

U.S. MONETARY POLICY SPILLOVERS ON BRICS COUNTRIES

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บทคัดย่อและแฟ้มข้อมูลฉบับเต็มของวิทยานิพนธ์ตั้งแต่ปีการศึกษา 2554 ที่ให้บริการในคลังปัญญาจุฬาฯ (CUIR)
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การลั่นไหลของนโยบายการเงินของประเทศสหรัฐอเมริกาต่อประเทศในกลุ่ม BRICS



วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต

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งานวิจัยฉบับนี้ได้ศึกษาผลกระทบของนโยบายการเงินของประเทศสหรัฐอเมริกาต่อประเทศในกลุ่ม BRICS ในช่วงทศวรรษ เริ่มตั้งแต่ช่วงเดือนเมษายน พ.ศ. 2548 ถึงเดือนกุมภาพันธ์ พ.ศ. 2559 ในการศึกษาได้มีการใช้การเปลี่ยนแปลงของทรัพย์สินทางบัญชีของธนาคารกลางของประเทศสหรัฐอเมริกาเป็นตัวแทนของนโยบายทางการเงินของทางประเทศสหรัฐอเมริกา จากการศึกษาโดยรวมพบว่านโยบายทางการเงินของประเทศสหรัฐอเมริกามีผลการทบต่อดัชนีผลผลิตออกเบี่ยนโยบาย อัตราแลกเปลี่ยน ดอลลาร์การค้า และ อัตราดอกเบี้ยพันธบัตรรัฐบาลของกลุ่มประเทศ BRICS แต่ไม่พบผลกระทบต่ออัตราเงินเฟ้ออย่างมีนัยยะสำคัญ จากการศึกษาระดับความสัมพันธ์ของนโยบายการเงินของประเทศสหรัฐอเมริกาต่อตัวแปรทางเศรษฐกิจประเทศปลายทางพบว่าผลกระทบมีความแตกต่างในแต่ละประเทศ นอกจากนี้จากการศึกษาพบว่าช่องทางการค้าเป็นสื่อส่งผ่านผลกระทบของนโยบายการเงินของประเทศสหรัฐอเมริกาต่อประเทศในกลุ่ม BRICS

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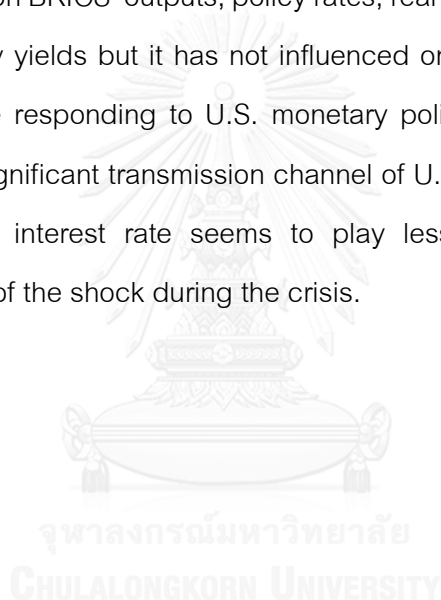
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This study examines the spill over effects of U.S. monetary policy on BRICS economies during the current decade starting from May 2005 to February 2016. The study uses the VAR model for data analysis and the change in Federal Reserve balance sheet as the proxy of the U.S. monetary actions. The overall results show that U.S. monetary policy has influenced on BRICS' outputs, policy rates, real effective exchange rates, trade balances and treasury yields but it has not influenced on inflation. The extent to which BRICS macro-variable responding to U.S. monetary policy varies across countries. In addition, Trade is a significant transmission channel of U.S. monetary policy spill over to BRICS outputs while interest rate seems to play less significant role due to the transmission channel of the shock during the crisis.



Department: Banking and Finance Student's Signature

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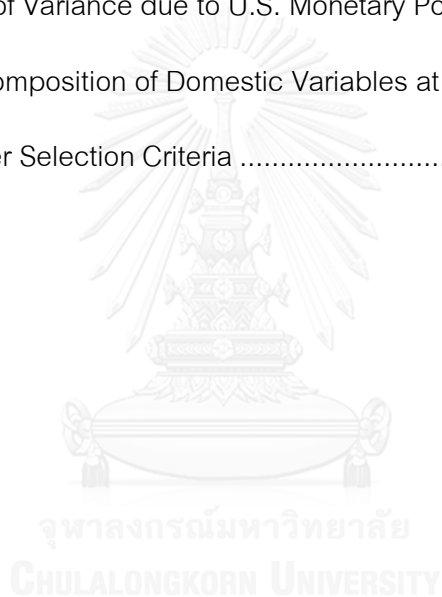
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Chapter I

Introduction

After September 2009, the failure of Lehman Brother put U.S. under severe financial failure and led to the financial crisis around the world. This event threatened the collapse of international financial systems which largely based on trust. To prevent the economy from long lasting recession, the Federal Reserve reduced the Federal Reserve rate to the lowest possible bound. However, this crisis was too big and too complex, even the conventional monetary policy would not be enough, to bring the U.S. out of recession. So Fed had to resort to more unconventional method by adopting series of unconventional monetary policies by expanding its balance sheet to restore the functioning of financial markets and institutions. During that time, Fed both directly imported bad assets from financial institutions to prevent them from bankruptcy and inject liquidity into the scarce financial market by purchasing large scale of mortgage back securities and treasury bonds. In addition, Fed put more effort fighting the crisis through the expectation channel, un-constraining its conventional tool, by providing information and committing the future path of interest rate in order to provide further monetary policy accommodation at the zero lower bound. All of these unconventional policies were clearly related, as they both ultimately aim at boost economy and reach stability but relied on different instruments¹

From the discussion above, there is reason to believe that the significant implementation of Fed monetary policies would affect the other countries based on the following explanations.

¹ Liquidity Provision and Forward Guidance

1.1 Hyper-Globalization

In era of Hyper-globalization, there is evidence that world economic integration has become more intensified although, there is less co-movement in core CPIs across countries and more likely to move along with the underlying economic conditions (Carney, 2015). This reflects that central banks still be able to control their domestic destiny and still be independent. However, after the 2008 world financial crisis, the correlations of headline CPI across countries keep increasing which imply that the central banks are more likely dependent. This evidence indicates that highly synchronizing of the global rate cycle which amplifies the influence of the global factors on domestic environment cannot be avoided and needs to be more concerned by policy makers (Carney, 2015).

In addition, the global economic integration also lead to the decreasing of central bank's independent. In this era, the cross country economic linkages have increased through the commodity price, trade channel, and financial channel. Nowadays, it is common knowledge that the commodities' price shock is an important determinant of the global inflation landscape²³. Through the trade channel, the Information Communication Technology (ICT) revolution has made an intense unbundling of production chains, increased competition oversea and shifted in the 'supply chain trade'. All of these create the imported cost pressures and change the mark up over cost which might lead to the change domestic price level and decreases effectiveness of domestic monetary policy⁴. Through the global financial channel, less capital control allows investors to seek for more efficient opportunity for either cheaper money or higher return when the advanced economic country loses its financial conditions. The globally-active bank play major role to encourage cross- border lending which lead to currency appreciation in

² See also, Gregorio et al. (2008) and Carney 2015

³ Energy and food prices contribute around 3% to the global inflation spike at the onset of the crisis and are currently account for approximately 0.5% of global inflation.

⁴ Change in price level affect the national Phillips curve. For instance, it decreases the effectiveness of monetary policy as the central bank cannot control the inflation and it can lead to the change in domestic unemployment rate.

the recipient countries of the capital inflow. These evidences of increase in the intensity of global economic linkages lead to the further studies that there are spillover effects from one country to another's and linkages between the monetary policy actions across countries. Furthermore, under this circumstance, there is a possibility that one country's monetary policy actions (easing or tightening) could affect the other countries' economies in different degrees.

1.2 Spillover Effect

Existing studies define the effect of one country's monetary policy on another country as 'the spillover effect of monetary policy'. Although this topic has been studied by many researchers, intensity of global financial cycle and the use of unconventional monetary policy in U.S. in large scale have again shed the light on this topic. According to Rey (2015), there is evidence that the global financial cycles can amplify changes to the monetary policy transmission mechanism through liquidity and credit creation and destruction. Thus, the global financial cycle is one of the influential factors that motivate the re-study on these areas. Moreover, the enormous use of U.S. unconventional monetary policy during the subprime crisis 2008 brings this topic under spotlight that, under intensity of economic integration, to what degree and to which directions, this implementation of U.S. monetary policy both in and out will affect the other economies.

In the discussion about monetary spillover, the monetary policy action of the Central⁵ is believed to affect the economy of Periphery⁶ through three broad channels which are the trade channel, the capital channel, and the expectation channel. For the trade channel, the implementation of monetary policy will affect the exchange rate and then affect the demand of import and export of home countries on foreign markets which can lead to the change in foreign output. For the capital channel, if the home country is the

⁵ Central refers to the large economy whose central bank's actions can affect the others economies.

⁶ Periphery refers to the economy which is affected by those actions.

large open economy like U.S. and the world capital market is integrated to some extent, the change in home country interest can affect the world real interest rate and then affect the world aggregate demand for current goods, including foreign current goods. As a result, foreign output may grow. In addition, the interest rate difference between markets might cause shifts in money from central to periphery and those inflows can lead to economic booms in recipient countries. Besides trade and capital channels that have been examined broadly, there are other possible channels of monetary policy spillover such as the expectation channel. Market participants can form expectations based on the effectiveness of the policies in different directions⁷, which lead to unexpected demand in some particular assets and then affect the assets' price.

1.3 Trilemma

Recently the evolutions in financial integration have led to the unavoidable financial openness. Both advanced and emerging economies have increasingly opened their boarder to the international financial flow. It is the important concern for the policy makers that the international capital flow might lead to gaining welfare or doing harm to the recipient countries. Based on the international economic theory named 'Trilemma', or 'The Impossible Trinity', in the financial integrated world, if there are free capital flows, the only possible way for the countries to have monetary independency is to adopt the float exchange rate regime. Whereas, the fixed exchange rate will export the monetary policy of the center economy to periphery. However, Rey (2015) argued that with the deeper financial integration, external financial development influenced capital flows, credit growth, and bank leverage which weaken 'Trilemma', where countries with both float and non-float exchange rate regime could be affected by the monetary policy conditions set in the main world financing centers. In the other words, in the hyper-

⁷ For example when Central Bank uses the unconventional tool such as QE, one investor may positively perceive that the economy will recover soon, while another investor may take this action as the signal of abnormal policy intervention which implies that economy is in bad situation.

globalization environment, there is a possibility of international monetary policy spillover from central economy to periphery regardless of exchange rate regime.

1.4 Problems and Statement

It is important to study spillover effect of monetary policy by Central country to periphery countries which are small open economies, since the monetary policy shocks in a central economy could have negative effects on periphery. Therefore the understanding about international monetary spillover would allow the central bank to create the proper policy to react this effects. The effect could spill in many forms, such as actual capital flow or the fluctuation in exchange rate with potentially large impact on economic activity, inflation, and financial stability including variation in exchange rate, assets prices and credit volumes. Under the intense global economic integration through the trade and financial markets, it seems to be impossible for countries to insulate from the influence of the international monetary spillover if the countries have to participate in global market like the saying that 'one cannot avoid to be wet if they want to swim'. Therefore, the main issue seems to be the extent of external linkages and the degree of spillovers rather than the ability to completely shield the economy from them. There are evidences that U.S. monetary policies have spillover effects on both advanced and emerging markets across regions such as in Europe⁸, Latin American⁹ and Asia¹⁰. Apart from separations of regions, there are two broad categories of research in this area which is likely to separate the examination of effect on macro economy¹¹ or on the financial market¹².

⁸ See also, Lenza et al. (2011) and Peersman (2011)

⁹ See also, Reinhart et al. (1993), Canova (2005), and Kandil (2009)

¹⁰ See also, Hong and Wei (2009) and Sato et al. (2011)

¹¹ See also, Kim (2001), Maćkowiak (2007), Sato et al. (2011)

¹² See also, Ehrmann and Fratzscher (2006), Valente (2009)

1.5 Studies in The Past

It has been found that monetary policy in the U.S. has been empirically shown to be central in driving a global financial cycle (Rey, 2015). The issue of how the small open economy is effected by monetary policy of a large economy has been investigated in the past literatures, for example Mackowiak (2007) using the VAR methodology to investigate the role of external shock originated from U.S. on macroeconomic fluctuations in emerging economies. It was found that the external shock from U.S. accounted for large variation in exchange rate and price level, output and short term interest rate. Along the similar lines, Canova (2005) investigated whether and how shocks originated in U.S. were transmitted to Latin American countries by using the VAR methodology. It was found that U.S. monetary shock led to a significant response in the macroeconomic variables of Latin American countries. In addition, Sato et al (2011) found that U.S. shock was an important source of fluctuations in the real output of some South Asian countries. In addition, there are some research evidences, showing that the price level and real output in some emerging markets response to U.S. monetary policy shock by larger than the variables of U.S. itself (e.g. Maćkowiak (2007) and Chen et al. (2015)).

Key determinants

In addition, there are analyses about key determinants of spillover effect magnitude and direction. Based on the past studies, exchange rate regime, financial linkage, and trade openness are the factors that determine the magnitude in response to the shock.

Whereas the nature of product (complement or substitute) could be the factor which determines the direction of the effects. For the exchange rate regime, the trade balance and real effective exchange rate of countries with non-floating exchange rate regime responded more to interest rate shocks from U.S. while there was less significant interest rate responding to those with floating exchange rate regime (Canova, 2005). For the degree of global integration of a country, equity markets in countries which higher degree of global integration, high trade openness and holding large magnitude of cross

boarder financial assets, reacted two to three times more strongly to U.S. monetary policy shocks than those with less integrated countries (Ehrmann & Fratzscher, 2006). For the nature of product, the direction of spillover could be determined by whether the home and foreign goods were substituted or complemented for consumers in home country. When the goods were substituted, monetary expansion of home country would worsen trade balance of foreign countries as home country product became cheaper, and then import demands from foreign countries in terms of foreign output would decrease. When the goods were complemented, the monetary expansion would benefit the foreign countries as the imported input price was decreased, leading to a decrease in price level and increase in output (Haberis & Lipinska, 2015).

Unconventional monetary policies

Unconventional monetary policies were largely implemented after the world financial crisis 2008. Unconventional monetary policy has been implemented first in 1999 by the central bank of Japan (BOJ) and followed by the U.S. Central bank, the Federal Reserve in 2008, the European central bank and the Bank of England in 2009. As a result, after the crisis, there were increases in number of studies focusing on the effect of unconventional monetary policy. However, the evidences which are available so far are mainly focused on the financial market impact, since the high frequency financial data allows for the study in short period. Overall, the past studies found that the unconventional monetary policy had significant effect on financial market, particularly on risk spread or yield in financial market¹³. There are also literatures which examined the effect on macro-variables, but due to the data limitation, those studies are considered to be less in relative to the studies of impact on financial market.

¹³ The studies about the impact of unconventional monetary policy shock on long term interest rate and asset price (e.g. Hamilton and Wu (2011), Neely (2010), Joyce et al. (2011)) and The studies about the impact of U.S. unconventional monetary policy shock on the money market, and foreign exchange market (e.g. Christensen et al. (2009)). Overall, these studies found the significant effect of the unconventional monetary policy shock on bond yield.

There are variety of the policy indicators used in the past studies, such as the 10-years government bond yield, the spread between 10-years government bond yield and 3 month or short term interest rate, the size of central bank asset, and the monetary base. However, due to the zero lower bound and the substantial implementation of unconventional policies, the change in the Federal Reserve Balance Sheet is used as U.S. monetary policy measure in this study so that it can reflect both conventional and unconventional monetary actions. For example, the Last Scale of Asset Purchase program (LSAPs)¹⁴, the Term Asset Backed Securities Loan Facilities program (TALF)¹⁵, and other special private credits which are unconventional policy programs affecting the size of FED balance sheet as well as the Open Market Operation and the Required Reserve from Commercial banks which are conventional policy tools. The study period represents the current decade information.

1.6 Monetary Autonomy, Monetary Independence, and Financial Contagion.

There was a study in the past which defined three notions of external linkages which are the Monetary Autonomy, the Monetary Independence and the Financial Contagion. Firstly, Monetary Autonomy refers to the ability of central bank to achieve the desired targets regardless the reason behind those targets. Secondly, Monetary Independence refers to the extent that the setting monetary policy and the monetary condition are influenced by the external environment as the central bank observes the external development and creates the trade-off policy which reacts to the shocks and/or achieves its goal. Thirdly, financial contagion refers to the situation that domestic condition is driven by the shifts in global risk preference regardless of the central bank action and fundamental changes (Disyatat and Rungcharoenkitkul (2015)).

¹⁴ Also known as 'Quantitative Easing or (QE)'. It is the series of large scale purchases in U.S. mortgage back securities and U.S. Government securities.

¹⁵ Is the program that the Federal Reserve provide credit to asset-backed securities with original auto-loans, credit card loans together with the purchase of mortgage back security and long term government treasury.

In the globally integrated environment, it is necessary that the policymakers have to consider the external impacts such as central country's monetary policy, and then react their policies to achieve the goal. In the other word, Central bank accept the fact that their monetary policy is no longer purely independent but still be able to reach the Monetary Autonomy .So, this study will focus on the degree of monetary independent. Moreover, In order to take into account of the effect of financial contagion on the outcomes, the VIX index will be included in the model.

1.7 Research Question

There are arguments which claim that the conduct of the QE not only results in large amount of liquidity flowing into the US financial markets but also leaks to other economies due to economic integration. The change in conduct of U.S. monetary policy is coinciding with large scale of capital inflow to the emerging markets. The studies of spillover on another country have been done in two aspects which are spillover on macroeconomic and financial market. The countries that originate the effect are normally the United State, the United Kingdom, and Japan

Central Country

This study has carefully selected the sample countries that can give clear and broad picture of the impacts, this study has drawn the selection based on the following discussion. For the Central economy, it should be area that Central Bank implements the divergent and significant monetary policies and it must have the financial condition which is loose enough for the effects to spill out. Focusing on the earliest world subprime crisis 2008, the Federal Reserve actions are outstanding among other central banks. It is the first central bank which adopts the unconventional monetary policy during the 2008 world financial crisis. Since the crisis originated in U.S., Fed has adopted many dramatically significant and divergent policies such as lowering its policy rate to the zero lower bound, directly injecting large amount of liquidity to the economy through the Quantitative Easing programs, or trying to shape market expectation by

using the forward guidance to handle the crisis and to stabilize the economy after the sign of recovery. Therefore, in this paper, I will focus on the action of the Federal Reserve as the spillover effect creator.

Capital Control Conditions

In the scope of capital flows, there is international macroeconomics and finance framework called 'Impossible trinity', which also known as the 'Trilemma'. In Trilemma states that there are three conditions in international financial framework that cannot coexist, otherwise the system will collapse. It is impossible to have free capital mobility, fixed exchange rates, and independent monetary policy at the same time. In this study, there must be free capital flow condition in peripheries because there must be economic integration environment between Central and peripheries which is a key determinant of monetary policy spillover channels. It is important to note that the more lack of economic or financial integration is, the less channels for the spillover have. For example, Myanmar is also an emerging country but due to lack of financial facilities, there are not many international investments over there. Therefore, even there is spill out of QE from U.S, there is very low possibility that we will see this inflow to Myanmar.

