INTERNATIONAL SPILLOVERS OF MONETARY POLICY

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We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

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LIST OF ABBREVIATIONS

AE	Advanced Economic
BOJ	Bank of Japan
CB	Central Bank
CESEE	Central, Eastern and South Eastern Europe
CIP	Covered Interest Parities
CPI	Consumer Price Index
ECB	European Central Bank
EM	Emerging Market
EME	Emerging Market Economy
FDI	Foreign Direct Investment
FED	Federal Reserve
FEM	Fixed Effect Model
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GLS	Generalized Least Square
GMM	Generalized Method of Moments
IFS	International Financial Statistics
IMF	International Monetary Fund
LM	Lagrange Multiplier
LSAP	Large-Scale Asset Purchases
LSDV	Least Squares Dummy Variable
MLE	Maximum Likelihood Estimation

OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
QE	Quantitative Easing
QQE	Quantitative and Qualitative Easing
UIP	Uncovered Interest Parity
UMP	Unconventional Monetary Policy
US	United States
WG	Within-Group

ABSTRACT

In this paper we investigate how monetary policy in advanced economies affects financial conditions in emerging market economies and other countries' economies. We find evidence for the working of several international transmission channels starting with traditional interest rate channels, going on to channels operating such as macroeconomic channel, trade channel and financial channel. Furthermore, we find strong evidence that Federal Reserve, European Central Bank and Bank of Japan short-term interest rates also affect the other nations' long-term interest rates significantly. Finally, we also found that Global Financial Crisis has significant impact in influencing a country monetary policy.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Research Background

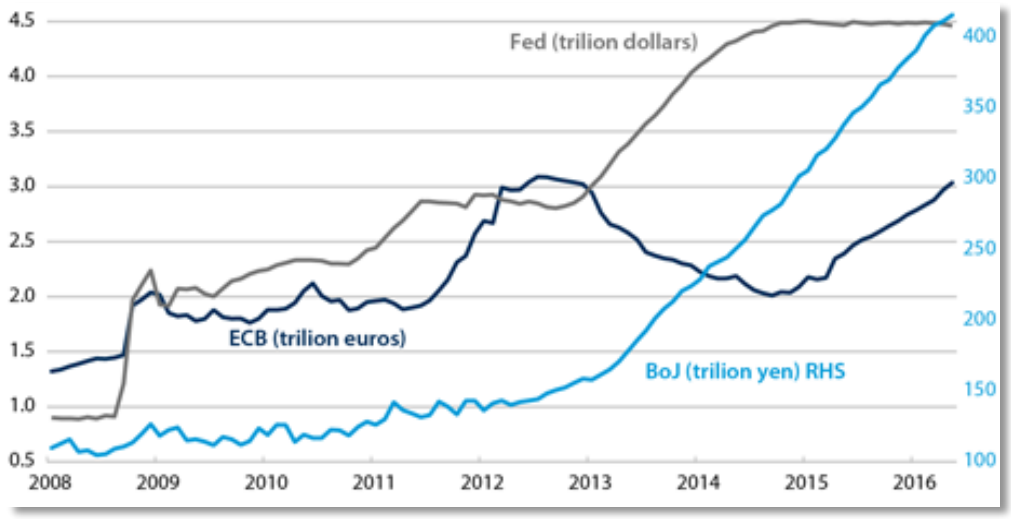
Since global financial crisis (GFC) in year 2008, monetary policy is accommodated in most of the economies. Lombardi, L Siklos, and Amand (2017) argued that, the international monetary policy spillover effects is not new but it has taken greater urgency which focused on market volatility and related financial stability risks to intervene in financial markets on a scale up to this time concealed, notably in advanced economies (AEs) such as United States (US), Euro area, and Japan. Therefore, low interest rate have mantained by central banks (CBs) of advanced economies' to boost up their balance sheet to the year-end 2016.

According to Jürgen Stark, member of the Executive Board of the European Central Bank (ECB), GFC illustrates the power of monetary policy on the positive side. CB implements monetary policy by lowering the interest rate could prevent a global depression. Hence, CB in AE maintained their short-term interest rate at low level even closer to zero bound and negative in long-term interest rate. However, Labonte (2013) pointed out that the economy recovery is sustainable at low rate without boosting the monetary policy. In general, the monetary policy had spillover effects to the rest of world, especially on capital flows and asset prices in emerging market economies (EME)s. When oil prices went down, there is a slightly dropped in price of other commodity and thus reduction in inflation. In this case, the decrease in inflation rate would lead to slower down the economic growth.

Federal Reserve (FED) short-term interest rates rise relative to other countries, EMEs attracted by the interest rates bring capital flows into US. This would lower down the expectation of US inflation, increase the exchange rate in US and leads to currency appreciation. (Labonte, 2016). For example, Labonte (2016) clarified the FED decline the short-term interest rate to a magnitude of 0% to 0.25%. CB's asset was expanded under this circumference. Thus, US economy has been

burgeoning regularly and therefore ended the economic recession in June 2009. In short, even the inflation is low, the inflation would increase by boosting monetary policy as long as full employment has reached (Powell, 2013). Further, the money supply would leads to price stability.

Figure 1.1: Balance Sheets of FED, ECB and BOJ



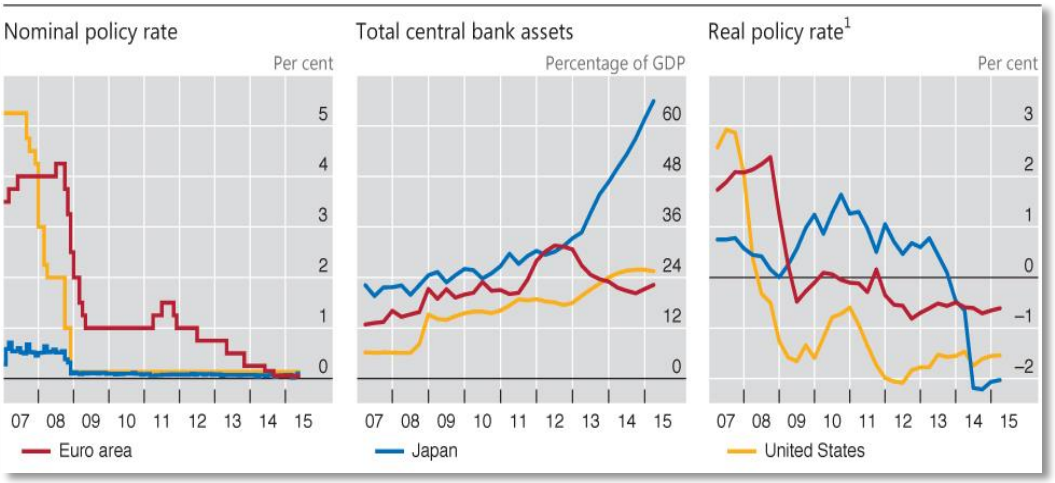
Adopted from: Oxford Analytica Daily Brief (2016)

In contrast, ECB address concerns to the risk when lengthen lower inflation as well as downward inflation expectations by further cutting down interest rate and improve the money supply in September 2014. As a result, the long-term interest rate fall further below zero which is -0.2% which brings a push up in asset prices leads to large capital flows to emerging market (EM) in year 2015. In addition, this programme was scheduled to last at least by the end of September in 2016 until constant inflation and accomplish ECB's objective 2% inflation. This is because risk is possibly triggered by the impact of market sentiment shifts. The yield could drastically increase and reverse the capital flow to EM. This process could become disorderly in asset classes and certain markets with impaired liquidity. Therefore, the correlation among major asset classes increase, the potential for contagion higher (Lagarde, 2015).

Other than that, the lower interest rates in euro area are expected to raise the interest differentials with neighbouring economies by pushing up their exchange

rates and reduced in their yield curves. Then, equity returns also respond quickly in order to expect higher growth and lower bond yields (Diamond, 1999). Moreover, Bank of Japan (BOJ) becomes more challenging to reach the objective of 2% inflation due to a dramatic improvement in the balance sheets and higher asset prices. Hence, BOJ increases the aim for annual improvement in money supply by prolonging the purchasing maturities in order to restrict bond yield under quantitative and qualitative easing programme (QQE) that avoid legacy of enduring deflation. According to Figure 1.1, the balance sheets had expanded sharply from around 35% in April 2013 to 65% in the beginning of year 2015.

Figure 1.2: Low Policy Rates and High Central Bank Assets in AEs

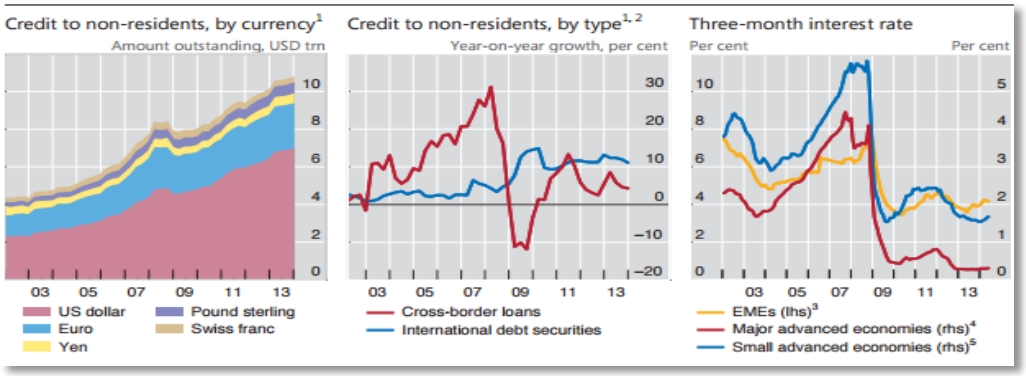


Adopted from: Hofmann and Takáts (2015).
Note: Nominal interest rate with consumer price deflation without including food and power source

In addition, AE influence risk-taking in yields of asset that denominated in disparate currencies. Henceforth, outstanding circumference can cause a large adjustment in financial flows and asset prices. EMEs also become further integrated by developing financial markets with the rest of the world. International monetary Fund (IMF) Deputy Managing Director discovered that there is a sudden rapid currency appreciation and rapid growth in foreign exchange markets due to the international monetary policy spillovers. However, if this volatility leads to devaluation in a number of EMs, these markets may impose pressure and burden on nonfinancial corporates and influence the foreign currencies borrowed heavily. So, this vulnerability leads to exacerbate capital outflows.

Furthermore, Jürgen Stark pointed out that the countries that are most affected by rapid capital reversals and high foreign currency debts, a vigilant macro prudential stance is the first line of defence. In order to access foreign currency risks especially bank and corporate foreign currency exposures, the regular monitoring and stress tests are needed at macro prudential level. For instance, Korea provides a good example to help countries cope and reduce the market volatility by combining powerful fundamentals with decisive and speed up the policy action. The short-term external debt was declined by half between year 2007 and year 2013 where those effective steps have been taken in order to strengthen the resilience of the financial sector.

Figure 1.3: Co-Movement Interest Rate and High Global Financing in Foreign Currencies



Adopted from: Hofmann and Takáts (2015).
Note:
[1] Exchange rates for each currency at end-2013. Credit is the international claims of banks situated outside LBS-reporting nations are gauged as liabilities, which includes debt securities of non-financial issuers and loans to non-banks. LBS-reporting banks announced to banking offices in non-reporting nations, enlarging the adjustment for loans received on nonbanks and loans received on non-reporting nations.
[2] Based on the sum of credit in currencies shown in the left-hand panel.
[3] Short-term interest rate of EMEs that includes Brazil, Chile, China, Chinese Taipei, Colombia, Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey.
[4] Short-term interest rate of major AEs that includes US, euro area, Japan, and UK.
[5] Short-term interest rate of minor AEs that includes Australia, Canada, New Zealand, Norway, Sweden and Switzerland.

After that, there is an increase in the role of asset management industry and capital markets which have become significant providers of credit while taking position in the period of stress. Numerous asset managers offer funds that allow investor redemptions on a daily basis when the asset may become illiquid. Besides that, if

investor scrambles for the way outs, the risk of herd behaviour could increase and leads to fire sales. Additionally, other part of the financial system becomes contagion. If certain financial assets exaggerate the volatility of local markets and currencies in the secondary market liquidity are decline drastically, the EMEs could also be affected (Furusawa, 2015).

Some of the fundamentals such as Gross Domestic Product (GDP) growth, inflation reduction, stronger current account positions and high liquidity in financial markets helped to maintain market volatility. Thus, these fundamentals become great significance for EM to execute structural reforms that can stimulate sustainable, strong and stable growth. As the fundamentals are stronger, it can best be achieved by implementing fiscal, monetary and exchange rate policies. At the moment, the financial systems are resilient to asset price volatility and immediate slump in market liquidity were ensured by EMEs.

1.1 Problem Statement

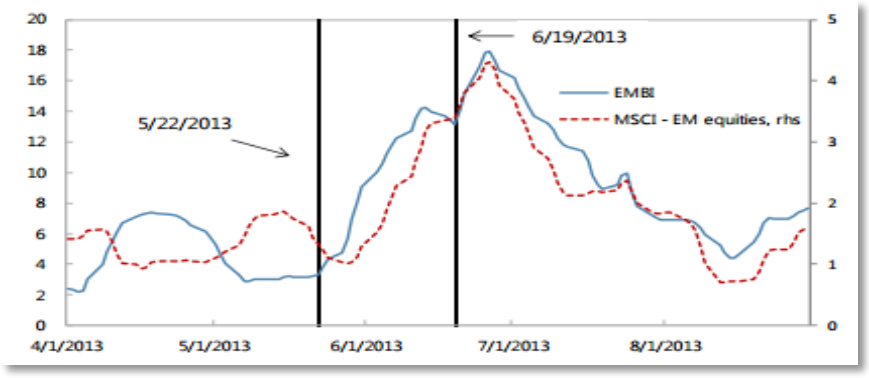
This paper trying to investigate the presence and magnitude of spillover monetary policy from AEs to the rest of the world. Since early interwar period, international monetary policy spillover has been the subject of much economic debate. After the GFC in year 2008, these spillover gained attention again when interest rate differentials among different countries widened substantially and many CBs implemented new monetary stimulus.

Among different researches, a numerous studies are focusing on evaluating the FED's monetary policy impact has on EMEs. For example, Fratzscher, Duca, and Straub (2016) gauged the spillover of FED's Unconventional Monetary Policy (UMP) to different global region. From the study, it is discovered that such policies have risen asset prices globally and cause a depreciation in US dollar. Therefore, the study make conclusion that FED's UMP will affect capital flows to EMEs in a pro-cyclical manner. Bowman, Londono, and Sapriza (2015) found that UMP announcements by the FED will cause EMEs asset prices, especially

sovereign yields in local currency to experience large fluctuations. During 2010-12, some of the EMEs experienced appreciation of their currency and significant capital inflows.

As the FED's monetary policy might has different spillover effects, so different countries may view policy by FED as favourable or unfavourable. On one hand, the depreciation of US currency accompanied by US asset purchases put downward pressure on US currency for about 1%. Thus, US trading partners were being hurt. It causes a decline in foreign net export and reducing GDP of foreign countries by 0.15%. On the other hand, the increase of US domestic demand in turn causes foreign exports to increase by nearly 0.15%. Thus, the overall impact on foreign GDP is nil. However, foreign interest rates tends to decrease due to decrease in US interest rate which in turn lead to a positive spillover to foreign economies. One of the underlying reasons why FED's monetary policies will lead to spillover is because US dollar is a dominant international currency in the world. Accordingly, FED's monetary policy is likely to have large impacts on the rest of the world.

