Hacettepe University Graduate School Of Social Sciences

Department of Economics

INTERNATIONAL TRANSMISSION MECHANISM OF UNCONVENTIONAL MONETARY POLICY

Mesut TURKAY

Ph. D. Dissertation

Ankara, 2016

INTERNATIONAL TRANSMISSION MECHANISM OF UNCONVENTIONAL MONETARY POLICY

Mesut TURKAY

Hacettepe University Graduate School Of Social Sciences

Department of Economics

Ph. D. Dissertation

Ankara, 2016

ACCEPTANCE AND APPROVAL

The jury finds that Mesut TURKAY has on the date of 25.11.2016 successfully passed the defense examination and approves his Ph.D. thesis titled "International Transmission Mechanism of Unconventional Monetary Policy".

Prof. Dr. Timur Han GÜR

Prof. Dr. Ergun DOĞAN

Prof. Dr. Hakan Naim ARDOR

Doç. Dr. Naci CANPOLAT

Doç. Dr. Yasemin YALTA

I agree that the signatures above belong to the faculty members listed.

Prof. Dr. Sibel BOZBEYOĞLU

Graduate School Director

DECLARATION

I promise that my thesis is completely my own work and that I have provided a source for every quotation and citation. I give permission for paper and digital copies of my thesis to be kept in Hacttepe University's Graduate School of Social Sciences' archives under the conditions indicated below:

☐ My thesis/Report can be accessed in full from any location.

☐ My thesis/Report can only be accessed from Hacettepe University premises.

☒ I do not want my thesis/report to be accessed until 2. year(s) later. After this amount of time if I have not applied to an extension of time, my thesis/report can be accessed in full from any location.

25.11.2016

Mesut TURKAY

ACKNOWLEDGEMENTS

This thesis becomes a reality with the kind support and help of many individuals. I would like to extend my sincere thanks to all of them.

First and foremost, I would like to express my deepest gratitute to my advisor Dr. Timur Han Gur for his full support, expert guidance, understanding and encouragement, without which this work would not have been possible. In addition, I would like to thank my committee members Dr. Ergun Dogan and Dr. Naci Canpolat. I am extremely grateful for their support and advice.

I would like to thank my friends and colleagues at Undersecretariat of Treasury for their valuable help and support. Their contributions are sincerely appreciated and acknowledged.

Finally, I would like to thank to my family for the encouragement which helped me in completion of this work. My beloved and supportive wife who is always by my side when times I needed her most and my lovable daughter, Damla, who served as my inspiration and motivation to pursue this undertaking deserve special acknowledgement. Thanks to my parents and sister for their unconditional love and support during the course of my study. I would not have been able to complete this thesis without their continuous love and encouragement.

ABSTRACT

TURKAY, Mesut. *International Transmission Mechanism of Unconventional Monetary Policy*, Ph. D. Dissertation, Ankara, 2016.

The use of unconventional monetary policies by leading advanced country central banks has been accelerated especially after the global crisis of 2008-09 and become the new normal for the monetary policy. Among these policies, especially quantitative easing (QE) policy has taken the center stage and the literature concerning the effects of this policy on various economic indicators has exploded. The aim of this study is to contribute to the literature by analyzing the international transmission mechanism of unconventional monetary policy. In this context, two empirical studies are performed to analyze the spillover effects of QE policies on emerging market (EM) economies using panel data. The first study employs panel vector autoregression model and finds long run cointegration relationship between bond purchases and EM macro variables. QE implemented by Fed reduces sovereign bond yield and inflation, leads to exchange rate appreaciation and stimulates economic activity in EM economies. The second study use Augmented Mean Group (AMG) estimator that is robust to slope heterogeneity and cross section dependence. It examine the impact of QE carried out by Fed on local government bond yields in EM countries. Results show that both country specific variables such as central bank policy rate, inflation rate, budget deficit and global variables such as US bond yield and QE variables are significant determinants of domestic government bond interest rate in EM economies. The announcements regarding QE programs as well as actual bond purchases are found to lower EM bond interest rates.

Key Words

Unconventional Monetary Policy, Quantitative Easing, Spillover Effects, International Transmission Mechanism

ÖZET

TÜRKAY, Mesut. *Geleneksel Olmayan Para Politikasının Uluslararası Aktarım Mekanizması*, Doktora Tezi, Ankara, 2016.

Geleneksel olmayan para politikaları özellikle 2008-09 küresel ekonomik krizi sonrası dönemde önde gelen gelişmiş ülke merkez bankaları tarafından giderek artan bir şekilde kullanılmaya başlanmış ve para politikası için yeni normal haline gelmiştir. Bu politikalar arasında özellikle niceliksel gevşeme ön plana çıkarken, bu politikaların çeşitli ekonomik göstergeler üzerindeki etkilerine ilişkin çalışmalar hızlı bir artış göstermiştir. Bu çalışmanın amacı geleneksel olmayan para politikalarının uluslararası aktarım mekanizmasını analiz ederek mevcut literatüre katkıda bulunmaktır. Bu çerçevede, niceliksel gevşeme politikalarının gelişmekte olan ülke ekonomileri üzerindeki yayılma etkilerini incelemek için iki ampirik çalışma yapılmıştır. İlk çalışmada Durbin-Hausman eşbütünleşme testi ve panel vektör otoregresif modeli kullanılarak ABD Merkez Bankası tarafından uygulanan niceliksel gevşeme politikalarının gelişmekte olan ülke ekonomilerinin makroekonomik göstergeleri üzerindeki etkisi analiz edilmiştir. Sonuçlar tahvil alımları ile gelişmekte olan ülke makro değişkenleri arasında uzun vadeli eşbütünleşme ilişkisi olduğunu göstermektedir. Niceliksel gevşeme politikaları devlet tahvili faizi ve enflasyonu düşürmekte, ekonomik aktiviteyi desteklemekte ve reel döviz kurunun değer kazanmasına neden olmaktadır. İkinci çalışmada, ABD tarafından uygulanan niceliksel gevşeme politikalarının gelişmekte olan ülkelerin yerel para birimi cinsinden devlet tahvili faizi üzerindeki etkisini bulmak amacıyla Arttırılmış Ortalama Grup tahmin edicisi kullanılmıştır. Sonuçlar hem merkez bankası faizi, enflasyon ve bütçe açığı gibi ülkeye özgü değişkenlerin hem de ABD tahvil faizi ve niceliksel gevşeme göstergeleri gibi küresel değişkenlerin gelişmekte olan ülkelerdeki yerel para birimi cinsinden devlet tahvili faizinin belirleyicisi olduğunu göstermektedir.

Anahtar Sözcükler

Geleneksel Olmayan Para Politikası, Niceliksel Gevşeme, Yayılma Etkileri, Uluslararası Aktarım Mekanizması

TABLE OF CONTENTS

ABBREVIATIONS

ABSPP: Asset-Backed Securities Purchase Programme

ADF: Augmented Dickey-Fuller

AMG: Augmented Mean Group

APF: Asset Purchase Facility

BoJ: Bank of Japan

BoE: Bank of England

BPS: Basis Points

BVAR: Bayesian Vector Autoregression

CAB: Current Account Balances

CADF: Cross-Sectionally Augmented Dickey–Fuller

CBPP: Covered Bond Purchase Program

CCE: Common Correlated Effect

CDS: Credit Default Swap

CDS: Extended Asset Purchase Programme

DHg: Durbin-Hausman Group

DHp: Durbin-Hausman Panel

DSGE: Dynamic Stochastic General Equilibrium

ECB: European Central Bank

EFSF: European Financial Stability Facility

EM: Emerging Market

ESM: European Stability Mechanism

ETF: Exchange-Traded Fund

Fed: Federal Reserve

FOMC: Federal Open Market Committee

FSO: Funds-Supplying Operation

GMM: Generalized Method of Moments

GSE: Government-Sponsored Enterprise

GVECM: Global Vector Error Correction Model

IMF: International Monetary Fund

IRF: Impulse Response Function

J-REIT: Japanese Real Estate Investment Trust

LSAPP: Large-Scale Asset Purchase Program

LSDV: Least Squares Dummy Variable

LTRO: Long Term Refinancing Operations

MBS: Mortgage-Backed Securities

MEP: Maturity Extension Programme

MEP: Markov Switching Factor-Augmented Vector Autoregression

MW: Maddala-Wu

OMT: Outright Monetary Transactions

PSPP: Public Sector Purchase Programme

PVAR: Panel Vector Autoregression

MS-FAVAR: Panel Vector Autoregression

QE: Quantitative Easing

SMP: Securities Market Programme

SVAR: Structural Vector Autoregression

UK: United Kingdom

UMP: Unconventional Monetary Policy

US: United States

ZIRP: Zero Interest Rate Policy

ZLB: Zero Lower Bound

TABLES

FIGURES

INTRODUCTION

Central banks around the world conventionally implement a monetary policy by controlling short term nominal interest rates and affecting the economy through monetary transmission mechanism. However, there are times when monetary transmission mechanism as a conventional monetary policy does not work properly for some reason or turns out to be a weak, ineffective or even unavailable instrument in order to attain desired consequences. In those cases, central banks usually refer to unconventional monetary policy options such as quantitative easing, qualitative easing and forward guidance.

Unconventional monetary policy (UMP) is relatively a new concept and the popularity of these policies has had an increasing trend during the last decade. Especially, after the recent global economic crisis of 2008-09, upon reaching zero lower bound on interest rates, several advanced country central banks started to employ unconventional monetary policies intensively. In that context, major central banks announced asset purchase programs, altered the composition of their balance sheet, used forward quidance to provide signals to the financial markets and implemented several other unconventional policies especially during the crisis period.

Unconventional monetary policies have been used increasingly in the post global crisis period and have become the new normal for the monetary policy. Especially, the zero lower bound have made the conventional interest rate almost useless as a monetary policy tool. Due to weak economic growth and low inflation (deflation in some cases) in advanced economies, interest rates have failed to increase and zero short-term interest rates have persisted for years. In this process, major central banks in the world have gradually lowered their interest rate forecasts. Negative interest rates on government bonds have become more and more common among advanced economies and the number of countries having negative government bond yield continues to increase. The current global economic environment makes us think that unconventional monetary policies have become the new normal and they will be with us in the near future.

Among these unconventional monetary policies, especially quantitative easing (QE) policies have taken the center stage. QE policy was first conducted by Bank of Japan

(BoJ) in 2001 and has been the most common unconventional monetary policy option implemented by advanced country central banks in the post-global crisis period. European Central Bank (ECB), Bank of Japan (BoJ), Federal Reserve (Fed), Bank of England (BoE) and Swedish National Bank are among the central banks that have used QE policy in that period. According to the empirical studies, on average, these policies stimulated economic activity and inflation, increased global liquidity and capital flows into developing economies, supported asset prices, caused the appreciation of currencies and lowered government bond yields.

Due to the widespread use of unconventional monetary policies, it has been more and more important to understand the transmission mechanism of these policies more clearly and spillover effects of these policies both on domestic and international economic variables. Especially after global crisis, the attention of media, policy makers and academics regarding the impacts of these policies has gone up and the debate on whether they are effective or not have intensified. Therefore, more research is required to better understand the spillover effects of these policies.

There is a rich literature concerning the impact of unconventional monetary policies. Hovewer, the literature mainly concentrates on the domestic economic impact of QE and the studies about the international spillovers of QE policies are relatively rare. Therefore, we contribute to the literature by analyzing the international spillovers of QE policies on emerging market economies.

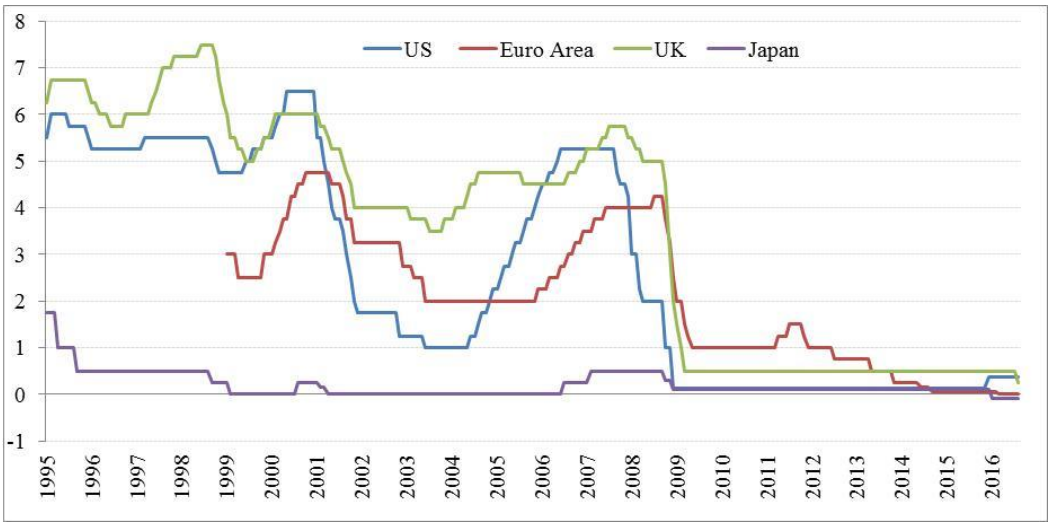
The study proceeds as follows. First chapter contains the definition and history of quantitative easing, country experiences with QE, transmission mechanism of quantitative easing and a comprehensive literature survey concerning the impact of QE on major macroecconomic indicators. In the second and third chapters, we conduct two empirical studies about the impact of QE on emerging market (EM) economies. More specifically, in the second chapter we build a panel vector autoregressive model (PVAR) so as to analyze the influence of QE policies implemented by Federal Reserve (Fed) on output, inflation, government bond yield and exchange rates in EM economies. In the third chapter, we employ Augmented Mean Group (AMG) estimator that allows for heterogeneity and cross section dependence to investigate the effects of QE

announcements and actual purchases by Fed on government bond yield in EM economies.

CHAPTER 1:
QUANTITATIVE EASING – DEFINITION, HISTORY, COUNTRY EXPERIENCES, TRANSMISSION MECHANISM AND LITERATURE SURVEY

Central banks all around the world most often perform monetary policy by using nominal short term interest rates as an operating instrument and influence the economy through monetary transmission mechanism. As a standart/conventional way of use, central banks raise policy interest rate when economy is strong and/or inflation is high and lower it when economy is weak and/or inflation is low compared to the target level. However, when traditional channels of conventional monetary policy are ineffective, unavailable or weak, central banks implement UMP such as quantitative easing, qualitative easing, forward guidance or liquidity operations. For instance, when interest rate is lowered down to zero lower bound (ZLB), conventional monetary policy hits the limit[1]. This was experienced by Japan at the end of 1990's and US, UK, Euro Area and many others after the crisis of 2008-09. Figure 1 below shows that major central bank policy rates have bottomed to ZLB in the post-crisis period.

Figure 1: Central Bank Policy Interest Rates (percent)



Source Bloomberg

[1] However, there are increasing number of cases that central bank policy interest rates are lowered below zero in the post great recession (2008-09) period. Japan, Sweden, Switzerland are among them. Central banks especially use negative deposit interest rates and try to encourage lending by banks. Hence, in practice ZLB is in fact not always a limit to monetary policy.

Policy interest rates reaching the ZLB naturally led to the discussions regarding the effectiveness of conventional monetary policy and policy options at ZLB. The debate about the consequences of zero lower bound go back at least to Keynes (1936) who refers to liquidity trap as a factor limiting the the capacity of central banks to support the economic activity. Many economists such as Paul Krugman (2005) and Michael Woodford (2011) argue that fiscal policy is much more effective to stimulate the economic activity than monetary policy at ZLB. Conversely, some others claim that central banks can affect output and prices even at ZLB. For example, Mishkin (1996) argues that the view stating monetary policy has nothing to do to support economic activity at ZLB is "demonstrably false." Monetary policy can affect inflation expectations and thus real interest rate which impacts economic activity at ZLB. Milton Friedman (1997) argues that since Bank of Japan (BoJ) lowered interest rates till zero, they should buy government bonds by injecting cash to support the economy.

Interest rates hitting ZLB does not mean that central banks lack tools to support the economy and monetary policy is totally ineffective. Bernanke and Reinhart (2004) propose three unconventional monetary policy options that can be implemented when ZLB is reached. First is forward guidance that is using communication policies to set public expectations about the future course of monetary policy and interest rates. Second is quantitative easing (QE) that is boosting the balance sheet size by buying financial assets. Third is qualitative easing which is changing the composition of the balance sheet but keeping its size constant.

There is a large and growing literature about these unconventional monetary policy options. This thesis will concentrate on quantitative easing which is the leading and most widespead unconventional monetary policy alternative. First part of this chapter will contain the definition and history of quantitative easing, second part will present country experiences with QE, third part explains transmission mechanism of QE and the channels through which it affects the economy and the fourth part provides a detailed literature review concerning the impact of QE on major economic indicators.

1.1. DEFINITION AND HISTORY OF QUANTITATIVE EASING (QE)

Quantitative Easing (QE) can be described as the policy of increasing central bank balance sheet through purchases of financial assets financed by central bank reserves. QE increases monetary base from the asset side and reserves accumulate on the liability side (Lenza et al., 2010). Described in another way, quantitative easing is a kind of open market operation which involves the unsterilised swap of central bank money for private assets (Breedon et al., 2012).

Widespread use of QE policies after the global economic crisis of 2008-09 intensified the debate about these policies and some argue that they have practically the same effects as of printing money. There are some similarities and differences between printing money and quantitative easing. Printing money refers to creating money in order to finance government deficits or pay governement debt which is sometimes called "government debt monetization". On the other hand, the money created with QE policy is used to purchase securities like government bonds and mortgage backed securities. Since central banks in many developed economes like UK, US, Japan and EU are not legally allowed to buy government debt from primary markets, under a QE scheme they buy it from the secondary market. Main aim of monetizing debt is to finance government spending while the goal of QE is to boost economic activity.

