, which is that the international diversification of investment portfolios in order to protect against county risk seems not as efficient and valid as before because the contagion between markets largely removed its benefit.

That is why to identify the contagion effects, and find out the timing of the correlation volatilities, and furthermore to investigate the channels of spread and the determinants of the dynamic conditional correlations are useful and meaningful for financial markets and financial stability.

Moreover, from the investment management point of view, to know whether the relationship between two assets is stable through time is always important to guide the investment. From the macroeconomic point of view, it is important to design fiscal and monetary policies by understanding the transmission channels of financial shocks. For the practitioners, understanding contagion can help them with option pricing, risk management, portfolio allocation, and valuing risk to make suitable investments (Rigobon, 2002: viii).

1.1.3. The Importance Of Emerging Markets Economies (Emes) And Stock Markets

There are some important reasons we focus on emerging market economies. First, the EMEs were affected in a pronounced and dynamic way by the GFC, and the effects varied between EMEs. Second, the importance of emerging markets economies in the global financial and economic market rose rapidly from the late 20th century. They developed faster and changed the structure of the global economy and political economics. The third reason is that emerging markets economies played significantly rolesas engines for the world recovery from the financial crisis.

Emerging market economies were influenced significantly by the GFC. EMEs suffering from the externally driven collapses in trade, the financial volatility risk, and deterioration in financial institutions' balance sheets, higher interest rates, decline of asset price, and the increased uncertainty. Because the fiscal imbalances influence the foreign exchange market, causing adverse selection and moral hazard problems, then economic activity declines, and the banking system faced liquidity problems which then negatively impact on economic activity like a vicious cycle.

It seemed that emerging economies were uncoupled and insulated from this crisis from its beginning, since the financial integration degree was not high as in the advanced economy so policymakers could decrease the impact from the crisis by some regulations and independent policy. However, the 2008 GFC was unprecedented and transmitted to even emerging economies in terms of financial markets and the real economy, which spread to the emerging economics rapidly after Lehman Brothers was bankrupted in 2008 (Dooley & Hutchison, 2009: 1331).

We choose emerging economies also because they play a more essential role in the global financial and economic market. It is the main recovery power for the world economy. Developing Asia was the only region that had positive related strong growth (4.8% in 2009) after the financial crisis according to IMF estimates. In addition, they have many common characters like the weak ability to transfer crisis risk and to defend risks, an unsound financial system, and a nontransparent market.

Emerging markets play a more important role in global economics and financial markets. They have become one of the major recovery engines and powerhouses. According to the CIA World Factbook2015 statistics, China and India, two main emerging market economies, account for 40%of the world's labor force and population and their combined economic output ($27.8 trillion) is greater than Europe ($19.18 trillion) and the United States ($18.0 trillion). Their position and status worldwide has become irreplaceable and cannot be ignored.

Specific characteristics of each emerging market economy are widely different which explains why some countries exposure to the financial crisis was resistant. Due to the emerging markets economies all having their own complicated and different circumstances, the contagion phenomenon, performance, and mechanism vary from one to the other. Therefore, we want to study the common points and also the specifications of them, try to explain the global financial crisis contagion effects on them and provide useful and specific policy and actions to prevent and mitigate the impacts of a global financial crisis.

The classification of emerging market economies has not reach the full consistency for the different institutions. For example, the International Monetary Fund (IMF) and Morgan Stanley Capital International (MSCI) both classify 23 countries as emerging markets but there are differences between these two lists. Standard and Poor's (S&P) and Russel, and Dow Jones classify 21 and 22 countries as EMEs, respectively. Therefore, in our study we selected fifteen common countries that all five institutions put in their emerging markets list. They are Brazil, China, Colombia, Hungary, Indonesia, India, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand and Turkey.

1.2. The Structure And Main Methods Of The Thesis

In this thesis, we employed different empirical methods to identify the contagion effect and the contagion channels. In Chapter 2 there is a brief literature review about contagion, from the definition, reasons, contagion channels, and previous studies about contagion's four aspects. Based on the theories and previous empirical studies, we can use our methods to measure contagion and hence select possible factors as the potential channel variables. Therefore, the literature review chapter laid foundations for the other chapters.

In Chapter 3 and Chapter 4 we established the framework to have an overview of the selected emerging market economies and stock markets, and the consequences from the GFC. In Chapter 3, we created a three hierarchy level framework including economic, social and welfare aspects that consist of 31 indicators to analyze all the selected emerging economies.

In Chapter 4, we focus on the selected stock markets and make a comparative analysis. First examined is the definition and development of each stock market, then according to the important indicators of that stock market, we establish a framework for stock markets from four dimensions, namely, size and activities, access and liquidity, efficiency, and stability and volatility, making a total of 9 indicators to investigate each stock market.

Chapters 5, 6, and 7 are empirical studies identifying financial contagion effects and contagion channels of the GFC from the U.S. stock market to selected emerging stock markets. In Chapter 5, we employed Johansen co-integration to consider the long-term relationship between the U.S. and the selected emerging stock markets. In terms of the short term, multivariate VAR, Granger-Causality test and impulse response methods were applied.

In Chapter 6, the Dynamic Conditional Correlation – Multivariate Generalized Autoregressive Conditional Heteroskedasticity (DCC-GARCH) model introduced by Engle (2002) was employed to the stock return data. DCC-GARCH is a promising method and has many advantages that suited it for this study. It can capture time varying and cross-market correlation coefficients by standardized deviations and correlation matrix, and therefore handle the heteroskedasticity problem and is widely used for financial data. It provides consistent estimates for the conditional correlation matrix (Kearney and Poti, 2006: 310).

Besides tests for market comovements, DCC-GARCH is useful to compute the degree of comovements between markets. After estimating the dynamic conditional correlation (DCC), we applied paired-sample t-test to compare the crisis and pre-crisis sample means to identify the contagion effect. Moreover, we added dummy variables and used the GARCH model to especially focus on the analysis of the dynamic conditional correlation to investigate the volatilities of DCCS.

Furthermore, in Chapter 7 we examine the financial contagion channels, in other words, the determinants of the dynamic conditional correlation after identifying the contagion effect in the previous two chapters. We did a comprehensive study from the financial channel and fundamental channel perspectives and filled the gap in the contagion channel literature. DCCX-GARHC model that is an extension from DCC-GARCH will be applied; because it is a promising tool that can add exogenous variable simultaneously while estimating dynamic conditional correlation. Therefore, we added VIX, Sovereign CDS spread and the TED as the global financial factors that may impact on the dynamic conditional correlation. On the other side, we used the panel regression to the fundamental channels, by using export, import, inflation rate, interest rate and industrial production as the potential determinants. Finally, we will give a brief conclusion and implications for the whole thesis.

CHAPTER TWO

LITERATURE REVIEW AND CONTAGION

Financial crises contagion has been a great concern during the past two decades, especially nowadays when the GFCs and the subsequent Sovereign Debt crisis has drawn researchers' attention back to the contagion again. The contagion effects play a very important role for investors and policymakers in optimizing asset allocation, determining monetary and fiscal policy, and in preventing risk. The contagion channels could provide a door to decrease impacts on financial markets. Therefore, effective regulation and government policies will minimize the risk of contagion from a financial crisis.

There are some important issues we are concerned with for the literature review. The definition of financial contagion, causes, transmission channels, the methodology of measurements of financial contagion, and current existing research about the GFC and the contagion effects.

2.1. The Definition Of Contagion

There are several broad and restrictive definitions of financial contagion but so far no consensus on it. Through the literature studies, the description of contagion is classified by the degree of its spread and the channels through which it occurs.

In the spread of financial shocks between various countries, contagion has been defined as a "substantial rise in linkages between different markets after a shock to one economy" (Seth and Sighania, 2017: 392). The importance is the changing of the degree of correlation between markets before and after a financial shock. If two markets keep highly correlated before and after a shock, it is not necessarily a contagion, it is just interdependence, and the essential point is the increase of the correlation after a financial shock. If the cross-market linkages rise significantly after a crisis, it suggests that contagion occurred since the transfer mechanism strengthened after a shock. That is the popular and most used definition, known as "shift contagion."

The second category depends on the channels. The fundamentals of transmission like trade and economic linkages or related capital markets are not considered as contagion, only the transmission shock except those is considered as the contagion, and called "pure contagion." According to Forbes and Rigobon (2002), the international stock market, bond market, and the foreign exchange market are leading financial markets that are referred to in the contagion literature.

From other dimensions, according to the World Bank, contagion is defined conceptually in three categories, in a broad definition, restrictive and very restrictive sense.

A broad definition is given as fundamentals-based contagion (Calvo and Reinhart, 1996: 17). It refers to the transmission of financial shock through real or financial linkages. The restrictive definition from the World Bank according to Nieh, Kao and Yang (2011: 21)

> "Contagion is the transmission of shocks to other countries or the cross-country correlation, beyond any fundamental link among the countries and common shocks. This definition is usually referred to as excess co-movement, commonly explained by herding behaviors."

The more restrictive definition is from Forbes and Rigobon (2002: 2224), *“Contagion occurs when cross-country correlations increase during ‘crisis times’ relative to correlations during ‘tranquil’ times”.*

This one is widely used for current researches to identify and measure financial contagion. In our study, we follow Forbes and Rigobon (2002: 2224), which also is the very restrictive definition from the World Bank that defined *“Contagion as a significant correlations increases in cross-market linkages after a shock to one country (or group of countries) relative to correlations during ‘tranquil’ times. “*

This definition is widely used by many research works. The logic of a contagion test based on correlation is that during a crisis, contagion from one market to another is signaled through a significant increase in the correlation of these markets. That is, if the price of one market falls, the price of the other one also drops.

2.2. Causes Of Contagion -- How Contagion Arises

2.2.1. Herding Behavior

Herding behavior is a widely and commonly accepted reason for contagion (Cheung, Tam and Sezto, 2009: 2). Imperfect and asymmetric information are the core reasons. The expectation formation model explains why herding behavior can be rational among investors and fads. Because obtaining information is costly, individual investors are not able to get private information, and the easy way for them is to follow the other experienced and more prominent investors or institutions, which causes markets to move together. Moreover, because of lacking information the individual investors find it hard to differentiate the foreign exchange from each other, so the crisis panic will lead them to wholesale withdrawal from foreign investments.

2.2.2. Financial Market Integration And Globalization

The degree of financial market integration causes contagion as well. Dornbusch, Park and Claessens (2000: 181) pointed out that if in a region many financial markets are tightly integrated, or the market highly related to the global financial market, then asset price changing, volatility, and other economic variables impact each other a lot and level of comovement will be high. The defense ability from financial shock and crisis are meager because of the similarities and integration as a whole.

Conversely, if a country is not integrated into a group or global market, due to capital control, government interventions, or lack of access to the international financial market, from the theoretical aspect, those countries may be immune to contagion.

However, in the real world, globalization shortens the distance between almost all counties, increases the similarities, even if the market is not highly integrated, from trade links, financial links, and other dependent factors, the relationships between each other are closer than before. Therefore, it is hard to be immune from financial shocks as a member of the global family.

The countries with more globally open market and financialization, with their financial assets traded widely in the global market and with a high liquidation domestic financial market, are more vulnerable to financial contagion (Kodres and Pritsker 1998, 771-4; Dornbusch, Park and Claessens, 2000: 182). Global diversification of financial portfolios involves the cross-market hedging of macroeconomic risks; if a country has a high degree of comovement of asset returns with a crisis-affected country will be more vulnerable to contagion (Kaminsky and Reinhart, 2000: 148).

2.2.3. Macroeconomic Feedback Models

Cheung, Tam, and Szeto (2009: 3) pointed out that macroeconomic feedback models about the "adverse expectations of a particular event make that event more likely." The shift of expectations and the actions taken according to the expectations can be the trigger for the expected issues to happen, which makes the possibility higher and more likely. It is a similar logic to the bank run. When the investor fears a something, they will take actions according to their expectations and panicked irrational imagination, and these results in higher likelihood for the event.

2.2.4. Liquidity And Bank Runs

The bank run is a classical model to show why contagion arises. People worry about the ability to be repaid by the bank, and then they run to withdraw their deposits and savings, which cause the bank run and insolvency as further investors flock to also withdraw their deposits. The more depositors withdraw their money, the higher the possibility of bank default, which encourages further withdrawals, and it is a vicious circle and self-fulfilling prophecy. If it gets serious, it can lead to the bankruptcy of the bank. It is not hard to apply this logic to the financial crisis.

2.2.5. Wake-Up Call

The wake-up call theory of contagion is also an important reason explaining contagion (Ahnertand and Bertsch, 2015: 5). It is based on the information choice of investors after observing a financial crisis in other regions and is also related to some fundamental similarities between the two regions. A financial crisis in region 1 becomes the wake-up call to investors in region 2 and that leads investors to reassess by considering the risk.

2.3. Contagion Channels

Besides identify the financial contagion effect, to find out the financial channels and determinants are important. In this section, we will review the basic theories about contagion channels from different perspectives. They are also intersection reasons among these channels.

2.3.1. The Important Contagion Channels

Contagion can take place through the financial institutions collapse, stock market crashes and equity price rapidly dropping for most of the stock markets, an exchange rate with high volatility (Kim, Kim, and Lee, 2005: 209), liquidity problems on the credit market, a sudden stop of capital inflows, portfolio inflows, international market conducting and so on.

Why do some countries seem immune from financial crisis but others suffer colossal loss, even when those economies are different from each other. The vulnerability of economies and financial markets are important factors that decide the degree of contagion effects. According to previous studies (Dornbusch, Park, and

Classens, 2000: 179) about how the contagion spread, generally the transmission channel can be classified as fundamental and finance channels.

2.3.2. The Theories About Contagion Channels

There are large bodies of theoretical literature on contagion channels involved in the transmission shocks from one country to another. We can classify them into some basic types. These are the fundamentals bases (real linkages), financial linkages, investor behavior, and liquidity based (Rigobon, 2002: 4).

The fundamentals channels are the so-called real links between two economies, which include the transmission through trade and monetary and fiscal policies. The financial links focus on the financial market links associated with the organization and functioning. Investor behavior theories are about investor beliefs, expectations, and asymmetrical information. Moreover, the liquidity-based theory is about the constraints on security market participants and how these constraints affect pricing and overall functioning of the securities markets.

2.3.3. Trade Links And Competitive Devaluations

The local shock or crisis in the first economy can affect the other economies that have similarities of fundamentals or linkage through trade links and devaluation of the currency. When the local country has a financial crisis or shock, the currency devaluation will decrease the asset values then cause capital outflows from that country. Meanwhile, the original crisis country could become a speculative attack target since there is expectation of exports decline, therefore, deterioration of trade further.

The crisis country's import demand will decline suddenly when there is a shock; the export will be affected adversely as well. The trade balance deterioration negatively impacts on economic growth, economics will impact on the finances as well. So investors will reassess their international investment portfolio. The expectation of the crisis country asset price decrease will lead investors to cut investment, withdraw their savings, and then capital outflows rising may finally trigger a crisis.

Actually the trade linkage is easy to understand, when the first crisis country has a problem, imports will be impacted directly, which means trade partner exports decline simultaneously. It impacts economic growth of the export countries, and if there is deterioration of foreign trade, it negatively impacts other countries' financial markets.

At the same time, because in the first country currency devaluation occurs during the financial shock, it gives pressure to the importer partner as their goods and services are a relatively higher price than before. This especially carries a global financial crisis to the emerging market economies. The U.S dollar is one of the most critical global currencies, so devaluation of the U.S dollar creates pressure on all other importer economies, most of which are emerging countries.

2.3.4. Financial Linkages

Besides the direct, visible trade channel, financial linkage is one of the main contagion channels as well. The degree of financialization and financial integration partly determines the contagion effects and channels. In their detailed aspects, there are many different passages that propagate contagions (Rigobon, 2002: 46-49).

Common creditor

Kaminsky and Reinhart (2000: 167) argued that when one country in crisis, the common creditor will pull their lending from an economy if they realized or suffered sustained losses or a weakened capital position from the other market. If many common creditors pull out their investment, the economic sectors of that economy have a reverse impact and face a crisis risk.

Interconnected lenders

When a financial crisis starts, the original country's bank reduces the amount of lending and increases the interest rate for lending among banks. This first gives other banks a signal to understand there is a risk or some problems in the banking or financial system, then all other banks follow this behavior because of the liquidity limit as well. It is like the domino phenomena of contagion. Cheung, Tam, and Szeto (2009: 5) give an example to explain this, that there are three international banks called A, B, and C that are in three different countries. Bank A borrows from B, and bank B borrows from Bank C. When the country of Bank A has a shock, it impacts on Bank B and the country that B belongs to, and the same domino effect occurs for Bank C and its country. From the interconnected lenders, financial contagion spreads from one country to another.

Interactions under the market-based financial system

Besides the defaults perspective, based on the market-based financial system, financial contagion can also be transmitted through price changes and measure risks and the market-to-market capital of financial institutions, (Cheung, Tam, and Szeto, 2009: 5). The balance sheet is the barometer of the market, and it immediately responds to asset-price changing. Moreover, it is the direction and sign for the market participants, and they will take actions according to the balance sheet. Because of these reasons, any risk or potential shock is reflected in the balance sheet and can be amplified through the changing of market price. The seriousness of the contagion is impacted by the degree of exposures of the market.

2.3.5. Based On Liquidity Theory

The liquidity constraints play a role in assigning the investment, especially when a financial shock hits one country, and investors withdraw funds from other countries as well. Many of the financial transactions are conducted by international financial agents rather than by principals or individuals.

Portfolio rebalancing due to liquidity limit

Kaminsky and Reinhart (1999: 17-19) stated that financial market contagion could occur during portfolio rebalancing, especially when the aims are due to correlated liquidity shocks. If one economy is in financial shock or potential crisis, and realizes it might need to increase cash for redemption, to rebalance the portfolio and save the market, it will sell assets in other economies. This then propagates the financial shocks to others.

Another case of portfolio rebalancing due to liquidity limit is about the leverage, as Cheung, Tam, and Szeto (2009: 6) pointed out. When one economy in a negative shock, the value of leveraged investors' collateral will decline significantly, and that pushes them to sell part of their holdings in unaffected economies to meet margin calls and solve liquidation needs. The classical example is hedge funds which have higher leverage. If one market looses then it is necessary to decrease the size of this market, then rebalance the portfolio in related markets.

Cheung, Tam, and Szeto (2009: 6) also argued that cross-market hedging is another crucial reason for portfolio rebalancing and a contagion channel. When there is a financial shock, the investor adjusts their portfolio allocation of hedges funds to avoid risks and minimize the losses. They reassign their investment, especially the potential risk holdings, resulting in the leverage ratio declining objectively. This causes a high leverage portfolio liquidity decline and finally shifts the financial contagion by portfolio rebalancing through the cross-market hedging channel.

2.3.6. Investor’s Behavior Theory

Besides the foundation reasons and liquidity base, another factor is the investor's behavior. Although there are some overlapping parts among these theories, there also are some features with different aspects. Dornbusch, Park, and Claessens (2000: 181) argued that whether the investor’s behavior is rational or irrational, specific shocks spread from one country to another, and the difference depends on the scope of rational versus irrational behavior both individually and collectively.

We subdivided investor behavior into five broad categories as Claessens, S., & Forbes, K. (2004: 6) suggested: liquidity problems, incentive problems, informational asymmetries, market coordination problems, and investor reassessment.

2.3.6.1. Liquidity Problem

As mentioned above, the liquidity problem limits the investor's portfolio and total wealth. Investment losses in one market may induce investors to sell off securities in other emerging markets to collect cash in anticipation of higher redemptions.

Besides individual investors, the liquidity problem is also faced by commercial banks. If the bank experiences a marked deterioration in the quality of loans to one country, this may lead them to reduce their exposure to other high- risk investments in other areas, which may possibly include other emerging markets.

There are certain types of investors highly likely to face liquidity driven problems. For instance, highly leveraged investors such as hedge funds, banks facing margin calls, and open-ended fund managers who need to raise liquidity in anticipation of future redemptions (Dornbusch, Park, and Claessens, 2000: 183). This is how the financial contagion spread because of the liquidity problem. Investors sell other market assets in their portfolios to raise liquidity for collapses or problem assets, causing the price of other market assets to go down, and thus transferring the original disturbance from one market to another.

2.3.6.2. Incentive Problems

The incentive structure and risk aversion can induce individual financial agents to sell off several markets at the same time, to restrain the initial crisis. Then the price of the asset declines significantly and the currency of this country depreciates. The model

Value-of-Risk, demonstrated by Schinasi and Smith (2000: 169-170), is applied by many commercial banks to explain the reason for optimal asset decisions during the financial shock to sell most high-risk assets. Although it is rational individual behavior, it still can cause adverse outcomes.

2.3.6.3. Informational Asymmetries

Informational asymmetries and investor expectation are other important reasons for financial contagion. As an individual investor, it is hard to get the whole picture of the financial market for each country's market, because it is costly and impossible to get the latest and most accurate information. Lacking sufficient information, individual investors may expect the crisis to spread to other similar fundamental countries as well. In line with this expectation, they may take some actions to avoid large losses, sell off the asset, and withdraw the investment and so on. Therefore, other countries asset price and the financial market will impact on and influence the expected outcome. Then financial contagion is transferred to other markets.

Calvo and Mendoza (1997) divided investors into informed and uninformed groups. The uninformed investor takes into account decisions made by better-informed investors, and they will also seek new information from the earlier acting investors to reassign their portfolio.

Information asymmetry is caused by the high cost of collecting and processing information. Therefore, as rational investors, they choose to follow informed investors, such as big investment agents and high reputation financial institutions to keep lower costs for acquiring information. This could lead to herd behavior, no matter whether the investors are rational or not. This herd behavior causes more massive capital outflows (Scharfstein and Stein 1990: 477; Wermers 1995: 618-9) during the crisis period, and if the informed investors pulls investment out of the crisis country, then the uninformed investors follow this action by considering the reputation.

2.3.6.4. Multiple Equilibriums

Financial contagion occurs when the crisis market causes another market's equilibriums to move or jump to a bad equilibrium, characterized by significant asset price decline, currency devaluation, capital outflows, or debt default. Changes of investor expectation are self-fulfilling in a financial market subject to multiple equilibriums (Dornbusch, Park and Claessens, 2000: 184-5).

The logic is very similar to the bank run, when there is any information or news about a bank default, the depositor worries about their savings, then two possible equilibriums may result. If the depositors all expect the bank to be unable to repay, they will run to the bank to withdraw their deposit, and then the real bank run might happen. The second equilibrium is good if the depositors trust the bankability and would like to keep their money in a bank, then probably the bank will handle the short time liquidity problem and nothing untoward happens in the end.

In a financial crisis, investor expectations also drive the equilibriums. If they follow others and expect the other emerging markets will also face a crisis and sell off their portfolios, then the capital outflow will be more than it should be, the asset price will go down faster, showing other investors that the crisis is already impacting on a different market, and they will also follow this action. This is like a circle, the final result reaches bad equilibrium, and financial crisis contagion occurs in different emerging markets.

The empirical test for the equilibrium model is not easy because many factors can influence the equilibrium and trigger a crisis. For example, Drazen (2000: 47) demonstrated that political factors played an essential role in the contagion during the 1992-1993 Exchange Rate Mechanism crises.

2.3.6.5. Investor Reassessment

Dornbusch, Park, and Claseesns (2000: 181-2) also concluded another reason could result in contagion if investors change their reassessment of the rules under which international financial transactions occur. If some high credit countries are in crisis or debt default that may increase the concern that other weaker situation countries will follow similar unilateral policies and not repay debt or deposit, then when the number of them increases the international financial institutions (for example, the IMF and European Union, or the country's government financial department), could not bailout creditors as investors expected. Then investors reassess the rule and take into account this factor to adjust their investment.

This happened in financial history, as in the 1998 Russian default and the East Asian financial crisis. In addition, it also happened in the 1998 Brazil crisis Dornbusch, Park, and Claseesns (2000: 185). The IMF has realized itself after being called on to rescue so many countries in liquidity crises that, in the end, it is hard to deal with this problem. Then the liquidity runs from one country to another, and contagion has occurred.

2.4. The Existence And Methodology Of Measurement Of Financial Contagion

Many studies have been conducted with different measures of financial contagion to identify whether contagion occurred after the GFC or not. Seth and Sighania (2017: 393) did a relative comprehensive literature review by synthesizing 104existing studies on financial contagion from 1996 to 2016 according to the research methodology, country of origin, data characters, publication information, and type of sectors.

They stated that among the 104 research papers they reviewed (Table 2.1), DCC-GARCH model is the majority and most frequently model applied for a contagion study.

Then the correlation and regression models, Granger causality, and VAR analysis are the second most common frequency models. The third level, less than 10 percent among all studies, is the regime switching model or Markov switching model, latent factor model, variance decomposition model, and vector error correction model (VECM). Besides these widely applied methods, there are also some studies that applied wavelet analysis, Ordinary Least Square, co-skewness, co-Kurtosis from the probabilities aspect, and Principal Compensate Analysis Parameter Stability model, Capital Asset Pricing Model (CAPM), and Flight-to-quality, etc. to contagion research.

Table 2. 1: Review Of The Tools/Methodology For Previous Studies

Tools or Methodology Used	**No. of time**	**Percentage**
DCC	26	14.94
GARCH (univariate or bivariate)	26	14.94
Others*	25	14.37
correlation	22	12.64
Regression analysis	13	7.47
Granger causality test	10	5.75
Vector Autoregression (VAR) analysis	10	5.75
Factor model	7	4.02
BEKK-GARCH	6	3.45
Johansen cointegration	6	3.45
impulse response	6	3.45
Markova switching model or regime switching model	5	2.87
Latent factor model	5	2.87
Variance Decomposition Model	5	2.87
Vector Error Correction Model	2	1.15

*Note: others * includes wavelet analysis, Ordinary Least Square, co-skewness, co-kurtosis, Principal compensate analysis, Parameter Stability model, CAPM, Flight-to-quality, etc.*

To measure contagion, there are a series of econometric methods that are still developing and improving by detecting and correcting bias. There are almost two stages or generations about methods in financial contagion studies. The main difference is if it considers the heteroskedasticity, endogeneity and omitted variables.

The first significant contagion study was King and Wadhwani (1990: 5) that supported the contagion effects in almost all stock markets after the 1987 stock market crash between the U.S, UK and Japan. In that study, they used stock indexes by testing cross-market correlations and found a significant increase in the correlations after the U.S. crash. Calvo and Reinhart (1996: 8-10) used this approach and found Asian and Latin America emerging market stock and equity price correlation increased significantly after the 1994 Mexico crisis by the spillover effects, which was interpreted as contagion.

A similar methodology and framework were applied to investigate the contagion effect on emerging markets include the stock market, currency prices, interest rate, and sovereign spread during the 1997 East Asia Crisis between the financial markets of Thailand, Malaysia, Indonesia, Korea and the Philippines by Baig and Goldfajn (1998). They found evidence of cross-border contagion in the currency and equity market after controlling for owner country news and other fundamentals. Their research confirmed that correlation cross markets significantly increased during the crisis for many of the countries; furthermore, they noted that credible policy actions can influence this type of contagion significantly.

However, Forbes and Rigobon (2002) challenged these methods as biased, concluding by pointing out that the correlation coefficients methodology applied in the studies may be biased because of heteroskedasticity. The simple linear framework may not show the real reason for the correlation coefficients increasing and that indicate contagion, since heteroskedasticity and other econometric problems could cause the same results. The conclusion could not reveal the real reasons for correlation changing being due to contagion or the problems of methods. They pointed out that it may bias results if the data has heteroskedasticity, endogeneity and/or omitted variables problems.

Forbes and Rigobon (2002) posted a new method of correcting the heteroskedasticity problem by adjusting the cross-market correlation coefficients (hereafter, FR's test). By applying this method, they found that no contagion existed during the1987 U.S. stock market crash, 1994 Mexican peso crisis, and the 1997 East Asian crisis. Instead of contagion, they concluded that "there is no contagion, only interdependence". The found that there was a continuation of strong global cross-market linkages that caused the high level of market co-movement during the crises periods.

However, Li (2009: 3) pointed out that although there is no heteroskedasticity problem of Forbes and Rigobon (2002), there are still limitations of the assumption of bivariate normal distribution between the two markets and there are omitted variables and endogeneity. Therefore, Forbes and Rigobon's (2002) correlation-adjusted test is not an appropriate and accurate model to measure contagion as well. They pointed out that the increasing of asset-price correlation was also led by omitted variables, such as economic fundamentals, risk perceptions, and preference. There is no way to tell whether the change was because of the contagion or omitted variables. Moreover, it is also hard to measure non-linear dependence if it is just based on the normality distribution.

Therefore, Li (2009: 9) applied a rank-based approach called Kendall's tau for financial contagion based on a non-parametric correlation. Since the non-parametric correlation is based on the measure of the concordance between two variables instead of related to the variance that reflects the direction of their co-movement, so the method avoids the heteroskedasticity problem. In addition, the improvement and advantages are that Li's (2009: 4) test does not rely on the given probability distribution assumption, so it allows for maximal flexibility in fitting into the data. Moreover, compared to the FR's test in terms of the omitted variables, there is no restriction that existence of a regression relationship is between variables or not.

Furthermore, Li (2009: 7-8) applied a ranked correlation coefficient test to a variety of recent financial crises to the Canadian banking system and found that financial contagion existed during the 1987 U.S. stock market crash, and 1997 East Asian crisis and 2007 subprime crisis, but there was no evidence from the 1994 Mexican peso crisis, although contagion occurred in Argentina, Brazil and Chile. It also found that the most recent 2007 subprime crisis had more persistent and stronger contagion than others.

Gravelle, Kichian, and Morley (2006: 409) specify a Markov regime – switching model that has three features to test shift-contagion for currency returns of developed countries and bond returns for the emerging market. It identified the volatility of common shocks by structural transmission. One of the notable advantages is that the timing of volatility in endogenously estimated instead of being exogenously assigned.

A new model wavelet-based multi-scale correlation was proposed by Gallegati (2012: 3492-4) for stock market contagion studies of the U.S. subprime crisis. Ranta (2013) extended and applied this approach to analyze the contagion of different crisis episodes for the world stock markets. However, those studied ignores the heteroscedasticity bias due to market volatility, and they focused on correlation changes between the pre-crisis and crisis periods at different time scales.

Wang et al. (2017: 163-164) extended the multiscale approach developed by Zebende (2011), which adjusted the multiscale correlation coefficient (MCC) by considering that volatility was changing and heteroskedasticity bias, and also by quantifying the level of correlation between two-time series at different time scales. They contributed to the contagion literature that the occurrence of stock market contagion during GFC depends on the time scale as well as the recipient countries.

Da Silva et al. (2016) applied this MCC to investigate the 2008 GFC contagion effect between G7 countries in terms of GDP. In their study, they investigated whether there was contagion from the US to G7 and BRIC countries or not during the GFC by developing a multiscale FR statistic, and applied daily data from September 1995 to

January 2013 divided into two periods by the crisis. The empirical finding is different from previous studies due to the method that can be used with different time scales. The FR statistics displayed the clear contagion during the global financial crisis from the US to other G7 countries, except for Japan, and to BRIC counties except for Russia and India at the beginning periods. The important and different finding is that contagion existed from the US to Japan, China, and Brazil when the time scale was larger than 50 days or more.

Mollah, Quoreshi and Zafirov (2016: 153) applied bi-variate conditional correlations with the Fisher Z transformation test to confirmed contagion in 19 (30) countries during the GFC, and these results also support previous studies of Chiang et al. (2007: 1206) and Hon et al. (2004: 95). In the same paper, Mollah et al. (2016: 155-7) also used unrestricted vector auto regression (VAR) and dynamic conditional correlation to show contagion effects during the GFC, and found evidence for contagion which identified the U.S. as the source of contagion. Furthermore, it pointed out that the benefits of portfolio diversification were significantly decayed.

Dooley and Hutchison (2009) applied a VAR model to 14 emerging markets by focus on CDS spreads using data from 2007-2009 and identified the linkage and high volatility between the US market to selected emerging markets. Dungey and Gajurel (2014: 161) used a latent factor model and found strong evidence of contagion from US equity markets to advanced and emerging economies.

2.4.1 The Literature Review For GARCH Models And DCC

However, there was a heteroskedasticity problem for these studies, Forbes and Rigobon (2002) pointed out, and the reason is that these studies arbitrarily divide the sample into two sub-periods and conclude there is no contagion, only interdependence. Therefore, to avoid the heteroskedasticity bias, the dynamic conditional correlation was validly used by the researchers to study contagion from the financial crisis. GARCH model is one of the favorite and suitable models to apply.

This puzzle was resolved by the Chiang, Jeon and Li (2007), who applied a multivariate AR(1)-DCC-GARCH model on nine Asian stock markets and covered a long time span. Their conclusions provided supportive evidence of a contagion effect during the Asian crisis and herding behavior of investors after the crisis. In their study, they found a higher correlation during and after crisis, where volatility is also increased.

Naoui et al (2010) did a comprehensive study about contagion character and identified three types as a simultaneously common shock, inter-countries trade and financial link, and pure contagion caused by panic movement. This study applied DCC - GARCH model and chose five developed countries and ten emerging countries by using August 2007 to February 2010 stock index daily data to classify the ten emerging counties into three groups by the spillover effects correlation levels. The result shows that Brazil, Mexico, and Argentina had 80% high conditional correlation with the American market during the crisis; India, Malaysia, and Singapore were around 50%.

There are also many findings about the contagion of the US financial crisis to emerging economies. Kim, Kim, & Lee (2015) applied BEKK and multivariate GARCH models to identify the transmission mechanism of the GFC to five emerging Asian countries by estimating dynamic conditional correlations of financial asset returns. They found that non-negligible financial contagion existed from the U.S. to emerging Asian countries but just lasted a short time. At the same time, their study investigated the sovereign CDS premium, Libor-OIS spread, and the amount of foreign order flows in the foreign exchange markets as factors that affect the dynamic conditional correlations significantly.

Specifically, Latin America equity markets in emerging economies are desirable to investors due to the high growth rate. Hwang (2014: 311) found that there was significant contagion from the US financial crisis to four Latin America countries and handout effect was instead short-lived, by employed unconditional correlation coefficient and DCC-GARCH model using 2006-2010 daily data.

China has attracted considerable attention for researchers, due to the particular government interference and the fixed exchange rate system; it seemed insulated from the financial crisis with minimum loss. It is also hard to find out the real impact in the financial market. Kim, Kim, and Lee (2015: 193) exclude China and Hong Kong since the government has much inertial movement, which is unsuitable for the GARCH model. Fortunately, from the latest study Hou and Li (2016) for the first time applied the asymmetric VAR ADCC GARCH approach to reveal transmission from the US to the Chinese futures market was significant, by analysis of sample data from May 16, 2010 to July 31, 2013.

Instead of contagion of the financial crisis into the Chinese financial market being a new finding, most previous research focused on the spillover of the U.S 2008 financial crisis to the industrial and foreign trade sectors. Morrison (2009: 2-4) found that China's economy growth, international trade volume and foreign direct investment and many other sectors were hardly hit by the U.S. financial crisis. The Shanghai Stock market lost nearly two-thirds value from December 31. 2007 to December 31, 2008. Approximately 20 million migrant workers lost jobs in 2008, and the industrial output increase rate dropped 7% from 2008 to 2009.

Financial crisis contagion applies not only to the financial market but also strongly impacts on real economics and even caused the biggest recession since the 1930s. Nikkinen, Saleem and Martikainen (2013: 1469) utilized multivariate GARCH model which indicated that current US subprime crisis volatility spillover effects on BRIC financial market and industrial sector in the full sample and also during the crisis meant especially Russia and India were hardest hit in their equity markets.

Karanasos, Yfanti, and Karoglou (2016) applied vector AR-DCC-FIAPARCH model to eight national stock markets' daily returns from 1998 to 2010, considering the structural breaks of each time series linked to the Asian and Global financial crisis. This model is proved to capture the volatility and correlation process thoroughly compared to more straightforward specifications, (multivariate GARCH with CCC) and provides a complete framework for the analysis of the financial market co-volatility process. They found strong evidence that there is an increased contagion effect between markets during the crisis events due to the higher dynamic correlations. In addition, the continuous herding behavior among investors is depicted as the correlations remain high (they also found a higher association in the recent GFC than the1997 Asian crisis).

Cho and Parhizgari (2008) Applied AR(1)-DCC-GARCH(1,1) model on daily returns of eight East Asian stock markets to detect the mean and median changing of DCCs to analyze the 1997 East Asian financial crisis contagion. In their study, they took Thailand and Hong Kong as the alternative sources of contagion, and after analysis of 14 source-target pairs they concluded that there was an upward trend in DCCs after the breakout date of the crisis.

Syllignakis and Kouretas (2011) provide potential contagion effect evidence between US, Russian, and German and seven Central and East Europe emerging markets by analyzing the weekly stock returns from 1997 to 2009. They use the AR(1)-DCC-GARCH(1,1) model, and found a statistically significant increase in conditional correlation, especially during the 2007-2009 GFC. They demonstrated that domestic and foreign monetary variables and exchange rate movements have a substantial impact on the corresponding conditional correlations. Furthermore, the macroeconomic fundamentals are essential factors in explaining the conditional correlations during the crisis.

Kenourgios and Samitas (2011: 296) consider a long-run conintegrating relationship by applying the asymmetric generalized Dynamic Conditional Correlation Multivariate GARCH, (AG) DCC-GARCH(1,1) model of Cappiello, Engle, and Sheppard (2006: 537) to confirm the increased dynamic correlations between five emerging Balkan stock markets, (Turkey, Romania, Bulgaria, Croatia, and Serbia) and the US and three developed European markets (UK, Germany, and Greece) during the current financial crisis. They conclude the higher stock market interdependence is due to herding behavior during the crisis period.

Kenourgios, Samitas, and Paltalidis (2011: 92) extended financial contagion studies to five recent financial crises from 1995 – 2006 between BRIC (Brazil, Russia, India, and China) and two developed markets (the U.S. and U.K.). The non-linear dynamics approached multivariate regime-switching Gaussian copula model and AG-DCC were applied. It found that a financial contagion effect exists during each studied financial crisis from the source country to others. They proposed an explanation of contagion similar to the "domino effect," and also pointed out that preventing crisis spread is unlikely due to behavioral reasons. Moreover, they provide evidence that the emerging BRIC markets are vulnerable to financial contagion.

More recently, Kenourgios and Padhi (2012: 24) extended their contagion study to nine emerging stock and bond markets and four different crises, namely, the Asian crisis, Russian default, Argentine crisis, and subprime crisis, and Thailand, Czech Republic, Argentina, and the U.S. were selected as the source of the contagion, respectively. For the period between January 1994 to December 2008, Johansen cointegration and VEC analysis is conducted for the entire periods and found long and short-run dynamics in both stock and bond markets for the subprime crisis, the stock market in the Russian and Asian crises. However, no impact was found in the Argentine turmoil. Moreover, AG-DCC analysis provided evidence of contagion in these four crises and also pointed out that the stock market seems to be the transmission mechanism during crises.

Kazi, Guesmi, and Kaabia (2011: 1) use a multivariate DCC-GARCH (1,1) model to investigate the dynamic conditional correlations between seventeen OECD stock market returns before and during the current GFC. The break date detected (01-10-2017) by using the Bai and Perron (2003) structural break test, depend on this whole period from 2002 to 2009 being divided into two periods, pre-crisis and crisis period. The empirical result supports the contagion effect existence of the GFC due to the DCC increasing significantly when the two periods are compared.

More specifically, Kotkatvuori-Örnberg, Nikkinen, and Äijö (2013: 70) investigated the GFC with two special major events - JP Morgan's acquisition of Bear Stearns and the Lehman Brothers' collapse impacting on 50 equity markets form six regions. Multivariate GARCH (1, 1) model was applied after calculated unconditional variance and DCC. The result showed that the current crisis significantly impacted on stock markets' comovements and especially the effect of the Lehman Brothers' collapse is prominent across all regions.

DCC-GARCH is widely used to detect the dynamic relationship in financial markets. Lestano and Kuper (2016: 382) applied (GARCH-DCC) to identify stock markets and foreign exchange markets relationships in the Asian Crisis and GFC by comparing correlation between pre – and post-crises for six Asian countries. They found the correlations were stronger and more significant during the crisis periods.

Baur and Schulze (2005: 22) argued that the correlation coefficient is inadequate for testing and responding to financial contagion since the limitation of the linear measurement and because it is hard to determine a relationship if the contagion is characterized by non-linear changes. Therefore, their study was based on measuring joint movement, namely, joint exceedances (coexceedances) of two financial market returns that were compared with a certain threshold to test the existence of contagion in particular periods by applying the quantile regression (QR) model of Koenker and Bassett (1978) to analyze the behavior of extreme coexceedances for different regimes of coexceedances. Baur and Schulze (2003) applied the quantile regression framework to analyze the Asian crisis in 1997 and found contagion occurred among countries and also across regions.

Luchtenberg and Vu (2015: 178) found strong evidence of the 2008 GFC contagion existing both in emerging markets and mature financial markets by considering uni- and bi-directional contagion applied within a parametric regression framework based on Forbes and Rigobon (2002), Bekaert et al. (2003) and Corsetti et al. (2001, 2005). It applied Dungey et al. (2005: 11) bivariate test, asymmetric GJR-

GARCH model, and measured the effect of contagion from the pre-crisis and during-crisis period. Dummy variables were used to determine whether contagion occurred from one market to another or not. This study investigated 10 stock markets in three geographic regions: North America, Europe and East Asia Pacific. They also found determinants of contagion in both economic fundamentals such as trade structure, interest rates, inflation rates, industrial production, and regional effects, and in the investors' risk aversion.

CHAPTER THREE

AN OVERVIEW OF THE SELECTED EMERGING MARKET ECONOMIES AND THE IMPACTS OF THE GLOBAL FINANCIAL CRISIS ON THEM

In this chapter, we conduct a brief review of emerging countries, from the definition, characters, classification, importance by macroeconomics and financial indicators, and the impacts from global financial crisis perspectives. Notably, we will analyze the significance and development of the selected emerging markets by horizontal and vertical aspects. For each country, we will vertically investigate the development by time, and cross-countries we will use a horizontal view that cross data to see the position, potential, and development of the countries. Through the comparison of countries with the same time section data, we will show the country's overall strengths and weaknesses comprehensively. In addition, we will classify them into different groups by the various indicators, to understand better about the role, possibilities and contagion effect, and channels from the financial crisis.

Moreover, for each indicator, we will analyze the selected 15 emerging markets and the US, especially during the global financial crisis period, to see how GFC impacted on them and to try to explain why this happened as well. We established the structure by the leading economic indicators from two pillars that are economic indicators, and social and welfare indicators (see Table 2). The commercial aspect includes national account, industry structure, and price indicators - three dimensions. The social and welfare element consists of the people and labor market, education and equity indicator sizes to examine the selected emerging market.

3.1. Definition Of The Emerging Country (Market)

There is no consensus definition about an emerging market but if we do a Google search, there are rich results. We will synthesize them at the end of this section and give a definition containing features of the emerging country. An important note is that we do not differentiate the emerging country (market) and the emerging market economy.

According to Richard (2015), the expression “emerging countries” was first coined in the early 1990s as part of the widespread euphoria about the spreading of economic and financial liberalization policies in the developing world.

The International Monetary Fund (IMF) says that “Emerging markets are typically countries with low to middle per capita income that have undertaken economic development and reform programs and have begun to ‘emerge’ as significant players in the global economy.”

Amadeo (2019) from “the balance” defined emerging markets, also called emerging economies or developing countries, are nations that are investing in more productive capacity. They are in the transition process from the traditional economies that have mainly relied on agriculture and raw materials export, toward the developed countries direction. To improve the quality of life is one of the main aims of their leaders. Therefore, they are industrializing rapidly and adopting a free market and mixed economy.

Emerging markets are broadly defined by “the balance” as nations in the process of rapid growth and industrialization. Often, these nations are transitioning to an open market economy with a growing working-age population. The term itself was coined in the 1980s, by Antoine van Agtmeal.

Heakal (2017) in the Investopedia defined the EME according to their characters. EME are transitional economics that are in the process of moving from a closed economy to an open market economy while building accountability within the system, through embarking on an economic reform leading to a country toward a stronger and more responsible economic performance level, and more transparency and efficiency in terms of the capital market. In addition, EMEs experience exchange rate system reform, either changed from a fixed exchange regime to a floating regime or loosening the control of government. It benefits by strengthening investors' confidence and by boosting local investors desire to invest inside the country.

In addition, in the development process, the EME is most-likely receiving aid and guidance from large donor countries or organizations. The EMEs is an attractive destination for investment, local and international. It increases the local economic confidence, takes more attention from the world, and adds volume to the country's stock market and a capital market that can improve the long-term investment to the infrastructure, bring new technology, create more employment opportunities, and finally contribute to economic development.

Besides these popular economic websites, there are many different ways defined emerging market from the researchers' aspect. The Center for Knowledge Societies in a 2008 Emerging Economy Report defines Emerging Economies as those "regions of the world that are experiencing rapid informationalization under conditions of limited or partial industrialization." It implies that an emerging market is at the intersection of non-traditional user behavior, the new user groups, and a community that is rising and adopting products and services, and innovations in product technologies and platforms.

In 2009, the president of the International Academy of Emerging market Dr. Kvint published this definition[2]:

> "Emerging market country is a society transitioning from a dictatorship to a free-market-oriented-economy, with increasing economic freedom, gradual integration with the Global Marketplace and with other members of the GEM (Global Emerging Market), an expanding middle class, improving standards of living, social stability and tolerance, as well as an increase in cooperation with multilateral institutions"

[2]https://www.forbes.com/2008/01/28/kvint-developing-countries-oped-cx_kv_0129kvint.html#e356ad4555b4

The French economist JulienVercueil (2012) recently proposed a pragmatic definition of the "emerging economies," with three characteristics. Firstly, EMEs have intermediate income, namely, the PPP per capita income is between 10% and 75% of the average EU per capita income. Secondly, EMEs have experienced rapid and significant growth during at least the last decade, and because of this catching up growth, the income gap with other economies has narrowed. Thirdly, EMEs seem to be a by-product of current globalization due to the profound institutional transformations and economic openings that integrate them deeply into the world economy.

Different indices included different counties by their criteria. Also, because of globalization, there is no difference from geographic region to classify counties into different groups. The World Bank classifies economies based on their GNI per capita, computed by the "Atlas" method. Thus, there is no single definition for an emerging market.

3.2. Characteristics Of An Emerging Market

From the first definition section, we noticed that many of them defined an emerging market by their common characteristics and have interrelated causal relationships. In all, compared to developed countries, they have a lower income level. This distance makes them share a relatively high and catching–up development rate. According to this, usually, the EMEs has a higher return. However, it will take time to synchronize and adapt rapid social change with the structure and management. Thus, the lag instrument catch-up leads to a high volatility character.

The EM is experiencing the transition process, from a traditional closed system to the open mode, benefiting from various developments and opportunities, but it also has brought high risk and uncertainty. The society is still fragile in the face of global shocks and sensitive to disasters, and political stability presents challenges as well. Investor confidence also changes due to global or regional issues frequently. Below is a detailed explanation.

Lower income level

The per capita income has gaps between emerging countries and developed countries, as EMEs are often in the process of moving from a closed economy to an open market economy. According to the World Bank list, a country withlower-than-average per capita income less than $4,035[3] will be included in the developing countries list. Julien Vercueil used intermediate income defined as PPP per capita income comprised between 10% and 75% of the average EU per capita income.

Rapid growth rate: Catching-up growth

Due to the considerable difference in income level between the advanced and emerging market economy, another character of the emerging market is the rapid growth rate. During the last decade, with the rapid catching up growth rate, the income gap with the advanced economies has narrowed. The rapid changes to a more industrialized economy accelerate the growth rate of the EM. Compared to the most developed countries such as The United States, Germany, the United Kingdom and Japan with a growth rate of less than three percent in 2015, the economic growth rate in EMEs such as China and India was around 7 percent, which kept the rapid growth of the economies.

Higher than average return rate

This rapid growth in the short term leads to a high return in the economic and financial market. It attracts more investors and investment will raise the return rate because commodity price and stock return have increased. For example, in the beginning many EMEs are the export-driven economic growth type, and the cost of production in their country is low due to having enough population to provide a lower cost labor force, so they bring higher growth rate and profit. It leads to stock price increasing and attracts more investors, that in turn increases price and the returns from stocks and bonds.

[3] https://www.thebalance.com/what-are-emerging-markets-3305927

Therefore, they usually have a good balance of payments and a growing labor market. The consequence of the higher return rate makes the EM more attractive and accelerates growth, and it seems to be a virtuous cycle.

Transitional economy

An emerging market is in the process of transition in many dimensions. This includes the primary demographic characters, such as fertility rates, life expectancy, and educational status and so on. Usually, the population is younger and keeps growing, and the advantage is the young generate more activity in terms of production and consumption compared to ageing workers in the long run. The disadvantage is the negative role of increased risk of political instability and other social problems.

Especially, EME is in the transition process in the nature and depth of their economic, financial and political structures and institutions. Mody (2004: 4) also emphasized that capital markets are in a transition to greater integration and international features. Because of the transition process, immaturity is the specific character of EM, and this immature feature causes high risk and volatility. In addition, the development of fundamental infrastructure takes time to build and cannot catch up with the speed of growth at the beginning, which causes mismatch problems.

Emerging market economies are experiencing the transformation of integration and globalization procedures. Globalization eliminates distance geographically and regionally. Institutional alterations and economic opening simultaneously result in integration of emerging markets into the world economy deeply. The transformation from a closed market to the open market accelerates the integration of the different markets and countries.

High volatility

The rapid growth rate and social changes lead to another common character which is high volatility. EMEs usually focus on a rapid growth rate during the industrialization process, but other policies are not maturing simultaneously. Volatility often comes from three main factors: natural disasters, external price shocks, and domestic policy instability (Moda, 2004: 5).

Natural disasters are uncontrollable factors because many of the EMs are traditionally reliant on agriculture and highly sensitive to natural disasters. For instance, earthquakes in Haiti, tsunamis in Thailand, or droughts in Sudan. However, Mody (2004: 5) stated that even these volatility impacts could be mitigated if prevention and disaster management measures are in place. It is a mismatching of maturity policies and the growth speed.

The EME is susceptible to volatility of external price changes due to being in the transition process. For example, currency swings or commodities price swings. Many of them are too new and have weak power to control or influence the price. The balance[4] takes an example: in 2008, U.S. subsidized corn ethanol production resulted in the oil and food price skyrocketing. This caused many emerging countries to experience food riots. Also, many EMs are export-led, such as China, and the exchange rate changing directly impacts on international trade. Especially in the financial market, if the U.S. stock price changes or U.S. interest rates change, the price of most EME will be affected.

Policy instability

Kaminsky, Reinhard, and Vegh (2004: 31) pointed out that emerging government’s policies are “procyclical" that reinforce economic booms and aggravate recession, rather than acting as stabilizing forces. The EME policy is still immature, with perceived arbitrariness in policymaking. An unstable system hurts the growth rate

[4] https://www.thebalance.com/what-are-emerging-markets-3305927

because it impacts on investor confidence and long-term investment decisions on assets (Mody, 2004: 5). For example, the policy for FDI, essential for the capital market, means that if the policies are always changing, then the attractiveness of investment will decrease.

In sum, the definition of emerging market economies can be given according to the common characteristics: an economy in the transmission process from lower income to advanced income level, experiencing economic and political transition from a closed system to an open system with many reforms. It has a rapid growth rate usually followed by a high return rate and meanwhile a high level of risk and volatility, and is sensitive to policy changes and global or regional shocks. The maturity, infrastructure and policy matching are taking time to catch up with the rapid growth rate.

3.3. The Classification Of The Selected Emerging Markets

With the strengthening and increasingly important role of emerging markets in international economic and political status, there are more and more studies on them. Many new classifications, groups and new terms are continually developing. An example is BRIC, that stands for Brazil, Russia, India, and China; BRICET, that represents the BRIC plus Eastern Europe and Turkey, and BRICS, which means BRIC plus South Africa, and BRICM stands for BRIC plus Mexico. Added to this, there are MINT, Next Eleven, CIVETS and so on.

There are many different indexes which include a list for emerging market depending on their criteria. The most popular and widely accepted are IMF, BRICS+ Next eleven, FTST, MSCI, S&P, EM bond index, Dow Jones, Russell, and Columbia University EMGP. There is no commonly agreed upon emerging countries list, and there are some good performance EMs that appear on every list, such as BRICS, Mexico, and Turkey.

Considering the above reasons, we selected the emerging economies in our study from among these common lists. Therefore, 15 emerging economics were chosen, and they are Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, the Philippines, Poland, Peru, Russia, South Africa, Thailand, and Turkey. Geographically, our selected EMs countries belong to ASEAN (Indonesia, Malaysia, Philippines, Thailand), Emerging Europe (Poland, Russia, Turkey, and Hungary), Latin America (Brazil, Chile, and Mexico), and South Asia.

3.4. A Review Of Selected Emerging Market Economies

In this section, we will do a general review for the 15 selected emerging markets and the US, from two pillars, namely economic indicators and social and welfare indicators. The commercial aspect includes national account, industry structure, and price indicators (three dimensions). The social and welfare aspect consists of the people and labor market, education and equity indicator dimensions to examine the selected emerging market. The structure is as below in Table 3.1.

Table 3.1: Structure Of The Selected Countries' Economic Indicators

Economic Indicators	National Account	GDP GDP growth rate GDP per capita consumption Net Export -- Import good and service of GDP Import good and service of GDP Foreign Direct Investment Gross domestic saving (% of GDP) Total Capital Formation (% of GDP) Tax Revenue of GDP International reserve
	Industry structure	Primary Industry (% of GDP) Secondary Industry (%GDP) Tertiary Industry (% GDP)
	Price	Consumer Price Index Real effective exchange rate Inflation Real Interest rate Tariff rate
Social & Welfare Indicators	People and Labor Market	Population Population growth rate unemployment rate dependency ratio total labor force labor force participation rate
	poor & equity	poverty headcount GINI Index
	Education	HDI Education Index Literacy rate R&D

Source: by the author.

Below we provide detailed information about the main macroeconomic indicators, the dates mostly coming from the World Bank, IMF, OECD database, CFA report, and other research publications. The periods cover from 2000 to 2015. In order to keep the whole study unified, we apply the World Bank's abbreviation as the standard for the country. Brazil (BRA), China(CHN), Colombia (COL), Hungary (HUN), Indonesia (IDN), India (IND), Mexico (MEX), Malaysia (MYS), Peru (PER), the Philippines (PHL), Poland (POL), Russia (RUS), Thailand (THA), Turkey (TUR), South Africa (ZAF), and United States (USA).

3.4.1. Major Economic Indicators Of Development And The Impacts From The GFC

The importance of emerging market economies is increasing significantly. In the last ten years, emerging economies have contributed more than 50% of world economic growth. In particular, after the 2008 GFC, the EMs became the recovery powerhouse, and not only contributed more than 70% to global economic growth but also increased their position and influence in the world economy. According to IMF data, in the world economy, the proportion of emerging economies rose from 23.6% in 2000 to 41% in 2012, purchasing power parity (PPP) increased from 40.7% to 53.7%, the international trade ratio rose from 15% to 40% and the proportion of EM global FDI inflows rose from 32% in 2007 to 58% in 2012.

Further, PwC announced at the beginning of 2013, in terms of GDP measured in purchasing power parity, the emerging markets and developing economies would be bigger than advanced economies in fact. Meanwhile, the BRICK four EM play an essential role in world economic growth, notably China and India developed very fast in ICT, biotechnology and nanotechnology fields, helping them to edge ahead of competitive economies.

Moreover, through these important indicators, we will analyze why the GFC 2007-2009 was witnessed as the worst financial crisis since the 1930s depression, and ask how it has influenced the emerging market economies. Tin the global economic downturn amid the deepening global financial crisis, the EMs experienced sharply slowing growth and increased vulnerabilities.

3.4.2. Overview Of The Selected Emerging Market

Based on the economic indicators we selected in the table 2, we will do a brief review for the selected 16 economies. In addition, we will see the consequences of the impacts from GFC to them.

3.4.2.1. GDP, GDP Growth Rate And Per Capita

According to the World Bank GDP 2015 data, China (11.06 trillion USD) and India (2.09 trillion USD) are the most prominent emerging economies, followed by a second group of Brazil (1.80 trillion USD), Russia (1.37 trillion USD) and Mexico (1.15 trillion USD). The next group at less than a trillion USD is Indonesia and Turkey, and their GDP was 861.256 billion USD and 859.794 billion USD respectively. Then Poland (477.279 billion USD), Thailand (399.235 billion USD), South Africa (317.611 billion USD), Malaysia (294.434 billion USD), the Philippines (292.774 billion USD), and Colombia (291.520 billion USD) GDPs were between 290 billion USD and 500 billion USD. Peru and Hungary's GDP were 189.212 and 122.879 billion USD, the last two places among the selected EMs.

For each selected individual EMs, from the GDP Figure 3.1, we can see that their economy expanded from 2000 to 2015 with a significant steady increase upward trend, and among them, China, Russia, Indonesia, and India's GDP expanded 9.13, 5.26, 4.9 and 4.52 times. All others enlarged their economies. However, the GFC impacted on all of them more or less, except China and India, as we can see from the Figure 3.1 gray shaded part. GDP has a drop during 2007-09, and then economies recovered from 2009 or 2010.

One of the powerful advantages of the selected EMEs is that during 2007-2009, most of them had positive economic growth, especially China and Indonesia. Their GDP rose 43.85 and 24.84% during the GFC. Brazil, Peru, Colombia, the Philippines, and India had more than a 10% increased. Thailand, Malaysia and Poland‘s economies also got more prominent but at less than 10%. The biggest negative influences were in Mexico (-14.23%), Hungary (-6.619%), Russia (-5.93%), Turkey (-4.61%) and South Africa (-0.61%).drop in their GDP.

Notably, China as the biggest EME is the primary driver of emerging market strength. China is the second biggest economy in the world in terms of GDP and the largest exporter of tradable goods. Although China's growth slowed down from more than 10% in 2010 to around 8% in 2012 and 7% around 2015, it is still at a sustainable level. Because China, even though in the transition process, is projected a soft landing with a GDP growth rate close to 8%. Also, China's investment share of GDP is close to 48%, one of the peaks in economic history. Furthermore, China still has massive foreign exchange reserves of US$3.3 trillion in 2016, almost half of the whole emerging economies international reserves (Hale, 2012: 43).

3.4.2.2. GDP Growth Rate

Another important character for the emerging market is the real GDP growth rate. The real GDP growth rate of selected EMs, the US, and advanced countries indicated the same pattern (Figure 3.1), which rapidly fell during the GFC, the advanced and emerging economies dropped by -3.4% and -1.335% respectively. Our selected emerging markets grew faster, the average is 4.07% from 2000 to 2015, but the advanced economies were only 1.838%. Therefore, from the economic growth aspect, EMs is the world economy driver and recovery engine.

We can divide the selected 15 emerging economies into two groups by the real GDP growth rate, using the average rate from 2000 to 2015 compared to 5% as the criteria. China (9.593%), India (7.077%), Indonesia (5.307%), Turkey (5.237%), Peru (5.169%), Malaysia (5.122%), and the Philippines (5.113%) are in the same group, others can be classified in another one which has less than 5 % GDP growth rate.

China and India as the two biggest emerging markets had an average annual real GDP growth rate of 9.593% and 7.077% respectively. In the first decade of the 2000s, China's economic growth was more than 10%, which shocked the world and attracted global attention. Even during the GFC, as the steadiest and most prominent economy in the emerging market, China had around a 10% GDP growth rate, whereas the advanced economies were suffering negative growth. After 2012, the Chinese economy slowed down and entered more steady and sustainable growth pattern.

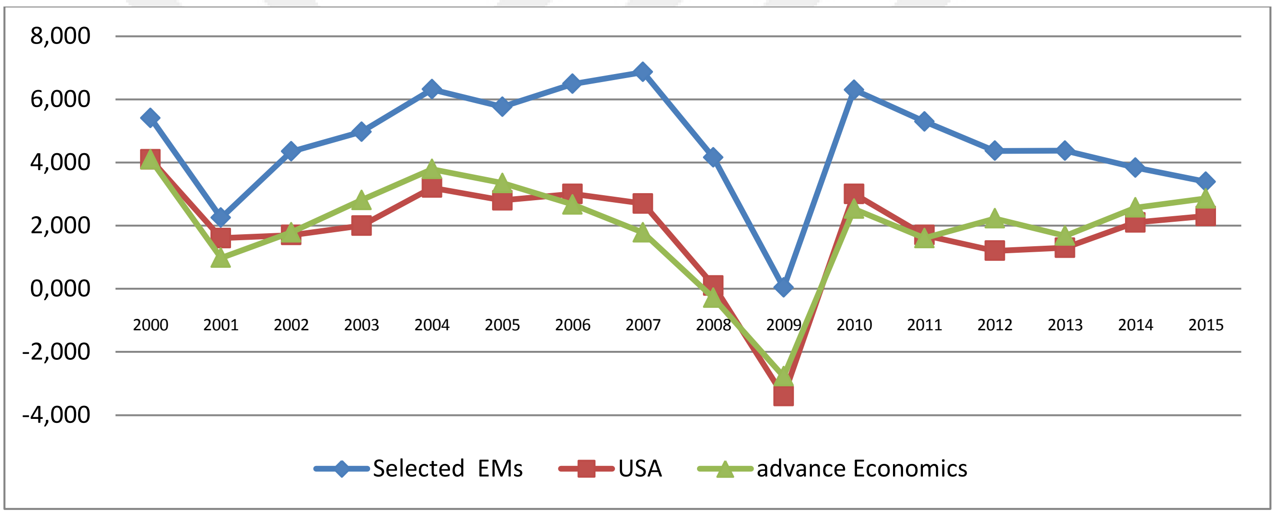

Figure 3. 1: GDP Growth Rate, Emes, USA And Advance Economies 2000-2015.

Data: advance countries from IMF, EMs calculated by author.