Figure 1.4: Large Fluctuation in Asset Prices Follow Tapering Talks

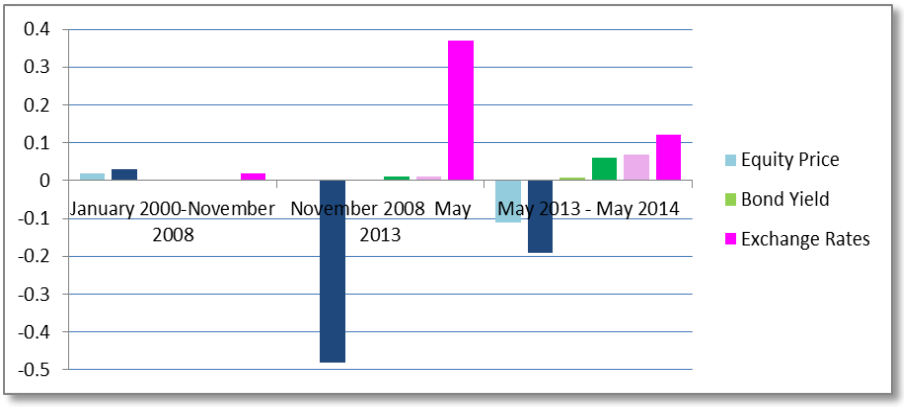


Adopted from: Chen, Mancini, and Sahay (2014)
Note: EMBI refers to Emerging Markets Bind Index

In May 2013, when the US FED Chairman, Ben Bernanke hinted their intention to wind down the volume of its bond purchase programme namely Large-Scale Asset Purchase (LSAP), the global financial market became volatile. This is because the global is worrying that the US ultra-easy monetary policy will end

soon and it would lead to an increase in US policy rate. EM financial markets such as Indonesia, India and Turkey started to experience massive capital outflow, exchange rate depreciation and stock price declines. The expectation of US to tighten their monetary policy causes EME financial markets to experience large volatility. Figure 1.4 shows there is a large fluctuation in EMs equity and bond prices in the period on April 2013 to September 2013. This is due to the hint of the FED to reduce its bond purchases.

Figure 1.5: Reaction of EMEs on US Monetary Policy Announcements (January 2000 – March 2014)



Adapted from: Chen et al. (2014)
Note: The light colours indicate effects of market surprise while darker colours indicate signal surprise.

Besides that, Chen, Mancini, and Sahay (2014) also found that the equity price, bond yield and exchange rates of EMEs were also affected by US monetary policy surprises. Figure 1.5 shows Chen et al. (2014) result in examining the reaction of 21 EMEs —Brazil, Chile, China, Colombia, Israel, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Romania, Russia, Singapore, South Africa, Taiwan Province of China, Thailand, and Turkey—to 125 US monetary policy announcements between January 2000 and March 2014.

It clearly shows that unexpected monetary announcement of FED has largest impact during the period of November 2008 to May 2013 which is when US implementing unconventional monetary policy. In general, spillover effects were larger when announcements regarding future policy action were out of market

expectation as compare to market surprise information that affected longer-term US bond yields across all phases of monetary policy.

Besides that, Chen et al. (2014) also found out that spillover effects were also depend on a country's economic situation and it is shown in Figure 1.6. Countries with stronger fundamentals would experience smaller spillover.

Figure 1.6: Fundamentals Matter in Determining Spillover Effects

	Equity		Bond Yields		Exchange Rates	
	Market Factor	Signal Factor	Market Factor	Signal Factor	Market Factor	Signal Factor
Growth of GDP						
Inflation						
Current account						
Share of local debt held by foreign investors						

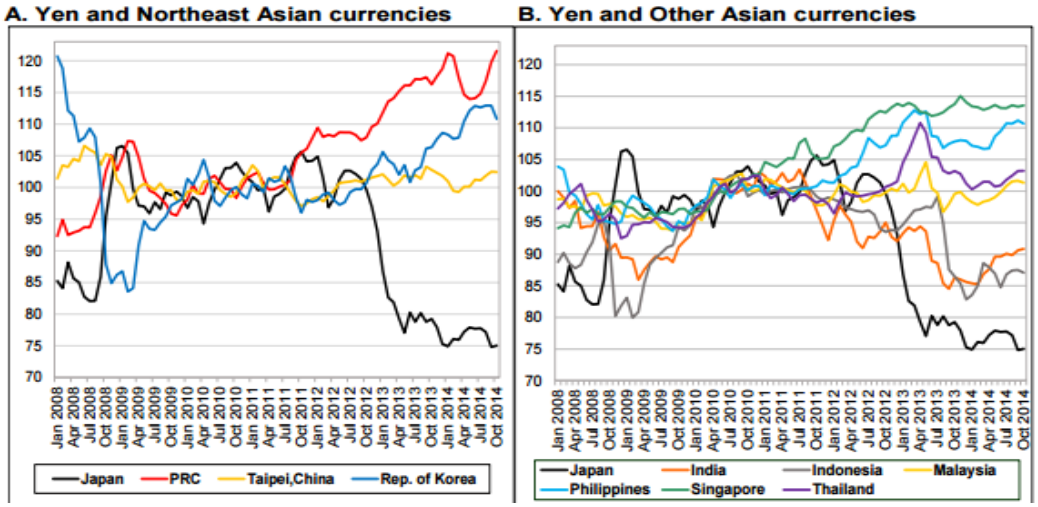
Adapted from: Chen et al. (2014)
Note: Blue boxes indicate factors that reduce the effects of U.S. unconventional monetary policy shocks; orange boxes indicate factors that enlarge the effects. The darker the colour, the more remarkable the effect. The signal factor refers to the information about future monetary policy a shock conveys. The market factor refers to the information about the availability of bonds to private investors, risks to growth and inflation, and changes in central bank preferences and objectives.

As most of the studies are on FED policies' impact, some looks into additionally reviews to recognize ECB's monetary policies impact. Ciarlone and Chang (2016) provided evidence that the short-term and long-term effects of the ECB's asset purchase programmes spillover to Central, Eastern and South Eastern Europe (CESEE) countries. In short-term, news related to ECB's monetary policies appears to move different factors in CESEE financial markets in the expected direction. In long-term, banking capital and cross-border portfolio flow towards CESEE economies were also affected by both the announcement and the actual implementation of the ECB's asset purchase programmes. On 22 January 2015,

the announcement of ECB's extended asset purchase programme also caused a depreciation of the euro and increases in both domestic and global equity prices.

Due to long-term deflation and economic stagnation, Prime Minister of Japan implemented a new policy called "Abenomics" which is also known as QQE in April 2013. Due to the implementation of this new policy package, policy makers in emerging Asia are concerning whether it would lead to a negative impact on the foreign country's output through yen depreciation. In reality, Japan QQE positively affects Asia's emerging economies. Figure 1.7 shows the real effective exchange rates of Japan and emerging Asian economies. Since mid-2012, the yen has depreciated by more than 20% on a real effective basis. It in turns causes the renminbi, the Korean won, the Singapore dollar and the Philippines peso to appreciate substantially on a real effective basis.

Figure 1.7: Real Effective Exchange Rates of the Yen and Emerging Asian Currencies



Source: Bank for International Settlements.
Note: Real effective exchange rates are measured using CPIs.

CBs in EM respond to changes in AE policy rates by changing their own policy rates (Takáts & Vela, 2014). The spillover effects can either be favorable or unfavorable and it depends on how each of the monetary policy from AEs affects the world. Therefore, it is important for us to identify and gauge how each of these policies work and spillover in order to better cope with it.

1.2 Research Objectives

In line with the bipolarization of the debate, monetary policy spillover may either be positive or negative. These spillover received attention after the GFC when interest of the world differentials among global regions and many CBs experimented with unconventional and new forms of monetary stimulus. The most important questions about monetary policy spillovers are still remain open and this paper analyses the spillover of monetary policy.

1.2.1 General Objective

The research's aim is to investigate the central bank of Federal Reserve's, European Central Bank's and Bank of Japan's monetary policy spillovers to the world.

1.2.2 Specific Objectives

To be more specifically, it focus on several objectives on this research. There are four main objectives in this paper.

1. To examine the impact of Federal Reserve's, European Central Bank's and Bank of Japan's monetary policy on the world economy.
2. To investigate the spillovers magnitude of monetary policies.
3. To examine for a number of transmission channels of monetary policies.
4. To evaluate the effect of global financial crisis to global interest rate.

1.3 Research Questions

To further extend the research objectives, there are several questions that will be established in this research.

i. Does Federal Reserve's, European Central Bank's and Bank of Japan's monetary policy spillover to the rest of the world?
ii. Do monetary policies have significant spillover effects with sizeable magnitude?
iii. Do global financial crisis shocks have significant impact on 10-year Treasury bond?
iv. Through what channels global monetary policy creates spill over?

1.4 Hypotheses of the Study

i. Federal Reserve's, European Central Bank's and Bank of Japan's monetary policy has significant spillover to the rest of the world.
ii. Federal Reserve's, European Central Bank's and Bank of Japan's interest rate is statistically significant with sizeable magnitude.
iii. Federal Reserve's, European Central Bank's and Bank of Japan's short-term interest rate will move long-term interest rate of the rest of the world in parallel direction.
iv. Federal Reserve's, European Central Bank's and Bank of Japan's monetary policy have spillover effect through different channels.
v. Global financial crisis has significant shocks to long-term interest rate.

1.5 Significance of the Study

Due to the recent GFC and the subsequent recession in many developed countries, many central banks from the developed countries used interest rate to defend

against the deflation and low inflation or even deflation. This research contributes to the ongoing debate about the relevance of monetary policy spillover.

In this paper, the empirical research are aims to provide understanding major CB monetary policy to stimulate economy could lead to spillover effect to the rest of the world. Besides that, Uncovered Interest Parity (UIP) condition is used as empirical model in order to determine how monetary policy could spillover to the rest of the world. Thus, it is expected to develop a new finding to determine the spillover by using UIP.

From the perspective of government, the research brings contribution to policymakers to understand the study on the monetary policy spillover. Thus, one of the findings from this study are aim to provide contribution to government in making decisions for policy implementation.

1.6 Chapter Layout

The rest of the paper is structured as follows: Section 2 reviews the literature on monetary policy spillover and transmission channels; Section 3 layouts empirical framework and description of data; Section 4 analyses and discusses the results. Finally, Section 5 concludes and recommends it.

1.7 Conclusion

Followed by GFC in year 2008 that adversely hit all the banking institutions around the globe, it actively pushed policy makers to implement and create effective and creative monetary policy responses. After the GFC, international spillover of monetary policy gained attention again and lead many researchers started to pay attention and examine how these monetary policies will lead to international spillover. It is important for us to understand how international spillover of monetary policy as the spillover effect might differ across EMs, AEs

or developing countries. For example, policy makers in AEs emphasize that monetary policy is effective from the domestic point of view and help the economic recovery although it is associated with certain risks. On the other hand, policy makers in EMs argue that monetary policy would probably lead to volatility in asset prices and capital flow. Therefore, the objective of this paper is to gauge the spillover of monetary policies from AEs to global interest rate.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

Monetary policy transmission mechanism is the process where a CB's monetary policy decisions are passed on. The spillover impacts can be determined from various variables through various transmission channels. The transmission channels include expectations, interest rate, liquidity, credit, portfolio balancing, trade and bank lending channels.

Furthermore, in order to conduct monetary policy effectively, the decision makers must speculate the timing accurately and its impact on the economy. Economist investigated that monetary policy will contribute to economic overheating and asset market excesses due to currency appreciation and pressure of capital inflow. A little change in the monetary aggregates can bring a huge impact to our economic situation because all the channels are interrelated to each other.

Economy of US is often defined to be "the engine" of world economy. Everyone concern about what US FED will do in the next all the time. Georgiadis, 2016; Chen, Fliardo, He, & Zhu, 2014; Ireland, 2010; Labonte & Makinen, 2008 and Yang & Hamori, 2014 study on the spillover effects by speculate global effects on real activity of conventional US monetary policy. While some of the researchers such as Sousa and Zaghini (2008), Falagiarda, McQuade, and Tirpák (2015), Babecká, Claeys and Vašíček (2016) agree that there are spillover effects of ECB monetary policy to the rest of the world.

Chinn (2013) concluded that monetary policy will support portfolio rebalancing by encourage the revaluation of emerging market's currency. He has provided evidence of impact on exchange rates and asset prices. Fic (2013) is more focus on the financial impact after the unconventional monetary policy implemented in BIRC countries which are Brazil, India, Russia and China. He shows the impact on exchange rates, long term bond yield and asset prices. There is cross- border

spillovers of Fed's UMP and conclude that such policies leads capital flow to emerging market economies in a pro-cyclical manner, increase asset prices of those affected countries and caused US dollar to depreciate (Fratzscher et al, 2013). Rogers et al. (2014) concluded that among advanced countries, US, UK Euro area and Japan play an important role on the cross-country spillover. Their pattern of monetary spillover is similar and he found that the shock of US monetary policy on asset prices is larger compare to the other three economies.

Eichengreen and Gupta (2014) show that countries with larger and deeper financial markets will tend to have larger impact on foreign reserves, asset prices and also exchange rates. Mishra, Moriyama, N'Diaye and Nguyen (2014) has different view with them, they claimed that countries with deeper financial markets, stronger macroeconomic fundamentals and a tighter macro-prudential experienced slightly impact on both currency depreciation and increases in government bond yields.

Based on the previous research, the researchers classified the few channels in their studied. Thus, transmission channels will provide a better understanding on how the monetary policy will propagate through various types of variables.

2.1 Transmission Channels

2.1.1 Expectations Channel

Babecká, Cukováa, Claeysb, and Vasícekc (2016) informed that the future stance of policy might affect the unwinding of positions through the signalling or expectations channel and foreign economic situation might be influenced too. Spillover impact on foreign macroeconomic developments depends on the relative strength of the different channels in place (Tillmann, 2016).

Decrease of short-term nominal interest rate normally will increase higher expected exchange rate which follow by increase in net inflows of bonds and

equities (Kiendrebeogo, 2016). Expectation channel states that the expected future interest rates would reduce by forward guidance or asset purchases. Besides, long-term interest rates are being influenced through expected overnight rates. Weaker growth forecasts, asset purchase announcements and forward guidance would reduce expectations of the future federal funds rate. Then, decrease of average expected overnight rate leads to a reduction in long-term interest rates (Bauer & Neely, 2014; Mishkin, 1996). A CB would be able to commit to a specific future policy path. By influencing the overall market expectation, lower down longer term yields, inspires confidence and then push the asset prices up to certain level (Fic, 2013).

2.1.2 Interest Rate Channel

Besides, according to Babecká, Cukováa, Claeysb, and Vasícekc (2016), lowering interest rate leads to portfolio rebalancing and push investor to ask for higher interest rate which is higher return. This will ease monetary conditions abroad by reducing foreign long-term interest rates. However, this situation could be neutralised by appreciation of the foreign currency.

The effect of monetary policy on the nominal interest rate can be explained through interest rate channel, assuming short run period's sticky price (Papadamou, Sidiropoulos, & Spyromitros, 2015). Decrease in the CBs policy rate translates into lower short-term interest rates. As a result, when real interest rates are reduced , the real cost of borrowing will decrease in terms of consumption and investment, lowering down investment expenditure which causes private domestic demand to increase. The increase in the domestic demand would in turn increase the output and then push up the employment (Ireland, 2005). The interest rate channel may still be valid even we relax the assumption of sticky price, the action of a CB of reducing policy rate would push up price level and reduce real interest rate. Thus, spending and output will be increase.