Periphery Countries

According to the belief that the growth in the emerging markets during that period is caused by the capital inflow, it is interesting to see whether the use of unconventional monetary policy in the U.S. has contributed to this emerging market of macro-economic fluctuations. There are evidences on previous studies that Fed's QE generally leads to the currency appreciation, rising in equity price and decreasing in government bond yield of the emerging markets¹⁶. Based on announcements, the effects are peak during QE1 while the impact of QE2 seems to be comparatively lower to the other two rounds (Chua et al., 2013). The peak announcement effect during QE1 is not surprising since it

¹⁶ See for example, Gagnon et al. (2010), Neely (2010), and Chua et al. 2013

has the financial turmoil at that time so the market responses are stronger. Lower impact during QE2 can be partially explained by the emerging markets' prepared intervention during that period.

For this study, BRICS as a group of five major emerging markets is selected as the peripheral. BRICS countries meet the criteria as they have high potential growth. Moreover, they are able to attract the flow of fund and have economic integration with U.S. and with the global economy through both trade and financial channels. In addition, not only included in G20, as a group, BRICS has been considered as one of the powerful economic community that has a significant influence on world economies. According to the large and fast growing history, Goldman Sachs predicted that BRICS could be larger than G6 in U.S. dollars term in the future. Apart from those reasons, in the period of crisis, BRICS seems to have more economic stability than the European and other emerging areas. Moreover, as a group of high potential growth economy opened their borders to financial flows, BRICS as a country is diversified in terms of exchange rate regime and monetary policy regime which are the key determinants of spillover magnitude. This diversification allows the study to examine the influence of monetary policy and exchange rate regime on spillover effect. If the country employs inflation target, no or less significant response is expected while the trade balance and real effective exchange rate of the country with non-float exchange rate regime is expected to respond more to the shock in relative to those with floating exchange rate regime (Canova, 2005). Also, this diversification increases the robustness of the study as it allows them to check all possible effects on different market conditions. The following table shows the monetary policy regime and the exchange rate regimes according to the de facto arrangements, as analyzed by the IMF staff in 2014.

Table 1 IMF De Facto Arrangement Exchange Regime

Country	Exchange Rate Regime	Category of Exchange Rate Regime	Monetary Policy Regime
United State	Free Floating	Floating Regime	Inflation Targeting
Brazil	Floating	Floating Regime	Inflation Targeting
China	Crawl like Arrangement	Soft Pegs	
India	Floating	Floating Regime	
Russia	Other Managed Arrangement	Residual	
South Africa	Floating	Floating Regime	Inflation Targeting

Source: summaries from IMF and Hammond (2012)

In summary, this research paper studies the monetary policy spillover effect from US as Central economy on the macro-variables, a group of advanced and largest emerging economies or BRICS including Brazil, India, Russia, China, and South Africa. This study focuses on the effect of U.S. monetary policy shock on BRICS macro-variables such as output, price level, interest rate, exchange rate, trade balance, and treasury yield. In addition, this paper examines the possible monetary policy endogeneity of the monetary policy between the two areas. To examine more updated situations, the study includes data over the current decade from April 2005 to February 2016, using the Vector Auto Regressive Model (VAR), as the study tool. The following are the main research questions.

- I. Do US monetary policy actions affect macroeconomic variables in BRIC countries?
- II. Are trade and interest rate the channels for such transmission?
- III. To what extent do US monetary policy actions affect macroeconomic variables in BRIC countries?

1.8 Contribution

This study expects to contribute to the understanding of U.S. Monetary Policy Spillover on BRICS countries during the current decade. The focus of this study is on the period that U.S. employ Unconventional Monetary Policy for long period, therefore the effect should be more pronounced than the normal period. This study will benefit both the monetary authorities and the portfolio investors.

For the authorities, the understanding about the transmission channels would increase the understanding about transmission mechanisms of the spillover effects which allow the policy makers to prepare the counteract policies to handle those effects on the right channel. While the effect on the macro variables especially on the output and inflation reflects the seriousness of the external monetary risk that could not be overlook and need a good counter actions.

For the portfolio investors, the understanding about the international monetary policy spillover would indicate important aspect of the external effects from cross countries correlations that could affect the portfolio risk diversification. In addition, they will have additional factor to form expectations on BRICS monetary policy actions due to the better knowledge about monetary policy linkage across countries.

These studies will be ordered as follows; Section II presents the review on the topics related to the monetary spillover. Section III discusses about the data and research methodology. Section IV discusses about the finding of this study. Section IV shows summary of the research.

Chapter II

Literature Review

Many previous studies in the spillover effect of monetary policy, 'the effect of monetary policy action of the central economy on the periphery counties' was focused on normal economic situation. In general circumstance, central banks are likely to use the conventional instruments such as policy rate, or open market operation as the conventional instruments to shape the economy. Once there is economic fluctuation, the central bank will manipulate its tools into the size and direction to stabilize its own economy. However, the effects of these policy implementations leak to other countries, peripheries, bringing either fortune or uncertainty to their economies. In academic term, we call the situation that one country's monetary policy action affects the other country's economy as the effect of the monetary policy. There are many studies about the spillover effect of the use of conventional monetary policy tools. During the crisis, the use of conventional tools became insufficient to control the situation. There was an implementation of un-common used monetary policy tools, known as the unconventional monetary policy tools. When the policy rate, the most common and effective tools were lower to the last scale at zero lower bound, many large central banks adopted the new scope of instruments which was known as unconventional tools to fight with the crisis. The unconventional central bank action is the Large Scale of Asset Purchase (LSAPs) campaign on financial products such as the mortgage back securities or the Treasury bond. Like the uses of conventional tools, there are also signs of spillover effect of unconventional policy action across countries.

2.1. Theory and Past Empirical Study

2.1.1 Related Theoretical Framework

- **Impossible trinity:** is the theory about monetary policy independence, also known as the international macroeconomics and finance framework called 'Trilemma'. It states that there are three conditions in international financial framework that cannot coexist more than two at the same time otherwise the system will collapse. The three angles comprise of the independence of monetary policy, the stable foreign exchange rate, and free capital controls. It is impossible to have free capital mobility, fixed exchange rates, and independent monetary policy at the same time.
- **Uncovered Interest Rate Parity** is a parity condition stating that the difference in interest rates between two countries is equal to the expected change in exchange rates between the countries' currencies. If this parity does not exist, there is an opportunity to make a profit.
- **The Mundell-Fleming-Dornbusch Model:** predicts the two way impacts of monetary policy shock which are the beggar-thy-neighbor and the prosper-thy-neighbor effect from central economy to foreign output under the floating exchange rate regime with assumption that prices are sticky or fixed in short run.

Based on the Theoretical Framework, there are two board effect of the spillover effect of Central Economy to the periphery which are negative effect (Beggar-thy neighbor effect) and positive effect (Prosper-thy neighbor effect). The following are the description about the notions.

- **Beggar-thy –neighbor effect:** Monetary expansion in central economy leads to decrease in foreign output. When monetary expansion leads to currency

depreciation in home country, the relative price of home product will be declined. As a result, home products become more competitive leading to an increase in trade balance while foreign products become more expensive leading to a decrease in foreign trade balance and foreign output. In addition, the depreciation of home currency leads to appreciation in foreign currency. Thus, the imported input price of foreign decreases which lead to a decrease in foreign price level. Also, the cheaper import price may stimulate the foreign import; as a result, foreign output decreases.

- **Prosper-thy-neighbor effect:** Monetary expansion in central economy leads to increase in foreign output. Home country's interest rate decreases during the monetary expansion. If home economy is large and the world economy is integrated to some extent, the decrease in home country's interest rate will decrease the world interest rate which leads to increase in world aggregate demand. As a result, home and foreign output increase. In addition, foreign central bank will decrease its interest rate in response to home country interest rate shock to protect foreign currency from appreciation which could worsen foreign trade balance. As foreign interest rate decreases, foreign output increases.

2.1.2 Puzzles in Previous Empirical Studies

According to (Kim and Roubini (2000)), the past empirical studies about the monetary policy mechanism sometimes have found a puzzle in their results. The following are the summary of 4 types of puzzles commonly found in this area which are Liquidity Puzzle, Price Puzzle, Exchange Rate Puzzle, and Forward Discount Bias Puzzle.

- **Liquidity Puzzle** is the condition that when put the positive shock on Monetary Aggregate (M0, M1, or M2) as the measure of Monetary Policy, the nominal interest rate increases rather than decreases.

- **Price Puzzle** is the condition when put the positive shock on Interest Rate as the measure of Monetary Policy. Output and Money supply decrease as expected but the Price level is increased instead of decreased.
- **Exchange Rate Puzzle** is the condition when put the positive shock on Interest Rate as the measure of Monetary Policy, the exchange rate of home country will be appreciated instead of depreciated.

Based on the past empirical studies, there are suggestions about the Liquidity Puzzle and the Price Puzzle. For Liquidity Puzzle, Sims (1992) suggested that the shock in monetary aggregate might represent the money demand shock rather than the monetary policy shock. Sims suggested the use of the short term interest rate as the measurement of monetary policy. In order to solve the Price Puzzle, Christiano and Eichenbaum (1992) and Strongin (1995) suggested the use of narrower monetary aggregate such as the Non Borrowed Reserve ratio. In addition, Sims (1992) also suggested that the Price Puzzle might be caused by the inflationary pressure which leads to the increase in price and also, leads to the exchange rate puzzle. The works of Gordon and Leeper (1994), Sims and Zha (2006), and Christiano et al. (1996) showed that adding the inflation expectation proxy variable into the model could solve price puzzle. However, Kim (1999)'s results for non U.S. G5 countries showed the liquidity and price puzzles even when using the narrow monetary aggregate (NBR and M0) as monetary indicator and including the World Commodity Price in the model.

There are many research studies about the international spillover effect on U.S. monetary policy. Broadly, the studies can be separated into two categories which are the effect on macroeconomic condition and the effect on financial market. In addition, there are other studies about the transmission channels of the shock. Mostly, the previous research has focused on interest rate channel, trade channel and expectation channel. In the past, before the financial crisis 2008, most papers studied the effect of

U.S. conventional monetary policy, but later there were increments in number of studies on the effect of unconventional monetary policy. The following are the literature reviews on previous researches on the spillover effect of U.S. monetary policy on macro-variables which are the focus of this study.

2.1.3 Empirical Study

2.1.3.1 Spillover Effect of Conventional Monetary Policy

Before the study about the spillover effect, many previous studies in monetary policy were focused on the effectiveness of the policy. Most of the studies found that the monetary policy could effectively control domestic economy and the key effective instrument in anchoring mechanism which was the policy rate. For example, in a system without interest rate, the influence of money supply in economic function is higher comparing to its role in the system that includes interest rate (Sims, 1980). Not only in a normal condition, the study that compared the effectiveness of interest during an uncertain period also found the similarities in the dynamic response between two periods but the impulse response was stronger for the postwar period. The result implied that impact of the monetary policy seemed to be stronger toward the present time¹⁷. So far, the monetary policy action of the central economy has not only affected its own economy but also affected the leakage to another economy.

Eichenbaum and Evans (1995) 's work was one of the first paper that used VAR model to examine the impact of U.S contractionary monetary policy on foreign variables of 5 foreign countries which were Japan, Germany, Italy, French, and U.K. They found that foreign output rose first and then fell in long term. Foreign price increased in short term then converged back to initial level. They also examined the effect on Exchange rate and interest rate spread between U.S. and foreign countries. Their results showed that the shocks in U.S. contractionary monetary policy led to the appreciation in exchange rate and reducing the interest rate spread between U.S. and foreign countries. For the

¹⁷ Sims (1980) compared the effect between the interwar (1920 - 1941) and the post war period (1978).

interest rate gap, both U.S. and Foreign countries' interest rate increased but the increase in foreign countries was smaller. They defined the monetary policy shocks into 3 proxies which were the ratio of Non-Borrowed Reserve to total reserve (NBRX), the Federal Fund Rate, and the index proposed by Romer and Romer (1989). The data was presented in a monthly basic over 1974:1 – 1990:5. For the use of NBRX instead of Monetary aggregate, the intuition behind was based on Christiano and Eichenbaum (1992) that the innovation on Non-Borrowed Reserve primarily reflected exogenous shock to monetary policy¹⁸, while boarder monetary aggregate primarily reflected shocks to money demand. Their benchmark model included 5 variables which were $[Y, P, NBRX, (RFOR - RUS), SR^{For}]$. There were the model of U.S. Industrial Production, U.S. Consumer Price Index, the monetary policy measure, the spread between foreign short term interest rate and U.S. short term interest rate, and the real foreign exchange rate against U.S dollar. All data was represented in log form except for interest rate.

Kim and Roubini (2000), by using SVAR model, found the effects of non-U.S. G7 countries exchange rate and macro-variables. They found that the U.S. monetary contractions led to the appreciation in exchange rate and the increase in foreign interest rate while the responses on Output were mixed. They explained the increase in foreign short term interest rate in response to U.S. monetary contraction shock with 2 reasons. Firstly, since the U.S. was large economy, the increase in U.S. interest rate tended to increase the interest rate in other countries. Secondly, the increase in foreign interest rate was the response of foreign central bank to avoid inflationary effect from the currency devaluation. Their results showed the mix in output between the positive response in short run in most cases and the negative response in short run for Canada. They explained this difference with counteract of increase in interest rate and depreciation in currency. On one side, as the exchange rate depreciated, aggregate

¹⁸ NBR is a measure of the reserves in the banking system. Non-borrowed reserves represent the numerical difference between total reserves held at deposit at the Fed by member banks plus the composite cash in their vaults minus funds that have been borrowed from the Fed discount window.

demand was stimulated and output would increase. Whereas, on the other side, the higher interest rate decreased the aggregate demand and tended to reduce output. For Canada, the effect of currency depreciation was lower than the effect of increase in interest rate. Their model was [R, M, CPI, IP, OPW, FFR, E (/)], where, R was short-term interest rate, M was a monetary aggregate (M0 and M1), CPI was consumer price index. IP was industrial production, OPW was the world price of oil in terms of the U.S. dollar, FFR was the Federal Funds Rate of the U.S., and E(/) was the exchange rate expected as units of foreign currency for one unit of U.S. dollar. All data was in monthly basic over 1974 to 1992 and data ranges were varied across countries depending on the availability. All variables were in logarithm form except for interest rates. Complete seasonal dummies were used in all estimated, six lags were assumed.

Kim (2001), used the VAR model to study the international transmission mechanism of U.S. monetary policy shock on non U.S., G6 countries during the flexible exchange rate period. The result showed that U.S. expansionary monetary policy led to increase in non U.S., G6 outputs. In addition, the result showed that foreign trade balance didn't change much while the drop in non G6 real interest rate was significant. As a result, he concluded that the decrease in the world real interest rate seemed to be more important transmission channel through the capital market than trade balance in the transmission mechanism. The impulse response result showed that the increase in output of non-U.S., G6 countries was about one-fourth to on-half of the increase in U.S. output. In addition, the U.S. monetary policy shocks could explain around 4.0-4.3% of foreign GDP and 6.4-6.7% of foreign IP at the peak, which were considered to be small. Also, Kim examined the possible foreign policy endogeneity based on the response of short-term interest rate and the monetary aggregate. The result showed the initial slight drop in foreign interest rate which was small and insignificant and no initial increase in foreign money supply. Therefore, he concluded that G.6 countries did not seem to react strongly to U.S. monetary policy. His finding was contradict with the finding of previous studies such as Grilli and Roubini (1995) who found the significant increase in G7 short term

interest rate in response to the positive shock in FFR and suggested that the non U.S. G7 countries monetary policy closely followed U.S. monetary policy. Kim argued that this contradiction was due to the fact that those past studies did not control for the effect of inflationary pressure or supply shock while he controlled this effect by including the commodity price index in the system.

Kim used FFR and NBRX as the indicators of U.S. monetary policy. His 2 basic models were [RGDP, PGDP, PC, FFR] and [RGDP, PGDP, PC, NBRX, FFR], where FFR was the innovation in the first model and NBRX was the innovation in the second model. In addition to the basic model, Kim also examined more domestic variables such as trade balance, short-term interest rate, money supply, exchange rate, unemployment, import, export, investment, and consumption. The additional variables were added to the basic model one by one. In conclusion, the extended model of domestic variables showed the dynamic effects as expected with monetary expansion. The impulse response of the basic variables in the extended systems did not show that puzzling and dynamics were similar to those in basic system. Kim examined the data over 1974 to 1996 in quarterly and monthly basics. All data was in logarithm form except for interest rate and trade balance. For quarterly data, four lags were included, and for monthly data 6 lags were included.

Faust et al. (2003), studied the impact of us monetary policy shock on Germany and U.K.'s macro and financial variables. The authors claimed that using the recursive identification to study the impact of monetary policy on exchange rate created bias. The authors dropped all recursive assumptions and used vary different restrictions coming from financial market data based on the idea that, in the open economy, one must sort out the simultaneous inter-action of at least three financial market variables: home and foreign interest rate and exchange rate. However the authors found that the basic pattern of most of the response was little changed, but the effect of U.S. policy shock on output and interest rate lasted longer than the result form recursive identification The authors concluded that the peak timing of the exchange rate effect was quite

imprecisely: it might come immediately or several years later and U.S. policy shock could explain around 1/3 of foreign exchange rate variation in response to the shock. Faust et al used a seven-variable Variable VAR, $[y, p, y^*, i^*, nbrx, i]$, where y and y^* were variables of domestic and foreign output measure as industrial production. 'p' was U.S. price measure as CPI. 'i' and 'i*' were the three month U.S. and foreign interest rate. 'nbrx' was the ratio of non-borrowed reserve to total reserve. All data was in logarithm form except for interest rate. Data was in monthly basic form 1974:1 – 2001:10. The VAR model included six lags and constant.

Canova (2005), studied the impact of U.S. monetary policy on Latin American countries with divergent exchange rate regime classify as floater and non-floater. The authors used VAR methodology and found that firstly, U.S. monetary policy shocks brought large and significant response in several Latin American macroeconomic variables. Secondly, interest rate was the primary transmission channel of the shock while trade channel seemed to play an insignificant role. Thirdly, U.S. monetary policy shock could explain the large portion of the macro variables fluctuation in Latin American. According to the result, U.S. shock accounted for 23% -53% of the variability of eight variables within each country. Fourthly, the trade balance and real effective exchange rate of countries with non-floating exchange rate regime responded more to interest rate shocks from U.S. while there were smaller and less significant interest rate response and no changed in trade balances or in real exchange rate for those with floating exchange rate regime. However, the response on price level was contradicted to trade balance and exchange rate. The domestic inflation was less sensitive to U.S. shock to countries with non-floating exchange rate regime while there was large and significant positive response in domestic inflation of countries with floating exchange rate regime. The authors stated that the differences were more on magnitude of the effect than with the pattern of transmission.