In this first group, Turkey has the most significant fluctuation rate, especially during the crisis time, with GDP growth dramatically declined in the 2001 Turkish crisis and 2008-2009 GFC. Malaysia had a similar pattern to Turkey. India seemed the steadiest EMs in terms of growth.

Russia was the most impacted one from GFC. The GDP growth rate 5.248% in 2008 dramatically dropped to -7.821%. Others that had a negative growth rate in 2009 are Hungary (-6.60%), Turkey (-4.704%), Mexico (-4.700%), Malaysia (-2.526%), South Africa (-1.538%), Thailand (-0.691%) and Brazil (-0.126%). The others had positive growth, especially China (9.400%), and India (8.480%) [5] had very good performances.

The main problem for South Africa was the narrow GDP growth rate and higher inflation rate. The South African economy slowed down from 2011 and the GDP and growth rate both went down. Until 2015, the GDP was 314.7 billion USD. The real GDP growth rate had big fluctuation from 2.7% in 2000, increased to a peak of 5.6% before the GFC in 2008, and after that dramatically declined to -1.54%, recovering to 3% in 2010. However, the GDP growth rate stayed downward from 2011, was around 1.3% in 2015 and the per capita income is the highest in Africa.

Poland is an emerging European market and a member of the European Union (EU), and the only European country that kept continuous GDP growth from 2009 through 2017, although with a fluctuating growth rate. Especially after 2011, with the European crisis, the growth rate went down from 5% in 2011 to around 1.4% in 2013, and then rose again. The GDP value reached a peak in 2008 and then suddenly went down since the GFC, steadily growing again after 2009.

Table 3.2 shows the sharp decline of the real GDP growth rate of all selected EMs for individual economies and the world level. From the Figure 3.1 on GDP, the trend of the growth rate looks like a downward arrow from 2007 to 2010. We can generally classify selected EMs into three different groups by the economic growth rate pattern. Most of the selected EM showed a sharp decline in growth rate from 2007 to 2009, and reach bottom in 2009. The slope of the decline from 2008 is very deep, and it illustrates that the economic growth of those EMEs' economic growth rapidly slowed down during the GFC. Those countries are Thailand, Malaysia, South Africa, China, Russia, Turkey, and Hungry.

[5] The brackets is the 2009 real GDP growth rate in this paragraph.

Table 3.2: GDP Growth Rate And The Rate Of Change

GDP growth rate and the rate of change					
Country Name	ave 00-06	2007	2008	2009	ave10-11
Brazil	3.232	6.070	5.094	-0.126	2.484
Chile	5.014	4.905	3.530	-1.564	0.983
China	10.032	14.231	9.654	9.400	9.527
Colombia	4.180	6.901	3.547	1.652	2.599
Hungary	4.239	0.435	0.856	-6.600	-2.872
India	6.686	9.801	3.891	8.480	6.185
Indonesia	4.867	6.345	6.014	4.629	5.321
Malaysia	5.465	9.428	3.320	-2.526	0.397
Peru	4.529	8.518	9.127	1.096	5.111
Philippines	4.663	6.617	4.153	1.148	2.651
Poland	3.746	7.035	4.250	2.820	3.535
Russian	6.977	8.535	5.248	-7.821	-1.286
South Africa	4.135	5.360	3.191	-1.538	0.826
Thailand	5.240	5.435	1.726	-0.691	0.517
Turkey	5.497	5.030	0.845	-4.704	-1.930

Note: Data from the World Bank and calculated by the author.

The second group includes Poland, Colombia, the Philippines, Peru, and Brazil. In these countries the economic growth rate decreased between 35% to 100%. China and India show a different growth pattern, their GDP growth rate decreased relatively steadily and reached the bottom at 3.89% at the beginning of 2008 and then rebounded, especially for India, the GDP growth rate increasing even when other EMs continually went down. Their economies kept positive growth even in the GFC, which also shows the emerging market growth power as the engine of recovery in global economics.

If we consider the net growth rate decline range, we see Russia had the most significant net decline (-16.36%) within the selected EMs, followed by Malaysia (-

19.95%), and Turkey (-9.73%), whereas, India (-1.32%), Indonesia (-1.72%), Poland (-4.21%), and China (-4.83%) had considerably smaller declines. The other selected countries have considerable decline rates from 5% to 10%. This is also a reason we focus on the emerging market, and we want to see how the difference matters for EMs.

3.4.4.3. Per capita GDP

Although some countries had superior GDP, when we consider the number of people, the picture changes and may not indicate prosperity. Thus, per capita GDP measures the total output of a country by examining the number of people, the standard of living level, and the productivity of the country. That is, a rise of per capita GDP in a country indicates the growth of the economy and an increase of productivity as well. There are vast differences in per capita GDP between developed and emerging markets, even among the EMs. For example, in 2015 the USA has 56469.01 USD per capita GDP; the top in our selected EMs Poland only had 12564.48 USD, almost 4.5 times less than the USA. Hungary and Turkey also had good performance with 12564.484 and 12483.866 USD in 2015.

The GDP per capita Figure 3.2 shows the order of the selected EMs in terms of per capita GDP, although China had the most significant total output but when we consider the enormous population, it is just in the middle, 8069.21 USD in 2015, and even India was the last ranked with only 1596.47 USD. The difference between them is considerable. Indonesia and the Philippines also have less than 3500 USD per capita GDP. Malaysia, Russia, Mexico, Brazil, and China are in the second group with 8000 - 10000 GDP per capita, followed by Colombia, Peru, Thailand, South Africa with between 5700 and 6200 USD per capita GDP.

From Figure 3.2 the difference is shown by bar shape, the increased level from 2015 to the average covers 2000 to 2015. China increased the most during these 15 years, around 4370.55 USD more, followed by Poland, Turkey and Malaysia which increased more than 2000 USD. The group that rose less than 1000 USD included Russia, Mexico, India, and South Arica. Therefore, the increased range and rate can be used to measure the development, with a greater increase indicating greater improvement. Thus from our data, China, Poland, Turkey, Malaysia, Peru, Thailand, and Colombia's standard of living and productivity increased significantly from 2000 to 2015.

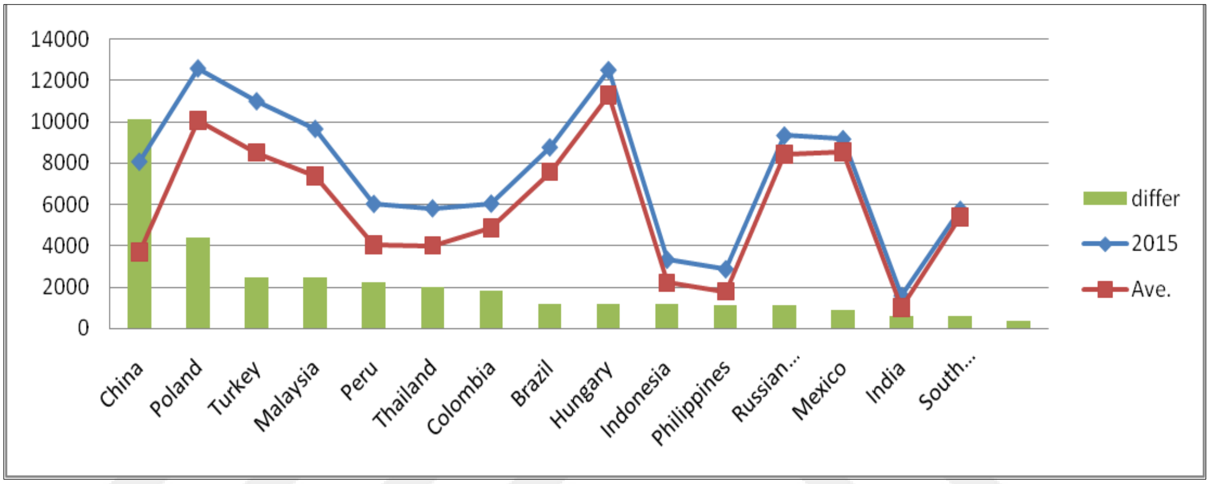

Figure 3. 2: GDP Per Capita 2015 For Selected Emerging Economies

3.4.4.4. Consumption

Consumption here means the household final consumption expenditure that is the market value of goods and services purchased by households and it can imply the economic situation. When the economy is good, people are more vibrant and like to spend money; in contrast, people do not spend more money during an economic downturn, because their income is also down.

According to the consumption, except Hungary, all other 14 selected EMEs have an increasing trend from 2000 to 2015. BRIC had the top four consumption among the 15 emerging markets. Hungary had a much steeper increase in its rate of consumption before the GFC, but after it went down and has not to recover back to the same level before the GFC.

Besides classifying them by size, we can also sort them by whether the GFC had an impact on them or not. China, Brazil, India, Indonesia, the Philippines, and Poland did not decrease significantly, but other EMs was all influenced by the GFC. Hungary and Mexico dropped the most at -6.636% and -6.458% from 2009 to 2008, respectively. Russia was also impacted a lot and consumption went down 5.127%. Turkey and South Africa were also negatively influenced and declined by 3.723% and 2.591%, respectively. Thailand dropped slightly by 0.899%. Although Malaysia and Colombia only had 0.554% and 0.567% rises, still it was positive.

3.4.4.5. International Trade: Balance Of Payment, Export And Import

Foreign trade

Foreign trade, as one of the crucial financial contagion channels, is very sensitive to a financial crisis. Many of the emerging markets more or less rely on international trade for development and were impacted significantly by the GFC. From the demand side, the advanced economies decreased which led to export falls for EMs. The world level value export dropped from 19.68 trillion in mid-2007 to 15.85 trillion in 2009, approximately 20% decline.

Figure 3.2 shows that except Turkey, all selected EMEs net export of goods and services negatively increased from 2007 to 2009, with the most influenced countries the export-led economies such as Malaysia, China, the Philippines, South Africa, and Thailand.

The export pattern is very similar among the selected EMs. There was a sharp decline from 2008 to 2009 for all. Russia was the most significant decline in terms of exported goods and services, approximately 35% from 2008 to 2009, followed by Hungry (-22.43%), Brazil (-21.18%), Malaysia (-19.49%), Poland (-18.98%), South Africa (-18.88%) and Turkey (16.59%). India was the least impacted economy and exports decreased 5.24%.The other selected EMs all declined between 10 to 16%.

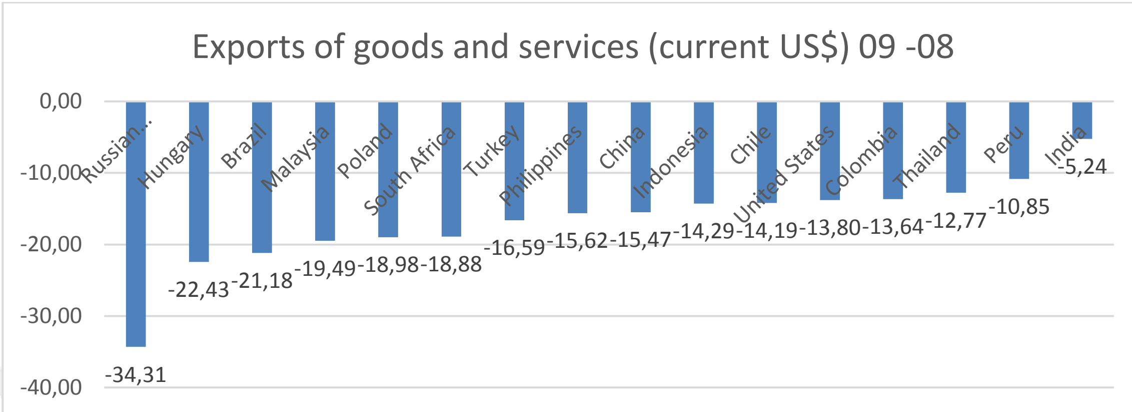

Figure 3. 3: Difference Of Export Of Goods And Services (Current Us$) Between 2008 And 2009

The pattern of imports also had a similar strong pattern for all selected EMs. They all dropped from 2008 to 2009, among them Russia (-30.4%), Thailand (-20.77%), South Africa (-17.66%), Chile (-16.61%) and Peru (-15.94%). From the Figure 3.3, which shows the difference between import and export of goods and services percentage of GDP, indicates that imports decline was indeed more extensive than the export decline in terms of the percentage of GDP. Therefore, imports were impacted more than exports by the GFC.

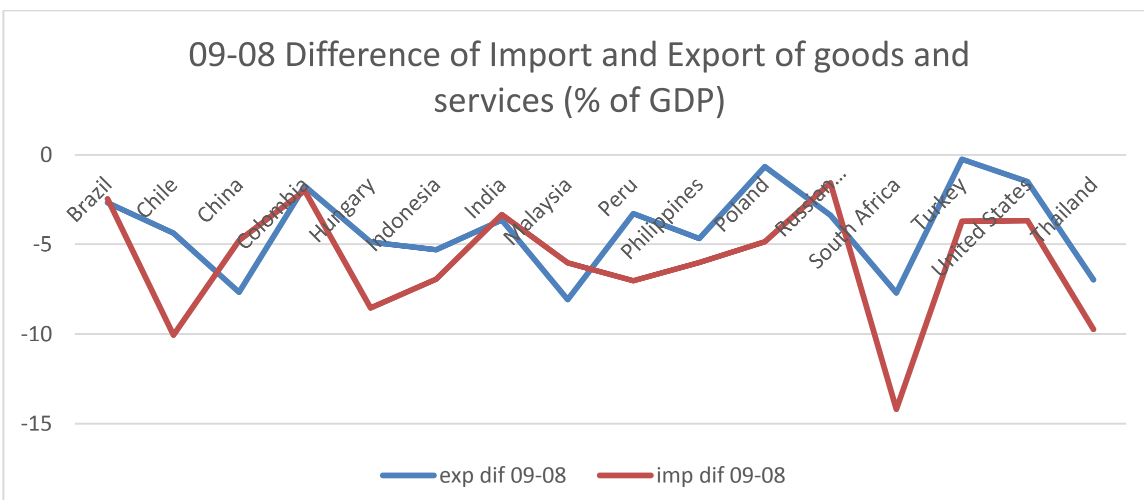

Figure 3.4: Difference Of Import And Export Of Goods And Services Between 09 And 08 Of Selected Emerging Economies

In terms of the percentage volume of exports of goods and services in 2009, except for Indonesia (5.81%) which had a positive change rate in 2009, all other selected EMs in our study showed a detrimental decrease in exports. The largest export decline occurred in South Africa (-17.02%), Thailand (-12.14%), Hungry (-11.40%), China (-11.30%) and Malaysia (-10.47%). In contrast, the GFC had the smallest impact on the export volume of Peru (-0.054%), compared to other emerging economies that lie between a two to ten percentage decline, such as Brazil (-8.69%), Russia (-6.74%), Poland (-6.28%), the Philippines (-5.49%), Turkey (-5.25%), Chile (-4.37%), India (-3.57%), and Colombia (-2.85%).

There are weaknesses for the Chinese economy in terms of international trade. It relies on exports and high real estate for residence for example. European and U.S. markets are the primary two export markets for China. Until 2012 more than 20% of China's exports were to Europe and 18% were to the U.S. Therefore, if these two markets' demand decreases for any reason, it directly negatively impacts on Chinese exports. If this happens, many aspects of the Chinese economy are affected. The speed of development slows down and international reserves face challenges. The other one, real estate, plays an increasingly important role in GDP growth. The high and rising housing price has encouraged more people to invest in real estate, although the government has taken many measures and new policies to control prices.

The relationship between emerging markets is multidirectional. For example, China is one of the biggest export EMEs, and at the same time, many other EMs relies on China's principal of the commodity. To meet the faster development of the economy, China is a big importer as well. Until 2012, China accounted for 40% of global copper consumption, much more than the total of U.S and Europe at 28%. Therefore, if China as the leading emerging economy were to spiral into a downturn, the global economy would be shocked through a commodity price collapse, which would transfer to Africa, Latin America, other Asian counties, and so on which rely on commodities.

Another critical indicator of emerging market economies is international trade, exports and imports. From the Figure 3.3, export of goods and services**,** we can see the reliance of economies on exports. Malaysia relies heavily on exports. Until the 2007 GFC, the net export ratio of GDP was more than 100%, and the average was 111.5% from 2000- 2007. The GFC impacted a lot on the exports of the whole world, and the export trend fell from 2008 until 2015 when exports accounted for 70% of GDP, still in the top among our selected countries.

According to IMF data, the absolute value of Malaysia's exports increased from 94,060.53 USD in 2002 to 199,041.10 USD in 2012, and it reached a peak before the GFC in 2008 of 198,755 USD, then had a sharp decline of more than 26% from 2008 to 2009 at 156,765.09 USD, but after that recovered again with an upward pattern. However, according to the World Bank data, the export of goods and services percentage of GDP decreased from 120% of GDP in 2000 to 70% of GDP in 2015. Therefore, the real value of goods and services increased but took less ratio of GDP, showing that the reliance on exports decreased. The major export and import markets included Singapore, China, the U.S. EU, and Japan.

Malaysia is a trade-dependent country; therefore, many preferential policies encourage international trade. For instance, Malaysia is a member of the World Trade Organization (WTO), and it adopts a liberal trade regime. There are no particular restrictions on free trade for companies. Import tariffs are mostly imposed on an ad valorem basis, with around 6.1% the average applied duty rate. According to the market profile of Research, 77% of non-agricultural imports were duty-free, and many products related to raw materials, and machinery and essential foodstuffs are subject to a lower duty rate. From the import aspect, the import tariff on a wide range of items has been abolished, such as manufacturing materials, including raw materials, components, equipment, and machinery, etc. Regional and global trade integration has been progressively carried out in a step-by-step manner.

Besides the WTO, Malaysia is also the membership of the ASEAN Economic Community, and under the Common Effective Preferential Tariffs (CEPT) scheme it benefits from only 0-5% import duties among the ASEAN. Furthermore, Malaysia has continued to participate in a wide free trade arrangement (FTAs). Bilateral FTAs, regional free trade agreement, economic partnership, and so on all exist. The country policy is to facilitate and support foreign trade; therefore, the percentage of export goods and services form of GDP is very high.

Other EMs having higher export goods and service ratio of GDP are Hungary and Thailand. The average percentages from 2000-2015 are 74.49% and 66.98% respectively. In particular, Hungary's export goods and service percentage increased by 35.3% during these 15 years. It as the emerging European market, and many EU countries from 2004 adopted the EU's common external trade policies and measures among the 28 member states.

Thailand is also one of the export-led Asian emerging countries. From the percentage of the export goods and services of GDP, we can understand that the financial crisis affected exports significantly. There were two dramatic declines from 2000 to 2015. The first one was 2000-2002, the time of Asian crisis, when the ratio of exports went down to the bottom at around 60% of GDP, after that it increased to a peak in 2008, then sharply declined by 10% to the lowest point at 64%. Another slight drop occurred from 2011-2013 because of the Russian crisis — still the ratio of export goods and services account was approximately 70% of the country's GDP.

Similar to Indonesia, Thailand has membership of many trade organizations, for instance, WTO and ASEAN. Logically, Thailand has signed many trade agreements with many countries in terms of variety of goods. There are many preference trade policies to support international trade. Thailand has signed double taxation agreements (DTAs) with 60 countries as well.

Thailand is a member of WTO commitments; therefore, it has been reducing tariff rates subject to the import tariff, and the government has cut a wide range of items of import duties. As the HKTDC research (2018: 3)[6] example stated, "the raw materials import tariff reduced from 7% to 1%, intermediate products from 12% to 5%, and finished products to 10%". In 2004, Thailand made a concrete step toward international trade with China and signed an Agreement on Trade in Goods to remove 95% traffic on a wide range of agricultural and industrial products of China-ASEAN trade. Thailand, as the member of ASEAN, signed an agreement with China called the China-ASEAN Trade Area (CAFTA) in 2010. By 2010, more than 90% of traded products between China and Thailand were tariff-free.

There are also the free trade agreements between Thailand and Japan that allow more than 90% of exports and imports from both sides to be tariff-free. Thailand has signed free trade agreements with China, Australia, Japan, and New Zealand.

It is worth mentioning that Thailand's electronics manufacture plays a more and more critical role in the world, especially with the rising global demand for electronic products and electrical appliances. Major export products include computers and parts, automobiles and parts, and machinery and equipment. In addition, rice exports to Africa, China and Iran are strongly supported. The main trade partners are China, Japan, the U.S., Hong Kong and China.

Besides the above-mentioned countries whose development relies heavily on exports, another group where export contribution to GDP is between 30 to 40 percent are the Philippines, Poland, Chile, Russia, and South Africa according to the average value of exports from 2000 to 2015. Among them, the Philippines export ratio of GDP decreased from more than 50% in 2000 to around 28% in 2015, although the average was around 39.24%. However, the absolute value of exports increased year on year. The

[6] Research, H. (2018). *Thailand: Market Profile*. Retrieved from http://emerging-markets-research.hktdc.com/business-news/article/Asia/Thailand-Market-Profile/mp/en/1/1X4UWAUC/1X003IMW.htm

major export items of the Philippines according to the Philippines Statistics Authority are electronic products which account for 50.5% of total exports, other manufactured goods, machinery, and transport equipment, sets used in vehicles, aircraft and ships, and woodcrafts and furniture.

As in the other strongly export-led economically developing countries, the Philippines is a member of the WTO since 2000, and it carried out the WTO Information-Technology Agreement (ITA) by imposing zero-tariffs on most information –technology equipment and inputs. The Philippines is also a member of ASEAN and the ASEAN Free-Trade Area (AFTA). Therefore, its import tariffs rate was reduced to a 5% cap on all products and benefits from the zero tariff lines because of the implementation of the ASEAN Trade in Goods Agreement (ATIGA).

Also, some regional free trade agreements have been signed by the Philippines government to support international trade and deepen the economic integration process. For example, with China, Korea, Australia, New Zealand, India, Hong Kong, and Europe , a Free Trade Agreement was ratified by 2017. Japan established the Economic Partnership Agreement in 2008. In particular to its comparative advantage, the Philippines is the only ASEAN country still enjoying the EU'S Generalized Scheme of Preferences Plus (GSP+) status that grants full removal of tariffs to over two-thirds of tariff lines. One more important advantage for international trade is that 5,000 lines of Philippine products are awarded to duty-free treatment.

Russia has a similar pattern to the Philippines, but although the average export ratio of GDP from 2000 to 2015 was around 31.86%, the percentage trend dropped from 44.06% in 2000 to 28.67% in 2015. From IMF export data, Russia exports were sensitive to the financial crisis as well, after 2008 reaching a peak 463,188.54 USD, but dramatically dropping by 36.5% to 294,110.50 USD in 2009 because of the GFC. Then they also increased with a steep slope and strong trend to reach another peak in 2012 of around 526,572.88 USD, and then sharply declined by 46.9 percent from 2014 to the lowest point in 2016 of 279,524.15 USD, because of the European and Russian financial crisis.

Russia experienced the triple shocks of Western sanctions during the Ukraine conflict, the dramatic decline of global oil prices, and a sharp depreciation of the currency RUB in 2014, the recession in 2015-2016 that lasted from the 2014 currency depreciation. Even in this situation, Russia kept surplus of foreign trade and the basic health level of international reserves.

Indonesia, China, Peru, Turkey, and India have more than 20% exports in GDP. Colombia and Brazil depend less than other selected EMs on exports, which account for 16.62% and 12.83% respectively. Russia is one of the big trade countries in the world, and there is considerable freedom and liberation of the business and trade regime. Companies and individuals are allowed to trade without special registrations, and nearly all products are free to import, although a few items including some strategic products need a report license and are subject to controls.

Russia has been the member of WTO on 22 August 2012, since when cutting tariffs on a wide range of products has been compulsory and export dropped to 7.8% in 2012 from 10% in 2011. Russia also opened the services markets to foreign providers in the services trade, and lifted the foreign equity limitation of 49% on telecom companies four years after accession. Furthermore, it allowed foreign insurers, bankers, and distributors to have better and fuller access to the Russian market. From 2010 Russia, Belarus and Kazakhstan started to pursue common external tariffs (CET), enabling free movement of goods, services, capital and workforce among these members.

According to the export data in 2016 of 879 billion USD, Mexico is the 12th largest export economy in the world. The main products for Mexico's export are cars, vehicle parts, delivery trucks, computers and telephones (OEC). The main destinations of these exports are the U.S., Canada, China, Germany, and Japan.

From the percentage of export goods and service of GDP of South Africa, we see an average level of around 30%, but during the GFC there sharply declined from 2008-2009. However, the absolute value of the exports went down from 2011 until 2016 and continued in a downward trend. In 2008 the exports totaled 79,991.39 USD, then dramatically dropped by 22.9% to 61,710.86 USD. After that, they significantly increased to a peak of 108,794.50 USD in 2011, and then kept going down.

As a member of WTO, South African imports from other WTO members are subject to the country's most-favored-nation (MFN) tariff rate. It has also signed some free trade agreements (FTA) with other countries. In particularly, with a FTA with the EU, 95% of exports from SA to the EU enjoy preferential access. The African Growth and Opportunities Act (AGOA) of the US means more than 7000 SA products are exported to the US with preferential and duty-free treatment until 2025.

An export ratio of GDP and the trade situation

Because exports one of the most important channels for financial contagion, as we mentioned before, a detailed review of this indicator for each selected EMs will be given in this section.

According to the average value of export goods and service as a percentage of GDP from 2000-2015, Indonesia (28.01%), China (27.34%), Peru (24.51%), Turkey (22.53%) and India (20.05%) belong to the 20-30% group. One of the common characteristics is that during 2008-2009 the ratio of exports declined significantly toa low point due to global demand falling during the GFC period, and then exports recovered after 2010 or 2011.

Among them, Indonesia’s export goods and services ratio of GDP had a downward pattern, from 38.49% to 21.15%. China’s percentage of export goods and services of GDP first increased from 21.24% in 2000 to a peak of 37.18% in 2007, and then sharply declined to 24.36% in 2009, a drop of more than 10%. However, after the GFC shock, the export goods and service did not account for higher than 30% of GDP.

The absolute value of exports kept increasing year-on-year, reaching 2,209,582.36 USD. Even in 2009, the amount was still 1,201,540.17 USD, although it had dropped by 15.8% from 2008.

China has the highest value of exports among the selected EMs, and it has free trade agreements with many regions and countries, and although import shave increased faster than exports, still it has a trade surplus of 442.5 billion USD (HKTDC, 2018:1)[7].

Indonesia is a member of WTO since 1995, and has benefited from lowering tariffs and non-tariff trade barriers. The import duty ranges between 0-20% for most items, but for some items such as alcohol, tobacco and cars the duty is up to 150%. Indonesia has also signed many free trade agreements, and it is a member of ASEAN, among its members import duties are only 0-5%. In addition, Indonesia has signed bilateral FTAs with Japan and Pakistan, and it has a double taxation agreement (DTAs) with over 60 countries/ territories, including the US, Japan Singapore and China.

Peru had a similar pattern before the GFC, with the ratio of exports of GDP increasing from 16.8% in 2000 to 31.52% in 2007 then dropping to 26.44% in 2009. After that it rebounded to another peak of 30.50% in 2011, but after 2011 it kept a downward decreasing trend to 21.30%.

Turkey exhibits a different pattern from the others, where the percentage of the export goods and services of GDP has the smallest fluctuation change compared to other countries. It jumped from 19.45% in 2000 to a peak of 26.58%in 2001, then dropped to 22.24% in 2003 because there was an economic crisis during 2000- 2001 in Turkey, caused by a lack of financial support from the banking system for economic growth. After that, in 2003 there was a modest stable pattern of the export ratio share of GDP.

[7] HKTDC, R. (2018). *Economic and Trade Information on China*. Retrieved from http://china-trade-research.hktdc.com/business-news/article/Fast-Facts/Economic-and-Trade-Information-on-China/ff/en/1/1X3C8S3L/1X09PHBA.htm

There was not a diametrical drop during the GFC, just from 2009 to 2010 a slight decline from 22.57% to 20.45% percent. The degree of dependence of economic development on exports has declined with time. Exports of electrical and electronic products and new technology products was growing. The top ten export markets of China in 2017 were the US, Hong Kong, Japan, South Korea, Germany, Vietnam, India, the Netherlands, the UK, and Singapore. They accounted for 58.7% of China's total exports in 2017.

Turkey's location is an advantage for international trade. In the last decade, Turkey has liberalized its import regime. There is no restriction for enterprises and individuals to engage in the import business. It is also a member of the WTO, and the tariff scheme follows the Harmonised System for commodity coding. In January 1996, the EU-Turkey Customs Union came into force, and all customs duties from both sides were abolished, as were other surcharges and import quotas levied on most manufactured products from each other.

The products that complied with import formalities and customs duties are processed with a different legal process from the source countries and can freely move within the EU and Turkey. Turkey did not apply EU anti-dumping measurement; however, it has its anti-dumping actions that are different from the EU according to the Turkish government's requirements.

India's export goods and service ratio of GDP had an increasing trend from 2000 - 2015, although this was interrupted by the financial crisis. It steadily rose from 13.13% in 2000 to 24.27% percent in 2008, and then sharply dropped to 20.62% percent in 2009. With a strong and steadily increasing trend, India's exports rose to 25.43% percent in 2013, and after that declined significantly again to 19.94% percent in 2015. There was a currency crisis in India in 2013 which may have affected exports.

India's trade regime has become more open since the 1991 economic liberalization. Import tariffs were reduced, the import license application process was simplified, and a number of quantitative restrictions were eliminated to support international trade. Like other emerging economies, India also concluded a number of free trade agreements with 10 other regions and countries who are members of ASEAN and the MERCOSUR. In addition, India engages in the Agreement of the South Asia Free Trade Area and the Asia Pacific Trade Agreement.

Brazil and Colombia have a lower ratio of export goods and services out of GDP, especially Brazil where the rate was around 12.83% from 2000-2015. Colombia has a relatively steady fluctuation change in export percentage, although the export value has increased. Brazil’s export ratio rose from 10.19% in 2000 to a peak of 16.54% in 2004, and then it started to take a lower rate. After the GFC, Brazil's export ratio moved to around 10%.

Brazilian trade policy is not free like the other above-mentioned economies. Importers have to follow the official procedure to get registration and licensing from the government institutions including the Ministry of Finance's Federal Revenue Secretariat and the Ministry of Development, Industry and Foreign Trade's Foreign Secretariat as authorization and inspection institutions.

An electronic procedure is conducted which the importer has to follow. There are many different taxes on import products. Also Brazil applies import duties to a wide range of imports as its primary instrument to regulate imports. Brazil has a free trade zone called the Manaus Free Trade Zone, and it is the largest and most extensively developed free trade zone in Latin America.

Colombia’s main export goods include crude petroleum and coal briquettes that accounted for 39% and 21.3 % of total exports in 2016, with total exports and imports reaching 30.2%and 42.9 billion USD in 2016 (OEC, 2019). Therefore, there was a trade deficit. The main export destinations are the U.S, Panama, the Netherlands, Ecuador, and Spain. The primary import source countries include the US, China, Mexico, Brazil, and Germany.

Import goods and a service percentage of GDP

From the average value of the ratio of imported goods and services of GDP, Malaysia, Hungary, and Thailand had 80.414%, 72.781% and 61.739% respectively, implying that they highly rely on imports. The Philippines (43.271%), Poland (39.787%), Mexico (29.783%) and South Africa (29.291%) are also the second higher group with more than 30% in terms of the ratio of import to GDP. Turkey, Indonesia, India, China, Peru, Russia, and Colombia are at a similar level, the ratio of import account to GDP being between 20- 30%. Brazil had the least one and only took 12.856% average ratio from 2000 to 2015. From the Figure 3.3 and Figure 3.4, we can see clearly that the GFC significantly negatively impacted on imports for all selected EMs and the USA.

3.4.4.6. Foreign Direct Investment (FDI)

The literature indicated that FDI is also impacted by many other factors like market size, the degree of openness, the role of institutions and the degree of integration of the world economy. Meanwhile, many factors such as labor and energy costs, domestic tax rates, level of investment incentives, and legal and institutional environments play significant roles in the inflow of FDI. Recently, political and economic stability, transparency regulations and corruption have gained importance in explaining the behavior of FDI inflows.

The typical character of the selected emerging economies of foreign direct investment (FDI) is that they are susceptible to financial or economic crises. In terms of our study, the FDI from 2000 to 2005 was at a relatively lower but stable level and then rose to a peak from 2006-2007. However, they all significantly declined from 2008 to 2009 because of the GFC. Hereafter, FDI rebounded from 2010 and reached a new peak around 2012. However, there were many crises that followed the GFC in 2007-09, and the FDI of our selected EMs dropped during these different crisis periods.

In our selected emerging economies, China has the most significant net FDI, increasing from 42.09 billion USD in 2000 to 242.49 billion USD in 2015. There were only two times of considerable decline during these 16 years. The first one was during the GFC, from 171.53 billion USD in 2008 it dropped by 23.6% to 131.06 billion USD in 2009. The second time was during the 2011 economic crisis when it fell by 13.9% but recovered again in 2013.

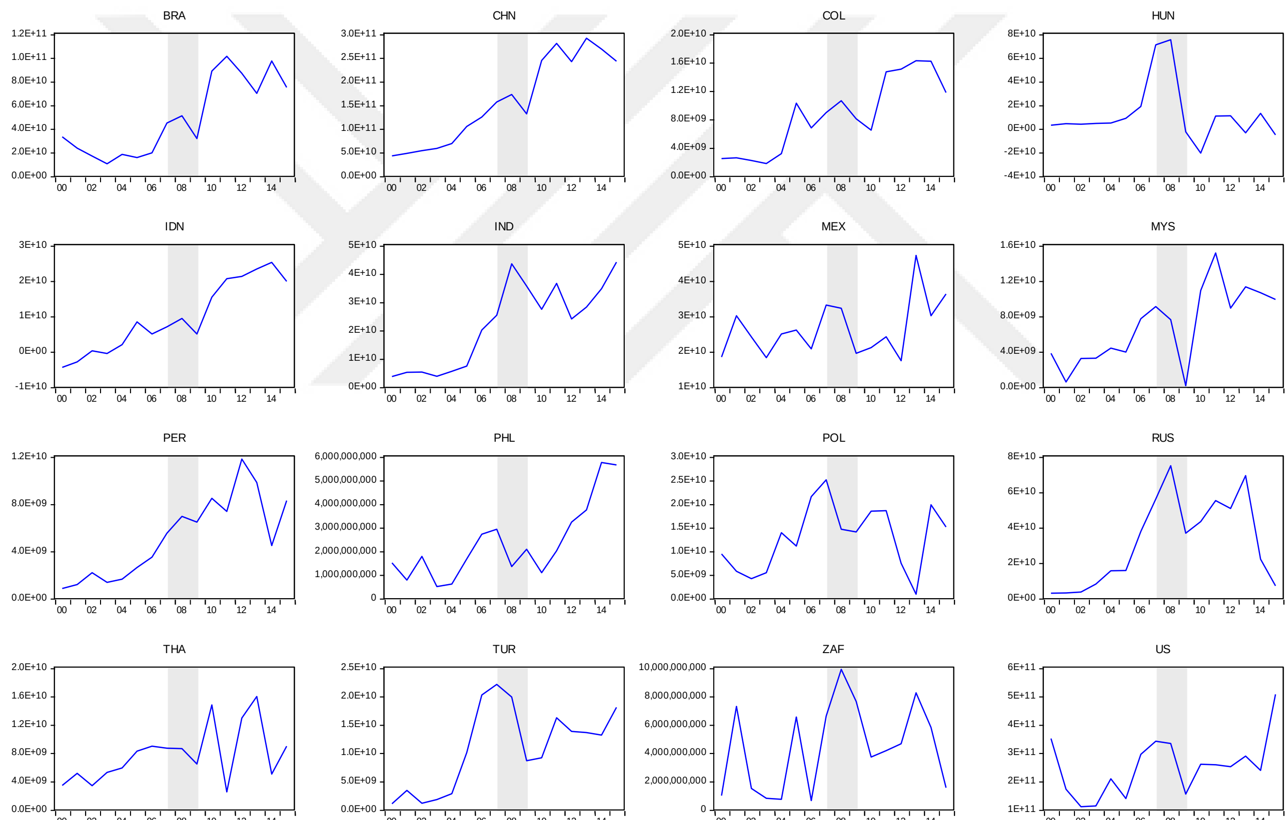

Figure 3. 5: Foreign Direct Investment, Net Inflows 2000- 2016 (Bop, Current Us$)

Note: Data from IMF.

The net inflow of foreign direct investment to Brazil reached 74.7 billion USD in 2015. It was impacted by the GFC and dropped by 38% from 50.72 billion USD in 2008 to 31.48 billion USD in 2009. Then it recovered to another peak of 101.16 billion USD in 2011, and then declined again to69.69 billion USD in 2013.

Russia has a very high fluctuation of FDI. From 2000 to 2005 the inflow of FDI to Russia was increasing but was less than 15.5 billion US dollar. It sharply climbed from 2005 to a peak in 2008 when net FDI inflow reached 74.78 billion USD and it had increased almost 6 times. Because of the GFC, the FDI dramatically dropped by 51.08% to 36.58 billion USD in 2009. It rebounded from 2010 and reached a new peak in 2013 of 69.22 billion USD. However, from 2014 until 2017 Russia's net flow of FDI rapidly declined again by 90.10% to only 6.85 billion US dollar, due to geopolitical tensions between Russia, Ukraine and Western countries and also the Russian financial crisis caused by Russian currency depreciation and investors lack of confidence in the market. By 2016, the Russian economy rebounded with 0.3% GDP growth and came slowly out of recession.

India is a country where FDI became the driver of economic growth and a significant source of non-debt financial resource for industrial development. Therefore, FDI has played an essential role in economic growth (IBEF, 2019). The Indian government implements many favorable policies to improve the business environment and to support and attract FDI inflow. For instance, the upper limit in the insurance sector increased from 26% to 49%in 2014, and "Made in India" was launched in September 2014 for 25 sectors. Because of this, the FDI inflow to India increased by 48% in April 2015.

There are some attractive advantages of FDI. For example, the relatively lower wages and production costs, tax exemptions and other specialized investment privileges. In terms of India, FDI also brings technical know-how, new management, new technology, and generates opportunities for employment.

The FDI of India increased almost 14 times from 3.58 billion USD in 2000 to a peak of 25.23 billion USD in 2008, then had a sharp decline because of the GFC and dropped by 36.88% to 27.40 billion USD in 2010. After that it immediately rebounded in 2011 to a new peak of 36.50 billion USD in 2011, then shrunk again from 2011-2012. However, the increasing trend was steady from 2012 and reached 44.01 billion USD in 2015, and it continues to rise.

In Poland, as one of the most attractive FDI countries among Europe, FDI reached a peak of 25.03 billion USD in 2007 and dropped by 41.78% to 14.57 billion USD in 2008 because of the GFC. Then it recovered to 18.49 billion USD in 2011, but sharply declined by 95.7% because of the European financial crisis to only 795 million USD in 2013. Afterward, it recovered faster to 19.78 billion USD again in 2014.

There was a wider range of changing FDI than in the other selected EMs. Due to many strengths, including a large number population, relatively cheaper skilled labor cost, strong economic growth, its membership of the EU and location in central Europe, a number of dynamic special economic zones, and the desired policy and support from the Polish government, Poland has become a very attractive country for FDI. Poland ranked 27 out of 19 states in the 2018 Doing Business ranking according to the World Bank.

According to OECE 2016 data, the main inflows of FDI to Poland are from the Netherlands, Germany, Luxembourg, France, and Austria. The main investment sectors are manufacturing (28.6%), professional, scientific and technical activities (18.8%), information and communication (17.7%), real estate (11.4%) and trade (%?). The weak point for FDI in Poland is that the procedure is slowing, but the Polish Government has implemented a new policy to speed it up.

Turkey's FDI also has the typical character as mentioned above. It increased from only 982 million USD in 2000 to a peak of 22.05 billion USD in 2007, then sharply declined by 61.06% to 8.58 billion USD in 2009 because of the GFC, afterwards rebounding to 16.18 billion USD in 2011 but then falling slightly again. The factors negatively affecting FDI in Turkey included political instability, currency devaluation, higher inflation, the conflicts in the Middle East and the emergency situation in the country. However, according to the UNCTAD 2017 World Investment Report, Turkey was the second largest recipient of FDI in West Asia.

The same as other emerging economies, Turkey has many strengths and favorable policies to attract FDI. The geographical location that connects Asia and Europe and easy routes to Africa are one advantage naturally, also the Turkish government promotes and supports investment in technology, textiles, services, telecommunications, shipbuilding, electronics, and bio-technologies. A series of legislative reforms adopted to facilitate the reception of FDI, such as establishing the Investment Support and Promotion Agency of Turkey, development of public-private partnerships for major infrastructure projects, simplified procedures and strengthened intellectual property protection, and the progress the country made to prepare to join the EU and so on, are all efforts that increase the attractiveness of foreign investment to Turkey.

Hungary is one of the most attractive European emerging markets for FDI due to its advantage as the gateway to Central and Southeast Europe, fast economic growth, a well-developed financial system, and the high quality of the infrastructure, workforce, and regulation. Furthermore, integration in the EU and support from large international organizations reinforces political and economic stability and reduces risk. The literacy rate was 99.1% in 2015; the labor force education level and training level are comparative high in Hungry, especially in engineering, medicine, and economics.

Automotive and electronic industries have notable supply chain opportunities in Hungary. According to the National Development Plan 2014-2020, 6 billion euro has been allocated for tourism, healthcare, infrastructure, and environmental protection programs.

Hungary's FDI had a dramatic climb from 8.5 billion USD in 2005 to75.01 billion USD in 2008. However, the GFC strongly and negatively affected FDI inflow which sharply declined by -103.96% to -20.93 billion USD in 2010. Even though it recovered in 2011 to a positive value, 10.51 billion USD, the average level of FDI inflow could not catch the level prior to the GFC.

The Hungarian government put a priority on attracting FDI, and they established the Hungarian Investment Promotion Agency (HIPA) that provides professional assistance to foreign investors. Also, the government implemented measures during the international crisis to maintain the country's appeal and attract FDI, and keep productivity at the same high level. Also, the lower exchange rate made Hungary less expensive than before.

The Hungarian government took some measurements to decrease the ratio of debt to GDP, and it successfully decreased that from 81.0% to 76.9 % from 2011 to 2014. However, through taxation increasing and new taxes imposed especially on foreign companies, there was a negative impact on the banking, energy and telecommunications sectors and this resulted in FDI inflow decline. In addition, the stock of FDI inflow decreased, and the main traditional invest countries of France, the U.K., Switzerland, and Luxembourg divested more than they invested (Central Bank of Hungary).

Indonesia's FDI inflow was almost negative from 2000 to 2004, expect in 2003, and from 2004 FDI inflow to Indonesia has been growing and expanding. It significantly dropped from around 47.66% from 9.32 billion USD in 2008 to 4.88 billion USD in 2009, but after 2009 rebounded with a rapid growth rate to a peak of 25.12 billion USD in 2014, and expanded to 32 billion USD in 2017. The biggest investor was Singapore followed by Japan and China. The main investment sectors, according to the Indonesia Investment Coordinating Board in 2016 are metal, machinery and electronic industry (13.4%), chemical and pharmaceutical industry (10%), paper and printing (9.6%), mining (9.5%) and transport (8.2%).

Although Indonesia has many obstacles for attracting FDI inflow, such as credit cost, uncertain regulations, low-quality infrastructure, high risk of terrorism and high non-ignored level corruption, the Indonesian government tries to implement the new policy and improve the investment environment.

Indonesia has an enormous market with around 230 million inhabitants, plus abundant natural resources, and strong internal demand caused by the development of the middle class, and all of these factors lay a strong basic foundation for FDI. Moreover, the Indonesian government implemented a set of economic policy packages between September 2015 and November 2016 to stimulate investment that focused on deregulation, law enforcement and business certainty, different types of tax cutting and tax incentives in special economic zones. The government also launched various programs to improve the investment climate.

FDI inflow to Colombia increased and expanded from 2.44 billion USD in 2000 to 16.16 USD in 2014. There was a sharp decline, as all another emerging markets, during the GFC from the peak of 10.56 to 6.43 billion USD in 2010, after that dramatically climbed to a new high level from 2011 of more than 14 billion USD.

This FDI achievement is attributed to economic stability, political stability, strong confidence of foreign investors, qualified and competitive workers, high quality of infrastructure, and a strategic geographic location and numerous development centers. Even in the crisis period, the steady growth maintained by the government, and Colombia had democracy and a stable environment on the South American continent, and the education system was excellent with 95% literacy rate. Several free trade agreements provide access to a market of almost 1.2 billion people.

Thailand is located at the heart of Asia, and is one of the significant regional FDI destinations among emerging Asian counties, and FDI is one of the vital factors playing a fundamental role in Thailand's economic development. Thailand's government actively promotes free trade and investment. As a member of WTO, its investment regime is in harmony with WTO regulations. There are no restrictions in the manufacturing sector; no export conditions and no local requirements. The government established an agency to help investors, the Thai Board of Investment (BOI), which offers a set of incentives in six industrial sectors including tax exemptions to reduce the cost and attract more investment.

Further, the new investment strategy approved in 2014 supported the investment benefit to society and the environment, and it gives priority to high-tech and creative industries, and digital development programs that utilize local resources. The impeding FDI weak points are lack of infrastructure and skilled workers, political uncertainty, and piracy and counterfeiting.

FDI inflow of Thailand is very sensitive and showed significant volatility from 2000- 2015. It increased from 3.37 billion USD in 2000 to the 8.56 billion USD in 2008, then had a slight decline of around 25.11% to 6.41 billion USD in 2009, and rapidly increased 2.3 times to 14.75 billion USD. After that, there was a dramatic decline of 83.23% to 2.47 billion USD in 2011. However, it rebounded significantly by 6.44 times to a peak of 15.94 billion USD in 2013 then dropped again.

The leading investors are Japan, Singapore, Taiwan, Switzerland, the U.S., and some other European countries. The main sectors according to 2017 Board of Investment data, are services (35.9%), paper and chemical goods (21.6%), agricultural products (19.2%), metallurgy and machinery (9.9%) and electronic and electrical goods (7.9%).

FDI inflow to Malaysia has big oscillations but an increasing trend from 2000-2015. From a low point of 760 million USD it increased to a peak that before the GFC was 9.07 billion USD, and then sharply dropped by 98.74% to a record low point of 114.67 million USD. However, FDI in Malaysia rapidly recovered from 2009 and jumped to 15.12 billion USD, a new peak, then declined 41.16% again to 8.90 billion USD. Then moving around 10 billion USD from 2013 to 2015, it became the highest recipient of FDI in the region (UNCTAD, 2017: 50)[8].

The primary investment sources are China, Switzerland, Singapore, the Netherlands, and Germany, based on Malaysia Investment Development Authority data.

[8] UNCTAD. (2017). *World Investment Report 2017-Investment and The Digital Economy*. Retrieved from https://unctad.org/en/PublicationsLibrary/wir2017_en.pdf

The investments are diversified into different sectors, but the leading sectors, according to the Malaysian Investment Development Authority’s 2017 data, are services (52.6%), manufacturing (25.4%) and mining (7.8%).

The Malaysian Government implemented a series of incentive measures to encourage FDI, especially in industries exporting "high-technology" products and back office operation services. The authorities try to create an attractive strength and environment for FDI, such as a liberal and transparent investment policy, improved infrastructure, competitive costs, developing the public services, and in particular it provides tax reductions to foreign companies.

The FDI inflow in Peru kept increasing from 809.70 million USD in 2000, after 2012 reaching a peak of 11.79 billion USD then falling to 4.44 billion USD in 2014, but after that it recovered again, and Peru is currently the fourth largest recipient of FDI in Latin America, according to the country's central bank, after Brazil, Colombia, and Chile. Even during the GFC, there was only a slight 7.12% decrease in FDI.

The performance was quite good, due to an attractive legislative and fiscal framework and relatively low wage costs and a non-restrictive policy on dividends. Moreover, there has been an improving business climate and openness of trade policy. The primary FDI sources are Spain, the European Union, the U.S., and the UK. The major sectors that attract FDI are mining, communications, industry, finances, and energy.

The weakness of Peru in terms of FDI is the customs barriers, strict tax legislation, and lack of infrastructure, low efficiency of public institutions and the rule of law needing to be improved. The government has taken actions to develop them. From the 1990s the Peruvian government promoted liberalization policies and tried to decrease barriers and open the economy more to foreign investors, and announced foreign investment laws to encourage private investment and enhance the investment environment.

According to the 2018 Doing Business Report of the World Bank, Peru ranks 58th out of 190 for FDI, and protection of investors are at a good level compare with Latin America and the Caribbean, the US, and Germany considering transparency, shareholder power, manager responsibility and general protection of investors. However, there is structural dependence on the capitalist mining sector, which causes a high level of permanent poverty and high unemployment.

From the Figure 3.5 for South Africa, we can see that FDI inflow has had massive fluctuation, and is very sensitive to crisis and the economic situation. There was an exciting almost 7.5 time increase in FDI from 2000 from 968.83 million USD to 7.27 billion USD in 2001, and then it sharply fell by 79.65% to 1.48 billion USD in 2002. Then it jumped by 9.3 times to another peak from 701.42 million USD in 2004 to 6.52 billion USD in 2005, after which it dropped in the next year again by 90.44% to 623.29 million USD in 2006. Afterward, another rise and drop happened between 2006 to 2010 because of the GFC, then it increased by 50.7% to a peak of 9.89 billion USD in 2008, then declined by 51.56% to 3.69 billion USD in 2010. Same as with our other selected EMs, in 2013 FDI inflow reached a new peak of 8.23 billion USD, then fell again.

South Africa as the largely free-market economy providing both public and private sectors opportunities to invest; the attractive sectors are energy, telecommunication, and services. SA has many attractive advantages for FDI such as a diversified, productive and advanced economy, prosperous natural resources, absolute political stability, and a transparent legal system, well-developed infrastructures, and an extensive stock exchange. SA also put into place economic reforms and reduced taxes and customs. Also, SA experienced an economic transition from the traditional industries to financial services and production. The government put into place many favorable policies and investment incentives to encourage foreign investors

However, as an emerging market, the country still has many weaknesses that adversely affect FDI inflow, such as high-cost electricity, a high crime rate, high levels of corruption and increasing social unrest and so on. All these factors have hampered FDI inflow and discouraged investor confidence.

The major investing countries, according to the South African Research Bank in 2017, are the UK, the Netherlands, the US, and Luxembourg. Financial and insurance services, real estate and business services became the top sectors for investors, accounting for 40.7% of FDI inflow in 2015. This is also a reason that SA FDI is sensitive to the global financial and economic situation. The manufacturing and mining sector account for 28.9% and 15.9%, respectively.

Foreign direct investment has been rising steadily in the Philippines from 1.49 billion USD in 2000 to 5.64 billion USD in 2015, although it was affected by the GFC and fell by 54.09%, since recently reaching a multi-decade peak of 8.7 billion USD in 2017.According to UNCTAD data, USD 8.7 billion surged to the Philippines during just the first 11 months of 2017, even surpassing the Central Bank of Philippines's year target of USD 8 billion. According to 2016 data from the Philippines Statistics Authority, the main investing countries are the Netherlands, Australia, USA, Japan, Singapore, South Korea and the U.K. The main investment sectors are electricity, gas, steam, and air conditioning supply (31.5%), real estate (20.9%), manufacturing (19.9%) and transport and storage (15%).

However, compared to the same regional peers and especially the other emerging markets, FDI inflow to the Philippines lag behind due to the constitutional limits on foreign investment, plus the threat of terrorism in some parts of the country, political instability, low quality infrastructure, and lack of transparency and the precariousness of the judicial system. Moreover, protections for foreign investors are much less than in East Asia and the Pacific, the U.S. and Germany in terms of all indicator indices on doing business (Santander, 2019).

The Philippines is located at the gateway of Asia and has a large domestic market and also benefits from many comparative advantages such as an English-speaking, well-skilled workforce, proximity to U.S. culture, favorable investment policy, and considerable natural wealth. In addition, the Philippines is a member of the ASEAN, sharing the same authorities, incentives, resources and favorable policies as other members. The country has opened up for more foreign investment through the laws liberalizing, and procedures have been simplified.

3.4.4.7. Gross Domestic Saving % Of GDP

According to the World Bank definition, gross national income minus total consumption plus net transfers is the gross saving, and taken as a percentage of GDP is the gross saving rate of GDP. Economic theory applies a different model stating that there is a positive relationship between domestic saving, investment, and economic development in the short run. Although investment is very important for growth, domestic saving is one of the major engines for development.

According to World Bank data, we calculate the average rate of the gross domestic rate, meaning China and Malaysia have a very high national saving rate of 47.148% and 40.369% respectively. India (32.220%), Russia (32.781%), Indonesia (30.781%), and Thailand (30.449%) are the second big group with a similar gross domestic saving rate of more than 30% of GDP. The next group includes Hungary (25.414%), Peru (23.601%), Turkey (23.233%), and Mexico (21.003%) that are between a 20 and 30% national saving rate. The other EMs are less than 20%: South Africa, Poland, Brazil, Colombia, and the Philippines.

All selected EMs national gross saving rates were impacted by the GFC and fell significantly, except for China and Indonesia. Before 2006 all of them had been increasing with fluctuations. After the common drop during the GFC, in some of them the gross national saving rate rose, such as in Hungary, Poland, Thailand, Turkey and the US, while in others after a slight rebound it went down again.

3.4.4.8. Total Capital Formation (% of GDP)

Base on the World Bank, Gross Capital Formation (formerly Gross Domestic Investment) consists of outlays in addition to the fixed assets of the economy plus net changes in the level of inventories. It measures investment. The investment is usually highly cyclical, and during the 2008 GFC there were significant declines in Gross Capital Formation for most of the selected EMs, except China and India. There is also much research finding that total capital formation plays a decisive role in economic growth, such as Uneze (2013: 281), and Adhikary (2011: 16).

Similar to total GDP, China and India are the top two in terms of the average aggregate capital formation from 2000 to 2015, with percentages of 42.955% and 35.497% respectively. The second group at between 20-30% are Indonesia, Turkey, Thailand, Hungary, Malaysia, Mexico, Russia, Colombia, Peru, Poland, and the Philippines. Among the 15 selected EMs, Brazil and South Africa have a 19.376% and 19.331% capital formation rate out of GDP, respectively.

Total capital formation is sensitive to crises. For example, when a company realizes there will be a crisis, they set the output down and invest less. Among all the selected EMs, expect Hungry with a decreasing trend, all others have an upward and increasing trend, although there are volatilities. The GFC impacted significantly on total capital formation, except in China and India, and in all other selected EMs investment capital decreased. Thailand, Russia and Peru are the worst three, dropping by 26.890%, 25.783%, and 23.682% respectively. Turkey (-20.450%), Hungary (-17.768%), Malaysia (-16.882%), Poland (-16.559%), the Philippines (-13.980%), South Africa (-10.563%) are in the second level at between 10 and 20% of capitation formation during 2008-2009. Mexico and Colombia dropped 6.259% and 4.458% respectively.

3.4.4.9. Tax Revenue of GDP

According to the World Bank definition, tax revenue refers to compulsory transfers for public purposes to the central government. With a stable economy, the ratio of tax to GDP is supposed to be relatively consistent. It is very sensitive to changes in the law and severe economic downturns. During such economic downturns, because economic growth goes down, more people lose their job; thus consumption drops, resulting in consumption and property tax revenues decreasing significantly. Therefore, the tax revenue of GDP declines during a crisis.

Except in China, Hungary, Malaysia, and Turkey, all other selected EMs saw the ratio of tax to GDP fall dramatically. The USA lost the most, 23.016% down. Then Russia (-18.091%), Indonesia (-16.925%), Peru (-12.449%), Poland (-12.294%), India (-10.326%), and the Philippines (-10.004%) lost more than 10%. South Africa, Thailand, Brazil, Mexico, and Colombia were also impacted between 2 and 10%.

3.4.4.10. International Reserve (IR)

An international reserve is part of the national wealth and one essential criterion to measure the power of a country. It is usually held by monetary authorities typically in the Central Bank, Treasury, or Ministry of Finance. There are many functions of an international reserve. The purposes can be precautionary against currency and capital account shocks as one of the right reasons for countries to accumulate international reserves. In particular, to maintain a fixed exchange rate regime, an international reserve is a necessary buffer. Even for a floating exchange rate system, an international reserve can be used by a government to make a financial market intervention to stabilize the exchange rate.

In addition, the international reserve as a tool of intervention strategies stabilizes the domestic currency value and boosts export growth (Dooley et al. 2003: 1). Moreover, IR is vital to maintain financial market stability, carry out economic adjustment and achieve internal and external balance. The central bank can sell or buy reserve to balance the investment and supply and demand of the local currency.

Of course, there are costs and risks in keeping an international reserve. First, it is an opportunity cost; the foreign currency is kept as the reserve and is not available to invest in the economy, and has been called "sterilization bonds" because for a central bank the net worth is unchanged. It the central banks sterilize the foreign reserve, and then the net asset is reduced efficiently. Whereas, if not, domestic liabilities will increase when foreign assets increase.

Second, the domestic government typically finances fiscal authority international reserves, so it is not a net national asset. The difference in the interest rate of domestic and reserve will impact on the cost of foreign reserve. Quasi-fiscal costs will incur if the local interest rate is higher than the reserve interest rate. In this case, if a country holds large stocks of international reserves it may inadvertently be counter-parties to the carry trade (Dominguez et al. 2012: 389). The carry-trades borrow in low-interest currencies and invest in a relatively higher interest rate currency to earn a profit because of the interest rate differences. On the contrary, for example, Japan, benefits from the net interest income on reserve because the reserve interest rate is higher than the domestic currency interest rate.

Third, sizeable international reserve exposes a country to currency risk. For example, China held a large amount of USD as global reserve. After the 2000 US depreciation, the value of the reserve had a significant loss. The loss of China's foreign exchange reserves was approximately $20 billion USD in 2003 and nearly 40 billion USD in the first half of 2004.

In terms of the selected EMs in our studies, we can divide 15 EMs into different groups depending on the size of the IR. China is top of them all, where the ratio of the emerging and developing Asia account increased from 46.81% in 1996 to approximately

80% after 2010. It accounted for almost one-third of the international world reserve after 2010, and by 2017 China's TIR reached 3,158,876.95 USD.

Russia, India, Brazil, Malaysia, and Thailand are following China and have an enormous amount of international reserve. The third group includes Turkey, Poland, and Indonesia, and then the remainder is in the fourth level that includes Hungary, the Philippines, South Africa, Chile, Peru, and Colombia.

Figure 3.6: Total International Reserve Excluding Gold: Brazil, India, Malaysia, Russia, And Thailand 1996 - 2017 (USD)

During a crisis, the role of the international reserve is essential. For a fixed exchange rate regime, it keeps the exchange rate steady. Due to the functions and costs of the international reserve, the IR policy is essential to a country’s economic growth and financial stability. Some studies focus on the most recent financial crisis and international reserve policy.

Aizenman et al. (2015) found that during the GFC from 2007-09 most of the previous significant variables that impacted on the hoarding of IR became less critical or moved in the opposite direction, and the degree of change is significant. It probably reflected the frantic market conditions and degree of the GFC was so severe it even impacted on normal economic relationships. Empirically they confirmed the structural changes associated with new patterns of hoarding IR after the GFC. This finding was also pointed to by Aizenman and Sun (2012: 268-9), showing many EMEs prefers to not deplete their IR to allow depreciation of exchange rate and domestic currency. Furthermore, they pointed out that the main factors that differentiate countries that did rely on reserves were their heavy trade orientation.

During the 2007-09 GFC, most EMs international reserves decreased first and then increased, because of the safe heaven reason and the cost of the international reserve. If there is dollar depreciation, all other countries that reserve in USD are losing value and the asset will shrink. This is another reason why countries try to accumulate more USD international reserve to support the amount of it. Enough IR can also help the EMs to increase the consumer and nation's confidence and act as a precaution to speculation.

3.4.4.11. Reserve Variation During The GFC

There are limited options when a country faces sudden capital outflows under the enormous pressure of currency depreciation. According to Dominguez et al. (2012: 397), the first option is to allow the exchange rate to float, and let the currency depreciate. Second, foreign reserves can be used to defend the exchange rate. The third option is to increase interest rates to discourage capital outflow. The fourth option is to impose capital controls directly. The last one is to a combination of all of the above.

However, all of those have limitations. The degree to which an authority can allow their country’s currency depreciate is limited, as if there is speculation or capital outflows are more than expected or too fast, it causes a potential crisis in the financial system. If the reserve is used to stabilize the exchange rate, then the reserve will decrease very fast and face many other more profound problems. Also, it has a limitation for the amount of the reserves. Raising the interest rate may negatively impact on domestic demand and investment, especially under the intense pressure of the capital outflow.

We have to separate China from the emerging economics when we try to draw Figure 3.6 because of the vast international reserves, excluding gold, which reached 2,416,043.68 USD at the end of 2009. It accounted for 78.8% of emerging and developing Asia and 44.2% of the emerging economies at the end of 2009. During the GFC, 2007- 09 hoarding of total international reserve exclude gold by China slowed down by two times. It went from 12.69% in Q1 2007 to 6.59%in Q4 2007, then it rebounded to 10.06%in Q1 2008, after which it remained down significantly until a low point of 0.39% at the beginning of 2009.

Dominguez et al. (2012: 404) analyzed the relationship between countries exchange rate and reserve and found that during the GFC for the emerging economies these two were negatively related, although they experienced both reserve lost and depreciation of their currency.

China had the most significant amount of international reserve among our studied emerging markets. From Q1 2008 it decreased slightly, especially in the third quarter of 2008, and maintained a similar level of around 2.6 billion USD until the first quarter of 2009. Then it started to increase again. If we look carefully, all the other selected EMs had a similar pattern as China. They all experienced slight IR decline during 2008 then recovered from 2009. However, we noticed that the time points that a decrease starts are different, that means probably the GFC impact on those EMs were by a process, and also that the fiscal policy of each country plays differing roles.