2.1.3 Liquidity Channel

Later on, monetary policy implemented by lowering down the interest rate hence increase money supply of the economy. The high growth rate of money supply always brings excess liquidity, which pushes the asset price up easily (Yang & Hamori, 2014). Lowering interest rate will encourage borrowing to finance consumption. For those who are without debt, lower interest rate makes return on saving become unattractive and hence encourage individuals to spend more.

Lower current and expected interest rate tends to raise the asset prices. Due to the reducing cost of borrowing in purchasing houses, and so increase the demand of assets. Due to the supply and demand law, increase in demand will increase asset price at the same time. The liquidity channel can raise asset prices to the extent that official asset purchases improve market liquidity by providing a consistent buyer (Neely, 2015). The liquidity channel is relatively less important for the monetary policy effect because the effect is obvious during the beginning stage of implementing monetary policy (Gagnon, Raskin, Remache & Sack 2011).

2.1.4 Credit Channel

The role of short-term interest rate is significant in the transmission mechanism. Interest that is paid in short-term will highly affect a firm's cash flow rather than long-term debt will do.

Lowering down the interest rate after implementing expansionary monetary policy will stimulate aggregate output which involves the credit rationing phenomenon and in turn reduces adverse selection and moral hazard problems. The one who willing to pay for higher interest rate is the one with the riskiest investment projects. Thus, when interest rate is low, less risk-prone borrowers occupied more among the one who demand loans and thus lenders are willing to lean compare to before, raising investment and output at the same time (Mishkin, 1996).

A prolonged period of relatively low interest rates can lead to financial imbalances by reducing risk aversion of banks and investors. Thus, low interest rates lead to excessive risk-taking. Bankers and investors are searching for higher return now.

This situation is now contributed to credit boom, rising of asset price and search-for-yield that eventually lead to the burst in the subprime and housing markets, the collapse of major financial institutions, and ultimately, the Great Recession (Hume & Sentence, 2009; Taylor, 1995; Diamond & Rajan, 2009; Chen, Filardo, Dong, & Zhu, 2014; Ramayandi, Rawat, & Tang, 2014).

2.1.5 Portfolio Balancing Channel

In other hand, money would definitely bring effect to balance sheets. Portfolio balance sheets will increase when financial institutions increase their lending and lead to bust in the purchase of private and government securities (Gambacorta, Hofman, & Peersman, 2014). Portfolio rebalancing channel will influence all investor's portfolio decision when there is a change in the relative demand and prices of various securities (Fic, 2013; Mishkin, 1996.).

Portfolio balancing channel implies that purchase of US assets would reduce the excess yields on those securities and assets. This situation will keep happening until a new equilibrium is reached (Neely, 2014). According to traditional interest rate channel, reduction in the short-term interest rate will increase consumers spending. Apart of that, cost of capital of firms will be reduced through the balance sheet channel, deepening and extending the initial expansion in output and employment (Ireland, 2005).

2.1.6 Bank Lending Channel

Apart of that, the banking system has become more internationally integrated now. According to Babecká, Cukováa, Claeysb, and Vasícekc (2016), there will be

direct impact through bank lending channel when monetary policy's operations targeted increase at the collateral of banks.

Based on the bank lending channel, CB lowers down interest rate and increase bank reserves by implementing expansionary policy. It forces the commercial banks to increase both their deposits and loans. Therefore, firms and individuals will increase their purchases of durable goods and investment capital by increasing their lending from bank. Increase in the spending and investment will positively affect total output. Apergis and Christou (2015) and Fic (2013) stated that monetary policy helps to ease financial conditions and supports bank lending to the private sector through bank lending channel.

2.1.7 Trade Channel

In addition, traditional Keynesian models that build on Fleming (1962), Mundell (1963), and Dornbusch (1976) and in the New Keynesian models, expected future appreciation requires an initial depreciation of the domestic currency. For example, when value of domestic currency is low, domestically produced goods are more attractive compared to foreign produced goods. Net import increases in the other countries; aggregate output decrease and increase in unemployment. While for the domestic country, the net export, employment and aggregate output increase.

Neely (2014) conclude that the trade channel can be use to determine the joint effect of monetary on nominal international interest rate in local currencies and exchange rates. According to Lipinska, Spange, and Tanaka (2011), the monetary policy will spill over through trade channel by affecting domestic labor supply and wages. It will also impact the demand for domestic goods relative to foreign goods. Lastly, a lower degree of financial market integration will prevent consumers to consume more by borrowing from abroad.

2.2 Empirical Review

(Georgiadis, 2015) found that the spillover effects of many economies are greater than the domestic effect in the US. Magnitude of spillovers depends on a number of country characteristics. Those characteristics included financial integration, trade openness, the exchange rate regime, industry structure, financial market development and labour market rigidities (Rey and Martin, 2006; Cavallo and Frankel, 2008).

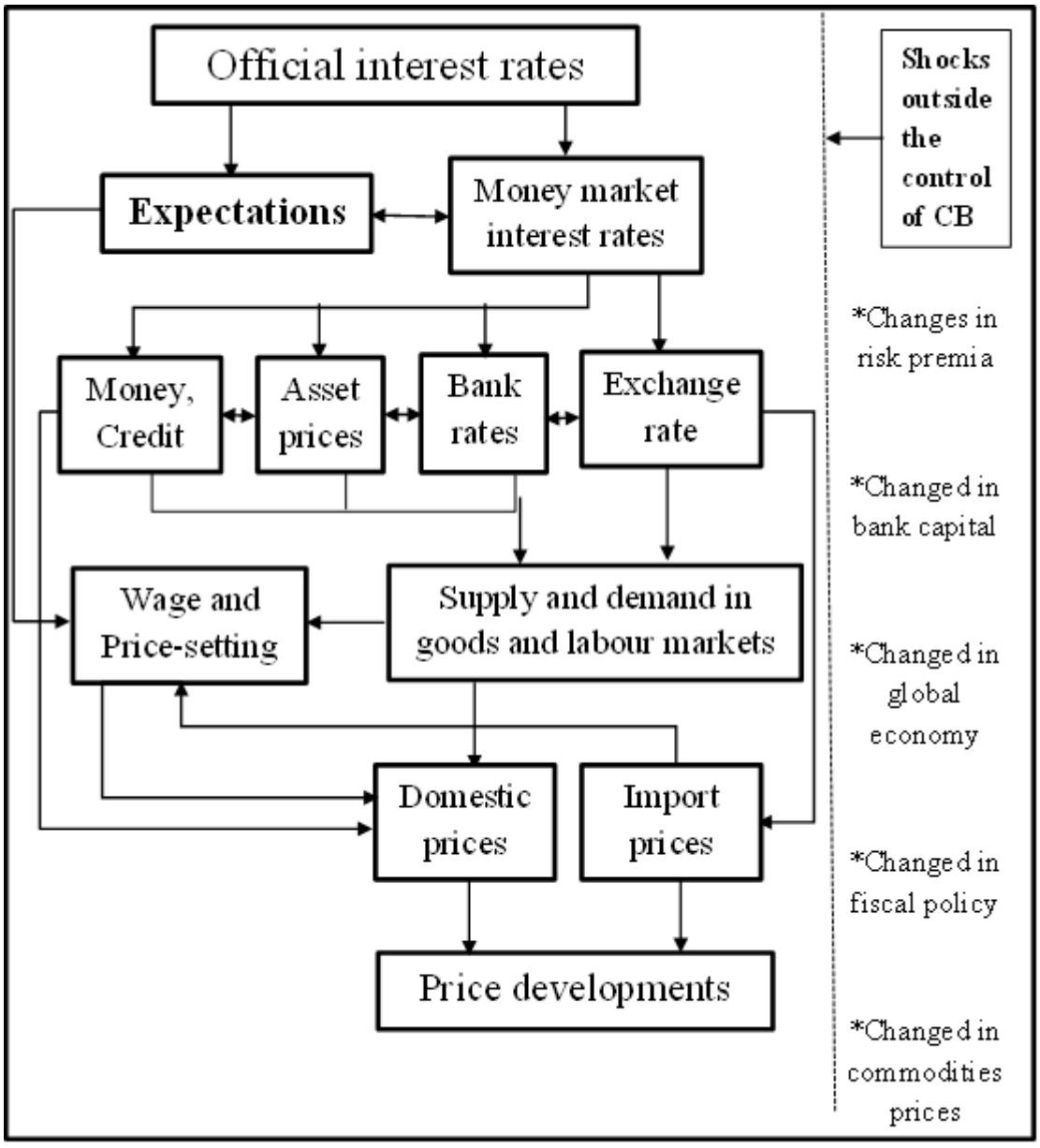
There are researchers speculate the spillover effect of US monetary policy by using VAR models (Kim and Roubini, 2000; Kim, 2001; Faust and Rogers, 2003). Two-country VAR models involve the US and domestic macroeconomics variables of another country or vice versa. This method only let researchers to estimate for a few countries only. These research shows that there is spillover effects of US monetary policy to both advanced and emerging market economies. However, these papers may limit by methodological constraints. These researches build on two-country VAR models do not take the multilateral nature of global interlinkages into account. Monetary spillovers those big advanced countries such as US, Japan and Europe may affect the other countries' economies, and thereby give rise to third-country effects and spillbacks happen. A bilateral model will fails to capture this spillback effect. D'ees, Pesaran & Smith (2010), Georgiadis (2015), Ganelli & Tawk (2016) and Chen, Filardo, He & Zhu (2012) use different methodology to estimate the spillover effect, they used a multi-country New Keynesian dynamic stochastic general equilibrium model which is the GVAR approach.

2.3 Theoretical Framework on Transmission Mechanism

Basically, monetary transmission mechanism is how monetary policy decisions affect the asset prices and hence the general economic condition. The decision makers influence the official interest rate in order to affect equity prices, interest rate, exchange rate, bank lending and balance sheets. The relative importance of

each channel may change from time to times, the four transmission channels jointly influence the aggregate demand for goods and services. Mishkin (1995) shows how this transmission mechanism work by influencing the short-term nominal interest rate, later on show the effect to various type of variables and lastly influence one country's total output.

Diagram 2.1 How the Monetary Transmission Mechanism Works



Adapted from: Mishkin (1995)

Policy makers influence economic situation by using monetary policy, and monetary policy works by manipulating the official interest rate. After that, this

expectations and money market interest rate would bring effect to others variables such as bank lending rate, asset prices, money credit and also exchange rate. These variables are interrelated to each other which are also making the effect propagate until supply and demand in labour and goods market. Thus positively affect our balance sheet, wage and price setting and lastly affect a country's GDP.

Changes in interest rate decision would influence market interest rate such as mortgage and bank deposit rate. The announcement policy actions affect the expectation about future path of economy. With the held of the expectation, the confidence level would change and hence affect the equity prices and exchange rate.

The changes in turn will affect the behaviour of firms and individuals on their saving, spending and the investment preference. For instance, higher interest rate encourage saving instead of spending. Depreciation of foreign currency make foreign good became more competitive in terms of their cheaper price compare to domestic goods. Thus, we can say that the changes in official exchange rate would change the demand of goods and services and lead to changes in GDP.

Most studies found out that if there is expansionary monetary policy, the cross-border spillover effects will be in the form of large capital inflows, currency appreciation, an increase in prices and interest rates, raised equity prices and temporary increases in output (Ganelli & Tawk, 2016). So that there is negative relationship between interest rate and crossborder's capital inflows, equity prices and exchange rate.

In the study of Mishkin (1996), there are interest rate effects on the exchange rate and then lead to changes in net export. Deposits denominated in foreign currencies will be attractive compare to domestic deposits when there is reduction in domestic interest, leading to depreciation of domestic currency deposits. Then the depreciation of domestic currency makes domestic goods become more competitive because it is cheaper compared to foreign goods, thereby causing a rise in net export and hence in total output. However in other study conducted by

Akonji, Danmola, Olateju and Abba (2013), money supply has significant and positive influence on current account.

Table 2.1 Summary of the Relationship between Regressand and Regressors

Regressors	Relationship with Long-Term Interest Rate
Capital Inflow	Negative
Equity Price	Negative
Exchange Rate	Negative
Current Account	Negative
GDP	Negative
Inflation Rate	Negative
Share Price	Negative
Unemployment Rate	Negative

Interest-sensitive spending can be affected by FED through influencing long-term interest rate. It can influence a firm's spending behaviour on their firm equipment, household's behaviour of spending on consumer durables, and residential investment (Labonte, 2017). Thus, overall GDP will increase when long-term interest rate is lower down.

According to Babecká, Cukovác, Claeysb, and Vasícekc (2016) and Akonji, Danmola, Olateju and Abba (2013), lowering interest rate leads to portfolio rebalancing and pushing investor to ask for higher interest rate. Portfolio adjustment will then leads to appreciation of foreign currencies (Takáts & Vela, 2014). Thus, there will be downward pressure on domestic currency and make foreign currency to appreciate. The relationship once again been proved by Sánchez (2008). They said the correlation between exchange rates and interest rate is negative.

Long-term interest rate will be negative affect the share price. A decrease in interest rates created upward pressure for asset prices, thus raise household wealth,

hence encourage borrowing and spending. As Kim (2009) investigated the spillover effect from the FED and the ECB target interest rate news on the market returns and return volatilities of 12 stock markets in the Asia-Pacific. They found that significant negative return due to monetary policy shock and return volatilities for these markets were sensitive to the interest rate news.

The CB will start to keep interest rate low when there is pressure of inflation start to build in response to a high unemployment rate. However, when the labour market is near to full employment situation, the rising of inflation is now become a major concern for CB. At that time, CB will allow the interest rate to rise which in turn will calm down an overheating market by reducing consumer spending, investment, exports and all the variables which would help to reduce the rising of wages and prices. Thus, there is negative relationship with interest rate and unemployment.

2.4 Conclusion

In this research, panel data is chosen instead of VAR and GVAR model. Instead of just estimate the effect between two countries only, this research estimate the effect of three major banks which are ECB, BOJ and FED with other 31 countries. It can give a big picture on how monetary policy affects the rest of the world but not only speculate the impact between two countries. This will enable to capture which country's monetary policy will bring larger impact compare to others.

There are two versions of interest parities which is Covered Interest Parities (CIP) and UIP. CIP involves no exchange risks because it can be hedged using financial products, while UIP required such risks and elements of speculation as the situation is satisfied without the use of any financial products to hedge against exposure to exchange rate risk.

Monetary transmission mechanism can be explained by using UIP. This is because UIP condition is considering as a central focal point in the policy debate over the

effectiveness of official intervention in exchange markets (Henderson & Sampson, 1983). UIP are key building blocks of many open macroeconomic models. It shows the relationship between the interest rate and an asset denominated in a domestic currency, the interest rate and similar asset denominated in foreign currency, and the expected rate of change in the spot exchange rate between this two currencies (Isard, 2006).

There are four assumptions in this parity condition. Firstly, there is free capital mobility; Secondly, no transaction cost which mean transaction is without charge. Thirdly, there is no default risk and investor concern only about the long run average return. Lastly, it do not care about the outcome of each investment.