Canova developed the bilateral block VAR model. There were a block of U.S. country, a block of Latin American Countries and a block of world variables. He identified the

structure shock from U.S. model and took it as the U.S. shock in each Latin American model. The country block included four variables which were a measure of log of real activity, log of inflation, the slope of the term structure of nominal interest rate, and log of real balance. The authors claimed that the world variables were included to capture the state of the world economy or those influences, independent of U.S. and Latin American developments that might cause co-movement in the two regions. The block of world variable included three variables which were an index of commodity prices, the emerging market bond index (EMBI) and the emerging market equity index (EMEI). All three variables entered the system only contemporaneously. The data was in quarterly basic over 1980:1 to 2002:4 and all series were seasonally adjusted.

Maćkowiak (2007), studied the impact of U.S. monetary policy shocks on 8 Emerging markets. A structural vector autoregressive model was estimated for each emerging market. The authors concluded that external shocks were an important source of macroeconomic fluctuations in emerging market. The results showed that external shock could explain around 50% variation in the exchange rate, 40% variation in the price, and around one-third of the variation in short-term interest rate. The U.S. monetary policy shocks seemed to have less impact on emerging markets relative to other kinds of external shocks as it accounted for less than 10% of macroeconomic fluctuations. However the responses of output and price of a typical emerging market to U.S. monetary policy shock were sizable, quick and strong. In addition, the price level and real output in emerging market responded to U.S. monetary policy shock by more than the price and real output in the U.S. itself. The authors stated that the results were consistent with the idea that “when U.S. sneezes, emerging market catches a cold.” Mackowiak’s model included main macroeconomic variables in the emerging market, main macroeconomic variables in U.S. and world commodity prices. The vector of emerging market $y_1(t)$ included a short term interest rate, the exchange rate, output and price level. The vector of variables external to the emerging economy $y_2(t)$ included the federal fund rate, the world commodity price, U.S money stock, and U.S. real aggregate

output. Data was in monthly basic over 1986:1-2000:12. All data was in logarithm, excepted for the interest rate.

Valente (2009), studied the impact of U.S. monetary policy announcement on Hong Kong and Singapore interest rate. The authors highlighted the difference between the Hong Kong and Singapore exchange rate regime. The market expectation on policy announcement was extracted from the federal fund future rate. By a modeled change in foreign bond yields on changes in short-term interest rate in U.S. with an ordinary least square regression, the result showed that the FOMC announcement had significant on term structure of interest rate among U.S., Hong Kong and Singapore. There was negative effect of U.S. shock on interest rate of short maturity bond but the effect decreased when the bond maturity increased. Data was in daily basic over 1994:2-2004:6.

Sato et al. (2011), studied the impact of U.S., Japan, and China output shock on East Asia. The authors found that the impact of U.S. shock on East Asia real output fluctuation was very strong while the impact of shock from Japan and China was relatively small and not comparable to U.S. In addition, the results showed that the world oil price shock became increasingly important in influencing the stability of output growth in the region.

The authors used VAR model with block exogeneity. The model was formed separately for each country which was assumed to be a small open economy. The foreign block included three variables which were U.S. output growth, Japan output growth, and the world oil price. China output growth was switch with Japan Output Growth when examining the effect on China. The country specific block included two variables which were output and inflation. Data was in quarterly basic over the period 1978:Q1 – 2007:Q4. All data was in logarithm form with seasonal adjusted.

Bluedorn and Bowdler (2011), examined the effects of U.S. monetary policy shock on G7 countries. The authors concluded that interest rate linkages were the important

transmission channel. The positive shock in U.S. interest rate raised foreign interest rate in short run but reduced it in long run. In addition, the monetary contractionary shock from U.S. led to the decrease in foreign price level both immediately and with delay.

2.1.3.2 Spillover Effect of Unconventional Policy

In the scope of unconventional monetary policy, Japan Quantitative Easing experiment was successful in stimulating real activity in the short-run and did not lead to increase in inflation (Schenkelberg & Watzka, 2011). Fasano-Filho et al. (2012), studied the effectiveness of Bank of Japan's Quantitative and Credit Easing and found that it had an impact on economic activity but less on inflation. Breedon et al. (2012), studied the impact of U.K. Quantitative Easing (QE) and found that QE significantly lower government bond yields through the portfolio balance channel. For the United States, Chung et al. (2011) found that QE1 and QE2 rose the real output around 3% in the second half of 2012; this amount was relatively equivalent to cutting the federal fund rate by 3% during the period before crisis. For the United Kingdom, the study of Joyce et al. (2011) found that their bond purchase increased output level by 0.5 to 2% at the peak which relatively equivalent to 150-300 basis point cut in the Bank rate. Gambacorta et al. (2012), studied the impact of U.S. unconventional monetary policy on advanced economies and found that individual country results suggested no major difference in macro-economic effect of unconventional monetary policies across countries. In addition, the authors found that the effects on outputs seemed to be qualitatively similar to the ones found in the literatures studying the effect of the conventional monetary policy.

Rosa (2012), studied the impact of LSAPs news on U.S asset price using the announcement that reported on the Financial Time articles and found that the impact of LSAP news on economic was large and high. Fed's LSAP were extremely successful in bringing down long term yield, boosting stock prices and reducing the value of the U.S. dollar when the policy rate reached the zero lower bound. In addition, examining cross

asset reaction, the author found that for most of the U.S. asset price, the effect of asset purchase were not statistically which different from an unanticipated cut in the fed fund target rate.

Gambacorta et al. (2012), studied the macroeconomic effects of unconventional monetary policies on eight advanced economies¹⁹ during the global financial crisis. The result showed that there was a significant increase in output and price level which indicated that the unconventional monetary policy measure was effective in stimulating the economy during the crisis. Output rose up to the peak after 6 months and back to base line after 18 months. The impact on price level found to be very slow with the peak only after two years or later. Individual country results suggested that there were no major differences in the macroeconomic effects of unconventional monetary policies across countries. In addition, the estimated output effects turned out to be qualitatively similar to the ones found in the literature on the effects of conventional monetary policy (see also Wu and Xia (2015)), while the impact on the price level was weaker and less persistent. Quantitatively, the magnitude of unconventional monetary policy effect appeared to be larger on output and smaller on price level comparing to the effect of conventional monetary policy shock.

The authors used panel VAR model to study the cross sectional dimension using the mean group estimator. The central bank asset was used as the measure of U.S. unconventional monetary policy. The benchmark model consisted with four variables which were the log of seasonally adjusted real GDP²⁰, the log seasonally adjusted consumer price index, the log level of seasonally adjusted central bank asset, and the level of implied stock market volatility (VIX) of the national stock market index. The authors also extended two models for robustness check: one included the Federal fund rate and the other included the outstanding debt of the central government. The result

¹⁹ Which are Euro area, the United State, the United Kingdom, Japan, Canada, Switzerland, and Norway.

²⁰ A monthly measure of real GDP was obtained based on a Chow-Lin interpolation procedure using industrial production and retail sales as reference series.

showed no significant difference. Data was in monthly basic over the period of 2008:01-2011:06

Moore et al. (2013), studied whether LSAPs by the Federal Reserve influenced capital flows out of the United States to emerging market economies and also analyzed the degree of pass-through from long-term U.S. government bond yields to long-term EME bond yields. They found that 10 basis point reductions in long term U.S. Treasury Yield results in a 0.4 percentage point increased the foreign ownership share of emerging market debt. This in turn, was estimated to reduce government bond yields in EMS by approximately 1.7 basis points. They also referred to other previous studies that during the same sample period, Federal Reserve LSAPs reduced ten year U.S. Treasury yields between 60 to 110 basis points which therefore, likely to contribute to U.S. outflows into EMSs and marginal reductions in long term EME government bond yields and the effects were quantitatively similar to conventional U.S. monetary policy easing. However, looking at individually, they found that the marginal effects very notably across emerging market countries.

Chen et al. (2015), studied the impact of U.S. quantitative easing (QE) on both emerging²¹ and advanced²² economies using a global vector error correction model (GVECM). The authors focused on the effect of decrease in U.S. term and corporate spreads. The authors concluded that, first; QE lowered U.S. corporate spread and had significant effect across the region and individual economies. They also argued that the purchases of U.S. treasury to lower the term spread were weak tool comparing with the impact of reduction in risk premium from purchase of private-sector assets which were stronger (see also, Blinder (2012)). Second, the impact on output inflation and credit were different across emerging economies. The authors explained that the differences in responses were caused by the difference in monetary policy and exchange rate regime

²¹ Which are 9 emerging Asian economies: China, Hong Kong SAR, India, Indonesia, South Korea, Malaysia, the Philippines, Singapore and Thailand and 4 Latin American economies: Argentina, Brazil, Chile, and Mexico.

²² Which are the United States, the euro area, Japan and the United Kingdom.

among emerging countries. In addition, there was a significant impact of reduction in U.S. corporate spreading on euro which increased credit and output form. The increase in credit was around 3 to 8 percentage point and the increase in output was around 7 to 16 percentage point. Third, U.S. QE had sizable and widespread effects on global equity prices. Fourth, the impacts tended to be greater on many emerging countries than on U.S. itself.

The model consisted of three parts which were country part, foreign part, and U.S. part. Each country VECM included six variables which were real GDP growth, the CPI inflation rate, a monetary policy indicator, credit growth, equity price, and foreign exchange pressure index. The foreign part included e.g. the average foreign real GDP growth and the VIX. For the U.S. part, there was the same set of country variables, but only non U.S. real GDP growth as a foreign variable. In addition, there were no other foreign variables in U.S. model according to its importance in global economy while VIX was treated as endogenous variable in U.S. model. Data was in monthly basic and the study period started from July 2007 to February 2013. The authors used the US term spreading between 10 year and 3 month Treasury yields and the U.S. corporate between the Bofa Merrill Lynch US corporate AAA bond yield and the effective federal fund rate, as two indicators for the Federal Reserve's unconventional measures.

Overall, the above studies found that the U.S. unconventional monetary policy significantly and effectively reduced the financial risk spread or yield and stimulated the economy or output and credit growth. However, there were some researches such as the weak spillover effect of the U.S. Unconventional Monetary Policy as follows.

Ahmed and Zlate (2014), studied the determinants of net private capital inflows to emerging market economies over 2002:Q1 to 2012:Q2. They concluded that they did not find statistically significant positive effects of unconventional U.S. monetary expansion on total net EME inflows, although they seemed to be a change in composition toward portfolio flows. Even for portfolio, U.S. unconventional policy was

only one among several factors while growth and interest rate differentials between EMEs and advanced economies and global risk appetite were statistically and economically important determinants of net private capital inflows.

Miyajima et al. (2014), studied the role of long term interest rates in international monetary transmission and found that Unconventional monetary policy in the United States and other advanced economies has been increasingly transmitted to Asia through global bond market (see also, Obstfeld (2015) and McCauley et al. (2015)). A very low U.S. term premium spilled over to Asia mainly through low domestic bond yield and the rapid expansion of bank credit. Miyajima stated that financial integration did not appear to reduce control of national monetary authorities over short- term policy rates but did compromise control over long term rate that are key determinants of economic activity.

Rafiq (2015), studied the effect of U.S. unconventional monetary policy (QE2) on group of frontier developing economies (FDEs) in Asia. They found that the spillovers from U.S. on FDEs in Asia were small. The relative insulation of Emerging Asia from the global financial cycle could likely be attributed to the presence of managed capital accounts coupled shallow financial markets.

In order to examine the effect of the monetary policy that leaks to the other economy, understanding more on the role of either conventional or unconventional monetary policy is important. In session 2.2 will discuss about the role of the conventional monetary policy in the normal economic circumstance. Section 2.3 will be the discussion about the use of unconventional policy tools by the Federal Reserve and the transmission mechanism channels through the LSAPs program. Lastly, in this hyper- globalization era which intensify financial integration, it is unavoidable to consider the importance global factor, this topic will be discussed in section 2.4.

2.2 Conventional Monetary Policy

After the finding that the monetary policy is able to stabilize economic in short-run, the goal of the central bank then not only to maintain the confidence on its currency but also to stabilize the economy. Typically, the central bank framework is to look at the current economic condition and to set the targets. The targeting rule is applied with two optimal goals which are the price stability and the maximum employment. In the target based framework central bank will forecast its goal variables and issue the strategies that will shape the economy to be in line with its stated objectives²³. Targeting rule is claimed to provide the transparency through the change in economic factors which incorporate with the forecasted goals. By this way, this framework provides public in the easy way to monitor their agent's performance through the outcomes which much easier than keep an eye on the whole process. Apart from the transparency, targeting based framework is also beneficial in communication way, for example Fed's commitment to two percent inflations provide the public information about the approach. It is likely to adopt in the year ahead. In addition, anchoring the inflation expectation in numerical way gave the central bank more scope to ease monetary policy in response to the great recession than it otherwise would have had (Bernake, 2015).

The key conventional monetary policy tools are the policy rate, the open market operation, and the discount window. Central bank sets policy rate as the base interest rate for the whole economy and alters it to change the short-term and affects long term interest rate. Open Market operation is used to affect the liquidity in the market. Central will sell government securities or financial instrument to reduce the money supply in economy and buy those assets to increase liquidity in the market. Discount window refers to the discount interest rate that central bank uses to provide loan to commercial bank and depository institution. Change in discount rate will alter the short term interest rate in the market or money market rate. In addition, there is the use of Require Reserve

²³ It has been used by three generation of the Central Bank Chief, Volcker, Greenspan, and Bernanke.

Ratio to affect the ability of banks to provide credit which leads to the economic expansion or contraction. There is evidence, that interest rate, the basic and effective monetary tool, are the key determinants of the monetary policy mechanism (Sims, 1980). However, the drawback of this framework is the limited lower bound of the policy rate that cannot be negative. Therefore, during the great financial crisis 2008, when Fed forced to decrease its repo rate to its zero lower bound at 0.25%, Fed had to implement the additional tools known as the Quantitative Easing and Forward Guidance to hand the economy together with the conventional one.

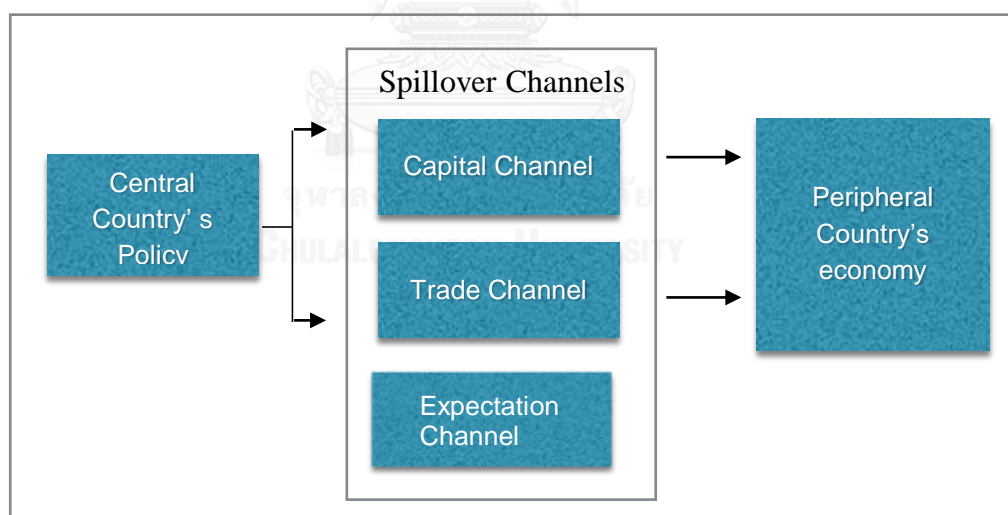
2.2.1 The Spillover Effect of Conventional Policy Tools and Transmission Channels

There was the evidence that U.S. monetary expansion decreased the world interest rate, which in turn stimulated the global aggregate demand, and increased foreign output. When Fed cut its Federal Fund rate (FFR), there were the decrease in the world interest rate and the increase in G6 countries outputs. At that time, foreign outputs were increased by a quarter to a half of the increase in U.S. output. Refer to those evidence at that time, Kim (2001) concluded that interest rate appeared to be the important transmission channel while trade balance, another theoretical transmission channel, seemed to play minor role. Later, the role of trade channel in the international monetary spillover mechanism was re-emphasized again when the Exchange rate regime found to play the important role in the spillover over mechanism. Floating function of exchange rate regime was the buffer that absorbed the effect of spillover through the trade. Based on the study of transmission of U.S. monetary policy shocks to a group of the Latin American countries that had different rate regime, there was the founding that the countries with fixed exchange rate regime had stronger response to the shocks than the countries with floating regime (Canova, 2005).

Studies about the transmission mechanism has been further researched to the conditions that influencing the impact. Economic integration found to be one of the important factors in the spillover mechanism. The relationship between the economic

integration and the level of spillover effect is positive. Based on the study of the effect of U.S. policy on the equity markets over 50 countries including both developing and developed nations, the authors found that countries hold more foreign assets, having higher degree of trade opens, or having the same economic cycle with the central economy responded to the shocks two or three time more than countries with less integration (Ehrmann & Fratzscher, 2006). Trade is one of common channel in the economic integration. Lately, the importance of trade as the key transmission channel has been highlighted again in emerging market comparing to the advance economy (Bagliano & Morana, 2012). In addition the scope of transmission through trade, the competitiveness and the substitute nature of products are the important keys that determine the degree of spillover. There is the evidence of positive relationship between them. (See also Mattoo et al. (2012))

Figure 1 Channels of Monetary Policy Spillover



Monetary spillovers can be originated from many channels for example through the trade channel, capital channel, and market expectation channel.

- **Trade channel:** the implementation of monetary policy will affect the exchange rate and therefore affect the demand of import and export of home countries on foreign markets which can lead to the change in foreign output.

- **Capital channel:** if home country is the large open economy like U.S.A. and the world capital market is integrated to some extent, the change in home country interest can affect the world real interest rate and then affect the world aggregate demand for current goods, including foreign current goods. As a result, foreign output may grow. In addition, the interest rate difference between markets might cause the shifts in money from home to other market; those inflows can lead to economic booms in recipient countries.
- **Expectation channel:** Market participants can have expectations on the effectiveness of the policies in many ways which can lead to unexpected demand for certain assets then affect the markets prices.

2.3 The Unconventional Monetary Policy

Unconventional monetary policy has been implemented first in 1999 by the central bank of Japan (BOJ) followed by the U.S. central bank, the Federal Reserve in 2008, the European central bank and the Bank of England in 2009. In 2004, the BOJ made three criteria for the assets to be purchased which were “soundness”, “liquidity” and “neutrality”. However, the actual sluggish responses of the financial markets might have accelerated the BOJ’s choice of the unconventional measures beyond the criteria (Takeda & Yajima, 2014). There are varieties of the policy measures designed by each central bank with a country-specific purpose of the credit expansions. For example, the BOJ began to purchase commercial papers, asset-backed securities and corporate bonds in 2008 in the aftermath of the Lehman shock, while the Federal reserve introduced the Term Asset Backed Securities Loan Facilities (TALF) which gave credit to asset-backed securities with original auto-loans, credit card loans together with the purchase of mortgage back security and long term government treasury. Although the details in the unconventional measures are different in each central bank, there are for the same purpose as to stimulate the economy.