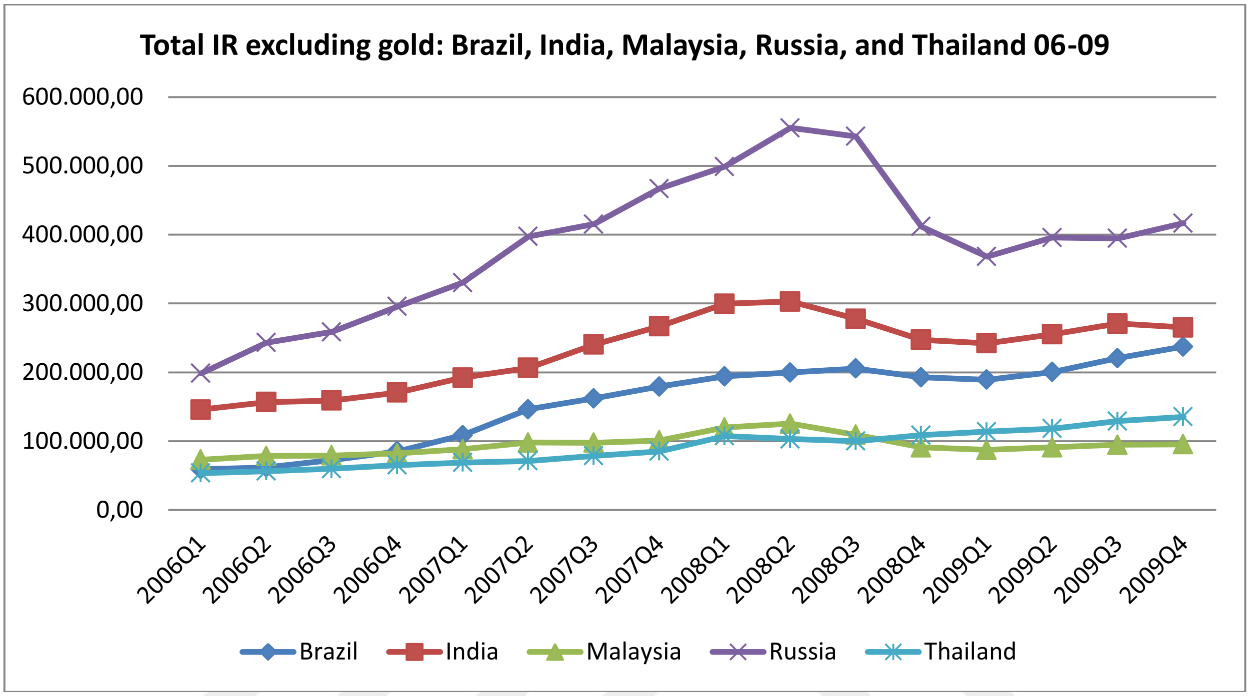

Figure 3.7: Total Ir Excluding Gold: Brazil, India, Malaysia, Russia, And Thailand 2006-2009

To see the trend of IR, we also calculated the growth rate of IR to see how the IR changed during the GFC. Figure 3.8 below illustrates the change rate of international reserve excluding gold for selected countries and areas. We used quarterly data from the first quarter of 2006 to the last quarter of 2009. To see the detail changing of international reserve and analyze it clearly, we used the world level as the reference line to compare with selected emerging market economies in the below study.

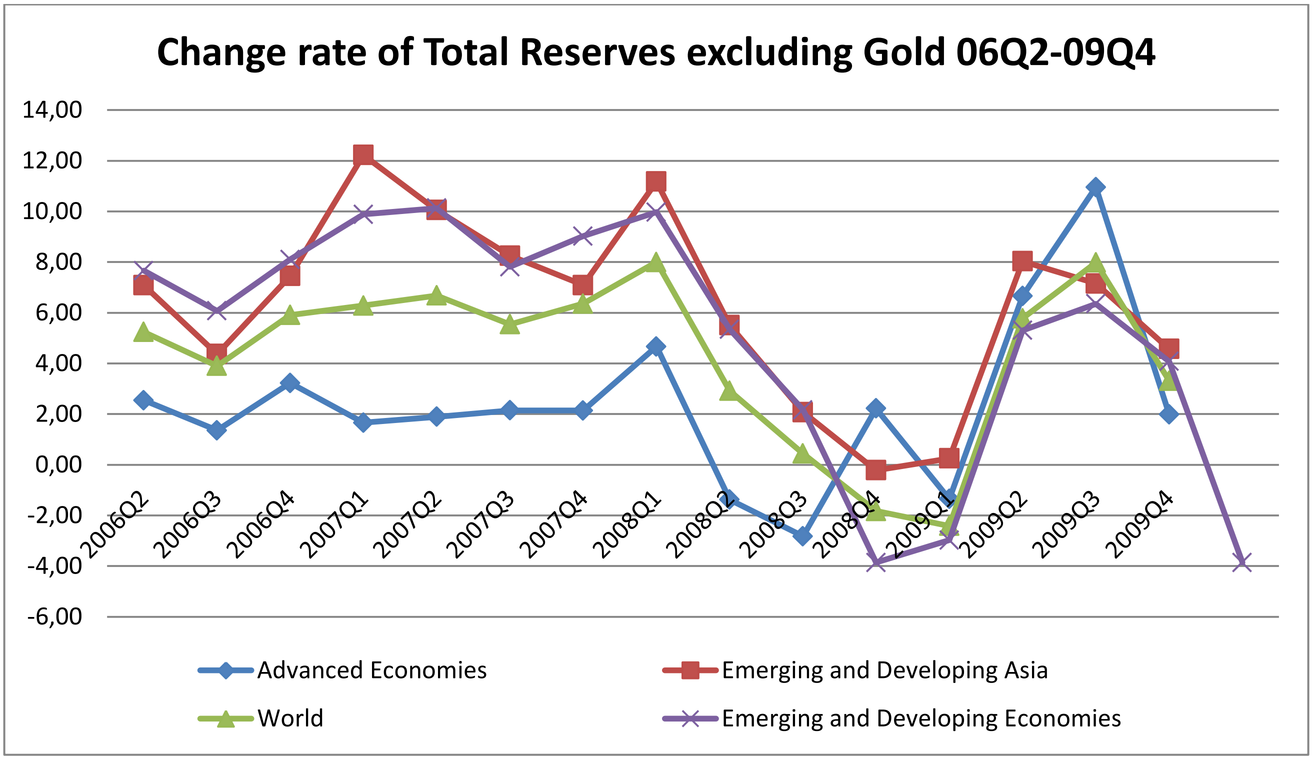

Figure 3.8: Change Rate of Total Reserves Excluding Gold 06Q2-09Q4

Note: original data source International Financial Statistics (IFS), change rate calculate by author.

Figure 3.8 illustrates the change rate for total reserves excluding gold of the world, in advanced economies (AE), emerging and developing Asia, and emerging and developing economies from the second quarter of 2006 to the fourth quarter of 2009. The common point is that from the first quarter of 2008 all of them sharply declined from a peak to a low point at the end of 2008. Moreover, the IR change rate is negative for all at the lowest point of each. It shows a net decreasing of total reserves during the GFC.

It was precisely that during Q3 and Q4 2008 that the growth rate of IR for almost all selected EMs, advanced economies, the world, and emerging Asia are negative, which indicates that the GFC impacted on international reserves significantly, financial policy either used the reserve to stabilize the exchange rate, or they could not avoid the reserve decrease.

Interestingly, from the beginning of 2009 the IR trend showed a deeper upward increase than decline, and the IR accumulation recovered rapidly and reached a new peak between Q2 2009 to Q3 2009. It implies that at the beginning of the GFC, the government used the IR to stabilize the exchange rate, and all economics started to hoard international reserve after they realized the financial shocks. Then Emerging and developing Asia, compared to the world, advanced economies and emerging and developing economies, had the most volatility change for international reserve even before 2007.

In addition, the selected EMs peak and trough lie in different periods, which shows the financial crisis started at different time for different countries, and the volatility range of the reserve was also different. The range of total reserve changed from -24.15%for Russia, 2008 Q4 minus 2008 Q3, to 35.48% for Hungary in the same period. It suggests that during the same period, the reserve policy varied between countries. Russia depleted IR, but Hungary increased the hoarding of reserves. The volatility of selected EMs is much more than in the advanced economies and the world level.

3.4.4.12. Industrial Structure

According to the agriculture value added of GDP, we calculated the average of 15 years from 2000 -2015, from which we can divide the 15 selected EMs into three groups. From the table 3, we can see that Indian agriculture accounted for one-fifth of GDP, then Indonesia, Philippines were also at more than 10%with 13.84% and 12.49% respectively. Another group is China (10.96%), Thailand (9.75%), Turkey (9.76%), and Malaysia (9.25%). However, Turkey's agriculture ratio of GDP decreased from 2010 to around 8%. Peru, Colombia, and Brazil are in the middle group, with agriculture accounting for 7.77%, 6.62% and 5.50% respectively. These three are located in South America. Then the other selected EMs, at less than 5%, are Russia, Hungry, Chile, Poland, and South Africa. In sum, the Asian emerging countries rely more on agriculture than Latin America, the emerging European market and South Africa.

Industrial added value of GDP

The industrial value added of GDP is an essential measurement of the industrial structure of a country. All our studied EMs had industrial value added of GDP of less than 50%. China, Indonesia, and Malaysia accounted for more than 43% and are in the top group of selected emerging countries. After the GFC there was a slight decline in this percentage. One of the possible reasons is that these counties manufacturing sections rely heavily on international demand.

The second group according to the percentage of industrial value added of GDP is Thailand (38%)[9], Chile (37.23%), Peru (36.48%), Russia (34.77%), Colombia (33.70%), the Philippines (32.83%), Poland (32.75%) and India (32.10%). Among them, Chile's industry ratio decreased significantly during the GFC, from 44.59% in 2006 to 37.38% in 2009. Peru and Russia also showed an apparent decline after the GFC, but others were relatively stable. Indonesia is the largest economy in the 10-nation ASEAN. Industry and service are the two main economic drivers' accounting for 46% and 40% of GDP in 2017 respectively. The major sectors included manufacturing, mining, construction, transport and communication, finance and real estate.

The least contribution of the industry selected emerging countries are Hungary (30.63%), South Africa (30.43%), Turkey (29.56%) and Brazil (26.44%). These four EMs industry value added of GDP all declined during the GFC.

Services, etc., value added (% of GDP)

The services and other sector percentages of GDP development is one of the indicators to show the development of a country. Among all selected emerging markets, we looked in terms of the services and other sectors. Value-added of GDP average value from 2000 to 2015 of more than two thirds was as follows: Brazil (68.06%), South Africa (66.69%), Hungary (64.89%), Poland (64.12%), Turkey (60.93%) and Russia (60.36%). Brazil, South Africa, Hungary, and Russia saw this ratio increase from 2000

[9] The number of the percentage is the average from 2000 to 2015.

to 2015. There was a small impact of the GFC to this services sector than to the industrial. Brazil and Hungary had a slight decline after the GFC, but Turkey had a significant decline after the GFC.

The Asian emerging markets' percentage of industry value added of GDP is lower than the other EMs in our selected EMs, but with an increasing trend. For Indonesia, the ratio of service section increased from 45% in 2000 to 53% in 2015. Malaysia increased with a big fluctuation, as between 2001-2003 there was the Asian crisis, therefore the service section was impacted a lot and had a dramatic decline, but after that rose with a clear increasing trend until 2009 when it reached a peak then sharply declined again. After that, from 2011 it kept increasing again. Compared to Malaysia, China's increase was relatively steady, from 39.79% in 2000 it rose to 44.73% in 2015. India has the minimum ratio of service sector among the selected counties, but also with an increasing trend.

Colombia, Chile, Peru, Philippines, and Thailand had half of GDP value added from industry. Chile and Peru had a similar pattern, and before 2006 the ratio was also similar as from 60%in 2000 it declined to 50%, then increased with a different gradient. Chile's service and other sector accounts to more percentage of value added of GDP, and dramatically rose from 2007-2009 because the industrial value added decreased sharply until 2015, when the level of value added of service reached around 63% of GDP. There was a typical pattern, after 2010 or 2011, where these four EMs service section's ratio of GDP increased. However, the Philippines service ratio kept an upward trend from 2000 to 2015, and even the GFC did not impact on it much, with it reaching 58.8% in 2015.

3.4.3. Price Indicator – Consumer Price Index, Inflation, Exchange Rate, And Interest Rate

3.4.3.1. Consumer price index- CPI

CPI is one of the most frequently used statistics for identifying inflation or deflation in a certain period, and also to measure the effectiveness of a government's economic policy. It is a measurement that examines the weighted average price of a basket of consumer goods and services, such as food, medical care, and transportation. The changing of CPI indicates changes related to the cost of living and gives ideas about price changes in an economy.

Figure 3.9 shows the increase of CPI from 2007 to 2009 and 2011 to 2015. During the GFC period, the economy went into a downturn, the unemployment rate rose and in the economic downturn, therefore, consumer prices increased slowly. Russian CPI increased the most both in the crisis period and after. Turkey, India, Brazil Indonesia, and South Africa followed and consumer prices rose in a big range also during and after the crisis. In Poland, Thailand, Hungary China and Malaysia CPI was more stable and increased within a relatively lower range compared to others. Mexico, Peru, Colombia, and the Philippines are in the middle group where CPI changed between 10-20%.

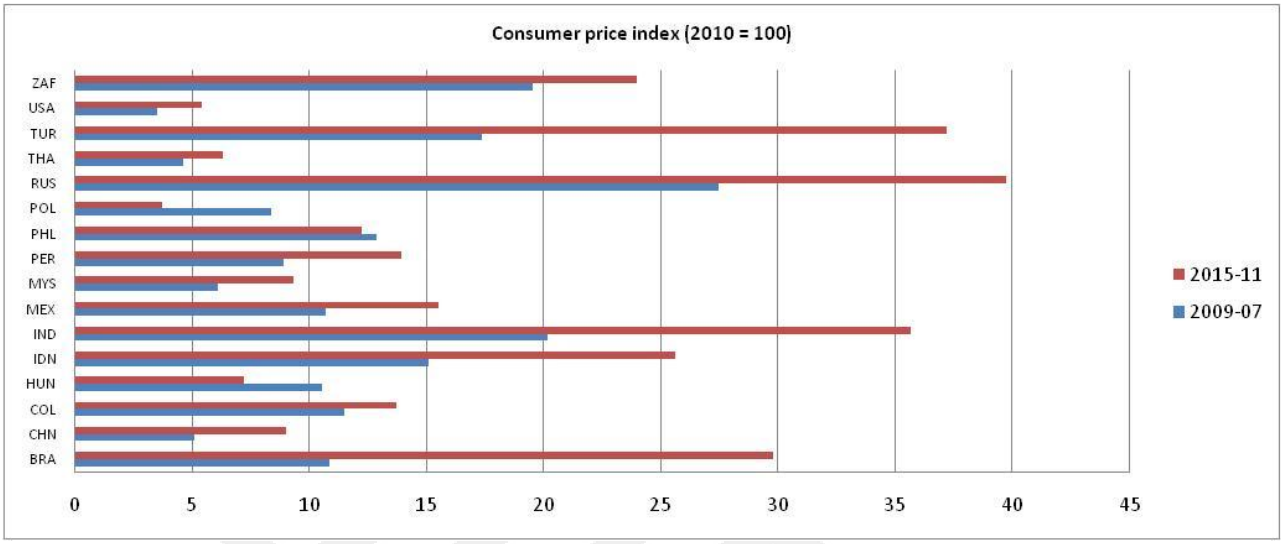

Figure 3.9: Increase of CPI 2007-2009 And 2011-2015

3.4.3.2. Exchange Rate

The exchange rate is a vital indicator to show the currency value of the country, thereby also represent the economic situation. An exchange rate is susceptible to the market and impact by many factors. During a financial crisis, because of economic growth being shocked suddenly and financial market volatility, exchange rates increase in response too.

There is no exception to that in the GFC of 2007-09 associated with significant movements in exchange rates. Kohler (2010: 39) pointed out that the exchange rate movements during the GFC were unusual. Many countries' currency depreciated sharply even though they were not located around the main crisis country, the US. One of the reasons is that financial contagion effects extended on a broader scope even beyond geographically fixed areas.

Risk aversion and the perceived risk of investing in particular currencies, plus liquidity problems, are some of the rational reasons for movements in exchange rates. During the 1997-1998 East Asian financial crisis, except for the Mainland of China and Hong Kong SAR that applied a fixed exchange rate, almost all other East Asia emerging-markets suffered substantial currency value declines against the USD. For example, the Indonesia currency lost 81.2% value against the US dollar according to IMF data, and in Malaysia, the Philippines, and Thailand currency depreciation rates were 39.1%, 37.2%, and 36.8% respectively.

The GFC was comparatively moderate compared to the Asian financial crisis of 1997-98. Goldstein and Xie (2009 : 12) calculated by using real effective exchange rates that the average depreciation for nine Asian currencies against the USD was 28% versus 5% for the 2007-09 GFC. In the table 4 we calculate for our target EM and see an average depreciation of 5.78%. However, there is an unknown factor within this generalization, such as China and Peru, whose currencies appreciated 5% and 10.8% respectively during this time. That is why the difference between the EM matters for the GFC and the basic reasons why essential learning for policymakers and investors are.

Table 3.3 shows that among the 15 selected EMs in our study, Russia's ruble experienced the most significant fall (18.2%) in its real effective exchange rate during the GFC from July 2007 to June 2009. The currencies of Turkey (16.3%) and India (15.6%) also depreciated significantly. In contrast, Peru and China's currencies appreciated in their real effective rates by 5% and 10.8% respectively. Another index from JP Morgan, the difference in weighted value, shows a more noticeable difference than the unweighted index.

During the GFC all selected EMEs ‘currencies depreciated sharply against the USD, but in contrast to the 1997-98 Asian crisis, the rebound was much faster and stronger, although the GFC impacted economic and financial markets over several years. The faster recovery may be due to the fact that after the Asian crisis many emerging markets were forced to abandon pegged exchange rates because of the risk of speculation.

McCauley and McGuire (2009: 92) pointed out that funding shortages in the non-US banking sector were the result of exchange rate pressures against the USD.

Other reasons, as Kohler (2010: 45) explained in his study, are that haven flows and interest rate differentials may explain some of the exchange rate movements. It is not hard to understand that high uncertainty and risk aversion impact on investors' decisions directly, and in seeking haven currencies they sell high-risk currency and invest in "safe" money that is supposed to be low risk and high liquidity (McCauley and McGuire, 2009: 86).

Moreover, interest rate differentials became an increasingly important factor that through short-term investment influenced the exchange rate more than previous financial crises (Kohler, 2010: 43). The relationship between exchange rate movement and the interest rate had a positive steeper slope in the GFC than in the last two crises, consistent with rapid unwinding of carry trades. A possible reason is the increasing attractiveness of carrying trade depends on the short-term interest rate differential. The difference in the interest rate can bring profit although there are carry-to risk ratios that are hard to measure.

In that study, they compared the Asian crisis of 1997-98, the following Russia crisis and the GFC of 2007-09 by using 33 economies in terms of the USD and Japanese Yen, and found that the countries which depreciated the most had the highest short-term interest rate in the period prior to the crisis.

Table 3.3: Exchange Rate Movements of Emerging Economies, 2007-2009

Economy	July 07-June 09 percentage change	JP Morgan REER July08-June09 percentage change	June 97-June 98 percentage change	JP Morgan REER June97-July 98 percentage change
Turkey	-16.3	-11.7		
India	-15.6	-11.1		
Philippines	-5.6	-8	-37.2	-25.2
Hungary	-6	-1.6		
Thailand	-0.6	-1.4	-36.8	-15.7
Colombia	-9.9	-1		
Russia	-18.2	3.2		
Chile	-1.1	4.1		
Peru	5	5.1		
South Africa	-7.8	5.6		
China	10.8	6.5		
Brazil	-3.6	7		
Malaysia	-2	10.6	-39.1	-24.5
indonesia	-9.9	18.7	-81.2	-64.4

Source: The impact of the financial crisis on Emerging Asia, Goldstein and Xie (2009: 13).

Therefore, from Table 3.3 showing exchange rate movements in standard effective exchange rate for the selected economic markets, we understand that in the chosen emerging markets exchange rates all declined significantly between July 2007 and June 2009. This is also a reason why we study financial contagion. What the reason is behind this and which indicator or link spreads the crisis from one country to far away economies is the key question.

3.4.3.3. Inflation

Consumer price inflation is a complicated indicator and needs to be analyzed together with other economic indicators. It measures the sustained increase of the general level of price for goods and services in a country (Hayes, 2017). It is not good if either too high or too low. Price level rises over time indicate economic development, but at the same time if inflation is too high then purchasing power weakens, so with the same money fewer goods and services can be purchased.

Compared to other economic indicators, inflation has a different pattern for individual countries. However, during the financial crisis, most of them had a similar pattern. Except for India and Mexico, they all had a sharp drop during 2008-09, called deflation (Hayes, 2017) and it implied that the economy went down, an event which occurs typically during a recession and crisis period.

About the inflation rate, we calculated the average inflation rate from 2000 to 2015. Among all, Turkey had 17.706% and very high average inflation, because of the 2000 -2001 Turkish crisis, and inflation was at a super high level of more than 50%, and even in 2002 still had almost 45%. The next EMs with a high inflation rate is Russia with an average of 11.886%. During 2000-2002 it also has a double inflation rate than average. China, Malaysia, Peru, Poland and Thailand had a reasonable inflation rate, between 2- 3%. The other emerging markets such as Brazil, Colombia, Hungary, Indonesia, and South Africa's inflation rates were around 4-7%.

The inflation has a similar pattern for selected EMs inflation. The inflation rate rose from the beginning of 2007 until the mid-2008, reaches a peak, and then starts to fall until 2009. It can be seen that the GFC impacted on not only exports but also on domestic demand, that is supposed to be the primary engine of projected growth. Core inflation and headline inflation rates both declined.

3.4.4. Social And Welfare Indicators

In this section, we will review the selected EMs from the social and welfare dimension by analyzing people and the labor market, poverty and equity, and education perspectives. We will horizontally compare developments between countries, and explain each country's evolution from a vertical angle. Population, population growth rate, unemployment rate, dependency ratio, labor force, labor participation rate will be included in the people and labor market. Poverty headcount ratio at national poverty lines and the Gini Index are used to indicate the poor and equity dimension. HDI, Education Index, literature rate and R&D indicators will explain the education level.

3.4.4.1. People And Labor Market

There is no doubt that China and India as the most prominent emerging economies have the most population. By 2015, they reached 1.307 and 1.309 billion respectively. Brazil and Russia have more than 200 million following China and India, after that is Mexico with populations between 120 million to 150 million. The U.S. has more than 310 million people.

A significant population is potential for the labor force, but the health of the population structure is also essential. As we all know, China experienced a demographic dividend that played a positive role in Chinese economic development. The education of the population can be another factor that impacts on long-term growth. It is not easy to implement policies or any improvements with an enormous population.

The population trend is one of the contributing factors to the higher growth rates of EMs compared with the developed nations. China has experienced a demographic dividend period, the abundant working age population provided a lower-cost labor force, and it became an indispensable condition for the rapid development of manufacturing and a lower commodity price level.

According to Hale (2012: 43), Europe's population is projected to drop by 4 million to 440 million, and Japan's population is projected to drop by 18 million to 108 million. The aging population will be a negative factor impacting on development, and both Europe and Japan will have more than 35% of the population above the age of 65. However, this number will be around 10-20% of the total. Therefore, the abundant young population and healthy age structure have become the advantage of the emerging market.

China's population is expected to decline by 2050 from 1.341 billion to 1.285 billion (Hale, 2012: 43), although the Chinese government has loosened the population policy and now allows second children for a family. According to the CFA 2012 Hale (2012: 43) work, the population of the Philippines and Indonesia are expected to increase 65.6% to 154 million and 8.8% to 260 million respectively. In Africa, the expectation for population is that it will more than double.

We also notice that, among these 15 EMs, Hungary and Russia’s populations were decreasing from 2000 – 2015. From the population growth rate, we can also see the trend. China, Thailand, and Russia have a very low population growth rate, less than 0.5% after 2010. Especially Russia, Poland, and Hungary have a negative population growth rate. Therefore, their populations are decreasing. It will cause other problems like labor force, an aging population and so on.

The population development trend also depends on the fertility rate. Usually the replacement rate is 2.1; therefore often a country should keep it higher than this so they can keep the same population level. If it is less than 2.1 then the population will decrease in the future. Colombia, Brazil, China, Thailand, Russia, Hungary, and Poland had less than a 2.2 fertility rate, and except China, Russia, and Hungary, all other selected emerging markets had a decreased fertility rate from 2000- 2015.

However, these latter three had a low fertility rate already, China because of the government “One Child Policy”, and Russia's government tried to counter a low fertility rate with government support to have more children. Hungary had an average total fertility rate higher than other EU counties, but still it is not actually high. So the government made an action plan and implemented good policies on debt, subsidies, new programs, and established institutions to support population growth and encourage women to have more than two births (Adam, 2017).

Table 3.4: Population Growth Rate And Average Fertility Rate From 2000-2015

	2000-2006	2007-2009	2010-2005	Fertility rate ave00-15
MA	2.045225	1.813589	1.78343	2.281375
PH	2.00038	1.633926	1.63336	3.349938
TR	1.413053	1.225802	1.545624	2.237313
ME	1.330691	1.599866	1.435004	2.43325
SA	1.303792	1.067336	1.356016	2.640188
PE	1.276225	1.231087	1.311948	2.398683
IDN	1.384241	1.350385	1.261677	2.222825
INDIA	1.659534	1.467323	1.252692	2.205354
COL	1.372827	1.180647	1.001429	2.077096
CHA	0.649661	0.51068	0.492917	1.569875
TH	0.784555	0.531363	0.436732	1.565625
RU	-0.40999	-0.06162	0.15239	1.467125
PO	-0.19308	0.009032	-0.07232	1.311875
HG	-0.23377	-0.16164	-0.3014	1.32375
US	0.95732	0.924524	0.750262	1.989656

Note: 1. Original data from The World Bank and calculated by author. 2. CHN (China), COL (Colombia), HG (Hungary), IND (India), INDIA (Indonesia), MA(Malaysia), ME (Mexico), PH (The Philippines), PO (Poland), TR (Turkey), SA (South Africa), RU (Russia), US(The United Sates)

Labor market indicator—total labor force, labor force participation rate, dependency ratio, and unemployment rate

Table 3.5: Labor Force, Participation Rate, Dependency Ratio, And Unemployment Rate Of Selected Emerging Economies 2000-2015

Country Name	Labor force, total, 2015	labor force participation rate, average (00-15)	Age dependency ratio (% of working-age population) average(00-15)	unemployment rate
Brazil	92923319.88	70.329	48.427	8.68
China	769513106.1	78.262	38.510	4.335
Colombia	21574273.5	70.027	50.182	12.191
Hungary	4299470.188	62.031	45.692	7.957
Indonesia	111876450.4	59.580	52.091	3.961
India	462000288.4	69.560	58.262	5.998
Mexico	47871503.38	64.313	57.958	3.294
Malaysia	11808468.19	64.036	51.569	4.013
Peru	15043009.81	78.225	57.897	4.35
Philippines	36304625.44	63.933	64.911	3.616
Poland	17735962.81	65.226	42.433	12.854
Russian	75529596.13	72.140	41.187	7.137
Thailand	38195456.88	56.708	40.666	24.442
Turkey	24262350.5	77.838	53.441	1.238
South Africa	154396282.5	51.304	55.628	9.597
United States	18524757	73.647	50.202	6.303

Note: all original data from World Bank and calculated by author. The labor force is 2015 data, The three indicators are average value from 2000 to 2015.

Total labor force and participation rate

As the two most populous countries, China and India have the largest labor force as well. By 2015 China and India had 787.073 and 503.835 million labor forces respectively aged between 14-65 years old, 4.9 and 3.1 times more than U.S. total labor force respectively. Indonesia and Brazil also have more than 100 million in the labor force. Then comes Russia (76.289m), Mexico (56.019m), the Philippines (42.982m) and Thailand (38.889m) with a total labor force between 30 to 80 million in 2015. Then the next group includes Turkey, Colombia, South Africa, Poland, Peru, and Malaysia, with total labor forces ranging from 14 to 30 million. The least one in terms of labor force is Hungary that only has 4.299 million as a labor force.

The total labor force (Table 3.5) shows that all selected countries in this study have an increased whole labor force trend with a different pattern of increase. Brazil, China, Colombia, India, Mexico, Malaysia, Peru, and the Philippines have a smooth increasing pattern; the others have a fluctuated model. Although the speed of the rise is changing as shown from the table 6, China, Brazil, and Peru’s labor force increase speed slowed down after 2010, and in contrast, Malaysia, Hungary, Poland, and Turkey's labor force increased faster after the GFC. Thailand and Poland had a slight decline in the labor force after 2012.

Labor force participation rate, total (%of total population ages 15-64)

The labor force participation rate patterns are changing among the 16 markets, as the table 6 shows. China and the US almost have a smooth decreasing trend, while in Brazil, India, Indonesia, Peru Thailand, and South Africa the participation rate declined after the GFC. Colombia and Russia roughly had a flat increasing trend. Hungary, Mexico, Malaysia, Poland, and Turkey experienced a steady rate and from a time point started to rise, most of them after the GFC.

If we consider the average labor force participation rate from 2000- 2015, China, Peru, Thailand, Russia, Brazil, and Colombia had more than 70% population aged 15-64 active in the labor market. The second group includes Indonesia, Poland, Malaysia, Mexico, the Philippines, and Hungary with labor force participation rates of between 60 and 70%. The last group is India, South Africa, and Turkey where around a 50-60% working-age population participates in the work market.

Dependency ratio

Dependency ratio measures the ratio of people who are not of working age, younger than 15 or older than 64, who are not included in the working-age population. From the dependency ratio Table 3.5, we can classify all selected markets into two groups. One is a smooth decline trend from 2000 to 2015, and they are Brazil, Colombia, India, Indonesia, Mexico, Malaysia, Peru, the Philippines, Turkey, and South Africa.

The other group experienced decreases reaching to a low point and then started to increase, including China, Hungary, Poland, Russia, Thailand, and the US.

From the population trend, we know most EMs try to encourage women to have more children and increase the fertility rate. For example, the Chinese government recently relaxed the "One Child policy" to support a family having 2 children. It is possible that the dependency rate rises because of more children. Another reason could be that life expectancy at birth has increased because of better quality medical care and life standards. Therefore, aging people more than 65 years old have also increased in number.

Unemployment rate

Unemployment is another important macroeconomic indicator. Advanced country and U.S. unemployment rates are around 6.838% and 6.306% respectively, according to IMF data. We classified our selected emerging markets by comparison with these two. We can see from Unemployment Table 3.5 that South Africa had a very high unemployment rate, reaching 24.813%. Poland, Colombia, Turkey, Brazil, Hungary and Russia also had high unemployment between 7 to 13%, but most of them had a downward trend. Not surprisingly, most the Asia EMs had a low and sound unemployment rate, like Indonesia, China, India, the Philippines, Malaysia, and Thailand, with an unemployment rate in the range from 1 to 6%.

The high unemployment rate is one of the severe problems for South Africa. Until 2016, it reached 26.3%, a historical record. Around 50% of youth between 15-24 are jobless, although the South African government implemented an Employment Tax Incentive. In addition, the particular institutions established for improving job opportunities, like the Inter-Ministerial Committee on Public Employment Program and many measurement action plans from the National Youth Development Agency.

3.4.4.2. Poverty And Equity

Poverty headcount ratio at national poverty lines (% of population)

There is a significant difference between emerging economies and developed economies in terms of the poverty line. Table 3.6 shows the national poverty headcount ratio that is the percentage of the population living below the federal poverty lines. One thing we noticed from Table 3.6 is that the average poverty headcount ratio in 2010-2015 increased from the 2007-2009 GFC time. In other words, after the GFC the poverty ratio rose. This also indicates that the GFC impacted on the real economy and life significantly.

Comparing among the selected EMs, South Africa is the poorest with more than 60%of the population living under the poverty line. Then come Mexico (46.2%), Colombia (44.34%) and India (33.5%) with more than one-third of the population living under the national poverty line. The best performance was in Malaysia where an only 4.78% poverty headcount ratio was less than 5%. The others were between 10 to 30% of the population being impoverished.

Although emerging economies develop very fast, the per capita income and the high poverty ratio plus the difference between the poor and the rich are potential problems for long-term development. This means one of the aims of the EMs' leaders is also to improve the quality of life.

Table 3.6: Poverty Headcount Ratio At National Poverty Lines (% Of Population)

Poverty headcount ratio at national poverty lines (% of population)					Gini Index
		2000-2006	2007-2009	2010-2015	Ave-2000-2015
South Africa	ZAF	66.60	62.10	64.35	0.62
Mexico	MEX		44.40	46.2	0.47
Colombia	COL	47.53	41.15	44.34	0.54
Peru	PER	54.50	37.73	46.12	0.48
India	IND	37.20	29.80	33.50	0.4
Philippines	PHL	25.75	26.30	26.03	0.42
Thailand	THA	30.85	19.43	25.14	0.4
Poland	POL	17.32	17.20	17.26	0.33
Brazil	BRA	22.27	14.50	18.38	0.55
Russian Federation	RUS	20.75	13.23	16.99	0.4
Indonesia	IDN	17.63	15.40	16.51	0.35
Hungary	HUN	13.90	12.37	13.13	0.3
China	CHN	n/a	n/a	10.25	0.43
Turkey	TUR	20.94	6.50	13.72	0.406
Malaysia	MYS	5.85	3.70	4.78	0.4617

Note: 1. World Bank Data and calculated by Author.2. n.a means the data is not available.2. The last column from the right is the Gini Index for selected EMs average value from 2000- 2015. Data source is the World Bank but calculated by Author.

Gini Index

As well as the poverty headcount ratio at national poverty lines indicating the poor population ratio, the equality measure is important to see wealth and income distribution. Is wealth is concentrated in the hands of a few people or is it evenly distributed? The GINI Index is widely used to measure the inequality of wealth and income distribution, and the range is between 0 and 1, 0 representing equally distributed and 1 representing inequality (Table 3.6).

South Africa has the highest Gini index in the world; an average of 0.62 out of 1, over 0.5 on the Gini Index indicates inequality of wealth and income distribution. Brazil and Colombia are 0.55 and 0.54 respectively, also a high value. Then Peru, Mexico, Malaysia, China, the Philippines, Turkey, Thailand, Russia and the USA's Gini Indices are between 0.4-0.5. Indonesia, Poland, and Hungary are less than 0.4. Among all, Hungary has the lowest Gini Index at only 0.3 out of1, and it shows that the equality in distribution of income and wealth is much better there than in the other selected EMs.

3.4.4.3. R&D, Literature Rate, Education Level And HDI

The Human Development Index (HDI) is formed from three dimensions including health, education and knowledge, and standard of living to measure the development of people and the capabilities of a country (U.U.N.D, 2018). It is useful to compare two nations that have similar GNI per capita, to gauge their government policies in promoting society and human development or not. Life expectancy at birth is used to assess the health dimension. The knowledge dimension is measured by the mean years of schooling and expected years of education, which form the education index. Logarithm GNI per capita measures a decent standard of living.

Table 3.7: HDI, R&D, Literature Rate, Education Index, And School Enrollment

Data source: World bank and calculated by Author. Note: n.a. indicates data is not available

	HDI Index				R&D	literate rate	education index	School enrollment, primary and secondary (gross), gender parity index (GPI)		
country	HDI Rank 2017	90-99	00-06	2007-2015	Ave00-15	percentage	2015	00-05	2006-10	2010-15
Brazil	79	0.644	0.695	0.731	n.a	92.6	0.681	1.028	1.042	1.028
China	90	0.542	0.623	0.706	0.115	96.4	0.63	0.966	0.995	1.005
Colombia	95	0.623	0.661	0.707	n.a	94.7	0.469	1.037	1.043	1.025
Hungary	43	0.731	0.790	0.824	1.075	99	0.834	0.995	0.989	0.996
India	131	0.457	0.518	0.589	n.a	72.1	0.535	0.825	0.960	1.036
Indonesia	113	0.561	0.621	0.667	0.773	93.9	0.622	0.979	0.994	1.001
Malaysia	59	0.680	0.729	0.773	0.037	94.6	0.7	n.a.	n.a.	1.040
Mexico	77	0.670	0.714	0.748	1.002	94.4	0.655	1.020	1.030	1.033
Peru	87	0.638	0.688	0.723	n.a	94.5	0.672	0.981	1.005	0.998
Philippines	116	0.599	0.636	0.669	0.439	96.3	0.637	1.027	1.023	1.014
Poland	36	0.738	0.797	0.835	n.a	99.8	0.852	0.987	0.993	0.988
Russian	49	0.711	0.741	0.790	0.479	99.7	0.816	0.996	0.989	0.991
South Africa	119	0.641	0.615	0.644	0.548	94.3	0.705	1.006	0.999	0.989
Thailand	87	0.607	0.672	0.724	0.324	96.7	0.641	0.994	1.024	1.016
Turkey	71	0.604	0.674	0.740	0.705	95	0.668	0.837	0.925	0.970
United States	10	0.874	0.892	0.912	0.238		0.9	1.002	1.003	1.002

The HDI Table 3.7 shows the selected 15 EMs and US HDI index, and there is big vast difference between US and EMs, from the rank and index. According to a 2017 HDI report, US ranks 10, but the best EMs among our study, Poland, ranks 36, followed by Hungary (43rd) and Russia (49th). It shows European EM have better human development than Asian Ems. Malaysia (59th) is the best HDI rank among Asian emerging markets. The middle group includes Turkey (71st), Mexico (77th), Brazil (79th), Peru (87th). China (90th) and Colombia (95th) rank higher than 90. The worst HDI are Indonesia (113th), the Philippines (116th), South Africa (119th) and India (131st). Although if we focus on the individual market, all of them try to increase HDI, yet still there is a vast difference between them.

In terms of the literacy rate, with the exception of India's 72.1% literacy rate, all other EMs are more than 94 percent. This indicates the education level of India is poor, that is why the whole HDI is low score and rank. Interesting is that Colombia has a very low education index, even less than India, while others are a similar order as the HDI rank. The education index is one dimension of HDI. Considering school enrollment, we can divide the whole into two groups according to a value more or less than 1.000, and the difference among them is small for this indicator.

In Table 3.7, one more indicator is R&D, representing research and development referring to innovation, investment in high technology to improve existing products and procedures development. Due to data availability issues, there are 5 EMs with no data, so we can only compare the other 10. In the Table 3.7, the data shows the percentage of R&D expenditure of GDP. Hungary and Mexico are at the top, then Indonesia, Turkey, South Africa, Russia and Philippines at more than 30% GDP investment in R&D. China only has 11.5%, and Malaysia has 3.7% from all available data.

CHAPTER FOUR

AN OVERVIEW AND COMPARATIVE ANALYSIS OF THE SELECTED EMERGING STOCK MARKETS AND THE IMPACTS FROM THE GFC

From the last decade, stock markets have attracted a great deal of attention, as the critical source of financial development. Also, they play a significant positive role in economic growth. This is particularly true for the emerging stock markets (EMS), which take an increasing share of the world stock market, and have become attractive to investors and researchers.

We divide this chapter into two main sections. The first section provides an overview of the emerging stock markets. Besides basic definition and development information, we establish a framework about the dimensions and indicators that measures and illustrates the development of the stock market. According to this framework, we did a comparative analysis among the 15 selected emerging stock markets and US stock markets. The second section gives a brief review of the general impacts of the GFC on the emerging stock markets.

This chapter lays the foundation for the next three chapters for quantitative empirical analysis of the financial contagion effect and contagion channels. We will apply different econometrics methods to identify the contagion effects of the GFC from the US to the selected emerging stock markets.

4.1. A Comparative Analysis Of The Development Of Stock Exchanges In Selected Emerging Market Economies

This section has a brief introduction of the selected emerging stock markets. Section 4.1.1describes the definition and the general development of the EMS. Section 4.1.2 reviews all selected EMS by basic information and 4.1.3 does a literature review about indicators of the development and evaluation of the stock market and establishes a framework for this study. Section 4.1.4 provides a comparative analysis of the selected EMS based on the framework and 4.1.5 describes the consequences impacted by the the GFC on the selected EMS.

4.1.1. Definition And Selected Stock Markets

The stock market is a market where trading of company stock includes the listed securities and unlisted ones in the national scope (Kaur, 2014: 549), thus it is different from the stock exchange. Stock exchanges are the marketplace where, organized by either the corporation or mutual organization, only their members or stockbrokers have a seat on the exchange to trade company stocks or other securities. The members play the role either as the agents for their customers or as principals for their accounts. Stock exchanges facilitate the issue and redemption of financial instruments that include payment of income and dividends.

In our study, we use the main national stock market to investigate the stock markets of the selected emerging countries. Our selected stock markets consisted of the national stock indices of Brazil (IBOV), China (SSEC), Colombia (COLCAP), Hungary (BUX), India (SENSEX) Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), Poland (WIG), the Philippines (PSEi), Russia (MICEX), South Africa (JALSH), Thailand (SETI) and Turkey (XU100) index, and the US(S&P 500 index). All the national stock-price indices are in local currency and based on daily closing prices in each domestic market. The source of all data is DataStream International.

4.1.2. The General Development And Brief Introduction Of The Selected Emerging Stock Markets

The size and number of stock markets grew steadily from the 1970s and 1980s, especially during the 1990s as a wave of liberalization and strong economic development in the emerging market played a fundamentally positive role of promotion.

In recent years, the share of the emerging stock market has increased significantly, whereas the US stock market has decreased tremendously from 50% to less than 35% according to Kaur (2014: 549).

During the 1970s and 1980s the stock markets in many developing countries newly opened or emerged, although some area had limited growth while others developed much faster, such as Latin America, Brazil, Mexico, India, Indonesia, Malaysia, Thailand, and China, etc. that were the emerging economies. Particularly after 1994 these markets were also opened to international traders instead of only to domestic ones and that encouraged and attracted international investors and facilitated the financialization of the financial and stock markets. The stock markets of the world developed steadily and with consistent growth. Kaur's (2014: 556) analysis of the evolution of the world's major stock markets confirmed this.

4.1.3. A Brief Introduction Of The Selected Emerging Stock Markets

In our study, we chose the main stock index from the selected EMs; below are a brief introduction. Table 4.1 shows the basic information about the established time, location, currency, indices and market capitalization. We can see that almost all of them have a long history and developed rapidly along with economic growth. We give a brief introduction about each market, and detailed information will be given in the following comparative section.

Table 4.1: Basic Information About The Selected Emerging Stock Markets

country	Aimed indices	Location	Currency	No. of listing	Market cap.	Other Indices	year establish
Brazil	Ibovespa	São Paulo, Brazil	Brazilian real	368	US$ 1.0 trilion (2018)		August 23, 1980
China	SSE Composite SSE 50	Shanghai, China	RMB	1041 (May 2015)	US$ 5.5 trilion (May 2015)		November 26, 1990
Colombia	COLCAP	Bogotá, Colombia	Colombian peso	89	US$ 236 billion		November 23, 1928
Hungary	BUX	Budapest, Hungary	Hungarian Forint	58 (Oct 2017)	US$ 29 billion (May 2018)	BUMIX CETOP	January 18, 1864
India	S&P BSE SENSEX	Mumbai, India	Indian Rupee		US$ 461 billion	SENSEX BSE 30	1875
Indonesia	IDX Composite	Jakarta, Indonesia	Indonesian Rupiah	567 (Dec 2017)	IDR 7.400 trillion (Jan 2017)	Jakarta Islamic Index LQ-45 Indeks Kompas100 Indeks BISNIS-27 Indeks PEFINDO25 Indeks SRI-KEHATI	December, 1912
Malaysia	MYX: 1818	Kuala Lumpur, Malaysia	MYR		US$ 189 billion (Apr 2004)		1964
Mexico	IPC	Mexico City, Mexico	Mexico Peso	140	US$ 402.99 billion (Feb 2016)	September, 1933	
Peru	S&P/BVL Peru General Index	Lima, Peru	Sol	282 (2017)	US$ 37.9 billion (2008)	IGBVL, S&P PERUGEN, S&P PERUSEL, S&P LIMA25, S&P IBGC ISBVL	December, 1860
Poland	WIG	Warsaw, Poland	PLN	479 (2017)	EUR 319 billion (2017)	WIG20 WIG30	April, 1991
Philippine	PSEi	Manila, Philippines	Philippine Peso	344 (2012)	US$ 896.58 billion (2017)		(MSE) 1929 (PSE) 1992
Russia	MOEX Russia Index	Moscow, Russia	Russian Ruble	219	US$ 635 billion (2016)	RTS Index	December, 2016
South Africa	JSE Limited	Johannesbur g, South Africa	Rand	388	US$ 1007 billion (2013) R 14271 billion (2016)	FTSE/JSE All Share Index FTSE/JSE Top 40 Index	November, 1887
Thailand	SET	Bangkok, Tailand	Tahi Baht	688 (2017)	US$ 569 billion (2018)		April, 1975
Turkey	BIST	Istanbul, Turkey	Turkish Lira	371	US$ 220.62 billion (2012)	BIST 30 BIST 50 BIST 100	1866 (as Dersaadet Securities Exchange) December 26, 1985 (as İMKB) April, 2013
U.S.	S&P 500 index	New York, U.S.	USD		US$ 23.9 trillion (2017)	S&P Dow Jones Indices NYSE NASDAQ	March, 1957

Brazilian Stock Exchange (IBOVESPA)

According to the StockMarketClock (2019)[10], The Brazilian Stock Exchange was founded on August 23, 1890, by Brasil, Bolsa, and BAlcao, and located in Sao Paulo, Brazil. In terms of the Market Capitalization ($837.77 Billion, March 2018), IBOVESPA is the 19th out of 79 global equity exchange markets, and the listed companies on the Bovespa are primarily local Brazil-based companies, and there is a different exchange for outside companies.

Shanghai Stock Exchange (SSE, 2015)[11]

The Shanghai Stock Exchange was the first stock trading and exchange market in China, which was formed on November 26, 1990, and started formally on December 19 in the same year, although in the early 1860s stock trading had already appeared in Shanghai. The primitive form of the stock bourses in China was the Shanghai Share Brokers Association that was established in 1891. After that Shanghai Security Goods Exchange and The Shanghai Chinese, Security Exchange started to operate in late 1920 and 1921 respectively. Shanghai became the financial center of the Far East by 1930s, and allowed not only local Chinese but foreign investors to trade many financial derivatives including stock, debentures, government bonds, and futures.

After China's 1978 reform and opening up policy since 1980, the SSE developed rapidly with the growth of the socialist market economy. In 1981 trading in treasury bonds was resumed that had been ceased in 1949. Stocks and enterprise bonds emerged in 1984 in Shanghai and a few other cities. By 2018, having experienced 28 years of development and evolution, the SSE had grown up and became the 4th rank in the world in terms of market capitalization with a great number of investors and list companies. Moreover, the SSE has a comprehensive and diversified stock market available for stock, bonds, funds, and many kinds of derivatives products to exchange. Besides, the SSE has

[10] It is available in this link: https://www.stockmarketclock.com/exchanges/bovespa
[11] SSE official website available link: http://english.sse.com.cn/aboutsse/sseoverview/brief/

an international level of exchange system and well-facilitated infrastructure, a relatively self-regulatory system, and stable government supporting background and is based on one of the biggest populations in a promising emerging country.

Colombia Stock Exchange (Spanish: *Bolsa de Valores de Colombia*, BVC[12])

The Colombia stock exchange was founded on November 23, 1928, and located in South America. It is the 36th largest exchange out of the leading 78 stock exchanges with USD 136 Billion (2018) market capitalization. The current BVC resultedfrom the merging of three independent stock exchanges in 2001: Bogotá (Bolsa de Bogotá, 1928), Medellín (Bolsa de Medellín, 1961) and Occidente (Bolsa de Occidente, Cali, 1983). The BVC does not have independent oversight and regulatory functions but is overseen by Super intendencia Financiera de Colombia, which is the government agency established in 1923 and responsible for managing financial regulation, protecting investors and to organize, promote and develop the security of the market (StockMarketClock-bvc, 2019). The BVC market index is COLCAP, and the currency used is the Colombian Peso. COLCAP index reflects the price changes for the 20 most liquid stocks at BVC.

Hungary Budapest Stock Exchange (BSE, 2019)[13]

Budapest Stock Exchange (BSE) was founded in 154 years ago in January 18, 1864, as the first Hungarian stock exchange and the second largest stock exchange in Central and Eastern European market in terms of market capitalization. The BSE plays an essential and pivotal role for the country and region's capital markets. After re-establishment in 1990, the BSE provided broader and more comprehensive high-level services in a broad range of investment instruments, and the exchange is controlled by listed issuers, Hungarian private investors, and the Hungary Central bank.

[12] Colombia stock market link: http://www.banrep.gov.co/en/stock-market
[13] Hungary Budapest Stock market: https://bse.hu/About-Us/About-Budapest-Stock-Exchange/Introduction

In addition, the BSE is a member of the World Federation of Exchanges and the Federation of European Securities Exchanges. The currency is the Hungarian forint, and up to October 2017, there were 58 listing companies listed. There are three indices, the BUX, BUMIX, and CETOP, but in our study we will use the BUX index which is the best-known Hungarian share index and based on the Xetra trading system.

Indian stock exchange market (S&P BSE SENSEX)

According to the information from the official website (BSE, 2018), the Indian stock exchange is the S&P BSE (Bombay Stock Exchange L.td.) or SENSEX (S&P Bombay Stock Exchange Sensitive Index), also called the BSE 30 or merely the SENSEX. It was established in 1875, founded as "The NativeShare&Stock Brokers Association." During the last 141 years, the BSE has become the leading exchange group of India with a broad range of trading in various markets including equity, currencies, debt, derivatives, and mutual funds and so on with an efficient and transparent system. It is famous as Asia's first and fastest stock exchange with the quickest speed of 6 microseconds in the world, and it provides an efficient capital-raising platform that facilitated corporate sector growth in India.

The BSE offers a series of services such as risk management, clearing, settlement, data series, and training to capital market participants. It has international connections around the world with its national-wide presence. In addition, the BSE is the first Indian exchange and the second in the world to obtain ISO 9001:2000 certifications and receive Information Security Management System Standard BS 7799-2-2002 certification for its online trading system. Moreover, the capital market educational institute of the BSE is the most respected one in the country. There is more than one index on the BSE, and up to September 2017 the SENSEX 30 accounted for 37% of GDP with around $837 USD. However, the share of it fell from 49% to 25% due to the rise of other indices such as BSE PSU, BSE-TECK, and Bankex, etc (BSE, 2018).

Indonesia Stock Exchange

The index of the Indonesian stock exchange is JKSE which combined the two previous stock exchanges, the Jakarta Stock Exchange (JSX) and the Surabaya Stock Exchange (SSX). Initially established in December 1912, due to World War I and II, it closed and reopened, until in 1977 the Capital Market Supervisory Agency was created by the Ministry of Finance and started to manage the stock market. Therefore, it belongs to the financial services authority. The Indonesian stock market developed very fast from the 1990s in that Bull Run period, based on the development of the financial market and the private sector.

The Indonesian stock market is an international stock exchange, according to the World Bank, and by December 2017, 51.33% were foreign investors, and 48.67% (628.346) of investors are domestic. There are seven indices on the Indonesian stock exchange, but the primary two used to measure and report stock market development are the Jakarta Composite Index and the Jakarta Islamic Index (JII). Besides these two, the IDX has four more indexes, namely Individual Index, Sector Stock Price Index, LQ 45 Index, Main Board and Development Board indices (IDX, 2018).

Malaysia Bursa Malaysia Berhad (MYX)

The Bursa Malaysia was established in 1964 and belonged to the publicly traded government-linked company under the Minister of Finance Incorporated. The predecessor was the Kuala Lumpur Stock Exchange that was founded in 1930 by the Singapore Stockbrokers' Association, then in 1964 the Stock Exchange of Malaysia was established and dealing with public trading of shares commenced. In 1973, the Stock Exchange of Malaysia and Singapore separated and became the independent Kuala Lumpur Stock Exchange Berhad and the Stock Exchange of Singapore. On 14 April 2004, the Kuala Lumpur Stock Exchange was renamed the Bursa Malaysia Berhad and after that it developed very fast (Berhad, 2019).

From 2005, the Bursa Malaysia Berhad launched different programs. According to a 2009 report (Berhad, 2009: 18), it had great achievements in terms of accessibility, efficiency, innovation of new products and services, and internationalized markets. Currently, Bursa Malaysia provides a wide range of products and services including equities, derivatives, offshore listings and services, bonds and Islamic offerings.

Mexican Stock Exchange (Bolsa Mexicana de Valores, Spanish)

The Mexican Stock exchange was founded on 5th September 1933 and belonged to the BMV Group, and it merged Bolsa de Valores de Mexico and other two exchanges into the Mexican Stock Exchange by law in 1975. It is the second (the first is Sao Paulo) and fifth largest stock exchange in Latin America and the Americas respectively, in terms of the market capitalization of $402.99 billion in February 2016. Among the 13 indices of the BMV, IPC is the primary benchmark stock index, and it stands for Indice de Precios y Cotizaciones. The IPC index has included BMV's own A shares since February 2009.

The Mexican Stock Exchange kept modernizing and had consolidated a fully electronic trading system by 1999. A milestone development was in 2001, when Citigroup as the first foreign group started trading on the BMV that led many other companies, especially from Central and South America. After that the market started to enter the international market step by step, in 2003 first allowing the local investor access to foreign securities from within the country. In 2006, the MexDer system opened the Mexican securities market to foreigners, after that in 2010 it reached the international market by signing an alliance with Chicago Mercantile Exchange that is world's largest derivatives exchange.

One conceived step of integration for the Mexican Stock Exchange was joining the Latin American Integrated Market (MILA) on 2 Dec. 2014, which includes Chile, Colombia, and Peru. The joint MILA strengthened market power and moved towards integrations members of the Pacific Alliance.

Peru Lima Stock Exchange (Bolsa de Valores de Lima, BVL)

Lima Stock Exchange was established in 1860 and started operation in 1861, but in the first 30 years there was no stock trade. It is located in the capital Lima and owned by MILA. The S&P/BVL Peru General Index is a value-weighted index among several indices because it tracks the largest and most frequently traded stock's performance on the Lima Exchange (Chen, 2018). Besides the trading floor, business is also conducted on an electronic system established in 1995. The development speed of the stock market is slow because Peru is a small economy, but it has extended steadily. For example, by June 2017 the number of listed companies was around 280.

Poland Warsaw Stock Exchange (WSE)

The Warsaw Stock Exchange (WSE) is the Polish stock market and located in Warsaw, and it was established on 12 April 1991. It has the WIG, WIG20 and WIG 30 indices. The WSE is a joint stock company by State Treasure that holds a 35% share in capital. In also provides a broad of range of instruments. WSE provides both trading platform and electronic trading. Warsaw Stock Exchange is the 33rd largest exchange out of 78 in terms of market capitalization, which was $168.09 billion in 2018 (GPW, 2018).

The Philippines Stock Exchange-PSE

The Philippine Stock Exchange (PSE)[14] as the only stock exchange in the Philippines, and it is also one of the oldest in Asia. It merged two former stock exchanges in the Philippines, namely, The Manila Stock Exchange (MSE) established on August 8, 1927, and the Makati Stock Exchange (Mkse) which was established on May 27, 1963. Therefore, the PSE started operation since 1927, but was officially established on December 23, 1992. (PSE, 2018)

[14] The Philippine Stock Exchange: https://www.pse.com.ph/corporate/home.html?tab=0

In 2001 the nature of the PSE transformed from a non-profit, non-stock, member-governed organization into a shareholder-based, revenue-earning corporation headed by a president and a board of directors (Wikipedia, 2018)[15].

Russia Moscow Exchange

Moscow exchange was established by the merging of two stock markets, the Moscow Interbank Currency Exchange and the Russian Trading System on 19 December 2011, and it is the largest exchange group in Russia and belongs to a public company operating under Russia's Central securities depository and provides the country's largest clearing service (MoscowExchange, 2011-2019). The trading market of the Moscow Exchange includes an equity & bond market, foreign exchange and money market, derivatives, and commodities market.

South Africa-Johannesburg Stock Exchange (JSE)

Johannesburg Stock Exchange is one of the oldest and largest stock exchanges in South Africa, and is ranked 17th in terms of capitalization out of the 78 stock exchanges (JSE, 2018). During the first South African gold rush in 1987 JSE was founded (JSE, 2013) and it had joined the World Federation of Exchanges in 1963 by following the first legislation covering financial markets in 1947. By the 1990s the JSE had upgraded to an electronic trading system. In 2005 the JSE demutualized and listed on its exchange.

The JSE offers five financial markets including equities and bonds, commodity and Interest Rate Derivatives and in 2001 the JSE acquired the South African Futures Exchange (SAFEX).In 2003 an alternative exchange for small and mid-sized listings, AltX, was launched. The equity market of JSE has two indices, the FTSE/JSE Africa Index Series, which covers 99% of market capitalization and almost 400 companies listed on Main Board and AIX.

[15] http://www.wiki-zero.net/index.php?q=aHR0cHM6Ly9lbi53aWtpcGVkaWEub3JnL3dpa2kvUGhpbGlwcGluZV9TdG9ja19FeGNoYW5nZQ

Thailand Stock Exchange of Thailand (SET[16])

The Stock Exchange of Thailand was founded on 30 April 1975 in HuaiKhwang, Bangkok, Thailand. The SET has 688 listed companies with $560 billion market capitalization. Although in the early 1960s Thailand implemented its first 5-year economic development plan, the first exchange could not survive due to lacking interest, modern technology and equipment, and know-how. During the 1970s with the development of the country, renewed efforts were made and established the exchange operation professionally. The Securities Exchange of Thailand started service in 1975, and was renamed the Stock Exchange of Thailand in 1991, in a set of regulations formalized by the Securities and Exchange Act of 1992 by the government. After that, the SET capital market developed rapidly in the 1990s with the growth of the economics as the member of the "Asian Tigers" (SET, 2018[17]).

The Stock Exchange of Thailand developed rapidly and by 2017 it has more than 600 listing companies and the market capitalization has increased almost five-fold compared to 2008. The listed companies' sectors are diversified and include consumer staples, consumer discretionary, financials, energy, real estate, utilities, and telecommunications sectors (SET, 2018). On 10 September 2014, the SET became the first Southeast Asian country and ASEAN member to join the United Nations Sustainable Stock Exchanges Initiative (SET).

Turkey Borsa Istanbul (BIST)

According to the Borsa Istanbul (2013-2019), The Borsa Istanbul is the sole exchange entity of Turkey and merged the former Istanbul Exchange (ISE), the Istanbul Gold Exchange and the Derivatives Exchange of Turkey. It was officially operated on April 5, 2013, but the predecessors opened in 1866 as Dersaadet Securities Exchange and in 1985 as IMKB. Therefore, the shareholders of BIST are 49% of government, 41%

[16] Stock Exchange of Thailand: https://www.investopedia.com/terms/s/set.asp
[17] https://www.investopedia.com/terms/s/set.asp

IMKB, 5%VOB, 4% IMKB members, 1% IMKB brokers and 0.3% IAB members. The indices of the BIST are the BIST 30, BIST 50 and BIST 100, and the BIST 100 includes another two.

American stock market and Standard & Poor's 500 indexes (S&P 500)

The Standard & Poor’s 500 is based on the market capitalizations of 500 large companies in America that have common stock listed on the NYSE (New York Stock Exchange) or NASDAQ. The NYSE is by far the world’s largest stock exchange by market capitalization (ZACKS, 2017). It was founded in 1792 in New York, has more than 225 years of history, 2400 listings and reaches $23.2 trillion capitalization (NYSE, 2016). The NYSE belongs to Intercontinental Exchange, which is also a listed American holding company.

4.2. Important Indicators And The Framework For Stock Market Development

The measure of stock markets has attracted more and more interest from scholars because the role of stock markets has been increasing over time. The framework and indicators vary from study to study. As El. Wassal (2013: 621) concluded finding that it is a complicated, complex and multi-faceted, multi-dimensional and long-term process to evaluate the development of the stock market. In El. Wassal (2013: 606) studies it is also mentioned that the stock market is just one part of the financial market, but the whole financial environment plays an essential role in the development of the stock market. Therefore, we have selected and analyzed the stock market indicators also considering the financial situation.

Beck et al. (2010: 77) listed and updated the indicators for financial development and structured the database. They pointed out that size, activity, and efficiency statistically, the stability of banks, nonbanks, equity market, and bond markets are essential from their analysis cross-country and over time. Besides the above-mentioned ones, many other indicators have gained importance, such as financial globalization, international bond issues, loads, offshore deposits, and remittance flows.

The Financial Sector Development Indicators (FSDI) uses statistics and analytical tools to provide a comprehensive, multi-dimensions evaluation system for the development of stock markets. It covers size, access, efficiency, and stability and combines with traditional financial sub-sectors such as banking, capital market, non-bank financial sectors, and institutional environments (Sukcharoensin and Sukcharoensin, 2013: 344).

The stock market, like any other market, is a complex and multifaceted concept. In our study, we establish a common use framework and indicators to examine the development and brief information about the selected stock markets from five dimensions, including market size, access, liquidity, efficiency, stability and volatility, institutional development and integration into the world stock market. Bayraktar (2014: 84) mentioned that all the financial markets are related to each other. One improvement will lead others to get better as well.

Market size

The size of the stock market is the general indicator to evaluate the development of the stock market. The most frequently used indicators are market capitalization ratio of GDP, market capitalization of listed companies ratio of GDP, percentage of total stock traded of GDP, and the ratio of stocks traded turnover.

Levine (1991: 1445) and Bencivenga, Smith, and Starr (1999: 233) pointed out the importance of stock market liquidity, that is how easily trading securities facilitates investment in the short and long term. Demirguc-Kunt and Levine (1996: 295) pointed that higher liquidity will allow investors to change their investment portfolios at lower cost and lower risk, but also faster and so facilitating longer-term more profitability. Theoretically, according to Demirguc-Kunt and Levine (1996: 295), the liquid markets benefit capital allocation and long-term economic growth. A comprehensive measurement for liquidity requires cost trading, such as time, place, uncertainty cost and so on.