The term "quantitative easing" was initially employed in 1994 by Richard Andreas Werner who was chief economist at Jardine Fleming Securities. He put together the Japanese word expansionary monetary policy (kin'yū kanwa, 'monetary easing') and quantitative (ryōteki) to form the term 'quantitative monetary easing' (量的金融緩和, ryōteki kin'yūkanwa) (Lyonnet and Werner, 2012).

Although some argue that Federal Reserve (Fed) employed a kind of quantitative easing policy in the 1930's and 1940's to combat the Great Depression, quantitative easing policy as we know today was initially applied by Bank of Japan (BoJ) in 2001. On March 19, 2001, they replaced the operating target of overnight interest rate with current account balance (CAB). Accordingly, this target would be achieved by buying government bonds.

However, interestingly, the word “quantitative easing” can not be found in any of the monetary policy statements or their translations (Voutsinas and Werner, 2011). The reason behind this could be that the term was first proposed by an opponent of central bank policies or that Bank of Japan staff argued in their reports that such a policy was not effective. During 2001, out of 29 speeches of the board members, only 11 speeches included the expression ‘quantitative easing’. Hovewer, these speeches did not state that this policy is being employed by BoJ. On December 9, 2002, almost two years after the program started, the governor of BoJ first time said that QE policy was being implemented by BoJ. In June 2003, new central bank governor Toshihiko Fukui used the expression 26 times in his speech and this seems to be the milestone for the expression.

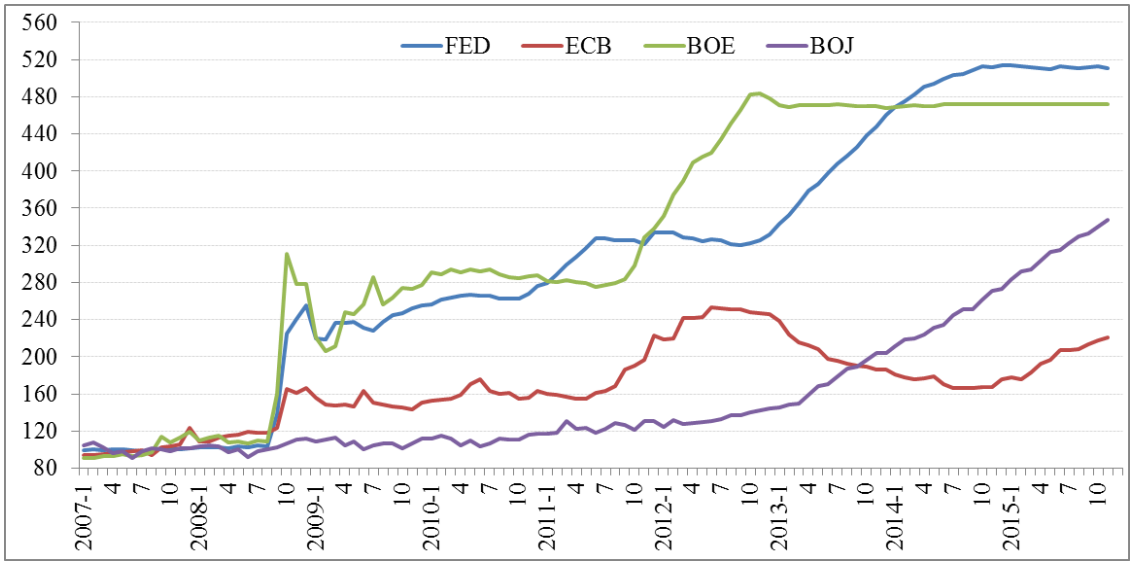
The term quantitative easing became much more popular after the great recession of 2008-09 due to its widespread use. While BoE used the same expression, Fed chairman Bernanke referred to their policy as “credit easing” (Bernanke, 2009). They later usually preffered the expression “large-scale asset purchase program (LSAPP)” instead of the term QE.

1.2. COUNTRY EXPERIENCES WITH QE

QE was first implemented by Bank of Japan (BoJ) in 2001. European Central Bank (ECB), Federal Reserve (Fed), Bank of England (BoE) and Swedish National Bank followed after the Great Recession of 2008-09 in order to avoid deflation and revive the economic activity. Size and composition of the QE programs vary across countries and depend on the structure of the economies and motivations for the QE actions (Fawley and Neely, 2013). While bond markets are more important in US and UK, banking sector is much more crucial in Europe and Japan. To give an idea, in 2007, ratio of bank loans to GDP was 63 percent (145 percent) for US (Europe), the ratio of debt securities to GDP was 168 percent (81 percent) in US (Europe) (Smaghi, 2009). Consequently, QE programs of the Fed and BoE concentrated on bond purchases and those of ECB and BoJ targeted the banking sector.

Quantitative easing programs led to the explosion of central bank balance sheets. Figure 2 below shows the size of balance sheets normalised to 100 in 2007. It shows that balance sheet size of Fed and BoE has increased about fivefold, ECB more than doubled and BoJ more than tripled.

Figure 2: Size of Central Bank Balance Sheets (2007=100)



Source: Bloomberg

Below we present a review of QE policies implemeted by leading advanced country central banks in the world.

1.2.1. Federal Reserve (Fed)

In response to the deteriorating economic conditions and credit market disturbances after Lehman Brothers bankruptcy in 2008, Fed first lowered federal funds rate close to zero (0-0.25 range) which is effectively their ZLB. Since conventional interest rate tool of monetary policy became useless, Federal Reserve started to implement UMP such as liquidity operations, forward guidance and quantitative easing to repair the functioning of financial markets and support economic activity. Among these unconventional tools, especially QE policies took the center stage after the crisis. To this end, the Federal Reserve (Fed) announced their plan on November 25, 2008, to buy $100 billion worth of government-sponsored enterprise (GSE) debt and $500 billion worth of mortgage-

backed securities (MBS) that are issued by GSE's. Major aim was to lower risk spreads on debt and calm down the markets. On March 18, 2009, the Fed announced extra purchases worth of $100 billion in GSE debt, $750 billion worth of MBS and $300 billion worth of government securities. Fed's November 2008 and March 2009 asset purchase programs together are commonly called "QE1" or as Kohn (2009) names "large-scale asset purchases" (LSAP1). QE1 totaled to $1.75 trillion which is worth 14.5 percent of total amount of treasury and agency securities at that time. 80 percent of QE1 consisted of GSE and MBS purchases and the operation finished in March 2010. The goal of QE1[2] program was to lower cost and increase the amount of housing loans to stimulate the housing market and improve financial market conditions (Fawley and Neely, 2013).

Financial markets stabilized as of the second half of 2010, hovewer real economic recovery was weak. On August 10, 2010, the Fed declared that it will reinvest principal payments of LASP assets into Treasuries so that the size of its balance sheet will be maintained. On November 3, 2010, FOMC announced the purchase of $600 billion worth of government bonds ($75 billion per month). Main goal of this program was to lower real interest rates and augment inflation rate. Popularly known as "QE2", this program was concluded in June 2011. Maturity extension programme (MEP)Twas announced on September 21, 2011, which was also called "Operation Twist". Under this programme, FED would buy $400 billion worth of government debt securities having maturities between six and thirty years and sell the same amount having maturity less than three years starting from October 2011 and ending in June 2012 (Meaning and Zhu, 2011). The program aimed to lower long term interest rates by "twisting" the yield curve. This program did not augment the monetary base since purchase and sales of assets with different maturities are the same (Fawley and Neely, 2013). Fed also declared that they will start to reinvest maturing MBS and agency debt in MBS. On June 20, 2012, the Fed extended the Operation Twist program by $267 billion till the end of the year.

[2] While we use the term QE here, Federal Reserve usually prefers the term Large Scale Asset Purchases (LASP).

Despite all these efforts, economic recovery was not strong enough and this led Federal Reserve to provide additional policy accomodation. FOMC announced third QE program on September 13, 2012. This time, instead of total amount of purchases, Fed started buy certain amount of assets every month. The program consisted of MBS purchases worth $40 billion per month. It was declared that open-ended purchases were to continue till the recovery of the labor market. FOMC announced the extension of QE3 program on December 12, 2012, to include long-term government bond purchases of $45 billion per month and the program increased to $85 billion per month. Chairman Ben Bernanke first signalled the probable tapering of QE3 in testimony before Congress on May 22, 2013. On December 18, 2013, FOMC announced the tapering of the QE3 program from $85 billion to $75 billion per month. After the announcement, actual tapering of the program started in January 2014, continued gradually during the year and finally finished on October 28, 2014. Federal Reserve balance sheet increased from about $900 billion in 2008 to about $4.5 trillion at the end of 2015.

1.2.2. Bank of England (BoE)

Due to the global economic crisis of 2008-09 and its adverse domestic economic implications, both conventional and unconventional monetary accommodation policies were implemented in the United Kingdom (UK). As conventional steps, BoE reduced policy rate gradually from 5 percent in October 2008 to 0.5 percent in March 2009. After reducing interest rate down to effective lower bound, Bank of England (BoE) started to carry out unconventional monetary policies. As a first step, on January 19, 2009, the BoE started Asset Purchase Facility (APF) to purchase up to £50 billion worth of assets to remedy the credit markets. It was not a QE program because the purchases of assets were matched with the sales of some other assets.

Quantitative easing (QE) programs of BoE can be seperated into two episodes. BoE first declared a public sector asset purchase of £75 billion with maturity between 5 and 25 years on March 5, 2009. The target of this program was to support demand through reduced interest rates, increase lending by banks and raise asset prices to support output growth and offset deflationary pressures. On May 9, 2009, it was announced that the

asset purchase program will be extented by £50 billion to £125 billion. The program was extended to £175 billion on August 6, 2009, and to £200 billion on November 5, 2009 (Meaning and Zhu, 2011). The first stage of purchases ended on February 4, 2010 and BoE declared that Treasury issuance, not money creation, would fund any new purchases. BoE bought £200 billion worth of gilts between March 2009 and January 2010. These asset purchases amounted to about 30 percent of total outstanding gilts and about 14 percent of GDP.

Concerned with low inflation and weak economic recovery, second stage of QE program started on October 6, 2011. The amount of the program was increased from £200 to £275 billion that is financed by central bank money. On February 9, 2012, and July 5, 2012, the program was expanded to £325 and £375 billion, respectively. Furthermore, BoE was also allowed to buy private assets worth £10 billion. The amount of private assets bought never exceeded £3 billion. As a result of these programs, size of BoE balance sheet increased from £80 billion in 2008 to about £400 billion at the end of 2015. On August 4, 2016, BoE cut interest rate by 25 bps to 0.25 percent (lowest rate in 322 years of bank history) and extended QE program by £60 billion to £435 billion so as to increase output growth and achieve inflation target after the referandum to leave the European Union.

1.2.3. European Central Bank (ECB)

The European Central Bank (ECB) responded to the global economic crisis of 2008-09 with interest rate cuts, provision of loans, long term refinancing operations (LTRO) and QE programs. As a first step, short term policy rate was lowered from 4.25 percent in September 2008 to 1 percent in May 2009. Policy rate was raised 1.5 percent in 2011. These rate hikes were reversed in November and December 2011 and interest rate was lowered to 1 percent. Weak economic recovery and deflation risks led ECB to lower interest rate to 0 percent by August 2016.

As for the unconventional monetary policy, the guide for ECB's actions is the Lisbon Treaty (2007) and it does not allow the central bank to purchase sovereign debt

securities as a bailout or monetary financing (Article 125 and 123, respectively). Therefore, asset purchases have been implemented to improve monetary transmission mechanism and correct market disturbances. On May 7, 2009, the ECB announced the purchase of covered bonds worth €60 billion in order to prevent credit crunch and stimulate economic recovery in the Euro Area. The covered bond market is crucial in Europe and amounts to about €2.4 trillion in 2008 (Beirne et al., 2011). That is, Covered Bond Purchase Program (CBPP) amounts to about 2.5 percent of the outstanding bonds. The objective of the CBPP was to lower money market rates, improve financing conditions, encourage lending by banks and boost the liquidity in private debt securities market. The purchases were sterilized and did not increase balance sheet of ECB. Thus, it was not a quantitative easing (QE) program. The CBPP was terminated at the end of June 2010.

Due to the deepening sovereign debt crisis, ECB announced Securities Market Programme (SMP) on May 10, 2010. The program allowed the ECB to buy government debt securities from the secondary market and aimed to augment the depth and liquidity of the market and restore monetary policy transmission mechanism (Fawley and Neely, 2013). The amount of purchases was not pre-announced and was to be determined according to the financial and economic conditions. Since the asset purchases were sterilized and had no impact on balance sheet size, the SMP was not a quantitative easing program. The purchases under SMP stopped in January 2011 but started again in August 2011 due to the deepening of the crisis. The amount of government bond purchases within SMP totaled to €219.5 billion. In addition to SMP, second Covered Bond Purchase Programme (CBPP2) that is worth €40 billion was also declared on October 6, 2011 (Szczerbowich, 2015). It was finished on October 31, 2012 and the amount of the program reached €16.4 billion.

The Eurozone debt crisis continued in 2012 with doubts about the solvency of Italy and Spain and the role of Euro as the common currency came into question. Mario Draghi, the President of ECB, declared on July 26, 2012, that they will do whatever is needed to save the euro. On September 6, 2012, they declared the government bond purchasing program that was called Outright Monetary Transactions (OMT). The objective of the program was to ensure the functioning of the monetary transmission mechanism,

improve credit conditions throughout the Eurozone and reduce the risk premium. The program allows the central bank to buy unlimited amount of euro area government securities from secondary market according to the conditions of European Financial Stability Facility (EFSF) and European Stability Mechanism (ESM). The maximum maturity of bond purchases was determined as 3 years. The purchases were going to be sterilized and thus balance sheet size will not change. The OMT program was announced but it has never been activated.

Due to deflation that started at the end of 2014, ECB decided to take further actions. In this vein, ECB declared an 'expanded QE programme' on January 22, 2015. It includes the third covered bond purchase programme (CBPP3), asset-backed securities purchase programme (ABSPP) and public sector purchase programme (PSPP). Accordingly, monthly security purchases would be €60 billion. Purchases started in March 2015 and it was planned that the program will last in September 2016. On December 3, 2015, ECB announced the extension of the asset purchase program through March 2017. On March 10, 2016, bond purchases were increased from 60 billion euros a month to 80 billion euros. On June 8, 2016, ECB also started to buy corporate sector bonds. As of July 2016, cumulative purchases of the program totaled to about €1,165 billion, 80 percent of which are treasury bond purchases.

1.2.4. Bank of Japan (BoJ)

The 1990's was a decade of very low growth and increasing deflationary pressures for Japan. In response, BoJ reduced policy rate gradually till zero in 1999. After adoption of zero interest rate policy (ZIRP) between February 1999 and August 2000, BoJ started QE policy on March 19, 2001, and became the first central bank to perform QE. According to this policy, BoJ began to use current account balances (CAB) instead of overnight rate as the operating target and increased CAB in excess of required reserves. At the time the program started in March 2001, the amount of required reserves was ¥4 trillion and CAB target was ¥5 trillion. BoJ raised required reserves to ¥5 trillion and CAB target to ¥35 trillion from March 2001 to December 2004 and kept it there for several years. Average excess reserves were ¥26 trillion during the Asset purchase program between March 2001 and March 2006. To reach the target of CAB, BoJ raised

purchases of government securities and some other assets. Major asset category bought during the program period was long term government bonds and monthly purchases were increased from ¥400 billion to ¥1.2 trillion. Later on, the program was extended to include private assets, asset-backed commercial paper and securities (Bowman et al., 2015a). Primary objective of the program was to increase lending through higher reserves in the banking system, boost asset prices and reduce inflationary pressures. The BOJ also provided forward guidance to maintain QE policy and zero interest rate until core inflation stopped declining. On March 9, 2006, the BOJ terminated QE policy and started to employ overnight call rate, set at 0 percent, as the main policy instrument again. Balance sheet was reduced by letting short term assets expire but BoJ continued monthly purchases of sovereign bonds worth ¥1.2 trillion.

On December 19, 2008, monthly government bond purchases were increased from ¥1.2 trillion to ¥1.4 trillion. On March 18, 2009, monthly purchases were boosted again from ¥1.4 trillion to ¥1.8 trillion. In addition, it was announced on January 22, 2009, and on February 19, 2009, that they will buy ¥3 trillion and ¥1 trillion in commercial paper, respectively.

On October 5, 2010, second quantitative easing program (QE2) was announced. This program included the purchases of short and long-term sovereign bonds, corporate bonds, commercial paper, Japanese real estate investment trusts (J-REITs) and exchange-traded funds (ETFs). Initial size of the program was ¥35 trillion which consists of new asset purchases of ¥5 trillion and funds-supplying operation (FSO) of ¥30 trillion. The program was expanded in 2011 and 2012 on nine occasions to ¥101 trillion by December 2012. In the course of this program, the purchases of different assets amounted to about ¥76 trillion. It included ¥44 trillion of sovereign bonds, ¥24.5 trillion of short term treasuries, ¥2.2 trillion of commercial papers, ¥3.2 trillion of corporate bonds, ¥2.1 trillion of ETF and ¥0.13 trillion of REITs.

On April 4, 2013, third qualitative and quantitative easing program (QE3) was announced. With this program, the main operating target became the monetary base instead of overnight call rate. According to the program, the central bank will implement open market operations such that the monetary base rises by about ¥60-70

trillion annually and double over the next two years. The size of the monetary base was ¥138 trillion at end of 2012 and it was expected to reach ¥200 trillion at end of 2013 and ¥270 trillion at end of 2014. Accordingly, the central bank will buy ¥50 trillion worth of sovereign bonds every year in order to reduce interest rates. Average maturity will be increased from about three years to seven years. In addition to government bonds, BoJ announced that they will also buy ¥1 trillion worth of ETFs and ¥30 billion worth of J-REITs annually.