In U.S. case, during the crisis, US inflation kept decreasing from 4.1 percent in December 2007 to -1.3 percent in September 2009. From September 2008 to March 2009, US stock market kept sinking in the red zone. Within 6 months, S&P 500 index fell by 31.6 percent. Considering the fact that the players in U.S. financial market were not local but international institutions or investors made this crisis not only affects U.S. but also the rest of the world. Thus, while the volatility, risk, and liquidity were spreading increasingly up to unforeseen levels, real outputs around the world were declining. To prevent the whole financial market from the domino situation, the Federal Reserve then forced to lower its policy rate to zero lower bound with forward guidance. The seriousness of the crisis which was extremely large and complicated even the common policy tools could not handle the situation. The limit of policy rate at zero lower bound pushed Fed to the news scope of monetary policy. There were the implementations of unconventional tools like the Large Scale of Asset Purchase (LSAP). Although, the unconventional monetary policy had been firstly used by the Bank of Japan in 2001 and then used more widely in the financial crisis by the Federal Reserve, the European Central Bank and the Bank of England, the market was still less familiar with it. In the next following section, the study will summary the main concepts of the unconventional policy and its transmission channels in details.

2.3.1 Quantitative Easing

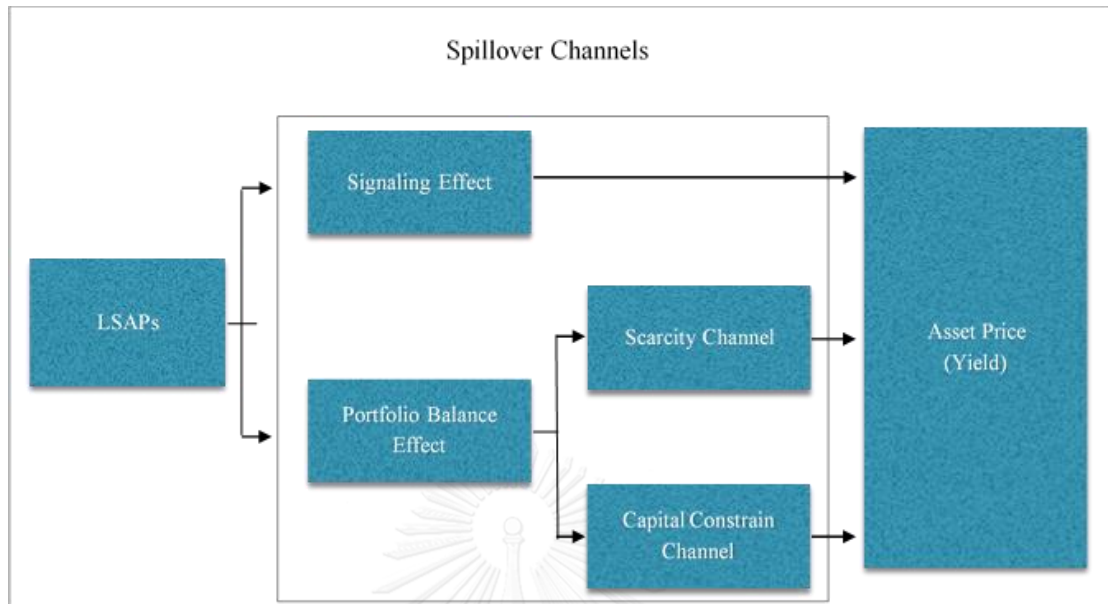
Quantitative Easing or QE is the general word that people refer to the LSAPs, Large Scale of Asset Purchases, which are the purchases of both private and government debt in substantially large amount. Specifically, Fed dramatically purchases the risky and less liquid Mortgage Back Securities (MBS) from private institutions and the safe and liquid treasury bonds from the government.

The impact of LSAPs depends on the economic conditions and the specific characteristic of the purchased assets. For the characteristic of purchased assets, whether assets are unique enough to change in demand or supply can move the market

or whether market players consider to be bored or tight to move in or out of one player can affect the whole market, are important conditions. Economic condition is another important condition for policy to be effective. According to the frictionless economy of Woodford (2012), applying LSAP on MBS would yield the different result on different economic condition. That was the purchase before the crisis which was likely to create none or less effect on MBS price but Fed purchased during the crisis, when the capital was scarce, would effectively affect the MBS price.

As LSAPs or the three QE program are the large scale of specific asset purchases which are Mortgage Back Securities and Treasury bond. The effects of LSAPs have been described with the term 'portfolio balance effect' which shows how the purchase or sell of a given asset changes its price and its substitutes'. The portfolio balance effect works through many mechanisms. The different asset purchases on LSAPs work through multiple channels. There are three board channels I will review in this section including the signaling channel, the capital constrain channel, and the scarcity channel. It is common knowledge that Fed action always creates the signaling effect in the economy. Unlike, normal conventional policy action, due to the difference in specific characters of MBS and Treasury bond, LSAPs on both assets create effects through both same and different channels. Both asset purchases work through signaling channels. Unlike MBS purchase creates through three channels, the purchase of Treasury bond creates the effect only to the signaling and scarcity channels. Note that there are the domestic effects in U.S. for all discussed channels, however, in the international transmission of U.S. monetary policy spillover to BRICS, the effect on MBS through the Capital channel is expected to be less important in relative to the effect on Government bond through the Scarcity Channel according to the ability to supply MBS asset of BRICS financial market which considered to be small in comparison to U.S. The followings are the reviews on each channel mechanism and how LSAP on MBS and Treasury bond work through them.

Figure 2 Channels of LSAP Program



Source: Summarize from Krishnamurthy and Vissing-Jorgensen (2013)

2.3.2 The Transmission Channels of Unconventional Policy

- Signaling Channel:** Comparing among 3 channels, Signaling Channel created border effect through the whole economy. Through the signaling channel, the announcement of more or cease of LSAP would be interpreted as the intention of Fed over the short- term interest rate. (Woodford (2012)). There is the empirical evidence that QE announcements delayed an anticipated rate hike cycle by the Federal Reserve on the yield curve of the federal fund future contract (Krishnamurthy & Vissing-Jorgensen, 2011). Through the expectation channel, during the crisis the implementation of QE indicated that the market had serious liquidity problem so Fed had to intervene by directly injecting money to the market. To prevent future loss from high default possibility or to prepare for situation by holding the liquidity on hand, these expectations will motivate investors to sell their assets on hand, then the increase in supply over demand will shift yield curve down yield the result corresponding to public expectation even Fed has not yet bought the first lot of asset.

- **Capital Constrain channel:** Unlike signaling channel, Capital Constrain channel is narrow as the purchase of asset can create the effect precisely and the asset is traded in narrow and segmented market. There are specific key environments for capital constrains to operate. First, the asset must be complex enough to create the specific risk considered to be concentrated in specialized investors' portfolio. Second, economic condition, the capital is scarce. In practice, capital constraint is hard to measure. However, risk premium offers an indirect way to imply the constraint. For example, in the context of MBS, there are limited numbers of specific investors in MBS markets such as banks, dealers, and asset managers. The only set of investors considered for limit access to the capital and the asset risks are diversified across all players. In this limited arbitrage opportunity environment, when the capital constrain is higher, investors will require more returns to compensate for their use of scarce capital. Hence, if risk premium is high, the capital constraint is likely to be tight. Then change in demand or supply of one of the market players can create the significant effect on price like the action of Fed through the LSAPs program. Exclude the implementation of LSAP, looking at 2008 crisis, when some MBS investors are in distress and have to sell their assets. As there is the limited number of investors in the market, the remaining investors have to absorb the sale with their limited capital. During the crisis, when the market faces illiquid situation, MBS holders will require larger compensation in order to absorb their additional risk, and then risk premium of MBS will largely increase leading to raising yields or the option adjusted spread (OLS), and then resulting in the large fall in MBS price.
- **Scarcity channel:** In Scarcity channel, investors have special demand on some specific assets so that the scarcity in supply of such assets will increase the convenience yield or the scarcity premium for holding the asset which in turn lower the yields and rise price levels of such assets. The key is that the price of the scarce asset will be increased relatively to the benchmarks.

2.3.3 Implication of LSAPs on Mortgage Back Security

Apart from signaling channel, LSAPs on MBS create effect through both capital constrain and scarcity channels. Fed's large purchase losses the market condition and lowers the risk premium resulting in lower required yields and increasing in assets' price. In terms of economic benefits, not only rescue many financial institutions and the financial system from domino bankruptcies as mention above, but also the LSAPs on MBS seem to provide the right medicine, 'liquidity', on the right problem spot which is the housing sector, the origin of 2008 crisis. When Fed planned to launch the LSAPs, it would be operated through the to-be-announced market, or TBA. According to Vickery and Wright (2013), 90 percent of MBS trading volume concentrated in the forward TBA. In TBA trade, the buyer purchased a contract to take delivery of securitized mortgage loans at a future date. On the agreement date, buyer would only know some specific feature of MBS such as the issuer, the maturity, coupon, etc. All actual parameter would be known with in just 48 hours before that delivery. Typically, in TBA, sellers preferred to deliver the 'cheapest -to- deliver' assets first. This is the pool of asset class that is likely to be pre-paid in their portfolio so that Fed purchases help to release that poor asset class in their balance sheet.

In terms of economic benefit, LSAPs provide liquidity and more rooms for new loans in banks and institutions' balance sheets and the lower yield in MBS secondary market resulted from loosen market condition provides them the incentives to create more loan as the cost of making a new loan is lower. Although there is the issue that the pass through from secondary market MBS rates to primary market loan rates has been less than one by one (Fuster et al., 2013), all of these create more liquidity to the housing sector which is stated by Fed as being important to economic recovery. In addition, LSAPs of MBS yield is not only affect the price of MBS but also the financial assets' price through change in the portfolio of financial intermediaries. As MBS is not the only asset in their balance sheets, the change in portfolio position form changing in MBS yield and price requires them to adjust other portions of assets in portfolio to meet their risk and

return target. Therefore, price of assets that has similar parameter to TBA will be raise as well.

2.3.4 Implication of LSAPs on Treasury bond

Unlike MBS, LSAPs on the Treasury bond do not work on the capital constrain channel but only the scarcity and signaling channels. As the special feature of the capital constrain channel is tight, the limit numbers of market players and board market of Treasury bond seem not to fit with it. In the scope of Treasury bond market, the scarcity channel is also kwon as the Safety Premium channel, Treasury bond is considered to be the special assets which are safe and liquid. There is the argument that Treasury bond fits the condition in the scarcity channel as it offers an almost certain promise of nominal repayment. Thus, it is always required as the collateral in financial transactions, by regulatory for some specific institution like banks or insurance companies, or for some certain investor who has investment need and can only be satisfied by holding the safe assets. Through the scarcity channel, LSAPs on Treasury bond will reduce the supply of this required asset in the market, then increase the convenience yield, and hence raise the Treasury bond price and lower their yields. However, the spillover effects to the other assets are limited to bonds which are considered to be safe asset. However, the effect of this channel considered to be narrow as there is the evidence of the spillovers to private assets, but only limit to the high grade bond such as Aaa bonds (Krishnamurthy & Vissing-Jorgensen, 2013).

In terms of economic benefit, the spillover effect on high grade bond yield seems to be limited as there is small supply of corporate debt in Aaa class. In addition, the benefit of LSAPs on Treasury bond seems to be ambiguous. Treasury bonds are valued because they offer unique convenience service, and then reducing in their supply may actually reduce welfare²⁴. However, there are other financial assets that also provide the

²⁴ See also, Krishnamurthy and Vissing-Jorgensen (2013)

convenience services. The decrease in Treasury bond yield will also reduce those assets yield. As the yield of other convenience assets decrease, private sector will have more intense to create more loans with lower cost. By this way, Treasury LSAPs can stimulate the issuance of private convenience asset and private economic activity.

Although the implementation of the scope of LSAPs through the capital constrain and the scarcity channels seems to create the narrow benefits in its own market and its substitute, purchase of MBS seems to provide the great benefit to the whole economy. To prevent the Giants to fail does not only prevent the domino effects in U.S. but also the whole as those are one of the largest international companies in financial world. Right cure on the housing sector that was the origin of the crisis hand the bottom to recovery. Even the welfare benefits of the Treasury LSAPs under the scarcity channel is ambiguous, it can't reject the purchase effectively in order to create the liquidity through the scarce economy as the purchase not only directly inject money supply but also stimulate the private issuance of convenience assets and the private economic activities. Even all central banks action claim to create the impact only on its nation economy, the implementation of U.S. monetary policy in 2008 seems not to fit this claim. Through the integration of world economy, financial integration seems to be the major bridge for both the crisis and the cure. The following part is the review on the Word Financial Integration and its mechanism that links to the spillover of crisis and monetary policy from central economy to the periphery.

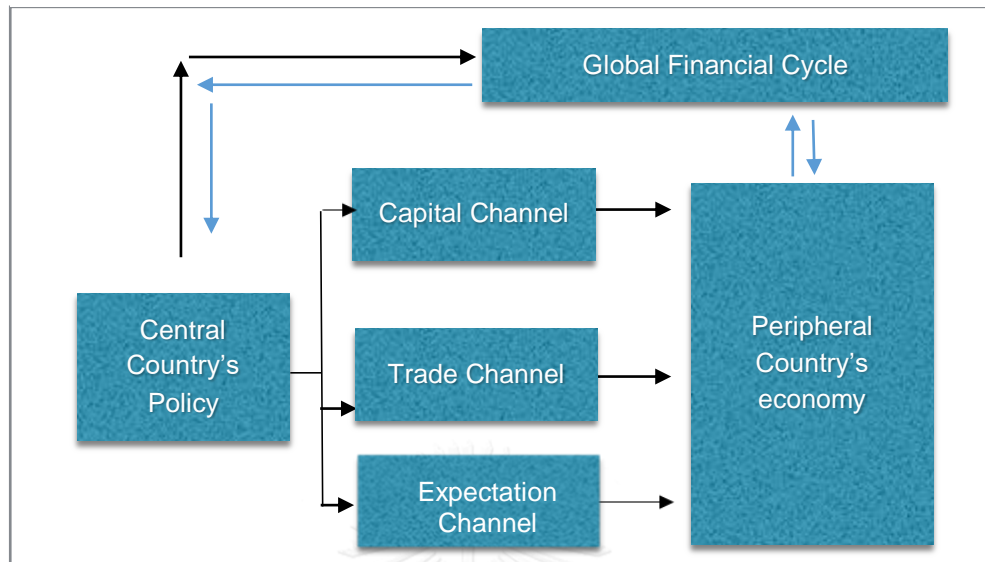
2.4 Global Financial Cycle and VIX

According to Rey (2015), there is a global factor that drives the global capital flow, gross capital inflow and out flow. This factor is believed to be the investment risk and risk aversion of the investor that can be proxy by VIX. VIX which is Chicago Board Options Exchange (CBOE) Volatility Index. It is widely used to measure of market risk (Whaley, 2000). The level of VIX indicates the investors' expectation about the market volatility into the future. VIX values greater than 30 can be defined as the high volatility that investor

fears about. While the value below 20 means the market is low uncertainty condition where the investor feels less stressful. There is the evidence that when VIX increase, all capital flows in all regions will decrease except the FDI. When VIX increases, the financial intermediaries need to increase their safety capital reserve to protect from the possible loss. In the other words, when VIX increases, the Value at Risk (VaR) constraint increases. The increasing in financial intermediaries' VaR constraint reduces the liquidity supply and then results in the reduction of the cross-border lending (Rey, 2015). Moreover, there is the evidence of positive relationship between the Federal Fund Rate (FFR) and VIX. When FFR decreases, VIX will decrease resulting to the surge of capital flows around the world (Rey, 2015). These evidences imply that, if there is no proper domestic capital control, through FFR, U.S. monetary policy can influence other economy and its monetary policy sovereign, regardless of the exchange rate regime. According to the relation between FFR and VIX, there is the ambiguous whether the transmission mechanism of U.S. monetary policy directly spills to the peripheral economy or it indirectly affects as the Fed cutting policy action drives the global capital flows which leak to the periphery. Thus, this study will include this global factor into the model to take this transmission into account together with the effect from global environment.²⁵

²⁵ See Bloom (2009), Bacchetta and Wincoop (2010), Bruno and Shin (2014)

Figure 3 the Transmission Channels of International Monetary Spillover



Chapter III

Data and Methodology

This study will examine the degree of spillover by assessing how much of the domestic monetary policies' outcomes (outputs and prices) reflect the exposure to the foreign monetary policy actions. In order to take into account the effect of financial contagion on the outcomes, the VIX index will be included in the model as the proxy of the Global financial factor. For the econometric model, this study employs the Vector Auto Regressive (VAR) model that has been widely used to study the monetary spillover effects and economic fluctuations. Each country in the BRICS will be examined separately.

3.1 Research Model

Vector Auto Regressive Model (VAR): VAR methodology has been largely used to analyze the macroeconomic effects of monetary policy. VAR is the econometric methodology that used for analyzing the interrelation of time series and the dynamics impacts of random disturbances or innovations on the system of variables. VAR allows the researcher to deal with a vector that has more than one variable and it helps in capture the feedback effects allowing the current and past values of the variables in the system. The structure will be done through the restriction on coefficients of variable in the model according to the expected transmission mechanism. In VAR model, the dependent variables are regressed on their lagged values. The identification of the optimal number of lags for each regression for each country in this study is based on the Akaike Information Criterion (AIC) as the AIC is the method that appropriate for small sample size.

3.2 Data

The data using in this study is monthly data for Thomson Reuters Data Stream. This study focuses on the effect during the past decade so that the test results are more proper to be used as inference for the present time. The period starts from May 2005 to February 2015, which incorporates the world financial period 2008. During this period there are the significant adoption of the U.S. unconventional monetary policy. After the main monetary instrument, the Federal Fund Rate or Target Rate has been pushed to its lower bound at 0.25%. Therefore, this study period allows to examine the spillover effects of U.S. monetary policy including both normal conducts (conventional policy) and the unconventional one. All data is standardized into the same based month, using May 2005 as the based month since it is the first month of in data length. Central Bank asset and Trade Balance are in millions of U.S.D. unit. Most of the data is in log seasonal adjusted form except interest rate data that used in level form.

3.3 Basic Model and Identification

Each BRICS country is examined in separate model. The number of lag included in each model are based on the lag length criteria. Variables in the model can be categorized into three parts which are the domestic variables, the U.S. Monetary Policy measures, and the global factor variables. All domestic variables and foreign variables are identified as endogenous variables. The global factor variables are set as exogenous variable. The following is the basic model and extended models of this study;

$$\text{Basic Model Y} = [\text{USCBA, IP, CPI, INT, FX}]$$

$$\text{Extended Model (1)} = [\text{USCBA, IP, CPI, INT, FX, TB}]$$

$$\text{Extended Model (2)} = [\text{USCBA, IP, CPI, INT, FX, GY}]$$

The models are structured based on the Cholesky decomposition where the variables are ordered based on the degree of exogeneity. Therefore, U.S. monetary policy variable is ordered in the first place according to the assumption that it contemporaneously affects all BRICS variables but there is no inverse effect from BRICS variables on U.S. monetary variable. In the other world, this order is under assumption that the monetary policy of U.S. which is considered as the central economy creates the effects on BRICS economies while the condition of BRICS which is considered as the periphery does not affect the monetary policy decision making in U.S.