However, given the limitation of data availability we use the percentage of total value traded to GDP, according to the World Bank methodology and database, the total number of listed and admitted to trading companies' shared trades, which includes both domestic and foreign shares, multiplied by their respective matching prices, and only one side transaction is considered. In the calculation method, the ratio of trade indicates the equities as a share of national output that is supposed to positively reflect the liquidity.

Moreover, another indicator for liquidity is the turnover ratio, which is the value of domestic shares traded divided by their market capitalization, according to the World Bank calculation. The higher turnover ratio implies lower transactions costs. If the turnover ratio is high but the capitalization is relatively low it means that the market is small but active.

Sukcharoensin and Sukcharoensin (2013: 343-4) applied the FSDI to analyze the ASEAN-5 equity markets. They mention that accessibility for investors and firms to the market is a critical factor to measure the stock market development. If market access is low cost it attracts more investment, and market size and liquidity will expand.

In addition, the concentration of the market can also be used to measure access, and according to the World Bank concentration can measure the market share of the largest 10 firms in terms of the capitalization. If most of the market is accounted for by the bigger companies, a monopoly may exist and the fair competition and vigor of the market will be limited. Moreover, it will hard for small companies develop, raise funds and take a stable and significant share of the market. Bayraktar (2014: 82) pointed out that all the financial markets impact on each other, so if one improves the others will get better as well, and vice versa.

According to the literature and other official reports and academic work, we established our framework considering the data source availability. It includes five dimensions and ten indicators. The dimensions are size and activities, access and liquidity, efficiency, stability and volatility and institution and government see (table 10). Some signs can measure different aspects, such as the number of listed companies and the ratio of stock traded total value of GDP and the turnover ratio of GDP can either measure the size of the stock market and the liquidity.

Table 4.2: Framework For Measuring The Development Of The Stock Market

Dimensions	**Indicators**
Size and activities	Market capitalization
	Market capitalization of listed companies % of GDP
Access and liquidity	stock traded total value % of GDP
	Stock traded, turnover ratio (%)
	listed domestic company
	Value trade excluding top 10 traded companies to total value traded
Efficiency	Average total cost
	The stock market return
Sability and Volatility	Stock price volatility

Source: created by the Author.

4.3. The Evaluation And Development Of The Selected Emerging Stock Market

We analyze the development of the selected emerging stock markets according to the framework, five dimensions and ten Indicators as in Table 4.2.

4.3.1. Stock Market Size

The market capitalization, the ratio of stock market capitalization in percent of GDP, the indicator as activities in the ratio of stock market total value traded in percent of GDP, and stock market turnover ratio. Among all, the most used are market capitalization and the ratio of GDP.

4.3.2. Market Capitalization

Market capitalization as one of the critical indicators from the ability of capital allocation and risk diversification aspects to show the size and development of a stock market. There are 60 major stock exchanges in the world with a total value of $79 trillion (2017 World Bank). The NYSE is still (Desjardins, 2016) in the top position, bigger than the other 50 major stock exchanges, and accounting for 27% of the total market for global equities (Desjardins, 2016). Compare to other countries, the US stock market accounted for 40.5% of the world stock market in 2015, and although this number had declined a little from 48.74 % in 2000, it is still the biggest stock market.

The first important common characteristic is that the selected emerging stock market share of the world market increased significantly from 2.78% in 2000 to 21.87% in 2015, hence around one-fifth of the world stock market capitalization is collected in these 15 emerging stock markets (see Figure 4.1). The first group is BRICS, which up to 2017 were $8.19T, $2.33T, $1.23T, $954.72M, and $623.42M. The second group range of market capitalization, from 100 million USD to 600 million USD according to the World Bank data in 2017, included Thailand, Indonesia, Malaysia, Mexico, the Philippines, Turkey, Poland, and Colombia. Peru and Hungary is the last group compared to the others and the value of the market capitalization is less than 100 million USD.

The second one is that all selected EMs' markets capitalization was negatively and significantly impacted by the GFC. They all reached a peak in 2007 and had a dramatic decline from 2007- 2009 during the GFC period. From the Table 4.3, the change from 2007 to 2008 and 2007 to 2009 was negative to a significant number. The market capitalization for the world dropped by 46.49% during 2007-08, for the USA it declined 41.82%, for the individual selected EMs, India, China, Hungary, Poland, Brazil, and Indonesia it dropped more than 50% of the market capitalization from 2007 to 2008. Colombia is the least of the EMs at around a 14% decrease, and all the others except Russia (which did not have available data) were approximately a 40 – 50% decline.

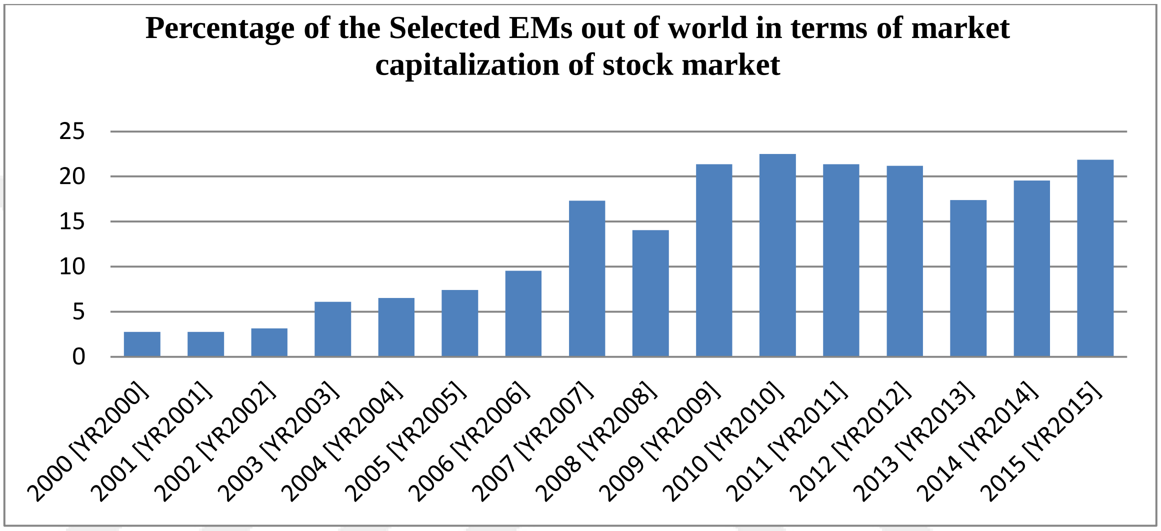

Figure 4.1: Percentage Of The Selected Ems Out Of World In Terms Of Market Capitalization Of Stock Market

Data source: The World Bank.

Market capitalization is the primary indicator for investors to forecast the security and profit and risk for their equity market investment, and to classify the company type. According to the INVESTOPEDIA, it categorized the companies into big-, mid-, and small-cap companies in terms of market capitalization.

Table 4.3: The Main Development Of Stock Market Indicators In Terms Of The Market Size, Activity, And Liquidity

		Market capitalization of listed domestic companies (current US$) ave00-15	Market capitalization of listed domestic companies (% of GDP)ave 00-15	Listed domestic companies, total ave 00-17	stocks total traded value % of GDP ave 00-15	stock traded turnover ratio % GDP 00-15
Brazil	BRA	7.46544E+11	49.01	370	24.90	54.18
China	CHN	3.2014E+12	51.87	1951	78.53	178.70
Colombia	COL	1.40381E+11	49.04	87	5.00	12.18
Hungary	HUN	24764047857	20.66	47	15.85	69.73
India	IND	1.07134E+12	76.72	410	44.43	106.07
Indonesia	IDN	2.03393E+11	32.52	5302	10.20	35.86
Malaysia	MYS	2.83342E+11	136.87	142	40.65	31.35
Mexico	MEX	3.13578E+11	30.47	917	7.73	28.04
Peru	PER	50655183750	39.10	203	2.74	7.72
Philippines	PHL	1.08505E+11	55.21	246	9.23	17.12
Poland	POL	1.19192E+11	29.10	517	10.38	37.65
Russian	RUS	6.95964E+11	40.18	352	26.88	47.09
South Africa	ZAF	6.15122E+11	211.17	526	54.53	27.97
Thailand	THA	1.97244E+11	66.44	281	49.84	82.80
Turkey	TUR	1.68411E+11	26.91	4884	39.81	163.70
United States	USA	1.75576E+13	124.59	372	220.05	183.24

Note: Data from World Bank, average value calculated by the Author. The annual data are in the appendix.

The large-cap company's minimum market capitalization is $10 billion, and they are very attractive for investors for long-term investment because they are the major actors in well-established industries with a consistent increase in share value and dividend payments.

A range of market capitalization between $2 billion and $10 billion is classified into the mid-cap companies; these have strong expanding potential but higher risk than the large-cap. If the company's capitalization is less than between $300 million to $2 billion it belongs to the small-cap group. They are young and active, develop very fast, are growing fast, but with high risk and are more sensitive to global economic and financial situations. For example, economic slowdowns or a financial crisis.

The ratio of the market capitalization of list companies percentage of GDP

Except for market capitalization, the rate of capitalization of GDP is the most used indicator to show stock market size, and it equals the value of listed shares divided by GDP. Demirguc-Kunt and Levine (1996: 294) mentioned that the market size is positively correlated with capital mobility and risk diversification.

Table 4.3 and 4.4 indicate that during the GFC of 2007-09 all our selected emerging counties and the U.S. had a significant decline in term of the ratio of market capitalization of GDP. That indicated that the financial market ratio decreased because of the financial crisis. The second significant drop was around 2011, and this is called the "August 2011 stock market fall", which was a sharp decline in stock exchanges across the US, Middle East, Europe, and Asia. France's then AAA rating and fears of contagion of the European Sovereign debt crisis could have been the right reasons for this drop.

The ratio of market capitalization percentage of GDP (Table 4.4) shows that South Africa and Malaysia among our selection have big financial markets. Especially South Africa, which takes 211.17% out of GDP, followed by Malaysia with 136.87% which is bigger even than the average of the U.S. stock market. This implies that South Africa and Malaysia's financial markets account for a substantial part of their economies, as the financial market is relatively more prominent.

Table 4.4: Market Capitalization During The GFC 07-09

	Ave 2000-06	2007 [YR2007]	2008 [YR2008]	2009 [YR2009]	2008-07	2009-07	Ave 2010-2017
WLD	34,140,706,252,569	60,304,387,757,290	32,267,926,316,880	44,607,468,031,010	-46.49	-26.03	59,583,891,069,635.20
USA	15,329,382,278,571	19,922,279,820,000	11,590,277,780,000	15,077,285,740,000	-41.82	-24.32	23,312,297,201,250.00
CHN	627,001,537,500	4,478,866,530,000	1,778,784,040,000	3,573,152,460,000	-60.28	-20.22	5,663,930,088,723.65
IND	509,724,077,500	1,819,100,510,000	647,204,770,000	1,306,520,250,000	-64.42	-28.18	1,501,743,193,462.57
ZAF	356,797,330,000	828,185,320,000	482,699,980,000	799,023,750,000	-41.72	-3.52	927,094,122,325.44
BRA	326,993,200,000	1,369,711,270,000	591,965,550,000	1,337,247,680,000	-56.78	-2.37	1,008,763,321,004.34
RUS	n.a.	n.a.	n.a.	761,735,930,000	n.a.	n.a.	669,436,037,830.57
THA	87,016,965,714	197,129,360,000	103,128,240,000	176,956,070,000	-47.68	-10.23	381,415,006,181.35
IDN	61,157,357,143	211,692,970,000	98,760,600,000	214,941,470,000	-53.35	1.53	405,905,477,492.00
MYS	159,493,024,286	325,290,260,000	189,239,210,000	289,219,390,000	-41.82	-11.09	428,603,716,722.57
MEX	176,687,341,429	397,724,640,000	234,054,920,000	352,045,440,000	-41.15	-11.49	445,554,505,452.95
PHL	32,165,935,714	102,852,740,000	52,030,600,000	86,349,430,000	-49.41	-16.05	224,977,987,028.81
TUR	91,670,312,857	284,530,840,000	117,584,350,000	231,676,450,000	-58.67	-18.58	227,295,232,137.25
POL	62,300,721,429	211,620,200,000	90,815,490,000	150,961,530,000	-57.09	-28.66	169,706,285,312.21
COL	53,352,565,000	101,955,950,000	87,716,200,000	140,519,920,000	-13.97	37.82	166,573,594,823.95
PER	18,191,674,286	69,386,470,000	37,876,760,000	71,662,540,000	-45.41	3.28	85,565,297,944.65
HUN	26,551,960,000	46,195,630,000	18,465,410,000	30,036,630,000	-60.03	-34.98	21,668,302,072.97

Note: World Bank data and calculated by the Author.

The second group is India, Thailand, the Philippines, and China whose ratios of market capitalization of GDP were more than 50%, showing the importance of the financial market in those EMs. Then come Brazil, Russia, Peru, and Mexico ranging from 30 to 50%, followed by Poland, Turkey and Hungary with less than 30% of GDP by market capitalization.

4.3.3. Access and Liquidity

One traditional indicator for measuring the development of the stock market is market liquidity. It implies how easily and quickly transfers can be made between buyers and sellers (Bayraktar, 2014: 82). The total value of stocks traded in percent of GDP (TVS/GDP) is used in analysis. (Levine & Zervos, 1998: 540). High liquidity promotes stock market development.

4.3.4. The Turnover Ratio of The Stock Market

Table 4.3 shows that the US is the most active stock market and has a 183.24 average annual turnover ratio. Among the selected emerging markets, China (178.70), Turkey (163.70), India (106.07), Thailand (82.80), Hungary (69.73) and Brazil (54.18) are very active and highly liquid stock markets (the turnover ratio is shown in brackets). The second group includes Russia, Poland, Indonesia, Malaysia, Mexico, and South Africa where the turnover ratio is between 25 to 50%. The Philippines, Colombia, and Peru have a small turnover ratio that indicates less liquidity.

It is worth mentioning that Thailand, Turkey, and Hungry have small (less than an average $529.32 million market capitalization), which means a small stock market, but they are very active because the turnover ratio is higher than the average 60.01 among the selected EMs.

Demirguc-Kunt and Levine (1996: 298) pointed that incorporating information on market capitalization, total value/GDP, and the turnover ratio can provide a comprehensive picture of the development of a stock market more than a single indicator. Turnover ratio and the ratio of the total traded out of GDP can capture trading relative to the size of the stock market and economy. In other words, if a market has a higher turnover ratio but a smaller ratio of trade to GDP, it shows this market is small but liquid and active. From Table 4.3, Hungary and Turkey are in this case, with a low value of total traded/GDP but higher turnover ratio compared with the annual average value.

4.3.5. The Total Number of Listed Domestic Companies

As the previous study Demirguc-Kuntt and Levine (1996: 294) did, the number of listed domestic companies can be used as a market size indicator. Table 4.3 shows the average number from 2000 to 2015, and indicates that India had a similar number of domestic companies as the US. China had a big market capitalization and a large number of domestic list companies in 1951. The smaller number of listed domestic companies is in Mexico, Colombia, and Hungary, which had 143, 87 and 47 respectively. It indicates that they had a smaller market in this perspective.

Table 4.3 shows that the U.S. had an annual average of 220.05% of the total traded value of GDP from 2000 to 2015.However, in all the selected EMs this ratio is less than 80%.Among them China had the most liquidity with 78.53% of GDP. Then South Africa, Thailand, India, Malaysia and Turkey's total traded valued accounted for between 30 to 60%. The next group includes Russia, Hungary, Poland, and Indonesia at between 10 to 30%. The last group of less than 10% involved the Philippines, Mexico, Colombia, and Peru.

4.4. Financial And Economic Stability Of The Financial And Stock Market

The institutional and government quality are also essential indicators that determine financial development, especially for an emerging market. Many previous studies have found the positive role of qualified institutions and a strong environment in promoting financial market development.

Access

We measure access with the concentration variable, the percentage of the value traded excluding the top 10 traded companies to total value traded. If the value is higher, it means fair competition and easier access for small companies to enter the financial market. Otherwise, a lower value means most of the market is concentrated in the bigger markets, so the degree of monopoly is higher.

Most of the selected EMs concentration level had a decreasing trend by time; the average among the 15 selected EMs is 47.59. Table 4.3 shows that in China, the U.S. Malaysia, India, and Thailand the percentage of that traded value excluding the top 10 companies were tremendously high, above 68%, which implies that these countries have a small concentration and higher level of free competition and easier access. Brazil, South Africa, Turkey, and Indonesia are more than the average value. However, in Russia and Hungary this indicator is low, especially in Hungary, with almost 97% trade value coming from the top 10 companies. It is a kind of monopoly in the financial market.

Volatility and Stability of the stock market

We will use data from the Global Financial Development Database (GFCC) from the World Bank group. The variable is stock price volatility, defined as the average of the 360-day national stock market index.

From the time series aspect, for most of the selected emerging stock markets, the volatility had a decreasing trend. The volatility Table 4.5 illustrates the decreasing percentage of volatility from 2000 to 2015. Malaysia, Thailand, Turkey, and Russia improved the most and volatility dropped by more than 60%. Mexico, Indonesia, India, Poland, the Philippines and Hungary also dropped by 40 to 50% of volatility. South Africa and Peru improved stability by 17.56% and 26.26%. Colombia and China are the group that did not change significantly compared to the other selected emerging stock markets, especially for China. It shows that the stability of the stock market improved with time.

In addition, another familiar character is that during the GFC, for all 15 selected emerging markets and the U.S. stock price volatility increased significantly. The Table 4.5 shows that the biggest one certainly is the U.S. stock market, where volatility jumped 243.52%, followed by Russia (101.60%), Brazil (92.83%), and Hungary (91.18%). Peru, South Africa, Indonesia, Mexico, Poland, and Malaysia also had more than a 50% increase in stock price volatility. Turkey, the Philippines, and Thailand had more than a 38% increase in volatility.

Notably, we need to mention China and Malaysia. The data on volatility were different from the others so it looks abnormal. It jumped 55.04% and 40.35% in 2007 2008 for Malaysia and China respectively, but during 2008 and 2009 the change was a tiny 0.53% (Malaysia) and 5.3% (China) compared to all other selected EMEs. This is most probably because of these two countries' government intervention in the stock market. Therefore, volatility was controlled.

Further, we also noticed that the India and Colombia data were different from the usual group. For India, the volatility increase was earlier in 2008, an increase of 40.07%, then it decreased when other EMs were growing. It may have been because the market was sensitive and the time of crisis was different than the others. Colombia was similar; the average is 24.03% during 2002-2015, but the volatility increase was during 2008-09. However, in 2007-08 and 2007-09 the stock price volatility dropped while the others were climbing up. It also implies a different time of the crisis and maybe the government implemented some particular policies to maintain stock market stability.

The efficiency of the stock market

There are two indicators we investigate to measure the effectiveness of the stock market. Return on equity can measure how a stock market uses investment to generate earnings growth, and the MSCI also investigates this indicator to see the quality factor. Another one is the average total cost. If the average cost is high, even with a high return, it may be not an efficient market.

Table 4.5: Annual Stock Indices Volatility Of Selected Stock Markets

Country	2000	2005	2006	2007	2008	2009	2010	2015	ave 00-15	2007-2008	2008-2009	2007-2009	2000-2015
Brazil	40.76	26.64	24.86	25.12	32.75	48.44	31.66	24.80	31.88	30.35	47.94	92.83	-39.15
China	27.76	21.76	21.56	27.74	38.93	41.00	29.52	26.53	29.35	40.35	5.30	47.80	-4.44
Colombia		21.54	29.20	33.52	23.09	26.65	17.54	16.67	24.03	-31.13	15.41	-20.52	-10.50
Hungary	30.49	19.50	24.10	22.63	24.23	43.27	36.21	18.21	27.33	7.07	78.56	91.18	-40.28
India	31.85	20.85	25.07	31.23	43.74	30.35	17.94		28.72	40.07	-30.61	-2.80	-53.78
indonesia	33.65	20.09	19.96	21.45	28.41	35.75	26.35	14.63	25.04	32.48	25.83	66.70	-56.52
Malaysia	27.00	10.24	7.77	12.28	19.04	19.14	12.05	9.09	14.58	55.04	0.53	55.86	-66.35
Mexico	33.05	15.62	19.27	22.01	24.98	35.36	24.54	13.35	23.52	13.48	41.59	60.68	-59.60
Peru	16.93	14.27	21.20	24.13	31.96	42.89	28.76	13.96	24.26	32.43	34.20	77.73	-17.56
Philippine	24.67	17.96	18.49	22.55	27.08	31.40	22.73	13.37	22.28	20.08	15.98	39.28	-45.79
Poland	32.27	17.47	20.97	24.49	27.07	38.39	31.78	15.43	25.99	10.53	41.80	56.73	-52.17
Russia	58.63	31.81	32.76	33.72	35.13	67.98	45.31	22.48	40.98	4.18	93.52	101.60	-61.66
South Africa	19.54	13.78	17.74	20.48	23.58	34.38	23.92	14.41	20.98	15.16	45.77	67.87	-26.26
Thailand	35.49	20.67	15.88	23.42	24.83	32.36	25.51	13.30	23.93	6.02	30.34	38.19	-62.53
Turkey	57.61	27.79	27.09	28.51	32.68	39.92	29.07	21.68	33.04	14.64	22.16	40.05	-62.36
U.S	20.44	11.02	10.45	11.53	21.43	39.59	26.34	12.57	19.17	85.94	84.75	243.52	-38.51

Sources: Global Financial Development Database 2017. (Original sources: Bloombery)
Note: Stock Indices volatility is the average of the 360-day volatility of the national stock market index.

The average annual return from 2000 to 2015 for the 15 selected stock markets is 14.66%, much higher than the U.S. at 3.79%. This means that the stock markets of the emerging countries were growing very fast and efficiently. Table 4.6 also shows that Russia, Turkey, Colombia, and Peru's stock markets had a more than 20% average annual return that implies their stock markets worked very well and had efficient growth. Indonesia, Mexico, South Africa, and India are around the average return. Hungary, Thailand, Malaysia, Poland, and the US had less than 10% annual stock return. However, it does not indicate those markets were not efficient; some of them had considerable volatility and were impacted severely during the GFC. Therefore, the average returns were low.

Table 4.6: Stock Market Annual Return Of The Selected Ems

	2000	2005	2006	2007	2008	2009	2010	2015	AVE00-15	2008-07	2009-08	2009-07
Brazil	46.71	23.47	38.06	39.63	4.04	-4.54	27.50	-5.59	12.15	-89.80	-212.40	-111.46
China	36.64	-22.21	41.30	159.99	-28.46	-8.79	2.37	66.27	12.76	-117.79	-69.12	-105.49
Colombia		83.69	62.97	8.37	-16.50	7.61	38.28	-25.87	22.69	-297.14	-146.11	-9.11
Hungary	30.14	61.79	18.21	16.12	-24.12	-18.96	39.99	17.15	9.93	-249.63	-21.38	-217.64
India	10.53	32.89	54.74	36.04	-6.88	-5.46	32.89	11.01	14.44	-119.09	-20.59	-115.16
Indonesia	-7.30	37.12	30.43	52.50	-2.99	-5.79	54.35	-0.01	16.83	-105.69	93.79	-111.04
Malaysia	20.83	6.22	5.73	37.15	-12.57	-5.53	26.84	-6.07	6.88	-133.84	-55.98	-114.90
Mexico	26.79	35.61	44.89	43.51	-9.90	-5.20	31.33	3.01	15.71	-122.75	-47.50	-111.94
Peru	-7.91	44.36	92.60	129.02	-29.22	-12.50	36.89	-15.87	20.90	-122.65	-57.22	-109.69
Phillipines	-27.02	23.11	19.72	44.77	-23.07	-6.12	42.58	9.53	10.23	-151.53	-73.45	-113.68
Poland	32.37	23.60	38.47	19.60	-28.38	-23.92	27.70	-7.60	5.00	-244.79	-15.74	-222.00
Russia	107.57	25.94	90.88	25.24	-20.93	-24.44	39.68	17.94	24.27	-182.93	16.73	-196.81
South Africa	21.01	34.03	43.63	33.06	-4.99	-13.08	22.46	5.36	14.89	-115.09	162.13	-139.56
Thailand	-18.88	4.31	3.94	6.79	-10.66	-14.80	45.37	0.02	9.64	-256.98	38.82	-317.92
Turkey	151.66	47.56	35.38	21.32	-21.66	-0.73	58.19	7.12	23.58	-201.59	-96.65	-103.41
U.S	7.53	6.77	8.55	12.72	-17.41	-22.29	20.24	6.71	3.79	-236.83	28.07	-275.23

Data Source: Global Financial Development

We calculated the changing of annual return during the GFC. Thailand is the worst one impacted by the GFC, where the stock return dropped by 317.97%in 2007-09, ever more than the U.S. at 275.23%. It was followed by Poland, Hungary, and Russia which lost around 200%. Colombia showed the least decrease, but if we pay attention to that we can see from 2006 to 2007 the stock market of Colombia dropped 86.71% and returned from 62.97% to 8.37%.If we look at the return changing during 2007-08, Colombia (-297.14%) had the most significant decline rate among all our Ems markets. Therefore, we should not just look at change from 2007-09, because countries had differing times to get financial contagion effects from the U.S.

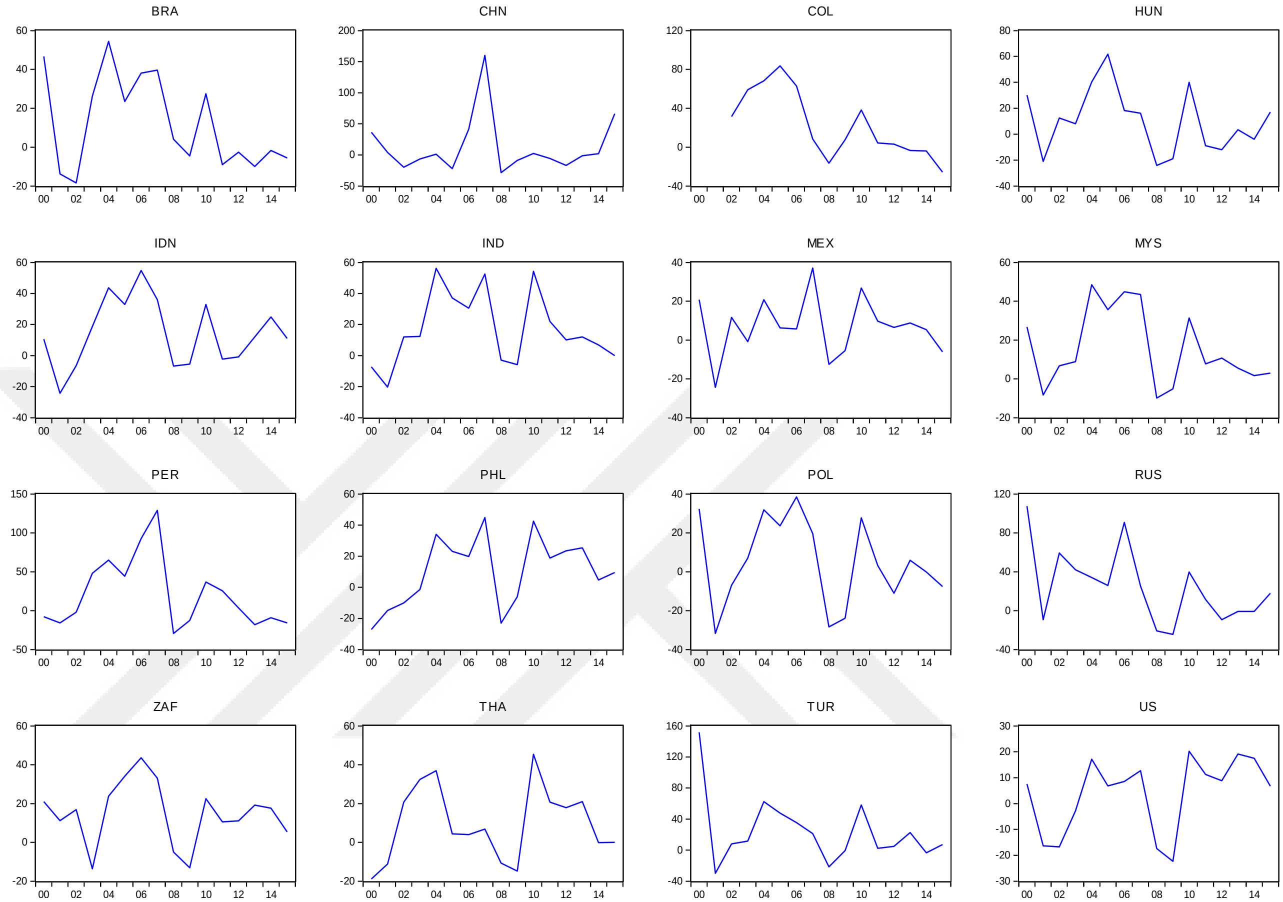

Figure 4.2: ***Annual Stock Return Of The Selected Emerging Stock Market Indices 2000-2016***

In all, all these emerging stock markets were influenced significantly by the GFC at different times and to different degrees. They were effectively working as a stock market but very sensitive to the global crisis with a very high volatility changing rate. It implies inter-linkage of the stock market and the contagion effects.

The institution and government regulatory indicators

Many other types of research have pointed out that the institutional and government regulatory impact on the functioning of the equity market (Pagano 1993: 619-620); Demirguc-Kunt and Levine (1996: 300). If the regulation is efficient and transparent, the stock market is more attractive for investors because of the symmetrical information and well organized and functional system. A qualified institution and well-functioning government regulation system will enhance the confidence of investors and enhance investment.

4.5. General Impact Of The GFC On Selected Equity Market

The equity market most directly and quickly responded to the financial crisis, and it was also one of the worst impacted markets. Bartram and Bodnar (2009: 1248) illustrated that world equity markets were up about 15% in 2007 and then from October 2007 started to give back the gain and sharply declined in the following six months. According to their calculation, the equity market precipitously lost 36.8% over 32 trading days from Friday, September 12 to Monday, October 2, 2008. Then the market portfolio fluctuation was within 10% of its value, and then stumbled downward into 2009. The total return at the lowest point at the end of 2009 lost 45.4% from the end of 2006, 52.6% since the end of 2007, and 16.5% from the end of 2008. The biggest changes unbelievably happened in two days, 10th - 13th July, 2008 when the peak returned to 8.5% and fell to the trough on 10/15/2008 at 6.4%.

The financial sector was negatively affected much more than the non-financial sectors, according to Bartram and Bodnar (2009: 1246), and the financial return index fell significantly more than the 63.9% of the financial industry compared to the non-financial sector that fell around -38.3% during the crisis period.

We can see from the U.S. that the financial market return lost -71.1% compared to the non-financial markets -35.9% during 12/31/06 to 2/27/2009. In terms of the emerging market during the same period, the loss of financial and non-financial markets was similar, that is -40.11% and -46.55% respectively. The difference from the developed market, the U.S. and the emerging market is that the loss difference of the financial and non-financial market total return index for the EM was smaller than the other two. A possible reason is that the country structure sectors vary from developed and emerging markets.

Figure 4.2 illustrates that there were significant losses in the emerging markets compared to the US market. From the Table 4.5, the sample includes from the peak of the return to 2/27/09, when the total wealthy loss was 9,209,840 USD for the U.S. market, and 5,146,304 USD for the emerging market. The loss is immense.

Taking data from DataStream for the selected economics, we calculated the equity price decline from peak-to-trough in the stock market of selected EMs and U.S. from 2007 to 2009. Although the EMs stock market volatility was not the same, some countries were much earlier, but some of them were late until the end of 2009 and they followed a very similar pattern. They all experienced a significant rise from 2006 until 2007, held out at a high price level for a while and then sharply declined to the low point. The slope of decline was very steep which indicated that the speed and magnitude of the price fall was significant.

CHAPTER FIVE

FINANCIAL CONTAGION BETWEEN US AND SELECTED EMERGING STOCK MARKETS DURING THE GFC

5. 1. Introduction

From the last decade, with globalization, financialization, and stock market integration, trade and financial linkage between the US and emerging markets economies have increased significantly. Especially this linkage became the spillover and contagion reasons during the financial crisis. The financial linkage and contagion effect impacts on optimal international portfolios and management or risk and asset diversification in the short term and long term. Therefore, studying the inter-linkage among cross-countries is essential and meaningful. Emerging markets played increasing roles and became recovery engines with the character to develop very fast and provide higher return but with higher volatility. The relationship and inter-linkages enlarge the results of financial instabilities. For instance, the latest one is the contagion effect of the GFC. It started from the U.S. but the impacts extended to the all the world's financial markets.

The term contagion was initially used in July 1997 (Seth and Sighania, 2017: 391) for the Asian Crisis that started from Thailand then spread rapidly to Russia, Brazil, and East Asia and further to developed markets like Europe and North America. Empirical research about contagion has grown extensively in the last few decades. Contagion has become an attractive subject for scholars because there were a series of financial crises at the end of 20th Century and they had common characteristics such as starting from one place and spreading to other markets in a short time with tremendous destructive power.

In this study, we try to investigate the long term and short term inter-linkage relationship empirically among 15 selected emerging markets and the US. Weespecially try to find out whether the source of the GFC was from the US stock market. The selected emerging countries and their stock markets are Brazil (BOVE), China (SSEC), Colombia (A.IGBC), Hungary (BUX), India(BSESN), Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), Poland (WIG), the Philippines (PSI), South Africa (FTSE), Thailand (SETI), Turkey (XU100), and from advanced markets, the US (S&P 500 index). They were selected from the common emerging countries among the IMF, MSCI, S&P and Dow-Jones lists (Kenton, 2018[18]).

Due to our study being time series data, after running the different unit root tests, we found the stock market indices are integrated at the first difference level, I(1). Therefore, we can employ Johansen Cointegration for the long term relations in the price level data. Then in order to find short term and temporary linkage cross-country, and detect whether the US stock market volatility and shock affected regional stock markets among the selected emerging markets, a VAR model, Granger causality test, impulse response function (IRF), and variance decomposition analysis (VDA) are widely used for this aim and were applied here.

Our objective is to study the co-movement and inter-linkages and causality of the stock markets among the US and 15 selected emerging countries. We use the high frequency daily stock index price and return from 1/3/2000 to 7/29/2016 that covers a long period. After an estimated Multivariate VAR model, we extend the research by applying a Granger- causality test to examine the relation and whether contagion existed among the selected countries' equity markets, then the IRF (Impulse Response Function) and VDA (Variance Decomposition Analysis) detect how long a shock will persist and how one market impacts on others.

The models we applied for the time series are applicable to investigate the previous events, the lag value in the model, and the impact on the current event in terms of the conditional variances. It can catch the speed, direction, and persistence of the effect from one to another. Furthermore, it can also detect the response of innovations and shocks.

[18] Emerging Market Economy: https://www.investopedia.com/terms/e/emergingmarketeconomy.asp

The main findings are that from the cointegration test result there are no long term relations among the cross-countries. In terms of the short term, after we ran the VAR model and checked the residual, and applied a Granger causality test, we found there were bi-directional causality and uni-directional causality relations. Further, from the cooperation of the different sub-sample periods, we confirmed the contagion effect from the U.S to the selected emerging stock markets. The impulse response function and the variance decomposition analysis also show the pattern of EMS response to the US shocks and confirmed the increased contributions from the US market to explain the variation of the other stock markets.

This study contributes to the literature in at least three senses. Firstly, the study covered a long period from January 2000 to July 2016, making it possible to understand not only short term but also long term relationships. It helps to make a decision about investment diversification. Secondly, it is the first study that chose the common emerging markets in the popular indices, and the cross-country study also helps to understand the integration of stock markets of emerging countries. Thirdly, it found the channels and integration level of the selected EMs.

The paper is organized in the following manner. The next section is a brief literature theoretical and empirical review of the contagion effect. Then data and estimation methodology are discussed in sections 3 and 4. Following that are the empirical results of cross- country contagion. Then there is a brief conclusion and limitations are considered in the last section.

5.2. Financial Market Contagion - Theoretical And Empirical Literature Review

Since there have been a series of financial, currency, and economic crises during the last two decades, the cross-country linkage of stock markets has become a popular topic attracting much attention from academicians and policymakers.

There are many methods applied to investigate linkage and causal relations amongst international stock markets. The methods sync with the development of econometrics technology as well. The previous works did not reach consistent results, because there are many factors which impact on the relations among the stock markets. The results vary depending on the selected markets, sample size, the data type difference by frequency, and different estimation methods.

In Chapter 2 the Literature Review, we already reviewed financial contagion; therefore, here we focus on the interrelationship and co-movement literature.

The very early research about the interrelationship of stock markets mainly applied correlation methods for the return of stock price. After that econometric technology became more sophisticated and the research methods more diversified. Eun and Shim (1989) applied a VAR model cross-country and found substantial interactions and an influential role for the US market (Chen, 2002). King and Wadhwani (1990: 7) also analyzed the three stock market correlation changing by a different model of the 1987 stock market crash. They found an increase in volatility leads in turn to a rise in the size of the contagion effects.

For the long term causality relations, a Johansen Cointegration is applied. In terms of the short term, there are many econometric methods that can estimate linkage of the stock market. Vector Auto Regression (VAR) and the Vector Error Correction Model (VECM) are widely used for stock market linkage. For instance, Boubaker, Jouini and Lahiani (2016), Dekker, et al.(2001), Masih and Masih (1999), Royfaizal et al. (2007), etc.

Masih&Masih (1999) applied VAR and VECM to invested dynamic causal linkages among nine major international stock indexes, and pointed out that the VAR model ignores the long term pure linkages. Widely used for short term are VAR, VECM, Toda and Phillips (1993) and Toda and Yamamoto (1995). These methods can be informative about the causal links among markets. Based on the VAR model, a Granger

Causality test, impulse response function and variance decomposition could provide the direction of the relations between markets. Rogers (1994) mentioned that impulse response function could observe contagion effects by abrupt changes over instability periods and tranquil periods.

Khalid and Kawai (2003) applied the VAR model and Granger causality test and impulse response to investigate inter-linkage and contagion effects among nine countries during the 1997 Asian crisis. Three cross-markets, namely, the stock market, interest rate, and exchange rates were examined by using daily data from July 1, 1997 to June 30, 1998. They did not find substantial evidence to support contagion by the said methods.

Chen, Firth, and Rui (2002) applied cointegration and VAR techniques to analyze the dynamic interdependence of the major stock markets in Latin America by using data from 1995 to 2000. Their study found one cointegrating vector seemed to explain the dependence on prices.

Inter-linkage and contagion

There is now consistency on the definition of contagion. Forbes and Rigobon (2002: 2222-2223) definition of contagion has been widely used in recent studies:

> *"A significant increase in cross-market linkage after a shock to one country (or a group of counties)" is called financial contagion.*

By this definition, if there are structural breaks in correlation between markets, with proper adjustment for heteroskedasticity, then there is a contagion effect.

Therefore, for the inter-linkage, we use the extended whole period data to investigate the long term and short term relations among the markets. To check whether there is contagion or not, we divide our timeline into three different periods, pre-crisis, crisis and post-crisis and examine whether there is a structural change of the correlation to conclude contagion effects occurred.

5.3. Data And Preliminary Analysis

5.3.1. Data - Stock Price And Return

The primary objective of this chapter is to further investigate the inter-linkages and causal relationship of the GFC contagion effects among the US and selected emerging markets' stock. We analyze the relationships by considering both long term and short term with different methods. The selected stock market daily index and the calculated returns are applied for the different method analyses.

The data in this paper were daily stock-price indices from January 3, 2000, to July 29, 2016 for the 15 selected emerging countries' equity markets and the U.S. S&P 500 stock market index. The data set consisted of the national stock indices of Brazil (BOVESPA), China (SSEC), Colombia (A.IGBC), Hungary (BUX), India (BSESN), Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), Poland (WIG), the Philippines (PSI), South Africa (FTSE), Thailand (SETI) and Turkey (XU100), and the US (S&P 500 index). All the national stock-price indices are in local currency and based on daily closing prices in each domestic market. The source of all data is DataStream International.

For the econometric analysis, the daily asset returns are calculated as the first difference of the natural log of each stock-price index, multiplied by 100. That is $\mathrm{r_{i,t}} = (\ln(\mathrm{p_{i,t}}) - \ln(\mathrm{p_{i,t-1}})) * 100$, where $\mathrm{p_{i,t}}$is the stock price level in country i at time t. We can also write it simply as:

$$R_t = \ln\left(\frac{p_t}{p_{t-1}}\right) * 100 \quad (1)$$

Where R_t is the daily index return, p_t is the closing price of stock index, and p_{t-1} is the previous working day's closing price.

Missing observations because of a holiday, bank off day and other reasons were replaced with the last available trading day's closing price on the market. The database applied is five days a week to avoid bias created by too much replacement and generation of unnecessary data.

Table 5.1 shows a descriptive analysis of the stock return. The mean, variance, standard deviation, normality test, skewness, and kurtosis are given. It is clear that the stock return declined sharply during the 2007-2009 GFC period. The return's volatility got more prominent during the great recession time. Figure 4.2 of the index also illustrates that there was co-movement between the selected emerging markets and the US stock market with a similar pattern.

Figure 5.1 illustrates stock prices for the U.S and the 15 emerging markets from 1/3/2000 – 7/29/2016. There are some common characteristics for them. Before the 2008 U.S. subprime crisis from 2000 - 2006, most of the markets experienced a sharp downturn from 2000 to 2003, which some called a "stock market crash" in stock markets in the U.S., Asia, Canada, and Europe. In November 2002 was the lowest point for this bear market. Then all stock markets' indices kept growing steadily with the increasing speed that can be seen from the steeper slope of the curve during 2003 - 2006.

During the crisis period, 2007-2009, the gray area in Figures 11 and 12, almost all stock indices reached their peak during 2007 and then dropped dramatically after the highest point from 2007 through 2009. The difference from the top to bottom is enormous, and the speed of the downturn is very fast and can be seen from the steep slope. In the crisis period 2007-2009, the volatility of stock indices was very high. It shows the degree and speed of fall for the stock indices was so fast and fierce. The trough point was around September 2008 near the Lehman Brother's Company bankruptcy date.

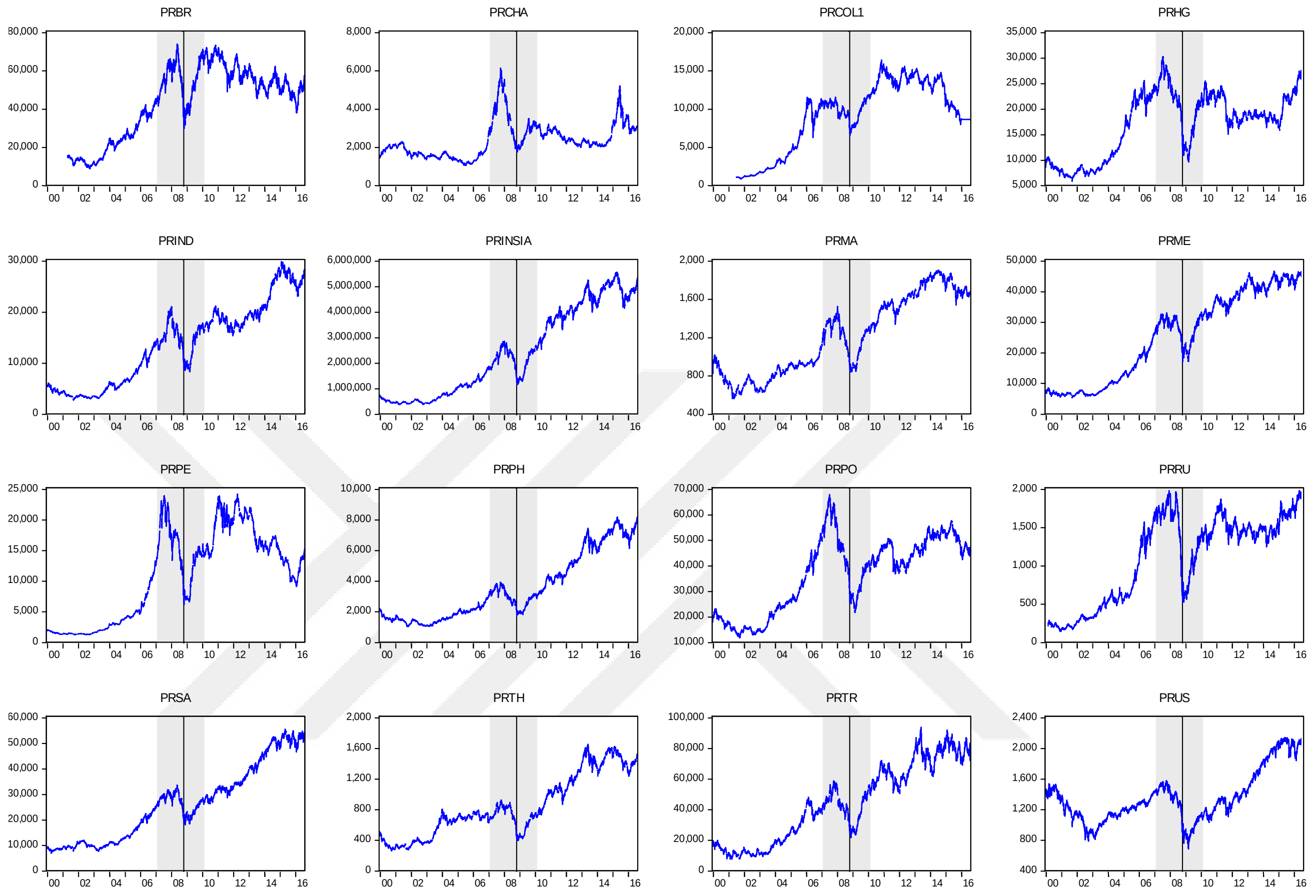

Figure 5.1: Stock Index Of The Selected 16 Equity Markets 2000-2016

Note: BR(Brazil), CHA(China), COL(Colombia), HG(Hungary), IND (India), INSIA (Indonesia), MA(Malaysia), ME(Mexico), PE (Peru), PH(the Philippines), PO(Poland), RU(Russia), S.A. (South Africa), TH (Thailand), TR(Turkey).

All these markets experienced a rise after 2009 except for China and Hungary. Almost all markets follow a similar path of rising relatively steadily and all of them were impacted by the 2012 European Debt crisis more or less, which can be seen from Figure 5.1. There is a slight decline around 2012 but recovering very soon, except for China. That is why many studies treat China separately because government intervention plays an essential role in the Chinese financial market.

To visualize the asset return for all markets, we plot asset return in Figure 5.2, and it shows clustering of more massive return volatility during the 2007-2009 crisis periods than before and after the crisis. This character is suitable for the GARCH model.

There are clustering volatilities that big volatility follows the biggest one, and small volatilities follow the smallest one. That character is suitable for the GARCH model, the variance changing over time. During the crisis period 2007-2009, the variation for all selected stocks got bigger and increased significantly. That shows the increasing volatilities in the financial crisis period.

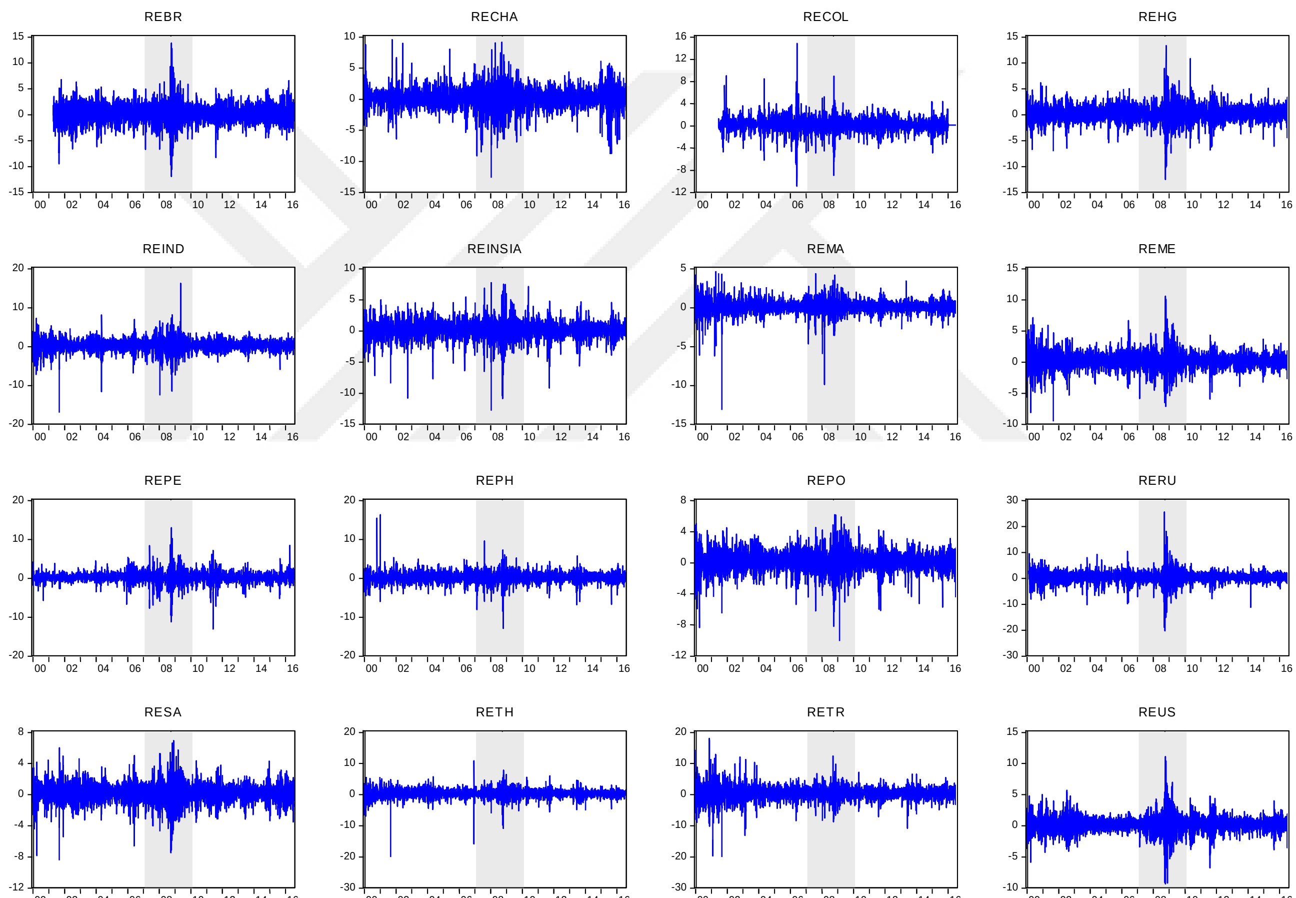

Figure 5.2: Stock Returns For 16 Selected Stock Markets1/03/2000 - 7/29/2016

Note: 1.The short name for countries: BR (Brazil), CHA (China), COL (Colombia), HG (Hungary), IND (Indian), INSIA (Indonesia), MA(Malaysia), ME (Mexico), PE(Peru), PH(the Philippines),PO(Poland), RU (Russia),SA(South Africa), TH (Thailand), TR (Turkey), and US (United States).2. The vertical line is the date for 15 September 2008, Lehman Brothers' bankruptcy day. The gray shaded area is 2007-2009 crisis period.

5.3.2. Timeline Dividing And Unit Root Test

5.3.2.1. Sub-Sample Time Selection

It is imperative to consider the chronology to study financial contagion according to the definition we applied. To compare whether there is a contagion effect or not, this study covers a long timeline from 3rd January 2000 to 29th July 2016. There are many previous studies which divided the timeframe according to the different points into several periods. Majid and Kassim (2016: 346) covered from 2006 to 2008 and divided it into two periods of pre-crisis and during crisis. Dooley and Hutchison (2009: 16) split the timeline from February 2007 until March 2009 into three periods, pre and post-crisis by the Lehman Bankruptcy which they called crisis point. It got more refinement in Min and Hwang (2012: 2069) who clarified crisis periods as first and second phases, and Cai, Tian, and Hamori (2016: 3793) also applied this four phases type.

This study aims to identify whether there is a contagion effect of the GFC essentially by comparing the changing of the correlation coefficients. Therefore, it covered a broad range timeline from January 2000 to July 2016 and divided into three different phases due to the GFC. We applied a Chow-test (Table 7.2) according to the U.S. S&P 500 index and the conditional covariance confirmed the selection of the period is based on the structural change time periods.

The sub-sample period one is tranquil pre-crisis, spanning 3rd January 2000 to 29th December 2006. The second period is the crisis period from 3rd January 2007 to 31st December 2009. Finally, the last period is the post-crisis period from 4th January 2010 to 29th July 2016. Individually, we also take 15th September 2008, the date of Lehman Brothers' Bankruptcy, as an essential point to analyze contagion effect. It can be seen in Figure 5.1 and 5.2's vertical lines.

5.3.2.2. Unit Root Test

We applied the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) unit root test to examine the time-series asset return properties of stationary, because much research has pointed out that ADF is an optimal and superior test for time series stationary, like Said and Dickey (1984) and Elliot et al. (1992).

From the unit root test in Table 5.1 we can see that all stock prices are not stationary in the level, the p-value is greater than 0.10 for all, but the first difference of the stock prices is stationary at a 1% significance level for all (P-value <0.01). Also, the returns for all stock markets are stationary at a 1% significant level because the p-values are less than 0.01. The unit root result indicated that all of the stock prices are integrated in order one, I(1)and the stock returns are stationary and integrated in I(0). Therefore the stock indices are integrated at the first level, I(1), and we can apply Johansen's cointegration test to the original stock price data to investigate the long term relationship.

The asset returns for all selected stock markets are stationary in level because the p-value is less than a 1% significance level that rejected the null hypothesis; there is unit root. Therefore, in the next section, we can run a VAR estimation, Granger causality test, and impulse response function into the stock return data. Moreover, in Chapters 6 and 7, we can employ DCC-GARCH and DCCX-GARCH to the stationary stock return data.

5.3.2.3. Time- Dividing And Lag-Length Determining

In terms of the price data, the empirical Johansen's cointegration test result reveals that there is no long term cointegration for almost all selected emerging stock markets during the entire pre-crisis, crisis, and post-crisis sub-sample periods. This result is consistent with Khalid and Kawai (2003: 147). There is cointegration only for Peru in the pre-crisis period, and South Africa and Mexico in the post-crisis periods.

Therefore, we are interested in short term causality correlation. These results suggested applying a Granger causality test to the first difference of the stock price and the stock returns within the unrestricted VAR framework to cross-country.

To find the causality relationship and identify contagion, as we did before, the entire period from 1/3/2000 to 7/29/2016 is divided into three sub-sample periods, namely pre-crisis (1/3/2000-12/31/2006), crisis (1/1/2007-12/31/2009), and post-crisis periods (1/1/2010-7/29/2016). We compare the causality correlation, impulse response and variance decomposition among the four-time panels. Because the Granger causality test and others are based on the VAR estimation and sensitive to the lag-length, for each period we run VAR separately.

Lag-length determination is important in the VAR model, and based on it the AIC and SC are the most widely used two. We ran unrestricted VAR estimation and selected a small number of criteria between AIC and SC, and we found AIC is smaller than SC for all cases. With the sufficient lags, the suggested lag-length is selected by AIC criteria. In terms of the first difference of the stock price, for the entire period, pre-crisis, crisis, and post-crisis lag-length is 2, 1, 1, and 1 respectively. In terms of the stock return, based on the AIC, lag length is 2, 1, 2, and 1 respectively. Additionally, for the variance decomposition, we ran unrestricted VAR for each case and the lag-length.

5.3.3. Descriptive Analysis And The Preliminary Analysis

Table 5.2 represents a summary of descriptive statistics of the daily stock-index return of the 16 stock markets. Accurately, the mean, standard deviation, skewness, kurtosis, Jarque-Bera, heteroskedasticity test ARCH (5) and LM test, and autocorrelation Ljung-Box Q test were reported. Panel A is the entire period from 3 January 2000 to 29 July 2016. Panel B, C, and D is pre-crisis (3rd January 2000-29th December 2006), during-crisis (3rd January 2007- 31st December 2009) and post-crisis (4th January 2010 – 29th July 2016) respectively.

All selected stock markets annualized mean of return are positive for panel A, indicating those stock markets were profitable on average over the entire period. There are some common characteristics for all four panels. The skewness, Kurtosis and also Jarque-Bera shows that asset returns are not normally distributed. The skewness is negatively skewed for most of the economies and shows that most of the return has a big and long tail in the left side which means more extreme value appeared. Kurtosis says that the returns are leptokurtic and steep with a sharp peak. All this suggests that those markets were easily influenced by the big shock of other markets, either good or bad shocks. In addition, the Jarque - Bera value is significantly 1% for all selected countries, which reveals that the asset returns are non-normality of high-frequency financial time series.

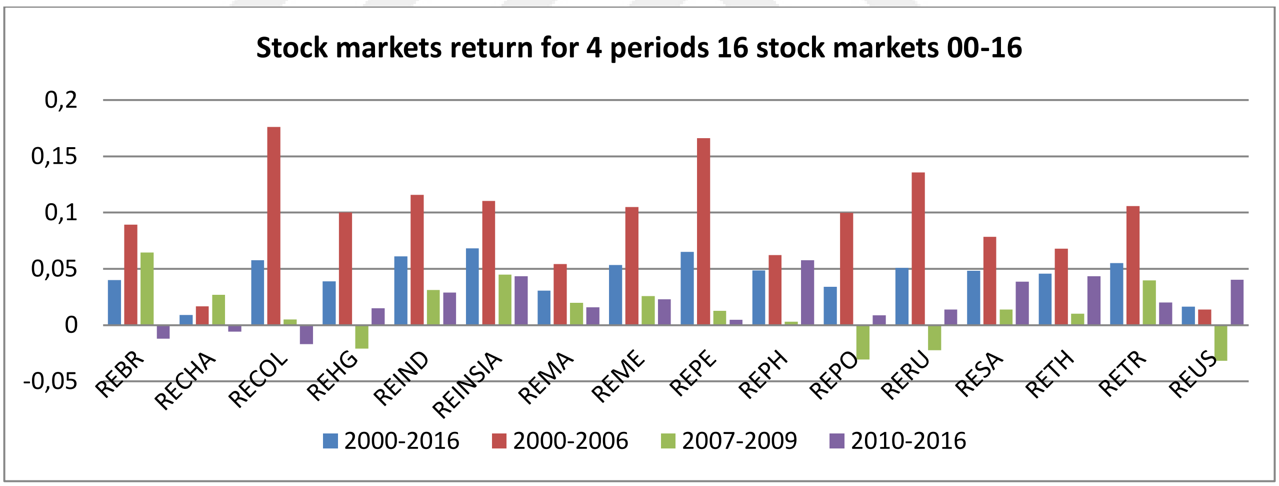

Figure 5.3: Stock Markets Returns For Four Panels Of 16 Stock Markets 2000-2016

Note: BR (Brazil), CHA (China), COL (Colombia), HG (Hungary), IND (Indian), INSIA (Indonesia), MA(Malaysia), ME (Mexico), PE(Peru), PH(the Philippines), PO(Poland), RU (Russia), SA(South Africa), TH (Thailand), TR (Turkey), and the US (United States).

Comparing the means of stock return before-, during- and after the crisis (Figure 5.3), except for the Chinese stock return having a slight rise, all other emerging markets and US stock returns experienced sharper declines during the crisis than in the pre-crisis period, which can be seen in Figure 5.3. It shows strong co-movements among all selected emerging stock markets, especially around the collapse of Lehman Brothers (15th September 2018) which is a vertical line in Figures 11 and 12.

According to the comparison of mean of return before and during the crisis, the most influenced countries in our studies are the U.S, Poland, Hungary, Russia, Colombia, the Philippines, and Peru which sharply dropped 333.931%, 130.737%, 120.816%, 116.577% 97.089%, 95.056% and 92.428% respectively. It seems that the European EMs were more sensitive than the Asian EMs.

Meanwhile, apart from the U.S. stock market, all of the other selected emerging stock returns could not recover to the same level as pre-crisis even if we take the longer period until July 2016. This implies the GFC had an extensive, profound and long lasting impact on the global financial markets. Also, we found that the stock returns post-crisis for most emerging stock markets continued to decline, also showing the herding behavior of the stock markets. Among all of them, only the Philippines, South Africa and Thailand stock returns had rose positively. From Figure 5.2 we can also see that China had a different pattern than our other selected emerging stock markets, as during the crisis period the mean is higher than before but post-crisis the return became negative and changed in a relative big range. Most of the selected emerging stock markets responded very fast and had co-movements with each other.

It is not worth to comparing asset return among different economies due to the market characteristics being different (Syllignakis and Kouretas, 2011: 719-20). In addition, except Colombia and Turkey, all other selected countries follow the same path of the standard deviations that are much higher during the crisis than pre-crisis. The increasing standard deviation also implies increase of volatilities from the GFC.

5.3.4. Unconditional Correlation

The pair-wise correlation is widely applied to show the fundamental relation between variables even though our data has a heteroskedasticity problem. Unconditional correlation follows the same path of the entire shape pre-, during- and after the crisis. In terms of the whole data from January 2000 to July 2016, the U.S stock market has a significant correlation with all studies in emerging stock markets at a 1% significant level, except the Philippines.

From the entire period, we notice that the European emerging stock markets have a higher correlation with the U.S. stock market. Especially in Mexico and Brazil where it is more than 0.6. In addition, Peru, Poland, South Africa, and Hungary are associated with the U.S. stock market with a correlation of more than 0.35.

Conversely, Asian emerging markets at a lower level correlated with the U.S stock market. Typically in the Philippines, except the post-crisis having 0.05 correlation coefficients at the 5% significant level, all other periods are not correlated with the U.S. significantly. China and Malaysia have a lower correlation which is less than 0.1 compared to other emerging countries, which shows it less correlated with the U.S stock market. In addition, China, Malaysia, Indonesia and Thailand have average correlation of less than 0.2. Because of the lower correlation of the Asian countries, therefore, during the crisis, the increasing level is higher than the changing of European emerging stock markets.