On October 31, 2014, BoJ boosted QE program such that the monetary base will rise ¥80 trillion a year. Under the new program, annual amount of government bond purchases will rise from ¥50 trillion to ¥80 trillion. Average maturity of government bond purchases will be extended to 7-10 years. Amount of annual ETF and J-REIT purchases will be ¥3 trillion and ¥90 billion, respectively. BoJ will implement the program in an open-ended manner and make adjustments when needed. On January 29, 2016, BoJ lowered interest rate applied to current accounts to -0.1 percent. On September 21, 2016, BoJ introduced quantitative easing with yield curve control. According to this policy, central bank controls both short and long term rates. BoJ will buy government bonds so that ten year government interest rate remains at zero percent target level. Annual pace of increase in the amount outstanding of government bonds is ¥80 trillion. In addition, BoJ also commit to expand the monetary base until year-on-year inflation rate exceed 2 percent and stays above the target in a stable manner. Size of BoJ balance sheet increased from ¥110 trillion in August 2008 to ¥453 trillion in August 2016.

1.2.5. Swedish National Bank

On February 12, 2015, Swedish National Bank joined other major central banks which establish a quantitative easing program. They cut key interest rate from 0 to -0.1 percent and launched a QE program to buy government bonds worth SEK 10 billion ($1.2bn) due to deflation risks. On March 18, 2015, the repo rate was cut to -0.25 percent and QE program worth SEK 30 billion consisting of government securities was announced. On April 29, 2015, the extension of QE program by a further SEK 40-50 billion was

announced. On July 2, 2015, repo rate was cut to -0.35 percent and QE program was extended further by SEK 45 billion until the end of 2015. On October 28, 2015, the Executive Board decided to extend the program further by SEK 65 billion so that the total amount of purchases will be SEK 200 billion by the end of June 2016. On February 11, 2016, interest rate was cut further to -0.5 percent. On April 21, 2016, further government bond purchase of SEK 45 billion was announced and total amount of purchases is expected to reach SEK 245 billion at the end of 2016.

1.3. TRANSMISSION CHANNELS OF QUANTITATIVE EASING

Transmission mechanism of conventional monetary policy has long been studied and thus the related literature somewhat matured. Romer and Romer (1990), Bernanke and Blinder (1992), Bernanke and Gertler (1995), Meltzer (1995), Mishkin (1995) and Taylor (1995) are among some leading studies that present a review of transmission mechanism and their channels that show how monetary policy influences the economy. On the other hand, transmission mechanism of UMP, and QE in particular, is relatively a new field of study. The implementation of first QE program by BoJ in 2001 is a milestone and studies about the transmission channels of quantitative easing policies has started to emerge afterwards. Quantitative easing policies became much more common with the widespread implementaton of QE among advanced country central banks after the global economic crisis. This naturally led to a burgeoning expansion of the literature concerning the transmission channels of QE policies.

Conventional monetary transmission mechanism and transmission mechanism of quantitative easing have some differences as well as similarities. Some channels are common to both conventional monetary policy and quantitative easing but QE policies have also some other specific transmission channels. We start with describing the transmission channels of quantitative easing policies that are similar to conventional monetary policy channels and then present a review of transmission channels that are specific to QE.

One transmission channel through which monetary policy affects other economies is the trade channel (also called income-absorption effect). Mundell-Fleming model (Mundell,

1963) shows that monetary easing has a positive impact on output level. In addition to conventional monetary policy, quantitative easing also has a similar effect on economic activity of home country. Kapetanios et al. (2012), Chung et al. (2012), Gertler and Karadi (2013), Baumeister and Benati (2013), Matsuki et al. (2015), Meinusch and Tillmann (2016) and Weale and Wieladek (2016) all empirically find out that QE policy boosts output in home country through various channels. Output growth in home country increases import demand and boost the economy of foreign exporters. Thus, QE supports demand in other economies (Dahlhaus, 2014). The strength of this channel depends on the effectiveness of QE policy in stimulating domestic output and the share of imports in home country GDP. Studies such as Ugai (2007) and Chen et al. (2012a) argue that the effect of QE on domestic output is limited and some others such as Peersman (2011) and Schenkelberg and Watzka (2013) claim the effect is temporary. The findings of these studies imply that the impact of QE through trade channel is limited. In addition, QE implented in a relatively closed economy may also have a relatively limited impact through trade channel. Total imports as percent of GDP is about 16, 21 and 23 percent of GDP for US, Japan and Euro Area in 2014, respectively. Therefore, assuming the influence of QE on output and income elasticity of import demand are the same for all, the effect of QE on other economies through trade channel might be the largest for Euro Area and weakest for US.

Another transmission channel of QE is the exchange rate channel (also called expenditure-switching effect). According to Mundell-Fleming model, monetary expansion leads to the depreciation of home currency. Similar to conventional monetary policy, the literature indicates that quantitative easing also gives rise to the depreciation of home currency. Joyce et al. (2011), Rosa (2012), Glick and Leduc (2013) and Neely (2015) empirically show that QE policies lead to the decline (depreciation) of home currency. This deteriorates the terms of trade, makes goods and services less expensive for foreigners and increases net exports. Therefore, QE exerts beggar-thy neighbour effects and has a negative impact on the output of foreign countries through expenditure-switching effect (Dahlhaus, 2014). This effect is strong especially if the country implementing QE policy has an important share in the world trade and the impact is greater on the major trading partners. Assuming that the effect of QE on domectic exchange rate and price elasticity of import demand are the same, QE

implemented in Euro Area or US might have a larger negative effect on foreign country's output through exchange rate channel compared to Japan. The negative impact through exchange rate channel might be larger on the major trading partners of the country implementing QE policy. For instance, QE implemented by US have a big impact on Canada through exchange rate channel since Canada is one of the leading trade partners of US. If the country that carries out QE policy has a reserve currency and constitutes a crucial role in the global economy, depreciation of the local currency also impacts developing country exchange rates, interest rates and size and volatility of capital flows (Fic, 2013). While the output of foreign country increases through trade channel, it declines through exchange rate channel. Empirical evidence does not predict which effect dominates. If the negative impact of currency depreciation is larger, output abroad shrinks, whereas it expands if positive trade channel prevails it (Kawai, 2015).

Another transmission channel of QE is the confidence channel. The announcement and implementation of the QE implies that the central bank will do whatever it requires to minimize the effect of economic crisis and reach economic objectives. Through this channel, QE enhances consumer and business sentiment which leads risk premium and uncertainty to decline, risk appetite and asset prices to increase. (Fratzscher et al., 2013). This channel supports economic activity through improved confidence, higher asset prices, lower uncertainty and risk premium. Reduction in option implied volatilities show the impact of QE through confidence channel. It also has a positive effect on the global economy through higher asset prices and improved confidence.

Quantitative easing also affects the economy through fiscal channel. By lowering government bond yields, QE reduces debt service costs and improves fiscal balance (Kozicki et al., 2011). Increase in central bank holdings of securities which provide interest income via asset purchases leads to a rise in central bank profit, consequently. Since most of the central banks around the world transfer their profit to the treasury, QE boosts non-tax revenue of the government and improves the fiscal position. For instance, Federal Reserve (Fed) net income of $97.7 billion in 2015, that is 0.54 percent of GDP, was transfered to US Treasury. This corresponds to the governmental revenue tranferred as the central bank profit and is somewhat analogical to the seigniorage revenue emerging due to inflation. Strenghtening economic activity through QE also

increases tax revenue and improves budget balance. That enables government to reduce taxes or increase government spending to support economic activity (Bernanke et al., 2004). In addition, QE increases the effectiveness of fiscal policy by lowering interest rates and lessening the crowding out of consumption and investment (Kohn, 2009).

QE also influences the economy through inflation channel by increasing inflationary pressure which leads to higher economic activity and depreciation of domestic currency. Asset purchases by central bank increase inflation expectations and affect interest rate (Krishnamurthy and Jorgenson, 2011). Increased inflation expectations reduce real rate and support economic activity. In addition, QE also lowers inflation uncertainty and the risk of deflation.

There are also various transmission channels specific to quantitative easing. Among them, especially portfolio balance and signalling channels are crucial and are cited most frequently in the literature. Theory on portfolio balance channel rely on the theories of famous monetary economists such as James Tobin (1961, 1963 and 1969), Milton Friedman (1978), Karl Brunner and Allan Meltzer (1973). The idea is that different financial assets are imperfect substitutes. Investors have different risk characteristics, preferences over maturity and asset classes and might face different regulations (Bernanke, 2012). Therefore, they demand assets with different types and maturities. According to this channel, QE alters the supply of assets that investors can buy and thus influence the price and yield of the assets. Central bank purchases of a specific asset decrease the amount of security that investors holds, increases price, lowers yield and term premium. As a result, investors rebalance their portfolios into other assets in search of higher return. For instance, purchases of government bonds by Federal Reserve (FED) create an excess demand over supply and lead to the scarcity of the bonds purchased in the market that consequently boost the price of bonds and lower the yield. Declining relative return of this asset causes some investors to change their portfolios. Demand for corporate bonds and equities rise which increases the prices and lowers the yield of these assets. Lower yields and higher asset values ease financial conditions, boost investment and consumption due to lower financing costs and wealth effects. Therefore, QE stimulates the economic activity through portfolio balance channel.

Portfolio balance channel also applies to global economy because of economic and financial globalization. Higher asset prices and lower yields as a result of QE lead to global portfolio rebalancing among investors. Some investors shift their portfolios towards emerging market bonds, equities and corporate bonds in search of higher return. Chen et al. (2012b), Fratzscher et al. (2013), Rogers et al. (2014), Bauer and Neely (2014), Bowman et al. (2015b), Neely (2015), Georgiadis and Gräb (2016) and Tillmann (2016) find empirically that quantitative easing policies ease financial conditions, lower bond yields and boosts asset prices globally, especially in emerging market economies. This in turn supports foreign consumption and investment through the same mechanisms described before.

Declining interest rates and search for yield by investors also influence the capital flows into and out of emerging market economies. Ahmed and Zlade (2014), Lim and Mohapatra (2016) and Kiendrebeogo (2016) show that QE policies lead to increased capital flows into emerging market economies, especially through portfolio flows. Fratzscher et al. (2013) find out that QE1 caused portfolio rebalancing from EM economies to United States funds and in the opposite direction under QE2. In addition, QE also boosts global liquidity. Increased global liquidity and capital flows have crucial effects on recipient country exchange rates, asset prices and credit growth. In addition, asset purchases by central banks crowds out investors from the markets and leads to higher corporate bond issuance through "gap filling" theory (Greenwood et al., 2010). Duca et al. (2016) show that QE implemented by Fed had a significant effect on global corporate bond issuance. The study finds that bond issuance in emerging market economies would be half the realized amount without QE.

Another leading transmission channel through which QE impacts the economy is the signalling channel (expectation effect). This channel implies that central bank announcements or operations give a signal concerning the current situation of the economy and future course of the monetary policy. Actions or operations of central banks give information concerning the future course of monetary policy directly or indirectly. Forward guidance that have been used by Federal Reserve (Fed) actively and very often in the post-global crisis of 2008-09 period is the leading direct signal (Bauer and Neely, 2014). In this form of signalling, central banks give signal about future

monetary policy to the public directly through monetary policy statements, press conferences or speeches by chair/members of the monetary policy committee. For instance, on December 16, 2008, FOMC stated that they expect low rates going on. On March 18, 2009, FOMC declared that they anticipate very low rates for a long period (Bauer and Neely, 2014). Quantitative easing announcements/actions can also provide indirect (implicit) signals. In this form of signalling, QE announcements/actions imply that lower inflation and/or weaker growth is expected. This is perceived as a signal that future policy rates will remain low for an extended period. Announcement and implementation of quantitative easing policy can also suggest that central banks intend to carry out a more accomodative monetary policy.

Signalling channel works through the standart expectations hypothesis which relies on the relation between the interest rates with different maturities. Accomodative monetary policy stance lowers market expectations of future rates and leads to the fall of long term interest rates (Christensen and Rudebusch, 2012). This channel has a larger effect on bond yields with intermediate maturity compared to long maturity bonds because low interest rate commitment expires as soon as the economy recovers. In addition to lowering intermediate and long term rates, the signal also reduces the uncertainty about the future policy and hence the risk and term premium. Furthermore, the signal reduces volatility, eases credit conditions, increases household and business confidence and supports asset prices all of which stimulate the economic activity. If QE is perceived by the public such that the conditions are worse than expected, then it may also lead to flight to safety (Neely, 2015).

Signalling channel also applies to the global economy. Due to economic and financial globalization, the interaction between countries has been increasing and central banks around the world face with similar challanges and problems such as high commodity prices or tight financial conditions. Therefore, policy rates of the central banks have a high correlation with each other. QE announcements of Fed or ECB affect both domestic and foreign expected future interest rates. QE announcements reduce bond yield through signalling effect and increase interest rate differential with other countries and leads to capital flows into higher yielding assets in search for return. Thus, carry trade and capital flows into emerging market economies accelerate due to international

signalling channel. Rising capital flows leads to exchange rate appreciation, increased asset prices, credit expansion and financial instabilities. International signalling channel has both negative and positive spillover effects on foreign countries. Net effect is ambiguous.

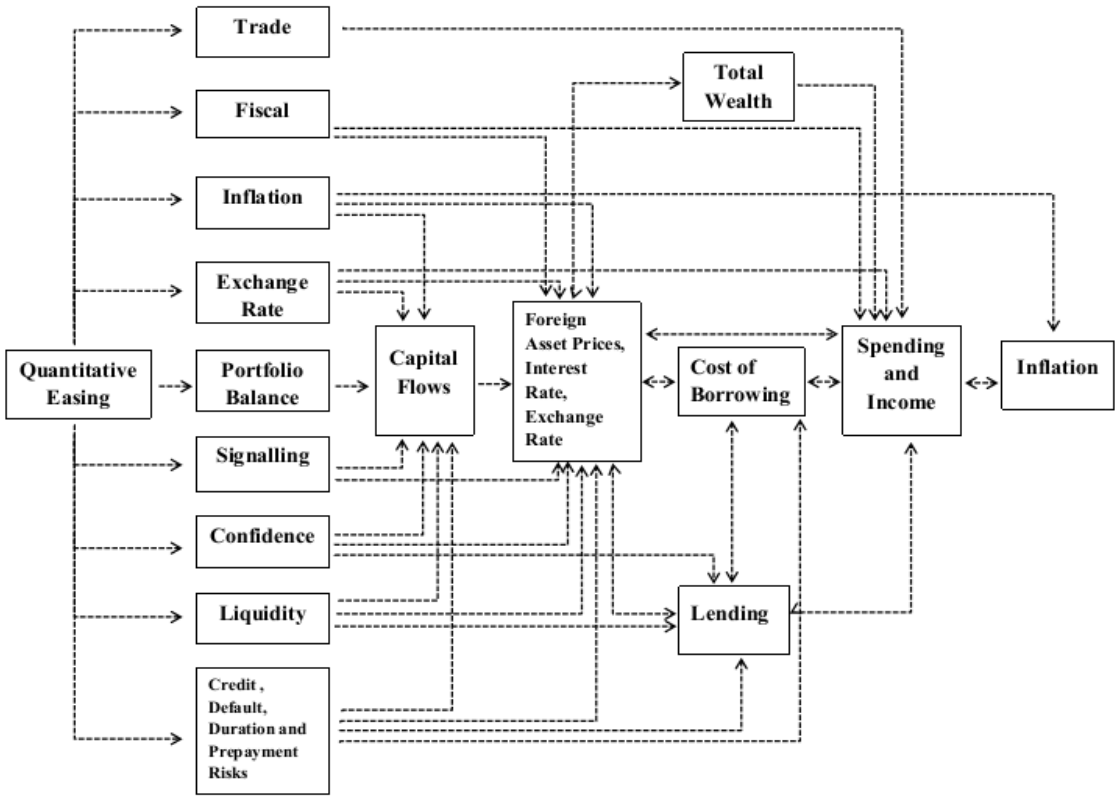
Except from portfolio balance and signalling channels, there are many other less-cited but important transmission channels that also influence the economy. One of them is liquidity, or market functioning channel. When spreads and risk premia are well above historical norms, liquidity is poor and market stress is at a significant level. QE increases liquidity and leads to better market functioning (Gagnon et al., 2011). Asset purchases also increase reserves of banks, lower liquidity premium and financing costs and enable them to expand credit both to domestic and international borrowers (Lim and Mohapatra, 2016). QE policy reduces the cost of buying and selling by lowering liquidity premium (Joyce et al., 2011). Through this channel, central bank purchases of securities calm down the markets, prevent panic, improve functioning of the market, augment market liquidity and allow dealers and investors to take position in financial markets. This channel is crucial and effective especially when QE is implemented during the worst time of financial crisis (Gagnon et al., 2011). According to Krishnamurthy and Jorgenson (2011), as one of the most liquid assets, treasury bonds have a liquidity premium and it is high during crisis periods. Thus, increasing liquidity through QE lowers this premium and raises yield. Liquidity channel also applies to the global economy. QE implemented in economically and financially important country such as US improves international liquidity and market functioning and provides positive international spillovers through this channel.