Domestic output and inflation level variables are ordered before the policy rate variables as the monetary authority is assumed to set the policy rate after observing the current value of economic activity and price level. Whereas the policy rate is not expected to contemporaneously affect output and price level due to the sluggish real sector and the stickiness in price. The real effective exchange rate is ordered after all variables in the basic model as exchange rate movement is expected to be contemporaneously affected by all both change in monetary policies variables of domestic and central economies together with the effect from change in domestic economic conditions. In the extended models that include trade balance and long term interest rate variables one by one, output and price variables are also ordered in the same place since a part of the sluggish real sector does not respond to monetary policy, change in trade balance and financial signal contemporaneously

BRICS countries are assumed to be small peripheries where their monetary policy conducts and the economic conditions will not affect the central economy or U.S., while the monetary policy of central economy will create an effect on BRICS economies. The following is example of the basic model and the coefficient matrix based on Cholesky decomposition and assumption. Assuming 1 lag for all countries.

$$\begin{bmatrix} USCBA_t \\ IP_t \\ CPI_t \\ INT_t \\ FX_t \end{bmatrix} = \begin{bmatrix} C_1 & 0_2 & 0_3 & 0_4 & 0_5 \\ C_6 & C_7 & 0_8 & 0_9 & 0_{10} \\ C_{11} & C_{12} & C_{13} & 0_{14} & 0_{15} \\ C_{16} & C_{17} & C_{18} & C_{19} & 0_{20} \\ C_{21} & C_{22} & C_{23} & C_{24} & C_{25} \end{bmatrix} \begin{bmatrix} USCBA_{t-1} \\ IP_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ FX_{t-1} \end{bmatrix} + \begin{bmatrix} C_{26} \\ C_{27} \\ C_{28} \\ C_{29} \\ C_{30} \end{bmatrix} VIX_t + \begin{bmatrix} C_{31} \\ C_{32} \\ C_{33} \\ C_{34} \\ C_{35} \end{bmatrix} WCP_t + \begin{bmatrix} C_{36} \\ C_{37} \\ C_{38} \\ C_{39} \\ C_{40} \end{bmatrix} + \begin{bmatrix} \varepsilon_{USCBA} \\ \varepsilon_{IP} \\ \varepsilon_{CPI} \\ \varepsilon_{INT} \\ \varepsilon_{FX} \end{bmatrix}$$

3.3.1 Domestic Variables

The vector of domestic variable includes the measurement of domestic output, inflation, monetary policy action, and uncertainty. Since achieving the growth in output and stable price are the ultimate goal as well as the outcome of monetary policy, accessing the effect on these two indicators is the main focus of this study.

3.3.1.1 Industrial Production Index (IP)

GDP (Gross Domestic Production) represent is not available in monthly term so the Industrial Production Index will be used as a proxy real activity from supply side since it is available on a monthly basis and also historically displays strong co-movements with GDP.

3.3.1.2 Consumer Price Index (CPI)

CPI is a statistical estimate constructed using the prices of a sample of representative items whose prices are collected periodically. All products and services combined to produce the overall index with weights reflecting their shares in the total of the consumer expenditures, with the same basket of product and service. The change in a CPI is used as a measure of inflation

3.3.1.3 Policy Interest Rate (INT)

INT is used as the domestic monetary policy measure over the study period regardless of the unconventional measure. Unlike advanced economy, policy rates of most emerging economies do not reach the zero lower bound and their use of credit easing and quantitative easing measures is limited. Thus, unconventional measures are much less important for emerging economies (Stone et al., 2011)

3.3.1.4 Real Effective Exchange Rate (FX)

FX is the real effective exchange rate which is the weighted average of a country's currency to a basket of other major currencies. The weights are determined by comparing the relative trade balances and adjusted for the inflation effects.

3.3.1.5 Trade Balance (TB)

$$\begin{bmatrix} USCBA_t \\ IP_t \\ CPI_t \\ INT_t \\ FX_t \\ TB_t \end{bmatrix} = \begin{bmatrix} C_1 & 0_2 & 0_3 & 0_4 & 0_5 & 0_6 \\ C_7 & C_8 & 0_9 & 0_{10} & 0_{11} & 0_{12} \\ C_{13} & C_{14} & C_{15} & 0_{16} & 0_{17} & 0_{18} \\ C_{19} & C_{20} & C_{21} & C_{22} & 0_{23} & 0_{24} \\ C_{25} & C_{26} & C_{27} & C_{28} & C_{29} & 0_{30} \\ C_{31} & C_{32} & C_{33} & C_{34} & C_{35} & C_{36} \end{bmatrix} \begin{bmatrix} USCBA_{t-1} \\ IP_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ FX_{t-1} \\ TB_{t-1} \end{bmatrix} + \begin{bmatrix} C_{37} \\ C_{38} \\ C_{39} \\ C_{40} \\ C_{41} \\ C_{42} \end{bmatrix} VIX_t + \begin{bmatrix} C_{43} \\ C_{44} \\ C_{45} \\ C_{46} \\ C_{47} \\ C_{48} \end{bmatrix} WCP_t + \begin{bmatrix} C_{49} \\ C_{50} \\ C_{51} \\ C_{52} \\ C_{53} \\ C_{54} \end{bmatrix} + \begin{bmatrix} \varepsilon_{USCBA} \\ \varepsilon_{IP} \\ \varepsilon_{CPI} \\ \varepsilon_{INT} \\ \varepsilon_{FX} \\ \varepsilon_{TB} \end{bmatrix}$$

Trade Balance is included in the model to investigate the transmission mechanism of U.S. Monetary Policy through the trade channel. Trade Balance is equal to Export – Import. There will be two conditions to infer the transmission mechanism and channel of U.S. monetary policy shock on BRICS economy. The first conditions is the significant response in Trade balance to the shock and the second condition is the significant response in output that consistent with change in trade balance.

3.3.1.6 10 Year Government Bond Yield (GY)

$$\begin{bmatrix} USCBA_t \\ IP_t \\ CPI_t \\ INT_t \\ FX_t \\ GY_t \end{bmatrix} = \begin{bmatrix} C_1 & 0_2 & 0_3 & 0_4 & 0_5 & 0_6 \\ C_7 & C_8 & 0_9 & 0_{10} & 0_{11} & 0_{12} \\ C_{13} & C_{14} & C_{15} & 0_{16} & 0_{17} & 0_{18} \\ C_{19} & C_{20} & C_{21} & C_{22} & 0_{23} & 0_{24} \\ C_{25} & C_{26} & C_{27} & C_{28} & C_{29} & 0_{30} \\ C_{31} & C_{32} & C_{33} & C_{34} & C_{35} & C_{36} \end{bmatrix} \begin{bmatrix} USCBA_{t-1} \\ IP_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ FX_{t-1} \\ GY_{t-1} \end{bmatrix} + \begin{bmatrix} C_{37} \\ C_{38} \\ C_{39} \\ C_{40} \\ C_{41} \\ C_{42} \end{bmatrix} VIX_t + \begin{bmatrix} C_{43} \\ C_{44} \\ C_{45} \\ C_{46} \\ C_{47} \\ C_{48} \end{bmatrix} WCP_t + \begin{bmatrix} C_{49} \\ C_{50} \\ C_{51} \\ C_{52} \\ C_{53} \\ C_{54} \end{bmatrix} + \begin{bmatrix} \varepsilon_{USCBA} \\ \varepsilon_{IP} \\ \varepsilon_{CPI} \\ \varepsilon_{INT} \\ \varepsilon_{FX} \\ \varepsilon_{GY} \end{bmatrix}$$

10 year Government Bond Yield is included in the model to examine the influence of U.S. monetary policy on BRICS long term interest rate. The 10 year government bond yield is a benchmark for long term interest rate in domestic financial market. There will be two conditions to infer the transmission mechanism and channel of U.S. monetary policy shock on BRICS economy. The first conditions is the significant response in 10 year government bond yield to the shock and the second condition is the significant response in output that consistent with change in yield.

3.3.1.7 Foreign Exchange Reserve (FER)

$$\begin{bmatrix} USCBA_t \\ IP_t \\ CPI_t \\ INT_t \\ FX_t \\ FER_t \end{bmatrix} = \begin{bmatrix} C_1 & 0_2 & 0_3 & 0_4 & 0_5 & 0_6 \\ C_7 & C_8 & 0_9 & 0_{10} & 0_{11} & 0_{12} \\ C_{13} & C_{14} & C_{15} & 0_{16} & 0_{17} & 0_{18} \\ C_{19} & C_{20} & C_{21} & C_{22} & 0_{23} & 0_{24} \\ C_{25} & C_{26} & C_{27} & C_{28} & C_{29} & 0_{30} \\ C_{31} & C_{32} & C_{33} & C_{34} & C_{35} & C_{36} \end{bmatrix} \begin{bmatrix} USCBA_{t-1} \\ IP_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ FX_{t-1} \\ FER_{t-1} \end{bmatrix} + \begin{bmatrix} C_{37} \\ C_{38} \\ C_{39} \\ C_{40} \\ C_{41} \\ C_{42} \end{bmatrix} VIX_t + \begin{bmatrix} C_{43} \\ C_{44} \\ C_{45} \\ C_{46} \\ C_{47} \\ C_{48} \end{bmatrix} WCP_t + \begin{bmatrix} C_{49} \\ C_{50} \\ C_{51} \\ C_{52} \\ C_{53} \\ C_{54} \end{bmatrix} + \begin{bmatrix} \varepsilon_{USCBA} \\ \varepsilon_{IP} \\ \varepsilon_{CPI} \\ \varepsilon_{INT} \\ \varepsilon_{FX} \\ \varepsilon_{FER} \end{bmatrix}$$

Foreign Exchange Reserve is included in the model to examine the effect of U.S. Monetary Policy on Inflation. U.S. monetary expansion can cause the foreign currency appreciation which leads to the lower import price. When import input cost changes, CPI is expected to change as well. However, the significant change in CPI might not be found if the foreign central bank manages their Inflation Target by intervening the exchange rate movement through the foreign exchange reserve.

- 3.3.1.8 Government Surplus/Deficit

$$\begin{bmatrix} USCBA_t \\ IP_t \\ CPI_t \\ INT_t \\ FX_t \\ GY_t \\ GDS_t \end{bmatrix} = \begin{bmatrix} C_1 & 0_2 & 0_3 & 0_4 & 0_5 & 0_6 & 0_7 \\ C_8 & C_9 & 0_{10} & 0_{11} & 0_{12} & 0_{13} & 0_{14} \\ C_{15} & C_{16} & C_{17} & 0_{18} & 0_{19} & 0_{20} & 0_{21} \\ C_{22} & C_{23} & C_{24} & C_{25} & 0_{26} & 0_{27} & 0_{28} \\ C_{29} & C_{30} & C_{31} & C_{32} & C_{33} & 0_{34} & 0_{35} \\ C_{36} & C_{37} & C_{38} & C_{39} & C_{40} & C_{41} & 0_{42} \\ C_{43} & C_{44} & C_{45} & C_{46} & C_{47} & C_{48} & C_{49} \end{bmatrix} \begin{bmatrix} USCBA_{t-1} \\ IP_{t-1} \\ CPI_{t-1} \\ INT_{t-1} \\ FX_{t-1} \\ GY_{t-1} \\ GDS_{t-1} \end{bmatrix} + \begin{bmatrix} C_{50} \\ C_{51} \\ C_{52} \\ C_{53} \\ C_{54} \\ C_{55} \end{bmatrix} VIX_t + \begin{bmatrix} C_{56} \\ C_{57} \\ C_{58} \\ C_{59} \\ C_{60} \\ C_{61} \end{bmatrix} WCP_t + \begin{bmatrix} C_{62} \\ C_{63} \\ C_{64} \\ C_{65} \\ C_{66} \\ C_{67} \end{bmatrix} + \begin{bmatrix} \varepsilon_{USCBA} \\ \varepsilon_{IP} \\ \varepsilon_{CPI} \\ \varepsilon_{INT} \\ \varepsilon_{FX} \\ \varepsilon_{GY} \\ \varepsilon_{GDS} \end{bmatrix}$$

Government Surplus/Deficit is included in the model to examine the effect of U.S. Monetary Policy on long term interest rate since higher deficits are likely to put substantial upward pressures on sovereign bond yields and lead to a significant increase in long-term interest rates. (Baldacci & Kumar, 2010).

3.3.2 Vector of Foreign Variables

Central Bank Asset (CBA): CBA is used as a proxy for U.S. monetary policy measure in this study. Based on the previous study about the unconventional monetary policy, the financial crisis has been used to identify the unconventional period, for example Girardin and Moussa (2011) and Gambacorta et al. (2012) In the conventional period, the regular tools that the Federal Reserve uses to control the money supply are the Federal Fund

Rate, Require Reserve Ratio, and The Open Market Operation. Since December 2008, after the federal fund rate has been lowered to its lower bound, Fed has relied on unconventional monetary policy tools such as large scale of asset purchases and forward guidance to create the change on long-term interest rate and influence economy. FFR has been used in most research as a proxy for conventional monetary policy action for example Christiano et al. (1999), Kim (2001), Maćkowiak (2007). For the unconventional monetary policy proxies, the central bank asset (Gambacorta et al. (2012)), monetary base (Girardin and Moussa (2011)), 10 year Treasury bond yield (Moore et al. (2013)), and the shadow rate (Wu and Xia (2015)) have been used.

However, in this study the unconventional monetary policy instrument of the Federal Reserve is chosen to represent the U.S monetary policy measure while policy rate is not included in the basic model due to the limitation in lower bound of policy rate during the crisis and the widespread use of unconventional monetary policies. Similarly, the open market operation in conventional period and the large scale of asset purchase in the unconventional period have altered the asset part in the central bank balance sheet and monetary based in the markets. Since the proxy of monetary policy should allow the study of the effect and the change on both conventional and unconventional period, the change in Central Bank Asset and the monetary base is the interesting proxy for U.S. monetary policy measurement. In this study, the Central Bank Asset is used instead of the monetary base as it is the better gauge for unconventional monetary policy during the crisis (Gambacorta et al., 2012).

3.3.3 Vector of Global Variables

All global variables are assumed to be exogenous variables in the model.

3.3.3.1 World Commodity Price (WCP)

In the real economy, as BRICS are open economies, there are many external factors besides U.S. monetary policy actions that can affect their economies. In the past

studies, the World Commodity Price (Maćkowiak, 2007), World Interest Rate, or Oil price are popularly used as proxy of the Global external shocks. This Price Variable is included in the model to protect the price puzzle.

3.3.3.2 *Chicago Board Options Exchange Market Volatility Index (VIX)*

The reason to include VIX to the basic model is that, the study period includes the period of World Financial Crisis and the widely use of unconventional monetary policies which cause the surge of funds through the World financial system. To encounter with crisis, not only U.S. central bank but also many other major central banks adopt the large scale of unconventional policies to fight the crisis. There were various styles of Central Bank Unconventional Balance Sheet Policies adopted since 2007, for example the Liquidity Provision to Funding and Credit markets by ECB, BoE, BoJ, and RBA, the Purchase of Long Term Public Securities by Fed, BoE, and BoJ, the Large-Scale Foreign Exchange Intervention by BoJ and SNB through FX purchase and The Central Bank Involvement in credit provision by BOJ (Stone et al., 2011). All of these examples can lead to the change in the world economies and create the surges in global financial cycles.

Since Global financial cycles, a world with powerful global financial cycles characterized by large common movements in asset prices, gross flows, and leverages, are associated with surges and retrenchments in capital flows, booms and busts in asset prices and crisis (Rey, 2015), it is important to disentangle the external change effect from global financial environment from the effect of U.S. monetary policy (see e.g. Sims (1992), Christiano et al. (1999)). Otherwise the results could be misleading as the over-estimated of the spillover effect of U.S. monetary policies. To control this effect, this study includes VIX, Chicago Board Options Exchange Market Volatility Index, as a proxy of global financial cycles suggested by Rey (2015) as was discussed in section II. Therefore, VIX is included as a proxy for World financial Volatility in model. It is trademarked ticker symbol for the CBOE Volatility Index, a popular measure of the

implied volatility of S&P 500 index options; the VIX is calculated by the Chicago Board Options Exchange (CBOE). In stock market, VIX represents one measure of the market's expectation of stock market volatility over the next 30-day period. In academic study, VIX is commonly referred to “fear index or the fear gauge” (Whaley, 2000) as it reflects the financial market risk aversion.

3.4 Research Questions

As discussed above, in the integrated financial world and open economy, it is impossible for central banks to stay independent and completely shield their economies. Thus, the main research questions are, to what extent and how macroeconomic fluctuations in major emerging markets are, BRICS economies, is caused by U.S. monetary policy shocks? In addition, not only the magnitude, but also the speed and transmission channels of the shocks are examined. Following are the main research questions of this study.

- I. Do US monetary policy actions affect macroeconomic variables in BRIC countries?
- II. Are trade and interest rate the channels for such transmission?
- III. To what extent do US monetary policy actions affect macroeconomic variables in BRIC countries?

3.4.1 Hypothesis I: U.S. Monetary Policy has significant influence on BRICS' Output

There are two possible cases of expected impulse response which are BRICS output increase in response to U.S. monetary expansion and vice versa. On positive response side, when U.S. adopts monetary expansion, the federal fund rate and other U.S. interest rate such as the U.S. Treasury bond yield decrease. As U.S. is the large open economy and the global financial world is integrated, the decrease in U.S. interest rate

leads to the decrease in world interest rate which then leads to the increase in consumption and investment. This due to the decrease in interest rate implies that the current consumption is cheaper than future consumption and the lower cost of investment, is likely to increase domestic output.

However, on negative response side, the monetary expansion will lead to the depreciation in U.S. dollars against other currency, and then foreign currency appreciates. The appreciation in foreign currency can worsen foreign balance as the price of export good becomes more expensive. As a result, the foreign output decreases. In addition, on the other side, as monetary policy normally creates against central bank forecasted economic outlook, the monetary expansion signals the bad outlook of U.S. central bank on its economy so that it runs the easing policy to counter the effect in advance. Therefore, investors and producers might delay their investments and productions in the first place to meet the expected slow growth in the future.

Based on these perspectives, there are two expected impulse response outcomes for Industrial production variables responding to the U.S. monetary expansionary shock including increase and decrease. Following is the VAR model, assuming that lags length criterion suggest 1 lags for each country.

$IP_t = [USCBA_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

3.4.2 Hypothesis II: U.S. Monetary Policy has significant influence on BRICS' Inflation

There are three possible cases of expected impulse response which are BRICS price level increase, decrease, and has no significant change in response to U.S. monetary expansion.

On negative response from supply side, when U.S. adopts the expansionary monetary policy, U.S. dollar will depreciate against the foreign currency. Since foreign currency appreciates, the import price will be decreased. If there is the spillover effect of the U.S.

monetary policy, CPI is expected to decrease as the imported input cost decreases. On positive response from demand side, if there is capital leaking out from U.S. to BRICS, and if the recipient countries already operate at full capacities, the oversupply of money can lead to the increase in inflation.