Table 5.3 illustrates that the unconditional correlation between the U.S. and all selected emerging stock markets in this paper increased significantly during the crisis period than before the crisis, also most of them are significant at a 1% level. However, China, Indonesia, Malaysia, and the Philippines are not statistically significantly correlated with the U.S market before the crisis. These four countries financial markets are not as integrated or open as others; government intervention plays an important role. Even so, in the post-crisis period all of the selected emerging stock markets are significantly correlated with the U.S stock market. It can imply that the financial crisis increased the correlation that shows the potential of contagion effect existence.

Table 5.1: Unit Root Test Results For 16 Considered Stock Market Index And Returns

	ADF	Phillips-Perron		ADF	Phillips-Perron		ADF	Phillips-Perron
Series	Prob.	Prob.	Series	Prob.	Prob.	Series	Prob.	Prob.
PRBR1	0.5038	0.9983	D(PRBR1)	0.0001	0	REBR1	0.0001	0.0001
PRCHA	0.9107	0.9858	D(PRCHA)	0	0	RECHA	0.0001	0.0001
PRCOL1	0.4836	0	D(PRCOL1)	0.0001	0	RECOL1	0.0001	0.0001
PRHG	0.7114	0.9881	D(PRHG)	0.0001	0	REHG	0	0.0001
PRIND	0.8891	0.9993	D(PRIND)	0.0001	0	REIND	0.0001	0.0001
PRINSIA	0.9625	1	D(PRINSIA)	0	0	REINSIA	0.0001	0.0001
PRMA	0.8846	0.8443	D(PRMA)	0.0001	0	REMA	0.0001	0.0001
PRME	0.935	1	D(PRME)	0.0001	0	REME	0.0001	0.0001
PRPE	0.8705	1	D(PRPE)	0.0001	0	REPE	0	0.0001
PRPH1	0.9876	0.9935	D(PRPH1)	0.0001	0	REPH1	0.0001	0.0001
PRPO	0.4464	0.9995	D(PRPO)	0.0001	0	REPO	0.0001	0.0001
PRRU	0.6534	0.9998	D(PRRU)	0.0001	0	RERU	0.0001	0.0001
PRSA	0.9401	1	D(PRSA)	0.0001	0	RESA	0.0001	0.0001
PRTH	0.9127	0.7944	D(PRTH)	0.0001	0	RETH	0	0.0001
PRTR	0.7016	0.892	D(PRTR)	0	0	RETR	0.0001	0.0001
PRUS1	0.9467	0.5704	D(PRUS1)	0.0001	0	REUS1	0.0001	0.0001

	ADF				PP - Fisher				ADF		PP-Fisher	
	Index-Level		First difference(Index)		Index-Level		First difference (Index)		Asset return		Asset return	
Method	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Statistic	Prob.	Stat.	Prob.
Chi-square	26.598	0.7366	1407.1	0	26.037	0.762	1279.05	0	1478.7	0	1157.26	0
Choi Z-stat	0.19982	0.5792	-35.1081	0	0.33042	0.6295	-33.6115	0	-35.6789	0	-31.6462	0
Result	**Stock indices I(1)**								**Asset return I(0)**			

Note: 1. D(PR…) denote the first difference of the stock price. The prob. Is the p-value of the unit root test. The null hypothesis there is a unit root.

Table 5.2: Descriptive Statistics Of Stock Return For 16 Stock Markets For Four Panels

Panel A. Entire 1/03/2000-7/29/2016																
	REBR	RECHA	RECOL	REHG	REIND	REINSIA	REMA	REME	REPE	REPH	REPO	RERU	RESA	RETH	RETR	REUS
Mean	0.0401	0.0089	0.0577	0.0387	0.0611	0.0681	0.0306	0.0533	0.0651	0.0485	0.0340	0.0509	0.0482	0.0456	0.0551	0.0163
S.D.	1.7701	1.6665	1.2683	1.5403	1.4611	1.3700	0.7596	1.2304	1.4364	1.2595	1.2454	2.0439	1.2252	1.2939	1.9206	1.2382
Skew	-0.0173	-0.4055	-0.1224	-0.1146	-0.2214	-0.8412	-0.7886	0.0860	-0.3997	-0.5854	-0.4318	-0.2267	-0.1391	-0.8070	-0.1343	-0.2138
Kurt.	7.2881	8.1635	16.2604	9.7141	13.0702	11.9334	15.2461	8.7693	14.0594	10.4403	7.1734	21.3432	6.4480	15.1531	7.3094	12.0528
JB	2903.98	4314.14	27777.11	7127.02	16045.02	13049.68	24074.92	5260.89	19415.72	8958.55	2868.19	53166.87	1889.60	23735.25	2944.03	12970.72
Obs.	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790	3790
Heteroskedasticity test																
ARCH(5)	0.1575	0.0253***	-0.0026	0.0710	0.0804	0.0295***	-0.0055	0.1531	0.0798	0.0214	0.1199	0.0744	0.1681	0.0322**	0.0337	0.2230
LM-F	1.7199	3.3357	23.4415	9.2040	3.2806	8.3550	14.8976	11.5401	40.2779	13.1381	3.7176	2.2743***	4.2555	2.0855**	0.3895	9.0294
Autocorrelation test																
Q(12)	22.361***	22.627***	144.16	80.417	46.602***	48.538	79.029	61.057	206.14	75.907	23.198***	29.916	30.755	33.193	31.317	58.802
Panel B. Before-Crisis 1/03/2000 12/31/2007																
	REBR	RECHA	RECOL	REHG	REIND	REINSIA	REMA	REME	REPE	REPH	REPO	RERU	RESA	RETH	RETR	REUS
Mean	0.0893	0.0167	0.1761	0.1000	0.1158	0.1104	0.0543	0.1050	0.1660	0.0622	0.0997	0.1356	0.0784	0.0678	0.1057	0.0137
S.D.	1.7163	1.3717	1.4979	1.3306	1.3378	1.2903	0.7067	1.1799	1.0204	1.1574	1.1408	1.9223	1.1415	1.3177	2.2168	1.0303
Skew	-0.1481	0.7155	-0.0311	-0.1716	-0.7126	-0.8337	0.3971	-0.0096	-0.0110	0.1139	-0.0102	-0.5549	-0.0813	-0.9760	-0.0314	0.2184
Kurt.	3.6765	8.3374	17.9225	4.3548	10.2989	9.2818	6.4937	5.1789	7.6559	4.7618	4.3138	6.5209	5.8771	22.3771	6.6508	5.7146
JB	31.36	1755.82	12804.30	112.31	3180.08	2428.89	738.12	273.02	1246.48	181.46	99.27	783.63	477.47	21808.83	766.62	434.71
Obs.	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380	1380
Panel C. Crisis Period 1/03/2007 12/31/2009																

	REBR	RECHA	RECOL	REHG	REIND	REINSIA	REMA	REME	REPE	REPH1	REPO	RERU	RESA	RETH	RETR	REUS
Mean	0.0645	0.0268	0.0051	-0.0208	0.0313	0.0449	0.0198	0.0257	0.0126	0.0031	-0.0306	-0.0225	0.0139	0.0102	0.0397	-0.0318
S.D.	2.3980	2.3815	1.3900	2.1734	2.2650	1.9051	1.1110	1.7967	2.2092	1.7333	1.7413	3.1952	1.7401	1.6842	2.1705	1.8868
Skew	0.0212	-0.5104	-0.4939	-0.0828	0.0097	-0.8162	-1.3501	0.2378	-0.2156	-0.7932	-0.4248	0.0605	-0.0892	-0.7765	-0.0580	-0.1703
Kurt.	7.8006	5.3830	9.4579	8.7153	8.6826	9.9970	13.7503	7.0786	8.3476	10.3251	5.9013	15.8328	4.9682	8.8977	5.8336	9.0737
JB	726.01	211.70	1344.42	1029.79	1017.20	1626.10	3870.05	531.13	906.67	1769.47	287.89	5187.87	123.03	1171.64	253.35	1165.69
Obs.	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756	756

Panel D. After Crisis 1/03/2010 7/29/2016

2010-2016	REBR	RECHA	RECOL	REHG	REIND	REINSIA	REMA	REME	REPE	REPH1	REPO	RERU	RESA	RETH	RETR	REUS
Mean	-0.0121	-0.0058	-0.0170	0.0149	0.0290	0.0435	0.0158	0.0229	0.0048	0.0578	0.0087	0.0138	0.0386	0.0433	0.0200	0.0403
S.D.	1.4468	1.4850	0.9561	1.3412	1.0264	1.1195	0.5844	0.9115	1.2720	1.0701	1.0386	1.3490	0.9848	1.0451	1.4834	1.0006
Skew	0.0145	-0.8471	-0.2304	0.0034	-0.1350	-0.6101	-0.3017	-0.3055	-0.6144	-0.6805	-0.6599	-0.6540	-0.2091	-0.3522	-0.5869	-0.4376
Kurt.	4.5098	8.3742	5.6698	7.7742	4.5360	9.3826	5.7838	5.8815	14.8606	7.8050	7.1447	8.2608	4.4316	6.9844	7.1612	7.0107
JB	157.16	2188.27	505.86	1570.80	167.63	2910.09	559.16	597.95	9798.85	1718.81	1303.90	2025.22	153.29	1128.24	1288.31	1161.39
Obs.	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654	1654

Note: 1. p –value of Jarque-Bera for all countries are statistically significant at 1% level.

2. The short name for countries BR(Brazil), CHA(China), COL(Colombia), HG(Hungary), IND (India), INSIA (Indonesia), MA(Malaysia), ME(Mexico), PE (Peru), PH(he Philippines), PO(Poland), RU(Russia), S.A. (South Africa), TH (Thailand), TR(Turkey).

3.S.D.,Skew, Kurt, JB, Obs. represent the standard deviation, skewness, Kurtosis, Jarque-Bera, and Observations.

Table 5.3: Pair-Wise Unconditional Correlations And Spearman Correlation Of Stock Returns Between The US And Selected Emerging Stock Markets In Four Periods

	Peason correlation						spearman correlation			
REUS	reus_entire	reus_pre	reus_crisis	reur_post	% crisis-pre	% post-pre	REUS1-entire	reus-pre	reus-crisis	reus-post
REBR	0.6118***	0.4825***	0.7476***	0.5657***	0.55	0.17	0.3179***	0.2084***	0.3652***	0.3958***
RECHA	0.0593***	-0.0039***	0.0445	0.1309***	12.54	34.97	0.2368***	0.1115	0.3519***	0.3028***
RECOL	0.2701***	0.0944***	0.3584***	0.4416***	2.80	3.67	0.0457***	0.0123***	0.0321***	0.0829***
REHG	0.3518***	0.1903***	0.4114***	0.4092***	1.16	1.15	0.3283***	0.2092***	0.3799***	0.4062***
REIND	0.2481***	0.0873***	0.3258***	0.2859***	2.73	2.27	0.2432***	0.0776**	0.3344***	0.3561***
REINSIA	0.1167***	0.0279***	0.1448***	0.1655***	4.19	4.92	0.5434***	0.4892	0.7003***	0.5043***
REMA	0.0884***	-0.0177	0.1292***	0.1333***	-8.30	8.52	0.1590***	0.0897	0.2192***	0.1889***
REME	0.6965***	0.5856***	0.7855***	0.6824***	0.34	0.16	0.2645***	0.1411***	0.3174***	0.3626***
REPE	0.3886***	0.1818***	0.4535***	0.4423***	1.49	1.43	0.0849***	0.0158***	0.1278***	0.1211***
REPH	0.0250	-0.0151	0.0306	0.0538**	-3.03	4.56	0.3147	0.2285	0.3314***	0.3875***
REPO	0.3732***	0.2071***	0.4104***	0.4808***	0.98	1.32	0.6214***	0.5698***	0.7168***	0.6186***
RERU	0.2842***	0.1270***	0.3226***	0.4080***	1.54	2.21	0.1782***	0.0675***	0.2491***	0.2441***
RESA	0.3652***	0.2335***	0.3878***	0.4664***	0.66	0.99	0.0236***	0.0152***	-0.0205***	0.0662***
RETH	0.1886***	0.0640**	0.2772***	0.2078***	3.33	2.24	0.2830***	0.1826***	0.3505***	0.3336***
RETR	0.2697***	0.1188***	0.3925***	0.3451***	2.31	1.90	0.0906***	0.0422***	0.1344***	0.1093***

*Note: 1. The *** and ** indicate statistical significance at the 1% and 5% level respectively.*

2. The short name for countries: BR (Brazil), CHA (China), COL (Colombia), HG (Hungary), IND (Indian), INSIA (Indonesia), MA(Malaysia), ME (Mexico), PE(Peru), PH(the Philippines), PO(Poland), RU (Russia), SA(South Africa), TH (Thailand), TR (Turkey), and the US (U.S.)

3. In terms of period, entire 1/3/2000-7/29/2016), pre (1/3/2000 – 12/31/2006), crisis (1/1/2007-12/31/2009), and post (1/1/2010-7/29/2016)

From the unconditional correlation Table 5.3 result, we can see that these 15 EMs behaviors were influenced by the U.S stock market and changed by time in response to the ongoing shocks. There are strong correlations between U.S financial markets and the selected emerging stock markets. The correlation increased dramatically during the crisis compared to before; also after the crisis still the impact of the GFC was persistent. Due to the asset return not being normally distributed, after the unconditional correlation test we also applied a Spearman correlation. These two unconditional correlation tests have a similar result.

However, because of the heteroskedasticity problem the volatilities also increase the correlation. Therefore, the unconditional correlation is not sufficient to examine transmission between the U.S. and emerging stock markets. Thus, in the following section and Chapter 6, we use the advance econometric tools to investigate the correlation and identify the contagion effects.

5.4. The Estimation Methodology And Process

In this section on time series analysis for the stock market linkages, we try to investigate the long term and short term relations. The process of estimation will be based on the previous section, with different types of unit root test result we identify the integration level for the stock price, I(1) and stock return I(0). Therefore, to detect the long term relationship and linkages, a Johansen Cointegration will be applied. In terms of the short-run correlation VAR estimation, Granger causality test, impulse response and variance decomposition will be conducted.

The nature of the idea is that we divide the entire period into three sub-sample periods as before mentioned, the pre-crisis (1/3/2000-12/31/2006), crisis (1/1/2007-12/31/2009), and post-crisis (1/1/2010-7/29/2016). Through comparing the increase of correlation or the number of correlations, we can identify the contagion effect. Firstly, if the number of cointegration relationships increased during the crisis or post-crisis than in the pre-crisis period, then it confirms the long-run linkage and contagion effect according to Sander and Kleimeir (2003: 179), Ramlall (2009: 30), and Boubaker et al. 2016: 16).

Secondly, the VAR process model will be applied to explore the short-run relations to the stationary return data, and the Granger (1969) Causality test will be conducted to find the cross-market causality relationships. Furthermore, the impulse response function will trace the effects of a standard deviation shock to one of the innovations or shocks on the current and future values of the endogenous variables. In addition, the variance decomposition analysis can measure the change in one of the variables as separate shocks affecting all variables. It provides information about the dynamic structure of the system in this regard (Boubaker et al., 2016: 22).

VAR model application

When we are not confident for the variables as exogenous or endogenous but need to find the interlinkage and relationship among them, we can use the VAR model that treats the variables symmetrically. Sim (1980) proposed that the VAR model captures dynamic interactions among the endogenous variables, and VAR is used for analyzing the dynamic impact of random disturbances on the system of variables. Under the unrestricted VAR framework, a dependent variable is the function of its own lagged and lags of the other variables only.In addition, the entire variable is the endogenous variables with the same format of function. It can be specified as:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + B x_t + \varepsilon_t \ (2)$$

Wherey_t is a k vector of endogenous variables,x_t is a d vector of exogenous variables,A_1, A_2, ...and $A_p$and B are matrices of coefficients to be estimated, and $\varepsilon_t$is a vector of innovations or shocks that may be contemporaneously correlated with each other but uncorrelated with its own lags, and not correlated with any other exogenous variables in the right hand of the function.

If we make it clearer for example in two variables case, in the Eq. (1), we calculated the daily return of the stock market indices,

$$Y_{1,t} = c_1 + A_{1.1}Y_{1.t-1} + A_{1.2}Y_{2.t-1} + e_{1.t} \quad (3)$$

$$Y_{2,t} = c_2 + A_{2.1}Y_{1.t-1} + A_{2.2}Y_{2.t-1} + e_{2.t} \quad (4)$$

Where Y_i is a $k \times 1$ vector of the endogenous variables (stock market returns), c_i is a $k \times 1$ vector that represent the constant term, e_t is a $k \times 1$vector and the residual at time t. The A coefficient capture dynamic (lagged) impact to the endogenous variables, $e_{i,t}$is expected to the white noise.

Determining the number of lags

From the equation and logic of the VAR model, we can see that we need to determine the number of lags before running the model. In practice, it is common to choose a lag-length arbitrarily big enough to ensure that the residual will be white noise and that at the same time maintains the accuracy of estimation. There are some criteria to help to select the proper lag-length. Such as Akaike information criteria (AIC), the Schwartz information criteria (SC) and sequential modified LR test statistic (LR), Final prediction error (FPE), and Hannan-Quinn information criterion (HQ). We will compare all of them, and select a suitable lag-length.Considering the degree of freedom, we prefer small lags while at the same time the preciseness of the estimation is important.

Estimate VAR model

VAR model estimation will identify the possible causal relationship among selected cross-countries. The VAR model will estimate each index return as the endogenous variable and determine the lag of its own, and other stock return lags as the exogenous variables.

Diagnose the residuals

The residual of the VAR model is expected to be white noise as well. We will examine correlograms for the ACF and PACF, and then the autocorrelation LM test will be use to identify whether there is autocorrelation or not. A normality test and white heteroskedasticity test will be applied to check the normal distribution and heteroskedasticity problem.

Granger causality/ Block Exogeneity test

The Granger causality test proposed by Granger (1969) will be employed to investigate the causal relationship between financial markets. Boubaker et al. (2016: 16) concluded that contagion amplifies the causality between markets following a shock. The nature of the Granger Causality test is to check whether the lag value of one variable will improve the forecasting result of the future value of another variable. If it helps then the former variable is said to be Granger causing the latter variable.

There are three different situations for the Granger causality test. If the equity markets Y and X are stationary and there is integration in the level, I(0), the Granger causality can be tested on the following bivariate p order VAR process, and the order of p selected from the VAR model by AIC criteria.

Case 1: stationary and integrated in level, I(0)

$$\begin{cases} Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{i=1}^{p} \gamma_i X_{t-i} + u_t \\ X_t = \alpha_0 + \sum_{i=1}^{p} \lambda_i X_{t-i} + \sum_{i=1}^{p} \delta_i Y_{t-i} + v_t \end{cases}$$

This is the short-run Granger causality that is based on the dynamics of the VAR process; therefore, the standard F-test will be used to test the null hypothesis that all coefficients

γ_i and δ_i are zero. The alternative hypothesis will confirm there is Granger causality correlation between Y and X.

The second case is that if the stock market is non-stationary but not integrated, then the VAR framework will be applied in the first difference series as in the below equation:

Case 2: non-stationary and non-integrated in level, then use the first difference

$$\begin{cases} \Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + u_t \\ \Delta X_t = \alpha_0 + \sum_{i=1}^{p} \lambda_i \Delta X_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + v_t \end{cases}$$

Case 3: non-stationary in level but integrated in first difference, I(1)

Engle and Granger (1987) suggested to add the error correlation term obtained from the cointegrating equation between two stock markets to case 2 to determine the vector error correction model (VECM) form. It follows the below form:

$$\begin{cases} \Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i \Delta Y_{t-i} + \sum_{i=1}^{p} \gamma_i \Delta X_{t-i} + \theta \Pi_{Y,t-1} + u_t \\ \Delta X_t = \alpha_0 + \sum_{i=1}^{p} \lambda_i \Delta X_{t-i} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \phi \Pi_{X,t-1} + v_t \end{cases}$$

Where Π_{t-1} is the one-period lagged error correction term

Instead of using the F-test, to test the error correction term coefficient, the t-test will be used for this long-run Granger causality that is based on the disequilibrium adjustment (Boubaker et al., 2016: 17).

Impulse response function (IRF) and variance decomposition analysis (VDA)

To make a comprehensive base on the VAR framework, the next step is to use impulse response and variance decomposition. These two can capture the impact from a shock to one market on each of the other stock markets. The impulse response function assesses the response of variables towards one standard deviation shock to the error terms of the other variables.

Therefore, the contagion effects can be detected and observed between stock markets when the impulse response function records abrupt changes over the crisis period compared to the tranquil period (Boubaker et al., 2016: 17). In addition, its own contributions to the forecast error variance fall while the cross contributions increase during the crash period (Roger, 1994).

Finally, we will apply the variance decomposition method to see how the U.S. stock market and the selected emerging stock markets impacted on the variance of the considered stock returns in the autoregression. Variance decomposition provides information about how many percents of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables. Eviews 14 was employed to conduct all methods and the analysis process.

5. 5. Empirical Analysis Of The Contagion By Var Model

5.5.1. Long-Term: Johansen Cointegration Test Result

After the unit root test to check out the stationary level of the price level data, it suggested that stock price are integrated of order one, I(1). Therefore, we can conduct a Cointegration test to the level series to investigate the presence of Cointegration relationships between the US stock market and the other considered EMs. The existence and increase in the number of cointegrating relationships can be explained by the crisis transmission from the U.S. to the selected equity markets, furthermore confirming a contagion effect.

Table 5.4: The Johansen's Cointegration Test Results

		Trace				Max-Eigenvalue			
		entire	pre-crisis	crisis	post-crisis	entire	pre-crisis	crisis	post-crisis
Brazil	r=0	3.4485	6.0509	3.1594	14.4711	3.3966	5.58499	1.6468	13.9593
	r=1	0.0519	0.4659	1.5126	0.5117	0.0519	0.4659	1.5126	0.5117
China	r=0	1.8751	11.1189	4.8811	4.3092	1.4155	9.6722	4.7356	3.4722
	r=1	0.4596	1.4467	0.1455	0.8370	0.4596	1.4467	0.1455	0.8370
Colombia	r=0	8.7997	6.3572	5.6702	9.1475	7.2814	5.6509	3.3442	8.8214
	r=1	1.5183	0.7063	2.3260	0.3262	1.5183	0.7063	2.3260	0.3262
Hungary	r=0	4.8362	5.9652	5.0229	5.7534	4.5909	5.9492	3.7679	3.5039
	r=1	0.2453	0.0160	1.2549	2.2495	0.2453	0.0160	1.2549	2.2495
India	r=0	4.9702	11.0860	2.4446	6.6224	4.8720	10.3134	1.8239	6.4402
	r=1	0.0981	0.7726	0.6207	0.1823	0.0981	0.7726	0.6207	0.1823
Indonesia	r=0	5.9291	12.4452	3.1673	11.8829	5.6886	9.5167	1.8528	11.3215
	r=1	0.2405	2.9285	1.3145	0.5615	0.2405	2.9285	1.3145	0.5615
Malaysia	r=0	7.8669	5.2821	3.6843	10.1431	5.7882	4.9732	2.7242	7.3929
	r=1	2.0788	0.3089	0.9601	2.7502	2.0788	0.3089	0.9601	2.7502
Mexico	r=0	6.2962	12.5160	6.3932	16.0141**	5.0722	9.3747	4.9134	15.6997**
	r=1	1.2240	3.1412	1.4798	0.3144	1.2240	3.1412	1.4798	0.3144
Peru	r=0	5.4752	43.4117***	8.3842	9.1150	4.1978	38.9777***	7.2729	8.8746
	r=1	1.2774	4.4340**	1.1112	0.2404	1.2774	4.43398**	1.1112	0.2404
Philippine	r=0	9.7478	7.3556	5.3750	8.0807	9.2690	6.6844	4.0382	7.7811
	r=1	0.4788	0.6712	1.3367	0.2996	0.4788	0.6712	1.3367	0.2996
Poland	r=0	7.5447	8.5114	8.8959	4.5681	6.6050	8.3278	7.1054	4.4412
	r=1	0.9398	0.1836	1.7905	0.1268	0.9398	0.1836	1.7905	0.1268
Russia	r=0	7.5107	8.7217	8.1612	3.9168	6.9801	7.4157	5.9030	3.1972
	r=1	0.5306	1.3061	2.2581	0.7196	0.5306	1.3061	2.2581	0.7196
South Africa	r=0	6.8332	10.4577	9.3353	22.9698***	6.8284	6.1428	8.0636	22.9229***
	r=1	0.0047	4.3149**	1.2718	0.0469	0.0047	4.3149**	1.2718	0.0469
Thailand	r=0	9.9144	8.7314	4.4329	9.3798	9.0611	5.9965	3.2820	7.9932
	r=1	0.8533	2.7349	1.1509	1.3866	0.8533	2.7349	1.1509	1.3866
Turkey	r=0	9.7123	9.2090	1.9194	12.2818	7.5021	7.4327	1.5959	11.7673
	r=1	2.2102	1.7763	0.3235	0.5145	2.2102	1.7763	0.3235	0.5145

Note: r denotes the number of the cointegration relationships to be tested. The Schwars information criterion is equal to 2 for all markets. The trace and Max-Eigenvalue is statistical value of the test. None of the values are statistically significant.

Table 5.4 presents the Johansen's Cointegration test result between the U.S. and the 15 considered emerging stock markets. We examine the Cointegration from the US to selected EMs, and the trace and maximum eigenvalue are giving in Table 5.4. The significance of them will reject the null hypothesis; there is no Cointegration. It illustrates that for the entire period 2000 -2016, there is no long term linkage between the U.S. and all 15 selected emerging stock markets.

We also tested for pre-crisis, crisis and post-crisis respectively. We found that in the tranquil period, only the Peru equity market had long term linkage with U.S. stock markets with two cointegration rank. However, during the crisis, there is no cointegration at all for each of the emerging stock markets. During the post-crisis, we found an increasing number of cointegration for Mexico and South Africa that could confirm the transmission of the U.S. shock to them and a contagion effect existence in the long term. Recalling the descriptive analysis, we notice the correlation between Mexico and the U.S. was very high at more than 0.6, and with South Africa it was also in a middle level at around 0.4.

However, there is no long term or increasing of the number of cointegration for most of the other considered stock markets. This result is opposite to Bekaert et al. (2005), Rmalall (2009), and Boubaker et al. (2016: 20-21) who found at least 1 cointegration increased during the crisis period than the tranquil period. Despite that, this finding is consistent with the non-crisis-contingent theories presented by Forber & Rigobon (2001: 49-51). It assumes that the transmission mechanisms are the same during a crisis as during more stable periods, and therefore, cross-market linkages do not increase after a shock. Besides the individual market, we did a full sample Johansen's Cointegration test as well for four-time panels. There is no Cointegration relationship in the long term for all.

5.5.2. Short-Run – VAR Framework Estimation

According to the unit root test, the stock return is stationary, and we can apply the VAR estimation to investigate the short term inter-linkage relationships between markets. After running the VAR model according to the AIC, SC and FPEHQ criteria, we determined the lag 2.

The Granger-causality test (Table 5.5 and 5.7), impulse response function (IRF) (Figure 5.4-5.11) and variance decomposition analysis (VDA) are within the VAR model (Table 5.8), therefore, we will run VAR separately for each test to define the lag-length based on the AIC. After running the VAR process, we have to check the residual autocorrelation, normality and heteroskedasticity problem. Because our data is a larger sample data, the normality can be solved by center limit theory. The VAR result is not put in the content but is available by reader requirement.

5.5.3. Granger Causality Results

5.5.3.1. Granger Causality Test Result For The First Difference Of The Stock Price

From the cointegration result we know that except for Peru in the pre-crisis, and for South Africa and Mexico in the post-crisis period being long term cointegrated, all the other selected stock markets had no cointegration for four-time panels. Therefore, we applied the Granger causality test based on the unrestricted VAR process to both the first difference of stock price and stock return respectively.

Firstly, the U.S. stock market is Granger causality with 14 emerging stock at the 1% significant level except for Brazil for the entire long term period. Notably, we can see that the Asian stock markets have more Granger causality relationships, like Indonesia (10), the Philippines (10), Malaysia (9), and India (7). Comparatively, European emerging stock markets were impacted less, like Hungary (4), Peru (3), and Brazil (2). The interesting point is that Brazil is the least Granger caused by other markets, and only Malaysia and Mexico can be the generated source, and even the U.S. stock market is not Granger Causality linked with the Brazilian stock market. However, the Brazilian stock market is similar to the U.S. stock market Granger caused in almost all other markets except the Chinese and U.S.

For all emerging stock markets, an F-test indicates that the U.S. stock market had a bidirectional Granger causality link with the Indonesia, Malaysia, and Peru stock markets. In addition, there is a 20 bidirectional Granger causality linkage, including Malaysia, with Brazil, Colombia, Indonesia, Mexico, South Africa, and the U.S.; Indonesia with the U.S., Mexico, Colombia, Turkey, and the Philippines; South Africa with Hungary, Russia, and India; the Philippines with Turkey, Mexico with Brazil, Poland, and the U.S.; Turkey with China, the Philippines; and Poland with Colombia. The most Granger causality linkage stock markets were in Malaysia and Indonesia that all had six bidirectional relationships.

However, Thailand is the only stock market not having bidirectional Granger causality linkage with others, although there are eight unidirectional links Granger caused to the Thailand stock market, that contains Brazil, China, Colombia, Hungary, Indonesia, Malaysia, Peru, and the U.S.

In sum, the Granger causality results show the short term linkage among markets. The US was one of the vital sources and leading country, Granger caused 14 selected emerging stock markets, except for the Brazilian stock market. In addition, because of the integration, there are 106 Granger causality linkage relationships among these 16 selected stock market indices for the entire period 2000-2016.

Table 5.5 Panels B, C, and D are Granger causality test results for the pre-crisis, crisis, and post-crisis three periods and the first difference of the stock index. It can be seen from the Table 5.5, pre-crisis and during the crisis period, the Granger causality relationships are multivariate and in a large number, but in the post-crisis periods, the number of the Granger causality linkages decreased among the selected stock markets.

Especially in panel B and C we illustrate how the U.S stock price impacted on the other selected emerging stock markets. The stock indices of China, Colombia, India, and Peru did not have Granger causality linkage with the U.S pre-crisis period; however, during the crisis period, the US Granger caused them. For the Hungary and Poland stock price, the Granger causality with the U.S was stronger during the crisis period than pre-crisis, for some other stock markets may respond late, like Indonesia and the Russian stock market which were Granger-caused by the U.S during the post-crisis period.

In addition, some of the selected EMS had high Granger causality linkage with U.S stock markets for the four panels, namely Malaysia, the Philippines, South Africa, Thailand, and Turkey. However, Brazilian and Mexico stock indices are not Granger caused by the U.S stock market for pre-crisis, crisis, and post-crisis periods.

We can conclude for these countries there were contagion effects of global financial crisis, due to the number or degree of the Granger causality linkage correlation increasing or getting stronger for most of the selected emerging stock markets during the crisis period than the pre-crisis period. However, there is no evidence for the Brazil and Mexico markets.

5.3.3.2. Granger Causality Test For Stock Return

We now turn the Granger causality test to the cross-country stock return presented in the Table 5.5. Firstly, for the entire period, U.S. stock return Granger caused all selected emerging stock market returns except Brazilian stock return. Therefore, the emerging stock markets had closed linkage with the U.S market, and that provides evidence for co-movement and integration, thereby laying the foundation of contagion possibility. Among them, there was bidirectional for U.S stock return from Indonesian, Malaysian, and Peruvian stock returns for the entire period 2000-2016.

Moreover, there are 20 bilateral causal linkages among these stock markets. The stock markets of Brazil and Malaysia, Brazil and Mexico, China and Turkey, Colombia and Indonesia, Malaysia and Poland, Hungary and South Africa, India and South Africa, Indonesia with Malaysia, Mexico, Philippines, Turkey and the US; Malaysia with Mexico, South Africa, and the US; Peru and the US, the Philippines and Turkey; Poland and Mexico; and Russia and South Africa. There are also 86 unidirectional causality relationships cross-country stock markets that can be found in the Table 5.6.

Secondly, if we look at Granger causality details for each period from the Table 5.6, we can see China, Colombia, India, and Peru Granger-caused by the U.S stock returns during the GFC period, but pre-crisis they did not have this relationship. In addition, Russian stock return was Granger-caused by the U.S. during the post-crisis compared to the pre-crisis and crisis period. Therefore, these results provide evidence for the contagion of these markets.

In addition, Hungary, Malaysia, Poland, Thailand, and Turkey Granger-caused by the U.S, stock returns for each period, and it indicates the close linkages between them. However, US stock return was not Granger caused in the Brazilian market. Quite the opposite, during the GFC period Brazil Granger caused U.S stock return significantly.

The Table 5.6 reveals that Brazilian stock as the active and leading stock market, it Granger caused 13 out of 15 selected emerging stock markets except for China and the U.S. market, and it had only bidirectional Granger causality pattern with the Malaysian and Mexican stock markets, those two being the most Granger causalities with many other markets.

According to the number of Granger causality relationships, we can divide the selected stock market into two groups. One of them was active and had multiple Granger causality relationships with other stock markets, like Indonesia (10)[19], the Philippines (10), Malaysia (9), Poland (9), Russia (9), Turkey(9), South Africa (8), Thailand (8), India (7), Colombia (6) and Mexico (6). Another group is opposite, and they were not

[19] The number in the parentheses is the number of the Granger causality with other stock markets.

Granger caused by other stock markets easily, for example, Brazil (2), the U.S. (3), China (3), Peru(3), and Hungary (4).

Among them, either the market is more prominent and strong like the U.S. market or they have a relatively closed financial system like China, and therefore it is not easy to be impacted by other markets. One more reason is that the Hungary and Peru stock market are the European and South America stock market and geographically far away from the Asian emerging stock markets. It is one possible reason for the lower number of the Granger causality relationship.

Finally, according to the number of the source market and the effect market, we can classify the considered stock markets into different types. The first type is a strong market type, which was the main Granger cause source market like the U.S, Brazil, and Mexico, those caused by a few markets but impacting on many other markets. The second group has a similar number pattern and caused many other markets but did not impact on them, like China and Peru. They are either far away from other markets or have a relatively closed financial system under government control.

The third is easily Granger caused by other markets, like Russia, the Philippines, Thailand, India, and Turkey. These markets are new and relatively more fragile than the U.S. and follow others. The fourth group is active and has more closed relations with other markets. They had many bidirectional Granger causality relationships with other markets, consisting of Malaysia, Indonesia, South Africa, and Colombia, where number of causing and caused by were similar.

5.5.4 Impulse Response Functions And Variance Decomposition Analysis

5.5.4.1. Impulse Response Function Result

In the last procedure, we will implement impulse response function (IRF) and variance decomposition analysis (VDA) within the unrestricted VAR framework to analyze how the U.S. innovations and shocks influenced the selected EMS. IRF

(Impulse response functions) are used to describe the unpredicted shock or innovation that is displayed through one of the errors on current and future values. Additionally, IRF can determine the period to restore equilibrium after an external shock hits the markets.

IRF (Impulse response function) is the reaction of the dynamic system output in response to some external change with input signals. Therefore, it is suitable for financial contagion study as it captures how other stock markets respond during external shock in the U.S. financial crisis source market. The nature of the impulse response functions is based on a generalized decomposition of the residuals and a one standard deviation shock to investigate the response of a stock market to innovations in another stock market over a given time horizon (Boubaker et al., 2016: 22).

Moreover, the variance decomposition analysis (VDA) provides detailed contributions over a certain time horizon from all equity variations to the forecast-error variance of an index return market. It also provides information about dynamic structure change in a system because VDA measures how much percentage change in all markets (including the own market) impacts on one market's variations.

In terms of the impulse response function, we use ten days horizontal and take the return of the U.S. stock market as the impulse source, and all other markets' returns as the response. The Cholesky (of adjusted) will be applied. As we did before, we will apply impulse response into four-panel periods to see how the U.S. shock affected other emerging stock markets.

Because we have a significant number of sample markets that includes 16 stock markets, it does not make sense to run the variance decomposition with all, given that some of the markets may not be related and integrated. We just focus on the relationship between the U.S. stock market and the selected EMS. Therefore, we will employ variance decomposition within a VAR framework only for the U.S. and each EMS by different periods, to investigate how the selected stock markets' variation was caused by the U.S. stock market dynamically.

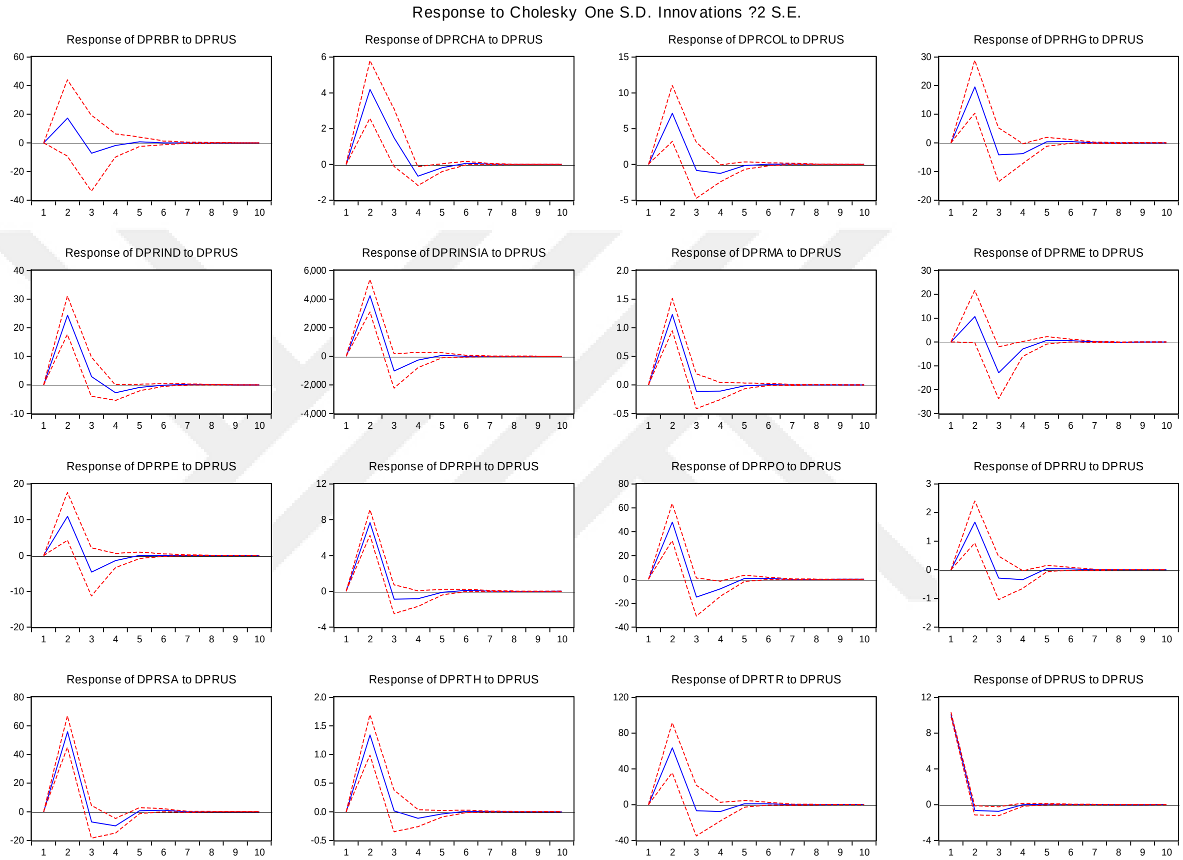

Figure 5.4: Impulse Response Of D(Stock Price) From US To EMS 1/3/2000-12/31/2016

Firstly, Figure 5.4-5.7 of the first difference in the stock Index illustrates that U.S. stock price impacted on the all the other selected EMS prices except the Brazilian stock price. Generally, almost for all markets the responses increased abruptly and reached a peak during the second day and changed direction from a positive to a negative relationship approximately in the third day. The selected emerging stock markets response to the US market is initially positive toward standard deviation shock and then changed to negative after the third day. After that, the impact disappeared around the fifth and sixth day. However, after the third day, the standard deviation is around zero, so the response of the shock or innovation is weaker than before.

To compare the different sub-sample periods, we use the same panel dividing[20]. We can see that there is no response from the Brazilian or Mexican stock price for four panels (Figure 5.4-5.7) because the standard deviations always include the zero line. It confirms the contagion for China, Colombia, India, Peru and Poland, these emerging stock index did not respond to the U.S. stock market pre-crisis, but impulses responded during the GFC period. In addition, in the Philippines and South Africa the response became steeper during the crisis than the pre-crisis period. Interestingly, for Indonesia, during the crisis the response disappeared compared to pre-crisis.

[20] Pane A: entire time 1/3/2000-7/29/2016; Panel B: pre-crisis 1/3/2000-12/31/2006; Panel C: crisis period 1/1/2007-12/31/2009; Panel C: post-crisis period 1/1/2010-7/29/2016.

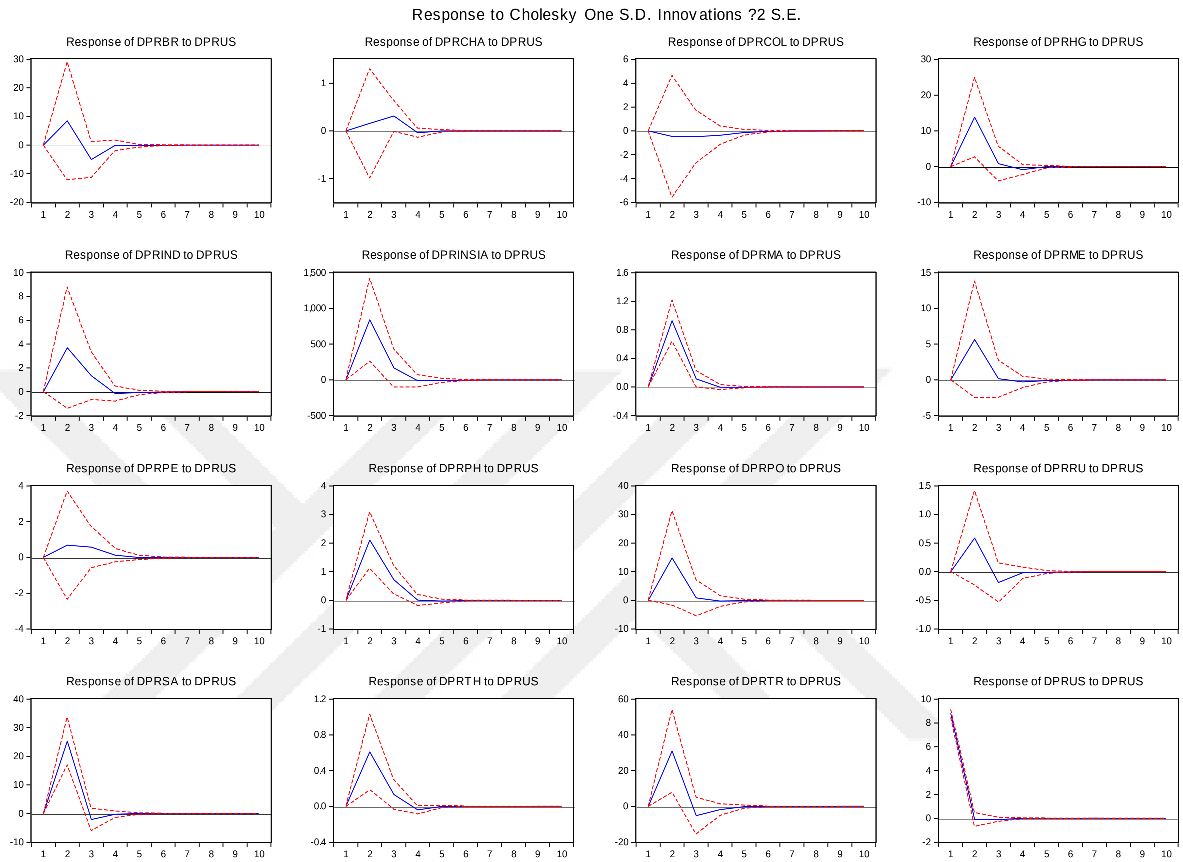

Figure 5.5: Impulse Response Of D(Stock Price) From US To EMS 1/3/2000-12/31/2006

Similarly, we compare the crisis and post-crisis period impulse responses of the selected emerging stock markets to the U.S. stock market (see Figure 5.6 and 5.7). We can see Russia responded to the U.S. during the post-crisis only, but pre-crisis and crisis period there was no response. That means the Russian market responded more slowly than others. For China, India, Indonesia, Malaysia, the Philippines, Poland, South Africa, and Thailand stock prices during the post-crisis responded steeper and stronger than crisis-period. This we can explain as herding behavior. After the markets realized the crisis, they started to follow each other and respond faster than before. It also makes sense for Colombia, Hungary, and Peru, the European and South America stock markets where during the post-crisis period the response disappeared. The same was true as before for Brazil and Mexico's stock markets and they did not show reaction to the U.S. innovations during the post-crisis period.

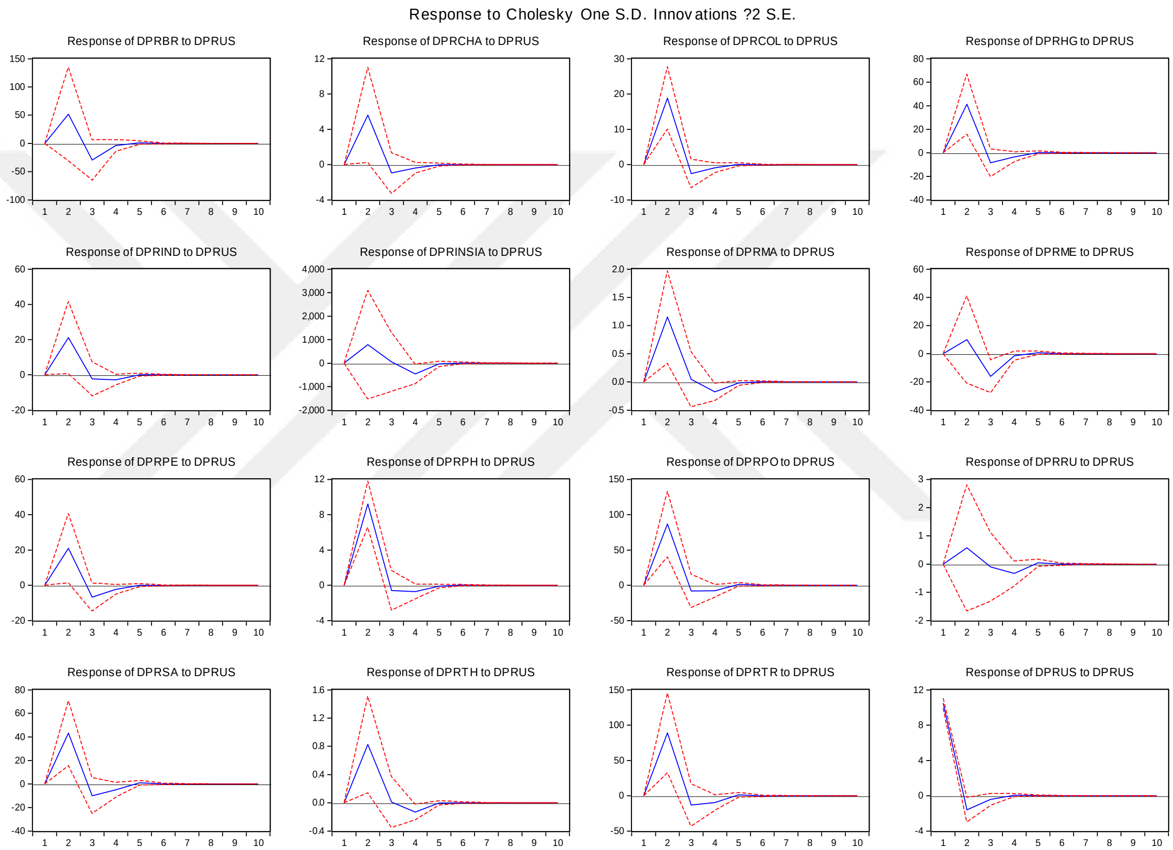

Figure 5.6: Impulse Response Of D(Stock Price) From US To EMS 1/1/2007-12/31/2009

Moving ahead with the impulse response function to the stock return (Figures 5.8-5.11), most of the emerging stock markets responded positively toward the U.S. stock market shock or innovation on the first day, except the Brazilian and Mexican stock markets (Figure 5.8). The response peaked between the second and third day and approached zero between the third and fourth days. Overall, we can see that the impulse responses were transitory in a short time instead of having a permanent impact equilibrium relationship for the four-time panels.

Compared to the pre-crisis and crisis period, we can confirm the contagion effect for China, Colombia, India, Peru, and Poland's stock markets because these markets did not respond to the U.S stock market during the pre-crisis period but responded significantly during the crisis period. In addition, the response level increased substantially to the U.S. stock market for Hungary, the Philippines, South Africa, Thailand, Turkey, and Malaysia. This implies that the correlation increased among markets during the crisis period than pre-crisis.

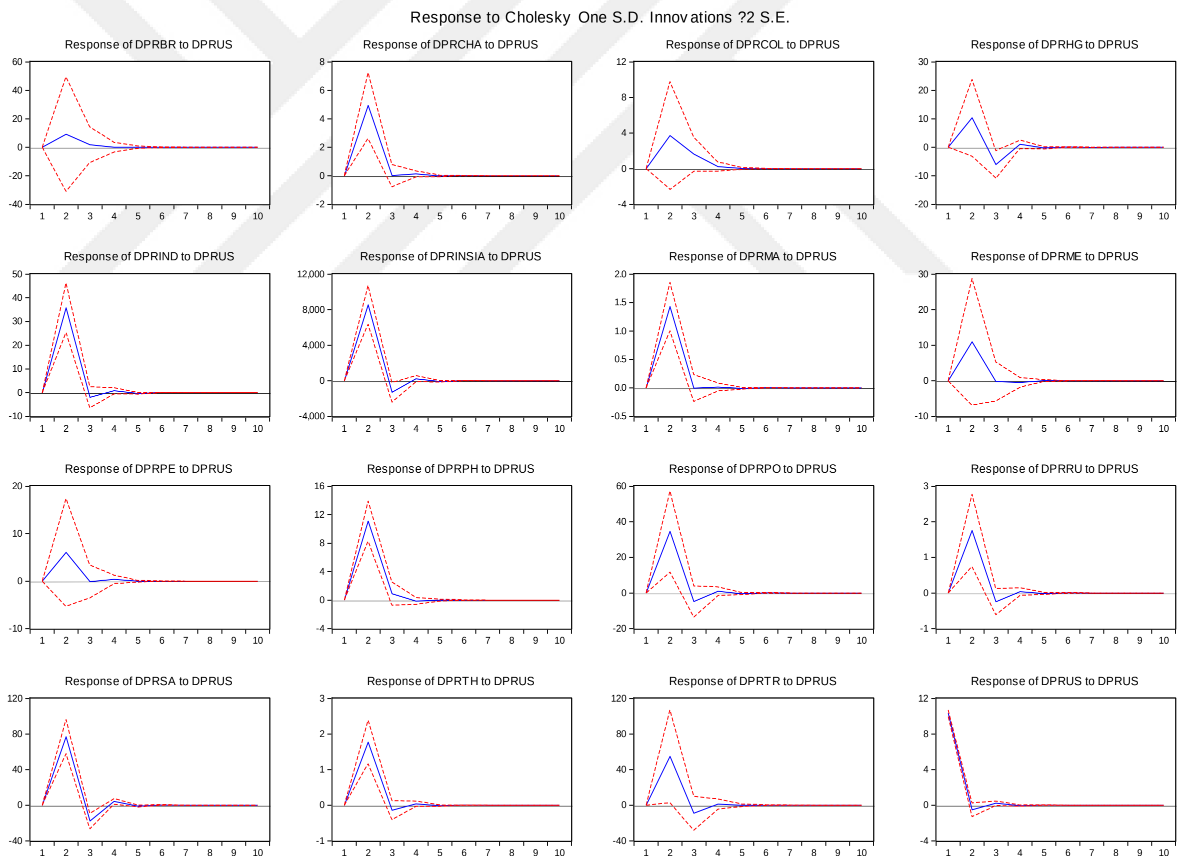

Figure 5.7: Impulse Response Of D(Stock Price) From US To EMS 1/1/2010-7/29/2016

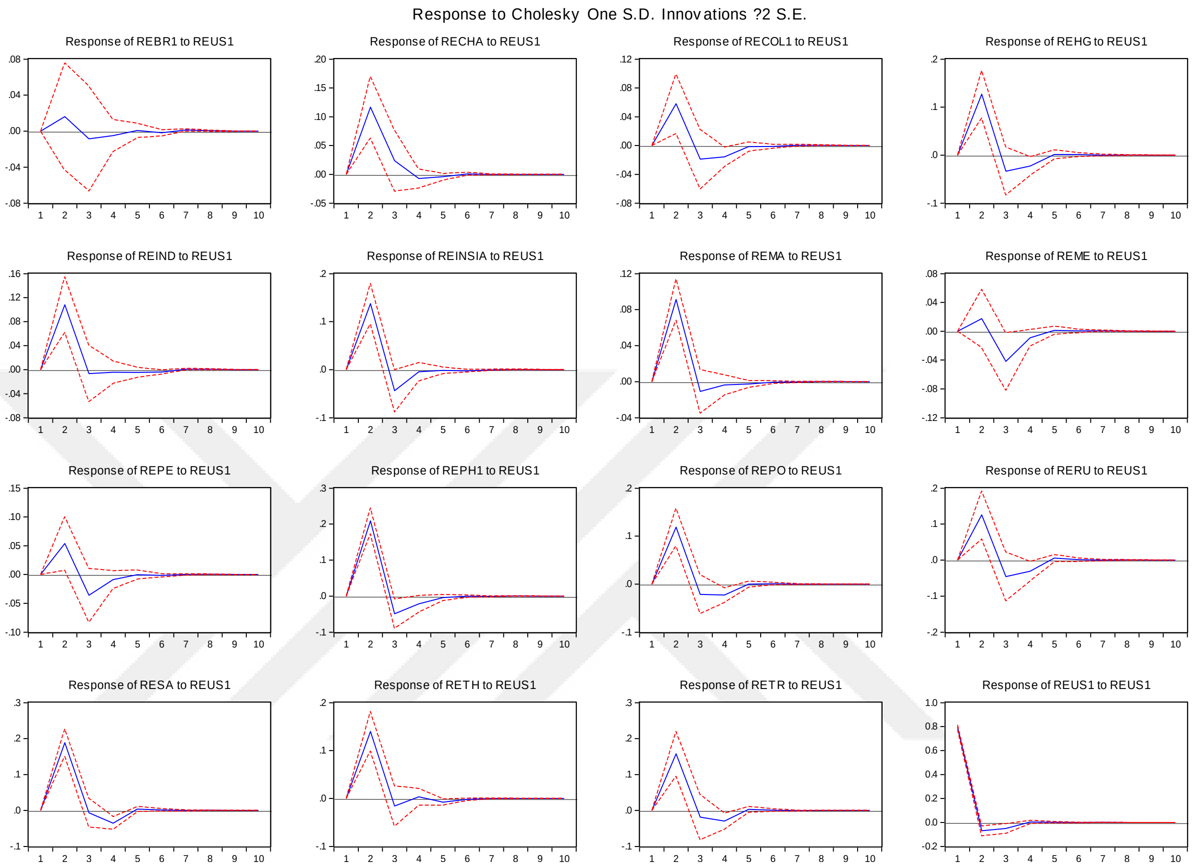

Figure 5.8: Impulse Response Of Stock Return From U.S. S To 16 EMS 1/3/2000 – 7/29/2016

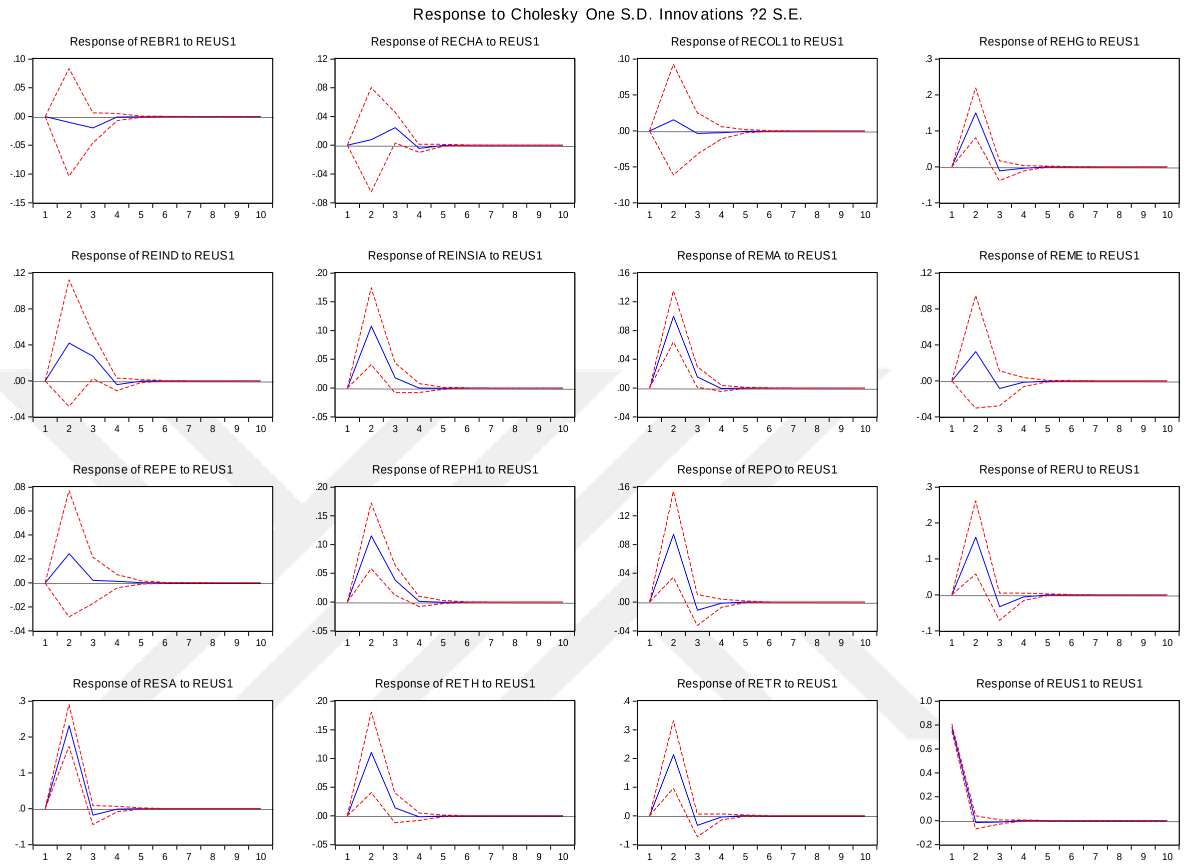

Figure 5.9: Impulse Response Of Stock Return From U.S. S To 16 EMS1/3/2000-12/31/2006

The same as for the price impulse response function, Indonesia responded to the U.S. market pre-crisis but did not respond during the crisis. Brazil, Mexico, and Russia did not respond to the U.S. market shocks. During the crisis-period, there is a more significant fluctuation of the response for EMS to the U.S. stock innovations, although the standard deviation includes the zero line.

Furthermore, the response of some stock market return to the U.S. market return increased, including China, India, Indonesia, Malaysia, Russia, and Thailand. That can provide evidence for herding behavior and co-movement.