Krishnamurthy and Jorgenson (2011) suggest some other transmission channels of QE. Among them, credit risk channel implies that QE policy lowers credit risk of banks, businesses and sovereigns through improving liquidity and confidence, declining uncertainty and risk premium, falling financing costs, higher asset prices and better growth prospects. Declining credit risk supports economic activity through higher asset prices and improved balance sheets of economic agents. Changing credit default swap (CDS) shows the impact of QE policies on the credit risk. Another transmission channel, also related with the credit risk channel, is the default risk channel. Since QE is

expected to stimulate the economy, it improves the balance sheet and financial health of the corporations. As a result, default risk of the corporations falls. Lower grade bonds such as Baa bonds or junk bonds have a higher default risk compared to Treasury bonds (Krishnamurthy and Jorgenson, 2011). CDS is employed to evaluate the default risk and the impact of QE on CDS of lower grade bonds is higher compared to that of Treasury bonds. Therefore, QE is expected to reduce the spread between the CDS of lower and higher rated bonds. Duration risk channel of QE implies that the purchases of the central bank lower duration risk of investors. By reducing the amount of long term securities, asset purchases remove duration risk and reduce risk premium. QE reduces long maturity bond yields relative to short maturity bond yields and flattens the yield curve. Prepayment risk premium channel is related with mortgage backed securities' (MBS) yield. MBS purchases under QE reduce MBS yields relative to other bonds (Krishnamurthy and Jorgenson, 2011). This effect is present only when QE consists of MBS purchases such as QE1 in US. All these transmission channels also apply to the global economy. QE implemented in a large and economically significant country, such as US, lowers credit, default and duration risks in other countries. Declining CDS spreads shows the impact of QE policies.

Fiqure 3 below presents a chart that shows international transmission channels of quantitative easing. QE affects international asset prices, foreign output and inflation through various transmission channels and these channels are transmitted mainly through capital flows (Barroso et al., 2015).

Figure 3: International Transmission Channels of QE



Source: The Author

A crucial point is the relative importance of these transmission channels. There are many empirical studies that analyze which channels are more important in the transmission mechanism. It is important to note that different channels can be affective at the same time (Fratzscher et al., 2013). The empirical literature about transmission channels of QE especially focus on the relative importance of portfolio balance and signalling channels. The empirical analysis of other channels is relatively rare.

The literature concerning the relative importance of transmission channels is divided. Some studies show that portfolio balance is the dominant channel of transmission while some others claim that signalling is the leading channel. There are also some other studies that point out the importance of other channels or the prevelance of more than one channel. Among the empirical studies about the transmission channels of QE, Kimura and Small (2006) examines QE policy of Bank of Japan and find out that QE lowers risk premium on government bonds but increases risk premium on equities. Accordingly, portfolio rebalancing effect is found to be significant. Ugai (2007) provide

a survey of empirical analysis concerning the impact of QE program in Japan. The evidence shows that QE has some signalling effect such that the policy signals a more accomodative monetary policy and lowers future rates. Oda and Ueda (2007) analyze the impact of QE in Japan on yield curve. Through a macro finance model, interest rate is decomposed into risk premium and expectations component. Model results imply that signalling channel is effective but portfolio balance channel is found to be insignificant. Gagnon et al. (2011) employ term structure model and find out that QE in US lowers long end of the yield curve by decreasing term premium instead of expectations of future rates. That is, portfolio balance channel dominates and signalling effect is negligible. Liquidity is the least important transmission channel of QE since it is operative only early in the crisis period. Joyce et al. (2011) use both event study and portfolio balance model to analyze the influence of QE in UK on long term gilt yield. The results imply that gilt yields fall by about 100 bps mainly through portfolio balance channel. Krishnamurthy and Vissing-Jorgensen (2011) propose event study and dynamic term structure models to investigate the channels through which QE1 and QE2 affect interest rates in US. They argue that both QE1 and QE2 reduce yields through signalling, safety and inflation channels. Programs augment inflation expectations, lower future short term interest rates and yield of safe bonds. Additional channels for QE1 are MBS risk premium, default risk premium and liquidity channels. QE2 is a Treasury-only purchase program and affects mainly through signalling channel. Hamilton and Wu (2012) use term structure model to show that QE in US flattens the yield curve and the primary channel that QE influence yields is the portfolio balance channel. D'Amico et al. (2012) also employ term structure model to analyze the impact of QE1 and QE2 on long term bond yield in US. Empirical model imply that the effect of the first and second QE programs on interest rates is through both portfolio balance and duration channels. Signalling (expectations) channel is not found to be significant. Using high-frequency data, Joyce and Tong (2012) investigate the effect of QE in UK on gilt yields. Results show that local supply and duration risk channels are dominant. Yields of longer maturity gilts and specific gilts that are being purchased fell more. Breedon et al. (2012) employ a term premium model to investigate the influence of initial QE program on bond yields. Model results indicate that QE reduced 10 year government bond yield by about 50 bps through portfolio balance channel. Glick and

Leduc (2012) employ event study methodology to show the effects of QE announcements on international financial and commodity markets. They argue that announcements of asset purchase programs have signalling effect such that market participiants lower their future growth expectations. Accordingly, yields decline, dollar depreciates and commodity prices fall through signalling channel. Christensen and Rudebusch (2012) apply term structure model and seperate yields into term premium and expectations of future interest rates to find out the relative importance of signalling and portfolio balance channels. They argue that relative importance depends on the central bank's communication policies and financial market structures. In the post global crisis period, Federal Reserve used communication policies actively and was more willing to provide both explicit and implicit signals compared to other major central banks. Thus, signalling channel of QE was relatively more effective for US. Model results show that more than half of the response of yield in U.S. is through signalling channel. Due to the differences between financial market structures, the role of term premium varied across countries. For instance, US government bond market is relatively more liquid and has a higher share of international investors compared to other major bond markets. UK results imply that gilt yields decline through lower term premium that is portfolio balance channel. Thornton (2012) finds no evidence that portfolio balance channel lowers term premium. Reduction in yields is due to signalling channel. Gilchrist and Zakrajšek (2013) show that QE lowered default insurance cost for corporates but no impact is found on the credit risk of financial sector. Albu et al. (2014a) and Albu et al. (2014b) find out that QE programs have a significant impact on sovereign CDS. Bauer and Neely (2014) analyze the impact of QE in US on global bond yields by employing dynamic term structure models and analyze which transmission channels are crucial. Dominant transmission channel differs across countries due to each country's bonds characteristics. Signalling channel is relatively more important for US and Canada but the impact is moderate for Germany and Australia. Portfolio balance channel is relatively more significant for Australia and Germany compared to Canada and US. For Japan, portfolio balance effect is small and there is no signalling channel. Signalling channel is bigger for countries that response much more to US monetary policy surprises. Bauer and Rudebusch (2014) also propose a dynamic term structure model and decompose yields into term premium and

expectations of future rates. Model results show that asset purchases lower yields through signalling channel. Lim and Mohapatra (2016) investigate the effect of QE on capital flows into developing countries. They find that the transmission channels of QE are liquidity, portfolio rebalancing and condence channels. Georgiadis and Grab (2016) analyze the effect of extended asset purchase programme (EAPP) on global asset prices and compare the transmission channels with previous programs. Leading channel of transmission for EAPP is found to be signalling while the main channels of transmission are confidence and portfolio re-balancing for Outright Monetary Transactions (OMT) and Securities Market Programme (SMP), respectively.

1.4. EFFECTS OF QUANTITATIVE EASING (QE) ON THE ECONOMY – LITERATURE SURVEY

The literature concerning the effects of QE on the economy is wide, varied and growing rapidly. Especially, low interest rate environment after the economic and financial crisis in 2008-9 and widespread use of UMP in this period drawed attention on the effects these policies. Hence, there has been an explosion of new studies and rapid growth of the literature after in the crisis. For the sake of simplification and clearer understanding, the literature may first be divided into two categories as the domestic and international economic effects of quantitative easing. An additional division may also be made as financial market and real economy effects of quantitative easing. Therefore, we can basically review the literature in 4 different parts.

An important part of the related literature focuses on domestic financial market effects of quantitative easing. More specifically, most of the studies in this category aim to investigate the impact of QE on long term bond yield. Literature on the effects of asset purchases goes back to the "Operation Twist" implemented in US in 1961. Using regression analysis, Modigliani and Sutch (1966) analyze the financial market effects of this program and find that operation twist did not influence long term bond yield. According to the study, short term yield increased and the spread between short and long rates declined with this program. After a long break, QE employed by BoJ between 2001 and 2006 boosted curiosity on the impact of QE and studies concerning the impact

of these policies on Japanese financial markets emerged. Among these, Bernanke et al. (2004) find no announcement effect of QE in Japan but macro finance yield curve approach implies that yields were 50 bps lower than expected during QE. According to Kimura and Small (2006), portfolio-rebalancing effect of QE in Japan is statistically significant but the impact on risk premium depends on the type of the asset subject to QE. Risk premium on government and high grade bonds declined but it increased for equities and low-grade corporate bonds. Oda and Ueda (2007) decompose interest rates into expectations and risk premium through a macro finance model. They find QE in Japan as effective, portfolio rebalancing effect as insignificant and signaling effect as significant. Ugai (2007) presents a survey of empirical evidence for Japan's QE and argues that signaling effect is significant. QE created an accommodative financial environment, helped to contain funding costs and uncertainties. However, the effect on bond yield and risk premium is mixed.

The real explosion of the literature concerning the effects of QE was with the widespread implementation of these policies after the global crisis. Many of the studies in this period focus on the effects of QE implemented by Fed on interest rates. As an early attempt, Doh (2010) employs preferred habitat model and finds out that treasury bond purchases under QE1 lowered ten year government bond yields by 39 basis points (bps). There are several studies using event study methodology to analyze the impact of QE on long term bond yields in US. Among them, Gagnon et al. (2011) estimate that QE1 reduced 10 year government bond yield by 91 bps. This fall reflects lower risk premiums instead of subdued expectations of future interest rates. According to Krishnamurthy and Jorgenson (2011), QE1 and QE2 reduced ten year interest rate by 107 and 30 bps, respectively. Interest rate on agencies, corporate bonds and MBS's also declined and the magnitude of the decline differs across bond type, maturity and program. Meaning and Zhu (2011) also find a larger effect on interest rates for QE1 compared to QE2. Effects are estimated to be 80 and 21 bps, respectively. Swanson (2011) revisits Operation Twist implemented in 1961 using event study and argues that the effect of the program, which lowers long term treasury yield by about 15 bps, is similar to QE2. Findings of Rosa (2012) point out that the impact of QE1 on 10 year US treasury yield is large and is equal to a 197 bps unanticipated fall in short term rate.

Another study employing event study, Thornton (2012) suggests that reduction of interest rates is due to signaling channel instead of portfolio balance channel.

Apart from event study, many other methodologies are also used to investigate the effects of QE on long term US yield. Among them, D'Amico et al. (2012), Hamilton and Wu (2012), Christensen and Rudebusch (2012), Li and Wei (2013), Bauer and Rudebusch (2014) all use term structure models. According to D'Amico et al. (2012), $300 billion Treasury bond purchase under QE1 lowered long term yield by 35 bps and $600 billion Treasury bond purchase under QE2 reduced government bond yield by 45 bps. Christensen and Rudebusch (2012) decompose yields and argue that the decline in US long term yield is mainly due to expectations of lower future interest rates. Hamilton and Wu (2012) find that replacing $400 billion short and long term debt reduces 10 year bond yield by 14 bps and increases 6 month yield by 11 bps. They find that same amount of long term asset purchases would lower 10 year bond yield by 13 bps. Li and Wei (2013) analyze the effects of QE1, QE2 and Operation Twist on 10 year treasury yield. Estimated impacts are 60, 19 and 19 bps, respectively. Accordingly, the cumulative effect of these three programs is found to be about 100 bps. Bauer and Rudebusch (2014) argue that the signaling effect is large for QE1 but weak for QE2 and Operation Twist. Employing a structural vector autoregressive (SVAR) model, Wright (2012) shows that QE1, QE2 and Operation Twist have significant effect in reducing long term government bond and corporate bond yield. Hovewer, the impact dies out in a few months. In addition, the effect on treasuries is about twice of the corporates. D'Amico and King (2013) and Kandrac and Schlusche (2013) investigate the stock and flow impacts of QE on interest rates by employing panel regression methodology. Using security level data, D'Amico and King (2013) estimate that $300 billion worth treasury securities purchase under QE1 lowered government bond yield by an average of 30 bps during the program that is called the stock effect. Furthermore, the purchases lowered the yield further by 3.5 bps on the days of the purchase and this is called the flow effect. Kandrac and Schlusche (2013) argue that flow effects are present in early programs but their magnitude is small and disappear over time. They find out that treasury purchases do not have any effect on market functioning.

Apart from the studies concerning the influence of QE on government bond yield in US, there are some others analyzing the effects of the programs on other variables such as mortgage backed securities (MBS) yield, corporate bond yield, exchange rate, equities, etc. Hancock and Passmore (2011) and Stroebel and Taylor (2012) analyze the effects of the MBS purchases by utilizing low frequency data and reach some mixed results. While Hancock and Passmore (2011) find a strong effect, Stroebel and Taylor (2012) obtain a small or insignificant impact. Hancock and Passmore (2011) argue that mortgage-backed security purchases (MBS) by Fed impose downward pressure on mortgage rates. By employing regression analysis, they estimate that the impact is about 100 bps. The analysis also implies that about half of the decline in mortgage rates is due to improved market functioning and clearer government backing, and the other half is related to portfolio rebalancing. On the other hand, Stroebel and Taylor (2012) show that changes in prepayment and default risks explain almost all of the movements in mortgage spread. Therefore, when these risks are taken into consideration, the effect of MBS purchases on mortgage spreads is found to be small and uncertain. The study raises doubts about the benefits of MBS purchases on reducing mortgage rates. Gilchrist and Zakrajšek (2013) investigate the effect of QE on credit risk and argue that QE announcements by Fed led to decline in the cost of default insurance. QE is found to reduce credit risk in the economy but no impact on financial sector risk. Results show that QE improved financial conditions in both business and household sectors. Glick and Leduc (2013) investigate the effects of QE on US exchange rate by employing event study methodology. Model results show that the surprises concerning conventional and UMP lead to the depreciation of dollar and the change in exchange rate is similar in both policies. According to the study, QE1, QE2, and QE3 programs led to the depreciation of the dollar by an average of 62, 24 and 14 bps, respectively. Using event study and non-linear least squares, Gilchrist et al. (2015) find out that QE lowers real borrowing cost and flattens the yield curve. According to the results, the impact of conventional and UMP on real borrowing costs are similar.

There are also several studies about the effects of QE on UK financial markets. Among them, Meier (2009) uses event study methodology to analyze the effect of QE announcements and finds out that long-term sovereign bond yields fell between 40 and 100 bps with the announcement of BoE in March 2009. Joyce et al. (2011) employ

several empirical methods such as event study, portfolio balance model, VAR and M-GARCH models in order to analyze the effects of asset purchases on yields and argue that QE in UK reduced long term treasury yields by about 100 bps. According to their analysis, the biggest part of the effect is due to portfolio balance effect. Another important conclusion of the study is that QE supported equity prices, lowered corporate bond yield and led to the depreciation of Sterling. Breedon et al. (2012) employ a term structure model for UK and estimate that QE lowers 10 year bond yield by about 50 bps through portfolio balance effect. Using structural VAR and cointegrated VAR models, Bridges and Thomas (2012) argue that asset purchase of BoE increased broad money stock by 8 percent. As a result, yields went down by 150 bps and asset values increased by about 20 percent. According to Joyce and Tong (2012), markets pricing of QE announcement take time and the effect differs across term structure. Biggest impact is estimated to be about 120 bps between the 15 and 20-year maturity. Christensen and Rudebusch (2012) argue that the fall in yields in UK as a result of QE reflects lower term premiums.

Literature about the impact of QE implemented by ECB on Euro Area financial markets is increasing. As an early attempt, Beirne et al. (2011) find out that First Covered Bond Purchase Program (CBPP1) which started to be conducted in July 2009 was effective to lower money market rates, ease funding conditions, boost lending and improve liquidity for private debt securities. Event study analysis shows that the program dampened euro area covered bond yields by about 12 bps. Pattipeilohy et al. (2013) analyze the effects of Securities Market Programme (SMP) and by using factor analysis show that the effect of SMP is only temporary. Ghysels et. al. (2014) build a multi-frequency component model to investigate the effects of SMP on bond yields. The results indicate that purchases were successful in lowering yield and volatility. Using event study methodology, Szczerbowicz (2015) find that ECB bond purchases reduced refinancing costs of banks and governments. The analysis shows that periphery economies benefited most from QE programs and ECB was able to create more homogenous credit conditions in the Eurozone. Eser and Schwaab (2016) employ panel regression to find out the effect of SMP on five year bond yields. According to model estimates, the reduction of sovereign bond yields per €1 billion bond purchase is between -1 and -2 bps for Italy, -6 to -9 bps for Portugal, -3 bps for Ireland, -4 to -6 bps for Spain and

between -17 and -21 bps for Greece. Another important finding of the study is that estimated impacts are lowers as the size and liquidity of the market increases.

Table 1 below presents a brief literature review about the impact of QE on domestic financial markets.

Table 1: Literature Review on Domestic Financial Market Effects of Quantitative Easing

Authors and Date	**Model and Country**	**Result**
Modigliani and Sutch (1966)	Regression US	Operation Twist did not influence long term interest rates.
Bernanke et al. (2004)	Event study, term structure model Japan	No announcement effect, purchases lower bond yield by 50 bps.
Kimura and Small (2006)	CAPM, Regression, MA-GARCH Japan	Risk premiums on assets with counter-cyclical returns declined, risk premium for assets with pro-cyclical returns increased.
Oda and Ueda (2007)	Macro-Finance Model Japan	QE was effective, portfolio rebalancing effect insignificant, signaling effect significant.
Meier (2009)	Event Study UK	QE lowered long term bond yield between 40 and 100 bps.
Doh (2010)	Preferred Habitat Model US	10 year bond yield declined by 39 bps.
Hancock and Passmore (2011)	Regression US	MBS purchases reduced mortgage rates by about 100 bps.
Krishnamurthy and Vissing-Jorgensen (2011)	Event Study, Regression US	QE1 and QE2 lowered 10 year bond yields by 107 and 30 bps, respectively.
Beirne et al. (2011)	Event Study, Error Correction, Cointegration Euro Area	Covered bond purchases lower money market term rates, eases funding conditions, increases lending, improves market liquidity for private debt.
Gagnon et al. (2011)	Event Study, Regression US	Ten-year treasury yield fell by 91 bps.
Joyce et al. (2011)	Event Study, Portfolio Balance Model, VAR, GARCH-M, Calibration UK	Long term government bond yield fell about 100 bps.