In summary, this study is aim speculated the impact of official interest rate that may cause international spillovers. Hence, UIP is chosen in this research. Moreover, the monetary policy tool is more on controlling interest rate as the UIP is examining the effect of interest rate to the other country's economic variables.

CHAPTER 3: METHODOLOGY

3.0 Introduction

The main methodology that will be used in this study to fulfil the research objectives will be discussed in Chapter 3. This chapter consists of four sections that describe the methodology of the research. The first section discusses the theoretical model applied which is UIP. Subsequently, the second and third section describes the empirical models and data collection and data processing respectively. Next, econometrics techniques will be discussed in final sections of this chapter.

3.1 Theoretical Model

In this section, the theoretical model will be discussed in assessing the impact of monetary policy on the long-term interest rate which is estimated by government bond yield.

The base model is derived from UIP which declares that the interest rate differential between two countries should be equivalent to the expected changes in exchange rate. Besides that, the interest rate for the UIP represents a key component in analyzing the financial arbitrage conditions and economic on international markets. In line with this, Cheung, Chinn, and Pascul (2005) found that the UIP performs well in assessing exchange rate movements in long-term, relative to other structural models of the exchange rate.

The UIP equation is as followed:

$$1 + i_d = (1 + i_f)(\frac{s^e_{t+1}}{s_t}) \qquad (3.1)$$

where i_f is the foreign country's interest rate ; i_d is the domestic country's interest rate; s_{t+1}^e is expected exchange rate; and s_t is current exchange rate. Then, taking logarithms of both sides, equation (3.1) becomes:

$$i_d = i_f - s_t + s_{t+1}^e \tag{3.2}$$

Apart from that, equation (3.2) is further derive following the expectation hypothesis theory in order to define long-term interest rate accordingly as equation (3.3):

$$i_L = \alpha_0 + \alpha_1 i_d + \alpha_2 i^e \tag{3.3}$$

where i_L is long-term interest rate; i^e is expected interest rate and α is the coefficients capture the change of interest rate and expected interest rate on the long-term interest rate.

Furthermore, equation (3.2) is substituting into equation (3.3) which allow the expected changes in exchange rate from period t to period t+1 to be expressed in the function of long-term interest rate. Thus, the function of long-term interest rate is derived in equation (3.4):

$$i_L = \gamma_0 + \gamma_1 i_f - \gamma_2 s_t + \gamma_3 s_{t+1}^e + \gamma_4 i^e \tag{3.4}$$

where γ is the coefficients capture the spillover effects on long-term interest rate. The i^e , interest rate expectation and s_{t+1}^e , exchange rate expectation are categorized into several categories which is used to capture the spillover effects of any variables that affect the interest rate and exchange rate. For example, inflation, GDP growth rate are used to capture the interest rate expectation while official exchange rate and foreign direct investment (FDI) net inflow and outflow are used to capture the exchange rate expectation. Hence, the empirical models are derived to measure the effect of how the US, ECB, BOJs interest rate spillover to the rest of the economy, namely EME and AE.

3.2 Empirical Models

3.2.1 Controlled Variables through Macroeconomics Channel

The proxy such as $S, rgdp,$ and pie are included in equation (3.5) to capture the international spillover effects from FED, ECB and BOJ through macroeconomics channel.

$$i_L = \beta_{0it} + \beta_1 i_f + \overset{(+)}{\beta_2 S_t} + \underbrace{\overset{(+)}{\beta_3 rgdp_{it}} + \overset{(+)}{\beta_4 pie_{it}}}_{\text{Macroeconomics Channel}} + \varepsilon_{it} \quad (3.5)$$

Where i_L represents long-term interest rate which is determined by government bond yield, and it is affected by proxy including:

S is the official exchange rate. Increase official exchange rate leads to increase in long-term interest rate. According to Krugman (2006), when the domestic currency depreciate today, the expected return on deposits depreciates in foreign currency. This is because the initial cost of investing would increase in foreign currency if domestic currency today depreciates. Thus, the long-term interest rate increase. In contrast, when the domestic currency appreciates today, the expected return of deposits appreciate in foreign currency. This is due to the initial cost of investing would reduce in foreign currency if domestic currency today appreciate Hence, the long-term interest rate decrease.

$rgdp$ is real growth rate of the economy. Increase real growth rate leads to increase in long-term interest rate. Better economic condition can increase the profitability of a larger number of programs in accordance with the expected net present value, which lower down the overall credit risk to banks (Kashya, Stein, & Wilcox, 1996) and increase the cost of investing. Consequently, the long-term interest rate increase.

pie represents inflation rate. Increase inflation rate leads to increase in long-term interest rate. In economics, inflation means a general raise in prices and fall in purchasing power. The Fisher's hypothesis states that inflation is the main determinant of interest rates. When the inflation raise by one per cent, the interest rate will raise by the same amount. Besides, Fama (1975) and Fama and Schwert (1977) test whether the Fisher effect holds in the US as implied by the Fisher hypothesis, and they discover evidence in favor of approximately constant real interest rates. For example, lenders will increase the interest rate to compensate for the loss due to erode of value of their money over the term of the loan caused by inflation.

3.2.2 Controlled Variables through Trade Channel

The proxy such as $S, ca, ifdi$ and $ofdi$ are included in equation (3.6) to capture the international spillover effects from FED, ECB and BOJ through trade channel.

$$i_L = \beta_{0it} + \beta_1 i_f + \underset{(+)}{\beta_2 S_t} + \underbrace{\underset{(-)}{\beta_3 ca_{it}} + \underset{(-)}{\beta_4 ifdi_{it}} + \underset{(+)}{\beta_5 ofdi_{it}}}_{\text{Trade Channel}} + \varepsilon_{it} \qquad (3.6)$$

ca is the current account balance of the economy. Aye Mengistu and Lee (2014) investigated that current account balance deficit which means the value of import is greater than the value of export and leads to increase in long-term interest rate. The current account balance deficit since cost of buying import decrease (Pettinger, 2010; Ali, Johari, & Alias, 2014). Therefore, higher export and lower import will leads to increase in long-term interest rate. In other words, current account balance improve which means the value of export is greater than the value of import and leads to decrease in long-term interest rate. The current account balance improve since cost of buying import increase (Pettinger, 2010; Ali, Johari, & Alias, 2014). Therefore, lower export and higher import will leads to decrease in long-term interest rate.

$ifdi$ is the net inflows of foreign direct investment. Increase net inflow of FDI leads decrease in long-term interest rate. Bakardzhieva, Naceur, and Kamar (2010) revealed that when the net inflows of FDI increase, the domestic exchange rate today depreciate. Thus, the expected foreign exchange rate depreciate and currency depreciate leads to decrease in long-term interest rate. In contrast, when the net inflows of FDI decrease, the domestic exchange rate appreciate. Hence, the expected foreign exchange rate appreciate and currency appreciate leads to increase in long-term interest rate.

$ofdi$ is the net outflows of foreign direct investment. Increase net outflow of FDI leads increase in long-term interest rate. Dhakal et al. (2010) said that net outflows of FDI do not necessarily has inverse effect on real exchange rate. However, Otieno (2012) argued that when the net outflows of FDI increase, the domestic exchange rate today appreciate. Thus, the expected foreign exchange rate appreciate and currency appreciate leads to increase in long-term interest rate. In other words, when the net inflows of FDI decrease, the domestic exchange rate today depreciate. Hence, the expected foreign exchange rate depreciate and currency depreciate leads to decrease in long-term interest rate.

3.2.3 Controlled Variables through Financial Channel

The proxy such as $S, debt$ and lsp are included in equation (3.7) to capture the international spillover effects from FED, ECB and BOJ through financial channel.

$$i_L = \beta_{0it} + \beta_1 i_f + \beta_2 S_t + \underbrace{\overset{(+)}{\beta_3} debt_{it} + \overset{(+)}{\beta_4} lsp_{it}}_{\text{Financial Channel}} + \varepsilon_{it} \qquad (3.7)$$

$debt$ refers to central government debt. Lavelle (2012) mentioned that central government debt has a significant negative impact on the expected foreign exchange rates. If a high debt was recognized in domestic country, without a reasonable way for dealing with it, the domestic exchange rate and domestic currency today would depreciate. Hence, the expected foreign exchange rate and

currency would depreciate. Belmont (2011) explained, a high debt would leads to increase in money supply that is unavoidable and encourage inflation. Then, long-term interest rate decrease. If low debt was recognized in domestic country, the domestic exchange rate and domestic currency today would appreciate. Therefore expected foreign exchange rate and currency would appreciate. This is due to low debt would leads to decrease in money supply and discourage inflation. Then, long-term interest rate decrease.

lsp is share price index (2010=100). Dimitrova (2005) clarify that the relationship between stock price index and expected foreign exchange is important. As the stock market is expanding, it is an indicator of a burgeoning economy, which would leads to increase in inflation expectations. When the stock price in domestic country increase, foreign investors would expect there will be a decrease in inflation and increase the demand of export goods in domestic country. Thus, the domestic exchange rate and currency would appreciate; the expected foreign exchange rate and currency would also appreciate. This will leads to increase in long-term interest rate.

3.2.4 Final Model

Most of the economies have been affected by the GFC in year 2008, and some countries are still recovering from the crisis. Therefore, GFC acts as dummy variable in the model in order to capture the spillover effects of GFC on the countries' economies. When the GFC arise, it will reduces demand of funds and hence decrease in long-term interest rate.

$$i_L = \beta_{0\text{it}} + \beta_1 i_f + \beta_2 S_t + \beta_3 rgdp_{it} + \beta_4 pie_{it} + \beta_5 ca_{it} + \beta_6 ifdi_{it} + \beta_7 ofdi_{it} + \beta_8 debt_{it} + \beta_9 lsp_{it} + gfc + \varepsilon_{it} \quad (3.8)$$

(-)

3.3 Data Collection Method and Data Processing

The time period covered in this dataset ranges from 1-1-2006 to 31-12-2015. This paper cover a set of 31 countries – Australia, Canada, Chile, Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Rep., Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom and United States.

The sample captures the period in which the FED, ECB and BOJ conducted measures of monetary policy. In research estimate the effect of annual changes in long-term (10 years) Treasury bill on changes in the prices of financial assets and macroeconomics condition.

The following country-specific variables are used in the model: real growth rate, share price (index 2010), Consumer Price Index (CPI), inflation, unemployment rate, the short-term interest rate, the real effective exchange rate, official exchange rate, central government debt, FDI outflows and inflow and current account balance.

Further data on inflation, unemployment, real effective exchange rate, official exchange rate, central government debt, FDI outflows and inflows and current account balance are obtained from Bloomberg, the IMF's International Financial Statistics (IFS) and World bank database while data on real growth rate, share price (index 2010) and short-term interest rate are taken from the Organisation for Economic Co-operation and Development (OECD), Penn World Table, ECB and Federal Reserve Bank of St. Louis database. All variables are in nominal rate and index have been converted to percentage point and natural logarithm prior to the estimation.

Selection of countries into the sample is driven by different considerations. Firstly, it only add countries that have comprehensive annual data on economic and financial conditions available. Secondly, this research control a large shock which

is GFC. Thirdly, it use the most influential CB such as FED, ECB and BOJ 3-month Treasury bill as a control variable to estimates on the long-term interest rate.

Table 3.1: Construction and Sources of Data

Variable	Proxy	Construction	Sources
Official exchange rate	LCU per US$, period average	LN	OECD
Real Growth Rate	This entry gives GDP growth on an annual basis adjusted for inflation and expressed as a percent	Percentage point	Federal Reserve Bank of St. Louis and Pennworldtable
Inflation Rate	Consumer prices (annual %)	Percentage point	World Bank
Current Account Balance	Current account balance (% of GDP)	Percentage point	World Bank and IFS
FDI, net inflows	Net inflows (% of GDP)	Percentage point	World Bank
FDI, net outflows	Net outflows (% of GDP)	Percentage point	World Bank
Central Government Debt	Central government debt, total (% of GDP))	Percentage point	World Bank and Bloomberg
Share Price Index	Share price index 2010	LN	OECD
Short-term interest rate	3-month Treasury bill (FED,ECB,BOJ)	Percentage point	ECB and Federal Reserve Bank of St. Louis
Long-term interest rate	10-years Government Bond yield (%)	Percentage point	OECD and Federal Reserve Bank of St. Louis

3.4 Econometrics Method

3.4.1 Pooled Ordinary Least Squares (OLS) Regression

Pooled analysis is a combination of cross-sectional and time series data. It is characterized by having repeated observations on fixed units (Podestà, 2002). Assuming that the OLS assumptions are not violated in this regression model, Pooled OLS can be used when the characteristic of the group are relatively homogenous which the effect of any given regressand or regressor are constant across the observations. This approach is the most restrictive model due to the constant coefficients of intercept (Schmidheiny, 2011).

Based on Gauss-Markov theorem, there are strictly uncorrected between all the regressors and error term. It is necessary to assume the error term is distributed identically and independently with zero mean and constant variance for OLS to be optimal. Therefore, the regression is normally distributed and proceeds with valid hypothesis testing. Besides that, OLS estimation can be used as long as fulfilled the BLUE conditions (Shaffer, 1991).

In fact, different countries seem to have various characteristic across the period, thus homogeneity (highly restricted assumptions) are hardly to be achieved. Podest à (2002) stated that when pooled data are applied while heterogeneity exists among the observations across the period, the estimated parameters in the OLS regression are likely to be biased, inefficient and/or inconsistent.

According to Schmidheiny (2011), pooled linear regression model estimated by OLS procedure is presented as:

$$Y_{it} = \beta_0 + \sum \beta_k X_{k,it} + \varepsilon_{it} \tag{3.9}$$

Where Y_{it} and X_{it} respectively indicate regressand and regressor for countries i on period t respectively; and ε_{it} is a stochastic error; β_0 and β_k indicate the constant intercept and the slope coefficients for specific k regressor respectively. Pooled OLS in this model can be written as equation (3.11):

$$i_L = \beta_0 + \beta_1 i_f + \beta_2 S_t + \beta_3 rgdp_{it} + \beta_4 pie_{it} + \beta_5 ca_{it} + \beta_6 ifdi_{it} + \beta_7 ofdi_{it} + \beta_8 debt_{it} + \beta_9 lsp_{it} + \varepsilon_{it} \tag{3.10}$$

where f refers to FED, ECB and BOJ

3.4.2 Fixed Effect Model (FEM)

FEM is also known as least square FEM. Treating the quantities as non-random, this model is a statistical model that identifies the observed quantities in terms of

regressor. Then, it is allowed to differ among individuals by using the intercept in the regression model in order to reflect unique characteristic of individual units by using dummy variables. This model is known as fixed effect Least Squares Dummy Variable (LSDV) model. However, dummy variable trap should be avoided when using dummy variables (Greene, 2003). Besides, FEM still produce consistent estimate no matter underlying model is Pooled OLS or REM but it cannot estimate coefficients for time-invariant variables. If the number of cross-sectional unit very large, a lot of degree of freedom is needed to be consumed even individual specific intercept is related to one or more regressors in this FEM (Skrivanek, 2009).

Croissant and Millo (2008) disclosed that the alternative to LSDV is using the within-group (WG) estimator. Wang and Ho (2010) proved that WG estimator subtracts the mean values of regressands and regressors from their individual values and used the mean-correlated variables to run the model. The mean-correlated variables wipe out time-invariant variables since it is in terms of the degree of WG estimation freedom.