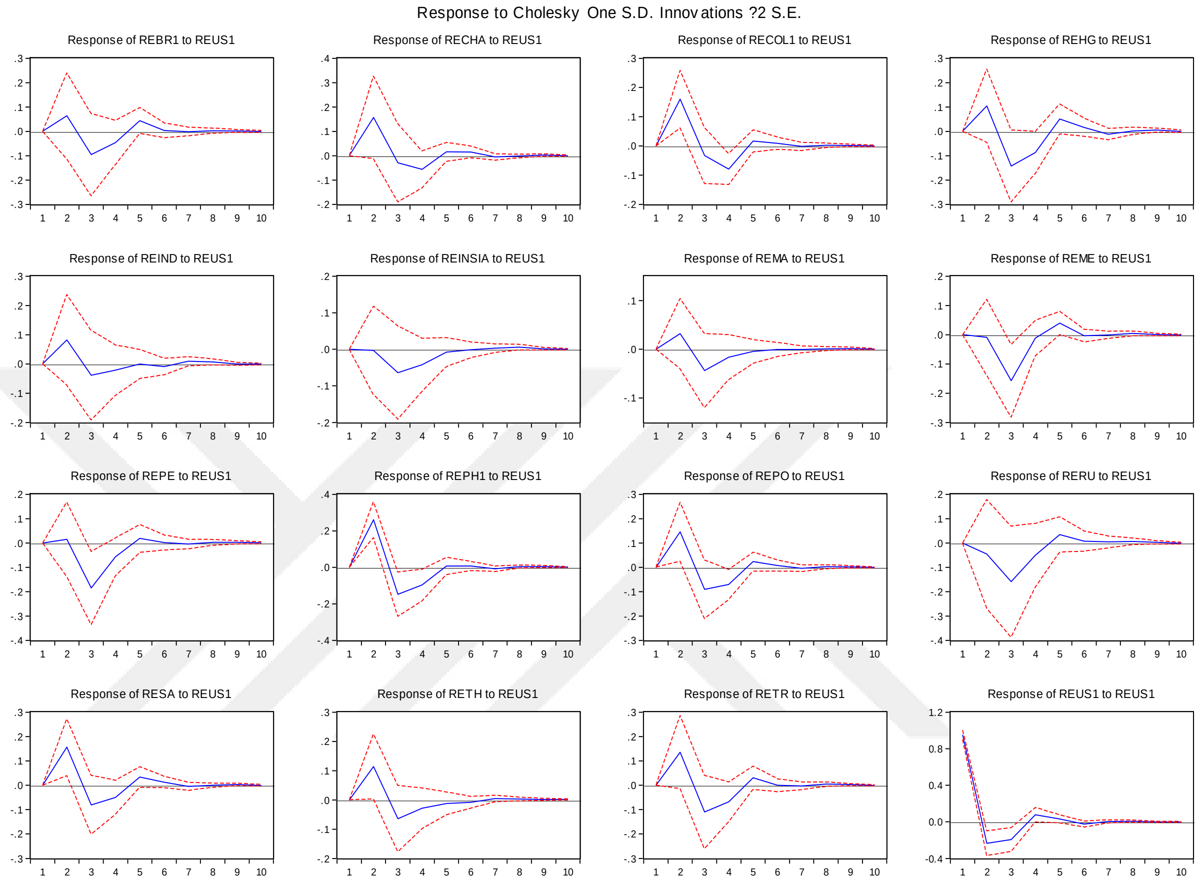

Figure 5.10: Impulse Response Function Of Stock Returns For 16 EMS 1/1/2007-12/31/2009

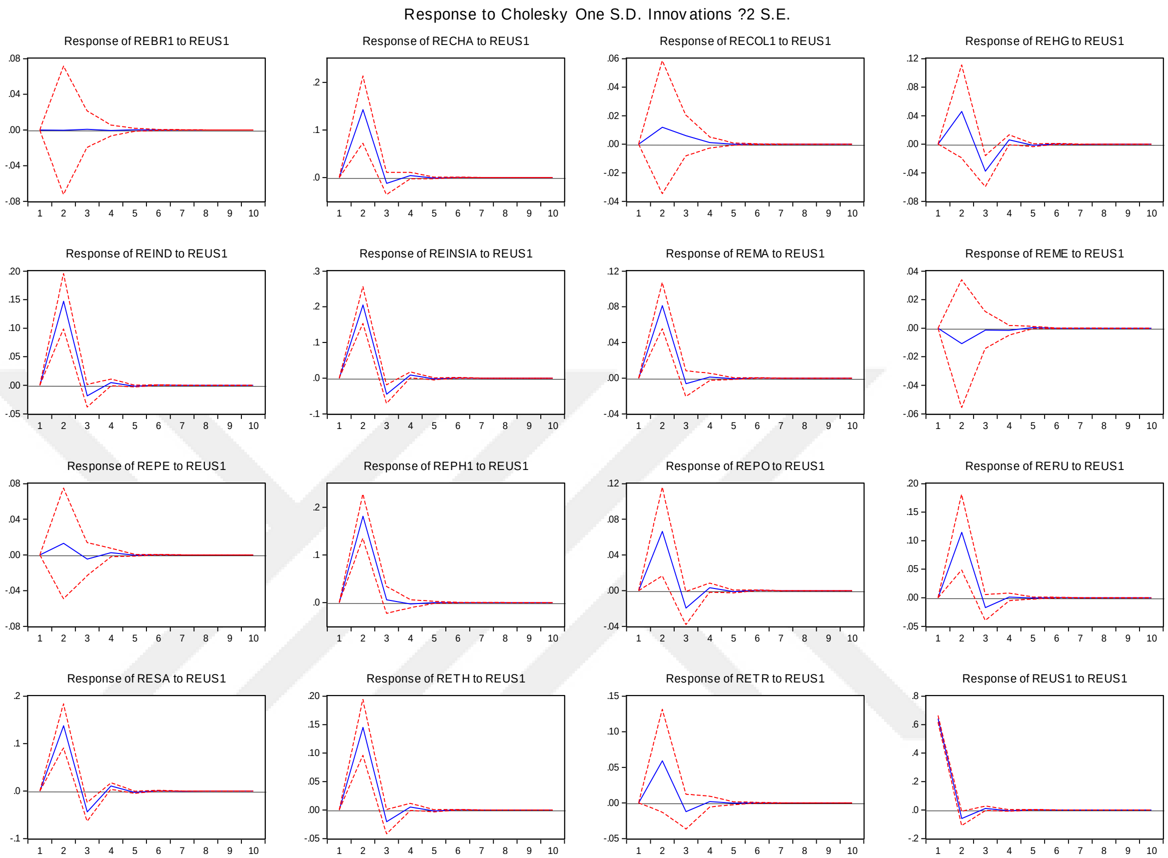

Figure 5.11: Impulse Response Function Of Stock Returns For 16 EMS 1/1/2010—7/29/2016

5.5.4.2. Variance Decomposition

Table 5.8 depicted the results of variance decomposition for a 10-day horizon. To simplify it in the Table 5.8 we included day 1, 2, 5, and 10 to investigate how the U.S. and the own markets contributed to one stock market return variation. As before, we did it with four panels, for the entire period, pre-crisis, crisis, and post-crisis period. Because the selected sample included 16 countries but we focus on the impact from the U.S., we did variance decomposition for the U.S. and the own country within the VAR framework.

From the Panel A entire period, we can classify the selected market into different groups. In the first one, Brazil and Mexico, the percentage of US contribution to the variance of the EMS was very low, less than 1%, and Brazil and Mexico are almost entirely explained by its innovations. The second group consists of China, Colombia, and Peru stock markets, that also lead by the own country's variations, but the U.S. takes account of only around 1.5%.

The third group includes Hungary, Russia, India, Poland, and Turkey; for these, the U.S. can explain the forecast-error variance of more than 5%. Then the fourth group consists of Indonesia and Thailand, where the own country contributions to the forecast-error variance are around 90% and the U.S can explain around 10%. The last group includes Malaysia, the Philippines, and South Africa where U.S. innovations contribute more than 15% for their variations. These results confirmed and are consistent with the impulse response function result as well.

Importantly, the percentage of the U.S. equity innovations in explaining the forecast-error variance of the emerging stock markets increased more during the crisis period than the pre-crisis period, which indicates a dominant role of the U.S. stock market on the selected equity markets. However, Brazil and Mexico did not change significantly compared to others. Interestingly, in the Polish stock market during the crisis, the U.S market contribution to the variation of the Polish market even decreased compared to the pre-crisis period. This result is consistent with Boubaker et al. (2016: 22-23).

Therefore, the GFC contagion effect from the U.S to the considered emerging stock markets is verified by the impulse response function and the variance decomposition analysis. Especially the evidence from the VDA shows the increasing contributions to explain the forecast-error variance of the US increased during the crisis period rather than the pre-crisis period.

5.6. Results

In this chapter, we investigated the GFC shock transmission and contagion effect from the U.S. stock market throughout the 15 selected emerging stock markets. We used the daily stock price and return data from 16 sample equity markets from 1/3/2000 to 7/29/2016. To identify contagion effect by definition, we divided the entire period into three sub-sample periods, namely, pre-crisis, crisis and post-crisis periods.

The emerging economies and US trader and financial linkage have shared an increasing trend since the last decade. Co-movement and financial integration are the considerations about risk diversification for investors. The relationship among these countries is essential to a source of contagion effects for the financial and economic crisis and events. Therefore, this study from two long term and short term dynamic interactions investigated the inter-linkage and relationships among the US and selected emerging stock markets, namely Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Poland, the Philippines, Russia, South Africa, Thailand, Turkey, and the US.

According to the unit root test results, the stock prices are integrated in order one, I(1)[21] and the stock returns are stationary and integrated in I(0), and we could employ the Johansen co-integration model and Granger causality test within a VAR framework

[21] I(1) and I(0) represent the data integrated in the first difference and original data.

to consider the long term and short term relationship among the U.S and EMS respectively. Furthermore, based on the unrestricted VAR (Vector auto-regression) model, we also employed the impulse response function and variance decomposition analysis to investigate how the EMS responded to the U.S. shocks during the GFC.

We found meaningful results of the contagion effect and integration relationship cross-country. There were long term co-movement and co-integration only for Peru in the pre-crisis period, and South Africa and Mexico in the post-crisis periods. There is no significant evidence of the existence of long term co-integration among the US and selected emerging stock markets during the crisis and full sample periods. This finding is consistent with Singh and Singh (2016: 123-124) and supports the benefits for international investors of long term investments.

The dynamic results relating to the short-run are complicated cross-country for the four-time panels. We did a Granger causality test within the VAR framework for the first difference of the stock price and stock return data as well. The results show that both bidirectional causality and unidirectional causality were running from one market to another for the four different time panels. This finding is different than Singh and Singh's (2016: 129) that only found unidirectional causality.

There were large numbers of Granger causality relationships among the considered stock markets. The U.S. stock market had Granger causality with 14 emerging stocks out of 15 markets at the 1% significance level (except for Brazil) for the entire long term period. In addition, there were totally 106 Granger causality linkage relationships among these 16 selected stock market indices for the whole period 2000-2016. Especially, we concluded that the Asian stock markets had more Granger causality relationships, like Indonesia (10), the Philippines (10), Malaysia (9), and India (7). Comparatively, European emerging stock markets were impacted less, like Hungary (4), Peru (3), and Brazil (2). There are clearly geographic concentrations and the Asian emerging stock markets are much more sensitive than European and African emerging stock markets.

In sum, the Granger causality results showed the short-run linkage among markets. The US, as one of the vital sources and the leading country, Granger caused 14 selected emerging stock markets except for the Brazilian stock market. In addition, some of the aimed EMS had high Granger causality linkage with U.S stock markets for the four panels, and they were Malaysia, the Philippines, South Africa, Thailand, and TR. However, Brazilian and Mexico stock indices are not Granger caused by U.S stock market for pre-crisis, crisis, and post-crisis periods. We classified the considered 16 stock markets into four different groups according to the ability and number of the Granger causality.

We identified the contagion effect because of the number and degree of the Granger causality relationships increased during the GFC period rather than in the pre-crisis period. However, the number of the Granger causality linkage decreased during the post-crisis periods among the selected equity markets.

Furthermore, we also resorted to impulse response function and variance decomposition analysis to examine the impact from U.S innovation and shocks on the selected emerging equity markets over the entire, pre-crisis, crisis, and post-crisis four panels. We identified the contagion effect of the GFC from the U.S to the considered EMS because the impulse response increased during the crisis period rather than in the pre-crisis period. In other words, in terms of the variance decomposition, the contribution of the U.S. stock market raised the percentage of explaining the variation of the EMS during the crisis period more than pre-crisis.

The empirical analysis results provide evidence of contagion between the U.S. equity market and most of the selected emerging equity markets. This finding of financial contagion existence among the international stock markets can help policymakers to develop a strong and prevailing financial system and monetary policy to make the financial market more immune to international shocks. In addition, it benefits investors concerning portfolio diversification and investment decision making by considering the long term and short term market co-integration and co-movements.

Table 5.5: Granger Causality Test Of The First Difference Stock Index For 16 Countries Of Four Time Panels

Panel A: entire period 1/3/2000-12/31/2006 with two 2 lags

Depdenent var. Excluded	DPRBR	DPRCHA	DPRCOL	DPRHG	DPRIND	DPRINSIA	DPRMA	DPRME	DPRPE	DPRPH	DPRPO	DPRRU	DPRSA	DPRTH	DPRTR	DPRUS
DPRBR		2.320893	6.06274**	15.0762***	7.9595**	18.6681***	23.0772***	7.6654**	7.9869**	4.6577*	8.1017**	51.4509***	21.1665***	22.5459***	34.8974***	3.079943
DPRCHA	1.3216		2.2783	4.2821	9.2751***	9.2598***	9.9173***	3.8753	0.6511	6.2461**	6.2635**	12.3404***	4.1711	16.9457***	6.6321**	0.0421
DPRCOL	2.0505	0.4492		2.5666	4.4528	4.9432*	6.5609**	0.2887	2.4569	4.2789	15.6463***	10.1127***	2.7453	5.1163*	9.9576***	1.2134
DPRHG	1.0518	0.8381	0.7187		4.2785	2.2254	0.3983	1.3757	2.3697	0.6479	3.2762	1.6822	10.6880***	10.8283***	1.5015	4.5629
DPRIND	4.1431	0.0949	1.1954	1.3082		3.121	2.0795	0.1969	1.7321	4.7534*	9.8081***	1.272	7.4086**	1.2524	1.3406	0.6208
DPRINSIA	0.0582	0.4356	5.1315*	4.132	4.4967		7.0073**	6.1678**	3.4452	34.059***	1.4965	7.7209**	0.4646	14.0769***	6.795**	7.8877**
DPRMA	7.0035**	0.9027	16.9534***	0.4216	4.7878*	9.5804***		6.0282**	1.7805	0.5446	4.6930*	5.5027*	11.2819***	6.1786**	1.5165	7.6368**
DPRME	9.6966**	0.251	6.7424**	24.833***	29.5516***	29.6996***	29.6809***		2.4059	38.1509***	58.4496***	18.1870***	29.5877***	4.2931	8.4155**	3.7425
DPRPE	1.7583	5.6796*	2.2384	0.0716	1.1903	11.9456***	6.3206**	4.7081*		4.6224*	1.1685	0.5577	1.0462	7.2738**	0.8661	5.4359*
DPRPH	1.4385	1.0808	4.0242	2.4436	0.6999	8.1975**	1.5418	0.4223	3.5097		0.3561	1.683	0.3205	3.5372	7.3707**	1.4893
DPRPO	1.4475	0.0779	7.1017**	0.4896	3.0774	1.3805	0.206	5.1696*	8.2735**	1.3687		0.3844	3.3175	1.3277	4.6193*	0.2404
DPRRU	1.9565	0.0562	3.4162	3.6543	2.6043	0.7912	2.7728	1.9283	0.5359	2.314	14.1548***		9.2751***	0.5244	4.007	4.0983
DPRSA	0.4429	2.0311	0.688	10.9767***	12.4909***	7.0146**	7.1959**	3.7466	0.7802	9.4337***	11.3021***	11.8013***		0.6313	15.2111***	4.2012
DPRTH	2.7872	2.1133	0.8993	2.3358	3.5916	0.9262	2.8833	2.4206	2.7264	7.8963**	2.9783	4.6746*	5.0582*		0.5565	4.3448
DPRTR	0.4645	8.1894**	0.618	2.6574	5.8709*	8.531**	6.6693**	2.7675	1.7445	9.5298***	3.4095	4.4994	1.3649	3.0935		0.4477

	DPRBR	DPRCHA	DPRCOL	DPRHG	DPRIND	DPRINSIA	DPRMA	DPRME	DPRPE	DPRPH	DPRPO	DPRRU	DPRSA	DPRTH	DPRTR	DPRUS
DPRUS	2.0687	30.3262***	13.7176***	17.8885***	56.318***	57.9452***	78.5267***	7.9453**	11.8714***	127.6011***	38.7583***	20.8391***	106.4858***	59.1577***	21.6321***	

Panel B: pre-crisis 1/3/2000-12/31/2006 with one lag

Depdenent var.	DPRBR	DPRCHA	DPRCOL	DPRHG	DPRIND	DPRINSIA	DPRMA	DPRME	DPRPE	DPRPH	DPRPO	DPRRU	DPRSA	DPRTH	DPRTR	DPRUS
DPRBR		0.0861	4.7024**	35.6727***	11.5132***	14.3759***	0.0091	0.8321	7.8337***	11.0048***	16.6329***	38.249***	18.0397***	8.6030***	45.3740***	0.0719
DPRCHA	0.0115		0.3976	1.7639	0.0103	0.3251	0.7916	2.5961	0.0226	1.1737	0.0004	0.0478	4.6265**	0.1852	2.9680*	0.1304
DPRCOL	9.9359**	2.5098		0.0055	7.7668***	3.7946*	2.7999*	4.8458**	14.6298***	6.7272***	2.6528	2.8738*	2.4832	0.528	19.0805***	5.6148**
DPRHG	0.6913	0.0013	3.0281*		6.1062**	13.2383***	1.5619	0.1137	1.8499	0.9364	0.0029	4.5364**	0.8754	0.6514	0.8803	1.1158
DPRIND	0.187	1.8272	16.394***	1.1063		3.3958*	2.0509	1.3027	3.8268*	0.0077	2.5187	0.3338	0.0291	0.4674	0.057	0.0157
DPRINSIA	6.4528**	0.0607	0.9142	2.1893	0.7586		0.0014	0.6131	1.3861	0.3517	1.821	1.8623	0.269	0.329	4.5587**	1.0476
DPRMA	0.0026	1.4312	0.5285	0.009	2.0137	0.0097		0.0029	0.3691	3.1963*	0.1666	0.0227	0.5049	4.4576**	0.2836	1.5335
DPRME	2.9172*	0.079	20.3619***	11.4434***	14.5657***	14.2341***	3.7177*		2.0839	17.2315	13.2549***	7.5431***	11.1735***	3.7080*	4.1305**	0.0618
DPRPE	7.5304***	2.0626	12.1826***	0.4616	0.2977	0.5774	1.7557	12.1903***		1.4329	0.9627	0.0006	0.1483	15.7487***	1.1117	4.6515**
DPRPH	0.5597	0.2064	2.471	0.2507	0.0427	0.4643	0.2344	3.2166*	4.9223**		0.8487	0.6762	1.9212	1.054	0.7781	0.1086
DPRPO	0.9032	0.5142	0.6275	0.921	3.2261*	9.8989***	0.9865	0.4023	5.6338**	0.0885		4.8427**	6.9431***	0.8269	2.2864	2.9421*
DPRRU	0.1717	0.0001	3.6090*	0.5899	2.5469	1.646	0.3654	3.2958*	14.8493***	2.0243	0.0514		0.2583	0.7957	0.0002	0.0014
DPRSA	8.6548***	5.2282**	3.4900*	0.2007	0.195	0.8841	0.026	1.9525	0.3678	3.1764*	1.0232	11.5965***		1.7987	8.4491***	2.7251*
DPRTH	0.0668	3.236*	0.1402	0.9027	1.7787	1.1168	4.5676**	0.4794	0.0088	3.3368*	2.4951	0.0076	1.5681		0.1609	1.1334
DPRTR	0.1306	0.3416	0.144	0.0202	0.2304	3.4042*	0.0375	5.7618**	1.0367	0.455	2.7004	1.0702	0.2652	5.8834**		0.0089
DPRUS	0.6787	0.0748	0.0335	6.2548**	2.0901	8.4646***	42.2244***	1.912	0.2066	18.4927***	3.2178*	2.0289	37.0526***	8.3390***	7.1807***	

Panel C: crisis 1/1/2007-12/31/2009 with one lag

Excluded	DPRBR	DPRCHA	DPRCOL	DPRHG	DPRIND	DPRINSIA	DPRMA	DPRME	DPRPE	DPRPH	DPRPO	DPRRU	DPRSA	DPRTH	DPRTR	DPRUS
DPRBR		0.056603	1.464422	3.3812*	0.661904	6.0587**	0.901559	7.5057***	0.091447	0.6482	3.1391*	4.3985**	0.145039	0.229279	4.5695**	5.2248**
DPRCHA	0.4967		1.5885	1.084	1.8584	3.0246*	0.4319	1.4464	0.3039	0.0268	2.7137*	7.3102***	1.2198	5.7304**	1.2989	0.0547
DPRCOL	0.1987	1.1713		0.0719	0.934	0.9305	0.0595	1.552	6.1004**	0.0967	3.8209*	2.3245	0.7745	0.2026	1.379	0.9619
DPRHG	0.1424	0.0118	0.4793		0.399	1.2727	0.0493	1.3694	0.0172	0.3566	0.4302	3.9862**	3.4549*	4.3132**	0.0272	0.9323
DPRIND	1.7365	0.004	3.2597*	0.1197		3.8260*	1.2505	0.4517	0.4022	0.0298	0.4364	1.8509	0.005	0	0.004	0.182
DPRINSIA	1.9266	3.0842*	1.3031	2.9176*	0.1222		6.1683**	3.5821*	2.5019	16.8691***	1.0432	1.1355	0.1227	0.0266	1.1964	4.2201**
DPRMA	3.1371*	0.8396	0.0092	0.059	0.1659	3.6972*		6.1284**	0.3261	2.5338	3.0657*	1.1217	2.5255	4.6199**	1.5418	3.8981**
DPRME	8.7939***	0.0276	4.5820**	16.4062***	15.9442***	15.9498***	9.8723***		6.9157***	11.5767***	14.8663***	19.8284***	19.218***	9.0827***	28.7785***	8.5825***
DPRPE	1.2031	5.6099**	0.0835	0.2346	0.1219	5.7294**	1.6817	0.2819		0.0999	0.4374	0.2133	0.7203	14.5696***	0.0515	0.1689
DPRPH	1.3402	0.0048	5.8447**	0.3361	2.7310*	2.8395*	4.0260**	0.5843	3.2848*		8.0795***	6.8055***	6.8207***	12.8813***	10.5648***	0.036
DPRPO	0.7355	0.1247	0.751	0.005	0.1768	0.1996	1.6631	0.2887	1.3993	5.1258**		0.9685	0.0084	0.0407	0.3029	0.0052
DPRRU	0.7498	0.356	3.0227*	2.2131	0.0229	0.0419	0.1176	3.7689*	0.0165	0.5918	6.0728**		0.3591	0.0627	0.8128	3.0668*
DPRSA	0.4098	0.8411	2.1664	2.7837*	8.0835***	3.2984*	3.9442**	0.9344	0.3133	1.3444	1.6145	4.0750**		0.0367	6.2438**	0.0201
DPRTH	1.4125	1.4969	0.0729	0.0918	1.8195	0.252	3.1759*	1.7227	0.101	0.4406	0.5891	2.3669	0.6731		0.5897	0.4283
DPRTR	5.6402**	3.2199*	0.6443	0.9271	1.5014	0.5195	0.0594	4.1276**	4.0247**	0.424	1.2606	6.88***	5.2081**	0.0094		1.7518
DPRUS	1.5684	4.3639**	18.4209***	10.5802***	4.3002**	0.4603	7.9182***	0.4203	4.6035**	51.327***	14.1094***	0.2692	9.9163***	5.8572**	10.0692***	

Panel D: post-crisis 1/1/2010-7/29/2016 with one lag

Excluded	DPRBR	DPRCHA	DPRCOL	DPRHG	DPRIND	DPRINSIA	DPRMA	DPRME	DPRPE	DPRPH	DPRPO	DPRRU	DPRSA	DPRTH	DPRTR	DPRUS
DPRBR		0.667649	4.5654**	8.5891**	9.1166***	7.3543***	14.4278***	0.948337	0.9631	1.2117	5.3338**	12.4487***	9.2193***	18.3096***	22.6259***	1.363692
DPRCHA	0.029		0.0283	2.7506*	4.3340**	5.9354**	10.1577*	0.0104	0.0278	11.9406*	0.3715	0.6187	0.1155	7.5922**	0.5385	0.0952

							**			**				*		
DPRCOL	0.3747	2.2993		1.9176	0.0753	4.3220**	5.3406**	1.1231	1.8964	2.3096	0.336	0.0246	0.0182	2.6662	0.6372	0.5607
DPRHG	0.03	0.4325	1.4514		3.9552**	1.0246	0.0917	0.0583	1.346	0.6112	4.1144**	0.3012	2.8415*	5.5559**	2.9525*	1.0146
DPRIND	0.9512	0.0131	0.2624	2.6819		0.0991	1.2242	0.1401	0.4426	4.2406**	1.919	0.2902	0.4128	0.0571	0.013	0.2333
DPRINSIA	0.2263	0.113	0.3349	0.0035	4.5269**		4.1728**	1.7566	2.3974	8.3785***	1.7276	6.3370**	3.6134*	11.0707***	3.3929*	2.9820*
DPRMA	0.573	0.0054	0.5716	1.1879	2.164	4.9995**		0.0649	0.1189	1.367	0.0776	0.9662	4.4572**	0.3873	0.936	0.6026
DPRME	0.4712	1.8442	0.0997	4.4838**	2.1417	5.6230**	7.5531***		0.4898	4.9956**	18.3603***	0.0307	3.0208*	1.0193	0.0983	0.0563
DPRPE	0.3	0.4434	0.0058	0.0023	0.9219	0.8352	0.2481	1.6808		0.913	0.0707	1.4567	0.0549	1.9103	0.0603	1.3759
DPRPH	0.1234	0.1324	2.4124	0.6885	0.5383	2.9607*	0.599	1.8838	0.0003		1.311	0.9678	0.0508	0.6745	5.8577**	0.0006
DPRPO	0.3539	0.1191	4.624**	1.0638	2.2171	1.1557	5.4284**	4.7514**	0.0653	4.3015**		0.1566	0.7145	0.8446	0.0655	0.0008
DPRRU	0.6938	0.2499	0.0908	1.0675	0.5005	0.1898	8.5258***	0.3709	0.3626	1.1555	1.0935		5.1054**	1.7797	1.3098	1.9893
DPRSA	0.2343	0.0008	1.5722	0.025	0.0004	1.8589	0.0126	0.8648	0.2264	1.2623	0.0809	0.4864		0.3456	0.0017	6.1776**
DPRTH	1.14	0.3409	0.1513	1.5107	0.4623	0.0673	0.1154	0.5347	5.2828**	2.048	0.1242	0.8305	1.3368		0.09	1.9236
DPRTR	1.2451	0.5095	0.4042	0.4906	0.2019	5.0968**	5.6502**	3.3720*	0.296	5.0123**	0.5056	0.8069	0.5065	1.0817		0.597
DPRUS	0.2122	18.309***	1.5059	2.3349	47.4156***	62.6341***	45.6871***	1.5187	1.1317	62.8975***	9.1999***	11.9920***	65.8073***	33.8152***	4.4283**	

*Note: 1. ***, **, and * denote significance level in1%, 5%, and 10% percent, respectively. DPR denote the first difference of the stock price.*

2. BR(Brazil), CHA(China), COL(Colombia), HG(Hungry), IND(India), INSIA(Indonesia), MA(Malaysia), ME(Mexico), PE(Peru), PH(Philippines), Po(Poland), RU(Russia), SA(South Africa), TH(Thailand), TR(Turkey), and US(United States).

Table 5.6: Summary Of The Granger Causality Test Results For 16 Selected Cross-Country First Difference Of Stock Markets Price Index For Four Time Periods

Stock index	Panel A:Entire 1/3/200-7/29/2016 caused by (VARs with two lags and a constant)			Panel : pre-crisis 1/1/2000-12/31/2006 caused by (VARs with one lag and a constant)			Panel C: crisis period 1/1/2007-12/31/2009 caused by (VARs with one lag and a constant)			Panel D: post-crisis 1/1/2010-7/29/2016 caused by (VARs with one lag and a constant)		
Effect		No.	bidir.		No.	bidir.		No.	bidir.		No.	bidir.
BR	MA**, ME***	2	2	COL***, INSIA**, ME*, PE***, SA***	5	5	MA*, ME***,TR**	3	2		0	0
CHA	PE*, TR**, US***	3	1	SA**, TH*	2	1	INSIA*, PE**, TR*,US***	4	1		0	0
COL	BR**, INSIA*, MA***, ME**, PO**, US***	6	3	BR**, HG*, IND***, ME***, PE***, RU*, SA*	7	5	IND*, ME**, PH**, RU*, US***	5	0	BR**, PO**	2	0
HG	BR***, ME***, SA***, US***	4	1	BR***, ME***, US**	3	0	BR*, INSIA*, ME**, SA*, US***	5	1	BR***, CHA*, ME**	3	0
IND	BR**, CHA***, MA*, ME***, SA***, TR*, US***	7	1	BR***,COL***, HG**, ME***, PO*	5	1	ME***, PH*, SA***, US**	4	0	BR***,CHA**, HG**, INSIA**, US***	5	0
INSIA	BR***, CHA**,COL*, MA***, ME***,PE***, PH**, SA**,TR**, US***	10	6	BR***, COL*, HG**, IND*, ME***, PO***, TR*, US***	8	2	BR**, CHA*, IND*, ME**, PE**, PH*, SA*	7	3	BR***, CHA**, COL**,MA**, ME**, PH*, TR**, US***	8	4
MA	BR***, CHA***, COL**, INSIA**, ME***, PE**, SA**, TR**, US***	9	6	COL*, ME*, TH**, US***	4	1	INSIA**, ME***, PH**, SA**, TH*, US***	6	3	BR***, CHA***, COL**, INSIA**, ME***, PO**, RU***, TR**, US***	9	1
ME	BR**,INSIA**, MA**, PE*, PO*, US***	6	3	COL**, PE***, PH*, RU*, TR**	5	4	BR***, INSIA*, MA**, RU*, TR**	5	5	PO**, TR*	2	1

PE	BR**, PO**, _US_***	3	1	_BR_***, _COL_***, IND*, PH**, PO**, RU***	6	2	COL**, ME****, PH*, TR**, US**	5	0	TH**	1	0
PH	BR*, CHA**, IND*,_INSIA_***, ME***, PE*, SA***, TH**, _TR_***,US***	10	3	BR***, COL***, MA*, _ME_***, SA*, _TH_*, US***	7	2	_INSIA_***, ME***, _PO_**, US***	4	2	CHA***, IND**, _INSIA_***, ME**, PO**,_TR_**, US***	7	2
PO	BR**, CHA**, _COL_***, IND***, MA*,_ME_***, RU***, SA***, US***	9	2	BR***, ME***, _US_*	3	1	BR*, CHA*, COL*, MA*, ME***,_PH_***, RU**, US***	8	1	BR**, HG**, _ME_***, US***	4	1
RU	BR***, CHA***,COL***, INSIA**, MA*, ME***, _SA_***, TH*, Us***	9	1	BR***,_COL_*, HG**, _ME_***,PO**, SA***	6	2	BR**, CHA***, HG**, _ME_***, PH***, SA**, TR***	7	1	BR***, INSIA**, US***	3	0
SA	BR***, _HG_***, _IND_**, _MA_***, ME***, _RU_***, TH*, US***	8	4	_BR_***, _CHA_**, ME***, PO***,_US_***	5	3	_HG_*, ME**, PH**, _TR_**, US***	5	2	BR***, HG*, INSIA*, MA**, ME*, RU**, _US_***	7	1
TH	BR***, CHA***, COL*, HG***, INSIA***, MA**, PE**, US***	8	0	BR***, _MA_**, ME*, _PE_***, TR**, US***	6	2	CHA**, HG**, _MA_**, ME***, PE***, PH***, US**	7	1	BR***, CHA***, HG**, INSIA***, US***	5	0
TR	BR***, _CHA_**, COL***, _INSIA_**, ME**, _PH_**, PO*, SA***, US***	9	3	BR***, CHA*, COL***, _INSIA_**,_ME_**, SA***, US***	7	2	_BR_**, _ME_***, PH***, _SA_**, US***	5	3	BR***, HG*,_INSIA_*, _PH_**, US**	5	2
US	_INSIA_**, _MA_**, _PE_*	3	3	COL**, PE**, _PO_*, _SA_*	4	2	BR**, INSIA**,_MA_**, ME***, RU*	5	1	_INSIA_*, SA**	2	1

Note: 1. ***, **, and * denote significance level in1%, 5%, and 10% percent, respectively. _2. BR(Brazil), CHA(China), COL(Colombia), HG(Hungry), IND(India), INSIA(Indonesia), MA(Malaysia), ME(Mexico), PE(Peru), PH(Philippines), Po(Poland), RU(Russia), SA(South Africa), TH(Thailand), TR(Turkey), and US(United States)._

Table 5.7: Summary Of Granger Causality Test Results Of The Cross-Country Stock Returns In Four Time Periods

	Panel A: Entire 1/3/2000-12/31/2016 with 2 lags	No	bi dir.	Panel B: Pre-1/3/ 2000 12/31/2006 with 1 lag	No	bi dir.	Panel C: Crisis 1/1/2007- 12/31/2009 with 2 lags	No	bi dir.	Panel D: Post –crisis: 1/1/2010- 7/29/2016 with 1 lag	No	bi dir.
REBR	MA*, PE**, RU*, SA*, TH**	5	5	0	0	0	INSIA**,MA*,ME***, PE**, TH*, TR***	6	4	0	0	0
RECHA	TH*, TR**, US***	3	2	COL**, SA**	2	1	PE*	1	0	US***	1	0
RECOL	IND*, INSIA***, MA**, ME***, PE***, PH**, PO*, RU**, US**	9	4	IND*, ME***, PE*	3	0	CHA**, IND**, INSIA**, MA**, ME**, RU*, US***	7	0	BR***, PO**	2	0
REHG	INSIA*, ME***, PE***, RU*, SA**, TR*, US***	7	4	BR*, ME***, PO**, US***	4	1	INSIA**, ME***, PE**, TH**	4	0	BR***, ME**, TH**	3	1
REIND	BR**, CHA**, COL***, ME***, SA*, TH**, US***	7	2	BR**, INSIA*, ME***, SA***	4	0	CHA**, INSIA*, ME***, SA**, TH**, TR**	6	0	BR***, CHA**, HG**, INSIA*, ME*, US***	6	0
REINSIA	BR***, CHA**, COL*,HG**, MA**, ME***, PE***, RU**, US***	9	2	BR*, HG**, ME***, TR**, US***	5	1	BR***, CHA**, HG*, MA***,ME***,PE*, RU**,	7	6	BR***, CHA***, COL**, MA*, ME**, SA**,TR**, US***	8	5
REMA	BR***, CHA***, COL**, INSIA***, PE**, TH***, US***	7	3	ME*, US***	2	0	BR**,INSIA***,ME***,PE* *,TH**	5	5	BR***, CHA***, COL***, INSIA*, ME***, PO**, RU**, TR**, US***	9	0
REME	HG*, MA*, PE*, TH**	4	3	CHA**, INSIA*,PE**,TH**, TR*	5	3	BR***,INSIA***,MA**,SA*, TH*, TR**	6	6	BR*, COL*, INSIA*, PO**	4	2
REPE	BR***, INSIA***, ME**, PO***, RU***, US**	6	3	BR**, ME*, PH***	3	1	COL**, INSIA***,MA*, ME**, PO***, RU**, TR**	7	2	BR***, HG*, INSIA*, TH**	4	1

REPH	BR***, COL**, INSIA***, ME***, RU***, SA***, US***	7	2	BR**, COL**, INSIA**, ME***, SA**, US***	6	0	BR*, INSIA***, ME**, PO**, RU***, SA**, US***	7	0	BR*, CHA***, COL*, HG*, IND***, INSIA***, ME**, PE**, PO*, TR*, US***	11	0
REPO	BR**, COL***, HG**, ME***, RU**, SA**, TR**, US***	8	2	BR***, INSIA*, ME*, TR*, US***	5	1	ME***, RU**, US**	3	0	BR***, HG*, INSIA*, ME***,US***	5	0
RERU	BR***, CHA**, INSIA**, ME***, PH*, SA***, TH**, US***	8	2	BR***, COL*, INSIA*, SA**, US***	5	0	BR***, CHA**, IND*, INSIA*, ME***, SA*, TH*	7	2	BR***, INSIA***, US***	3	0
RESA	BR***, COL*, HG**, MA***, ME***, PE*, RU*, TH***, US***	9	3	BR*, CHA**, ME**, TH*, US***	5	1	HG***MA**, ME***,PE**, TR*, US**	6	2	BR***, HG**, INSIA**, MA*, ME**, RU**, TH**, US***	8	2
RETH	BR***, CHA***, HG***, INSIA**, MA*, ME***, PE**, US***	8	5	ME***,US***	2	2	CHA***, HG***, INSIA***, MA***,ME***, PE***, PH**, RU*	8	4	BR***, CHA***, COL**, HG**, INSIA***, PE*, US***	7	3
RETR	BR***, CHA**, COL**, ME***, SA***, TH*, US***	7	1	BR***, COL**, US***	3	0	BR***, CHA**, INSIA**, MA**, ME***,SA**,	6	2	BR***, INSIA**	2	1
REUS	HG*, INSIA**, MA**, ME**, PE**,TH***	6	5	COL*, HG**, PE**, PO**, TH*	5	3	BR**, INSIA***, MA***, ME***, PE*	5	0	INSIA**,SA**, TH**	3	2

Note: 1. ***, **, and * denote significance level in1%, 5%, and 10% percent, respectively. *2. BR(Brazil), CHA(China), COL(Colombia), HG(Hungry), IND(India), INSIA(Indonesia), MA(Malaysia), ME(Mexico), PE(Peru), PH(Philippines), Po(Poland), RU(Russia), SA(South Africa), TH(Thailand), TR(Turkey), and US(United States).*

Table 5.8: Variance Decomposition Of Stock Returns For 16 Considered Stock Markets Of Four Panels

Panel A: entire 2000-2016															
		REBR1: lag 8			RECHA:lag 8			RECOL1:lag 2			REHG:lag 8			REIND:lag 7	
Period	S.E.	REBR1	REUS1	S.E.	RECHA	REUS1	S.E.	RECOL1	REUS1	S.E.	REHG	REUS1	S.E.	REIND	REUS1
1	1.742	100.000	0.000	1.520	100.000	0.000	1.218	100.000	0.000	1.516	100.000	0.000	1.477	100.000	0.000
2	1.744	99.819	0.181	1.535	98.170	1.830	1.243	98.678	1.322	1.564	94.214	5.786	1.513	95.690	4.310
5	1.747	99.751	0.249	1.539	97.997	2.003	1.244	98.671	1.329	1.574	94.146	5.854	1.525	94.605	5.395
10	1.751	99.432	0.568	1.543	97.572	2.428	1.244	98.671	1.329	1.582	93.790	6.210	1.529	94.316	5.684
Panel B: pre-crisis 2000-2006															
		REBR1:lag3			RECHA:lag 1			RECOL1:lag 1			REHG:lag 7			REIND:lag 4	
Period	S.E.	REBR1	REUS1	S.E.	RECHA	REUS1	S.E.	RECOL1	REUS1	S.E.	REHG	REUS1	S.E.	REIND	REUS1
1	1.694	100.000	0.000	1.308	100.000	0.000	1.429	100.000	0.000	1.350	100.000	0.000	1.469	100.000	0.000
2	1.695	99.969	0.031	1.309	99.942	0.058	1.468	99.412	0.588	1.393	94.178	5.822	1.487	97.711	2.289
5	1.705	99.245	0.755	1.309	99.942	0.058	1.470	99.393	0.607	1.398	93.767	6.233	1.502	96.792	3.208
10	1.705	99.236	0.764	1.309	99.942	0.058	1.470	99.393	0.607	1.407	93.532	6.468	1.502	96.791	3.209
Panel C:crisis 2007-2009															
		REBR1:lag 3			RECHA:lag 2			RECOL1:lag 2			REHG:lag 8			REIND:lag 3	
Period	S.E.	REBR1	REUS1	S.E.	RECHA	REUS1	S.E.	RECOL1	REUS1	S.E.	REHG	REUS1	S.E.	REIND	REUS1
1	2.341	100.000	0.000	2.244	100.000	0.000	1.310	100.000	0.000	2.046	100.000	0.000	2.151	100.000	0.000
2	2.364	98.360	1.640	2.277	97.132	2.868	1.369	92.034	7.966	2.182	91.353	8.647	2.231	92.993	7.007
5	2.373	98.251	1.749	2.278	97.091	2.909	1.373	91.789	8.211	2.225	91.683	8.317	2.248	91.855	8.145
10	2.374	98.245	1.755	2.278	97.090	2.910	1.373	91.785	8.215	2.311	88.556	11.444	2.248	91.831	8.169
Panel D:post- crisis 2010-2016															
		REBR1:lag 3			RECHA:lag 5			RECOL1:lag 5			REHG:lag 3			REIND:lag 3	
Period	S.E.	REBR1	REUS1	S.E.	RECHA	REUS1	S.E.	RECOL1	REUS1	S.E.	REHG	REUS1	S.E.	REIND	REUS1
1	1.430	100.000	0.000	1.387	100.000	0.000	0.916	100.000	0.000	1.326	100.000	0.000	0.983	100.000	0.000
2	1.431	99.882	0.118	1.414	96.519	3.481	0.923	99.808	0.192	1.336	98.595	1.405	1.021	92.931	7.069
5	1.433	99.878	0.122	1.418	96.297	3.703	0.929	98.945	1.055	1.338	98.510	1.490	1.025	92.298	7.702
10	1.433	99.878	0.122	1.419	96.222	3.778	0.933	98.763	1.237	1.338	98.509	1.491	1.025	92.293	7.707

Panel A: entire 2000-2016															
		REINSIA:lag8			REMA:lag 7			REME:lag 3			REPE:lag 8			REPH1:lag 3	
Period	S.E.	REINSIA	REUS1	S.E.	REMA	REUS1	S.E.	REME	REUS1	S.E.	REPE	REUS1	S.E.	REPH1	REUS1
1	1.336	100.000	0.000	0.772	100.000	0.000	1.305	100.000	0.000	1.372	100.000	0.000	1.166	100.000	0.000
2	1.407	91.095	8.905	0.824	88.930	11.070	1.313	100.000	0.000	1.411	99.032	0.968	1.279	84.253	15.747
5	1.414	90.439	9.561	0.828	88.252	11.748	1.316	99.916	0.084	1.418	98.993	1.007	1.281	84.106	15.894
10	1.417	90.232	9.768	0.829	88.109	11.891	1.316	99.915	0.085	1.421	98.861	1.139	1.281	84.099	15.901
Panel B: pre-crisis 2000-2006															
		REINSIA:lag 5			REMA:lag 1			REME:lag 1			REPE:lag 1			REPH1:lag 2	
Period	S.E.	REINSIA	REUS1	S.E.	REMA	REUS1	S.E.	REME	REUS1	S.E.	REPE	REUS1	S.E.	REPH1	REUS1
1	1.285	100.000	0.000	0.820	100.000	0.000	1.375	100.000	0.000	0.968	100.000	0.000	1.233	100.000	0.000
2	1.316	96.364	3.636	0.858	93.638	6.362	1.386	99.917	0.083	0.997	98.791	1.209	1.269	95.413	4.587
5	1.327	95.067	4.933	0.859	93.524	6.476	1.386	99.917	0.083	0.998	98.752	1.248	1.272	94.992	5.008
10	1.330	94.854	5.146	0.859	93.524	6.476	1.386	99.917	0.083	0.998	98.752	1.248	1.272	94.992	5.008
Panel C:crisis 2007-2009															
		REINSIA:lag 3			REMA:lag 3			REME:lag 3			REPE:lag 4			REPH1:lag 1	
Period	S.E.	REINSIA	REUS1	S.E.	REMA	REUS1	S.E.	REME	REUS1	S.E.	REPE	REUS1	S.E.	REPH1	REUS1
1	1.708	100.000	0.000	1.004	100.000	0.000	1.798	100.000	0.000	2.10857	100	0	1.381095	100	0
2	1.852	87.562	12.438	1.095	84.485	15.515	1.812	99.853	0.147	2.203	97.511	2.489	1.705	68.894	31.106
5	1.862	87.126	12.874	1.102	83.672	16.328	1.824	98.990	1.010	2.238	97.542	2.458	1.707	68.890	31.110
10	1.862	87.123	12.877	1.102	83.670	16.330	1.824	98.989	1.011	2.242	97.529	2.471	1.707	68.890	31.110
Panel D: 2010-2016															
		REINSIA:lag 3			REMA:lag 3			REME:lag 3			REPE:lag 3			REPH1:lag 5	
Period	S.E.	REINSIA	REUS1	S.E.	REMA	REUS1	S.E.	REME	REUS1	S.E.	REPE	REUS1	S.E.	REPH1	REUS1
1	1.046	100.000	0.000	0.530	100.000	0.000	0.908	100.000	0.000	1.255	100.000	0.000	0.949	100.000	0.000
2	1.128	86.389	13.611	0.580	84.546	15.454	0.910	99.978	0.022	1.270	99.921	0.079	1.047	82.509	17.491
5	1.145	85.719	14.281	0.581	84.349	15.651	0.913	99.856	0.144	1.275	99.317	0.683	1.055	82.336	17.664
10	1.145	85.693	14.307	0.581	84.346	15.654	0.913	99.855	0.145	1.275	99.316	0.684	1.057	82.118	17.882

Panel A: entire 2000-2016															
		REPO:lag 2			RERU:lag 8			RESA:lag 5			RETH:lag 7			RETR:lag 7	

Period	S.E.	REPO	REUS1	S.E.	RERU	REUS1	S.E.	RESA	REUS1	S.E.	RETH	REUS1	S.E.	RETR	REUS1
1	1.222	100.000	0.000	2.009	100.000	0.000	1.154	100.000	0.000	1.291	100.000	0.000	2.074	100.000	0.000
2	1.269	93.125	6.875	2.068	94.388	5.612	1.227	88.657	11.343	1.341	92.673	7.327	2.112	96.412	3.588
5	1.270	93.086	6.914	2.070	94.362	5.638	1.230	88.622	11.378	1.352	91.365	8.635	2.113	96.374	3.626
10	1.270	93.086	6.914	2.074	94.273	5.727	1.231	88.535	11.465	1.356	91.307	8.693	2.121	96.148	3.852
Panel B: pre-crisis 2000-2006															
		REPO:lag 4			RERU:lag 2			RESA:lag 1			RETH:lag 6			RETR:lag 1	
Period	S.E.	REPO	REUS1	S.E.	RERU	REUS1	S.E.	RESA	REUS1	S.E.	RETH	REUS1	S.E.	RETR	REUS1
1	1.199	100.000	0.000	1.970	100.000	0.000	1.081	100.000	0.000	1.381	100.000	0.000	2.610	100.000	0.000
2	1.259	90.784	9.216	2.039	93.824	6.176	1.158	87.747	12.253	1.417	95.336	4.664	2.657	96.557	3.443
5	1.265	90.066	9.934	2.043	93.535	6.465	1.158	87.729	12.271	1.432	93.905	6.095	2.657	96.556	3.444
10	1.265	90.049	9.951	2.043	93.535	6.465	1.158	87.729	12.271	1.437	93.551	6.449	2.657	96.556	3.444
Panel C:crisis 2007-2009															
		REPO:lag 2			RERU:lag 5			RESA:lag 5			RETH:lag 3			RETR:lag 6	
Period	S.E.	REPO	REUS1	S.E.	RERU	REUS1	S.E.	RESA	REUS1	S.E.	RETH	REUS1	S.E.	RETR	REUS1
1	1.634	100	0	3.08968	100	0	1.6162	100	0	1.56465	100	0	2.073673	100	0
2	1.707	92.811	7.189	3.213	92.505	7.495	1.737	86.943	13.057	1.663	88.489	11.511	2.162	93.001	6.999
5	1.712	92.492	7.508	3.223	92.462	7.538	1.765	86.628	13.372	1.682	87.238	12.762	2.175	92.426	7.574
10	1.712	92.489	7.511	3.227	92.457	7.543	1.768	86.369	13.631	1.682	87.234	12.766	2.204	90.217	9.783
Panel D: 2010-2016															
		REPO:lag 3			RERU:lag 3			RESA:lag 5			RETH:lag 3			RETR:lag 5	
Period	S.E.	REPO	REUS1	S.E.	RERU	REUS1	S.E.	RESA	REUS1	S.E.	RETH	REUS1	S.E.	RETR	REUS1
1	1.000	100.000	0.000	1.318	100.000	0.000	0.931	100.000	0.000	1.004	100.000	0.000	1.455	100.000	0.000
2	1.027	95.030	4.970	1.338	97.091	2.909	0.973	91.755	8.245	1.047	91.866	8.134	1.466	98.508	1.492
5	1.033	94.264	5.736	1.341	96.594	3.406	0.975	91.483	8.517	1.053	91.030	8.970	1.474	98.227	1.773
10	1.033	94.258	5.742	1.341	96.591	3.409	0.976	91.360	8.641	1.053	91.017	8.983	1.474	98.206	1.794

Note: 1. The lag is under VAR model base on the AIC criteria. 2. BR(Brazil), CHA(China), COL(Colombia), HG(Hungry), IND(India), INSIA(Indonesia), MA(Malaysia), ME(Mexico), PE(Peru), PH(Philippines), Po(Poland), RU(Russia), SA(South Africa), TH(Thailand), TR(Turkey), and US(United States).

CHAPTER SIX

FINANCIAL CONTAGION EFFECT OF GFC ON SELECTED EMERGING STOCK MARKETS AND DYNAMIC CONDITIONAL CORRELATION ANALYSIS

6.1. Introduction

The U.S. mortgage bubble burst in 2007 and the collapse of the U.S. housing market triggered the 2008 U.S. subprime mortgage crisis and moreover a global financial crisis (GFC). The consequences of the GFC were enormous, profound and still linger. Almost the whole world's stock markets fell sharply , interbank liquidity was frozen, many large financial institutions battled for survival, finally collapsed or were bailed out by their government, investor confidence dropped, and one after another country's economy dipped into recession. Lehman Brothers filed for bankruptcy, Indymac bank collapsed, Merrill Lynch was sold to Bank of America, and governments in many countries had to provide emergency funding as rescue packages to bail out their financial institutions to prevent further huge financial catastrophe and loss. The U.S Federal Reserve also put some financial institutions, for instance, Fannie Mae and Freddie Mac, under the control of themselves to save them.

A GFC has only happened four times in the last 200 years, but each time because of the contagion effects, internationalization, and integration of the financial market, it affected multiple regions around the world regarding financial markets and real economics. The profound and persistent negative influence of the 2008 financial crisis spread to various countries due to globalization and interconnection of the world. Therefore, the contagion effect became one of the essential and unignorable factors that give essential implications to policymakers, economists, investors, and bankers. Since the financial system and economic development vary from country to country, it is vital and makes sense to study contagion effects.

The definition of contagion has not reached a consistent agreement in the literature. Forbus and Rigobon (2002: 2223) defined contagion as cross-market correlation which has a significant increase during a financial crisis or shocks. It is the widely accepted and recently applied definition for contagion study. According to this approach, the difference between interdependence and contagion should be emphasized and differentiated. The important character of contagion is the significant increase of the correlation coefficient between two markets by comparing a relatively stable period and a turmoil (crisis or shock) period. Therefore, the closed co-movement or real strong linkages and high correlation only show the interdependence of two economies instead of contagion.

Contagion effects also spread to real economic sectors, and the emerging country growth rates were -1.9% and -3.2% in the fourth quarter of 2008 and the first quarter of 2009 respectively. It was roughly 10% below 2007 value during a similar period (Blanchard, Faruqee and Das, 2010: 263). Export demands for goods and services went down sharply 35% from peak to trough from July 2008 to February 2009 (Keat, 2009: 268).

It seemed that the emerging economies uncoupled and were insulated from this crisis from the beginning, since the financial integration degree was not as high as the advanced markets, policymakers could decrease the impact from the crisis by some regulations and independent policy. However, the 2008 GFC was unprecedented and transmitted to also emerging economies in terms of the financial market and real economy after Lehman Brothers was bankrupted in 2008 (Dooley & Hutchison, 2009: 1-7).

We choose emerging economies also because they play increasingly important roles in the global financial and economic market. They are the main recovery power for the world economy. Developing Asia was the only region that had positive related strong growth (4.8% in 2009) after the financial crisis according to IMF estimates. From another perspective, they have many common characteristics, for instance: a rapid development rate, high return with high volatility, weak ability to transfer crisis risk and to defend risks, an unsound financial system, nontransparent market, policy instability and they are transitional economies. The 15 emerging economies in this study are Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, Poland, the Philippines, Russia, South Africa, Thailand, and Turkey. Celik (2012: 1958) found that the emerging market, the foreign exchange market for his study, seemed to the most influenced by the contagion effects from the U.S.

In this chapter, we try to identify empirically the contagion effect of the GFC from the U.S. stock market to 15 selected emerging stock markets. If the contagion effect exists, we try to find when it occurred and the persistence of it. This study covers a long time, from January 2000 to July 2016. In order to identify the changing of the correlation, we divided this entire time span into three periods: a pre-crisis period from beginning of 2000 to the end of 2006, a during crisis period from January 2007 to December 2009, and a post-crisis period from January 2010 until July 2016. We applied Pearson unconditional correlation and DCC-GARCH model as presented by Engles (2002), through comparing the changing of the unconditional correlation and dynamic conditional correlation for three periods of the daily stock market returns, to detect the contagion effect from the U.S to the selected emerging stock markets.

This study focuses on more emerging countries and takes a longer time period to investigate the impact of the crisis. In addition, based on the different paths of the contagion it classifies selected emerging markets into different groups by level of development and degree of contagion. It further suggests sources of the contagion and provides efficient policies to minimize the losses.

The article is organized as follow. After an introduction part is the literature review about contagion effects. Section three is data and methodology, followed by empirical analysis of DCC-GARCH for selected emerging markets and the U.S. that estimate the parameters and dynamic conditional correlation for pre-, during and after-crisis. In section five, we analyze the differences of DCCs for the three phases of the crisis to identify the contagion effects. The last section considers conclusions and implications.

6.2. Brief Literature Review And Overview Of Selected Emerging Countries Economies And Stock Markets

6.2.1. Overview Of Selected Emerging Countries Economics And Stock Market

The importance of the emerging market economies is increasing significantly, with GDP growth much higher than the developed economies (Figure 3.1). In the last 10 years, emerging economies have contributed more than 50% of world economic growth. In particular, after the 2008 GFC, the EMs became the recovery powerhouse, not only contributing more than 70% to global economic growth, but also increasing their position and influence in the world economy. According to IMF data, in the world economy the proportion of emerging economies rose from 23.6% in 2000 to 41% in 2012, purchasing power parity (PPP) increased from 40.7% to 53.7%, the international trade ratio rose from 15% to 40% and the proportion of EMs global FDI inflows rose from 32% in 2007 to 58% in 2012[22].

6.2.2. Literature Review About Financial Contagion

Financial crises contagion has been a great concern during the past two decades, especially nowadays under globalization and a financial integration environment.

[22] http://www.londontranslations.co.uk/media-hub/the-importance-of-emerging-markets/

Contagious results play a very important role for investors and policymakers for optimal asset allocation and determining monetary and fiscal policy. We will do a brief literature review from these aspects: The definition of financial contagion, reasons and channels, what methodology is applied in contagion studies and previous studies about other crises and especially global financial crisis contagion.

6.2.3. Methods And Previous Studies To Identify Financial Contagion

There is much evidence to identify financial contagion by applying different methods on the emerging markets and developed counties. The essential idea is to evaluate and compare correlation coefficient between the source country of financial crisis or shocks and other selected countries. If the correlation coefficient significantly changes during a financial crisis then it implies a contagion effect exists during the crisis.

King and Wadhwani (1990: 6) supported contagion effects occurring in almost all stock markets after the 1987 stock market crash. Calvo (1999) found Asian and Latin American emerging markets' stock and equity price correlation increased significantly after the 1994 Mexico crisis by investigating spillover effects. Baig and Goldfain (1999 :168) analyze daily data by using the period 1995-1998 and confirmed contagion between five Asian countries during the crisis. Lin (2012: 161) also found that during the crisis, a contagion effect existed between exchange rates and stock price.

However, there were heteroskedasticity problems for these studies, Forbes and Rigobon (2002: 2238) pointed out that these studies arbitrarily divided the sample into two sub-periods and concluded there is no contagion, only interdependence. However, this puzzle is resolved by the Chiang, Jeon and Li (2007: 1208) who applied a multivariate GARCH model and covered a long time span and concluded with supportive evidence of contagion during the crisis.

Moreover, to avoid heteroskedasticity bias, the dynamic conditional correlation is validly used by researchers to study contagion from financial crisis. The GARCH model is one of the favorite and most suitable models to apply.

Naoui et al (2010) did a comprehensive study about contagion characteristics and identified three types as simultaneously a common shock, inter-countries trade and financial link, and pure contagion caused by panic movement. This study applied a DCC-GARCH model and chose 5 developed countries and 10 emerging countries by using August 2007 to February 2010 stock index daily data to classify 10 emerging counties into 3 groups by the spillover effects correlation levels. The result shows that Brazil, Mexico and Argentina had an 80% high conditional correlation with the American market during the crisis; India, Malaysia and Singapore were around 50%.

There are also many findings about the contagion of the US financial crisis to the emerging economies. Kim, Kim, & Lee (2015) applied BEKK and multivariate GARCH models to indentify the transmission mechanism of the GFC to five emerging Asian countries by estimating dynamic conditional correlations of financial asset returns, and they found that non-negligible financial contagion existed from the U.S. to emerging Asian countries but just lived a short time. At the same time, their study investigated the Libor-OIS spread, the sovereign CDS premium, and the amount of foreign order flows in the foreign exchange markets as factors affecting the dynamic conditional correlations significantly.

Specifically, Latin American equity markets among emerging economies are very attractive to investors due to their high growth rate. Hwang (2014: 322-323) found that there was significant contagion from the US financial crisis to four Latin American countries and the handout effect was not short-lived, by analyzing unconditional correlation coefficient and DCC-GARCH model of dynamic conditional correlation using 2006-2010 daily data.

Certainly, there are multiple methods to estimate the contagion effect of a financial crisis. Dooley and Hutchison (2009: 16) applied VAR model, Granger-Causality test, and impulse response function to 14 emerging markets by focusing on CDS spreads using data from 2007 to 2009 and identified the linkage and high volatility between the U.S. markets to selected emerging markets. Dungey and Gajurel (2015: 161) used a latent factor model and found strong evidence of contagion from US equity markets to advanced and emerging economies.

China has attracted great attention from researchers due to the special government interference and fixed exchange rate system making it seem insulted from financial crisis with minimum loss. It is also hard to find out the real impact in the financial market. Kim, Kim, and Lee (2015: 193) exclude China and Hong Kong since the government has much inertial movement which is unsuitable for the GARCH model. Fortunately, from the latest study Hou and Li (2016) for the first time applied an asymmetric VAR ADCC GARCH approach to reveal the transmission from the US to the China futures market was significant by analysis of sample data from May 16, 2010 to July 31, 2013.

Instead of contagion of financial crisis to the Chinese financial market being a new finding, most previous research focused on the spillover of the U.S 2008 financial crisis to the industrial and foreign trade sectors. Morrison (2009: 2-4) found that China’s economic growth, international trade volume and foreign direct investment and many other sectors were hit hard by the U.S. financial crisis. The Shanghai stock market lost nearly two-thirds of its value from December 31, 2007 to December 31, 2008. Approximately 20 million migrant workers lost jobs in 2008 and the industrial output increase rate dropped 7% from 2008 to 2009.

Financial crisis contagion is not only to the financial market but also strongly impacts on the real economy and even caused the biggest recession since the 1930s. Nikkinen, Martikainen et al. (2013: 1469) utilized a multivariate GARCH model to indicate that current US subprime crisis volatility spillover effects on the BRIC financial market and industrial sector in the full samples and also during the crisis, with especially Russia and India being hit hardly in their equity markets.

6.3. Data And Preliminary Analysis

The data applied in this study is the same as in the previous chapter, that of daily stock-price indices and the calculated return from January 3, 2000 to 29 July 2016 of 15 emerging stock markets and the U.S. stock market. The selected emerging stock markets are the same: the Brazil (IBOV), China (SSEC), Colombia (COLCAP), Hungary (BUX), India (SENSEX), Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), the Philippines (PSEi), Poland (WIG), Russia (MOEX), South Africa (SPBLPGPT), Thailand (SETI) and Turkey (XU100) indices, and the U.S. (S&P 500 index). All the national stock-price indices are in local currency and based on daily closing prices in each national market.

The data was extracted from DataStream International. The time period divisions are the same as Chapter 5 as well, we have four panels: A is the entire period 1/3/2000 - 7/29/2016, panel B is pre-crisis 1/3/2000- 12/31/2006, panel C is the crisis period 1/1/2007-12/31/2009, and panel D is post-crisis 1/1/2010-7/29/2016.

The preliminary analysis for price and return are the same as Chapter 5. Therefore, see Table 5.1 for the Unit root test, Figures 5.2 and 5.3 for the price and return. Table 5.2 gives the statistic descriptive of the stock return and also Figure 5.2. Table 5.3 illustrates the unconditional correlation.

To deal with heteroskedasticity problem better and also capture the time-varying characteristics, we applied a multivariate GARCH model and used dynamic conditional correlation to investigate the contagion effect and correlation from the U.S financial market to the other 15 emerging markets. In addition, EMs became much more correlated with each other during the crisis period than before.

6.4. Methodology And Analysis Process

The aim of this chapter is to identify the financial contagion effect of the global financial crisis by investigating whether the correlation between US and aimed stock markets increased or not during the crisis period than the pre-crisis period. To avoid heteroskedasticity problem, besides unconditional correlation, we will apply DCC-MGARCH model proposed by Engle (2002) to employ the stock price returns of different emerging markets and U.S in different crisis time periods. In order to find the possible contagion effect by investigate the changing of dynamic conditional correlations and reveal how the market response to financial shocks.

Therefore, the analysis procedure is as follow. Base on the stationary test and preliminary analysis for the stock price and return, firstly, we will apply DCC-GARCH model to get the dynamic conditional correlation between US and the selected emerging stock markets. Secondly, we will apply t-test and GARCH (1, 1) model with dummy variables to analyze the changing of the dynamic conditional correlations of different time periods by compare the sample means, namely, pre-crisis, crisis and post-crisis. If during crisis the DCC significantly increased, then we can identify the contagion effects of the GFC. Furthermore, if the post-crisis the DCCs continue increasing then we can identify the herding behaviors. Finally, according to the correlation with U.S stock market, we can classify the emerging stock markets into different groups.

6.4.1 DCC-GARCH Method

There are many advantages to applying the multivariate DCC-GARCH model. One of the main advantages of the DCC-GARCH model is that it can detect the possible changes of the conditional correlations over time that allowed us to investigate investors' behaviors dynamically in response to news and innovations (Celik, 2012: 1950). Moreover, the dynamic conditional correlation is suitable for identifying possible contagion effect due to herding behavior Chiang et al. (2007: 1209), Celik (2012: 1950) and Syllignakis and Kouretas (2001: 722)). The DCC-GARCH continuously adjusts the correlation for time-varying volatility, unlike the volatility-adjusted cross-market correlation applied in Forbes and Rigobon (2002: 2238) that can avoid the arbitrary bias from the volatility (Celik, 2012: 1950).

Importantly, DCC-GARCH could handle the heteroskedasticity problem by standardized residuals (Chiang et al. 2007: 1213). Although unadjusted Pearson correlation is widely used to study the correlation between variables, for time series data, it suffersheteroskedasticity bias problem in that correlation between countries increases simultaneously with the higher volatility during the crisis period. DCC-GARCH addresses the heteroskedasticity problem by standardizing residuals, with data series' residuals divided by the GARCH conditional standard deviation in correlation calculation.

In addition, the multivariate GARCH model is parsimonious as it can estimate up to 45 pair-wise correlation coefficient series in a single representation without adding too many parameters. In our study, the aim is to find contagion effect from the U.S to selected emerging markets; therefore, we apply DCC-GARCH (1, 1) to focus on the pair separately. The parameters of model are different but should meet the model requirement.