Meaning and Zhu (2011)	Event Study US, UK	QE1 and QE2 lowers 10 year government bond yield by 80 and 21 bps, respectively.
Swanson (2011)	Event Study US	Operation twist lowered long term sovereign bond yield by 15 bps.
Breedon et al. (2012)	Term Structure Model UK	Government bond yield fell about 50 bps.
Bridges and Thomas (2012)	SVAR, Cointegrated VAR, Sectoral Models UK	Yields go down by 150 bps, asset values increase about 20 percent.
D'Amico et al. (2012)	Term Premium Regression US	QE1 and QE2 reduced long term sovereign yield by 35 bps and 45 bps, respectively.
Christensen and Rudebusch (2012)	Dynamic Term Structure Model, Event Study US, UK	US yields fall due to the reduction of policy expectations, fall in UK is because of lower term premiums.
Joyce and Tong (2012)	Event Study, Panel Regression UK	Impact is up to 120 bps between the 15 and 20-year maturity.
Hamilton and Wu (2012)	Term Structure Model, OLS, VAR US	Operation Twist lowers 10 year yield by 14 bps, increases 6 month yield by 11 bps. Asset purchase of the same amount reduces 10 year bond yield by 13 bps.
Rosa (2012)	Event Study US, UK	Effect of QE is equal to 197 bps surprise reduction in Fed funds rate for 10 year yield.
Stroebel and Taylor (2012)	Regression US	Effect of FED's MBS purchases on spreads is limited.
Wright (2012)	SVAR, Event Study US	Impact of QE is only temporary.
Thornton (2012)	Event Study, Regression US	Effect of QE is due to signaling, not portfolio balance channel.
Kandrac and Schlusche (2013)	Panel Regression US	Flow effect is small and dissipates over time.
Li and Wei (2013)	Arbitrage-Free Term Structure Model US	QE1, QE2 and Operation Twist reduced ten-year bond yield by 100 bps.
D'Amico and King (2013)	Panel Regression US	QE1 lowered yields by 30 bps (stock effect), and further 3.5 bps on the days of the purchase (flow effect)
Gilchrist and Zakrajšek (2013)	Event Study US	QE lowered cost of insurance against default risk.
Glick and Leduc (2013)	Event Study, Regression US	Surprises concerning conventional and UMP lead to depreciation of dollar.

Pattipeilohy et al. (2013)	Factor Analysis Euro Area	SMP only has temporary effect on bond yield.
Bauer and Rudebusch (2014)	Dynamic Term Structure Model, Event Study US	Signaling effect is strong for QE1, weak for QE2 and Operation Twist.
Ghysels et al. (2014)	Multi-Frequency Component Model Euro Area	Purchases were successful to reduce yield and volatility.
Szczerbowicz (2015)	Event Study Euro Area	Sovereign and bank covered bond spreads declined, periphery countries benefited the most.
Gilchrist et al. (2015)	Event Study, Non-Linear Least Squares US	The impact of conventional and UMP on real borrowing costs is similar.
Eser and Schwaab (2016)	Panel Regression Euro Area	SMP lowered 5 year yield in Euro Area economies. Effects differ by countries.

Other part of the literature focuses on the domestic macroeconomic impact of QE policies. Although the literature in this field is growing rapidly, there are fewer studies compared to the ones investigating financial market impact of QE. Among the studies concerning US, Chung et al. (2012) study the macroeconomic impact of QE1 and QE2 and argue that the programs were effective. The model of Fed show that the combination of these two programs raised output by 3 percentage points and the inflation is estimated to be 1 percent higher compared to what it would have been otherwise. In addition, these policies created 3 million jobs and lowered unemployment rate by 1.5 percent. They also find that the impact of two asset purchase programs is equal to the reduction of fed funds rate of about 300 bps. Chen et al. (2012a) employ a Dynamic Stochastic General Equilibrium (DSGE) model to estimate the effect of QE2. Simulations imply that QE2 reduced risk premium by 12 bps, increased GDP growth by about 0.13 percent and inflation by 3 bps which shows that the impact of the program is only modest. The authors conclude that the effect of QE2 is persistent and slightly smaller than a 25 bps reduction in Fed funds rate. Another crucial finding exhibits that without commitment to sustain interest rate low, the impact on GDP is only 0.04 percent. Gertler and Karadi (2013) also apply a DSGE model and conclude that QE2 in US reduced long term interest rates by 12 bps which leads to a maximum rise in GDP of 1 percent. Baumeister and Benati (2013) argue by employing a time-varying vector

autoregression (VAR) model that QE mitigated deflation risk and further output collapses. Without the programs, GDP and inflation would have been 3 and 1 percent lower, respectively. Simulation results show that QE lowered unemployment rate by about 0.75 percent. Engen et al. (2015) simulate FRB-US large-scale macroeconometric model to investigate the impact of QE policy and find out that the peak effect of the programs is to lower unemployment rate by 1.2 percent and increase inflation by 0.5 percent. Weale and Wieladek (2015) use Bayesian VAR method and find that asset purchases in US have significant effects on GDP and inflation. Model results imply that asset purchases worth 1 percent of GDP increase output and prices in US by 0.58 and 0.62 percent, respectively. The effect of QE is through portfolio balance channel and reduces uncertainty. Meinusch and Tillmann (2016) employ a Qual VAR model and conclude that QE has a significant effect on sovereign yields, output, market uncertainty and equity prices. Accordingly, QE boosts industrial production and GDP by 0.6 and 0.15 percent, respectively. Another important result of the study is that QE is more effective than conventional monetary policy in terms of the effect on real activity.

Among the studies that examine the effects of QE on UK economy, Kapetanios et al. (2012) analyze the impact of the QE program on economic activity and prices by using Bayesian VAR, Change Point SVAR and Time-Varying Parameter VAR models. Model results imply that QE boosts economic activity by 1.5 percent and increases prices by 1.25 percent on average. Bridges and Thomas (2012) apply a SVAR model to investigate the influence of £200 billion worth of QE program in UK on output and inflation. Model results display that QE boosts broad money supply by 8 percent. Yields go down by 150 bps and asset values increase about 20 percent. Peak impact on GDP and inflation are estimated to be 2 and 1 percent, respectively. Paseran and Smith (2016) perform counterfactual analysis and find that QE in UK reduced spread between short and long term yield by 100 bps and this boosts growth by about 1 percent. However, the effect is not persistent. Weale and Wieladek (2016) use a Bayesian VAR model and show that asset purchases worth 1 percent of GDP increase output and price level in UK by 0.25 and 0.32 percent, respectively. They conclude that the effect is through investors risk appetite and household uncertainty.

Among the studies that analyze the influence of QE in Japan, Ugai (2007) presents a survey of empirical analysis. Accordingly, QE in Japan created an accommodative financial environment but the impact on output and prices was limited. Girardin and Moussa (2011) study the effectiveness of Japanese QE experience by using Markov Switching Factor-Augmented VAR (MS-FAVAR) method. Model results show that QE was successful in stimulating output and prices. Schenkelberg and Watzka (2013) argue that QE reduces bond yield and increases GDP and inflation. The study shows that QE shock increases industrial production by 0.4 percent. SVAR model results indicate that QE was effective in boosting economic activity temporarily at zero lower bound and the impact of QE on inflation is not persistent. Bowman et al. (2015a) use bank level data and panel regression to study the impact of QE on lending in Japan. They find a strong, positive and significant impact of QE on loans. Overall effect is estimated to be small and weak banks benefited more from QE compared to stronger banks. Employing a MS-VAR model, Matsuki et al. (2015) find that QE in Japan reduces short term rates and increases price level. Qualitative easing that includes government bonds and exchange traded funds (ETF) boost economic activity.

There are also studies that analyze the macroeconomic effects of the ECB's unconventional monetary policies after the great recession of 2008-09. Among them, Lenza et al. (2010) use Bayesian Vector Autoregression (BVAR) model and provide counterfactual analysis to show that unconventional monetary policy was successful in reducing money market spreads. The positive effect on output and inflation is found to be with a lag. According to model results, non-standart measures decreased unemployment rate by 0.6 percent and increased industrial production by 2 percent compared to no change scenario. Effects on the annual growth rate of consumer and corporate loans after 2 years are 1.5 and 3 percent, respectively. Peersman (2011) applies a SVAR model and show that QE has transitory impact on output and a permanent effect on inflation. Impact of unconventional monetary policies is found to be smaller compared to traditional interest rate policies. Other important results of the study are that QE reduces credit multiplier and the effect of 25 bps policy rate cut is equal to a 10 percent rise in monetary base. Altavilla et al. (2014) analyze macroeconomic impact of OMT program and find that announcement of the program lowered 2 years Spanish and Italian sovereign yields by about 2 percent and had almost

no effect on German and French yields by employing event study methodology. BVAR model results imply that the program led to a strong and significant rise in output, prices and credit in Italy and Spain, but a limited spillover effect in Germany and France. Effects on GDP are 1.5 and 2 percent for Italy and Spain, but only 0.34 and 0.46 percent for Germany and France, respectively.

A summary of the literature concerning the domestic macroeconomic effects of QE is provided in table below.

Table 2: Literature Review on Domestic Macroeconomic Effects of Quantitative Easing

Authors and Date	**Model and Country**	**Result**
Ugai (2007)	Survey of Empirical Analysis Japan	Impact of QE on output and prices was limited.
Lenza et al. (2010)	Bayesian VAR Euro Area	Unconventional policies lower unemployment rate by 0.5 percent, increase consumer and corporate loans by 1.5 and 3 percent respectively.
Peersman (2011)	Structural VAR Euro Area	QE has transitory effect on output and permanent impact inflation.
Girardin and Moussa (2011)	MS-FAVAR Japan	QE was effective to stimulate output and prices.
Chen et al. (2012a)	DSGE Model US	QE2 increases GDP growth by 0.13 percent and inflation by 3 bps.
Bridges and Thomas (2012)	SVAR, CVAR UK	QE in UK has a peak impact of 2 and 1 percent on GDP and inflation, respectively.
Kapetanios et al. (2012)	BVAR, MS-SVAR, TVP-SVAR UK	Maximum impact of QE on output and inflation are 1.5 and 1.25 percent, respectively.
Chung et al. (2012)	GARCH, DSGE, FRB-US, TVP-VAR US	QE in US raises GDP by 3 percent, creates 3 million jobs, lowers unemployment rate by 1.5 percent and increases inflation by 1 percent.
Baumeister and Benati (2013)	TVP-VAR model US, UK	Effect of QE on GDP, inflation and unemployment rate are 3, 1 and 0.75 percent, respectively.
Gertler and Karadi (2013)	DSGE Model US	QE2 reduces long term interest rates by 12 bps and this leads to a maximum rise in GDP of 1 percent.

Schenkelberg and Watzka (2013)	SVAR Japan	QE increases output and price level only temporarily.
Altavilla et al. (2014)	Event Study, BVAR Euro Area	Impact of OMT program is large for Spain and Italy, relatively muted for France and Germany.
Engen et al. (2015)	FRB-US Model US	QE lowers unemployment rate by 1.2 percent and increase inflation by 0.5 percent.
Bowman et al. (2015a)	Panel Data Regression Japan	They find a strong, positive and significant impact on bank loans.
Matsuki et al. (2015)	MS-VAR Japan	QE lowers short term interest rate and increases inflation. Qualitative easing boosts growth.
Weale and Wieladek (2016)	Bayesian VAR US, UK	Asset purchase worth 1 percent of GDP raises GDP and prices in US by .58% and .62% respectively. Impacts for UK are .25% and .32%.
Paseran and Smith (2016)	Counterfactual Analysis UK	QE in UK reduced spread by 100 bps and increased growth by 1 percent temporarily.
Meinusch and Tillmann (2016)	Qual VAR US	QE increase industrial production and GDP by 0.6 and 0.15 percent respectively.

QE policies not only affect domestic economy but also have crucial international spillover effects. Although many of the studies in the literature are about the impact of QE on domestic economy, there are also others which analyze the international spillovers of QE policies. Some of these focuses on international financial market impact of QE programs and some others analyze international macroeconomic effects of these policies. Among the studies that investigate international financial market spillovers, some focus on the influence of the policies on developing economies while some others on advanced economies or both. Many of these papers employ event study methodology to find out the international financial market impact of QE programs. Among them, Chen et al. (2012b) analyze the effect of QE implemented by major advanced countries on developing economies in Latin America and emerging Asia. Results show that QE increased stock prices, lowered government and corporate bond yields, created upward pressure on exchange rates, compressed CDS spreads and created an accommodative financial environment. The study shows that QE1 was more influencial compared to QE2. QE1 and QE2 lowered 10 years bond yield in emerging

Asia by 80 and 9 bps, respectively. QE programs of BoJ, BoE and ECB are also found to have sizeable per-dollar effects. Glick and Leduc (2012) investigate the announcement impact of QE policies by the Fed and BoE on international financial and commodity markets. Results imply that QE by US and UK led to lower long term bond yields in Europe, US, Canada, UK, Japan and Australia and depreciation of dollar and pound. Impact of QE1 is found to be larger compared to QE2. Due to signaling effect, QE policies reduced commodity prices. Fratzscher et al. (2013) analyze the effects of the Fed's QE1 and QE2 on 42 EM and 21 advanced economies financial markets. There are three important findings of the study. First, QE1 was effective in reducing sovereign bond yields and boosting equities globally. On the other hand, QE2 increased equities worldwide but had little impact on yields. Second, QE1 led to portfolio outflows from EM's and inflows to US funds. The opposite occured with QE2. Third, operations had more effect on asset prices and capital flows compared to announcements. Rogers et al. (2014) study the impact of UMP implemented by Fed, BoE, ECB and BoJ on sovereign bond interest rates, exchange rates and equities. QE policies are estimated to be effective in easing financial conditions. QE lowers bond yields and boosts asset prices. Moreover, spillovers from bond interest rates to other asset prices are bigger for the US than for other countries. Sonmezer (2014) analyze the effects of QE announcements by Fed on Turkish financial markets. QE announcements in general had an important effect on local and foreign bond yields. Especially, announcements concerning QE1 had a significant impact. When announcements are expected by the public, effect of them on prices is found to be insignificant. Neely (2015) analyzes the announcement impact of UMP in US on long term sovereign bond yield of US, Canada, Japan, Australia, Germany, UK and the value of dollar. Results indicate that these policy announcements reduced bond yields and lowered the value of dollar. The fall in 10-year bond yields range from 18 bps for Japan to 65 bps for Australia. Georgiadis and Gräb (2016) study the announcement impact of ECB's QE declared on January 22, 2015. Results show that the announcement increased global equity prices, caused depreciation of euro and had only a limited impact on bond prices. It is also found that equities and exchanges rates reacted stronger in EM countries compared to advanced economies and major transmission channel of the announcement is signaling.

Some other studies in the related literature apply panel regression method. Moore et al. (2013) analyze the impact of QE implemented by FED on EM bond markets. Model results suggest that QE1 and QE2 reduced ten year US bond yield by 100 and 13 bps, respectively. As a result of these policies government bond yields in selected EM countries fell by 17 and 2 bps, respectively. Furthermore, 10 bps fall in long term US bond yield creates a 0.4 percentage point rise in foreign EM debt ownership and this lowers EM bond yields by 1.7 bps. Ahmed and Zlade (2014), Lim and Mohapatra (2016) and Kiendrebeogo (2016) investigate the effects of QE policies on capital flows into developing countries within a panel regression framework. According to Ahmed and Zlade (2014), unconventional monetary policies in US applied after the global economic crisis increased total and portfolio inflows to EM countries. Portfolio flows are found to be more sensitive to such policies. Lim and Mohapatra (2016) find that at least 13 percent of the rise in capital inflows to EM economies between 2009 and 2013 is attributed to QE. Similar to Ahmed and Zlade (2014), portfolio flows are found to be more sensitive to QE compared to foreign direct investment. Kiendrebeogo (2016) find that unconventional monetary policies (UMP) of Fed led to increased portfolio flows into EM economies. The study argues that the exit from UMP will probably cause capital outflows. Chen et al. (2014) use both event study and panel regression to show that expansionary monetary policy in US impact capital inflows and asset prices in 21 EM countries. Other major findings of the study are that spillovers effects per unit of US unconventional monetary policy is stronger compared to conventional policies and countries that have better fundamentals are affected less from these policies. Bowman et al. (2015b) explore the impact of US UMP on government interest rates, equities and exchange rates in EM economies. The findings put forward that unconventional monetary policy announcements of Fed affect government bond yields in domestic currency and US expansionary monetary policy reduce bond yields EM economies. Furthermore, the impact of the changes in US financial conditions is larger for the countries that have vulnerable banking systems, higher CDS spreads, current account deficits, inflation and bond yield. Duca et al. (2016) investigate the relation between US QE policies and global corporate bond issuance. Model results indicate that QE by Fed had a strong effect on the size of corporate bond issuance both in EM and advanced countries. According to counterfactual analysis, bond issuance in EM countries would

be half the realized amount without QE. MacDonald (2017) analyzes the impact of asset purchase programs of advanced countries on 21 EM financial markets. Model output implies that asset purchases raise equity prices, lower local sovereign bond yield and lead to currency appreciation. Effect of QE on EM currency, equity and bond markets is heterogeneous. Degree of economic integration between advanced and EM countries explain some of the heterogeneity.