Based on the FEM presented by Megesa, Chelule, and Odhiambo (2016),

$$Y_{it} = \beta_{0i} + \alpha_i \mathrm{Z} + \beta_k X_{k,it} + \mu_{it} \tag{3.11}$$

where α_i indicates subject-specific intercepts and Z refers to dummy variables. β_{0i} represents fixed effects in the model. Henceforth, FEM for this study is written as equation (3.13):

$$i_L = \beta_{0i} + \alpha_i gfc + \beta_1 i_f + \beta_2 S_t + \beta_3 rgdp_{it} + \beta_4 pie_{it} + \beta_5 ca_{it} + \beta_6 ifdi_{it} + \beta_7 ofdi_{it} + \beta_8 debt_{it} + \beta_9 lsp_{it} + \varepsilon_{it} \tag{3.12}$$

where

gfc = dummy variable for GFC

1= GFC take into consideration

0= Otherwise

Based on the study of Gujarati and Porter (2009), there are two main assumptions from FEM: Firstly, there are some situations that time invariant variables may not be able to identify by LSDV. Since these variables will remain unchanged over time for an individual subject, the subject-specific intercepts absorbs all heterogeneity that may exist in regressands and regressors.

$$Cor\ (\alpha_i, X_{it}) \neq 0$$

Hence, the subject-specific intercepts and the regressor are correlated. Sometimes the invariant variables are called nuisance or lurking variables.
Secondly, the error terms follow the classical assumption,

$$\varepsilon_{it} \sim N(0,1)$$

Since i indicates cross-sectional observations and t indicates time series observations, the classical assumption for $\boldsymbol{\varepsilon_{it}}$ may have to be adjusted. Therefore, the cross-sectional error components are normally distributed.

3.4.3 Random Effect Model (REM)

Some or all of the regressors in this approach act as random causes which contradicts to FEM. REM break down the error term and rewrite the basic linear model in resulting from the three sources of variation which are time, observation or both.

From the study of Bell and Jones (2015), the REM is illustrates as:

$$Y_{it} = \beta_{1i} + \beta_k X_{k,it} + \mu_{it} \text{ , where } \beta_{1i} = \beta_1 + \varepsilon_i \qquad (3.13)$$

Now, assume there is a random variable with mean value of β_1 instead of β_{1i} which is fixed, the intercept of REM model expressed as β_{1i} where ε_i is a stochastic error term with a zero mean and variance of σ_ε^2. Since it assume all individual values have constant mean value for the intercept β_1, then the differences of the individual intercept values is the error term ε_i.

Thus, it obtain:

$$Y_{it} = \beta_1 + \beta_k X_{k,it} + \varepsilon_i + \mu_{it} \text{ , where } \nu_{it} = \varepsilon_i + \mu_{it} \quad (3.14)$$

The composite error term ν_{it} consist of two components: ε_i is cross-sectional or individual specific or error component and μ_{it} is combined time series and cross-sectional error component, it also called as idiosyncratic term. Thus, REM in this study is illustrate as:

$$i_L = \beta_{0it} + \beta_1 i_f + \beta_2 S_t + \beta_3 rgdp_{it} + \beta_4 pie_{it} + \beta_5 ca_{it} + \beta_6 ifdi_{it} + \beta_7 ofdi_{it} + \beta_8 debt_{it} + \beta_9 lsp_{it} + \nu_{it} \quad (3.15)$$

Assumption of REM:

$$\varepsilon_i \sim N\ (0, \sigma_\varepsilon^2)$$

$$\mu_{it} \sim N\ (0, \sigma_\varepsilon^2)$$

$$E(\varepsilon_i \mu_{it}) = 0; E(\varepsilon_i \varepsilon_j) = 0; (i \neq j)$$

$$E(\mu_{it} \mu_{is}) = E(\mu_{ij} \mu_{ij}) = E(\mu_{it} \mu_{js}) = 0; (i \neq j; t \neq s)$$

Therefore, this assumption captures the individual error components are uncorrelated with each other. There is no autocorrelation across both cross-section and time series. The important is ν_{it} uncorrelated with any regressors that include in the model. There is possible the latter is correlated to the regressors since ε_i be the component ofν_{it}. Otherwise, REM will provide inconsistent estimation of the regression coefficients.

3.4.4 Likelihood Ratio: Pooled OLS VS FEM

The use of panel data gives considerable advantages as opposed to using only time series or only cross-sectional data (Frees, 2004). However, the decision in choosing the most appropriate method is important. There are three tests to

identify and determine most appropriate method which are Likelihood Ratio, Breusch and Pagan Lagrange Multiplier (LM) Test and Hausman Test.

One of the main objectives behind pooling a time series of cross-sections is to increase the sample size in order to get more precise and reliable estimates of the parameters. In order to determine and decide between Pooled OLS and FEM, F-test is applied. F-test is used to determine whether there is common constant or different constant, hence decide Pooled OLS or FEM should be used.

$$\text{Test Statistic: } F = \frac{(ESS_R - ESS_U)/(N-1)}{ESS_U/((T-1)N-K)}$$

Where ESS_R denotes the residual sum of squares under the null hypothesis, ESS_U the residual sum of squares under the alternative, $N-1$ and $(T-1)N-k$ refer to the degree of freedom.

Hypothesis:

$$H_0: \text{There is a common intercept (Pooled OLS preferable)}$$

$$H_1: \text{There is no common intercept (FEM is more favorable)}$$

If the null hypothesis is rejected, there is no common intercept, thus using FEM is more preferable than REM.

3.4.5 Breusch and Pagan Lagrange Multiplier Test: Pooled OLS VS REM

LM Test which is developed by Breusch and Pagan in the year 1980. It is a hypothesis testing used to identify and choose a preferred model between Pooled OLS and REM.

Test statistic: R^2 ; where n is the sample size.

Hypothesis:

$$H_0: \text{No random effect (Pooled OLS preferable)}$$

$$H_1: \text{Random effect (REM preferable)}$$

If the null hypothesis is rejected, the model shows random effect, thus using REM is more preferable than Pooled OLS.

3.4.6 Hausman Test: REM VS FEM

Hausman specification test (Hausman, 1978) also sometimes known as Durbin-Wu-Hausman test which is a statistical hypothesis testing that specifies whether FEM or REM should be used. This test is basically examines whether or not the unique errors are correlated with the regressors. If no, then REM is preferable and vice versa (Clark & Linzer, 2012).

Hausman test makes comparison between REM and FEM. The property of null hypothesis ensures that the size of the test can be controlled asymptotically and it measures the probability of rejecting the null hypothesis. Furthermore, the alternative property gives the test its power and it represents s the probability of correctly rejecting the null hypothesis. Values of the power of 80% or above are considered "good" when corresponding to size of 5% (Cohen, 1988).

Test statistic: $H = (\hat{\beta}^{FE} - \hat{\beta}^{RE})[Var(\hat{\beta}^{FE}) - Var(\hat{\beta}^{RE})]^{-1}(\hat{\beta}^{FE} - \hat{\beta}^{RE})$

Where $\hat{\beta}^{FE}$ is the coefficient estimates from FEM and $\hat{\beta}^{RE}$ is the corresponding coefficient estimates from REM. If there is no correlation between regressor and the unit's effect, then $\hat{\beta}^{FE}$ should be similar to $\hat{\beta}^{RE}$.

Hypothesis:

$$H_0: \text{REM are consistent and efficient (REM preferable)}$$

$$H_1: \text{FEM are consistent and efficient (FEM preferable)}$$

If the null hypothesis is rejected, the coefficients are significantly different, thus using FEM is more preferable than REM.

3.5 Conclusion

Chapter 3 explains the data and methods used for this study. This study will use panel data to investigate the relationship between the variables. Panel data is the combination between cross-sectional and time series data (Baltagi, 2008).

The panel model will be used due to several advantages as it is more efficient in measuring the effects that simply cannot be observed in pure cross-section or time series data (Hsiao, 2007). In order to get a handle on the time ordering of variables and to track individual characteristics over the time period, this study is necessary to use panel data.

Secondly, using panel data can minimize the multicollinearity problem that most of the economic variable are usually correlated which each other. Thirdly, FEM and REM had taken heterogeneity into account and therefore there is no concern about heteroscedasticity problems. Fourthly, it minimize autocorrelation problems in this research as the period of time are only 10 years period and the sample of countries are larger than it. Lastly, since panel data are usually have a big sample size as N x T it tend to be normality distributed.

Besides that, the empirical methodologies are based on macroeconomics channel, trade channel and financial channel. Next, the data of this study are mainly retrieved from World Bank, Bloomberg, and OECD. These sources are committed to their accountability and being used in most of the related studies thus the data are reliable.

Eventually, the following chapter will discuss about the econometric treatment of this research regarding the tests, measurements, and results.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

After formed the empirical models based on UIP, three types of models that stated in methodology which are Pooled OLS, FEM and REM in order to identify the significance among the regressand and regressors. The final model also includes GFC as one of the dummy variables to examine the result of particular variables for each country.

4.1 Preferred Model

The purpose of Hausman Test, Breush and Pagan LM Test and Likelihood Ratio Test are choosing a preferred model between Pooled OLS, FEM and REM for each country. Firstly, Likelihood Ratio is used to examine the preferred model between Pooled OLS and FEM. Secondly, Breush and Pagan LM Test is used to test the preferred model between Pooled OLS and REM. Lastly, Hausman Test is used to identify the preferred model between FEM and REM.

Based on the Table 4.1, the result by using Likelihood Ratio Test shows the probability value is 0.0000 which is less than 0.01 significance level. There is sufficient evidence that using FEM is more suitable than Pooled OLS as the null hypothesis is rejected. Thus, FEM is preferred by using Likelihood Ratio Test in FEDs short-term interest rate.

Then, the probability value of Breush and Pagan LM Test is 0.0000 which is less than 0.01 significance level. The null hypothesis is rejected which proved that there is sufficient evidence that using REM is more suitable than Pooled OLS. So, The REM is preferred in FEDs short-term interest rate by using Breush and Pagan LM Test.

Table 4.1 Preferred Model for FED

	KPOOL OLS	FEM	REM
c	0.0799*** (0.0091)	0.1694*** (0.0256)	0.1045*** (0.0135)
i_f	0.2129*** (0.0774)	0.3595*** (0.0676)	0.3187*** (0.0598)
S	0.0024*** (0.0005)	-0.0266*** (0.0084)	0.0023** (0.0011)
$rgdp$	-0.2967*** (0.0494)	-0.2342*** (0.0396)	-0.2538*** (0.0384)
pie	0.3695*** (0.0546)	0.2300*** (0.0541)	0.2493*** (0.0504)
ca	-0.1202*** (0.0219)	-0.0136 (0.0350)	-0.0529** (0.0265)
$ifdi$	0.0512* (0.0285)	-0.0066 (0.0236)	0.0057 (0.0228)
$ofdi$	-0.0418 (0.0261)	0.0128 (0.0206)	0.0036 (0.0199)
$debt$	-0.0027 (0.0032)	-0.0081 (0.0086)	0.0030 (0.0049)
lsp	0.0090*** (0.0018)	-0.0185*** (0.0041)	-0.0150*** (0.0027)
gfc	-0.0087** (0.0036)	-0.0040*** (0.0029)	-0.0046* (0.0027)
Adjusted R^2	0.4523	0.7198	0.3385
F Statistic	24.6966	20.4059	15.6846
DW Test	0.6497	1.1429	0.9793
Hausmen Test			**1.0000**
Breush and Pagan Lagrange Multiplier Test	0.0000		
Likelihood Ratio Test		0.0000	

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

Lastly, based on the empirical result of Hausman Test, the probability value is 1.0000 which is greater than 0.10 significance level. As a result, the null hypothesis cannot be rejected due to insufficient evidence to prove that FEM is more suitable than REM. Therefore, REM is preferred for FEDs short-term interest rate. In conclusion, based on the result from all three tests, REM is the most preferred model for FEDs short-term interest rate.

Based on the Table 4.2, the result of preferred model by using Likelihood Ratio Test shows the probability value is 0.0000 which is less than 0.01 significance level. There is sufficient evidence that using FEM is more suitable than Pooled OLS since the null hypothesis is rejected. Thus, FEM is preferred by using Likelihood Ratio Test in ECBs short-term interest rate.

Then, the probability value of Breush and Pagan LM Test is 0.0000 which is less than 0.01 significance level. The null hypothesis is rejected which proved there is sufficient evidence that using REM is more suitable than Pooled OLS. So, The REM is preferred in ECBs short-term interest rate by using Breush and Pagan LM Test.

In the research, Hausman Test shows the probability value is 0.0001 which is less than 0.01 significance level. As a result, the null hypothesis is rejected due to sufficient evidence to prove that FEM is more suitable than REM. Therefore, FEM is preferred for ECBs short-term interest rate

In conclusion, based on the result from all three tests, FEM is the most preferred model for ECBs short-term interest rate.

Based on the Table 4.3, the result of preferred model by using Likelihood Ratio Test shows the probability value is 0.0000 which is less than 0.01 significance level. There is sufficient evidence that using FEM is more suitable than PooledOLS as the null hypothesis is rejected. Therefore, FEM is preferred by using Likelihood Ratio Test in BOJs short-term interest rate.

Table 4.2: Preferred Model for ECB

	KPOOL OLS	FEM	REM
c	0.0785*** (0.0090)	0.1288*** (0.0263)	0.0975*** (0.0134)
i_f	0.3603*** (0.1017)	0.6291*** (0.0918)	0.5547*** (0.0782)
S	0.0025*** (0.0005)	-0.0167** (0.0082)	0.0027** (0.0011)
$rgdp$	-0.3091*** (0.0491)	-0.2558*** (0.0386)	-0.2703*** (0.0373)
pie	0.3533*** (0.0546)	0.1739*** (0.0541)	0.2082*** (0.0497)
ca	-0.1178*** (0.0217)	-0.0716 (0.0339)	-0.0460* (0.0260)
$ifdi$	0.0521* (0.0283)	-0.0115 (0.0229)	0.0029 (0.0221)
$ofdi$	-0.0446* (0.0259)	0.0151 (0.0200)	0.0029 (0.0193)
$debt$	-0.0026 (0.0032)	0.0172** (0.0086)	0.0060 (0.0049)
lsp	-0.0089*** (0.0018)	-0.0151*** (0.0041)	-0.0143*** (0.0026)
gfc	-0.0094*** (0.0036)	-0.0033 (0.0028)	-0.0049* (0.0027)
Adjusted R^2	0.4617	0.7375	0.3786
F Statistic	25.6160	22.2214	18.4750
DW Test	0.6411	1.1787	0.9840
Hausmen Test			**0.0001**
Breush and Pagan Lagrange Multiplier Test	0.0000		
Likelihood Ratio Test		0.0000	

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

Table 4.3: Preferred Model for BOJ

	KPOOL OLS	FEM	REM
c	0.0808*** (0.0009)	0.1543*** (0.0258)	0.1086*** (0.0134)
i_f	2.3764*** (0.7948)	4.1133*** (0.6906)	3.9501*** (0.6117)
S	0.0025*** (0.0005)	-0.0115 (0.0086)	0.0027** (0.0011)
$rgdp$	-0.3090*** (0.0503)	-0.2545*** (0.0398)	-0.2788*** (0.0386)
pie	0.3462*** (0.0558)	0.1596*** (0.0569)	0.1842*** (0.0519)
ca	-0.1226*** （0.0217)	-0.0318* (0.0349)	-0.0571** (0.0263)
$ifdi$	0.0468 (0.0284)	-0.0175 (0.0236)	-0.0040 (0.0226)
$ofdi$	-0.0382 (0.0259)	0.0247 (0.0205)	0.0105 (0.0196)
$debt$	-0.0034 (0.0032)	0.0036 (0.0080)	0.0017 (0.0048)
lsp	-0.0091*** (0.0018)	-0.0205*** (0.0041)	-0.0159*** (0.0026)
gfc	-0.0150*** (0.0042)	-0.0146*** (0.0031)	-0.0148*** (0.0031)
Adjusted R^2	0.4549	0.7269	0.3647
F Statistic	24.9502	21.1042	17.4745
DW Test	0.6361	1.1441	0.9628
Hausmen Test			**0.0003**
Breush and Pagan Lagrange Multiplier Test	0.0000		
Likelihood Ratio Test		0.0000	

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

Then, the probability value of Breush and Pagan LM Test is 0.0000 which is less than 0.01 significance level. The null hypothesis is rejected which proved that there is sufficient evidence that using REM is more suitable than Pooled OLS. So, The REM is preferred in BOJs short-term interest rate by using Breush and Pagan LM Test.