However, the significant change in CPI might not be found if the foreign central bank manages their Inflation Target by intervention of the exchange rate movement through the foreign exchange reserve. Take into account the intervention of foreign central banks, to test this hypothesis; the foreign exchange reserve is included to the basic model. Following is the VAR model, assuming that lags length criterion suggest 1 lags for each countries.

$CPI_t = [USCBA_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

3.4.3 Hypothesis III: U.S. Monetary Policy can explain BRICS Monetary Policy

In the globally integrated economy, all central banks have to concern the external risks when making policy since there are the extent to which the setting of policy as well as the monetary condition are influenced by the external financial developments or shocks. For example, when U.S. runs the LSAPs program, the interest rates in U.S. decreases. Then, U.S. Capital is expected to flow out of country to seek for the better interest. If the amount are large enough, the recipient countries currency will be appreciated which can worsen their exports. In addition, if the recipient country is already operated at full capacity; the excessive amount of capital inflow may cause the inflation problem. Therefore, the policy makers should design the weighted trade off policies in response to the U.S. monetary policy shocks. The third hypothesis aims to examine the influence of U.S. Monetary policy on BRICS monetary policies. The policy rate response is expected to be negative in response to U.S monetary expansion. Following is the form of VAR model, assuming that lags length criterion suggest 4 lags for each country.

$INT_t = [USCBA_{t-1}, IP_{t-1}, CPI_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

3.4.4 Hypothesis IV: U.S. Monetary Policy has influence on BRICS' Real Effective Exchange Rate

U.S. monetary expansion leads to the devaluation in USD and appreciation in foreign currency against USD. The appreciation against USD will not only affect the bilateral trade between U.S. and foreign country but also affect the national competitive level with its trade rivals since USD is the major currency using as the mean of exchange around the world. USD is also one of the common major currencies in the basket using for weighting the real effective exchange rate of the nations. The effect of U.S. monetary action on the foreign currency varies across countries due to the difference in exchange rate regimes and the foreign central bank reactions.

There are three possible cases of expected impulse response which are BRICS real effective foreign exchange reserves which are positive response, negative response, and have no significant change response to U.S. monetary expansion. In no response perspective, countries with relatively fixed exchange rate, the effect is likely to reflect through the change in foreign exchange reserve due to the central bank intervention rather than the variation in exchange rate. In addition, if the currency of BRICS's trade partners also appreciates against U.S. dollars in the same level, the change in real effective exchange rate can be insignificant.

While the country with relatively float exchange rate regime is likely to have more response in exchange rate. For bilateral exchange rate, BRICS including its trade partner's currencies are expected to appreciate against USD depreciation. However, for the real effective exchange rate, if the inflow from U.S goes to BRICS more than its partner, the appreciation of BRICS currency against USD is expect to be higher in relative to their trade partners and then the real effective exchange rate is expected to appreciate. Also, the impulse response is expected to be negative. In positive response

side, if inflow from U.S. goes to trade partners more, BRICS foreign exchange reserve is expected to depreciate and the response is expected to be positive.

Since the effect of U.S. monetary policy can be reflected on both variables; exchange rate and foreign exchange reserve due to the difference in exchange rate regime and the central bank response, this study will examine the effect on exchange rate through the foreign exchange reserve in the extended model. Following is the VAR model, assuming that lags length criterion suggest 1 lag for each country.

$FX_t = [USCBA_{t-1}, IP_{t-1}, CPI_{t-1}, INT_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

$FER_t = [USCBA_{t-1}, IP_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

3.4.5 Hypothesis V: Monetary Policy Transmission has influence on BRICS's Trade Balance.

In order to test whether the trades balance is the transmission channel of the U.S. monetary policy as suggested by the basic MFD model or not. Trade balance variable is included in the extended model. If there is the transmission of the effect through this channel, the significant change in trade balance is expected to be found which is inconsistent with the significant change in output. Trade balance is expected to be worse due to currency appreciation and output is expected to decrease which is inconsistent with this. Following is the VAR model, assuming that lags length criterion suggest 1 lag for each country.

$TB_t = [USCBA_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

3.4.6 Hypothesis VI: U.S. Monetary Policy Transmission has influence on BRICS's Long Term Interest Rate.

In order to test whether or not, the interest rate is the transmission channel of the U.S. monetary policy. Long term interest rate variable is included in the extended model. As U.S. adopts the LSAPs program, central bank asset purchases, especially large amount of 10 years Treasury bonds, have reduced yield of long term bonds in the U.S. market. The decrease in long term treasury yields may cause the flow of fund toward BRICS financial market for the higher risk adjusted return. The higher demand on domestic asset will raise the price and lower the yield. If the interest rate is the transmission channel of the shock, domestic consumption and investment tends to be increase. As a result, output is expected to increase which is inconsistent with the decrease in yield. In order to test whether or not the U.S. monetary policy has an influence on BRICS's long term interest rate, the basic model that has GY10, 10 years Government Bond Yield as dependent variable will be used to examine the transmission. In addition, Government Surplus and Deficit (GSD) are added to the extended model to take into account the effect from fiscal deficit since higher deficit is likely to put substantial upward pressures on sovereign bond yields and lead to a significant increase in long-term interest rates. (Baldacci & Kumar, 2010). If there is the transmission of the effect through this channel, the negative response of GY10 is expected to be found, which is inconsistent with the significant change in output. Following is the VAR model, assuming that lags length criterion suggest 1 lag for each country.

$GY_t = [USCBA_{t-1}, IP_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

$GY_t = [USCBA_{t-1}, IP_{t-1}, CPI_{t-1}, INT_{t-1}, FX_{t-1}, GSD_{t-1}]$, where VIX_t and WCP_t are exogenous variables.

Chapter IV

Empirical Result

4.1 Descriptive data Analysis

Overall, over the period of 2005:04-2016:02, the mean industrial production indexes of BRICS countries are around 95% to 112%; around 95% for Brazil and India, around 103-105% for Russia and South African, and around 112% for China. The standard deviation of BRICS industrial production is around 4-6% except for India whose variation in output is relatively high which is around 14%.

The mean of BRICS consumer price index is around 101%-106%; 101%-102% for China, Russia and South Africa, around 104% for China and 106.5% for Brazil. The standard deviation of BRICS CPI is around 10%-28% which China is relatively low around 9%, Brazil and South Africa which are inflation targeting countries considered as medium 18-19%, and for Russia and India considered as relatively high 27-28%.

The mean of BRICS policy rate is around 6 -11%; around 6% for China, 7% for Russia and South Africa and 11% for Brazil. The standard deviation of BRICS policy rate is around 0.7-2.6%. The policy rate standard deviation is quite low for China and India which is around 0.7% and 1% respectively while the standard deviation of Brazil, Russia and South Africa is around 2-2.6%.

The mean of BRICS real effective exchange rate is around 88-103%, which is around 88-89% for Brazil and South Africa, 95-97% for Russia and India, and around 104 for China. The standard deviation of BRICS real effective exchange rate is around 4-14%. Overall the standard deviation of Brazil, Russia and South Africa foreign exchange rate is around 10-11%, around 14% for China, and relatively low in India around 4%.

The mean of BRICS foreign exchange reserve is around 39 thousands to 2.5 million (in millions of USD). The average of China foreign exchange reserve is very high when comparing to other BRICS countries' which is around 2.5 million of millions of Dollars. Whereas the average foreign exchange reserve of South Africa is relatively low: only around 39,620 million of USD. The foreign exchange reserves of other countries are in relatively similar level; 249,685 million of USD for India, 270,321 million of USD for Brazil and 421,340 million of USD for Russia. Overall the standard deviation of BRICS foreign exchange reserve is around 10 thousands to 1 million (in millions of USD). In comparison, the standard deviations are relatively low for South Africa (10,525) and India (53,979), medium for Brazil (105,821) and Russia (112,347) and relatively high for China (1,069,174).

The mean of BRICS Trade Balance is around (-14,545) to 26,828 million of USD. The average of India and Russia trade balances over the current decade are in deficit position: around (-9,731) and (-14,545) million of Dollar respectively. Whereas the trade balances of Brazil, China, and South Africa are in Surplus position: around 1,916 million of Dollar for Brazil, around 22,302 million of Dollar for China and around 26,828 million of Dollar for South Africa.

The mean of BRICS 10 year treasury yield is around 3.2 – 8.2%. In comparison, 10 year treasury yield is relatively low for Brazil and South Africa (around 3.2-3.6%), and relatively high for China, India and Russia (around 7.8-8.3%). The standard deviation is around 0.5-1.8%. The standard deviation of treasury yield is relatively high for India (around 1.8%) while the standard deviations of other countries are around 0.4% for South Africa, around 0.6% for Russia, around 0.8% for China, and around 1% for Brazil.

Table 2 Descriptive Statistics

This table indicates basic statistics of countries' variables during April 2005 to February 2016 in monthly basis; Industrial Production (IP), Consumer Price Index (CPI), Policy Interest Rate (INT), Real Effective Exchange Rate (FX), Trade Balance (TB), 10 Treasury Yield (GY).

	IP	CPI	INT	FX	FER	TB	GY
<u>BRAZIL:</u>							
Mean	95.46	106.51	11.33	88.49	270321.8	1916.17	3.15
Median	97.02	103.65	11.25	89.99	306220.0	1915.50	2.93
Maximum	103.64	147.14	17.25	108.07	378680.2	5917.00	5.05
Minimum	81.19	81.83	7.25	64.32	57364.66	-2247.00	1.47
Std. Dev.	5.30	18.21	2.29	10.42	105821.1	1540.13	1.04
<u>CHINA:</u>							
Mean	112.42	101.90	5.93	103.66	2514742.	22302.80	8.16
Median	113.09	100.53	6.00	101.54	2646954.	19376.00	8.17
Maximum	120.83	116.96	7.47	131.89	3992471.	86312.00	10.84
Minimum	105.18	86.23	4.35	82.61	669726.6	-11299.00	6.07
Std. Dev.	4.19	9.61	0.72	13.88	1069174.	14248.31	0.76
<u>INDIA:</u>							
Mean	95.58	104.02	7.06	96.54	249685.1	-9731.73	8.31
Median	100.88	100.89	7.50	96.27	261190.9	-9428.00	7.83
Maximum	115.24	152.18	9.00	104.58	332562.2	-2668.00	14.09
Minimum	63.66	65.04	4.75	86.78	131088.9	-19255.00	6.27
Std. Dev.	14.16	28.10	1.11	4.45	53979.20	4159.05	1.84
<u>RUSSIA:</u>							
Mean	103.16	102.40	7.11	94.78	421340.5	-14545.47	7.86
Median	105.32	101.76	6.08	97.39	453388.3	-14312.00	7.89
Maximum	112.40	158.28	17.44	111.71	576569.1	-5101.00	9.27
Minimum	88.45	60.35	5.02	68.48	141795.2	-23890.00	5.28
Std. Dev.	6.41	27.30	2.59	10.19	112347.4	5065.41	0.62
<u>SOUTH AFRICA</u>							
Mean	105.07	101.31	7.06	88.75	39620.27	26828.22	3.66
Median	105.39	100.37	6.50	90.40	43648.11	25946.00	3.55
Maximum	117.40	135.87	12.00	109.64	51478.59	38136.00	4.63
Minimum	93.38	71.47	5.00	63.56	16214.58	14225.00	2.86
Std. Dev.	4.93	18.86	2.08	10.70	10525.48	7509.01	0.43

In Millions of USD: FER and TB

In Percentage: INT and GY

4.2 Correlation Analysis

4.2.1 Correlation between BRICS variables and U.S. central bank asset

Table 3 Correlation between U.S. Central Bank Asset and BRICS Variables

This table shows correlations between U.S. Central Bank Asset and the BRICS macro variables

	Brazil	China	India	Russia	South Africa
USCBA					
IP	0.1630	-0.7895	0.8853	0.5486	-0.2217
CPI	0.9405	0.9396	0.9692	0.9664	0.9695
INT	-0.4840	-0.4437	0.1307	0.3883	-0.6837
FX	0.2401	0.9401	0.1892	0.0990	-0.5090
TB	-0.5370	0.4716	0.7037	0.4678	0.4299
GY	-0.8769	-0.2240	0.5424	0.3357	-0.0143

Overall, the correlation between U.S. central bank asset and BRICS macro-variables varies across countries. U.S. central bank asset has positive correlation with Brazil, India, and Russia output, while the correlation with China and South Africa output is negative. The correlation is quite strong for China (-0.79) and India (0.89), relatively moderate for Russia (0.55) and relatively weak for Brazil (0.16) and (-0.22). For Inflation, U.S. central bank asset seems to have strong positive correlation (around 0.93-0.97) with the price level of all BRICS countries

For policy rate, U.S. central bank asset has negative correlation with Brazil (-0.48), China (-0.44), and South Africa (-0.68) policy rate, while the correlation with India (0.13) and Russia (0.39) policy rate is positive. Significantly, the correlation between U.S. central bank asset level and the policy rate of India (0.13) is relatively weak in relative to other countries (0.39-0.48).

For real effective exchange rate, U.S. central bank asset has positive correlation with real effective interest rate of all BRICS countries except for South Africa. The correlation

with USCBA is very strong for China FX (0.94) and moderate for South Africa (-0.51) and relatively weak for Brazil (0.24), India (0.19) and Russia (0.10).

For trade balance, U.S. central bank asset has positive correlation with real effective interest rate of all BRICS countries except for Brazil. The correlation with USCBA is very strong for India TB (0.70) and moderate for other countries which are Brazil (-0.54) China (0.47), Russia (0.47) and South Africa (0.43).

For 10 year treasury yield, U.S. central bank asset has negative correlation with Brazil (-0.88), China (-0.22), and South Africa (-0.01) treasury yield, while the correlation with India (0.54) and Russia (0.34) 10 year treasury yield is positive. The correlation with USCBA is very strong for Brazil GY (0.88) and moderate for India GY (-0.55) and relatively weak for China (-0.22), Russia (0.34) and South Africa (-0.01).

4.2.2 Correlation between BRICS variables and the Multicollinearity

There are pairs of high correlation between variables in the models of Brazil, China, and India. For Brazil, there are strong positive correlation between industrial production and real effective exchange rate (around 0.85) and strong negative correlation between inflation and 10 year Treasury yield (around -0.84). For China, there are strong negative correlation between industrial production and real effective exchange rate (around -0.88) and strong positive correlation between inflation and 10 year real effective exchange rate (around 0.95). For India, there are strong positive correlation between industrial production and inflation (around 0.91) and strong positive correlation between industrial production and trade balance (around 0.84). For the robustness, the models with omitted variable from the high correlated pairs are checked whether multicollinearity can potentially be a problem. The dynamic response of variables in the omitted variable models is consistent with the dynamic response from the basic models in the other word so the results show that the high correlation between variables does not create a problem.

Table 4: Correlation between BRICS Variables in the Models

This table shows correlations of endogenous variables to check the whether each countries variables are highly correlate which may lead to the multicollinearity problem

BRAZIL						
	IP	CPI	INT	FX	TB	GY
IP	1.0000					
CPI	0.0931	1.0000				
INT	-0.6357	-0.3799	1.0000			
FX	0.8535	0.0829	-0.6756	1.0000		
TB	-0.3850	-0.4832	0.5085	-0.2895	1.0000	
GY	-0.1705	-0.8426	0.4834	-0.2551	0.5089	1.0000
CHINA						
	IP	CPI	INT	FX	TB	GY
IP	1.0000					
CPI	-0.7746	1.0000				
INT	0.4369	-0.2014	1.0000			
FX	-0.8808	0.9515	-0.4026	1.0000		
TB	-0.6556	0.5773	-0.1177	0.6223	1.0000	
GY	0.1988	-0.2025	0.0712	-0.1960	-0.0412	1.0000
INDIA						
	IP	CPI	INT	FX	TB	GY
IP	1.0000					
CPI	0.9122	1.0000				
INT	0.3153	0.2952	1.0000			
FX	0.3281	0.2759	0.2136	1.0000		
TB	0.8387	0.7240	0.3928	0.2243	1.0000	
GY	0.3446	0.4453	-0.2803	-0.0543	0.1363	1.0000
RUSSIA						
	IP	CPI	INT	FX	TB	GY
IP	1.0000					
CPI	0.6702	1.0000				
INT	0.0288	0.4600	1.0000			
FX	0.2938	0.0483	-0.6874	1.0000		
TB	0.7574	0.5002	-0.3459	0.7801	1.0000	
GY	0.7520	0.3932	-0.2700	0.4564	0.6860	1.0000
SOUTH AFRICA						
	IP	CPI	INT	FX	TB	GY
IP	1.0000					
CPI	-0.0377	1.0000				
INT	0.2832	-0.5786	1.0000			
FX	-0.2630	-0.6116	-0.1148	1.0000		
TB	0.2669	0.4953	-0.3086	-0.0834	1.0000	
GY	0.3608	0.0738	0.1204	-0.0662	0.5007	1.0000

* Bold latter –High Correlation

4.3 Granger Causality

Table 5: VAR Granger Causality – Wald Test

This table shows the statistic result of Granger Causality – Wald Test. The results show the joint probability that USCBA cause change in BRICS macro variables.