Apart from the studies that use event study and panel regression methods to analyze international financial market effects of QE, there are some others that employ various different methods. For instance, Albu et al. (2014a) and Albu et al. (2014b) analyze the impact of QE programs by ECB, BoE, BoJ and Fed on sovereign CDS in Central and Eastern Europe. The studies utilize ARMA-GARCH model and find that QE policies have significant effects on sovereign CDS. Bauer and Neely (2014) aim to find out which channel of transmission is relatively more important based on dynamic term structure models. The results imply that both signaling and portfolio balance channels contributed to the reduction in yields. Signaling effect is estimated to be strongest for US and Canada, negligible for Japan. On the other hand, portfolio balance effect is found to be more crucial for Australia and Germany compared to US and Canada. Tillmann (2016) proposes a Qual VAR model to analyze the effect of QE on EM financial indicators. According to model results, QE has a strong effect on EM financial conditions. It boosts equities, lower bond yields and increase capital inflows. Other important findings are that conventional and unconventional monetary policy have similar impact on EM bond prices and effect of QE1 is limited compared to QE2 and QE3.

A summary of the literature about the effects of QE on international financial markets can be found in the table below.

Table 3: Literature Review on International Financial Market Effects of Quantitative Easing

Authors and Date	Model and Country	Results
Chen et al. (2012b)	Event Study EM Countries in Asia and Latin America	QE increased stock prices, lowered government and corporate bond yield, created upward pressure on exchange rates and compressed CDS spreads.
Glick and Leduc (2012)	Event Study US, UK, Euro Area Canada, Australia, Japan	QE by US and UK reduce long term bond yield and lead to depreciation of currencies. Commodity prices declined.
Fratzscher et al. (2013)	Event Study 42 EM, 21 Advanced countries	QE1 and QE2 increased equities globally. QE1 reduced yields but QE2 had little impact. QE programs led to significant portfolio rebalancing.
Moore et al. (2013)	Panel Regression, VAR, Event Study 10 EM Countries	10 bps decline in US Treasury yield increase foreign ownership in EM bonds and this reduces EM bond yields by 1.7 bps.
Ahmed and Zlade (2014)	Panel Regression EM Countries	UMP in US after the crisis increased capital inflows to EM countries. Portfolio flows are more sensitive.
Albu et al. (2014a), Albu et al. (2014b)	ARMA-GARCH Model Central and Eastern Europe Countries	QE has significant impact on sovereign CDS.
Chen et al. (2014)	Panel Regression, Event Study 21 EM Countries	Spillovers of UMP are stronger compared to conventional policies. Countries that have better fundamentals are affected relatively less.
Bauer and Neely (2014)	Dynamic Term Structure Models, Event Study US, Canada, Australia, Germany, Japan	Signalling effect is strongest for US and Canada. Portfolio balance is relatively more influential for Australia and Germany compared to US and Canada.
Rogers et al. (2014)	Event Study Advanced Economies	UMP reduce bond yield, boost asset prices and ease financial conditions.
Sonmezer (2014)	Event Study Turkey	QE announcements affect financial market variables, especially bond yields, in Turkey.
Bowman et al. (2015b)	Panel Regression, VAR 17 EM Countries	UMP announcements lower sovereign yields in EMs. Countries with weak fundamentals are affected more from the changes in US financial variables.

Duca et al. (2015)	Panel Regression EM and Advanced Economies	QE by FED is found to have a strong effect on corporate bond issuance. Bond issuance in EM would be half the realized amount without QE.
Neely (2015)	Event Study US, Australia, Canada, Germany, Japan, UK	UMP announcements by Fed lowered global sovereign interest rates and led to depreciation of dollar.
Georgiadis and Gräb (2016)	Event Study EM and Advanced Countries	Announcement of ECB's EAPP increased global equities, caused depreciation of euro and had a limited impact on bond prices.
Kiendrebeogo (2016)	Panel Regression 98 EM and Advanced Countries	UMP in US led to increased capital flows to EM economies.
Lim and Mohapatra (2016)	Panel Regression Developing Countries	At least 13 percent of the rise in capital inflows to EM countries during 2009-13 is attributed to QE.
Tillmann (2016)	Qual VAR EM Countries	QE has strong impact on EM financial indicators. Effect of QE1 is limited compared to QE2 and QE3.
MacDonald (2017)	Panel Regression 21 EM Countries	Degree of economic integration between advanced and EM countries can explain the effect of QE.

Other part of the literature deals with international macroeconomic effects of QE policies. This field is dominated by the studies which use panel regression and VAR type models in their empirical analysis. Among the studies that employ panel regression, Gambacorta et al. (2014) investigate the macroeconomic impact of UMP on Canada, Japan, Euro Area, Switzerland, Norway, Sweden, UK and US in a panel SVAR framework. According to the model results, UMP shock causes a significant but transitory increase in economic activity and inflation. Impact is found to be close to conventional monetary policy. Impact of QE is similar across countries despite big differences between countries and policies implemented. Morais et al. (2015) examine the bank lending channel of both conventional and UMP employing loan level data for Mexico. Model results imply that impact of conventional interest rate policy is stronger compared to unconventional policies. QE increases credit supply to Mexican firms and risk taking in EM countries through credit expansion to riskier firms. Real outcomes of firms improve less.

VAR type models are also commonly used in the empirical investigation of the macroeconomic impact of QE policies. Chen et al. (2012b) and Chen et al. (2016) study the impact of QE policies implemented by FED on major advanced and emerging market economies in a global vector error correction model (GVECM) framework. Chen et al. (2012b) find out that real impact of QE on developing countries was larger than that on developed countries. Impact of the policies differs across countries and has opposite signs in some cases. For instance, increases in prices range from 0.5 percent in Singapore to 4 percent in Indonesia. Output increased 15 percent in Brazil but decreased by about 5 percent in Philippines. Chen et al. (2016) put forward that international spillovers vary across countries and time. Effects on EM countries are larger than on advanced countries. QE policies implemented by US supported recovery in EM countries in 2009 and 2012, but also led to overheating in China, Brazil and some other EM countries in 2010 and 2011. Ho et al. (2014) and Dahlhaus et al. (2014) build Factor-Augmented Vector Autoregression (FAVAR) models to examine the effect of US QE on Chinese and Canadian economies, respectively. Ho et al. (2014) argue that shocks concerning US monetary policy do not have a significant effect on Chinese economy through trade channel. Instead, interest rate and capital flow channels are effective. Decline in US policy rate increases housing investment and capital flows to China but response of economic variables at zero lower bound is different. Dahlhaus et al. (2014) estimate that compared with no-QE scenario, QE increases US economic activity by 2.3 percent and Canadian GDP by 2.2 percent between 2008Q4 and 2013Q3. Positive effect on Canada occurs mainly through financial channel. Net import is reduced due to higher exchange rate through trade channel. According to model output, ten year sovereign interest rate decline by 50 bps in Canada and inflation rises 0.5 percent. Carrera et al. (2014), Barroso et al. (2015) and Carrera et al. (2015) apply structural VAR models to analyze the macroeconomic effects of QE implemented by Fed. According to Carrera et al. (2014), QE increases capital flows to Peru which results in appreciation of the currency. Credit increases, EMBI spread falls. Effect on GDP and inflation is positive and significant in the medium run. Barroso et al. (2015) build a SVAR model and use counterfactual investigation to study the international spillovers of QE in US on Brazilian economy. The study show that QE in US leads to increased economic activity, exchange rate appreciation, capital inflows, rising credit growth and

stock market. Capital flows is thought to be the most significant channel through which QE affects the economy. Carrera et al. (2015) analyze the effects of Fed's QE policies on Chile, Colombia, Mexico and Peru. According to model results, QE in US increases capital flows, leads to currency appreciation and credit growth. Financial variables such as credit respond more than output and prices as a result of a QE shock.

Below is a bref literature on international macroeconomic effects of QE policies.

Table 4: Literature Review on International Macroeconomic Effects of Quantitative Easing

Authors and Date	**Model and Country**	**Results**
Chen et al. (2012b)	GVECM Major Advanced and EM Countries	Impact of QE on emerging economies was stronger compared to advanced economies. Effect differs accross countries.
Carrera et al. (2014)	Structural VAR Peru	QE in US increase capital flows to Peru, currency appreciates, output, credit and prices rise.
Gambacorta et al. (2014)	PSVAR Canada, Japan, Sweden, Euro Area, Norway, Switzerland, UK and US	UMP shock increases economic activity and prices significantly and temporarily. Effects of QE do not differ across countries.
Ho et al. (2014)	FAVAR China	Changes in US monetary policy do not influence Chinese economy from trade channel. Interest rate and capital flow channels are effective.
Dahlhaus et al. (2014)	FAVAR Canada	QE in US lowers 10 year yield by 50 bps and increases Canadian output and inflation by 2.2 and 0.5 percent respectively compared with no-QE scenario.
Barroso et al. (2015)	SVAR, Counterfactual Analysis Brazil	QE in US increase output, capital inflows, credit, stock prices and exchange rate. Capital flows is the most important channel.
Carrera et al. (2015)	Structural VAR Chile, Colombia, Mexico, Peru	QE in US increases capital flows, leads to appreciation of currencies and credit growth in Latin American economies.
Morais et al. (2015)	Panel Regression Mexico	QE increases credit supply to Mexican firms and risk taking in EM countries.

Chen et al. (2016)	GVECM Major Advanced and EM Countries	Effect of QE on EM countries is larger than on advanced countries. US QE stimulated economic activity in EM countries in 2009 and 2012.

As we have mentioned, empirical literature concerning the effects of QE is generally positive. The studies on average show that QE lowers unemployment rate, interest rates and risk premium, improve confidence and financial conditions, increase asset prices and lending, boosts output and inflation. On the other hand, there are also less cited negative effects of QE such as procyclical capital flows, financial instability, loss of export competitiveness, asset bubbles and risk of sudden stops (Lavigne et al., 2014). IMF (2013a) and IMF (2013b) study the net effects of QE and find out that overall net impact is positive. That is positive effects of QE outweigh the negative effects. Especially early QE policies are found to be successful to restore intermediation and market functioning. A worse financial meltdown and economic disaster was avoided (IMF, 2013b).

Rajan (2015) argues that QE policies in advanced countries have negative spillovers on emerging markets' financial stability. As Ahmed and Zlade (2014), Carrera et al. (2015), Kiendrebeogo (2016) and Lim and Mohapatra (2016) show, QE policies create abundant amount of global liquidity and lead to capital flows into developing countries. The rise in capital flows lead to appreciation of EM currencies and may cause loss of competitiveness. Some EM policy makers even argued that the monetary tsunami created by QE caused currency war and started a different form of protectionism (Fratzscher et al., 2013). Increasing capital flows as a result of QE is also blamed for accumulation of huge amount of debt, asset bubbles, fast credit growth and overheating of EM economies. The data implies that private sector debt accumulated and credit growth surged in the post global recession of 2008-09 period but empirical evidence is not enough to tell that it is only due to QE. Chen et al. (2016) argue that QE policies in advanced countries led to overheating in China, Brazil and many others in 2010 and 2011. QE policies also increase risk taking, distort the pricing of risk and hence threaten financial stability. Low interest rates leads to search for return and agents become more eager to take risk. Accumulation of risks in the financial system threatens financial stability. QE policies increased the amount of fixed income securities in portfolios and

this boosts interest rate risk. QE not only leads to increased capital inflows to EM economies but also may cause disruptive capital outflows once monetary policy normalization starts. This was experienced when Ben Bernanke, governor of Fed at that time, told in May 2013 that Fed will soon start tapering of QE program. Announcement of a probable tapering led to capital outflows from EM economies and affected financial stability adversely.

QE policies are found to lower bond yield and stimulate output that creates breathing space and gives time both to private economic agents and governments to make necessary economic adjustments (IMF, 2013b). QE might be beneficial only if this room is used as an opportunity to make adjustments. However, sometimes QE policies are relied upon too much and low interest rates and easy financial conditions may lead to the postponement of necessary structural reforms and budget adjustments. For instance, QE led to the delay of the necessary structural reforms in many EM economies like Brazil, India and South Africa (Lachman, 2014). Easy financial conditions due to accommodative monetary policies in Euro Area slowed down structural reform process, implementation of banking union and bank balance sheet repairs. Empirical studies show that QE in US and Japan reduced interest rate and this delayed necessary fiscal consolidation. Low interest rates may also encourage households to relever or delay deleveraging process (Kozicki et al., 2011).

As another negative effect of QE, it might damage the functioning of securities markets. If the central bank becomes dominant in some segments of the market as a result of asset purchases, liquidity and trading among agents may dry up and this creates problems for price formation (Bernanke, 2012). This could lead to higher liquidity premium and affect transmission mechanism adversely. If debt stock is small, asset purchases may distort the yield curve. QE programs lower interest rates and might influence some particular investors like pension funds that have long term assets and liabilities (Kozicki et al., 2011).

LSAP may also harm the credibility and independence of the central bank. Especially, if public thinks that asset purchases are similar to printing money and monetary financing of government debt, markets may lose confidence to the central bank. This may boost risk premium and increase inflation expectations. In addition, asset purchases may

increase interest rate risk and risky asset purchases may cause capital losses. Central bank balance sheet expansion to the level that is seen as unsustainable by the market may reduce public confidence to central bank policies (Bernanke, 2012). As central bank balance sheet grows, it becomes harder to manage it. Exit from a large balance sheet makes monetary policy much more complicated (Kozicki et al., 2011).

Similar to spillover effects of QE policies to other economies, there are also spillback effects of QE. Both positive and negative effects of QE spillback to advanced economies. Since EM economies represent a large share of global economy, negative spillover effects of QE policies on EM economies may spillback to developed countries through trade and financial channels (Rajan, 2015). IMF (2014) finds that spillback effects from EM to advanced economies are relatively limited. According to the analysis, about one-third of spillovers to EM spillback to advanced economies. Spillback effects are larger in crisis periods and for countries with more trade exposure to EM economies such as Euro Area and Japan.

CHAPTER 2:
INTERNATIONAL SPILLOVERS OF THE FEDERAL RESERVE'S BOND PURCHASES

2.1. INTRODUCTION

With the recent global economic crisis of 2008-09, a new era of monetary policy has begun. As a response, advanced country central banks have first reduced short term policy rates and many of them reached zero lower bound. This has made the conventional interest rate tool of monetary policy almost useless and thus central banks started to implement unconventional monetary policies. These policies have been employed increasingly after the global crisis and have become the new normal. Among these unconventional monetary policies, especially quantitative easing (QE) policies have taken the center stage.

With the widespread implementation of QE policies, attention of both media and academics have increased about the impact of these policies on the economy and whether they are effective in stimulating the economy. Weakening growth prospects despite expansionary unconventional monetary policies in the last couple of years has further intensified the debate on whether the QE policies are effective. Most of the literature focuses on the impact of these policies on advanced countries and there are limited numbers of studies that analyze the impact on emerging market economies. This is one reason that motivates us to conduct a study about the effects of QE on EM economies. This study aims to investigate the impact of QE policies implemented by Federal Reserve on major EM economies and contributes to the literature. This study also contributes to the policy making of central banks. QE policies lead to important international spillovers and this in turn cause spillback effects on the countries that implement QE. Since EM economies constitute a large part of the world economy, QE policies that affect them will have crucial spillback effects. As a policy implication, this study puts forward that advanced country central banks should take spillover and spillback effects into consideration while designing their policies. As another

contribution, within the best of our knowledge, the study is first to employ PVAR model to examine the impacts of QE programs on major macroeconomic variables of EM economies.

Major findings of the empirical investigation are as follows. We find long run cointegration relationship between bond purchases in US and industrial production, inflation, government interest rates and real exchange rate in emerging market economies. Panel VAR model results imply that US bond purchases lower bond yield and inflation, support output and lead to exchange rate appreciation in EM economies. In addition, MBS purchases of Fed and unconventional monetary policies of ECB and BoJ are also found to have significant economic effects on EM economies.

The paper proceeds as follows. Section 2 consists of the related literature review. Section 3 explains our data set and methodology. Section 4 presents the model results and section 5 concludes.

2.2. LITERATURE REVIEW

The literature concerning the effects of UMP, and QE in particular, has grown rapidly especially after the global crisis. Many of the studies in this field are on the impact of QE policies on domestic financial and real variables. Among the studies about the financial market effects of QE, Bernanke et al. (2004), Kimura and Small (2006), Oda and Ueda (2007), Krishnamurthy and Jorgenson (2011), Gagnon et al. (2011), Joyce et al. (2011), Swanson (2011), D'Amico et al. (2012), Christensen and Rudebusch (2012), Hamilton and Wu (2012), D'Amico and King (2013), Bauer and Rudebusch (2014) and Szczerbowicz (2015) analyze the effects of QE on long term sovereign interest rates in the country that QE program is implemented and find out that QE was effective in reducing bond yield. Gilchrist and Zakrajšek (2013) analyze the effect of QE on corporate credit risk and Glick and Leduc (2013) on US exchange rate. Model results imply that QE policies decrease credit risk and lead to exchange rate depreciation. Hancock and Passmore (2011) and Stroebel and Taylor (2012) study the impact of MBS purchases on mortgage yield. Most of these studies employ event study and term structure models.

From the studies that analyze the impact of QE on domestic macro variables such as growth, inflation, unemployment rate and lending, Ugai (2007), Girardin and Moussa (2011), Schenkelberg and Watzka (2013), Bowman et al. (2015a) and Matsuki et al. (2015) investigate the impact of QE for Japan, Lenza et al. (2010) for Euro Area, Kapetanios et al. (2012) and Paseran and Smith (2016) for UK, Chung et al. (2012), Chen et al. (2012a), Gertler and Karadi (2013), Baumeister and Benati (2013) and Meinusch and Tillmann (2016) for US. Weale and Wieladek (2016) analyze the effect of QE policy in US and UK on output and inflation. Most of these studies use vector autoregression (VAR) type models and indicate that QE has a significant effect on macroeconomic indicators. General finding is that QE increases output and inflation and lowers unemployment rate.