Based on the empirical result of Hausman Test, the probability value is 0.0003 which is less than 0.01 significance level. As a result, null hypothesis is rejected due to sufficient evidence to prove that FEM is more suitable than REM. Thus, FEM is preferred for BOJs short-term interest rate.

In conclusion, based on the result from all three tests, FEM is the most preferred model for BOJs short-term interest rate.

4.2 Spillover Effects through Different Transmission Channel

From Table 4.4 to Table 4.6, the control variables that included in the research is to test the spillover effects of FED's, ECB's and BOJ's monetary policy based on different channels.

4.2.1 FED's Monetary Policy Spillover Effects

Table 4.4 explains spillover effects of FED's monetary policy by using REM as the preferred model. In order to test number of transmission channel it take different channel like macroeconomic channel, trade channel and financial channel into consideration. Besides that, there are the variables included in the basic model such as FED's short-term interest rate and official exchange rate.

The result shows that for every 1 percentage point increase in FED's short-term interest rate, the long-term interest rate will increase by 0.1701 percentage point, on average, holding other variables constant.

Table 4.4 Spillover Effects of FED's Monetary Policy

Channels		(1)	(2)	(3)	(4)	(5)
Basic Model	i_f	0.1701***	0.2969***	0.1625**	0.2709***	0.3187***
		(0.0583)	(0.0549)	(0.0633)	(0.0620)	(0.0598)
	S	0.0014	0.0017	0.0016	0.0013	0.0023**
		(0.0015)	(0.0011)	(0.0012)	(0.0016)	(0.0011)
Macroeconomic Channel	$rgdp$		-0.2957***			-0.2538***
			(0.0305)			(0.0384)
	pie		0.2643***			0.2493***
			(0.0443)			(0.0504)
Trade Channel	ca			-0.0230		-0.0529**
				(0.0272)		(0.0265)
	$ifdi$			0.0043		0.0057
				(0.0279)		(0.0228)
	$ofdi$			-0.0096		0.0036
				(0.0239)		(0.0020)
Financial Channel	$debt$				-0.0024	0.0030
					(0.0060)	(0.0049)
	lsp				-0.0205	-0.0150***
					(0.0030)	(0.0027)
Global Financial Crisis	gfc					-0.0046*
						(0.0027)
Adjusted R^2		0.0221	0.3177	0.0166	0.1563	0.3385
F Statistic		4.4977	36.9783	2.0439	14.2908	15.6846
DW Test		0.7856	0.9814	0.7662	0.7607	0.9793

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

In the Equation 2, there are the control variables that involved based on macroeconomics channel which are official exchange rate, real gross domestic product and inflation rate. The spillover effect was higher than basic model 0.12 percentage point.

Furthermore, the controlled variables based on trade channel are included in Equation 3. The result indicates that it shows a different result compares to macroeconomic channel because the coefficient 0.1625 which is lower than basic model. In addition, the controlled variables based on financial channel are included in Equation 4. The spillover effect for this channel was 0.2709 coefficients. Lastly, the combination of all channel and add in GFC as dummy variable to capture the spillover effects from FED's short-term interest rate. The result show that which is for every 1 percentage point increase in FEDs short-term interest rate, the long-term interest rate will increase by 0.3187 percent, on average, holding others variables constant.

Based on empirical result, the FED's short-term interest rate have the largest spillover effect through the final model with coefficient 0.3187 compared to others channel.

4.2.2 ECB's Monetary Policy Spillover Effects

Table 4.5 explain spillover effects of ECB's monetary policy by using FEM as the preferred model. In order to test number of transmission channel it take different channel like macroeconomic channel, trade channel and financial channel into consideration. In basic model, the variable such as ECB's short-term interest rate and official exchange rate are included in Equation 1. The result shows that for every 1 percentage point increase in ECB's short-term interest rate, the long-term interest rate will increase by 0.3101 percentage point, on average, holding others variables constant.

Besides that, there are the control variables based on macroeconomics channel involved in Equation 2. The spillover effects is 0.21 percentage point higher than basic model. Besides that, the controlled variables based on trade channel which are current account balance, net inflow FDI and net outflow FDI are adding into Equation 3. The results show that it equally to macroeconomics channel which was 0.07 percentage point higher than basic model.

Furthermore, the financial channel's controlled variables are included in equation 4. The spillover effect for this channel was higher than basic model which was 0.4877 coefficients. Lastly, all controlled variable and GFC as dummy variable are involved in order to capture the spillover effects from ECB's short-term interest rate. The result show that which is for every 1 percentage point increase in ECB's short-term interest rate, the long-term interest rate will increase by 0.6291 percentage point, on average, holding others variables constant.

Table 4.5 Spillover Effects of ECB's Monetary Policy

Channels		(1)	(2)	(3)	(4)	(5)
Basic Model	i_f	0.3101***	0.5240***	0.3849***	0.4877***	0.6291***
		(0.0780)	(0.0740)	(0.0841)	(0.0867)	(0.0918)
	S	-0.0191**	-0.0106	-0.0245**	-0.0235***	-0.0167**
		(0.0095)	(0.0078)	(0.0097)	(0.0088)	(0.0082)
Macroeconomic Channel	$rgdp$		-0.3202***			-0.2558***
			(0.0297)			(0.0386)
	pie		0.1459***			0.1739***
			(0.0436)			(0.0541)
Trade Channel	ca			0.0696**		-0.0176
				(0.0309)		(0.0339)
	$ifdi$			-0.0063		-0.0115
				(0.0279)		(0.0229)
	$ofdi$			-0.0067		0.0151
				(0.0238)		(0.0200)
Financial Channel	$debt$				0.0051	0.0172**
					(0.0083)	(0.0086)
	lsp				-0.0243***	-0.0151***
					(0.0036)	(0.0041)
Global Financial Crisis	gfc					-0.0033
						(0.0028)
Adjusted R^2		0.5740	0.7154	0.5784	0.6689	0.7375
F Statistic		14.0112	23.8499	13.1118	19.1228	22.2214
DW Test		0.9339	1.1408	0.9212	0.8945	1.1787

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

Based on empirical result, ECB's short-term interest rate have the largest spillover effect through the final model with coefficient 0.6291 compared to others channel.

4.2.3 BOJ's Monetary Policy Spillover Effects

Table 4.6 explain the spillover effects of BOJ's monetary policy by using FEM as the preferred model. In order to test number of transmission channel it take different channel like macroeconomic channel, trade channel and financial channel into consideration. In basic model, the variable such as BOJ's short-term interest rate and official exchange rate are included in Equation 1.

The result shows that for every 1 percentage point increase in ECBs short-term interest rate, the long-term interest rate will increase by 2.6410 percentage point, on average, holding others variables constant.

Besides that, the control variables based on macroeconomics channel are included in Equation 2. The result was different compared to FED's and ECB's short-term interest rate which is 0.20 percentage point lower than basic model. Furthermore, the Equation 3 includes the controlled variables based on trade channel. The result indicates that it shows an inverse result compares to macroeconomics channel because the value is 0.62 percentage point which is higher than basic model. In addition, the controlled variable based on financial channel such as central government debt and share price are involved in Equation 4. The spillover effect for this channel is higher than basic model which is 3.3798 coefficients value.

Lastly, the combination of all controlled variable and GFC as dummy variable are included in final model to capture the spillover effects from BOJs short-term interest rate. The result shows that which is for every 1 percentage point increase in BOJ's short-term interest rate, the long-term interest rate will increase by 4.1133 percentage point, on average, holding others variables constant.

Based on empirical result, the BOJs short-term interest rates have the largest spillover effect through final model. This is because it provides the largest coefficients value compared to others.

Table 4.6 Spillover Effect of BOJ's Monetary Policy

Channels		(1)	(2)	(3)	(4)	(5)
Basic Model	i_f	2.6410***	2.4425***	3.2677***	3.3798***	4.1133***
		(0.5440)	(0.5530)	(0.5832)	(0.5938)	(0.6906)
	S	-0.0120	-0.0112	-0.0168*	-0.0167*	-0.0115
		(0.0097)	(0.0084)	(0.0098)	(0.0090)	(0.0086)
Macroeconomic Channel	$rgdp$		-0.2553***			-0.2545***
			(0.0289)			(0.0398)
	pie		0.1487***			0.1596***
			(0.0528)			(0.0569)
Trade Channel	ca			0.0846***		-0.0318
				(0.0307)		(0.0349)
	$ifdi$			-0.0091		-0.0175
				(0.0274)		(0.0236)
	$ofdi$			-0.0022		0.0247
				(0.0234)		(0.0205)
Financial Channel	$debt$				0.0047	0.0036
					(0.0082)	(0.0080)
	lsp				-0.0224***	-0.0205***
					(0.0036)	(0.0041)
Global Financial Crisis	gfc					-0.0146***
						(0.0031)
Adjusted R^2		0.5850	0.6859	0.5928	0.6698	0.7269
F Statistic		14.6134	20.8435	13.8528	19.1958	21.1042
DW Test		0.9654	1.0798	0.9532	0.9066	1.1441

Note: 31 Countries (Australia, Canada, Chile Colombia, Czech Republic, Denmark, Gabon, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea Republic, Latvia, Lithuania, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Russia, South Africa, Spain, Sweden, Switzerland, United Kingdom, United States).
Period: 2006-2015 (Yearly).
*Significant at 0.10 significance level
**Significant at 0.05 significance level
***Significant at 0.01 significance level

4.3 Conclusion

In the data analysis, Likelihood Ratio Test, Breush and Pagan LM Test and Hausmen Test are tested in order to identify the preferred model in FED, ECB and BOJ. In addition, this research also shows the result based on different channel to identify which transmission channel has a larger spillover effect for FEDs, ECBs and BOJs short-term interest rate. Lastly, this significant result is explained by

each country's preferred model. Thus, some conclusions are formed based on the empirical result in order to meet this research objectives and research questions.

Furthermore, FEDs and ECBs and BOJs short-term interest rate have a largest spillover effect through the final model. This indicates that the change of their interest rate would have a largest spillover effects to the rest of the world. Besides that, BOJ's monetary policy has a larger spillover effects compared to FED's and ECB's monetary policy. The short-term interest rate for FED's, ECB's and BOJ's moves in the parallel direction with long-term interest rate as when their short-term interest rate increase and the rest of the world increase long-term interest rate.

Furthermore, there are most of the controlled variables are consistent with the theory. For example, short-term interest rate, official exchange rate, inflation, current account balance, government debt, share price and GFC have the same expected signed based on empirical result. However, there is one of the controlled variable is inconsistent with theory which is the real gross domestic product. This might because of the global financial crisis shock cause the variable inconsistent with the theory.

CHAPTER 5: DISCUSSION AND CONCLUSION

5.0 Discussion of Major Findings

The main objective of this research paper is to examine the spillovers of monetary policies to the rest of the world. This research is looking for the impact of short-term interest rate for FED, ECB and BOJ by utilizing an UIP with expected trade rate and future interest rate. For example, change in interest rate, capital flows, stock markets and macroeconomics across the propelled economies countries in a panel model over the period of year 2006 to year 2015.

Based on empirical result, there is some conclusion would meet the objectives. Firstly, FED's, ECB's and BOJ's monetary policy are statistically significant spillovers with sizeable magnitude to the rest of the world. However, BOJ's monetary policy shows a stronger spillovers and larger magnitude compare to FED's and ECB's monetary policy as the empirical result shows that at least 3 times larger than FED and ECB. Furthermore, FED's, ECB's and BOJ's interest rate move long-term interest rate of the rest of the world in parallel direction while the increase in the short-term interest rate will move the rest of the world long-term interest rate increase.

Last but not least, BOJ's GFC is statistically significant to explain long-term interest rate. However, a GFC has a weak significant for FED and not significant for ECB's monetary policy to long-term interest rate.

5.1 Implications of the Study

This research shed light for policymakers to understand the spillover of monetary policy and using a better policy to defend against negative spillover effects or to support from the positive spillover. For example, data analysis found that 3-month

Treasury bill for US, ECB and BOJ have significant spillover over to the globe. Government can implement policy to stimulate their economy by taking other CB's monetary policy into account in order to make more accurate and effective policies.

The results may be interpreted as a support to concerns expressed by policymakers. In particular, countries that have been negatively or positively affected by spillovers of monetary policy from advanced economies. For example, capital outflows when capital is scarce and pushing capital into EMEs, pushing up asset prices and exchange rate when they already face a high capital inflows through other sources. Thus there may indeed be a case both for domestic policy reforms as well as for more coordination at the global level in order to deal with policy spillovers and externalities

Furthermore, financial investor or banking sector will also be benefited from this study as they could refer to this research to better understand the spillover effects of central bank and the movement of long-term interest rate. Thus, they can use it as a proxy to help them in forecasting the long-term interest rate.

5.2 Limitations and Recommendations

There are several limitations along the study in examining the international monetary policy spillover. Based on the limitations, this paper would like to provide some recommendation for future researchers.

One of the recommendations suggested to future researchers is to further investigate the spillover effects of other macroeconomic fundamentals that influenced by both net inflows and outflows of FDI. This is due to the analysis displays insignificant results of US, ECB and BOJ for both net inflows and outflows of FDI at all significance levels. In other words, it means that there is no impact in affecting long-term interest rate for the monetary policy spillover internationally. Thus, the spillover effects of both net inflows and outflows FDI

still remain unknown. Besides, this paper only analyze the spillover effects by 3-month Treasury bill to long-term interest rate. In other words, the results from this study only can be used as the reference in AEs since the results in EMEs may different from the result in AEs.

Furthermore, there are various transmission channels for international monetary policy spillover in this study such as bank lending, credit, liquidity, expectations, interest rates, portfolio balancing and trade channel which examined spillover effects by using macroeconomics fundamentals. However, this paper are unable to investigate the spillover effects through some of the channels due to limitation of data such as liquidity channel. From the research, money supply should take into account in order to examine the spillover effects through liquidity channel. The more macroeconomics fundamentals taking into account, the less panel data will be collected. This is because panel data need to consider both cross-sectional and time series data. Therefore, future researchers could make analysis to focus spillover effects through only one transmission channel such as international monetary policy spillover through interest rate channel. So that future researchers are able to collect sufficient data and obtain more accuracy result.