Moreover, the DCC-GARCH could be extended by including additional exogenous variables in the mean and variance equations to measure the common factors impact and to investigate the transmission channel of volatility in the crisis. Therefore, dynamic conditional correlation provides superior measurement in terms of correlation studies (Cho and Parhizgari, 2008: 20).

6.4.1.1. The DCC-GARCH Model Is As Below:

Mean equation: $y_t = \gamma_0 + \gamma_1 y_{t-1} + \gamma_2 y_{t-1}^{U.S.} + \varepsilon_t$ *(1)*

Variance equation: $h_{i,t} = \omega + \alpha_i \varepsilon_{i.t-1}^2 + \beta_i h_{i,t-1}, i = 1, \dots, n$ *(2)*

DCC equation: $q_{ij,t} = \bar{\rho}_{ij}(1 - a - b) + b\rho_{ij,t-1} + a\eta_{i,t-1}\eta_{j,t-1}$

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}}\sqrt{q_{jj,t},}}, where i, j = 1,2, \ldots, 10, and i \neq j$$

Consider y_t *is the asset returns serious for t=1, …, n.*

6.4.1.2. The Estimation Are Steps As Follows

Estimation of mean equation

Mean equation: $r_t = \gamma_0 + \gamma_1 r_{t-1} + \gamma_2 r_{t-1}^{U.S.} + \varepsilon_t$, (1)

Where $r_t$is the asset returns series, $r_{t-1}$is the AR(1) of asset return, which is for the autocorrelation of returns, $r_{t-1}^{U.S.}$is the one-day lagged U.S. stock return, which have been often used to account for a global factor (Dungey et al. 2006: 1209). In addition, from the descriptive statistics we know that there is an autocorrelation problem for the return data and normally in one lag. Additionally, from the investor's aspect, they make investments dependenton previous returns. Importantly, the U.S. financial market plays an important role in emerging markets (Chiang, Jeon and Li, 2007: 1215), that is why in the mean equation we include AR (1) and Lagged U.S return as explanatory variables.

The asset return and residual of the mean equation are not normal distribution; therefore, the Gaussian GARCH model was unable to explain the leptokurtosis exhibited in this study. We apply Student's t-distribution suggested by Bollerslev (1987: 543) instead of normal distribution. Johansson and Ljungwall, (2006) suggested Student's t distribution works well with fat-tailed residuals, and that is the case in our study. The distribution of the error term takes the form as below according to Bollerslev (1987: 543):

$$f(\varepsilon_t) = \frac{\Gamma[\frac{1+\nu}{2}]}{\sqrt{\nu\pi}\Gamma(\frac{\nu}{2})}[1 + \frac{\varepsilon_t^2}{\nu}]$$

Whereν is the degree of freedom of the t-distribution. We expect v to be significant during the analysis.

Estimation of the variance equation

Variance equation: $h_{ii,t} = \omega + \alpha_i \varepsilon_{i.t-1}^2 + \beta_i h_{ii,t-1}, i = 1, \dots, 15$(2)

Where $\varepsilon_{i.t-1}^2$ is the ARCH term, and $h_{i,t-1}$is the GARCH term that is dynamics of volatility. $\alpha_i, \beta_i and \omega$ are the parameters to be estimated. The parameter β_i measures the persistence conditional volatility, and the bigger value of β_i, the longer of persistence.

Estimation of multivariate conditional variance matrix

$H_t = D_t{}^{1/2} R_t D_t{}^{1/2}$ (3)

$R_t = diag(Q_t)^{-1/2} Q_t diag(Q_t)^{-1/2} Q_t$ (4)

$Q_t = (1 - \lambda_1 - \lambda_2) R_t + \lambda_1 \tilde{\varepsilon}_{t-1} \tilde{\varepsilon}'_{t-1} + \lambda_2 Q_{t-1}$ (5)

Where H_t is an N × N positive definite matrix, which is the conditional variance matrix of r_t by volatilities$h_{i,t}$.

$D_t$is a N × N diagonal matrix of the conditional variance of the residual returns:

$$D_t = \begin{bmatrix} \sigma_{1,t}^2 & 0 & \cdots & 0 \\ 0 & \sigma_{2,t}^2 & \dots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \sigma_{n,t}^2 \end{bmatrix}$$

In which each $\sigma_{i,t}^2$ evolves according to the univariate GARCH model of the form:

$$\sigma_{i,t}^2 = s_i + \sum_{j=1}^{p_i} \alpha_j \varepsilon_{i,t-j}^2 + \sum_{j=1}^{q_i} \beta_j \varepsilon_{i,t-j}^2$$

Rt is N × N time-varying matrix of conditional quasicorrelations,

$$R_t = \begin{bmatrix} 1 & \rho_{12,t} & \cdots & \rho_{1m,t} \\ \rho_{12,t} & 1 & \ldots & \rho_{2m,t} \\ \vdots & \vdots & \ddots & \vdots \\ \rho_{1m,t} & \rho_{2m,t} & \cdots & 1 \end{bmatrix}$$

$\tilde{\varepsilon}_t$is an m×1 vector of standardized residuals, ${D_t}^{-1/2}\varepsilon_t$; and $\lambda_1$and λ_2 are nonnegative and satisfy the $0 \leq \lambda_1 + \lambda_2 <1$ parameters that govern the dynamics of conditional quasicorrelations.

The DCC-GARCH model proposed by Engle (2002) followed two-step estimation of conditional variance matrix Ht. The first step is to get the standard variance $\sigma_{i,t}^2$ from the univariate GARCH model. The second step is to transfer the standard variance obtained from the first step to conditional correlation by $\tilde{\varepsilon}_{i,t} = \varepsilon_{i,t}/\sqrt{\sigma_{i,t}^2}$.

The dynamic conditional correlation (DCC) calculates conditional covariance matrix based on variance equation. We calculate the conditional correlation in the bivariate case:

$$\rho_{ij,t} = \frac{q_{ij,t}}{\sqrt{q_{ii,t}q_{jj,t}}}, i, j = 1,2, \ldots, n, and i \neq j$$

$$\rho_{12,t} = \frac{q_{12,t}}{\sqrt{q_{11,t}q_{22,t}}}$$

$$= \frac{(1-\lambda_1-\lambda_2)\bar{q}_{12,t} + \lambda_1\tilde{\varepsilon}_{1,t-1}\tilde{\varepsilon}_{2,t-1} + \lambda_2 q_{12,t-1}}{\sqrt{(1-\lambda_1-\lambda_2)\bar{q}_{11} + \lambda_1\tilde{\varepsilon}_{1,t-1}^2 + \lambda_2 q_{11,t-1}}\sqrt{(1-\lambda_1-\lambda_2)\bar{q}_{22} + \lambda_1\tilde{\varepsilon}_{2,t-1}^2 + \lambda_2 q_{22,t-1}}}$$

Where ρ_{ij} is the unconditional correlation of $\tilde{\varepsilon}_{i,t}$and $\tilde{\varepsilon}_{j,t}$.

The parameter λ_1 show the volatility of the shock, specifically showing the immediate and short term impact of the volatility on the DCCs. λ_2 indicates the persistence of the shock.

The DCC-model can be estimated by using a two- stage approach to maximize the log-likelihood function (Engle 2002). The log-likelihood was written as the sum of a volatility part and a correlation part.

$$L_{(\theta,\phi)}=\left[-\frac{1}{2}\sum_{t=1}^{T}(nlog(2\pi)+log|D_t|^2+\varepsilon'_t D_t^{-2}\varepsilon_t\right]+\left[-\frac{1}{2}\sum_{t=1}^{T}(log|R_t|+\widetilde{\varepsilon}'_t R_t^{-1}\tilde{\varepsilon}_t-\widetilde{\varepsilon}'_t\tilde{\varepsilon}_t\right]$$

6.5. Contagion Effect Test And Analysis Of The Dynamic Conditional Correlation (DCCs)

6.5.1. Contagion Effect Test: Paired T-Test Methodology –Welch's Approximation

We analyze the dynamic conational correlations by dividing them into four panels as before, the entire period, pre-crisis, crisis and post-crisis period. From the descriptive analysis by comparing the different period sample means of the DCCs identifies contagion effects.

Furthermore, and a more formal method, is to apply a two-sample t test with unequal variances of Welch's t –test. It can test the consistency of the two sample means of the DCCs for before crisis and during crisis periods, to identify whether the dynamic conditional correlations have increased or not, thereby concluding the existence of the contagion effect.

We define the null and alternative hypothesis as:

$$H_0: \mu_\rho^{crisis} = \mu_\rho^{pre-crisis}$$

$$H_1: \mu_\rho^{crisis} \neq \mu_\rho^{pre-crisis}$$

where μ_ρ^{crisis} and $\mu_\rho^{pre-crisis}$ are the conditional correlation coefficient means of population in the pre-crisis and crisis periods. The sample size of the two periods use $n^{crisis}$and $n^{pre-crisis}$, and the population variance σ_{crsis}^2 and $\sigma_{pre-crsis}^2$ are different and unknown. We use $\bar{\rho}_{i,us}^{crisis}$ and$\bar{\rho}_{i,us}^{pre-crisis}$ as the sample mean of the DCCs for the crisis and pre-crisis period, and s_{crisis}^2 and $s_{pre-crisis}^2$ as the variance for the two samples. Then the t-statistic is calculated as :

$$t = \frac{(\overline{\rho}_{i,us}^{crisis} - \overline{\rho}_{i,us}^{pre-crisis}) - (\mu_{\rho}^{crisis} - \mu_{\rho}^{crisis})}{\sqrt{\frac{s_{crisis}^2}{n^{crisis}} + \frac{s_{pre-crisis}^2}{n^{pre-crisis}}}}$$

Where $s_{crisis}^2 = \frac{1}{n^{crisis}-1} \sum_{t=1}^{n^{crisis}} (\rho_{i,us}^{crisis} - \bar{\rho}_{i,us}^{crisis})^2$,

$s_{pre-crisis}^2 = \frac{1}{n^{pre-crisis}-1} \sum_{t=1}^{n^{pre-crisis}} (\rho_{i,us}^{pre-crisis} - \bar{\rho}_{i,us}^{pre-crisis})^2$, and the degree of freedom v is

$$v = \frac{\left(\frac{s_{crisis}^2}{n^{crisis}} + \frac{s_{pre-crisis}^2}{n^{pre-crisis}}\right)^2}{\frac{\left(\frac{s_{crisis}^2}{n^{crisis}}\right)^2}{n^{crisis}-1} + \frac{\left(\frac{s_{pre-crisis}^2}{n^{pre-crisis}}\right)^2}{n^{pre-crisis}-1}}$$

If the t-statistics are significantly greater than critical value, we reject the null hypothesis H_0 that sample mean of DCCs during crisis equates to pre-crisis period, then we can identify the existence of the contagion effect. HERE.

6.5.2. Dynamic Conditional Correlation -Test For Changes In DCCs

In this section we employ the methodology proposed by Chiang et al (2007: 1219) that add dummy variables to investigate the time varying behavior of the dynamic conditional correlation, in order to see how the external shocks impact on the correlation movement and variability during the different phases of the crisis.

First, a higher level of correlation volatility indicates systematic risk, due to the benefit from the market – portfolio diversification diminished. Second, a higher volatility of the correlation casts doubts on investment and portfolio decision making according to the correlation coefficient, since the stability of correlation periods is not reliable.

We use two dummy variables according to the crisis time and which allowed us to analyze the correlation changing dynamically associated with different stages of the crisis. The significance of the estimated coefficients of the dummy variables indicates structural changes in mean/variance shifts of the correlation coefficients, due to external shocks during the GFC.

The regression model is given by:

$$\rho_{ij,t} = \sum_{p=1}^{p} \emptyset_p \rho_{ij,t-p} + \sum_{k=1}^{2} \alpha_k DM_{k,t} + e_{ij,t}$$

Where $\rho_{ij,t}$ is the pair-wise dynamic conditional correlation between US stock return and selected emerging stock market return. It is estimated from the DCC-GARCH model, and the i represents the crisis source country the U.S., and j represents the selected emerging countries, Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand, and Turkey. The lag length in the equation is determined by the AIS and SC criterion:

$$h_{ij,t} = A_0 + A_1 h_{ij,t-1} + B_1 \varepsilon_{ij,t-1}^2 + \sum_{k=1}^{2} d_k DM_{k,t}$$

The dummy variables were created according to the crisis time period. $DM_{1,t}$is a dummy variable for the crisis period (2007/1/1 -2009/12/31); $DM_{2,t}$ is the dummy variable for the post-crisis period (2010/1/1 until 2011/12/31). Considering that after the GFC, the eurozone crisis happened, we did not take the sample until at the end of entire time period, therefore the $DM_{2,t}$ is from 2009/1/1 until 2011/12/31. We applied the Chow-test in order to check the division of periods is significant and there are structural break during the periods.

Since for all cases of our pre-test (return and DCC descriptive analysis), there are ARCH effect and significant heteroskedasticity, the conditional variance equation was assumed to followed GARCH (1,1) specification with three dummy variables, that will use maximum- likelihood methods to estimate. This also follows previous studies from Chiang et al. (2007: 1220), Min and Hwang (2012), Hwang (2014), and Syllignakis and Kouretas (2011).

As the model implies, if the estimated coefficient of the dummy variable is significant, then it indicates structure changes in mean and/or variance shifts of the correlation coefficients due to the external shocks during different time periods of the crisis. The result is in Table 6.4.

6.6. Empirical Findings

6.6.1. Empirical Results Of DCC- GARCH

Table 6.1shows the analysis result from the DCC-GARCH model. First for the mean equation, that is the return equation in Table 6.1, the constant term is statistically significant for each selected EMs at 1% significant level, except China at 10% and Hungary at 5% significant level. However, it is not significant for the Philippines. The AR(1) term in the mean equation $\gamma_1$is not significant for China, India, the Philippines or Thailand, but highly positively significant for Colombia, Malaysia, and Peru at 1% and Indonesia and Mexico at 5% significant level respectively. In addition, it is negatively significant for Brazil, Hungry, Russia, South Africa, Poland and Turkey. It confirms the influential role of the US stock markets on the selected EM stock markets, except for the Philippines.

Moreover, the impact from U.S. previous return γ_2 in the mean equation are highly positive and statistically significant for all selected emerging market returns. In addition, for Hungry, India, Indonesia, Russia, South Africa, Thailand and Turkey impact levels are more than 20% which iş a large magnitude. These results evidenced that the U.S. stock market had a strong influence on the selected emerging markets. It is consistent with Cai, Tian and Hamori (2016: 3789), and Kim, Kim, and Lee (2015: 203-5) that the U.S. stock market plays an influential role on emerging East Asian stock.

Table 6. 1: Empirical Analysis Of Results From The DCC-MGARCH Model

Countries	Return equation			Variance equation					
	$r_t = \gamma_0 + \gamma_1 r_{t-1} + \gamma_2 r_{t-1}^{u.s.}$			$h_{i,t} = \omega + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1}, i = 1, \dots, 15$					
	γ_0	γ_1	γ_2	ω	α_i	β_i	Persis.	Quasicorr.	v
Brazil	0.0830***	-0.0374**	0.0531**	0.0489***	0.0640***	0.9209***	0.9849	0.6025***	7.7288***
	0.0215	0.0158	0.0265	0.0115	0.0074	0.0092		0.0626	0.6462
China	0.313*	0.0007	0.1096***	0.0284***	0.0589***	0.9274***	0.9863	0.0433**	6.0046***
	0.018	0.0148	0.0162	0.0069	0.0078	0.0092		0.0202	0.4032
Colombia	0.0694***	0.1153***	0.0660***	0.0687***	0.1699***	0.7842***	0.9541	0.2596***	5.6199***
	0.0134	0.0163	0.0127	0.0133	0.0186	0.0225		0.0554	0.3867
Hungary	0.0436**	-0.0477***	0.2364***	-0.6968	0.1317***	1.1913***	1.323	0.2838***	4.4711***
	0.0216	0.017	0.0219	0.5729	0.03	0.2751		0.0205	0.2491
India	0.0867***	0.0184	0.2292***	0.0326***	0.0873***	0.8964***	0.9837	0.2163***	7.8323***
	0.0164	0.0154	0.0164	0.0071	0.0101	0.0112		0.0477	0.604
Indonesia	0.0923***	0.0391**	0.2905***	0.0647***	0.1256***	0.8353***	0.9609	0.1027***	6.3552***
	0.0149	0.0154	0.0155	0.0155	0.018	0.0238		0.0171	0.4252
Malaysia	0.0245***	0.0965***	0.1935***	0.0086***	0.0886***	0.8956***	0.9842	0.1913***	5.7983***
	0.008	0.0145	0.0086	0.0021	0.0124	0.0137		0.0419	0.3605
Mexico	0.0806***	0.0383**	0.0444**	0.0137***	0.0610***	0.9293***	0.9903	0.6598***	8.0770***
	0.014	0.0151	0.0176	0.0031	0.0061	0.0068		0.0411	0.6599
Peru	0.0606***	0.1585***	0.0813***	0.0470***	0.1466***	0.8237***	0.9703	0.3187***	7.2374***
	0.0133	0.0154	0.0127	0.0091	0.0165	0.019		0.0679	0.5445
Philippine	0.0444	0.0889	0.3579	0.1058	0.1896	0.7440	0.9336	0.0495	4.6638
	0.0158	0.0161	0.0149	0.1988	0.0398	0.1810		0.0223	0.2747
Poland	0.0466***	-0.0299**	0.2283***	0.0142***	0.0521***	0.9383***	0.9904	0.3719***	7.7727***
	0.0148	0.0148	0.0165	0.0037	0.0064	0.0074		0.0803	0.6103
Russia	0.0873***	-0.0683***	0.2461***	-0.9123***	0.2300***	1.0052***	1.2352	1.3793	3.9739***
	0.0242	0.0174	0.0253	0.4614	0.0357	0.1397		7.3827	0.1913
SA	0.0799***	-0.0782***	0.3097***	0.0172***	0.0737***	0.9139***	0.9876	0.3841***	9.4072***
	0.0138	0.0148	0.0157	0.0043	0.0084	0.0096		0.0579	0.844
Thailand	0.0774***	-0.0037	0.2376***	0.0390***	0.1066***	0.8712***	0.9778	0.2409***	6.7233***
	0.0147	0.0153	0.015	0.0078	0.0115	0.0129		0.0618	0.4711
Turkey	0.1002***	-0.0343**	0.2589***	0.0436***	0.0628***	0.9263***	0.9891	0.2756***	7.0639***
	0.0235	0.0152	0.0245	0.0116	0.0089	0.0101		0.0616	0.5065

*Note: 1. v is the degree of freedom of t-distribution. The standard errors are in the parentheses. ***, **, and * denote statistical significance at 1%, 5%, and 10% levels.*

The coefficients of variance equation for all selected emerging markets α_i and $\beta_i$are highly statistically significant at a 1% level, except for the Philippines, and it reveals a dynamic, substantial time-varying co-movement of the volatilities between the U.S. stock market and selected emerging markets. Moreover, this result indicates that ARCH term and GARCH term lagged conditional volatility are both significant in the variance equation, justifying the appropriateness for GARCH (1, 1) specification.

The parameter β_i represents the persistence of the DCC process (Harkmann (2014: 61), for GARCH the desired requirement for β_i is range from 0 to 1, that means the closer to 1, the longer the effect will last. Regarding requirement of β_i , only Hungary and Russia was greater than 1, all the other selected emerging markets fell in the range and with a related higher level which was between 0.7842 (Colombia) and 0.9383 (Poland). This result shows the impact was persistent for a relatively long time.

In addition, in our study we run DCC-GARCH model for each pair, namely, a selected emerging market and the U.S. The model conditional variance averages close to 1, which shows the conditional correlations high persistence. The estimated parameter persistence in the Table 6.1, which is the sum of constant term α_i and conditional variance $\beta_i$was less than 1 but very close to 1, which also illustrates that the GARCH (1,1) model fits the data very well, except for Hungary and Russia (Persistent=1.323 and 1.2352 respectively), and shows that the volatility in the GARCH models displayed high persistence additionally, consistent with the result of Syllignakis and Kouretas (2011: 722).

This DCC-MGARCH could also get the estimated conditional quasicorrelation between the volatilities of the two stock markets. The values of quasicorrelation for the U.S and selected EMs are high and positive, except for China, India and the Philippines, which indicates that high volatility in the emerging markets is associated with high volatility in the U.S stock market. These three Asian emerging stock markets are very special cases and different from the other EM stock markets as government intervention play an essential role in the financial market.

The last column in the Table 6.1 is the degree of freedom (v) of the Student's t-distribution. For all selected emerging markets the estimator v are all significant at a 1% level, except for the Philippines. It indicates that the error term has a heavier tail than the normal distribution and is more suitable for this analysis. To conclude from the DCC-GARCH estimator result, the stock market volatilities of selected emerging markets are associated with the U.S. stock market and impact at a highly persistent and statistically significant level, except for the Philippines stock market.

6.6.2. Dynamic Conditional Correlation (DCC) Analysis

One of the important advantages of the multivariate DCC-GARCH model is that we can obtain dynamic conditional correlation for all possible pair-wise (max 45 pairs) for the index returns of the markets and estimate it with particular study purposes. In this paper, we applied this model to investigate the contagion effect of the 2008 U.S. financial crisis from the U.S stock market to the 15 selected emerging stock markets. Figure 6.1 illustrates the dynamic conditional correlations (DCCs) during the entire period, namely January 2000 to July 2016, for each selected EMs against the U.S stock market. The Table 6.2 represents the descriptive statistics result for the four different panels as before.

It can be seen that the selected EMs do not follow an identical pattern. Firstly, China, Indonesia and the Philippines exhibited a similar pattern. There is no significant increase or jump before, during or after the GFC according to the mean value of stock return. It seems there was no contagion and it stayed relatively stable during the whole period for China, Indonesia and the Philippines' stock markets.

Especially for China, the DCC values were at a very low level, less than 0.1, for most of the time with the exception of the beginning of the crisis time, namely 28th

February 2007 – 1st May, 2007. That is why many studies, for instance Kim, Kim, and Lee (2015: 193), treated China as a special case. Actually for the China stock market, on 28th February 2007, the DCC increased suddenly to the highest level of 0.2626, but it immediately went back to the lower level at the beginning of May and even changed direction to negative against the U.S. stock market. It is more interesting regarding Indonesia, where the maximum value of DCC at 0.3283 was on 18th September 2001 near the stock market crash that happened in 2002, but did not show any significant change during the 2008 GFC, when the range was 0.0887 to 0.1971with 0.0097 very low volatility, even lower than China.

Secondly, for the other selected emerging markets, namely Brazil, Colombia, Hungary, India, Malaysia, South Africa, Russia, Thailand and Turkey, they followed a similar pattern related to the response of the 2008 financial crisis. Generally speaking, the common characteristics of the depicted dynamic conditional correlations in Figure 6.1 is the location of peak, the changing trend, and the shapes of the DCCs in three periods being consistent. Before the GFC the first peak appeared during September or October 2001 until the beginning of 2002, when the DCC experienced a sharp increase because of the 2002 stock market crash. All those markets were affected by the contagion from the U.S. stock market. At the end of 2004, it returned to a normal level. The contagion did not persist for a long period. Except for the first dramatic increase resulting from the 2002 stock market crash, DCCs in the first period from 2000- 2006 are relative steady and lower compared to the GFC period.

Moreover, the second peak was reached and dramatically jumped with an upward trend during the GFC period from 2007 to 2009. The DCC reached a peak point after September 15 2008 either at the end of 2008 or during 2009 for aimed markets. The shaded area in Figure 6.1 describes how DCC among the US and those EMs stock markets had a strong and highly increasing trend during the crisis period. It started to increase from the end of 2006 with a strong upward rising trend that is shown by the slope of the graph, and reached the peak at around the end of 2011 or beginning of 2012, then stayed there for a while. However, almost all of them could not go down to a similar lower level as before the crisis. That confirms the contagion effect was persistent for a long period which is also consistent with the Table 6.1 DCC-GARCH results.

In addition, the DCCs reached a third peak after the GFC period around August 2011 when the euro-zone sovereign debt crisis escalated on April 23, 2010 after Greece requested financial support. It may also relate to the 2008 financial crisis that could have caused the Euro-Zone financial market problems. Therefore, the influence and contagion effect of the 2008 financial crisis was profound and huge. After the highest value, the DCCs decreased but could not go back to the same lower range as before.

In Figure 6.1, the vertical line represents the date of September 15, 2008 when Lehman Brothers was announced bankrupt. It is clear that from that day there is a significant jump in the DCCs for most of the EM stock markets. Our result confirmed the finding of Cai, Tian, and Hamori (2016: 3801), which refined the crisis into two different phases by September 15 2008 and found the DCCs of the second crisis phase to be higher than the first phase from the end of 2006 to the crisis date. High contagion of the financial crisis is implied with this co-movement.

The third phase of our study for the selected emerging market is from 2010 to 2016, a long period. One of the common characteristics of the DCCs for all the selected EMs, expect China, Indonesia and the Philippines, is that they rose again due to the sovereign debt crisis. It started at the end of 2010 and reached the peak at the end of 2011 or in the first season of 2012 then went down in the middle of 2013. However, the average level of DCCs did not return back to the same lower level as pre-crisis but stayed at a high level. It indicates that the sovereign debt crisis also had a contagion effect on the other emerging countries.

Regarding the obtained average results of DCCs over the entire period, we could classify these 15 selected emerging stock markets into four different groups. China

(0.0634)[23], the Philippines (0.0659), Indonesia (0.1348), Malaysia (0.1114) and Thailand (0.1749) are in group one with a low correlation of less than 0.2 with the U.S stock market. The second group is middle value of DCCs, that means value between 0.2 and 0.3, and these markets also followed the same pattern and showed contagion effects, and it includes Colombia (0.2841), India (0.2305), Russia (0.2857), and Turkey (0.2702). The third group is the stock markets which have DCCs between 0.3-0.4, including Hungary (0.3202), Peru (0.3701), Poland (0.3668), and South Africa (0.3869). Then comes the high DCCs group with relative higher DCCs of more than 0.4, and which includes Brazil (0.5784) and Mexico (0.6616), which implies highly interdependence with the U.S. stock market.

There are some geographically concentrated characteristics. Generally speaking, the Asian stock markets among our study were more independent than European and African stock markets against the U.S. stock market, namely China, Indonesia, Malaysia, the Philippines, Thailand and India. That is, the association between European and African stock markets and the U.S. stock market were more closed than the Asian emerging markets[24]. Those European emerging stock markets are Brazil, Hungary, Peru, Poland, Mexico, and Turkey in our study. It is worth mentioning that although the average level of DCC between Turkey and the U.S. stock market was not high, the variation and changing of it is the biggest among the entire selected EMS.

With the exception of China, Indonesia, and the Philippines, all the other selected emerging countries followed a similar pattern of DCCs volatility. During the crisis period, the DCCs increased dramatically and with a higher value compared to the pre-crisis period. It is evidence that there were contagion effects of the GFC from the U.S stock market to the selected emerging stock markets. Among them, Mexico showed the highest level of dynamic correlation followed by Brazil, and oppositely, the Philippines

[23] The numbers in the brackets are the mean of DCCs for entire periods from Jan. 2000 to July 2016.

and China exhibited the lowest DCC level. However, the jumping degree during the crisis period was obviously big and significant.

In the Table 6.2 we calculated the DCCs differences among three periods. D(pre-crisis) represents the percentage difference of DCCs sample mean value between the crisis period and pre–crisis period. The results indicated that for all selected EMs, the DCCs increased during the crisis period rather than pre-crisis period. The most increased stock market of the DCCs was Colombia with 156.98% and followed by Turkey with a 20.55% high level increase during crisis and pre-crisis periods. Russia, Poland India and Hungary belong to the high changing DCCs group that with a more than 50% increase rate. This result indicated that these emerging stock markets impacted seriously and sensitively to the GFC compared to the other selected countries. Moreover, it shows that higher DCC does not mean contagion but just dependence and co-movement with the U.S stock market. However, the changing of DCCs can show the contagion effect level.

Except Indonesia, all of the stock markets' percentage changes of DCCs are more than 30% during the crisis period than pre-crisis. It provides evidence of the contagion effect of the GFC to these emerging stock markets. We will do formal t-test to compare whether the sample means of the crisis period increase rather than in the pre-crisis period in the following section.

Moreover, the difference mean between post-crisis and crisis period D(post-crisis) results show that after the 2008 GFC the average DCCs of the selected emerging stock markets against the US had a slight change from in the crisis period. There are some studies, for instance Chiang et al. (2007: 1218), Hirshleifer and Teoh (2003: 49) that distinguish the contagion and herding of a financial crisis. According to their definition, if the response of the other markets is simultaneous with a high correlation to the financial shocks then there is a herding phenomenon.

In our study, the DCCs of China, Colombia, India, Peru, Poland, Russia, South Africa, and Thailand's stock markets increased in the post-crisis period than the crisis period, confirming herding behavior and the consistency of the impact from the GFC. It supports that the 2008 GFC had a profound and persistent contagion effect on emerging countries and there were herding behaviors among these emerging stock markets. Additionally, the last term is the difference of DCCs between post-crisis and pre-crisis periods. We can see the DCCs increased significantly and for a long period. It confirmed our DCC-MGARCH model analysis result that the contagion effect did not disappear very fast but kept persistence and lasted longer and even got bigger.

All these variations of DCCs significantly increased in during and after crisis periods than in the pre-crisis period. It shows the contagion effect of the GFC from the US stock market to our selected emerging stock markets, except for Indonesia which only had weak impact from the U.S stock market. This result is consistent with many other studies about contagion from financial crisis, such as Syllignakis and Kouretas (2011: 724), Harkmann (2014: 64), Cai, Tian, and Hamori (2016: 3801). The impact remained persistent and the DCCs level after crisis did not return to the previous lower level. However, Celik (2012: 1957) pointed out that China's stock market was one of the most influenced markets by global financial contagion in terms of the foreign exchange market.

Table 6.1: Descriptive Statistics Of DCCs Between The U.S And The Selected 15 Emerging Stock Markets For Four Panels

Panel A. Entire 1/03/2000-7/29/2016															
	BR	CHA	COL	HG	IND	INSIA	MA	ME	PE	PH	PO	RU	S.A	TH	TR
Mean	0.5784	0.0634	0.2841	0.3202	0.2305	0.1348	0.1114	0.6616	0.3701	0.0659	0.3668	0.2857	0.3869	0.1749	0.2702
S.D.	0.1501	0.0292	0.1598	0.0983	0.0772	0.0090	0.0275	0.0956	0.1454	0.0297	0.1069	0.1184	0.0992	0.0492	0.1087
Skew	-0.2908	1.1622	0.0404	-0.0560	0.1753	0.2395	0.1053	-0.2035	0.1920	-0.1247	-0.0676	0.1946	0.1158	-0.0311	0.0185
Kurt.	2.5253	7.0027	2.3007	2.1350	2.2129	16.9440	2.2975	2.3073	2.1842	3.2423	1.9882	2.3116	2.0043	2.3697	1.8257
JB	85.25	3240.49	74.96	115.06	112.29	29443.10	81.34	97.63	122.98	18.29	157.62	94.57	158.06	60.68	208.79
Obs.	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630	3630
Panel B. Before-Crisis 1/03/2000 12/31/2007															
	BR	CHA	COL	HG	IND	INSIA	MA	ME	PE	PH	PO	RU	S.A	TH	TR
Mean	0.5273	0.0551	0.1380	0.2445	0.1690	0.1340	0.0878	0.6122	0.2855	0.0567	0.2603	0.1849	0.3076	0.1387	0.1787
S.D.	0.1065	0.0218	0.1101	0.0808	0.0589	0.0094	0.0166	0.0780	0.1021	0.0290	0.0566	0.0648	0.0627	0.0325	0.0758
Skew	0.0489	0.1372	1.1287	0.4894	1.3514	-0.9818	-0.4497	-0.4016	0.0748	-0.4579	0.0443	-0.4361	0.6790	-0.2406	0.9645
Kurt.	2.5483	2.9867	4.5847	2.4536	5.8528	18.9056	2.7219	2.6132	2.8900	2.9926	2.3278	3.5281	3.9367	2.3056	3.4289
JB	12.17	4.30***	433.63	71.63	880.26	14640.15	50.51	45.31	1.97***	47.82	26.20	59.27	155.12	40.69	222.60
Obs.	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368	1368
Panel C. Crisis Period 1/03/2007 12/31/2009															
	BR	CHA	COL	HG	IND	INSIA	MA	ME	PE	PH	PO	RU	S.A	TH	TR
Mean	0.7140	0.0647	0.3546	0.3712	0.2629	0.1355	0.1256	0.7654	0.4025	0.0718	0.4152	0.3381	0.4066	0.1804	0.3608
S.D.	0.1066	0.0378	0.0838	0.0762	0.0798	0.0097	0.0220	0.0488	0.1451	0.0260	0.0523	0.0956	0.0841	0.0634	0.0680
Skew	-0.9208	1.5681	0.1697	-0.3835	0.2346	1.0447	0.1255	-0.6398	-0.3716	-0.0347	-0.3433	-0.0699	-0.4186	0.1427	-1.0416
Kurt.	2.6950	7.6576	3.4253	2.3386	1.7670	11.8043	2.4792	3.3257	2.2798	2.3701	2.6252	2.4363	2.0637	1.7532	4.8260
JB	108.74	983.97	9.24	32.01	54.31	2555.38	10.43	54.41	33.42	12.53	19.09	10.53	49.23	51.05	239.50
Obs.	749	749	749	749	749	749	749	749	749	749	749	749	749	749	749
D(crisis-pre)	35.4188	17.4887	156.9777	51.8443	55.6233	1.0632	43.0795	25.0297	40.9753	26.5784	59.5223	82.9235	32.1714	30.1192	101.8557
Panel D. After Crisis 1/03/2010 7/29/2016															

	BR	CHA	COL	HG	IND	INSIA	MA	ME	PE	PH	PO	RU	S.A	TH	TR
Mean	0.5575	0.0703	0.3813	0.3633	0.2702	0.1351	0.1258	0.6550	0.4304	0.0711	0.4392	0.3508	0.4489	0.2048	0.3080
S.D.	0.1620	0.0284	0.1251	0.0779	0.0501	0.0082	0.0227	0.0874	0.1424	0.0300	0.0808	0.1026	0.0828	0.0278	0.0883
Skew	-0.4784	0.7980	0.1143	0.1747	-0.0634	1.2449	-0.0640	-0.0899	-0.0282	0.1252	-0.3977	-0.1197	-0.3221	-0.1234	0.0405
Kurt.	2.4980	4.4444	2.8486	1.7895	2.2580	17.1999	1.5329	2.1018	1.7132	3.1574	2.1805	2.1721	2.3939	2.5004	1.8436
JB	73.59	292.11	4.74**	100.06	35.72	13102.40	136.72	52.90	104.58	5.52*	82.22	46.82	49.33	19.58	84.71
Obs.	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513	1513
D(post-crisis)	-21.9150	8.6483	7.5433	-2.1186	2.7554	-0.2274	0.1879	-14.4312	6.9181	-0.9344	5.7748	3.7428	10.4107	13.5035	-14.6327
D(post-pre)	5.7417	27.6495	176.3624	48.6274	59.9113	0.8334	43.3483	6.9864	50.7281	25.3957	68.7344	89.7699	45.9314	47.6898	72.3187

*Note: 1. the short name for countries represent the dynamic conditional correlation between U.S. and the selected stock market. 2. The short name for countries BR(Brazil), CHA(China), COL(Colombia), HG(Hungary), IND (India), INSIA (Indonesia), MA(Malaysia), ME(Mexico), PE (Peru), PH(Philippines), PO(Poland), RU(Russia), S.A. (South Africa), TH (Thailand), TR(Turkey). 3.S.D.,Skew, Kurt, JB, Obs. represent the standard deviation, skewness, Kurtosis, Jarque-Bera, and Observations. D(Crisis-pre), D(post-crisis) and D(post-pre) are the percentage of changes of the sample means between crisis and pr-crisis, post-crisis and crisis period and the post period and pre-crisis periods. 4.In terms of the JB value, without * means significant in 1% level. *** mean insignificant, **significant in 10%, *significant in 5% percent.*

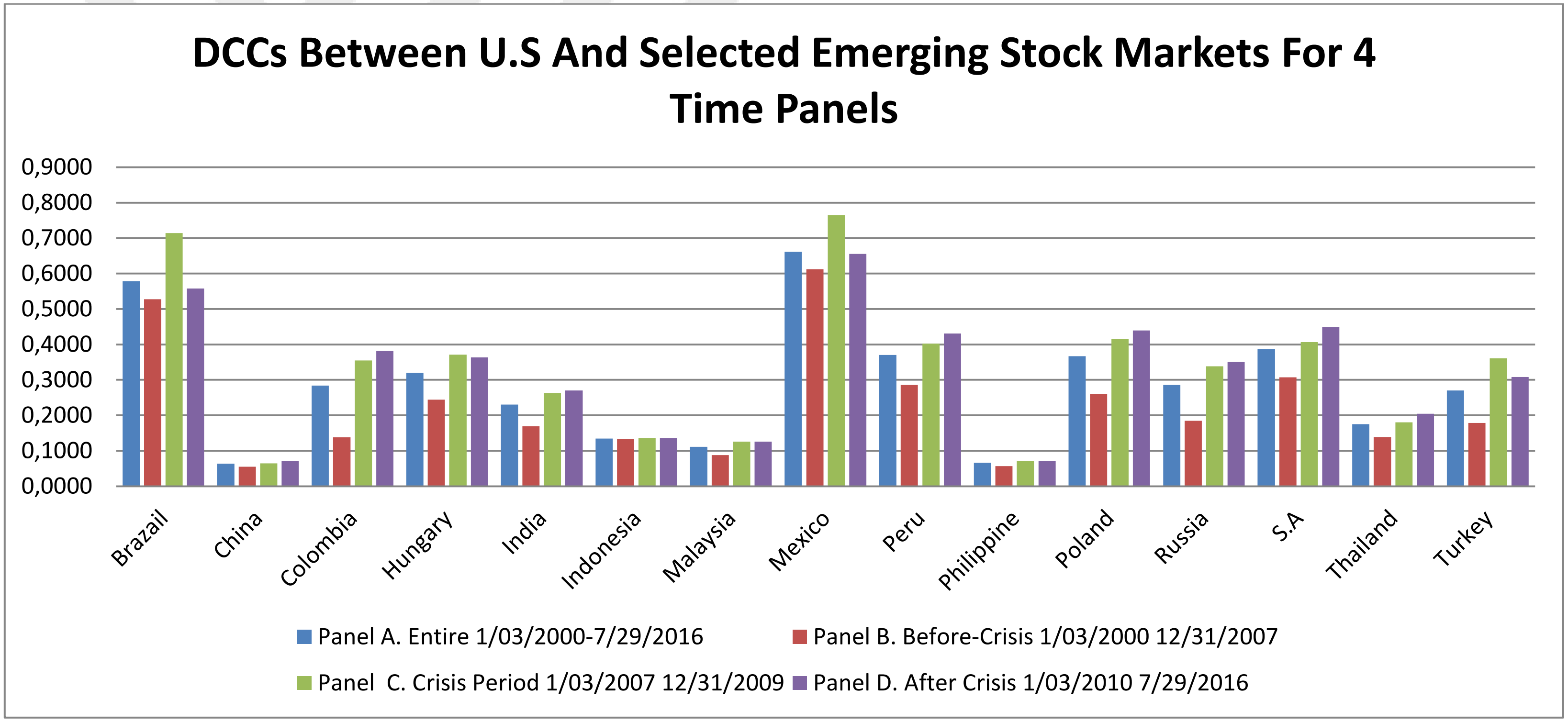

Figure 6.1: The Means Of Dynamic Conditional Correlation Between The US And 15 The Selected Emerging Stock Markets For Four Time Panels (1/3/2000-7/29/2016)

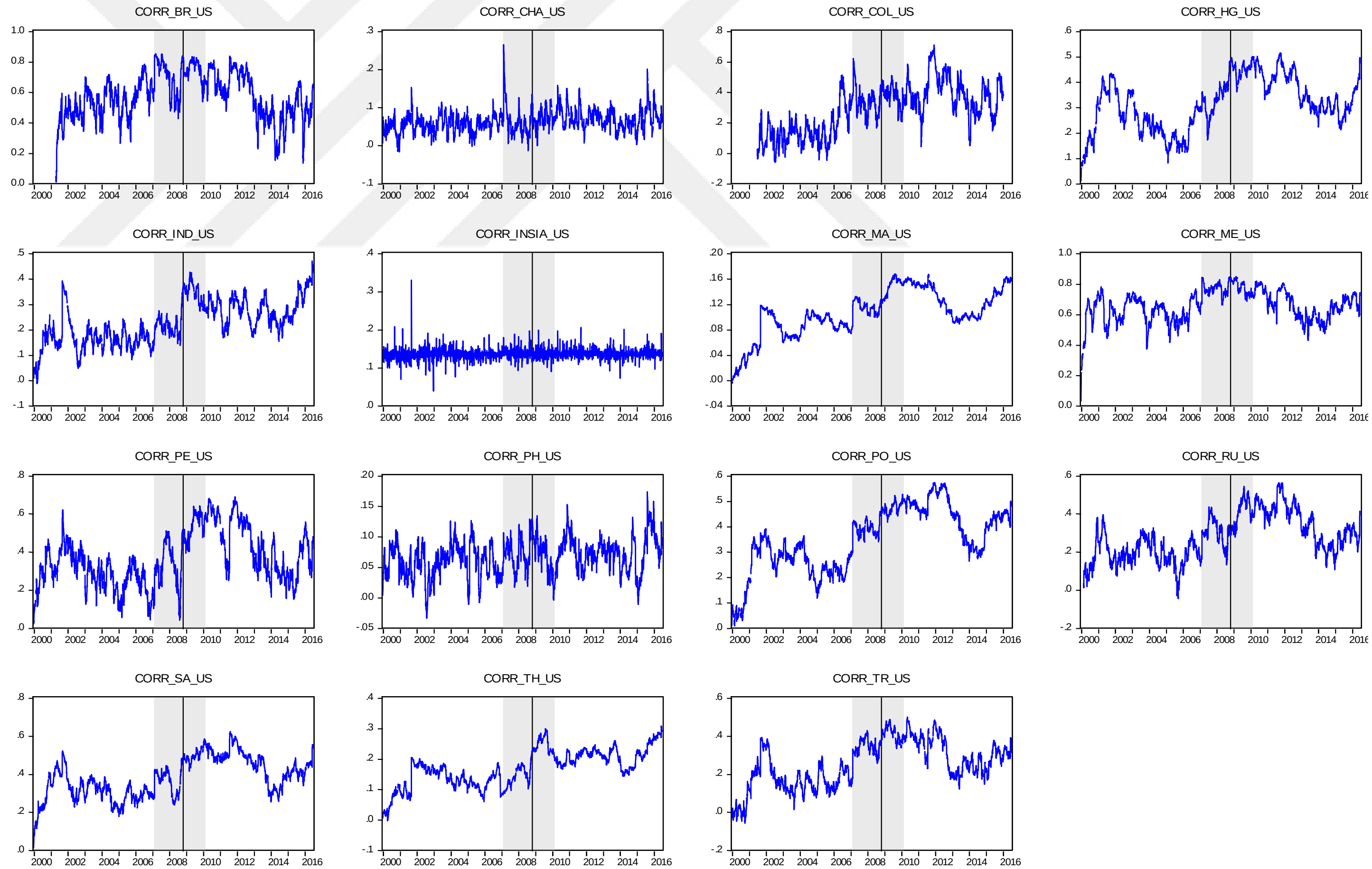

Figure 6.2: Dynamic Conditional Correlation (DCC) Between The US And The Selected 15 Emerging Stock Markets 1/3/2000-7/29/2016

Note: The short name for countries: BR (Brazil), CHA (China), COL (Colombia), HG (Hungary), IND (India), INSIA (Indonesia), MA(Malaysia), ME (Mexico), PE(Peru), PH(the Philippines),PO(Poland), RU (Russia),SA(South Africa), TH (Thailand), TR (Turkey), and US (United States)

6.6.3. Empirical Result Of Contagion Effect Test: Pairs T-Test Methodology –Welch's Approximation

To identify the existence of financial contagion, we employ the t- tests to compare the sample means of DCCs during the crisis and before the crisis. From the Table 6.3 t-test result, we reject the null-hypothesis that the sample means are equal to each other. Therefore, we confirmed there were contagion effects from the US to all selected emerging stock markets during the GFC in 2008. All the p-value for t- statistics is statistically significant to a 1% significant level and the entire sample means of the DCCs increased statistically significantly during the crisis period rather than in pre-crisis period. Therefore, we found evidence of contagion effects from the GFC from the U.S. on the selected emerging stock markets.

Table 6.2: T-Test Result For Sample Means Of The Crisis Period And Pre-Crisis Period

DCC_EMS_us	sub-periods	mean	std. dev.	t-statistics	Welch's d.f
corr_br_us	pre-crisis	0.517335	0.118031	-40.1805***	1755.01
	crisis	0.712968	0.105809		
corr_China_us	pre-crisis	0.052994	0.022401	-7.9432***	993.329
	crisis	0.064665	0.037633		
DCC_chile_us_	pre-crisis	0.420449	0.002281	-38.0336***	1776.32
	crisis	0.557	0.002772		
corr_Colombia_us	pre-crisis	0.13833	0.109751	-51.4506***	1963.14
	crisis	0.354142	0.08395		
corr_hg_us	pre-crisis	0.240404	0.088743	-37.4542***	1653.96
	crisis	0.370975	0.076166		
corr_India_us	pre-crisis	0.160834	0.06251	-31.0519***	1169.24
	crisis	0.262417	0.080065		
corr_Indonesia_us	pre-crisis	0.133908	0.010873	-3.4822***	1594.37

	crisis	0.135432	0.009695		
corr_Isreal_us	pre-crisis	0.200949	0.059531	-44.0433***	2510.59
	crisis	0.27485	0.024585		
corr_Korean_us	pre-crisis	0.17975	0.052084	-23.6156***	2510.75
	crisis	0.214428	0.021531		
corr_Malaysia_us	pre-crisis	0.075269	0.029151	-47.1416***	1863.11
	crisis	0.125357	0.022091		
corr_Mexico_us	pre-crisis	0.607105	0.097298	-53.9357***	2453.12
	crisis	0.765182	0.049223		
corr_Peru_us	pre-crisis	0.2856	0.100912	-20.1280***	1083.74
	crisis	0.40216	0.144823		
corr_Philippine_us	pre-crisis	0.05691	0.02791	-12.8106***	1583.53
	crisis	0.071473	0.026043		
corr_Poland_us	pre-crisis	0.235813	0.086286	-63.7838***	2235.41
	crisis	0.41489	0.052511		
corr_Russia_us	pre-crisis	0.186828	0.075303	-38.921***	1228.75
	crisis	0.336917	0.09572		
corr_SouthAfrica_us	pre-crisis	0.302506	0.07658	-29.1539***	1320.16
	crisis	0.406275	0.083999		
corr_Singapore_us	pre-crisis	0.207096	0.072037	-23.9764***	1701.63
	crisis	0.27371	0.060033		
corr_Thailand_us	pre-crisis	0.123382	0.044259	-22.4441***	1085.6
	crisis	0.180256	0.063342		
corr_Turkey_us	pre-crisis	0.155014	0.092216	-22.4441***	1896.05
	crisis	0.360537	0.068579		

Note: pre-crisis period is 1/1/2000 – 12/31/2006, and crisis period is 1/1/2007-12/31/2009.
All the t- statistics are significant at 1% significance level.

6.6.4. Dynamic Contagion Correlation Analysis Empirical Results - GARCH (1, 1) With Dummies

First, DM_1 in the mean equation are positive and highly significant for Brazil, India, Indonesia, Malaysia, Mexico, Peru, Poland, South Africa, and Turkey for the first lag of the dynamic conditional correlation. However, as the lag AIC criteria suggested, Hungary has two lags, and this means in the mean equation we should put two lags of the DCC for Hungary[25]. The dummy variable during the crisis is positive and significant for Hungary (10% significant level), of the two lags of Hungary.

According to the AIC criteria, Hungary's lag length is 2. The coefficient of correlation for ρ_{t-1} and ρ_{t-2} for Hungary is (1.3597*** and -0.3592***) respectively. The coefficient of DM1 and DM2 is 0.0003* and 4.60E-05 respectively. In addition, both of the coefficients in the variance are significant for DM_1 and DM_2 at 1% significant level.

This positive and significant result of a dummy variable for the crisis period implies the correlation during the crisis period is significantly higher than for the pre-crisis period, and that the correlation between the U.S. stock market and these markets is getting closed and co-movement is bigger than before. It shows the impact of the crisis on the dynamic conditional correlation.

However, DM_1 for China, Colombia, the Philippines, Russia and Thailand are not significant. This implies that the crisis did not influence the correlation between U.S. stock markets and this stock market directly, although there is significant increasing of the DCCs and confirmed contagion effect. There are some reasons for that, it could be caused by the time period dividing, or government intervention, or different speed of response to the external shocks.

However, as the information spread and one after another stock market experienced sharp declines in their returns, investors gradually learned that the crisis was having a negative impact on the markets. Then they started to follow the sophisticated and reputable investors from the bigger market, to imitate their behaviors. With the accumulation of information and widespread loss in the world of regional differences, the benefit of the diversification of the asset portfolio diminished, so panic and lack of confidence pushed investors to follow others. Therefore, in the end, the investment strategies showed a convergence trend, that caused the higher correlation of the markets.

This could be seen from the post-crisis period, where in order to avoid the impact of the Eurozone crisis, we did not include the post crisis period until the end of the entire time span. Instead we defined the post-crisis dummy from 2010 to the end of 2012. The coefficients of dummy variable for post-crisis in the mean equation DUM2 are positive and significant almost for all selected emerging stock markets, except Hungary, the Philippines and Thailand. The increasing of correlations are consistent with Figure 5.1 of a co-movement trend as the return Figure 5.2. In addition, this finding supports the herding behavior hypothesis after the crisis. Chiang et al. (2007: 1220) found similar results for the selected stock markets.

Hungary did not change significantly, neither increased nor decreased, which might be due to these two markets hangover with a similar high correlation. Thailand, as before mentioned, has considerable government control, which is why during and after the crisis there is no significant increase of the correlation. The Philippines' result was consistent with the previous result of DCC-GARCH and correlations, and it shows more independence from the U.S stock market.

In terms of the variance equation, they are significant for almost for all the selected markets, except Colombia, India, Indonesia and Russia for the crisis period and India and the Philippines for the post-crisis periods. The high significance for the dummy of crisis and post crisis impliesa clustering phenomenon of the markets. It confirmed the structure change and volatilities of the correlation coefficients due to external shocks during and post the crisis period. The significance of dummy in the variances during and post crisis shows more volatile changes due to the external shocks. The impact extended to the post-crisis for most of the stock markets, indicating the explosive changes in volatility and the profound influence of the GFC.

In sum, the findings above indicate that the GFC profoundly and significantly increased the correlation coefficients between the U.S. and the selected emerging stock markets. The evidence also suggests that the correlation coefficient could vary greatly when the crisis hit the market, as the information accumulated gradually, and investors followed the sophisticated and related reliable investors. Therefore, the dummy variables highly and significantly increased during the crisis period, and even extend to post crisis, implying that variability could be prolonged for a significant period of time (Chiang et al., 2007: 1221-2). Moreover, due to the evidence of the herding phenomenon, the benefit of holding a diversified international portfolio will only have limited gains when a crisis hit the markets.

It is interesting that there was no significant change of the correlation coefficient between the U.S. and Indian stock market in terms of the variance equation, and there were no significant changes to Hungary, the Philippines or Thailand in terms of the mean equation. However, the DCCs increased during the crisis than post-crisis period, and identified a contagion effect from the t-test. In terms of Hungary, as mentioned before, it highly correlated with the U.S. stock market. The Philippines was the opposite, more independent and less associated with the U.S. stock market, even though there was still contagion effect. Finally for Thailand, it may imply a slower and slighter reaction to the U.S. stock market than others highly associated with the U.S. stock market.

Table 6.3: Dynamic Conditional Correlation (DCC) Result With Dummy Variables In The GARCH Model

	Brazil	China	Colombia	Hungary	Indian	Indonesia	Malaysia	Mexico	Peru	Philippine	Poland	Russia	South Africa	Thailand	Turkey
Mean equation															
Constant	0.0108***	0.0027***	0.0029***	0.0014***	0.0022***	0.1069***	0.0006***	0.0110***	0.0041***	0.0016***	0.0012***	0.0023***	0.0025***	0.0008***	0.0017***
	7.6829	8.0127	4.131225	3.1073	3.2996	35.5106	8.4495	8.3157	5.0054	6.1454	3.0445	4.7138	3.7769	3.6583	3.8073
ρ_{t-1}	0.9805***	0.9534***	0.9881***	0.9957***	0.9882***	0.2036***	0.9945***	0.9826***	0.9867***	0.9761***	0.9960***	0.9902***	0.9928***	0.9961***	0.9916***
	346.0373	189.0229	386.1607	637.2154	355.1919	9.0638	1294.15	436.6388	390.7942	270.9476	739.838	494.9698	511.6633	789.1894	466.9719
DUM1	0.0036***	9.55E-04	9.80E-04	5.17E-04	1.24E-03**	9.89E-04**	2.92E-04***	2.93E-03***	1.89E-03**	0.0003	8.44E-04**	0.0007	8.06E-04*	1.47E-04	1.73E-03***
	2.9795	1.5322	0.949014	1.5815	2.4168	2.4735	3.8288	5.3706	2.5148	0.9138	2.0176	1.0569	1.771	0.8225	2.7681
DUM2	0.0039***	7.68E-04**	1.90E-03*	3.36E-04	1.10E-03**	1.10E-03***	1.41E-04**	1.44E-03***	2.82E-03***	0.0002	7.60E-04**	0.0022***	1.01E-03**	-1.67E-05	1.07E-03*
	4.3622	2.0406	2.096215	0.9048	2.058	2.8188	2.1522	3.0654	3.3081	0.7212	2.0788	3.5818	2.1244	-0.0943	1.9132
Variance Equation															
Constant	9.52E-05**	6.71E-06***	1.15E-05**	2.65E-05***	6.95E-05	2.78E-05***	8.60E-07***	5.87E-05***	1.09E-04***	2.63E-05***	1.61E-05***	2.64E-06***	3.19E-05***	2.53E-06***	5.80E-05***
	14.0127	16.5716	8.333025	6.8691	1.5904	7.9314	22.1659	25.0786	3.0955	11.91846	16.6768	18.16593	8.5792	14.806	5.9211
RESID(-1)^2	0.0738***	-0.0034	-0.0061**	0.0296***	-0.0035***	0.0481***	0.4580***	0.1222***	0.0118***	0.0594***	0.0710***	-0.0056***	0.0268***	0.0439***	0.0300***
	14.4265	-5.1688	-13.5197	9.9223	-28.3366	9.1019	21.4983	16.8464	4.3258	25.92842	16.2562	-17.67264	6.4822	14.7432	5.8931
GARCH(-1)	7.52E-01**	0.8941***	0.9791**	0.5196***	0.6111**	0.6684**	0.4486***	0.5500***	0.6483***	0.3033***	0.6446***	0.9869***	0.5498***	0.8595***	0.4876***
	50.2276	162.3541	334.4536	7.866269	2.489007	16.90083	22.41796	33.45927	5.84047	5.451045	33.23868	1157.175	10.75652	112.4983	5.818645
DUM1	-4.91E-06*	7.80E-06***	-1.25E-07	-4.04E-06***	-4.24E-05	-2.43E-07	1.13E-06***	-1.83E-05***	-6.94E-06**	2.59E-06***	3.75E-06***	7.73E-08	2.74E-06***	-1.26E-06***	-7.35E-06***
	-2.0079	23.078	-0.3838	-4.8708	-1.5834	-0.3265	21.669	-12.4854	-2.3041	3.634354	9.6932	1.361331	4.5693	-13.0171	-4.5538
DUM2	-5.07E-05**	7.61E-07***	-3.50E-07*	-9.91E-06***	-3.92E-05	-9.20E-06***	1.66E-07***	-1.37E-05***	-2.44E-05***	1.90E-07	-7.56E-06***	-8.22E-07***	-8.97E-06***	-1.35E-06***	-1.27E-05***
	-13.7513	6.0309	-1.7346	-6.5769	-1.5769	-6.8942	8.8078	-11.4196	-3.1009	0.356345	-14.0328	-14.48434	-7.8681	-13.3759	-5.2979

Q(5)	5.2887	1.661	4.8761	3.6037	3.2441	10.38*	4.5675	2.5561	3.3877	118.38***	1.6256	3.4262	2.4843	2.831	3.7304
ARCH(5)	-0.0085	0.2173	-0.0068	0.1895	0.2097	0.5026	0.4539	0.1365	0.2152	-0.0037	0.1677	0.0095	0.0353	0.0421	0.233

Note: The estimated equation are $\rho_{ij,t} = \sum_{p=1}^{p} \emptyset_p \rho_{ij,t-p} + \sum_{k=1}^{2} \alpha_k DM_{k,t} + e_{ij,t}$ and $h_{ij,t} = A_0 + A_1 h_{ij,t-1} + B_1 \varepsilon_{ij,t-1}^2 + \sum_{k=1}^{3} d_k DM_{k,t}$.

The values in the parentheses are the Z-statistics. $\rho_{ij,t}$ is the dynamic conditional correlation (DCC) between U.S. stock market and selected emerging stock market that from the DCC-GARCH model. DM_1 is the dummy variable for the crisis period (1/1/2007-12/31/2009); DM_2 si the dummy variable for post-crisis period (1/1/2010 – 12/31/2011). The Lag length is determined by AIC criterion. Q(5) is the Ljung-Box Q-statistics that tests serial correlation of the residuals up to the 5th days. ARCH(5) is the ARCH LM test up to five days, testing the heteroskedasticity of the residuals. ***, **, and * represent statistical significance at 1%, 5%, and 10% levels, respectively.

The 2007-2008 GFC led to the Great Recession, and it has been witnessed as the worst economic disaster since the Great Depression of 1929. Not only in the U.S. financial and economic market, but it also caused a global economic downturn. Therefore, in this paper, we set out to identify the financial contagion of the GFC to the 15 selected emerging stock markets. They are Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand and Turkey.

This study employed returns of daily stock-price indices data during January 2000 to July 2016, and it divided the entire period into three different periods, namely pre-crisis (1/03/2000-12/31/2006), during-crisis (1/1/2007-12/31/2009), and post-crisis (1/1/2010-7/29/2016) periods. The advantage is to apply Engle's (2002) multivariate DCC-MGARCH model to get the time varying dynamic conditional correlation (DCC), and compare the changing of the DCCs and unconditional correlation among pre-crisis, during crisis and post-crisis time periods between the U.S. stock market and the selected emerging stock markets to identify the financial contagion effect of the GFC.

After calculating DCCs between the U.S. and the 15 selected emerging stock markets, we did pairs t-test with Welch's approximation to compare the sample means of the crisis period and pre-crisis period. In order to investigate how the external shock impacted on the DCCs, we also extended the study by applying the GARCH (1, 1) model with two dummy variables.

There are meaningful and expected empirical results. Firstly, through estimating the dynamic conditional correlation during periods of financial turmoil among selected emerging stock markets and the U.S. stock market, we concluded that there are substantial evidence of significant variation and co-movement of the dynamic conditional correlations pre-, during- and post- financial crisis for all selected emerging stock markets except Indonesia. It supports contagion effects for all 15 selected emerging stock markets due the correlation increasing in the crisis-period than pre-crisis period, and their having very similar patterns of dynamic conditional correlation.

Secondly, from the t-test result, we can identify financial contagion effect existence for stock markets from the U.S to the selected emerging countries as evidenced by the increasing of correlation patterns for all selected emerging stock markets. Because all t-statistics were significant, it rejected the null hypothesis that there was no changing for the sample means between the crisis and pre-crisis periods.

Moreover, from the DCC-GARCH results and GARCH (1.1) with dummy variables analysis, due to the dummy variables being highly and significantly increased during the crisis period, and even extending to post-crisis, it implies that variability could be prolonged for a significant period of time (Chiang et al. ,2007: 1221-2). We can conclude that the GFC profoundly and significantly increased the correlation coefficients between the U.S. and the selected emerging stock markets. The evidence also suggests that the correlation coefficient could vary greatly when the crisis hit the market, as the information accumulated gradually, and investors followed the sophisticated and related reliable investors.

Additionally, due to the evidence of the herding phenomenon, the benefit of holding a diversified international portfolio will only have limited gains when a crisis hits the markets. The high significance for the dummy of crisis and post-crisis implies clustering phenomenon of the markets. It confirmed the structure change and volatilities of the correlation coefficients due to external shocks during and post the crisis period. The significance of the dummy in the variances during and post-crisis shows more volatile changes due to the external shocks. The impact extended to post-crisis for most of the stock markets, indicating the explosive changes in volatility and the profound influence of the GFC.

According to the obtained results of changing of DCCs, considering the increase during the crisis period than in the pre-crisis period, we can classify the selected emerging stock markets into four groups. The first group, including China, the Philippines, Indonesia, Malaysia, and Thailand, were characterized by weak association with the U.S stock market with DCCs less than 0.2. The second group is composed of

Colombia, India, Russia, and Turkey, with correlation variables between 0.2 and 0.3 with the U.S. stock market. The third group, including Hungary, Peru, Poland, and South Africa recorded moderate DCC correlation with the U.S. stock market from 0.3 to 0.4. The fourth group composed of Brazil and Mexico was highly correlated with the U.S. stock market with more than 0.55 DCCs.

Together with the abovementioned conclusion and the correlation finding, one more very important finding has to be mentioned here. There was a geographical concentration of the financial contagion and integration. The European emerging stock markets were much more closely associated with the U.S. stock market than the Asian emerging stock markets. It implies the financial integration levels of European EMs are higher than Asian EMs, that is, the Asian EMs are more independent.