Dependent Variable: USCBA		
	Chi-sq	Prob.
BRAZIL	91.3721	0.0000***
CHINA	110.9543	0.0000***
INDIA	93.8397	0.0000***
RUSSIA	38.763	0.0031***
SOUTH AFRICA	146.9564	0.0000***

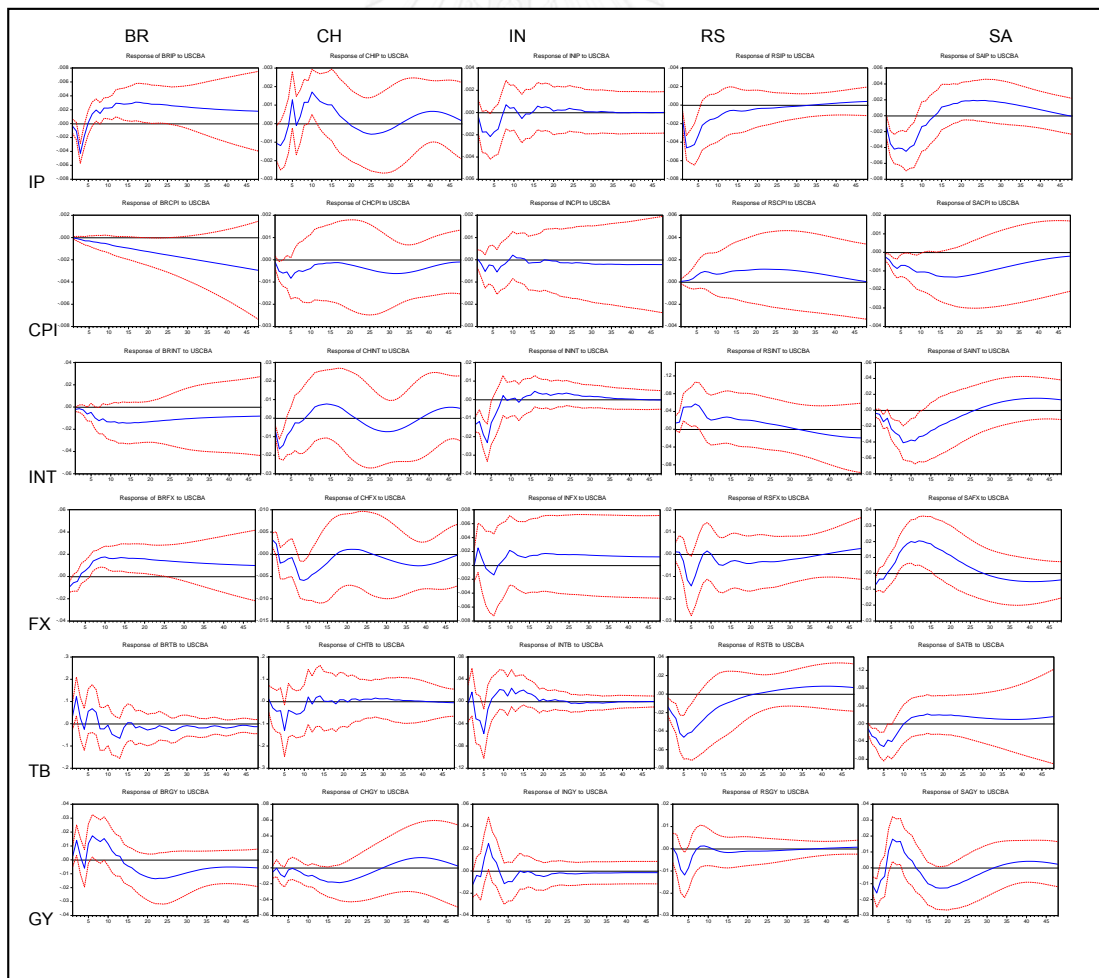
*** Statistically significant at 99% confident interval

The Results from VAR Granger Causality show that U.S. monetary policy significantly causes change in BRICS economies. The causality is jointly significant at 99% confidential level. Overall, the change in U.S. central causes the change in BRICS real effective exchange rate for all BRICS countries except Russia. In addition, the changes in U.S. central bank asset also cause the change in BRICS 10 year treasury yield in all BRICS except for Brazils. The causality between U.S. monetary policy variables and other BRICS macro variable besides the real effective exchange rate and 10 years treasury yield varies across countries. Based on countries, the results show that change in U.S. central bank asset causes change in Brazil real effective exchange rate and trade balance. For China, change in U.S. central bank asset causes change in price level, policy interest rate, real effective exchange, and 10 years treasury yield. For India, U.S central bank asset causes change in policy rate, real effective exchange rate, 10 years treasury yield. For Russia, U.S. CBA causes change in industrial production, price level, trade balance and 10 years treasury yield. For South Africa, change in U.S. central bank asset causes change in price level, real effective exchange rate and 10 year treasury yield.

4.4 Impulse Response Function-Vector Auto Regression Analysis

Overall, there are the significant spillover effects of U.S. monetary policy on BRICS economies. In terms of Monetary Policy Regime, the result shows that countries with 'Inflation Targeting' Monetary Policy Regime significantly respond to the shock with the longer period than countries with other monetary policy regime. Overall, the effect on inflation targeting countries is around 1-2 years for countries which employ inflation targeting monetary policy like Brazil and South Africa while the effect on countries with other regime lasts only around 1-3 quarters. In addition, in terms of Exchange Rate Regime, the result depicts that countries with Non-Float Exchange Rate Regime respond to the shock shorter than those with Float Exchange Rate Regime. The effect on

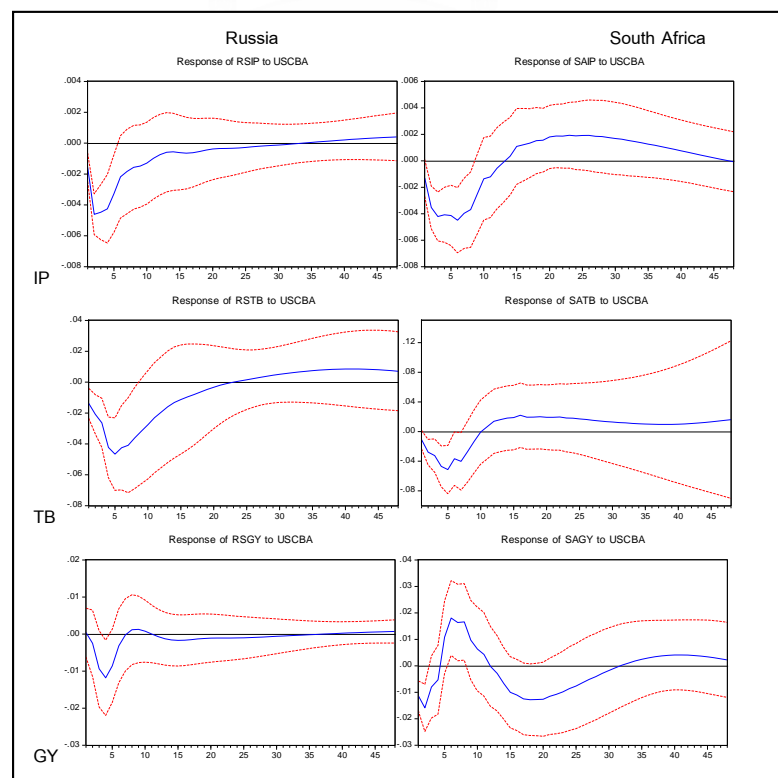
Figure 4 Response to Cholesky One SD Innovations in U.S. Central Bank Asset ± 2 S.E



countries with non-float exchange rate regime which are China and Russia lasts only 1-3 quarters while the effect on countries with float exchange rate regime except for India like Brazil and South Africa lasts around 1-2 years (See figure 4).

For the transmission mechanism of U.S. monetary shock to BRICS economies. The empirical results show that Trade channel play significant role as the transmission channel of the shock to output while interest rate channel seem to be less important during the study period. There are significant responses in the outputs of Brazil, Russia, and South Africa while there are also significant responses in trade balance variables (proxy of trade channel) and 10 year treasury yield variables (proxy of interest rate channel) in Russia and South Africa. For trade channel, the negative responses to U.S. shock in trade balance are consistent with the negative responses in outputs as worsen in trade balance lead to the decrease in output. For interest rate channel, the initial negative responses in treasury yield are not consistent with response in outputs.

Figure 5 Significant Response of Russia and South Africa's Output, Trade Balance and 10 year Treasury Yield



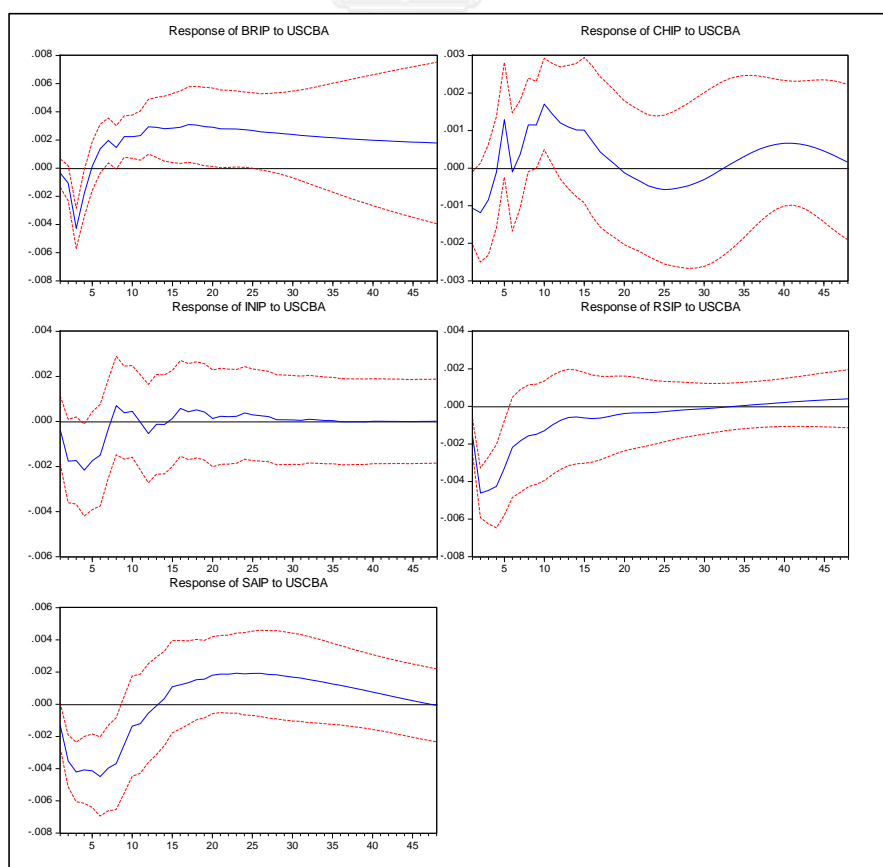
In terms of countries, Brazil is affected for the longest period (around 1-2 years) while China faced the shortest period which is only around 1 quarter. The other countries are affected around 2 quarter to 1 year. South Africa is affected in all tested variables, which are output, inflation policy rate, exchange rate trade balance and government treasury yield while India shows significant response only in interest rate variables including short term interest rate and treasury yield. The other countries show the significant response only in 2-4 variables. For the robustness, the models including the foreign exchange reserve and the government surplus and deficit are examined to ensure that the robustness of the study models and the empirical results of these models yield the relatively similar impulse response dynamic found in based models. Overall, the spillover effect of U.S. monetary policy on BRICS economies varies across economies and across variables. The followings are the impulse response analysis categorized in term of variables.



4.4.1 Output

Output responses are significant in Brazil, Russia and South Africa. Overall, the responses are negative around 0.45-0.48 bps and the effect lasts around 2 quarters to 1 year. The negative responses in output are consistent with the intuition. The monetary expansion will lead to the appreciation in foreign currency which worsen foreign balance as the price of export good becomes more expensive. As a result, the foreign output decreases. In addition, as monetary policy normally creates against central bank forecasted economic outlook, the monetary expansion signals the bad outlook of U.S. central bank on its economy. As a result, it runs the easing policy to counter the effect in advance in order that investor and producer might delay their investment and production in the first place to meet the expected slow growth in future and then output decreases.

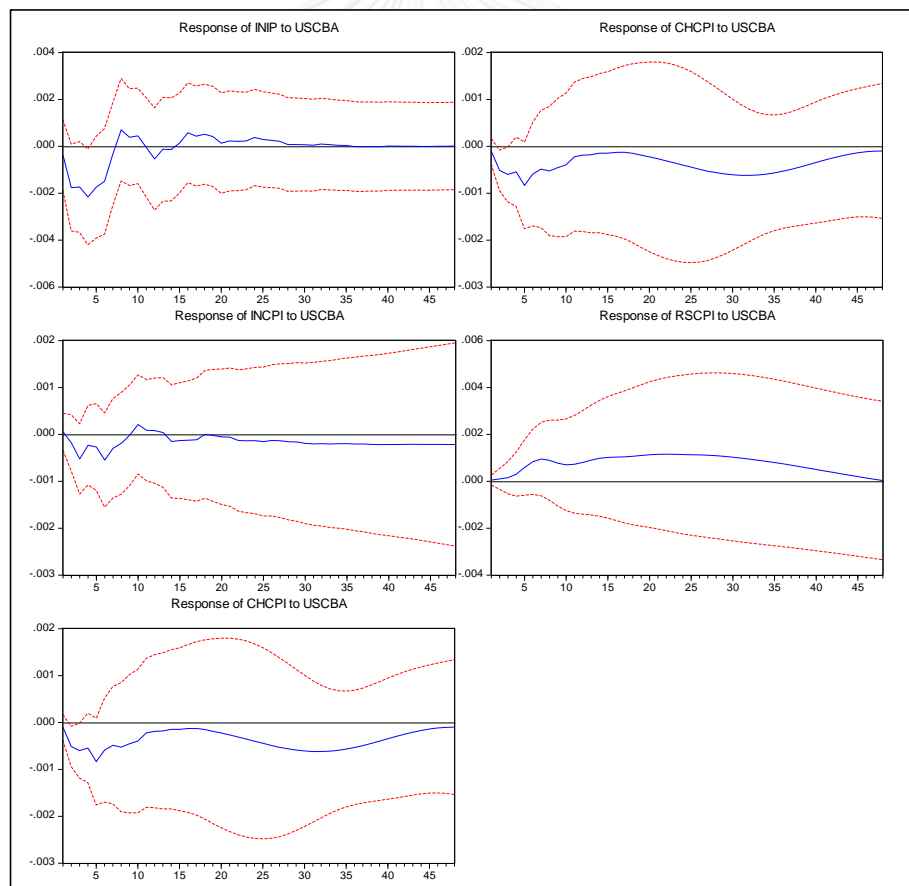
Figure 6 Impulse Response of BRICS Industrial Production to 1 SD shock in U.S. Central Bank Asset



4.4.2 Inflation

The response of BRICS Price level is not-significant in most BRICS countries except for South Africa. For South Africa, the response is negative, around 0.1 bps within 3 quarters. The negative response to U.S. monetary policy shock is consistent with the intuition on supply side and U.S. expansionary leads to the appreciation in BRICS currency and decrease in imported input price. As BRICS are manufacturing countries that import significant number of inputs for production, the decrease in imported input price can lead to the decrease in price level.

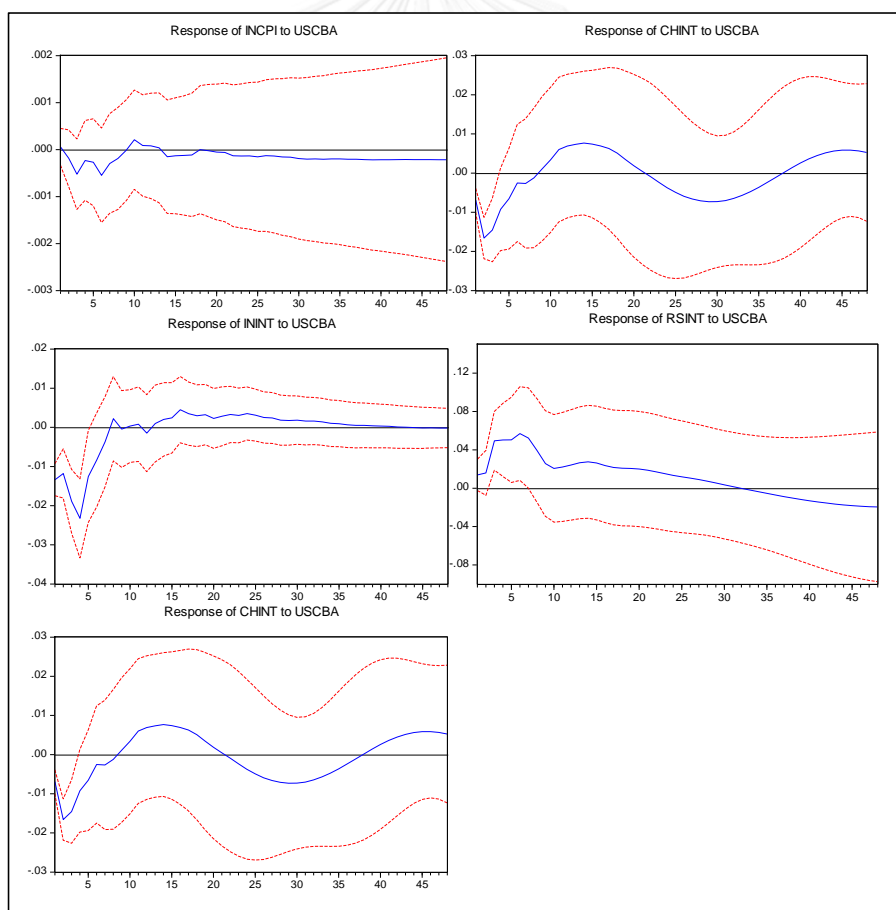
Figure 7 Impulse Response of BRICS Consumer Price Index Balance to 1 SD shock in U.S. Central Bank Asset



4.4.3 Policy Interest rate

The response of BRICS Policy Rate to the shock in U.S. monetary policy is significant in most BRICS countries except for Brazil. Overall the responses are negative as expected except for India, around 1.6-5 bps and the effect lasts around 1quarter to 1 year. The negative response to U.S. monetary policy shock is consistent with the intuition in which foreign central banks will decrease the policy rate in response to the decrease in U.S. interest rate (increase in U.S. central bank asset) to protect their economies from currency appreciation and worsened trade balance.

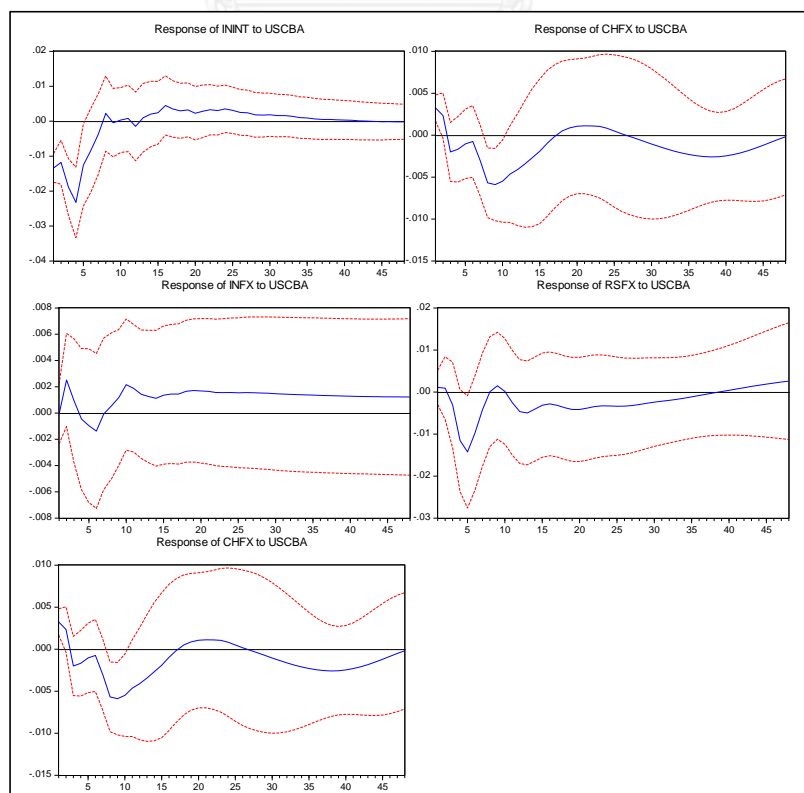
Figure 8 Impulse Response of BRICS Policy Rate to 1 SD shock in U.S. Central Bank Asset



4.4.4 Real Effective Exchange Rate

In response to the shock in U.S. monetary policy, BRICS Real effective exchange rate significantly responds in India, Brazil, China, and South Africa. The response is negative around -0.5 bps in China but the effect is shortly significant only in 1 quarter. In contrast there are Positive responses around 1.8-2 bps in Brazil and South Africa with relatively longer effect which the significant is about 3 quarters to 2 years. The negative response in China is consistent with the intuition. Inflows from U.S. go to China more than its trade partners so China currency becomes more appreciated than its trade partner. As a result, China Yuan appreciates, leading to negative response in FX. In contrast the positive response in Brazil and South Africa real effective exchange rate is consistent with the intuition. Inflows from U.S. go to their trade partners more than to them so currency of trade partner becomes more appreciated and trade currency of Brazilian Real and South Africa Rand becomes depreciated, resulting in positive response in FX.