There are relatively less studies about the international spillovers of QE policies. Among the papers that analyze international financial market effects of QE, Chen et al. (2012b), Glick and Leduc (2012), Fratzscher et al. (2013), Neely (2015), Georgiadis and Grab (2016) use event study methodology and find out that QE policies increased global equities and lowered government and corporate bond yields. QE led to exchange rate appreciation and easing of financial conditions in EM countries. On the other hand, Moore et al. (2013), Chen et al. (2014), Bowman et al. (2015b) use panel regression method to investigate the global financial market effect of QE programs and point to similar findings. Ahmet and Zlade (2014), Kiendrebeogo (2016) and Lim and Mohapatra (2016) examine the effects of QE on capital flows into EM economies by using panel regression and find empirically that QE boosts capital flows to EM economies. Duca et al. (2016) shows that QE policies increase corporate bond issuance worldwide. Tillmann (2016) builds a Qual VAR model to study the impact of QE on EM financial indicators and find that it has a strong impact on financial variables such as government interest rates, equities and exchange rates.

Most of the studies on the international macroeconomic spillovers of QE policies use VAR type models. Among these, Gambacorta et al. (2014) employ a panel structural VAR model for selected advanced countries and find out that unconventional monetary policies increase output and prices only temporarily. Dahlhaus et al. (2014) uses Factor-Augmented Vector Autoregression (FAVAR) model to investigate the effects of QE in

US on Canadian economy and conclude that QE in US boosts output and prices in Canada. Barroso et al. (2015) and Carrera et al. (2015) employ structural VAR models to analyze the effects of QE on Latin American countries. Model findings imply that QE in US increases output, lending, equity prices and capital flows to Latin America. Chen et al. (2016) study the impact of QE policy in US on both advanced and emerging market economies using global vector error correction model (GVECM). Model results imply that the impact of QE on emerging market economies is larger compared to advanced economies. QE policies both supported recovery in EM countries and also contributed to overheating.

As summarized above, although there are relatively more studies on domestic economic effects of QE policies, the number of studies on international spillovers of QE policies is limited. Especially, those about the impact of QE on developing countries are scarcer. Therefore, it is important and necessary to enrich the related literature. This study is a contribution to the existing literature.

2.3. DATA AND METHODOLOGY

In our study, we employ monthly data that covers the crisis and afterwards from 2008:1 to 2015:12 for 18 emerging market economies according to data availability. The countries included in the study are: China, Colombia, Brazil, Hungary, Czech Republic, India, Korea, Indonesia, Peru, Mexico, Philippines, Malaysia, Poland, Turkey, Singapore, South Africa, Taiwan and Thailand. Consumer price index and industrial production data are taken from WorldBank Global Economic Monitor database, real exchange rate from BIS database and data for quantitative easing and government bond yield are received from Bloomberg. All data are in logarithmic form and seasonally adjusted, except government bond yields that are used in levels.

This section advances as follows. First, panel unit root test is conducted to find out whether the analyzed variables are stationary. Second, we perform panel cointegration test to investigate the long-run relationship between the variables. Third, PVAR model is built to analyze the impact of QE in US on major economic variables in emerging market economies.

2.3.1. Unit Root Test

It has been the norm to start empirical studies in economics with unit root tests to analyze the stationarity of the variables. We use both Maddala and Wu (1999) and Pesaran (2007) panel unit root tests which are employed extensively in applied studies.

Maddala and Wu (1999) put forth a Fisher-type test:

$$P = -2\left(\sum_{i=1}^{N} lnp_i\right) \rightarrow \mathcal{X}^2(2n) \quad (1)$$

that combines the p-values of each cross-sectional unit.

The null and alternative hypotheses are given as:

$$H_0 = p_i = 1, i = 1,2,\ldots,N \quad (2)$$

against the alternatives

$$H_A = p_i < 1, i = 1,2,\ldots,N_1; p_i = 1, i = N_1 + 1, N_1 + 2, \ldots, N \quad (3)$$

Unit root tests are performed separately for every cross-section units. The Augmented Dickey-Fuller (ADF) regression is:

$$y_{i,t} = \alpha_i + p_i y_{i,t-1} + \sum_{j=1}^{p_i} \theta_{ij} \Delta y_{i,t-j} + \epsilon_{i,t} \quad t = 1,2,\ldots,T \quad (4)$$

This equation is applied separately for cross-section units and ADF t-statistic is calculated for individual series. P-value is used to compute test statistics and it is compared with the critical value (Baltagi, 2013).

Other than first generation Maddala and Wu (1999) test, we also employ second generation Pesaran (2007) unit root test that takes cross section dependence into account. Pesaran (2007) enlarges standart ADF regression with the cross section averages of lagged levels and first-differences of each series. It is called cross-

sectionally augmented Dickey–Fuller (CADF) test. The test is based on the AR(p) equation below augmented with the lagged and current values of $\mathbf{y_t}$.

$$y_{i,t} = \alpha_i + \gamma_i y_{i,t-1} + \cdots \ldots \delta_{i0}\bar{y}_t + \delta_{i1}\bar{y}_{t-1} + \cdots .. + \delta_{ip}\bar{y}_{t-p} + \epsilon_{i,t} \qquad (5)$$

In order to get the CIPS statistic, we transform the equation above into first difference and compute individual ADF statistics ($CADF_i$) for every cross section. The simple average of the $CADF_i$ statistics gives the CIPS statistics:

$$CIPS = \frac{\sum_{i=1}^{N} CADF_i}{N} \qquad (6)$$

For the cross sectionally invariant variable, that is quantitative easing, we employ Ng-Perron (2001) unit root test.

2.3.2. Cointegration Test

Then we investigate whether there is a cointegration relationship between the variables. For this purpose we perform the Durbin-Hausman co-integration test introduced by Westerlund (2008). One important reason we prefer this test over others is that it can be employed even when variables are integrated of different order.

Durbin-Hausman test has two dimensions: the panel dimension (DHp) and the group dimension (DHg). The assumption for the Durbin-Hausman panel (DHp) test is that the autoregressive parameter is the same for every cross-section. With this assumption, when null hypothesis is rejected, we say that there is cointegration for all cross-sections. The Durbin-Hausman group (DHg) test allows the autoregressive parameter to change across cross-sections under the alternative hypothesis. Therefore, the rejection of the null hypothesis shows that there is co-integration for some individuals.

In order to derive the calculation of Durbin-Hausman test, assume that we consider the panel data model below:

$$y_{it} = \alpha_i + \beta_i x_{it} + z_{it} \qquad (7)$$

$$x_{it} = \delta x_{it-1} + w_{it} \qquad (8)$$

We assume that z_{it} obeys the following set of equations.

$$z_{it} = \acute{\lambda}_i F_t + e_{it} \quad (9)$$

$$F_{jt} = \rho_j F_{jt-1} + u_{jt} \quad (10)$$

$$e_{it} = \phi_i e_{it-1} + v_{it} \quad (11)$$

Here F_t is a k-sized vector of common factors F_{jt}. λ_i is the conformable vector of factor loadings. In order to obtain Durbin-Hausman test, we take first diference of the equation (9). It becomes:

$$\Delta z_{it} = \acute{\lambda}_i \Delta F_t + \Delta e_{it} \quad (12)$$

Since Δz_{it} is not known, we can not estimate λ_i and ΔF_t directly. We get OLS estimates and implement principal components. We write it as:

$$\Delta \hat{z}_{it} = \Delta y_{it} - \hat{\beta}_i \Delta x_{it} \quad (13)$$

$\Delta \hat{\bar{F}}_t$ is principal component estimator of ΔF_t and can be acquired by calculating $\sqrt{T-1}$ times the eigenvector from the greatest eigenvalues of the $(T-1) \times (T-1)$ matrix $\Delta \hat{z} \Delta \hat{z}$. $\hat{\lambda}$ is calculated as :

$$\hat{\lambda} = \frac{\Delta \hat{\bar{F}} \Delta \hat{z}}{T-1} \quad (14)$$

Defactored and first differenced residuals can be calculated as:

$$\Delta \hat{e}_{it} = \Delta \hat{z}_{it} - \hat{\bar{\lambda}}_i \Delta \hat{\bar{F}}_t \quad (15)$$

$$\hat{e}_{it} = \sum_{j=2}^{t} \Delta \hat{e}_{ij} \quad (16)$$

The null hypothesis of no cointegration is asymptotically equal with testing whether $\phi_i = 1$ below:

$$\hat{e}_{it} = \phi_i \hat{e}_{it-1} + error \quad (17)$$

One other estimator that we need to form Durbin-Hausman test is the Kernal estimator and can be written as below:

$$\hat{\omega}_i^2 = \frac{1}{T-1}\sum_{j=M_i}^{M_i}\left(1-\frac{j}{M_i+1}\right)\sum_{t=j+1}^{T}\hat{u}_{it}\hat{u}_{it-j} \qquad (18)$$

The $\hat{u}_{it}$ is OLS residual found from equation (17). M_i is bandwidht parameter which shows the number of autocovariances of $\hat{u}_{it}$ to calculate the kernel estimator. $\hat{\omega}_i^2$ is consistent estimator of ω_i^2 and variance estimate is exptessed as $\hat{\sigma}_i^2$. We build two variance ratios $\hat{S}_i = \hat{\omega}_i^2/\hat{\sigma}_i^4$ and $\hat{S}_n = \hat{\omega}_n^2/(\hat{\sigma}_n^2)^2$, where

$$\hat{\omega}_n^2 = \frac{1}{n}\sum_{i=1}^{n}\hat{\omega}_i^2 \text{ and } \hat{\sigma}_n^2 = \frac{1}{n}\sum_{i=1}^{n}\hat{\sigma}_i^2 \qquad (19)$$

After all these calculation, Durbin-Hausman test statistic can be found as below:

$$DH_g = \sum_{i=1}^{n}\hat{S}_i\,(\tilde{\phi}_i - \hat{\phi}_i)^2\sum_{t=2}^{T}\hat{e}_{it-1} \qquad DH_p = \hat{S}_n = (\tilde{\phi} - \hat{\phi})^2\sum_{i=1}^{n}\sum_{t=2}^{T}\hat{e}_{it-1} \qquad (20)$$

DH_g shows group statistics and DH_p shows panel statictics.

2.3.3. Panel VAR Model

We employ panel vector autoregression (PVAR) model using a least squares dummy variable (LSDV) estimator of Cagala and Glogowsky (2014) to analyze the relationship between US Federal Reserve bond purchases and industrial production, CPI, government bond interest rate and real exchange rate in emerging market economies. Optimal lag order is chosen to be 1 by using Akaike, the Bayesian and the Hannan-Quinn information criterias. First order PVAR model can be written as:

$$Z_{i,t} = \alpha + \Gamma_t Z_{i,t-1} + \sum_{i=2}^{n}\alpha_i D_i + e_{it} \qquad (21)$$

Where i=1,2,…..,N (N=18), t=1,2,….., T (T=96) and Γ_t is the lag operator. $\mathrm{Z}_{\mathrm{i,t}}$ is a five variable vector consisting of QE, IP, CPI, IR and RER; in which QE is total Federal Reserve bond purchases, IP is industrial production, CPI is consumer price index, IR is 10 year government bond yield and RER is real exchange rate of selected EM economies. As for other variables, α is intercept, $\mathrm{D_i}$ is a dummy variable for the *i*th

country and e_{it} are idiosyncratic errors. If we include dummy variable for each country as well as an intercept, we fall into dummy variable trap. One of the individual dummies is dropped because we include a constant and use N-1 dummy variables. By adding dummy for each country, we control for unobserved heterogeneity. Each dummy shows the impact specific to the country.

When N is large, LSDV estimator is not practical due to the need of large number of dummy variables. We prefer LSDV estimator over Generalized Method of Moments (GMM) since the properties of GMM estimators are valid when N is large and GMM estimators give biased and inconsistent results in panels with small N (Bruno, 2005). Since we have a time series panel with relatively small N and large T ($T > N$), it is better to use LSDV estimator. This estimator is consistent and the bias is negligible with large macro panels such as we have.

One important issue and question is whether we need stationary variables in the VAR system. Sims (1980) and Sims et al. (1990) claim that we should not take the difference of the variables even when there is unit root. They argue that the aim of the VAR model is to find the relationships between the variables, not to estimate the parameters. Sims et al. (1990) put forward that when cointegration exists between variables, VAR model can be run in levels. Due to these influencial studies, we estimate our model in levels. Estimation in level form is found to be stable.

The Cholesky ordering in our VAR system is such that the variables that appear early in the system are relatively more exogenous than the following. These variables influence the following variables both contemporaneously and with a lag. On the other hand, the variables that appear later in the system impact the former variables with a lag. Quantitative easing variable comes first in our specification since it is relatively exogenous for EM countries. Domestic factors are thought to lag behind global factors in spillover analysis. Industrial production and inflation appear earlier than government bond yield and real exchange rate because the former variables impact the latter ones contemporaneously while the latter ones influence the former variables only with a lag. Bond yield and exchange rate are the most endogenous variables in our system. Our cholesky ordering is in line with the the literature and we order output and prices before

financial market indicators similar with Souza and Zaghini (2008), Belke et al. (2010) and Brana et al. (2012).

Once the coefficients estimates of the model are obtained, we calculate the impulse responses to analyze the effects of Federal Reserve bond purchases on major macroeconomic variables of EM economies. Impulse responses show the response of an endogenous variable to a shock in another variable.

2.4. RESULTS

Unit root test results present mixed evidence about the stationarity of the variables. Pesaran's (2007) CIPS test and Maddala and Wu (1999) test results imply that some variables are I(0) while the others are I(1). According to Ng-Perron (2001) unit root test, quantitative easing variable is non-stationary; it is I(1). Durbin-Hausman test results imply that there exists co-integration among variables. There is a long run relationship between bond purchases in US and major macroeconomic variables in EM countries. Results of the tests are presented below.

Table 5. Panel Unit Root Test Results

	CIPS Tests				
	Intercept	Intercept + trend		Intercept	Intercept + trend
IP	-4.061***	-4.471***	**ΔIP**	-20.560***	-20.557***
CPI	2.569	1.631	**ΔCPI**	-16.972***	-16.759***
RER	0.659	-1.692**	**ΔRER**	-20.055***	-19.756***
IR	-0.049	0.011	**ΔIR**	-18.846***	-18.360***
	Maddala and Wu Test				
	Intercept	Intercept + trend		Intercept	Intercept + trend
IP	28.449	85.906***	**ΔIP**	938.75***	701.59***
CPI	41.245	51.822**	**ΔCPI**	486.31***	448.72***
RER	49.355	71.994***	**ΔRER**	696.26***	605.74***
IR	52.616	54.174**	**ΔIR**	790.23***	689.24***

*, **, *** show significance level at 10%, 5% and 1%, respectively. For CIPS tests the null hypothesis assumes non-stationarity.

Table 6. Ng-Peron Unit Root Test Results

Series	MZa	MZt	MSB	MPT
QE	-0.538	-0.298	0.554	19.664
ΔQE	-17.963***	-2.996***	0.167***	1.364***

*, **, *** show significance level of at 10%, 5% and 1%, respectively

Table 7. Westerlund Durbin-Hausman Test Results

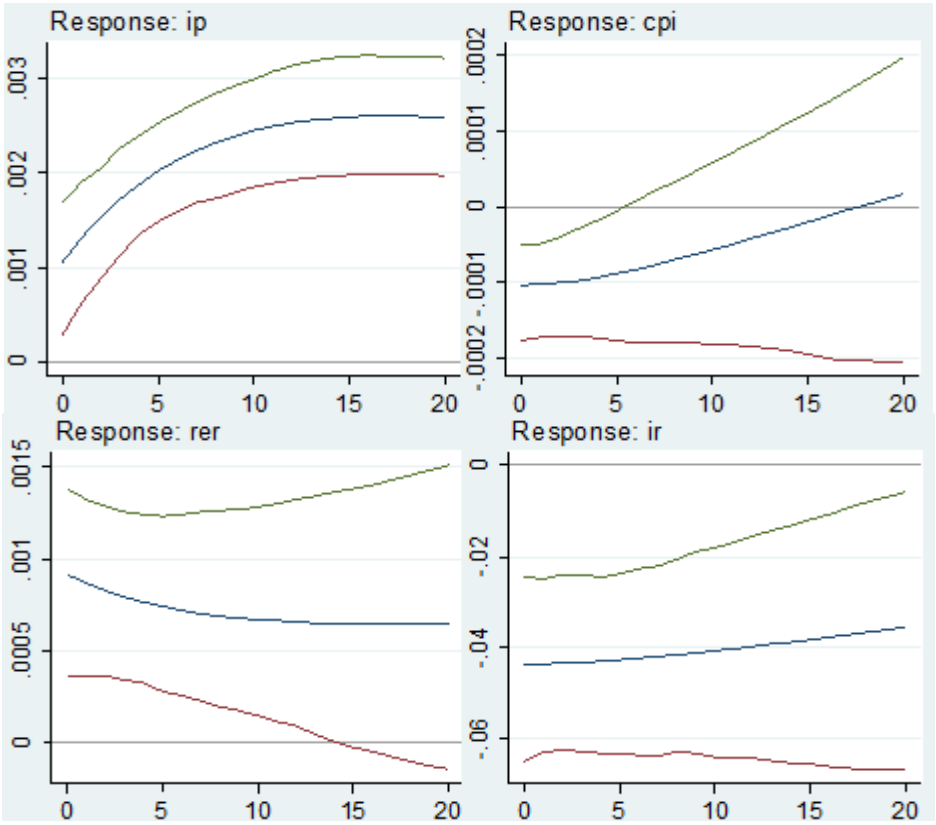
Westerlund (2008) Durbin-h Test	
	Value
DHg	-2.165**
DHp	-2.915***

*, **, *** show that test statistics are significant at the 10%, 5% and 1%, respectively.