Although this study has been successfully filled up the gap in examine the international monetary policy spillover through transmission channels, there is still some area that has been underexplored. As a recommendation, future researchers could further examine the impact of negative interest rate leads the spillover of monetary policy in AEs. Jobst and Lin (2016) discovered that until now, negative interest rates have promoted simple financial status and provided to a modest growth in credit, indicating that the zero lower bound is less mandatory than previously speculation. On the other hand, lower down the interest rate leads counterbalance on bank profitability. Substantial rate reduces may counterbalance the profit from greater asset values and higher aggregate demand at the same time. Hence, the monetary policy may need to depend more on credit easing and the increasing of ECB’s balance sheet instead of massive additional decline in the policy rate.

Along the research, this paper also found that the negative interest rate have been implemented in Sweden, Denmark, Japan and more in the recent years but this paper only capture the sample data from year 2006 to 2015 in the study. According to the sample data, its only use 3-month Treasury bill to determine the spillover effects of the CB. As recommendation, future researchers could include the negative interest rate in the sample size and investigate the results of negative interest rate as a new finding of the research. Therefore, the spillover effects can be differentiated between positive rate and negative rate in future studies.

5.3 Conclusion

In this research, the main objective is to study the monetary policy spillover of FED, ECB and BOJ by using the data from the year 2006-2015, to study the spillover channels and magnitude of the monetary policy. Furthermore, GFC is also taken into account as control variable. Also, the models are based on UIP to determine the spillover effects. A series of tests have been conducted and the results obtained are discussed in previous chapter. Based on the result, it clearly showed that there is significant spillover of monetary policy from ECB, FED and BOJ to the rest of the world. Referring to the result obtained, it is consistent with the estimation in this research from the beginning, and it is believed that these variables are the real fundamental variables in accessing international spillovers of monetary policy due to higher coefficient among the variables.

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APPENDICES

Appendix A: Likelihood Ratio Test of FED

Redundant Fixed Effects Tests

Equation: LIKE_US

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	10.448999	(28,249)	0.0000
Cross-section Chi-square	223.782650	28	0.0000

Cross-section fixed effects test equation:

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 04/05/17 Time: 16:13

Sample: 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.212867	0.077400	2.750223	0.0063
LEXR	0.002390	0.000536	4.462041	0.0000
RGDP	-0.296741	0.049424	-6.004030	0.0000
PIE	0.369537	0.054599	6.768173	0.0000
CA	-0.120184	0.021884	-5.491803	0.0000
IFDI	0.051172	0.028532	1.793506	0.0740
OFDI	-0.041756	0.026131	-1.597954	0.1112
DEBT	-0.002692	0.003232	-0.832760	0.4057
LSP	-0.008981	0.001823	-4.926698	0.0000
DUM_GFC	-0.008744	0.003602	-2.427222	0.0159
C	0.079940	0.009064	8.819065	0.0000

R-squared	0.471339	Mean dependent var	0.047278
Adjusted R-squared	0.452254	S.D. dependent var	0.027400
S.E. of regression	0.020279	Akaike info criterion	-4.921052
Sum squared resid	0.113909	Schwarz criterion	-4.781147
Log likelihood	719.6314	Hannan-Quinn criter.	-4.864986

F-statistic	24.69655	Durbin-Watson stat	0.649684
Prob(F-statistic)	0.000000		

Appendix B: Breush Pagan Lagrange Multiplier Test of FED

Lagrange Multiplier Tests for Random Effects

Null hypotheses: No effects

Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	157.1281	0.007405	157.1355
	(0.0000)	(0.9314)	(0.0000)
Honda	12.53507	0.086053	8.924485
	(0.0000)	(0.4657)	(0.0000)
King-Wu	12.53507	0.086053	6.258930
	(0.0000)	(0.4657)	(0.0000)
Standardized Honda	14.27387	0.970189	6.334327
	(0.0000)	(0.1660)	
			(0.0000)
Standardized King-Wu	14.27387	0.970189	3.875684
	(0.0000)	(0.1660)	(0.0001)
Gourierioux, et al.*	--	--	157.1355
			(< 0.01)

*Mixed chi-square asymptotic critical values:

1%	7.289
5%	4.321
10%	2.952

Appendix C: Hausman Test of FED

Correlated Random Effects - Hausman Test

Equation: HAUS_US

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	0.000000	10	1.0000

* Cross-section test variance is invalid. Hausman statistic set to zero.

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
I_US	0.359454	0.318738	0.000986	0.1948
LEXR	-0.026644	0.002295	0.000069	0.0005
RGDP	-0.234248	-0.253779	0.000094	0.0439
PIE	0.230040	0.249345	0.000391	0.3290
CA	-0.013591	-0.052935	0.000523	0.0852
IFDI	-0.006572	0.005693	0.000040	0.0536
OFDI	0.012789	0.003552	0.000029	0.0889
DEBT	0.008105	0.002995	0.000050	0.4719
LSP	-0.018477	-0.014993	0.000010	0.2742
DUM_GFC	-0.003990	-0.004602	0.000001	0.5432

Cross-section random effects test equation:

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 04/05/17 Time: 16:19

Sample: 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.169423	0.025617	6.613653	0.0000
I_US	0.359454	0.067573	5.319527	0.0000
LEXR	-0.026644	0.008355	-3.189078	0.0016
RGDP	-0.234248	0.039603	-5.914883	0.0000
PIE	0.230040	0.054149	4.248262	0.0000

CA	-0.013591	0.035021	-0.388088	0.6983
IFDI	-0.006572	0.023641	-0.277990	0.7813
OFDI	0.012789	0.020646	0.619425	0.5362
DEBT	0.008105	0.008645	0.937486	0.3494
LSP	-0.018477	0.004148	-4.454589	0.0000
DUM_GFC	-0.003990	0.002920	-1.366629	0.1730

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.756936	Mean dependent var	0.047278
Adjusted R-squared	0.719842	S.D. dependent var	0.027400
S.E. of regression	0.014503	Akaike info criterion	-5.503630
Sum squared resid	0.052372	Schwarz criterion	-5.007604
Log likelihood	831.5228	Hannan-Quinn criter.	-5.304853
F-statistic	20.40586	Durbin-Watson stat	1.142855
Prob(F-statistic)	0.000000		

Appendix D: Likelihood Ratio Test of ECB

Redundant Fixed Effects Tests

Equation: LIKE_ECB

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	11.395571	(28,249)	0.0000
Cross-section Chi-square	237.543067	28	0.0000

Cross-section fixed effects test equation:

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 04/05/17 Time: 16:22

Sample: 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.

I_ECB	0.360329	0.101685	3.543600	0.0005
LEXR	0.002473	0.000532	4.645556	0.0000
RGDP	-0.309088	0.049070	-6.298889	0.0000
PIE	0.353297	0.054601	6.470464	0.0000
CA	-0.117769	0.021701	-5.426932	0.0000
IFDI	0.052125	0.028285	1.842876	0.0664
OFDI	-0.044571	0.025900	-1.720922	0.0864
DEBT	-0.002648	0.003202	-0.826920	0.4090
LSP	-0.008931	0.001805	-4.947634	0.0000
DUM_GFC	-0.009448	0.003580	-2.639027	0.0088
C	0.078496	0.008995	8.726220	0.0000

R-squared	0.480456	Mean dependent var	0.047278
Adjusted R-squared	0.461700	S.D. dependent var	0.027400
S.E. of regression	0.020103	Akaike info criterion	-4.938447
Sum squared resid	0.111944	Schwarz criterion	-4.798542
Log likelihood	722.1364	Hannan-Quinn criter.	-4.882382
F-statistic	25.61598	Durbin-Watson stat	0.641105
Prob(F-statistic)	0.000000		

Appendix E: Breush Pagan Lagrange Multiplier Test of ECB

Lagrange Multiplier Tests for Random Effects

Null hypotheses: No effects

Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both
Breusch-Pagan	173.6148	0.829688	174.4444
	(0.0000)	(0.3624)	(0.0000)
Honda	13.17630	-0.910872	8.672964
	(0.0000)	--	(0.0000)
King-Wu	13.17630	-0.910872	5.708110
	(0.0000)	--	(0.0000)
Standardized Honda	14.97395	-0.244506	6.031926
	(0.0000)	--	(0.0000)
Standardized King-Wu	14.97395	-0.244506	3.203886

	(0.0000)	--	(0.0007)
Gourierioux, et al.*	--	--	173.6148 (< 0.01)

*Mixed chi-square asymptotic critical values:

1%	7.289
5%	4.321
10%	2.952

Appendix F: Hausman Test of ECB

Correlated Random Effects - Hausman Test

Equation: HAUS_ECB

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	36.181010	10	0.0001

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
I_ECB	0.629122	0.554738	0.002310	0.1217
LEXR	-0.016722	0.002668	0.000066	0.0170
RGDP	-0.255818	-0.270320	0.000102	0.1510
PIE	0.173867	0.208235	0.000451	0.1055
CA	-0.017649	-0.046002	0.000474	0.1928
IFDI	-0.011501	0.002892	0.000037	0.0182
OFDI	0.015062	0.002866	0.000027	0.0184
DEBT	0.017200	0.006031	0.000050	0.1154
LSP	-0.015117	-0.014325	0.000010	0.8008
DUM_GFC	-0.003261	-0.004932	0.000001	0.0871

Cross-section random effects test equation:

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 04/05/17 Time: 16:25

Sample: 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.128771	0.026271	4.901605	0.0000
I_ECB	0.629122	0.091794	6.853615	0.0000
LEXR	-0.016722	0.008193	-2.041115	0.0423
RGDP	-0.255818	0.038637	-6.621060	0.0000
PIE	0.173867	0.054060	3.216210	0.0015
CA	-0.017649	0.033906	-0.520518	0.6032
IFDI	-0.011501	0.022904	-0.502135	0.6160
OFDI	0.015062	0.019985	0.753650	0.4518
DEBT	0.017200	0.008614	1.996893	0.0469
LSP	-0.015117	0.004085	-3.700448	0.0003
DUM_GFC	-0.003261	0.002828	-1.153150	0.2500

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.772273	Mean dependent var	0.047278
Adjusted R-squared	0.737519	S.D. dependent var	0.027400
S.E. of regression	0.014038	Akaike info criterion	-5.568805
Sum squared resid	0.049068	Schwarz criterion	-5.072779
Log likelihood	840.9079	Hannan-Quinn criter.	-5.370028
F-statistic	22.22139	Durbin-Watson stat	1.178655
Prob(F-statistic)	0.000000		

Appendix G: Likelihood Ratio Test of BOJ

Redundant Fixed Effects Tests

Equation: LIKE_JAPAN

Test cross-section fixed effects

Effects Test	Statistic	d.f.	Prob.
Cross-section F	10.854448	(28,249)	0.0000
Cross-section Chi-square	229.757370	28	0.0000

Cross-section fixed effects test equation:

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 04/05/17 Time: 16:26
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	2.376432	0.794752	2.990156	0.0030
LEXR	0.002489	0.000538	4.627760	0.0000
RGDP	-0.308968	0.050270	-6.146155	0.0000
PIE	0.346168	0.055838	6.199546	0.0000
CA	-0.122596	0.021716	-5.645453	0.0000
IFDI	0.046777	0.028436	1.644994	0.1011
OFDI	-0.038202	0.025891	-1.475519	0.1412
DEBT	-0.003430	0.003218	-1.065763	0.2875
LSP	-0.009148	0.001822	-5.020772	0.0000
DUM_GFC	-0.015023	0.004206	-3.571647	0.0004
C	0.080791	0.009047	8.930192	0.0000

R-squared	0.473886	Mean dependent var	0.047278
Adjusted R-squared	0.454892	S.D. dependent var	0.027400
S.E. of regression	0.020230	Akaike info criterion	-4.925880
Sum squared resid	0.113360	Schwarz criterion	-4.785975
Log likelihood	720.3267	Hannan-Quinn criter.	-4.869815
F-statistic	24.95016	Durbin-Watson stat	0.636142
Prob(F-statistic)	0.000000		

Appendix H: Breush Pagan Lagrange Multiplier Test of BOJ

Lagrange Multiplier Tests for Random Effects
Null hypotheses: No effects
Alternative hypotheses: Two-sided (Breusch-Pagan) and one-sided (all others) alternatives

	Test Hypothesis		
	Cross-section	Time	Both

Breusch-Pagan	167.8978	0.021341	167.9191
	(0.0000)	(0.8839)	(0.0000)
Honda	12.95754	-0.146084	9.059066
	(0.0000)	--	(0.0000)
King-Wu	12.95754	-0.146084	6.265428
	(0.0000)	--	(0.0000)
Standardized Honda	14.74539	0.669947	6.473288
	(0.0000)	(0.2514)	
			(0.0000)
Standardized King-Wu	14.74539	0.669947	3.858984
	(0.0000)	(0.2514)	(0.0001)
Gourierioux, et al.*	--	--	167.8978
			(< 0.01)

*Mixed chi-square asymptotic critical values:

1%	7.289
5%	4.321
10%	2.952

Appendix I: Hausman Test of BOJ

Correlated Random Effects - Hausman Test

Equation: HAUS_JAPAN

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	32.549023	10	0.0003

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
I_JAPAN	4.113303	3.950138	0.102639	0.6105
LEXR	-0.011461	0.002724	0.000073	0.0961
RGDP	-0.254504	-0.278753	0.000096	0.0133
PIE	0.159558	0.184216	0.000541	0.2893
CA	-0.031774	-0.057094	0.000527	0.2702
IFDI	-0.017477	-0.004008	0.000045	0.0451
OFDI	0.024681	0.010484	0.000033	0.0137

DEBT	0.003593	0.001749	0.000041	0.7723
LSP	-0.020488	-0.015855	0.000009	0.1325
DUM_GFC	-0.014642	-0.014803	0.000000	0.8007

Cross-section random effects test equation:

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 04/05/17 Time: 16:28

Sample: 2006 2015

Periods included: 10

Cross-sections included: 29

Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.154301	0.025798	5.981178	0.0000
I_JAPAN	4.113303	0.690552	5.956544	0.0000
LEXR	-0.011461	0.008590	-1.334203	0.1834
RGDP	-0.254504	0.039819	-6.391487	0.0000
PIE	0.159558	0.056920	2.803173	0.0055
CA	-0.031774	0.034895	-0.910541	0.3634
IFDI	-0.017477	0.023584	-0.741053	0.4594
OFDI	0.024681	0.020469	1.205778	0.2290
DEBT	0.003593	0.007968	0.450937	0.6524
LSP	-0.020488	0.004059	-5.047670	0.0000
DUM_GFC	-0.014642	0.003146	-4.653793	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.763074	Mean dependent var	0.047278
Adjusted R-squared	0.726916	S.D. dependent var	0.027400
S.E. of regression	0.014318	Akaike info criterion	-5.529204
Sum squared resid	0.051050	Schwarz criterion	-5.033178
Log likelihood	835.2054	Hannan-Quinn criter.	-5.330427
F-statistic	21.10418	Durbin-Watson stat	1.144124
Prob(F-statistic)	0.000000		

Appendix J: FED's Basic Model

Dependent Variable: I_LT
Method: Panel EGLS (Cross-section random effects)
Date: 03/03/17 Time: 20:49
Sample: 2006 2015
Periods included: 10
Cross-sections included: 31
Total panel (balanced) observations: 310
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.170103	0.058329	2.916259	0.0038
LEXR	0.001354	0.001488	0.909937	0.3636
C	0.042630	0.004742	8.990267	0.0000