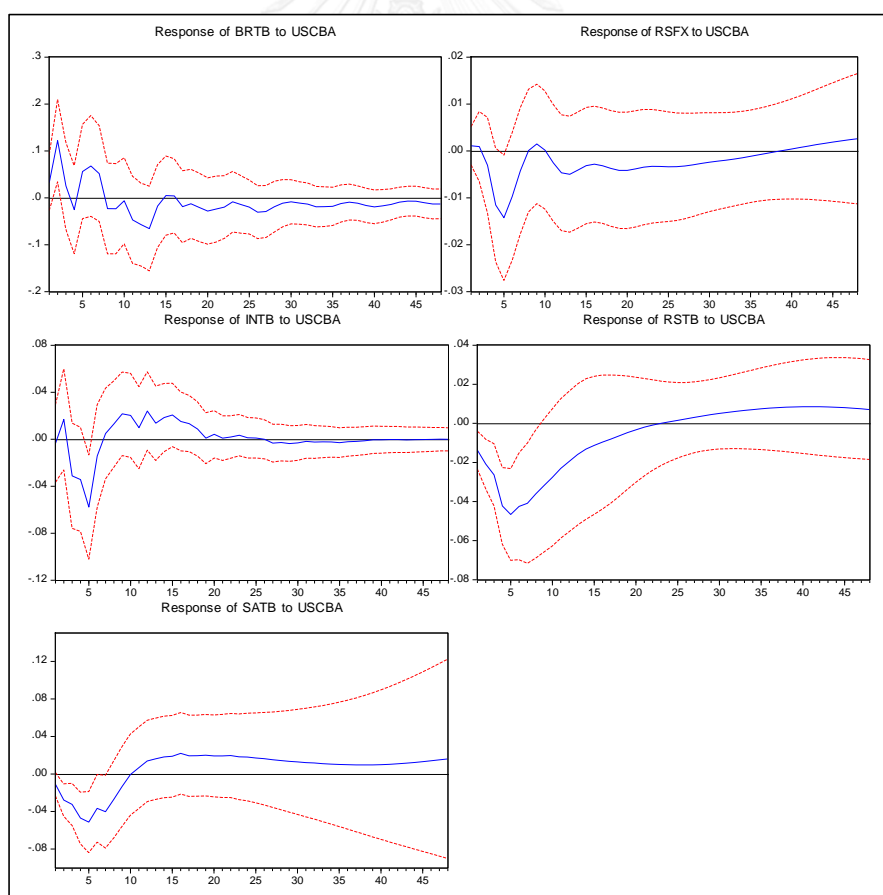
Figure 9 Impulse Response of BRICS Real Effective Exchange Rate to 1 SD shock in U.S. Central Bank Asset



4.4.5 Trade Balance

Trade Balance responses are significant in Russia and South Africa. Overall the responses are negative around 4.5-5 bps within 2-3 quarters. The negative response in trade balance is consistent with the intuition. U.S. monetary expansion leads to appreciation in foreign currency and more expensive price of export good, which resulting in worsened trade balance. Based on the result, significant negative response, in Russia and South Africa trade balance seems to be consistent with decrease in Russia and South Africa output. This can imply the transmission mechanism of U.S. monetary policy shock on BRICS economies through Trade Channel.

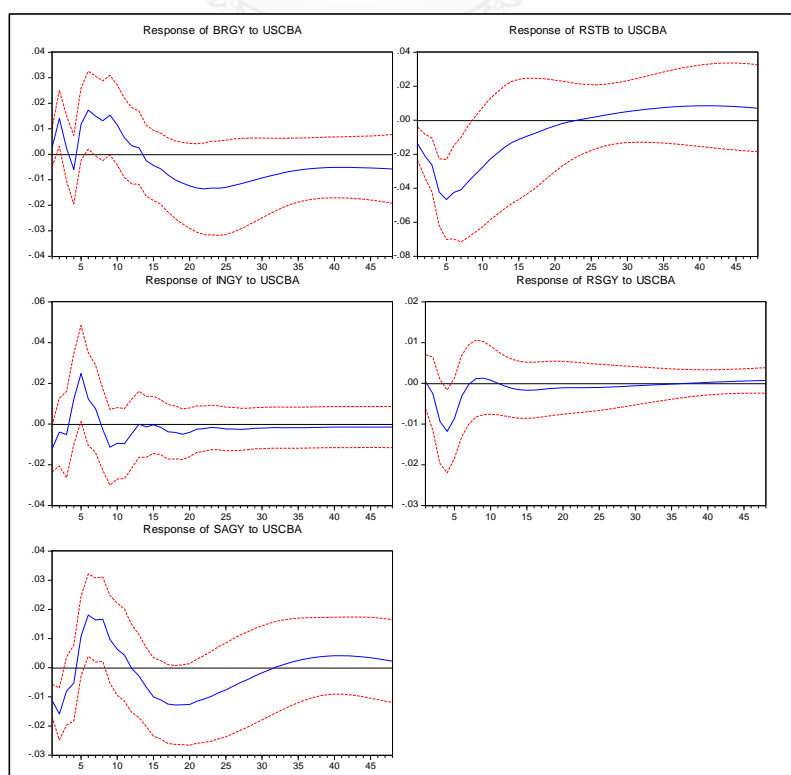
Figure 10 Impulse Response of BRICS Trade Balance to 1 SD shock in U.S. Central Bank Asset



4.4.6 10 year Treasury Yield

10 year Treasury Yield responses are significant in Russia and South Africa. Overall the responses are initially negative around 1.2-.1.5 bps with around 2 months. However, the response in South Africa becomes positive at peak around 1.5 bps after five months and significant around 3 months. The negative response in treasury yield is consistent with the intuition. U.S. monetary expansion leads to the decrease in U.S. interest rate which resulting in capital outflow from U.S. and the flow of fund towards BRICS financial market for the higher risk adjusted return. The higher demand on domestic assets will raise the price and lower the yield of financial assets which imply with negative response in GY variable. Based on the results, the significant negative response in Russia and South Africa long term yield seems not to be consistent with the decrease in Russia and South Africa outputs. This may imply that during the current decade which is ranged in the period of financial turmoil, the interest rate channel seems to play insignificant role as the transmission channel of U.S. monetary policy on BRICS economies.

Figure 11 Impulse Response of BRICS 10 years Treasury Yield to 1 SD shock in U.S. Central Bank Asset



4.5 Variance decomposition-Vector Auto Regression Analysis

4.5.1 The Trend Analysis of Average Variance Decomposition Fraction of U.S. Monetary Policy on BRICS variables.

This table summarizes how much U.S. monetary policy shock and domestic policy rates can explain BRICS variables comparing between first year and second year. The table provides overall results on BRICS and each individual country.

Table 6: The Fraction of Variance due to U.S. Monetary Policy Shock

THE FRACTION OF THE VARIANCE DUE TO U.S. MONETARY POLICY SHOCK								
Variable	Source of Disturbance	Horizon (months)	Brazil	China	India	Russia	South Africa	Average BRICS
IP	U.S. monetary policy shock	1 to 12	33.6	10.1	7.1	47.0	33.5	26.3
		13 to 24	49.0	14.8	4.8	47.5	40.0	31.2
	Domestic Policy Rate	1 to 12	4.1	2.3	1.9	2.8	3.8	3.0
		13 to 24	26.9	12.4	1.6	7.5	4.8	10.6
CPI	U.S. monetary policy shock	1 to 12	7.0	5.5	1.6	1.2	17.7	6.6
		13 to 24	23.6	3.0	1.1	3.9	23.9	11.1
	Domestic Policy Rate	1 to 12	6.7	7.2	2.5	1.9	0.3	3.7
		13 to 24	18.4	9.4	4.6	7.4	1.4	8.2
INT	U.S. monetary policy shock	1 to 12	9.4	15.5	37.0	11.0	17.7	18.1
		13 to 24	23.6	9.0	27.2	13.1	22.2	19.0
	Domestic Policy Rate	1 to 12	81.7	53.9	56.2	46.1	56.9	59.0
		13 to 24	64.5	51.8	48.8	38.6	42.5	49.2
FX	U.S. monetary policy shock	1 to 12	24.1	10.9	1.0	2.6	19.4	11.6
		13 to 24	60.7	9.9	1.4	3.0	39.9	23.0
	Domestic Policy Rate	1 to 12	1.7	10.0	0.9	5.0	0.7	3.7
		13 to 24	7.1	16.4	0.4	12.5	1.9	7.7
TB	U.S. monetary policy shock	1 to 12	14.6	8.3	7.2	24.5	6.1	12.1
		13 to 24	17.8	7.4	10.9	30.0	5.7	14.4
	Domestic Policy Rate	1 to 12	9.2	5.4	0.4	14.1	15.2	8.9
		13 to 24	10.3	29.5	1.3	25.9	38.0	21.0
GY	U.S. monetary policy shock	1 to 12	12.4	4.9	5.0	6.7	22.8	10.4
		13 to 24	21.1	0.9	5.9	8.5	33.3	13.9
	Domestic Policy Rate	1 to 12	11.8	19.9	2.3	2.8	9.3	9.2
		13 to 24	16.5	1.9	4.1	5.9	9.4	7.6
Note: "1 to 12" stands for the average from 1 month after a shock to 12 months after a shock. "13 to 24" stands for the average from 13 month after a shock to 24 months after a shock. Each row in the column "Average BRICS" is the average of the entries in the same row.								

Overall, the empirical results show that, within two years period, the variance decomposition fractions of U.S. monetary policy on BRICS variables increase over the time in most BRICS countries except for the decreasing trend in China and mixed trend in India. For Brazil, Russia and South Africa, the result shows the increasing trend over 2 years except for South Africa's trade balance. U.S. monetary policy seems to account for less variation when time passes. In contrast, U.S. monetary policy accounts for less variation in China variables overtime, except for output variable. The results are mixed for India.

4.5.2 The Comparison between Variance Decomposition Fractions of U.S. Monetary Policy Variable and Domestic Policy Rate at 2 years period

Table 7 Variance Decomposition of Domestic Variables at 2 years period

This table compares the degree of variance decomposition between U.S. monetary policy shock and domestic policy rates on BRICS variables at 2 year period.

Account of U.S. Central Bank Asset						
	IP	CPI	INT	FX	TB	GY
BRAZIL	52.5946	31.0957	28.8490	20.6429	39.2006	26.9033
CHINA	12.4533	2.8019	9.0306	8.4473	6.4287	22.2240
INDIA	5.0082	0.7515	26.7737	2.2731	13.1200	5.6236
RUSSIA	46.8288	4.4180	12.5420	2.9034	29.1076	8.5875
SOUTH AFRICA	43.4145	24.7443	33.6956	33.8009	13.1099	34.8097
Account of Domestic Policy Rate						
BRAZIL	28.7250	19.4911	59.0897	9.6373	10.1752	14.7648
CHINA	18.3447	8.1826	52.4083	16.9794	33.9347	2.9305
INDIA	0.8140	4.0656	43.1599	0.5914	2.3399	3.8372
RUSSIA	8.4078	7.8821	37.4926	13.8469	27.1516	6.7184
SOUTH AFRICA	8.0190	2.0794	24.0405	0.7499	8.1685	7.6277

Bold latter- Higher degree of variance decomposition, comparing between U.S. monetary policy and domestic monetary policy.

Overall, U.S. monetary policy can explain the variation in BRICS economies around 1% – up to 53%. Comparing to the domestic policy rate, at 2 years policy period, U.S. monetary policy shock can explain more variation of domestic variables in countries with inflation targeting monetary policy regime which are Brazil and South Africa in comparison to countries with other monetary policy regime (China, India, and Russia). In addition, based on exchange rate regime, change in U.S. central bank asset can explain less variation of domestic variables in countries with non-float exchange rate regime which are China and Russia in comparison to countries with float exchange rate regime. Based on variable, at 2 years period, overall, U.S. monetary policy can explain more variation in BRICS output, trade balance and long term interest rate than BRICS policy rate itself except for China. Followings are the variance decomposition analysis based on variables.

4.5.3 The Variance Decomposition Fraction Analysis at 2 years period

4.5.3.1 Output

For Output, U.S. monetary policy can explain variation in BRICS Output around 5 -52 percentage. It can explain high variation in Brazil, Russia, and South Africa outputs which are around (43%-53%) and relatively low variation in China and India outputs which are around (5-12%).

4.5.3.2 Inflation

For price level U.S. monetary policy can explain variation in BRICS CPI around 1-31% percentage. It can explain high variation in Brazil and South Africa CPI which are around (25%-31%) and relatively low variation in China and India and Russia CPI which are around (1-4%).

4.5.3.3 Policy Rate

For policy rate, U.S. monetary policy can explain variation in BRICS INT around 9-34% percentage. It can explain high variation in Brazil India and South Africa INT which are

around (27%-34%) and relatively low variation in China and Russia INT which are around (9-13%).

4.5.3.4 Real Effective Exchange Rate

For real effective exchange rate, U.S. monetary policy can explain variation in BRICS FX around 2-34% percentage. It can explain high variation in Brazil and South Africa FX which are around (21%-34%) and relatively low variation in China India and Russia FX which are around (2-8%).

4.5.3.5 Trade Balance

For Trade balance, U.S. monetary policy can explain variation in BRICS TB around 6-39% percentage. It can explain high variation in Brazil and Russia TB which are around (29%-39%) and relatively low variation in China India and South Africa TB which are around (6-13%)

4.5.3.6 10 Year Treasury Yield

For 10 year Treasury Yield, U.S. monetary policy can explain variation in BRICS GY around 6-35% percentage. It can explain high variation in Brazil China and South Africa GY which are around (22%-35%) and relatively low variation in India and Russia GY which are around (6-9%).

Chapter V

Conclusion

This study investigates the spillover effects of U.S. monetary policy during the current decade to BRICS economies. The findings are consistent with the saying that “When U.S. sneezes, Emerging Market catches cold.”(Maćkowiak , 2007) Overall, the spillover effects of U.S. monetary on BRICS economies lasts around 1 quarter to 1 year and the response ranges around 0.1 -5 basis points at peak. In addition, U.S. monetary policy shock can explain the wide portion of the macro variables fluctuation in BRICS. According to the variance decomposition result, U.S. shock accounts for 1-53% of the variation of variables within BRICS countries.

Monetary Policy Regime and Exchange Rate Regime

Each BRICS country receives the spillover effects from U.S. monetary policy differently based on their monetary policy regimes and exchange rate regimes. This study finds that the effects seem to be longer for countries with Float Exchange Rate Regime and Inflation Targeting monetary policy regime. Moreover, when comparing with the explanatory ability of domestic policy at 2 years policy period, the results from variance decomposition show that U.S. monetary policy shock can explain less portion of variation in domestic variables in countries with fixed exchange rate regime, in relative to countries with float exchange rate regime.

Impact on Macro variables and Policy Rate

From the empirical result, there are the significant spillover effects of U.S. monetary policy on BRICS macro-variables. However, the impact on BRICS variable is different across countries. This finding is consistent with the finding from previous studies like Moore et al (2013) and Chen et al (2015) which also find the significant spillover effects of U.S. monetary policy on Emerging countries. In addition, there are significant

responses in policy rate of all countries except Brazil and most of BRICS policy rate responds in the same direction with U.S. monetary policy which is the decrease in response to the increase in U.S. Central Bank Asset. Focusing on the optimal target of central banks which are output and inflation, there is also significant response in BRICS industrial production but no significant response in price level. This finding is consistent with the studies of Kim (2001) that find significant effect on G6 output but insignificant response in inflation to U.S. monetary policy shock. This should be considered as results that can be handled because negative effect on output is a lot easier to handle comparing to an increase in living cost which may create effect in the long run. In addition, there are also the significant response in other domestic's variables including real effective exchange rate, trade balance and treasury yield.

Transmission Channels

Focusing on the transmission mechanism, during the study period which is considered to be the period with financial turmoil and economic downturn, for BRICS countries, trade channel seems to play the significant role as the transmission channel of the shock while Interest rate channel seems to play insignificant role. U.S. monetary policy seems to worsen BRICS trade balance which is consistent with the decrease in output. Whereas the negative response of treasury yield seems not to be consistent with change in output. Overall, the details of transmission through trade channel is consistent with the basic version of Mundell – Flemming Dornbusch (MFD). This finding is contradict with some past studies concluding that interest rate seems to be more important transmission through capital market than the trade balance in transmission (see Kim 2001 and Canova 2005). The contradiction in finding may be caused by the difference in study period and the differences in research targets. To be more specific, the decrease in interest rate can be more effective increase in consumption and investment during the normal period but may be less effective during the crisis as consumer and investor are worried about uncertainty.

Policy Implication

From the finding, U.S. monetary policy has significant effects on BRICS economies. In other word, it can strengthen or weaken the influence of domestic monetary policy over domestic conditions. Therefore, in the globally integrated economies, the authorities should carefully consider the external development especially the monetary policy implementation of central economy like the Federal Reserve and other major central banks, taking into account the spillover effect on their economies before creating their tradeoff policy actions. In addition, the empirical results show that there is international monetary policy spillover effect in both countries with Float and Non-Float exchange regime.

The monetary authorities should note that in the intensify economic integration environment and relatively free capital mobility environment, the floating exchange rate regime may not be the flawless buffer against the monetary policy spillover of central economy as suggested in the 'Trilemma' international monetary policy framework. Based on the empirical result, having exchange rate float doesn't mean that the countries have the independent monetary policies. In the other words, according to BRICS, countries with float exchange rate regime are still affected by the spillover effects of U.S. monetary policy.

In addition, based on the finding that significant negative response in policy interest rate of BRICS central bank seems to track the U.S. monetary expansion, this reflects that BRICS central banks respond to the change in U.S. monetary policy conditions. Investors who invest internationally should be aware off the spillover effects and the degree of policy endogeneity between U.S. and BRICS which can affect the effectiveness of their portfolio diversification.

Further Research

For the further research, there are several issues that have not been addressed much in present analysis, for example the studies on difference between the spillover effects of Conventional and Unconventional Monetary policy on macro economy which cannot be done in this study due to the limitation of data. In addition, it will be interesting to study about the international transmission mechanism through more channels with more classification exchange rate regimes.



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APPENDIX

Table 8 VAR Lag Order Selection Criteria

Exogenous variables: C VIX WCP

Included observations: 125

Akaike Information Criterion					
Endogenous variables	BRAZIL	CHINA	INDIA	RUSSIA	SOUTH AFRICA
USCBA IP CPI INT	5	4	5	4	3
USCBA IP CPI INT FX TB	6	6	5	4	3
USCBA IP CPI INT FX GY	6	4	5	5	6
Maximum number of lags include in the models	6	6	5	5	6

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