There are meaningful implications for investors and governments' financial institutions for making investments, managing portfolios and risk assessment. To recognize the dynamic correlation between international financial markets could provide valuable information for international investors. In addition, our findings imply that the financial markets of emerging countries are sensitive and vulnerable to external shocks, and that has useful implications for policymakers. Trying to identify the contagion channels and realize the signs of a potential crisis will help them to stabilize their financial mechanisms and systems.

CHAPTER SEVEN

DETERMINANTS OF DYNAMIC CONDITIONAL CORRELATION AND CHANNELS OF THE FINANCIAL CONTAGION

In this chapter, we examine the contagion channels and the determinants of the dynamic conditional correlation from the financial and fundamental perspectives. It will contribute to and fill the gaps in the contagion study. We applied the DCCX-GARCH model that is an extension version of the DCC-GARCH by adding VIX index of stock market, TED spread, and Sovereign CDS spread as exogenous variables into the calculation of conditional variances.

It allows simultaneous estimation of the conditional correlation coefficients and identifies the financial channels of the contagion effects. Due to this, it can provide evidence of the determinants of the conditional correlation changing over time. It shows that increase of VIX increases stock market volatility, while increase in the TED decreases the conditional correlation. In terms of the CDS, there are different impact results. In terms of the fundamental channel, we apply panel data analysis to the monthly data.

After selecting the appropriate model from the pooled OLS, fixed effect and random effect model by employing F-test, LM-test and Hausman test, we confirmed the fixed effect model is the most suitable model. The fixed effect panel data analysis result shows that the difference from the U.S. and selected emerging counties of exports, industrial production, and inflation rate are significant determinants of the DCCs. The robust fixed effect model additionally implies that the interest rate is also a determinant factor of DCC for general situations. By adding the dummy variables into the regression, we found that DCC was significantly impacted by the crisis and post-crisis periods.

7.1. Introduction

In the first two empirical analysis chapters, we applied different methods to identify the contagion effects of the global financial contagion of the GFC from the U.S. stock market to the 15 selected emerging stock markets. It is meaningful and important to find out the channels of the financial contagion effects and determinants of the dynamic conditional correlation, to see why and how the correlation changed and which factors contributed to contagion effects. These results can guide investors and policymakers to minimize lose during a crisis period. Therefore, we developed this third empirical chapter to focus on analysis of the dynamic conditional correlation and to deeply investigate the channels of financial contagion and the determinants of the dynamic conditional correlation.

We confirmed from the DCC-GARCH model and Granger causality, impulse response within the VAR structure. The dynamic conditional correlations (DCCs) among the U.S. stock market and all selected emerging markets significantly increasing during the GFC period. In this chapter, we are interested in the correlation because, firstly, a higher level of correlation volatility indicates systematic risk, due to the benefit from the market – portfolio diversification is diminished. Secondly, a higher volatility of the correlation casts doubts on the investment and portfolio decision making that is according to the correlation coefficient, since the stability of the correlation periods is not reliable.

Importantly, the transmission mechanism of the financial contagion and the determinants of the correlation can be used as the measures that give the signal to the markets, and may forecast a future crisis and help individuals to make better decisions.

Therefore, our aims in this chapter are to find the transmission channels and determinants of the dynamic conditional correlations. Particularly, we will analyze from financial channels and fundamental channels two perspectives of the recent 2008 GFC from the U.S. stock market to the selected 15 emerging stock markets.

Our research tries to fill the gap in GFC contagion channels studies. There are few studies about the financial channels of the GFC, although there are rich researches to identify the financial contagion effect by a variety of methods. There are even some studies about contagion channels; they were all just focused on one aspect, whereas we will analyze the dynamic conditional correlation from both financial and fundamental perspectives to make a comprehensive study. In addition, we cover a long time period from 2000 to 2016 and 15 emerging markets that are commonly accepted in all emerging country indices.

In order to find the financial channels of contagion, the DCCX-GARCH model (Dynamic conditional correlation- Multivariate Generalized Autoregressive Conditional Heteroskedasticity model with Exogenous variables) which is the extension model from the DCC-GARCH (Engle's 2002), is applied. With the DCCX-GARCH model proposed by Min and Hwang (2012: 2070-2071), they pointed out that this methodology is useful to identify the contagion channels as it can estimate both dynamic conditional correlation and the impact of explanatory variables simultaneously within one framework.

We added exogenous financial market variables with high frequency daily data as VIX index of stock market, TED spread, and Sovereign CDS spread to the DCC-GARCH model variance equations to see how they impact on the volatility of the conditional variance volatilities.

Furthermore, to find out the fundamental factors of the contagion, we ran a panel data regression analysis to the conditional correlation by considering trade-balance that include export and import, interest rate, inflation rate and industrial production as the independent variables to the monthly data. The expected result is to see how these macroeconomic variables impact on the conditional correlation changing, thereby, to identify the determinants of the contagion from a fundamental perspective.

The remainder of this chapter is organized as follows. In the second part we review the previous studies and the variables that may impact on the conditional correlation. Then data and preliminary analysis will be given, followed by the methodology for different objectives. After that empirical results for the financial and fundamental perspectives will be presented. The last part is the conclusions and limitations.

7.2. Literature Review And Determinants Of The Conditional Correlations

There are different types of financial contagion channel according to previous studies. We can classify them into two categories; one category includes fundamental contagion and pure contagion by considering their individual behaviors. Another classification is financial contagion and fundamental contagion by taking into consideration the factors that affect the contagion channels from macroeconomic perspectives.

The financial contagion literature distinguishes contagion as pure contagion and fundamental contagion. Dornbusch, Park, and Claseesns (2000: 179-180) proposed fundamental contagion can be explained by economic fundamentals. Lin et al. (1994) showed that, apart from economic similarity and association, there is an important channel called pure contagion. The idea is that investors' irrational behavior causes irrational phenomena in the financial market; for instance, financial panics and herding behavior. These finally lead to financial shocks from one place to another.

There is a group of previous studies (Bracker et al. 1999; Connolly et al., 2007; Luchtenbery and Vu, 2015; Baele et al., 2010; Norden and Weber, 2009; Kim, Kim, and Lee, 2015; Johnson and Soenen (2003); Min and Hwang, 2012;Cai et al., 2016; Mollah et al., 2016; Leung et al., 2017) who did research about the determinants of stock market co-movement and correlation.

In our study about financial channels we consider the financial channel from the financial market, and the fundamental channel which is because of economic fundamentals.

7.2.1. Financial Channels Literature Review

After identifying the contagion effect from the U.S. stock market to the selected emerging markets, we extended the study to finding the channels of transmission mechanisms of the contagion. In this study, we employed a DCCX-GARCH model by adding exogenous variables in extension from the DCC-GARHC model, which was proposed by Min and Hwang (2012: 2070-2071). It can estimate both conditional correlation and effects of the explanatory variables simultaneously in one framework.

There are a large number of variables and factors that can be considered as the determinants of the DCCs. The common and widely applied variables are the VIX index, Credit Default Swap (CDS) spread, and the TED spread (Kim, Kim, and Lee (2015: 209) and stock market capitalization, Min and Hwang (2012: 2071-2072), Cai et al. (2016: 3791), Kim, Kim, and Lee (2015: 200-201).

Kim, Kim, and Lee (2011: 200) point out that sovereign CDS premium as the costs of insuring against a sovereign default, which can measure the country risk of emerging Asian economies. Min and Hwang (2012: 2071-2072) find that higher CDS spread increased stock price volatility, also consistent with Bystrom (2005: 1) who found an increase in stock volatility had a positive correlation with CDS spread. Cai et al. (2016: 3793) used sovereign CDS spreads as the measure of country risk (Longstaff et al. 2011: 76), and found the same positive association of stock price volatility and CDS spread. However, Norden and Weber (2009: 529) found the comovement between CDS and stock market was negatively associated, and they reported that a positive stock return leads to negative CDS spread changes by using 2000-2002 data.

The VIX index[26], the Chicago Board Options Exchange (CBOE) volatility index, is used to measure the volatility and uncertainty of the market, and it is one of the widely used barometers of investor fear. Giot (2005: 92) showed that VIX index and stock return are negatively related. Cai et al. (2009: 2026) showed that if two countries experienced higher stock market volatility, the correlation with emerging countries increases. However, Min and Hwang (2012: 2072), Kim, Kim, and Lee (2015: 207), and Cai et al. (2016: 3789) found that VIX index had a significant positive effect on the conditional correlation, which is consistent with Cai et al. (2009: 2027). It implies that uncertainty in one stock market will spread to the US and vice versa.

The TED spread is defined as the difference between the three-month LIBOR and the yield on the US Treasury bills with same maturity. It can measure the level of financial stress in the interbank market. Brunnermeier and Pedersen (2008: 2228) pointed out that TED spread can provide a useful basis for gauging the severity of a liquidity crisis. Kim, Kim, and Lee (2015: 200) employed TED spread as a measure of liquidity availability. Min and Hwang (2012: 2072) and Cai et al. (2016: 3800) found an increase in TED spread decreases the conditional correlation.

Besides the common factors that were added in the DCCX-GARCH, there are some other financial variables considered as possible determinants of the conditional correlation. For instance, Cai et al. (2016: 3791) added foreign investment to measure the financial interdependence of local stock markets. The conclusion is that foreign investment did not impact on the conditional correlations significantly between two countries.

Min and Hwang (2012: 2071) also add relative stock market capitalization as exogenous variables as the measure of financial interdependence from the US. Min and Hwang (2012: 2071) concluded that a higher level of relative capitalization of the market decreases the conditional correlation for OECD countries, and this finding is

[26] From kim&KIM (2011). The VIX index is a volatility index implied by the current prices of options on the S&P 500 index. It represents expected future stock market volatility over the next 30 days.

consisting with Johnson and Soenen (2003: 87). It is logical result, because the high capitalization of the market means the bigger market will be less independent on the U.S stock market, and therefore their correlation will decrease.

In addition, the Libor-overnight index swap (OIS) spread was also selected by Kim, Kim, and Lee (2015: 200) as possible variables that determine conditional correlations of the asset return besides Sovereign CDS premium, the VIX index, the TED spread, the Libor-overnight index swap (OIS) spread, and the market capitalization.

Therefore, in our analysis by using a DCCX-GARCH model, we employ CDS spread, VIX index, and TED spread as the common financial indicators and marker barometer as the exogenous variables to simultaneously estimate DCC over time, that can be identified as the financial channel of contagion and as the possible determinants of the dynamic conditional correlation in the stock market.

7.2.2. Fundamental Determinants Literature Review

Leung et al. (2017) applied a GARCH model from two aspects, namely, the macroeconomic fundamental contagion and pure contagion to analyze the determinants of financial contagion in crises. In their study, interest rates, trade balance and inflation were the factors for fundamental contagion, and liquidity and information asymmetry were the factors to impact on the pure contagion.

Chen et al. (1986) applied a discounted cash flow model and concluded that economic variables including changes in the interest rate, inflation rates, and industrial production influenced the stock prices and market returns and therefore the correlation among countries. However, market portfolio and aggregate consumption were not significantly impacted on the stock market, neither the oil price risk.

Schwert (1989) showed stock market volatility changing by time and there were a variety of economic indicators related to this time varied change. The macroeconomic factors are trade-balance, which include import and export, inflation rate, and interest rate, and which are related variables of stock market volatility.

Leung et al. (2017: 169) distinguish financial contagion as fundamental-based and pure contagion channels. They include interest rate, trade balance, and inflation as the possible fundamental determinants. In addition, they investigated the liquidity and information asymmetry for the pure contagion channels.

Luchtenbery and Vu (2015: 202) applied a logistic regression model using the contagion as the dummy dependent variables, and the ratio of trade, export, import, inflation, interest rate, market capitalization, industrial production, volatility of stock market and region variables as the exogenous variables, to investigate the determinants of financial contagion. They found that economic factors contributed to the correlation changing as the fundamental channel of the contagion, namely trade structure, interest rate, inflation rates, and industrial production. In addition, they also tested pure contagion and found empirical evidence that investors' risk aversion and regional effects were attribute determinants of the correlation relations.

7.2.3. Indicators, Macroeconomic Fundamentals

We run a panel regression model using the possible indicators to investigate whether the existence of contagion effects are attributed to these indicators. They are trade balance, that consists of import and export two variables, interest rate, inflation rate, and industrial production as the fundamental macroeconomic factor impacting the changing of the correlation among countries from the theoretical and empirical aspects.

1. Trade-balance

There are rich empirical literatures on the factors driving contagion among cross-countries, and bilateral trade and financial relationships as the particularly important one as the transmission channel for several types of economic crises. Especially as seen in during the 1980s to 2010s, for instance, Kaminsky and Reinhart (2000: 161-2)

Hernandez and Valdes (2001: 1), De Gregorio and Valdes (2001: 289), Kali and Reyes (2010: 1072), and Forbes (2012).

Forbes and Rigoben (2002: 2229) explained the mechanism of how international trade impacts on the correlation among countries. A crisis in one country devalues its currency and that raises the competitiveness of its goods, potentially causing a decline in other countries' competitiveness, therefore impacting on sales and output. If the loss continues and is severe enough, it influences the exchange rate or causesa currency speculation problem, and then impacts on asset pricing and the correlation among countries.

Dornbusch, Park, and Claessens (2000: 180) confirmed this mechanism and pointed out that the trade balance and exchange rate impact on each other, and during the financial crisis the source crisis country's currency experiences sharp depreciation that impacts on other trading partners, assets price sharply declines and capital outflows get bigger.

Therefore, in our study, we include import and export as the trade balance variables to investigate whether trade is a transmission channel of the financial contagion.

2. Inflation rate

The main mechanism for inflation rate being added is as factors that determine the correlation, due to asset pricing theory. The inflation rate impacts on the correlation by influencing the stock price, and then the return of asset. There is a variety of literature studies about the asset pricing model.

Chen et al. (1986: 383) pointed out that they expected inflation, through changing cash flows and thereby the nominal interest rate, then impacts on the changing of price-level of the asset. It causes a systematic effect and then extends the price changing alone with general inflation. Additionally, changes in the average inflation rate are associated with change of the asset valuation.

There are related studies like Leung et al. (2017: 170-171), Mollah et al. (2016: 163), Luchtenberg and Vu (2015: 183) which also use inflation as one of the determinant factors of financial contagion. As mentioned before, we expect the diverging inflation rate has a negative relationship with the dynamic conditional correlation as Luchtenberg and Vu (2015: 185) pointed out that diverging economic fundamentals cause less co-movement in stock returns between countries.

3. Interest rate

Interest rate as the asset return was observed to have very high volatility during the crisis period. It is also one of the necessary and important factors in the asset pricing model. There are many researches which investigate the importance of interest rate as the factor impacting on asset return and correlation among countries.

Forbes and Rigoben (1999) explained the fundamental mechanism of the interest rate and how it attributes on the asset return and causes co-movement among countries. They state that rises in the international interest rate contract the international capital supply and lower international demand simultaneously in a number of countries. The aggregate shock will lead many countries' stock market co-movement in some degree, thereby directly increasing correlations between affected stock markets in different countries.

Many previous studies examined the contagion or spillover effects of financial contagion by including interest rate as an exogenous variable. For instance: Leung et al. (2017), Luchtenbery and Vu (2015: 183), Mollah et al. (2016).

4. Industrial production

Industrial production is an important economic indicator about capacity utilization, which covers the main sectors for production and includes manufacturing, mining, and gas and electric utilities. It is as one of the barometers of economic structure changes.

The mechanism of industrial production to the conditional correlation is that it implies inflation from the industrial level first. If the cost of raw materials and commodities increases, that is represented in the increasing of the industrial production level, then it is passed on to the consumer in the final product. Then the whole economy understands the situation of the economy and follows each other.

Therefore, we believe that industrial production is one of the determinants of the dynamic conditional correlation, the same as Luchtenbery and Vu, (2015: 185-6). It affects co-movement between countries, especially from the turning point, when the economy goes either up or down.

7.3. Data And Preliminary Testing

7.3.1. Data And Preliminary Test For Dynamic Conditional Correlation

In terms of the DCCX-GARCH model, it is the extension of the DCC-GARCH model, and we use the same data as in the previous chapter for the stock market index and to calculate return. Additionally, we add VIX, TED, and CDS daily data for all as the exogenous variables to the DCCX-GARCH model.

The data for the stock market is daily stock indices from January 3, 2000 to 29 July 2016, for the equity markets of the 15 emerging markets and the U.S. stock markets. In line with other studies about contagion of financial crisis, such as Baele et al. (2004), Cappiello et al. (2006: 16), Chiang &Jeon and Li (2007: 1209), Syllignakis and Kouretas (2011: 721), Harkmann (2014: 58), and Kim, Kim, and Lee (2015: 196), stock market indices are a sensitive measure variable and can capture changes in the market relatively quickly, and therefore we can use it to study contagion in financial markets.

The data in this paper were daily stock-price indices from January 3, 2000 to July 29, 2016, for the 15 selected emerging countries' equity markets and the U.S. S&P 500 stock market index. The data set consisted of the national stock indices of Brazil (BOVESPA), China (SSEC), Colombia (A.IGBC), Hungary (BUX), India(BSESN), Indonesia (JKSE), Malaysia (KLSE), Mexico (IPC), Peru (SPBLPGPT), Poland (WIG), the Philippines (PSI), South Africa (FTSE), Thailand (SETI) and Turkey (XU100) index, and the US (S&P 500 index). All the national stock-price indices are in local currency and based on daily closing prices in each national market. The source of all data is DataStream International.

For the econometrics analysis, the daily asset returns are calculated as the first difference of the natural log of each stock-price index, multiplied by 100. That is, $r_{i,t} = (\ln(p_{i,t})/\ln(p_{i,t-1})) * 100$, where $p_{i,t}$is the stock price level in country i at time t. Missing observations because of a holiday, bank holidayor other reasons were replaced with the last available trading day closing price on the market. The database applied is 5 days a week to avoid bias created by too much replacement and generation of unnecessary data.

The dynamic conditional correlation is based on the calculated DCC from the previous chapter's DCC-GARCH results. See the descriptive analysis in Table 6.2. Therefore, in our t-test and dynamic conditional correlation analysis part we use the DCC results.

The exogenous variables in this study includes sovereign CDS premium, VIX index, and TED spreads as the potential determinants of conditional correlation and financial contagion channel. The 5-Year CDS spread and the TED spread we collected from the Bloombergand DataStream Thomas Reuters, and the VIX index[27] from the Federal Reserve Bank of St. Louis.

[27]Chicago Board Options Exchange, CBOE Volatility Index: VIX [VIXCLS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/VIXCLS, December 22, 2018.

7.3.2. Data And Preliminary Analysis –Financial Channels DCCX-GARCH

Because the DCCX-GRACH model is the extension of the DCC-GARCH, the stock indices and returns are the same as in the previous chapter. Here, we only mention the exogenous variables. The exogenous variables in this study include high frequency daily date for sovereign CDS premium, VIX index, and TED spreads as the potential determinants of conditional correlation and financial contagion channel.

VIX and Volatility of the Cboe Volatility Index can measure the "fear gauge" of the market, and it is based on real-time prices of options on the S&P 500 Index (SPX). It can reflect investors' consensus view of future (30-day) expected stock market volatility. Therefore, VIX is widely used by many studies as the equity market barometer. It provides information to the investor about risk management and taking efficient allocation strategies to leverage volatility and benefit from diversification of their portfolio.

The daily TED spread is defined as the difference of the 3 Month LIBOR and the 3 Month Treasury bill rate. TED spread is the measure of perceived credit risk in the U.S. economy. LIBOR is the measure of the interbank lending rate, therefore, an increasing TED spread difference between LIBOR and T-bill rate indicates an accelerating lack of trust between banks and a corresponding tightening of credit for all other counterparties. For some countries, the 3 Month Treasure bill rate is not available, therefore, we use the Interbank 3M rate or deposit 3M rate to calculate the TED spread rate.

There is one data limitation for TED data, as for some countries TED data is not available, and therefore we use the general TED instead of the special country TED. Those countries include Brazil, Colombia, Poland, the Philippines, Mexico, and South Africa.

We collect monthly data for CPI and calculate the inflation rate. The industrial production and interest rate data are from Datastream and Financial Statistics (IMF-IFS). Monthly country trade data export and import are collected from IMF-IFS.

Table 7.1: Descriptive Statistics Of The Exogenous Variables, CDS Spread, VIX Index And TED Spread Daily Data From 2000- 2016.

	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Obs.
CDS_BR	368.0891	174.3025	3951.5	61.5	518.3701	3.8349	19.7936	53286.54	3752
CDS_CHA	68.99197	69.995	276.298	10	45.5310	1.1032	4.7739	1080.335	3235
CDS_COL	215.0688	154.269	862.5	65.825	144.1804	1.7399	5.9236	3003.679	3490
CDS_HG	218.6691	183.24	744.02	11	162.4497	0.6650	2.7712	229.0183	3018
CDS_INDIA	181.9178	164.78	320.9	137.53	43.7382	1.6800	4.6999	430.7044	729
CDS_INSIA	211.5658	178.714	1248.35	92.262	124.0103	3.5086	17.7781	28971.17	2598
CDS_MA	95.05666	89.0495	491.591	12.348	59.7046	0.9857	4.9552	1146.736	3570
CDS_ME	133.1791	115.262	601.206	28.167	75.0955	1.8456	7.3683	5122.84	3759
CDS_PERU	166.8741	137.665	605.833	59.659	88.2973	2.0195	7.3641	4872.228	3307
CDS_PH	229.3319	171.53	824.775	78.505	142.5800	1.0035	2.7667	574.2212	3376
CDS_PO	95.46695	78.2	417.7	6.8	76.3285	1.1714	4.2156	874.5343	3013
CDS_RU	268.9878	198.25	1113.375	36.875	218.6958	1.6715	5.3216	2798.897	4055
CDS_SA	162.2056	164.814	663.334	24.57	84.5456	1.0110	5.5346	1765.242	4030
CDS_TH	104.3093	105.3	524.2	21	55.9305	1.2222	6.8064	2608.185	3059
CDS_TR	346.3214	240.339	1416.875	110.946	263.2937	1.7630	5.2093	2918.735	4046
VIX	20.55978	18.475	80.86	9.89	8.7546	2.0952	9.9289	11392.45	4170
TED_CHA	3.710427	3.8804	6.4611	1.2044	1.2498	-0.2157	2.1545	96.1161	2560
TED_HG	7.132136	7.36	15.08	0.93	3.0945	-0.3043	2.3309	147.4315	4325
TED_IND	7.040312	6.375	12.5	4.5781	1.9689	0.6060	2.2332	145.2766	1695
TED_INSIA	9.422015	8.1425	17.99249	4.19	3.5139	0.8613	2.7688	544.4031	4325
TED_MA	3.141683	3.15	3.92	2.045	0.4236	-0.4987	3.1065	181.3067	4325
TED_PE	4.580815	4.86	7.97	1.49	1.3026	-0.3269	3.2177	70.1673	3546
TED_RU	8.782924	6.99	23.845	3.885	3.9851	0.9405	3.1398	618.6839	4174
TED_TH	2.285103	2.21	3.575	0.39	0.6524	0.1429	1.9122	86.69685	1645
TED_TR	39.43083	38.5	52	32	4.5030	1.9159	6.2578	217.1202	206
TEDRATE	0.445183	0.29	4.58	0.09	0.4365	3.5446	20.7666	62006.43	4067

Note : The Jarque-Bera values are all statistically significantly at 1% significant level.

7.4. Methodology And Process

The aim of this study is to investigate the channels and determinants of the dynamic conditional correlation from financial and fundamental aspects by applying different models and methods to different frequency data. We employ a DCCX-GARCH model to the daily data by adding VIX, TED spread, and CDS spread as the exogenous variables. In addition, the multivariate panel data analysis is applied based on the monthly data. Four macroeconomic variables, namely international trade, interest rate, inflation rate and industrial production are added as the independent variables. In order to finalize the GFC impact, we add two dummy variables for global crisis and the post-crisis period as the independent variables.

The process is as follows; because contagion study is very sensitive with the separation of the time periods, each of our models and analysis compares different crisis periods. Therefore, to identify the financial crisis the sample selection is very important. We apply a Chow-test to the stock market index and the conditional variances to confirm the period selections are statistically significant in the structural break points.

7.4.1. Identifying The Crisis Period And Subsamples --Chow-Test

7.4.1.1. The Importance Of Identifying The Financial Crisis Periods

According to the definition of contagion, to identify the contagion effect is to compare the correlation between pre-crisis and crisis periods, where an increasing correlation shows there is contagion. That is why how we identify the period becomes a necessary and important issue.

Mun and Brook (2012) pointed out that to understand the chronology of events of the GFC is an important issue for contagion studies. Therefore, from the previous studies of contagion, many of them identified the period informally by important economic or financial events to determine the start and end date of a crisis and its duration, such as Forbes and Rigobon (2002: 2238-9), Corsetti et al. (2005: 1178), and Bekaert et al. (2005)

However, Pesaran and Pick (2007) pointed out that sample selection bias may have happened and mislead the contagion results because of separating the crisis and non-crisis periods. Therefore, many studies applied a formal statistical test to confirm the structural break and correct the subsample selection, for instance Luchtenbery and Vu (2015: 183).

In our study we combine these two methods together, due to the differences of the emerging stock markets; we select a wider range by year and divide the entire time period January 2000 to July 2016 into three subsamples. Then we apply a formal statistical test to confirm the separation of the sub-periods makes sense and is realizable.

7.4.1.2. Chow-Test Process And Methodology

Based on the different sub-samples, we apply a Chow-test on stock index, condition variance, and the dynamic conditional correlation to investigate our subsamples periods are characterized by a structural break in the entire selected time period. The idea of a Chow-test is to examine whether two sets of observations belong to the same regression or with different subsamples as the individual regression.

The GFC originated in the U.S stock market, therefore we apply U.S. stock market data to check the estimated break dates and to test the periods we applied in this study. We first test the U.S. S&P 500 stock index because it is the market observable date to make investment decisions.

However, because the stock market is the time series data, the price of the return is non-stationary, and violated the Chow-test requirement. In order to define the volatility breakpoint, we apply a Chow-test to the conditional variance of the U.S S&P 500 stock return to identify the date we selected and sub-crisis periods.

In addition, the multiple breakpoint tests of the Chow-test is applied to find the possible break date by a formal test to all dynamic conditional correlations to get an idea of when the crisis happened. We run the Chow-test between each sequenced combinational of subsamples, divide the entire time period from 2000 – 2016 into three subsamples, namely 2000- 2006, 2007-2009 and 2010-2016, and then investigate between each two samples and define whether there is a structural break or not.

Therefore, according to our Chow-test result as in the below Table 7.2, we can confirm that the way we divided data into three sub-periods cannot be rejected, and thud the result can be more realizable. To apply this formal test we can statistically confirm our dividing subsamples is statistically significant and make sense.

The Chow-test Statistics are below and when we apply an F-test to test the null hypothesis there is no structural break.

$$F = \frac{(RSS_c - (RSS_1 + RSS_2))/(k+1)}{(RSS_1 + RSS_2)/(n_1 + n_2 - 2(k+1)}$$

where RSS denotes the sum of the squared residuals and the subscripts is the total sample and subsamples.

7.4.2. DCCX-GARCH Methodology

Based on the DCC-model, the DCCX estimates correlation by incorporating exogenous variables into the conditional variance. Then it simultaneously investigates how the exogenous variables dynamically impact on the conditional correlation.

$$h_{12,t} = \rho(X_t)\sqrt{h_{11,t}h_{22,t}} \qquad (1)$$

$$\rho(X_t) = 2\left[\frac{\exp(\gamma' X_t)}{1+\exp(\gamma' X_t)}\right] - 1 \quad (2)$$

Where -1< $\rho(X_t)$ <1 is a monotonic increasing function of X_t, a k x 1 vector of the economic fundamental variables that may affect the magnitude of the conditional correlations. Therefore, DCCX can be used as the tool to examine the possible propagation channels of the co-movement in the stock markets.

With reference to Kim, Kim, and Lee (2015: 199-200), Min and Hwang (2012: 2070-2071), and Cai et al. (2016: 3793) we also use the equation (2) parameterization for the conditional correlation function. Where $X_t = [x_1, x_2, ..., x_k, DM_1, DM_2]^{'}$, while $\gamma = [\gamma_{0,}\gamma_1, ..., \gamma_{k+2}]^{'}$ is a vector of the coefficient of X_t on the conditional correlation. We use sovereign CDS premium, VIX Index and TED spread as exogenous variables, as these are supposed to have an influence on the conditional correlation base in the theoretical and empirical literature.

As we mentioned before, the chronology of events and separation of the periods are a very important issue in contagion studies. In this study, due to the CDS available and following Min and Hwang (2012) and Cai et al. (2016), we apply a DCCX-GARCH model from 1st September 2006 to 29th July, 2016, and add two more dummy variables to represent different crisis periods to avoid too much missing data of the CDS. DM_1 is the first stage from 15th September 2008 to 14th September 2009, and DM_2 is from 15thSeptember 2009 to 31st December 2011. Before DM1 is the pre-crisis period, after DM2 is the post-crisis period.

Therefore, in this study, from the significance and the sign of γ_k, we can see how the different exogenous variables impact on the conditional correlation by the DCCX-GARHC model.

7.4.3. Panel Data Analysis Methodology And Process

We will apply panel data analysis to investigate the fundamental determinants of conditional correlation. Panel data analysis was implemented in this research study since it is a useful methodology which eliminates problems related to multicollinearity as well as an estimation bias to a certain extent. Also, the time-variant relationship between independent and dependent variables is specified by the panel data analysis (Baltagi, 2001).

The procedure for the panel data is as follows. Firstly, method selection, and we run a different test to choose the most suitable regression from Pooled OLS, fixed-effect or Random effect regression. Secondly, residual diagonals for autocorrelation and heteroskedasticity are employed.

F- test is applied to determine which method performed best to chose between fixed-effect and pooled OLS. In the next stage of the analysis, the Breusche and Pagan Lagrange multiplier test (LM test) is employed to decide whether the Random effect model or the pooled OLS model is appropriate for the study. In addition, the fixed-effects model and the random-effects model are compared by using Hausman's test. The proposed model is given as:

$$\rho_{i,US,t} = \alpha_0 + \alpha_1 \rho_{1,US,t-1} + \beta_1 \lg\_ D\mathrm{Im}_t + \beta_2 \lg\_ DEx_{i,t} + \beta_3 DInt_{i,t} + \beta_4 D\inf_{i,t} + \beta_5 Dip_{i,t} + \gamma_1 dm1 + \gamma_2 dm2 + \varepsilon_t$$

$\rho_{i,US,t}$ is pair-wise dynamic conditional correlation coefficient between the US stock market and the selected emerging stock markets, and the lag is determined by Akaike Information Criterion (AIC).After the lag selection, we put lag 1 for the panel data. Most of the emerging stock markets have one lag[28]. Dm_1 (2007-2009) and dm_2 (2010-2011) are dummy variables for the financial crisis period and post-crisis period. lg_DIm represents the logarithm of the import difference between the US and the selected emerging countries, lg_DEx is the logarithm of the export difference between the US and EMs, d_int is the difference of the interest rate between the US and the selected EMs, d_Inf is the difference of the inflation rate between the US and the selected EMs, and d_ip[29] is the difference in industrial production between the US and the selected emerging economies.

The pair-wise dynamic conditional correlation (DCCs) is based on the DCC-GARCH results, and we converted the daily data to monthly data. Additionally,

[28] The AIC suggested India (2), Indonesia (4), Mexico (3), the Philippines (2) and Turkey (3).
[29] We did not take the logarithm because the negative difference creates much missing data.

variables that include monthly data of import, export, interest rate and inflation rate are from International Financial Statistics (IFS), and the industrial production data is collected from Thomas Reuters DataStream.

The significance of the coefficient $\beta_i, i = 1,2,...,5$ will show the contribution from those variables to the conditional correlations. We expect them to be statistically significant. The coefficients of dummy variables show how the crisis impacted on the conditional correlation.

As before, we want to study how the GFC and post-crisis period impact on the dynamic conditional correlation. Therefore, we also run our panel analysis with two dummy variables. The crisis dummy (dum1) is the crisis period from January 2007 to December 2009, and post-crisis dummy (dum2) is from January 2010 to December 2011.

7.5. Empirical Results

7.5.1. From The Chow –Test Result To Time-Period Dividing

Table 7.2: Chow- Test Results For U.S. S&P 500 Index And Conational Variance Of Return

test Statistics of the conditional variance of the U.S. stock return			
Period	time	S&P 500 Index	Conditional Variance of return
Crisis	2007-2009	2.3109***	7.2446***
Post- crisis	2010-2016	2.7566***	0.1130***

*Note: *10%, **5%, and ***1% significant level. Chow-test is for structural breaks for time series. The result of the Chow-test confirms the structural break for the selected subsamples statistically.*

7.5.2. Empirical Analysis For DCCX Model To Identify The Financial Channels Of The Contagion Effects

After identifying the contagion effect from the U.S. stock market to the selected emerging markets, we extend the study to finding the channels of the transmission mechanisms of the contagion. In this study, we employ the extension DCC-GARCH model by adding exogenous variables called the DCCX-GARHC model, as proposed by Min and Hwang (2012: 2070-2071). It can estimate both conditional correlation and effects of the explanatory variables simultaneously in one framework.

In the previous chapter we reported the DCC-GARCH model result and the dynamic conditional correlations. In this chapter we applied the DCCX- GARCH model byadding dummy variables into the main and variance equations of the DCCs to investigate the volatility of the conditional correlation. Here, we only report the DCCX-GARCH model result for the coefficient of the exogenous to identify the contagion channel from CDS spread, TED spread and VIX index of different periods that are represented in the dummy's coefficient.

Table 7.3 illustrates the estimation results for DCCX models. Firstly, increase TED spread negatively impacted on the conditional correlation for China and Russia. The negative correlation is consistent with Min and Hwang (2012: 2071-2072). However, the rise of TED led to a higher conditional correlation significantly for Brazil, Hungary, Indonesia, Peru, South Africa, and Turkey. This finding is consistent with Kim, Kim, and Lee, (2015: 206-8).

Increase in TED implies a tighter and worsening situation for liquidity because of the fear of shocks. Therefore, for the Chinese and Russian stock markets, when the liquidity decreased the dynamic conditional correlation with the U.S. stock market also decreased. Oppositely, in terms of the other positive significant correlation, when the TED increased the liquidity decreased, and the dynamic conditional correlation with the U.S. market also increased. Both results are reasonable.

Secondly, as we expected VIX index had significant positive impact on the conditional correlation, except in Turkey. It indicates that the volatility and uncertainty from the U.S. stock market spread to these countries' stock markets. The higher VIX index increases the conditional correlation. This result is consistent with Kim, Kim, and Lee (2015: 207-9), Min and Hwang (2012: 2071-2072), and Cai et al. (2016: 3801).

In terms of the CDS spread, Brazil, Peru, Russia and Turkey are positively significant, that means an increase in the CDS increases the dynamic conditional correlation. This is consistent with the finding from Bystorm (2005), Kim, Kim and Lee (2015: 207-9), Min and Hwang (2012: 2071-2072), and Cai et al. (2016: 3801). It reveals an increase in stock price volatility has a positive correlation with the CDS spread. In other words, increase of the CDS shows that the volatility of the stock price is increasing, which then leads to return's volatilities rising too, therefore the correlation increases. Oppositely, it is negatively significant for Thailand, which means decrease of the CDS of Thailand leads to higher volatility of the correlations. However, for the other selected stock markets, the CDs are not significant.

In terms of the crisis period and post-crisis period factors, for the crisis period dummy variables were positively significant for China, Indonesia, Malaysia, Mexico, Peru, Poland, Russia and South Africa. It reveals that the crisis period essentially increased the dynamic conditional correlation for these stock markets. Interestingly, it is negatively significant for Hungary, and we know from the DCC result that Hungary is highly associated with the U.S. stock market. The crisis dummy variable was not significant for Brazil, Colombia or Turkey.

The post-crisis dummy variable for Brazil is not a surprising result.. Hungary, Malaysia, Mexico, Poland, and Russia in the post-crisis period negatively related to the dynamic conditional correlation. During the post-crisis period the dynamic conditional correlations decreased compared to the crisis period.

However, Colombia and Turkey's dummy variables are not significant, which means the dynamic conditional correlation was not impacted significantly by the crisis and post-crisis. It may because Colombia and Turkey had high correlation with the U.S stock market, thus during the crisis they had co-movement with the U.S. market but did not show big changes.

In sum, we applied the model extension version of the DCCX-GARHC by adding an exogenous variable of financial market indicators into the calculation of conditional variances. It allows simultaneous estimation of the conditional correlation coefficients and identifies the financial channels of the contagion effects. Due to this, it can provide evidence of the determinants of the conditional correlation changing over time.

The DCCX-GARCH results indicated that increasing the volatility (VIX) of the stock market will increase the dynamic conditional correlation. Increase of the CDS also implied stock price volatilities rising, that is why it also increased the DCC for almost all stock markets. Only the TED spread showed both positive and negative association with the DCC. For most of the stock markets, the two dummy variables which represent the crisis and post-crisis period were significant. Especially during the crisis period, the dynamic conditional correlations were increasing.

7.5.3. Fundamental Contagion Channels –Panel Data Analysis Results

For the panel data analysis, the first step is to select a suitable model. The F-test provides information to determine whether the pooled OLS model or the fixed effects model is suitable to employ. The results implied that (11.10; $p<.01$) the fixed effects model was appropriate to use rather than the pooled OLS model.

In addition, the LM (Breusch and Pagan Lagrangian multiplier test for random effects) indicated which model to choose between a random effects regression or a simple OLS regression. According to the LM test result (0.00, $p>0.10$), the simple OLS regression model was superior to the random effect model.

After finding the superior of the Pooled OLS of the fixed and random effect, the last step was to decide the more suitable model between random effect model or fixed effect model by applying Hausman's test. The Hasamans's statistics (180.66; $p<0.01$)

revealed that the fixed effects model was the more suitable model compared to the random-effects model.

Therefore, after running the necessary tests, the pooled OLS and fixed effect model were superior to the random effect from Breush and Pagan Lagrangian multiplier test (LM test) and Hausman's test result, respectively. Moreover, the fixed model is better than the OLS model from the F-test. Therefore, the results of the fixed effect model were taken into consideration for further discussion about the implications of the study.

Furthermore, since the OLS model is better than the random effect for our study and for some correlation between the U.S. and the selected stock markets which have more than one lag, we also apply the Pooled OLS test to investigate how those factors influenced the stock markets' conditional correlations.

After selection of the appropriate model we needed to diagnose the residuals for the autocorrelation and heteroskedasticity problem. Firstly, for autocorrelation, we apply a simple test proposed by Wooldridge (2002), instead of the likelihood-ration test, since an iterated GLS does not produce maximum likelihood.

Our panel data had an autocorrelation issue according to the indicated Wooldridge test (without dummy model (434.616; $p<0.01$); with dummy model (493.923; $p<0.01$)).For autocorrelation, the p- value is less than 0.01, rejecting the null hypothesis that there was no serial autocorrelation and which indicated the presence of a serial correlation.

Secondly, for the heteroskedasticity issue, a desirable result came out with the model including dummy variables. There is no heteroskedasticity issue in our panel data with dummy variables, which does not influence the OLS results. A likelihood ratio test for heteroskedasticity was employed. According to the revealed test results (-2055.21, $P>0.10$), we cannot reject the null hypothesis (homoskedasticity), indicating that there was no heteroskedasticity issue.

If we do not include the dummy variable, generally the model shows within a long time period what the determinants of the conditional correlation are. The heteroskedasticity result (2064.83, $p<0.01$) showed that the null hypothesis (homoskedasticity) could be rejected, and that it may influence the OLS result. To resolve the issue of heteroskedasticity, cluster-robust variance and covariance estimators were employed (Wooldridge, 2010). The robust fixed effects model is given in Table 7.4.

From the adjusted R square, the independent variables explained to a high level the variation in the dependent variables. For OLS the adjust R square was more than 96% for both with the dummy and without dummy models, and for the fixed effect model both the degree of explanation was more than 84%. That confirmed our model and our results are good.

According to the FE_dum (fixed effect dummy) model results, lg_dex (lag difference of export) (β=.022; p<.10) was found to have a significant positive effect on DCC. As well, d_ip (difference of industrial production) had a negative significant effect on the dependent variable (β=-.00013; p<.10). In addition, the same fixed effect results indicated that there was a negative significant effect between d_inf (difference of inflation rate) and DCC (β=-0.0019; p<.05). Finally, dum1 and dum2 (GFC crisis and post-crisis periods) had a strong statistically significant positive impact on DCC (γ_1=.011 andγ_2= .013; p <.01). However, there was not any statistical significance between lg_dim and d_int (difference of import and difference of interest rate) and DCC.

As we expected, the dynamic conditional correlation (DCC) between the U.S. stock market and other selected markets were impacted by the difference from the U.S. and the selected countries' exports, which implies that international trade. In addition, both robust-FE indicate that the interest rate had a statistically significant impact on the DCC as well, which is consistent with many previous studies (Chen et al., 1986: 383; Schwert, 1989: 1133; Leung et al.,2017: 173; Luchtenbery and Vu, 2015: 198). However, the interest rate is not significant in the FE_dum model.

This result implies that in international trade especially the export value from the U.S. to the selected countries is an important determinant of the dynamic conditional correlation.

Industrial production, as we expected, also had a significant impact on the dynamic conditional correlation. Industrial production represents how big a country's economy is, and as we expected when a country different to the U.S. is getting smaller, namely, the more similar the size of the country's economy, the more the conditional correlation increases. This implies closer relationships between big and similar economies in the co-movement.

In addition, the Federal Reserve watches industrial production closely because the industrial sector is the fundamental factor that influences raw materials price and the future inflation rate. If the price is going up, then the cost of production rises, and that finally impacts on the final products and so to individual consumers. Therefore, industrial production is the indicator that shows the volatility during a business cycle turning point in terms of the nominal output. Our result confirmed this, that industrial production can be a barometer for the markets, and it is the determinant of the dynamic conditional correlation.

Finally, as we expected, during the crisis-period and post-crisis period, the correlation was impacted by the GFC, which also confirmed the contagion as before, moreover the herding phenomenon too.

In terms of the interest rate, it negatively and significantly impacted on the DCCs in both the FE-robust models. It shows that when the interest rate difference from the US to the other selected economies increased, the DCC decreased. That shows when the DCC is high, the interest rates are closer to each other, so the benefit of diversification decreases. It also implies that during the crisis time, because of being highly correlated with each market and the contagion effect, there is no diversification profit. In addition, it suggests that during the non-crisis period, the DCC is lower, and the difference of the interest rate is getting bigger, and that is a benefit for investors to diversify their assets.

7.6. Results

In this chapter, we used two different methods and made a comprehensive study about the contagion effect channels and determinants of the dynamic conditional correlation from financial and fundamental perspectives.

We applied the DCCX-GARCH model proposed by Min and Hwang (2012: 2070-2071), an extension from DCC-GARCH by adding exogenous variables VIX, TED spread, and CDS spread into the calculation of conditional variances, to analyze simultaneously how these financial indicators impact on the changing of the dynamic conditional correlation. It can provide evidence of the determinants of the conditional correlation changing over time. The DCCX-GARCH model confirmed the financial channels for different countries.

In sum, the DCCX-GARCH results indicated that increasing the volatility (VIX) of the stock market increases the dynamic conditional correlation. An increase of the CDS also implied the stock price volatilities were rising, that is why it also increased the DCC for almost all stock markets. Only the TED spread showed both a positive and negative association with the DCC. For most of the stock markets, the two dummy variables which represented crisis and post-crisis periods were significant. Especially during the crisis period, the dynamic conditional correlations were increasing.

In terms of the fundamental determinants, we applied a panel data analysis to investigate international trade, inflation, interest rate, and industrial production to determine the dynamic conditional correlation. The fixed effect model is superior to the pooled OLS and random effect model. The result confirmed that exports, inflation, and industrial production are the determinants of the dynamic conditional correlation and play an important role in it. From the robust fixed effect model, we can also conclude that the interest rate is an essential factor that also affects DCCs.

Moreover, with each method we added two dummy variables, one present in the GFC and another one in the post-crisis period, to figure out whether the financial shocks affected the correlation. The statistics' significant results confirmed the crisis and post-crisis impact on the dynamic conditional correlation for most of the emerging stock markets.

This chapter's findings are significant and useful for the policy market and investors. By looking at the financial indicators and important macroeconomic indicators, they can adjust asset allocation and prevent potential losses. Moreover, our comprehensive study from both financial and fundamental aspects fills the gap in the contagion channel literature. There are very few studies about an empirical analysis of the contagion channel, especially the fundamental channels. Furthermore, we have contributed to the contagion studies by establishing a relationship between DCC and fundamental determinants and financial factors.

There are of course some limitations to this study. Firstly, during the analysis, some data was not available for the entire period, hence there is missing data problem in the study. Secondly, due to the data availability problem, the DCCX-GARCH model are not convergent in STATA 14 for India and the Philippines. Therefore, we could not find the financial channels for these two stock markets.

Thirdly, the potential factors that we added in this study depend on the previous studies and literature, and there may be other important determinants we did not include. Also because of the data availability, we considered market capitalization and turnover, but could not find data for all the selected emerging stock markets. Fourthly, the panel data had an autocorrelation problem that we ignored in this study. Fifthly, because we covered a long-time period, the dividing of the sub-sample period is artificial although significant by Chow-test. More sensitive or other methods could refine the time selection.

In future study, many other methods can be applied by adding more potential determinant factors for the dynamic conditional correlation. The time division can be more refined and accurate, as just stated. More importantly, according to each channel and determinant, appropriate suggestions can be proposed to minimize the impact of the crisis and loss.

Table 7.3: DCCX- GARHC Result For Financial Channels Of The Contagion Effect

DCCX	Brazil	China	Colombia	Hungary	Indonesia	Malaysia	Mexico	Peru	Poland	Russia	S.A.	Thailand	Turkey
cons	-0.1124	-0.1214	-5.7041	-1.2638***	-2.7771***	-2.5081***	-1.0151***	-2.0837***	-0.8265***	-0.0744	-1.0828***	-2.0556***	-5.0326***
	(0.2249	0.4211	6.2678	0.3177	0.5563	0.2662	0.1764	0.3068	0.1748	0.3318	0.2163	0.4043	0.5931
ted	0.0384*	-0.0969*	0.3827	0.1001***	0.1206***	0.0561	0.179	0.1885***	-0.1765	-0.0335**	0.3265***	0.0075	0.3247***
	0.0221	0.0557	0.3385	0.0232	0.0375	0.0451	0.1093	0.0419	0.1172	0.0163	0.1011	0.1479	0.1181
vix	0.0490***	0.0225**	0.0985***	0.0588***	0.0500***	0.0398***	0.0485***	0.0242***	0.0562***	0.0398***	0.0446***	0.0873***	0.0033
	0.0047	0.0115	0.0261	0.007	0.0167	0.0101	95024	0.0082	0.0082	0.0062	0.0058	0.0171	0.0069
cds	0.0002**	-0.0027	-0.0072	-0.0002	-0.0004	0.001	-0.0008	0.0015**	-0.0005	0.0012***	0	-0.0051***	0.9924***
	0.0001	0.0024	0.0047	0.0003	12527	0.0017	-0.0008	0.0007	0.0008	0.0004	0.0005	0.0018	0.0996
DM1	-0.1069	1.1243***	2.4659	-0.2959*	0.6495***	0.5722***	0.2903**	0.9459***	0.5066***	0.6678***	0.1977*	-0.062	0.1693
	0.1014	0.2678	5.798	0.1519	0.1897	0.1473	0.1135	0.1525	0.1123	0.1295	0.1059	0.2703	0.1389
DM2	-0.6241***	-0.0377	0.1443	-1.2638***	0.2008	-0.4872**	-0.3924***	0.7197***	-0.3735***	-0.3770***	-0.0601	-0.0661	0.112
	0.1012	0.2083	5.3042	0.3177	0.2222	0.1987	0.1274	0.1832	0.1175	0.1339	0.1052	0.182	0.1488
log-likelihood	-8666.433	-5936.504	-7361.334	-6580.43	-6239.538	-5870.3	-6886.645	-6756.045	-5944.256	-10361.29	-5979.554	-6077.079	-9828.37

*Note: 1.The numbers in the parentheses are SEs. *, ** and *** is the significance level 10%, 5% and 1%, respectively. X_0 is the constant, X_1 is TED spread, X_2 is the VIX volatility, X_3 is the CDS. 3. India and the Philippines DCCX-GARCH is not convergent in Stata 14.*

Table 7.4: Estimated Coefficients From The Panel Data Analysis, From 1999M12 To 2016 M07

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	OLS	AREG	FE	robust_FE	RE	OLS_dum	AREG_dum	FE_dum	robust_FE_dum	RE_dum
ldcc	0.97***	0.88***	0.88***	0.88***	0.97***	0.96***	0.86***	0.86***	0.86***	0.96***
	(199.31)	(100.86)	(100.86)	(55.23)	(199.31)	(192.83)	(93.25)	(93.25)	(44.69)	(192.83)
lg_dex	0.0077	0.020*	0.020*	0.020	0.0077	0.0076	0.022*	0.022*	0.022*	0.0076
	(0.95)	(1.71)	(1.71)	(1.60)	(0.95)	(0.94)	(1.96)	(1.96)	(1.83)	(0.94)
lg_dim	0.010	-0.0031	-0.0031	-0.0031	0.010	0.0078	-0.0074	-0.0074	-0.0074	0.0078
	(0.75)	(-0.21)	(-0.21)	(-0.24)	(0.75)	(0.58)	(-0.50)	(-0.50)	(-0.59)	(0.58)
d_ip	0.000057	-0.00021**	-0.00021**	-0.00021*	0.000057	0.000076*	-0.00013*	-0.00013*	-0.00013	0.000076*
	(1.35)	(-2.56)	(-2.56)	(-2.00)	(1.35)	(1.77)	(-1.65)	(-1.65)	(-1.70)	(1.77)
d_inf	-0.0024***	-0.0018***	-0.0018***	-0.0018***	-0.0024***	-0.0026***	-0.0019***	-0.0019***	-0.0019**	-0.0026***
	(-5.21)	(-2.58)	(-2.58)	(-3.04)	(-5.21)	(-5.55)	(-2.65)	(-2.65)	(-2.87)	(-5.55)
d_int	-0.000049	-0.00012	-0.00012	-0.00012*	-0.000049	-0.000059	-0.00014	-0.00014	-0.00014**	-0.000059
	(-0.56)	(-0.85)	(-0.85)	(-1.92)	(-0.56)	(-0.68)	(-0.99)	(-0.99)	(-2.43)	(-0.68)
dum1						0.0055**	0.011***	0.011***	0.011***	0.0055**
						(2.52)	(5.11)	(5.11)	(3.77)	(2.52)
dum2						0.0062**	0.013***	0.013***	0.013***	0.0062**
						(2.32)	(4.81)	(4.81)	(3.15)	(2.32)
_cons	-0.080*	-0.046	-0.046	-0.046	-0.080*	-0.070	-0.036	-0.036	-0.036	-0.070
	(-1.81)	(-0.88)	(-0.88)	(-0.87)	(-1.81)	(-1.56)	(-0.69)	(-0.69)	(-0.62)	(-1.56)
N	2413	2413	2413	2413	2413	2413	2413	2413	2413	2413
R^2	0.96	0.96	0.84	0.84		0.96	0.96	0.84	0.84	
adj. R^2	0.960	0.962	0.839	0.840		0.960	0.963	0.841	0.842	
F-test			8.93***					11.10***		
LM-test			0.00					0.00		

Hausman's test	130.65***	180.66***
Heteroskedasticity test	2064.83***	-2055.21
Autocorrelation test	434.616***	432.923***

t statistics in parentheses; * $p< 0.10$, ** $p< 0.05$, *** $p< 0.10$

CONCLUSION

In this thesis, we tried to investigate how the recent GFC impacted on the 15 commonly accepted emerging economies and their stock markets. They are Brazil, China, Colombia, Hungary, India, Indonesia, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand, and Turkey. We identified the financial contagion effects of the recent GFC from the U.S. stock markets to the selected 15 emerging stock markets by a different methodology and from various aspects. Furthermore, our study found out the determinants of the dynamic conditional correlation from the financial channel and fundamental channel, two perspectives to fill the gap in the financial channel studies.

The study covers a long period from 3/1/2000 to 7/29/2016, enabling us to divide the entire period into three sub-sample periods according to the crisis period, namely, pre-crisis, crisis, and post-crisis periods. In terms of investigating the existence of financial contagion; we use daily data of the 16 stock market indices and the daily returns. In order to examine the financial contagion channels, we add VIX, sovereign CDS spread, and TED spread daily data as the exogenous variables. In addition, to find out the fundamental determinants of the dynamic conditional correlation, we added export, import, inflation rate, interest rate, and industrial production monthly data as the independent variables.

A variety of methods were applied in this study. Firstly, to identify the financial contagion effect we employed co-integration, VAR, Granger Causality, and impulse response methods from the long and short perspectives to investigate the financial contagion between stock markets. We found a significant result and confirmed contagion effects from the GFC for most of the stock markets in the short-term. However, there is no long-term relationship between them. In sum, we found there is no long-term correlation among the stock markets, but there is short-term causality correlation both in uni-direction and bi-directions among the stock markets. In addition, the impulse response result confirmed the impact from the U.S. stock market to most of the selected emerging stock markets within 2-3 days.

Second, the multivariate DCC-GARCH model (Engle, 2002) was employed to examine the contagion effect between the US and selected emerging stock markets. Additionally, the formal t-test was applied to identify the contagion. Furthermore, we used the GARCH (1,1) model by adding dummy variables, in order to find out how the financial crisis impacted on the dynamic conditional correlation.

The main empirical findings are that there was a statistically significant increase of dynamic conditional correlations between U.S equity markets and all 15 selected emerging stock markets during the crisis period rather than in the pre-crisis period that confirmed the financial contagion effect from the U.S to the all selected emerging stock markets.

In addition, there is a geographical concentration to the financial contagion and integration for the selected emerging stock markets. The European emerging stock markets are much more associated with the U.S. stock market than the Asian emerging stock markets. According to the DCCs analysis, we furthermore classified the 15 EMs into four groups. Moreover, the financial contagion is more persistent, and there is a herding phenomenon of the GFC among the selected emerging stock markets.

Another main object was to investigate the financial channels and find out the determinants of the dynamic conditional correlation. We did a comprehensive study about the financial channels and filled the gapsin the literature. From two aspects, financial and fundamental, we applied the DCCX-GARCH model and Panel data analysis based on the datasets and frequency data. The DCCX-GARCH model allows simultaneous estimation of the conditional correlation coefficients and determinants over time and is suitable to identify channels of the financial contagion. Panel data regression is suitable for the fundamental determinants and established relations between dynamic conditional correlation with fundamental factors.

The summarized finding is that, in terms of financial channels, the DCCX-GARCH results indicated that increasing the volatility (VIX) of the stock market would increase the dynamic conditional correlation. An increase of the CDS also increased DCCs because of the stock price volatilities rising CDS increased. Only the TED spread show both a positive and negative association with the DCC. In addition, crisis and post-crisis period had a significant impact on the DCCs for most of the stock markets, especially during the crisis period when the DCCs were increasing.

Moreover, the panel data analysis result reveals the fundamental determinants of DCC. Firstly, we found the increase of export difference from the U.S. to the selected emerging markets increased the dynamic conditional correlation. That confirmed that trade-linkage are an important fundamental channel for contagion. Secondly, increasing the difference of industrial production decreases the DCCs, which implied the size of economics is an essential factor in determining the correlation. The more similar the economic scale, the higher the co-movement and correlation between them.

Thirdly, we found increased difference in the inflation rate negatively influences the dynamic conditional correlation. This implied that if the price volatilities are similar then the changing of stock return is at a high level of co-movement, which causes a higher conditional correlation. Finally, we also added two dummy variables that represent the crisis and post-crisis period and which are both positively and significantly associated with DCC. It confirmed the DCCs increased during the crisis period and post-crisis period, when contagion and herding behavior existed.

In sum, this study found strong evidence of the GFC contagion effect from the U.S. stock market to the 15 selected emerging stock markets by different methods. Moreover, it found that VIX, TED spread and CDS were the critical financial channels of the contagion, and export level, inflation rate, interest rate, and industrial production were the essential fundamental determinants of the dynamic conditional correlation.

One of the main contributions is to fill the gap for the financial contagion channel studies. Though there are rich researches in identifying financial contagion, there are few about detecting the financial channels. Our study was from two perspectives, financial and fundamental, and did a comprehensive study. We applied different methods to the various frequency data to investigate the determinants of the dynamic conditional correlation between the US and selected emerging stock markets. We established a relationship between dynamic conditional correlation and fundamental financial and economic indicators.

In addition, we also reviewed the selected emerging economies and their stock markets based on the framework established in this study. We examined the impacts of the GFC on the economies and stock markets of the selected emerging markets.

These research results are significant for policymakers and investors. The contagion result is useful for risk measurement, asset diversification, asset pricing, portfolio allocation and decision making of policy-makers, investors, and portfolio managers. Recognizing the importance of the dynamic conditional correlation between international financial markets provides valuable lessons for international investors and governments in making their investment decisions and in assessing the risks of financial institutions.

Due to to our findings implying that the financial markets of emerging countries are sensitive and vulnerable to external shocks, policymakers can identify the contagion channels and realize the signs of a potential crisis.

All together our results will contribute to the stability of the financial system.

There are also limitations due to data availability issues and many other reasons.

- Data availability and missing data (eg. capitalization and turnover)
- Due to the data availability problem, the DCCX-GARCH models are not convergent in STATA 14 for India and the Philippines.

- The potential factors that we added in this study depend on the previous studies and literature, so there may have been other important determinants we could not include.
- The panel data had an autocorrelation problem for each model, but we ignored it in this study.
- Time dividing is an issue - because we cover a longtime period, the dividing of the sub-sample period is artificial, although significant by Chow-test. A sensitive test or other ways can refine the time selection.
- There are many other methodologies and new technologies to detect contagion. We cannot apply them all.

In future studies, other methods can be applied by adding potentially more important determining factors for the dynamic conditional correlation. The time divisions can be more refined and accurate. More importantly, according to each channel and determinant, the appropriate suggestion can be proposed to minimize the impact from the crisis. Comparisons among methodologies can also be done.

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Computer Graphics Certificate, Capital Normal University, Beijing, 9/04 - 7/06

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Eurasian Universities Union (EURAS) central office in Istanbul Aydin University, specialist

Responsible for EURAS Academic Journal, organized EURIE (Eurasian Higher Education Summit), invited Chinese higher education institutes and universities to participate EURIE annual summit, and organized conferences. 02/19 - present

Istanbul Aydin University, China Study Center, Coordinator

Liaised with Chinese Consulate and Embassy, organized activities, responsible for academic and cooperation works with Chinese universities and institutions, managed and planned China study center activities, produced newsletter, communicated with students' students, organized and participated summer school with universities in China. 02/16-02/19

Istanbul Aydin University, Lecturer in Business Administrative Department

Taught Mathematics for Business and Doing business in China for Bachelor student, Istanbul, 09/2015 - present

Istanbul Aydin University, Chinese Language Teacher

Taught Chinese Language to university students, Istanbul, 09/14 - present

Istanbul Aydin University Department of International Student Recruitment, International Student Advisor

Recruit new International students, organize and participate International Exhibition, plan and organize student's activities, contact Chinese universities about International program. Istanbul, 12/13 - present

Fatih University Economics Department, Project Research Assistant

Project: "The Productivity of Agricultural Products and Efficiency of Agricultural Subsidies: A Comparison of EU Countries with Turkey". Search materials, write literature review part, data analyze with econometrics methodology and output analyze. Istanbul, 08/13 - 02/14

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Project: "Economy of Turkey-EU Convergence of key macroeconomic indicators: Time Series Analysis Project Duration". Collect and analyze data, write part of the project report, apply Endnote program to make reference list and help the dean of the Faculty of Economics and Business Administration to do some research work. Istanbul, 03/13 - 09/13

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Project: "Competitive Position of Istanbul in the Global Financial Centers" and "Panel Data Analysis of Tourism Demand for Turkey". Collect and analyze data, write part of the project report, apply Endnote program to make reference list and help the dean of the Faculty of Economics and Business Administration to do some research work. Istanbul, 08/11 - 02/13

Abu Dhabi Chinese School, School Coordinator and Teacher Supervisor

Liaised with Chinese Embassy, organized curriculum, supervised Chinese School teachers, managed and planned school activities, produced school newsletter, communicated with students' parents. Abu Dhabi, 4/09 - 7/10

Abu Dhabi Chinese School, School Coordinator and Chinese Language Teacher

Taught Chinese Language to grade one, and coordinated Chinese team teachers, Abu Dhabi, 9/08 - 8/09

Sheikh __Palace, Private Tutor for 5 year old Sheikh Rashid

Taught Chinese language to Sheik Rashid, Abu Dhabi, 9/08 - 6/10

Beijing Fang Cao Di International School, Math Teacher, Class Teacher and Class Counselor

Taught math, organized school and class activities, managed daily lessons, China, 7/07 - 7/08

XueEr Si Olympic Mathematics School, Part - time Olympic Mathematics Teacher

Taught Olympic mathematics to fourth grade, developed math booklets for grade one, Beijing, 11/06 - 6/08

Additional Qualifications:

HSK Test Center in Confucius Institute at Bogazici University, Director of the HSK Examination A- Level Certificate, 12/2015.

Turkish Language Teaching Application and Research Center, Turkish Language Qualification Certificate, A1, 9/2011.

Beijing Education Council, Teacher’s Qualification Certificate, 6/2007.

Beijing Personnel Department, Computer Applications Technology Certificate, 9/2007.

Ministry of Higher Education, China College English Test-Band Four Certificate, 3/ 2005.

Beijing Education Council Department of Language and Literacy community, Mandarin Qualification Certificate, One-Level Grade B, 11/2005.

Chinese Language Council International, Qualification certificate about teachers of Chinese to Speakers of Other language, 8/2009.

Capital Normal University, Computer Graphics certificate，7/ 2007.

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Yearly Capital Normal University Scholarships, 2004 - 2006.
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