Effects Specification		
	S.D.	Rho
Cross-section random	0.020131	0.5502
Idiosyncratic random	0.018202	0.4498

Weighted Statistics			
R-squared	0.028467	Mean dependent var	0.012943
Adjusted R-squared	0.022138	S.D. dependent var	0.018641
S.E. of regression	0.018434	Sum squared resid	0.104321
F-statistic	4.497686	Durbin-Watson stat	0.785579
Prob(F-statistic)	0.011878		

Unweighted Statistics			
R-squared	0.042054	Mean dependent var	0.047081
Sum squared resid	0.222758	Durbin-Watson stat	0.367900

Appendix K: FED's Spillover through Macroeconomic Channel

Dependent Variable: I_LT
Method: Panel EGLS (Cross-section random effects)
Date: 03/23/17 Time: 15:09
Sample: 2006 2015
Periods included: 10
Cross-sections included: 31
Total panel (balanced) observations: 310
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.296925	0.054903	5.408169	0.0000
LEXR	0.001748	0.001098	1.592633	0.1123
RGDP	-0.295742	0.030451	-9.712027	0.0000
PIE	0.264348	0.044301	5.967046	0.0000
C	0.038426	0.003596	10.68620	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.014554	0.4818
Idiosyncratic random	0.015092	0.5182

Weighted Statistics

R-squared	0.326582	Mean dependent var	0.014670
Adjusted R-squared	0.317750	S.D. dependent var	0.018893
S.E. of regression	0.015605	Sum squared resid	0.074272
F-statistic	36.97829	Durbin-Watson stat	0.981357
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.298467	Mean dependent var	0.047081
Sum squared resid	0.163133	Durbin-Watson stat	0.446800

Appendix L: FED's Spillover through Trade Channel

Dependent Variable: I_LT

Method: Panel EGLS (Cross-section random effects)

Date: 03/03/17 Time: 20:53

Sample: 2006 2015

Periods included: 10

Cross-sections included: 31

Total panel (balanced) observations: 310

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.162515	0.063297	2.567520	0.0107
LEXR	0.001603	0.001238	1.295024	0.1963
IFDI	0.004347	0.027912	0.155730	0.8763
OFDI	-0.009638	0.023934	-0.402676	0.6875
CA	-0.022967	0.027205	-0.844240	0.3992
C	0.042442	0.003995	10.62378	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.016291	0.4450
Idiosyncratic random	0.018194	0.5550

Weighted Statistics

R-squared	0.032523	Mean dependent var	0.015678
Adjusted R-squared	0.016611	S.D. dependent var	0.019052
S.E. of regression	0.018893	Sum squared resid	0.108512
F-statistic	2.043885	Durbin-Watson stat	0.766222
Prob(F-statistic)	0.072430		

Unweighted Statistics

R-squared	0.080700	Mean dependent var	0.047081
Sum squared resid	0.213772	Durbin-Watson stat	0.388938

Appendix M: FED's Spillover through Financial Channel

Dependent Variable: I_LT
Method: Panel EGLS (Cross-section random effects)
Date: 03/03/17 Time: 20:54
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.270913	0.061957	4.372619	0.0000
LEXR	0.001325	0.001591	0.832920	0.4056
DEBT	-0.002404	0.006047	-0.397478	0.6913
LSP	-0.020456	0.002987	-6.849149	0.0000
C	0.137127	0.015900	8.624143	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.020289	0.6117
Idiosyncratic random	0.016166	0.3883

Weighted Statistics

R-squared	0.168046	Mean dependent var	0.011614
Adjusted R-squared	0.156287	S.D. dependent var	0.018086
S.E. of regression	0.016594	Sum squared resid	0.077930
F-statistic	14.29075	Durbin-Watson stat	0.760685
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.111984	Mean dependent var	0.047278
Sum squared resid	0.191338	Durbin-Watson stat	0.309821

Appendix N: FED's Spillover through All Channel (Taking GFC into Account)

Dependent Variable: I_LT
Method: Panel EGLS (Cross-section random effects)
Date: 03/23/17 Time: 13:44
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.318738	0.059831	5.327262	0.0000
LEXR	0.002295	0.001064	2.156375	0.0319
RGDP	-0.253779	0.038398	-6.609109	0.0000
PIE	0.249345	0.050408	4.946561	0.0000
CA	-0.052935	0.026531	-1.995220	0.0470
IFDI	0.005693	0.022771	0.249999	0.8028
OFDI	0.003552	0.019920	0.178336	0.8586
DEBT	0.002995	0.004928	0.607806	0.5438
LSP	-0.014993	0.002655	-5.646817	0.0000
DUM_GFC	-0.004602	0.002741	-1.679205	0.0942
C	0.104533	0.013493	7.747248	0.0000

Effects Specification

	S.D.	Rho
Cross-section random	0.012763	0.4364
Idiosyncratic random	0.014503	0.5636

Weighted Statistics

R-squared	0.361525	Mean dependent var	0.016068
Adjusted R-squared	0.338475	S.D. dependent var	0.018782
S.E. of regression	0.015248	Sum squared resid	0.064403
F-statistic	15.68461	Durbin-Watson stat	0.979270
Prob(F-statistic)	0.000000		

Unweighted Statistics

R-squared	0.394892	Mean dependent var	0.047278
Sum squared resid	0.130381	Durbin-Watson stat	0.483721

Appendix O: ECB's Basic Model

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/03/17 Time: 20:56
Sample: 2006 2015
Periods included: 10
Cross-sections included: 31
Total panel (balanced) observations: 310

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_ECB	0.310050	0.078013	3.974323	0.0001
LEXR	-0.019113	0.009452	-2.022024	0.0441
C	0.079372	0.018083	4.389293	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.618120	Mean dependent var	0.047081
Adjusted R-squared	0.574004	S.D. dependent var	0.027433
S.E. of regression	0.017905	Akaike info criterion	-5.107144
Sum squared resid	0.088801	Schwarz criterion	-4.709380
Log likelihood	824.6073	Hannan-Quinn criter.	-4.948135
F-statistic	14.01120	Durbin-Watson stat	0.933862
Prob(F-statistic)	0.000000		

Appendix P: ECB's Spillover through Macroeconomic Channel

Dependent Variable: I_LT
Method: Panel EGLS (Cross-section random effects)
Date: 03/23/17 Time: 15:09
Sample: 2006 2015
Periods included: 10

Cross-sections included: 31

Total panel (balanced) observations: 310

Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_US	0.296925	0.054903	5.408169	0.0000
LEXR	0.001748	0.001098	1.592633	0.1123
RGDP	-0.295742	0.030451	-9.712027	0.0000
PIE	0.264348	0.044301	5.967046	0.0000
C	0.038426	0.003596	10.68620	0.0000

Effects Specification		
	S.D.	Rho
Cross-section random	0.014554	0.4818
Idiosyncratic random	0.015092	0.5182

Weighted Statistics			
R-squared	0.326582	Mean dependent var	0.014670
Adjusted R-squared	0.317750	S.D. dependent var	0.018893
S.E. of regression	0.015605	Sum squared resid	0.074272
F-statistic	36.97829	Durbin-Watson stat	0.981357
Prob(F-statistic)	0.000000		

Unweighted Statistics			
R-squared	0.298467	Mean dependent var	0.047081
Sum squared resid	0.163133	Durbin-Watson stat	0.446800

Appendix Q: ECB's Spillover through Trade Channel

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 03/03/17 Time: 21:02

Sample: 2006 2015

Periods included: 10

Cross-sections included: 31

Total panel (balanced) observations: 310

Variable	Coefficient	Std. Error	t-Statistic	Prob.

I_ECB	0.384911	0.084079	4.577990	0.0000
LEXR	-0.024460	0.009696	-2.522665	0.0122
IFDI	-0.006251	0.027911	-0.223960	0.8230
OFDI	-0.006718	0.023806	-0.282205	0.7780
CA	0.069552	0.030879	2.252421	0.0251
C	0.089265	0.018519	4.820254	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.626149	Mean dependent var	0.047081
Adjusted R-squared	0.578395	S.D. dependent var	0.027433
S.E. of regression	0.017812	Akaike info criterion	-5.109040
Sum squared resid	0.086934	Schwarz criterion	-4.675115
Log likelihood	827.9012	Hannan-Quinn criter.	-4.935575
F-statistic	13.11180	Durbin-Watson stat	0.921233
Prob(F-statistic)	0.000000		

Appendix R: ECB's Spillover through Financial Channel

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/03/17 Time: 21:03
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_ECB	0.487692	0.086730	5.623116	0.0000
LEXR	-0.023476	0.008811	-2.664277	0.0082
LSP	-0.024277	0.003590	-6.762111	0.0000
DEBT	0.005141	0.008257	0.622660	0.5341
C	0.192141	0.025301	7.594088	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.705858	Mean dependent var	0.047278
Adjusted R-squared	0.668946	S.D. dependent var	0.027400
S.E. of regression	0.015765	Akaike info criterion	-5.354559
Sum squared resid	0.063378	Schwarz criterion	-4.934845
Log likelihood	804.0565	Hannan-Quinn criter.	-5.186363
F-statistic	19.12277	Durbin-Watson stat	0.894533
Prob(F-statistic)	0.000000		

Appendix S: ECB's Spillover through All Channel (Taking GFC into Account)

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/23/17 Time: 14:08
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_ECB	0.629122	0.091794	6.853615	0.0000
LEXR	-0.016722	0.008193	-2.041115	0.0423
RGDP	-0.255818	0.038637	-6.621060	0.0000
PIE	0.173867	0.054060	3.216210	0.0015
CA	-0.017649	0.033906	-0.520518	0.6032
IFDI	-0.011501	0.022904	-0.502135	0.6160
OFDI	0.015062	0.019985	0.753650	0.4518
DEBT	0.017200	0.008614	1.996893	0.0469
LSP	-0.015117	0.004085	-3.700448	0.0003
DUM_GFC	-0.003261	0.002828	-1.153150	0.2500
C	0.128771	0.026271	4.901605	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.772273	Mean dependent var	0.047278
Adjusted R-squared	0.737519	S.D. dependent var	0.027400
S.E. of regression	0.014038	Akaike info criterion	-5.568805
Sum squared resid	0.049068	Schwarz criterion	-5.072779

Log likelihood	840.9079	Hannan-Quinn criter.	-5.370028
F-statistic	22.22139	Durbin-Watson stat	1.178655
Prob(F-statistic)	0.000000		

Appendix T: BOJ's Basic Model

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/03/17 Time: 21:06
Sample: 2006 2015
Periods included: 10
Cross-sections included: 31
Total panel (balanced) observations: 310

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	2.641012	0.543940	4.855336	0.0000
LEXR	-0.012025	0.009657	-1.245174	0.2141
C	0.064486	0.018618	3.463634	0.0006

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.628003	Mean dependent var	0.047081
Adjusted R-squared	0.585029	S.D. dependent var	0.027433
S.E. of regression	0.017672	Akaike info criterion	-5.133365
Sum squared resid	0.086503	Schwarz criterion	-4.735601
Log likelihood	828.6716	Hannan-Quinn criter.	-4.974356
F-statistic	14.61343	Durbin-Watson stat	0.965445
Prob(F-statistic)	0.000000		

Appendix U: BOJ's Spillover through Macroeconomic Channel

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/23/17 Time: 15:48
Sample: 2006 2015
Periods included: 10

Cross-sections included: 31

Total panel (balanced) observations: 310

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	2.442505	0.552996	4.416858	0.0000
LEXR	-0.011198	0.008414	-1.330807	0.1844
RGDP	-0.255313	0.028881	-8.840088	0.0000
PIE	0.148693	0.052822	2.814981	0.0052
C	0.063663	0.016199	3.930050	0.0001

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.720438	Mean dependent var	0.047081
Adjusted R-squared	0.685873	S.D. dependent var	0.027433
S.E. of regression	0.015375	Akaike info criterion	-5.406122
Sum squared resid	0.065009	Schwarz criterion	-4.984251
Log likelihood	872.9489	Hannan-Quinn criter.	-5.237476
F-statistic	20.84353	Durbin-Watson stat	1.079769
Prob(F-statistic)	0.000000		

Appendix V: BOJ's Spillover through Trade Channel

Dependent Variable: I_LT

Method: Panel Least Squares

Date: 03/03/17 Time: 21:07

Sample: 2006 2015

Periods included: 10

Cross-sections included: 31

Total panel (balanced) observations: 310

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	3.267663	0.583180	5.603179	0.0000
LEXR	-0.016760	0.009767	-1.715990	0.0873
IFDI	-0.009090	0.027439	-0.331291	0.7407
OFDI	-0.002216	0.023361	-0.094848	0.9245
CA	0.084550	0.030709	2.753291	0.0063
C	0.072829	0.018797	3.874506	0.0001

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.638927	Mean dependent var	0.047081
Adjusted R-squared	0.592804	S.D. dependent var	0.027433
S.E. of regression	0.017505	Akaike info criterion	-5.143815
Sum squared resid	0.083963	Schwarz criterion	-4.709890
Log likelihood	833.2913	Hannan-Quinn criter.	-4.970350
F-statistic	13.85282	Durbin-Watson stat	0.953212
Prob(F-statistic)	0.000000		

Appendix W: BOJ's Spillover through Financial Channel

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/03/17 Time: 21:08
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	3.379765	0.593839	5.691387	0.0000
LEXR	-0.016605	0.009042	-1.836414	0.0675
LSP	-0.022351	0.003611	-6.189237	0.0000
DEBT	0.004699	0.008179	0.574531	0.5661
C	0.170274	0.026488	6.428247	0.0000

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.706649	Mean dependent var	0.047278
Adjusted R-squared	0.669836	S.D. dependent var	0.027400
S.E. of regression	0.015744	Akaike info criterion	-5.357250
Sum squared resid	0.063207	Schwarz criterion	-4.937536
Log likelihood	804.4440	Hannan-Quinn criter.	-5.189054
F-statistic	19.19579	Durbin-Watson stat	0.906601

Prob(F-statistic)	0.000000

Appendix X: BOJ's Spillover through All Channel (Taking GFC into Account)

Dependent Variable: I_LT
Method: Panel Least Squares
Date: 03/23/17 Time: 14:39
Sample: 2006 2015
Periods included: 10
Cross-sections included: 29
Total panel (unbalanced) observations: 288

Variable	Coefficient	Std. Error	t-Statistic	Prob.
I_JAPAN	4.113303	0.690552	5.956544	0.0000
LEXR	-0.011461	0.008590	-1.334203	0.1834
RGDP	-0.254504	0.039819	-6.391487	0.0000
PIE	0.159558	0.056920	2.803173	0.0055
CA	-0.031774	0.034895	-0.910541	0.3634
IFDI	-0.017477	0.023584	-0.741053	0.4594
OFDI	0.024681	0.020469	1.205778	0.2290
DEBT	0.003593	0.007968	0.450937	0.6524
LSP	-0.020488	0.004059	-5.047670	0.0000
DUM_GFC	-0.014642	0.003146	-4.653793	0.0000
C	0.154301	0.025798	5.981178	0.0000

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.763074	Mean dependent var	0.047278
Adjusted R-squared	0.726916	S.D. dependent var	0.027400
S.E. of regression	0.014318	Akaike info criterion	-5.529204
Sum squared resid	0.051050	Schwarz criterion	-5.033178
Log likelihood	835.2054	Hannan-Quinn criter.	-5.330427
F-statistic	21.10418	Durbin-Watson stat	1.144124
Prob(F-statistic)	0.000000		