After testing for stationarity and cointegration, we estimate panel VAR model to investigate short run dynamics. Figure 4 demonstrates impulse responses derived from the model. Each column of the figure gives the impulse responses (over 20 months) to a one-standard-deviation positive US bond purchase shock. The responding variables are named at the top of row/chart. The upper (green) and lower (red) lines plotted in each graph are one-standard-error bands, while the line in the middle (blue) corresponds to the mean response.

Impulse response results show that a positive shock to US bond purchases lowers government bond interest rates in EM countries and lead to appreciation of exchange rate in the short run. This is mainly due to surging capital flows into EM countries through transmission channels such as portfolio balance and signalling. Results imply that the impact of bond purchases on industrial production is positive and permanent. The peak effect of QE on industrial production occurs in about 1 year. Impulse responses indicate that bond purchases have a negative influence on inflation in the short run, but this effect disappears over time. It seems that opposite forces of inflation lowering impact of exchange rate appreciation and inflation increasing effect of booming economic activity balance each other over time. Results are broadly similar to previous papers such as Chen et al. (2012b), Bowman et al. (2015b), Barroso et al. (2015), Carrera et al. (2015), Chen et al. (2016), Georgiadis and Grab (2016) and Tilmann (2016) which show that QE lowers government bond interest rates, lead to exchange rate appreciation and support economic activity in EM economies.

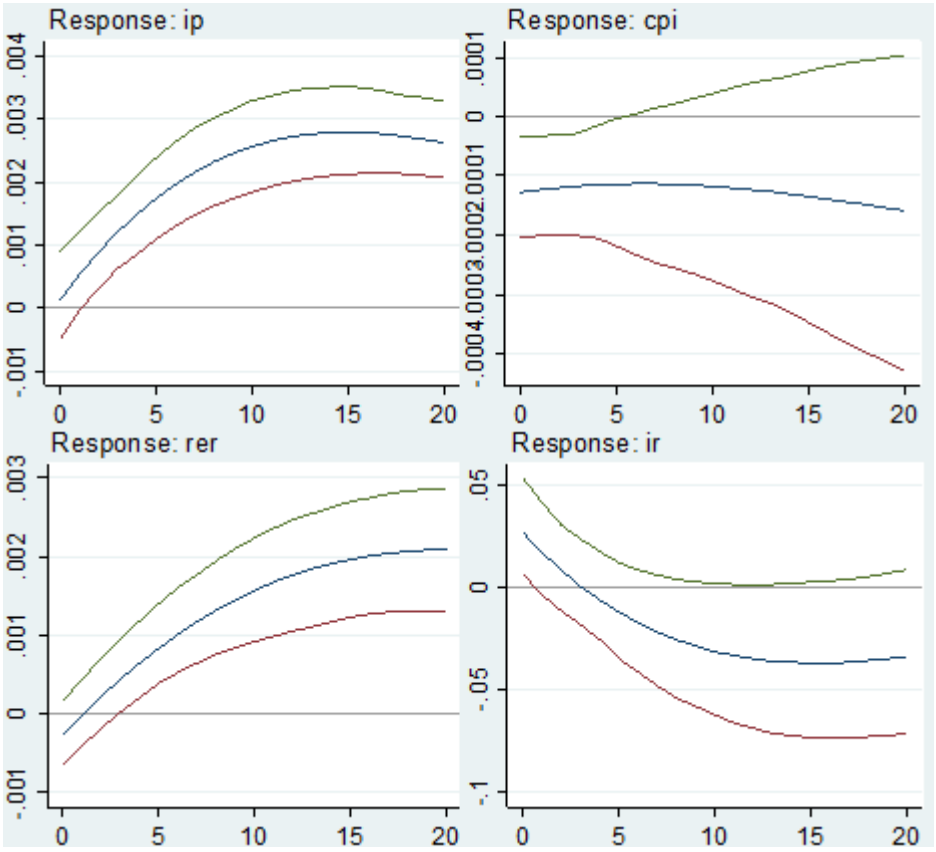
Figure 4. Impulse-Response Functions to a Positive US Bond Purchase Shock



Note: Impulse-responses are computed from PVAR model. 95% confidence bounds are based on Monte Carlo simulation.

We also analyze the impact of mortgage backed securities (MBS) purchases of Federal Reserve (Fed) on major economic indicators of EM countries. According to impulse responses shown in figure 5, different from government bond purchases, MBS purchases do not have a significant effect on government interest rates. The results concerning real exchange rate, industrial production and inflation are very similar to bond purchases.

Figure 5. Impulse-Response Functions to a Positive MBS Purchase Shock

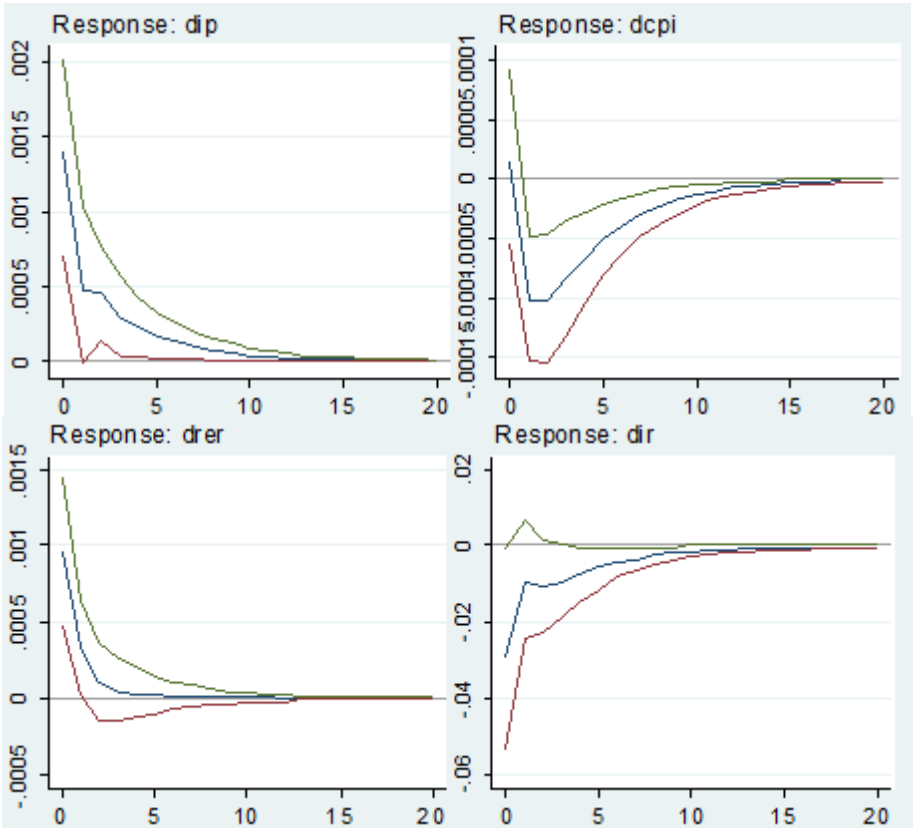


Note: Impulse-responses are computed from PVAR model. 95% confidence bounds are based on Monte Carlo simulation.

UMP of other leading central banks such as ECB and BoJ also have crucial effects on emerging market economies. Hence, we investigate the impact of these policies in our PVAR setting. Model results show that unconventional monetary policies of ECB and BoJ that lead to balance sheet expansion lower government bond yield and inflation in EM economies. No significant effect is found on industrial production.

We implement robustness analysis using different specifications. First, we run the model with more lags (2 to 4) and find very similar results. Second, instead of running the model in levels we use first differences of the variables. Impulse response in figure 6 below provides the results. The same results apply and we find that bond purchases by Federal Reserve lower government interest rate and inflation, increase industrial production and lead to real exchange rate appreciation.

Figure 6. Impulse-Response Functions to a Positive US Bond Purchase Shock in First Difference Representation



Note: Impulse-responses are computed from PVAR model. 95% confidence bounds are based on Monte Carlo simulation.

2.5. CONCLUSION

Unconventional monetary policies performed by leading central banks after global economic crisis period have both domestic and international economic effects. Due to the widespread use of these policies, it has been more and more important to analyze the spillovers they create. So far, the studies on international spillovers of these policies are relatively rare. This study aims to contribute to the existing literature by investigating the effects of Federal Reserve bond purchases on major economic indicators of emerging market economies. Results show that there exists both short and long run relation between Federal Reserve bond purchases and EM macroeconomic variables. In the short run, bond purchases lower government bond interest rates and inflation, cause real exchange rate appreciation and support economic activity. In addition, there is a

long run cointegration relationship between bond purchases and EM macro indicators. We also find that MBS purchases by Fed and unconventional monetary policies of ECB and BoJ also have significant economic effects on EM countries. The results are robust to alternative specifications.

The results of this paper are similar with the literature and give important lessons to central bankers. Central bankers in advanced countries should be increasingly aware that their policies create important international spillovers to emerging market economies. Since EM economies represent a considerable share in the world economy, spillovers might also create spillbacks to advanced countries. Moreover, central banks in EM countries should monitor the policies of major advanced country central banks closely and take into consideration their policy decisions and future expectations when conducting monetary policy.

CHAPTER 3:
IMPACT OF QUANTITATIVE EASING ON GOVERNMENT BOND YIELDS: EVIDENCE FROM A HETEROGENEOUS PANEL OF EMERGING MARKET COUNTRIES

3.1. INTRODUCTION

In order to tackle the 2008-09 economic crisis, that was the worst since the Great Depression, Federal Reserve (Fed) first employed the conventional interest rate tool of monetary policy and lowered short term interest rate till zero lower bound (ZLB). Upon reaching ZLB, Fed started to implement unconventional monetary policies (UMP). In particular, three rounds of QE policies were conducted which included mainly the purchases of government securities and MBS. As a result of these asset purchases, monetary base and balance sheet of Fed increased about fivefold. Other leading central banks such as Bank of Japan (BoJ), European Central Bank (ECB) and Bank of England (BoE) also followed Fed to carry out UMP after the global crisis and there has been a huge explosion of global liquidity. Primary target of these policies was to reduce long term bond yields and support output growth through increased consumption and investment.

Due to low growth and inflation outlook and policy rates at zero lower bound for many advanced economies, unconventional monetary policies have been increasingly used in the post-crisis period and have become the new normal. Hence, it has been more and more important to understand the transmission mechanism of UMP and spillover impact of these policies both on domestic and international economic indicators. This is one crucial reason that motivates us to conduct an empirical study on the spillovers of QE policies.

There are several studies concerning the effects of UMP on major economic variables of the country these policies are implemented. Hovewer, studies about the international spillovers of these policies are relatively rare. More research is needed to better

understand international spillover effects of UMP and this is another crucial motivation of the study.

Despite the growing size (from $1.3 trillion in 2000 to $7 trillion in 2015) and thus importance of emerging market (EM) domestic government debt, studies about the determinants of local EM government bond yield are scarce. We contribute to the literature both by modelling local government bond yield in EM economies and analyzing the effect of QE on interest rates. While other studies in the literature assume homogeneous slope coefficients and cross section independence, we use Augmented Mean Group (AMG) estimator that allows for slope heterogeneity and cross section dependence. Since almost all of the real world data contain cross section dependence and slope heterogeneity, this method provide more consistent and unbiased results compared to others.

The empirical analysis shows that both country specific variables such as central bank policy rate, inflation rate and budget deficit and global variables such as US bond yield and QE variables are significant determinants of local sovereign interest rates in EM countries. Model results indicate that both announcements regarding QE programs and actual bond purchases lower EM government bond yields. The effect of mortgage backed security (MBS) purchases of Fed on bond yields is found to be insignificant. Results are robust to several alternative specifications.

The remainder of this study is organized as follows: In section 2 we provide the related literature. Section 3 contains our data set and empirical methodology. Section 4 reports the model results, section 5 includes robustness analysis and section 6 concludes.

3.2. LITERATURE REVIEW

The literature regarding the impact of QE policies have grown rapidly especially with the widespread implementation of these policies after the global economic and financial crisis in 2008. There are various studies about the impact of these policies both on financial and real sector variables. Since long term bond yields have a considerable impact in monetary transmission mechanism and lowering bond yield is the major target

of QE policies, many of the studies in the related literature concentrate on the effects of QE on long term bond yields.

There are several studies concerning the impact of QE both on domestic and international sovereign bond yield. Hovewer, those on domestic interest rates are more common. Among the studies that analyze the effects QE policies on long term bond yields in US, Modigliani and Sutch (1966) is one of the oldest. They analyze the influence of Operation Twist implemented in 1961 on long term US government bond yield and find no significant impact. The related literature exploded especially in the post-global crisis period. Doh (2010) uses preffered habitat model and estimate that QE1 in US lowers ten year bond interest rate by 39 bps. Event study methodology is very common in the analysis of the effects of QE on long term bond yield. Among studies using that method, Gagnon et al. (2011) find the effect of QE1 on 10 year government bond interest rate as 91 bps. Krishnamurthy and Jorgenson (2011) investigate the impact of QE1 and QE2 on government bond yield and estimate the effects as 107 and 30 bps, respectively. Meaning and Zhu (2011) estimate the same impact as 80 and 21 bps. Swanson (2011) evaluates the impact of Operation Twist implemented in 1961 and find the impact on long term bond yields as 15 bps. Thornton (2012) argue that the fall of long term bond yields is due to signalling channel, not portfolio balance channel. D'Amico et al. (2012), Hamilton and Wu (2012), Christensen and Rudebusch (2012), Li and Wei (2013) and Bauer and Rudebusch (2014) employ term structure models to analyze the impact of QE on long term US government bond yield. Findings of D'Amico et al. (2012) imply that treasury bond purchases under QE1 and QE2 reduce long term bond yield by 35 and 45 bps, respectively. Christensen and Rudebusch (2012) put forward that QE lowers US bond yields due to signalling channel. Analysis of Hamilton and Wu (2012) show that buying $400 billion worth of long-term government bond reduces yield by 13 bps. Li and Wei (2013) find out the impacts of QE1, QE2 and Operation Twist as 60, 19 and 19 bps, respectively. Bauer and Rudebusch (2014) find that signalling effect is large for QE1 but weak for QE2 and Operation Twist. Wright (2012) applies a Structural Vector Autoregression (SVAR) model and find out that asset purchases in US lower government bond yield but the effect dies out in a few months. D'Amico and King (2013) and Kandrac and Schlusche (2013) investigate stock and flow impact of QE programs on government interest rates

using panel regression methodology. D'Amico and King (2013) find stock effect of bond purchases under QE1 as 30 bps on long term bond yields and flow effects as 3.5 bps on the day of the purchase. Model results of Kandrac and Schlusche (2013) show that flow effects are present only in early programs and their magnitude is small.

Looking at the studies that analyze the impact of QE in UK, Meier (2009) estimates the impact of QE announcement in March 2009 on government interest rate to be between 40 and 100 bps. Joyce et al. (2011) find that QE program reduce long term bond yield by 100 bps using several methods such as event study, portfolio balance and VAR models. Bridges and Thomas (2012) and Breedon et al. (2012) find out that QE lowers long term bond yield in UK by 150 and 50 bps, respectively. According to Joyce and Tong (2012), effect of QE announcement on bond yield is up to 120 bps. Christensen and Rudebusch (2012) use term structure model and argue that lower yields in UK as a result of QE are due to the fall in term premiums. Among studies that investigate the effects of asset purchases in Euro Area, Pattipeilohy et al. (2013) find the effect of Securities Market Programme (SMP) as temporary. Ghysels et. al. (2014) argue that SMP has a significant lowering impact on bond yields. Szczerbowicz (2015) find out by using event study methodology that ECB bond purchases reduced sovereign spreads and refinancing cost of banks. Eser and Schwaab (2016) analyze the effects of SMP on 5 year government interest rate and find that the estimates vary from -1 to -2 bps for Italy to -17 to -21 bps for Greece per €1 billion bond purchase. Among the studies concerning the impact of QE in Japan, Bernanke et al. (2004) estimate that QE in Japan lowers bond yield by 50 bps. Kimura and Small (2006) argue that portfolio balance effect of QE is significant while Oda and Ueda (2007) claim that portfolio rebalancing effect is insignificant and signalling effect is significant. Findings of Ugai (2007) also imply that signalling effect is significant.

Studies related to international spillover impact of QE policies on long term government interest rates are relatively rare. Among them that employ event study methodology, Chen et al. (2012) analyze spillover effects of QE implemented in US on emerging Asian economies. Results show that QE1 and QE2 lower 10 year sovereign bond yields of emerging Asian economies by 80 and 9 bps on average, respectively. Glick and Leduc (2012) analyze the announcement effects of asset purchases in US and UK and

estimate that the reduction in 10 year bond yields due to QE1 and QE2 in US varies from 23 bps in Japan to 99 bps in US. Similarly, Neely (2015) also investigates the announcement effects of QE1 implemented in US on 10 year bond yields of major advanced economies. According to the model results, the impact ranges from 18 bps for Japan to 100 bps for US. Georgiadis and Gräb (2016) study announcement impact of ECB's QE program on global financial markets. Results imply that the announcement had a limited effect on bond prices and the effect is significant only for Euro Area, Japan and emerging Asia. From the studies that employ panel regression model, Moore et al. (2013) find the effect of QE1 and QE2 on EM sovereign interest rates as 17 and 2 bps on average, respectively. MacDonald (2017) finds that QE programs in US lowered bond interest rates in EM economies and heterogeneous effect depends on the degree of economic integration. Bauer and Neely (2014) employ dynamic term structure model to study international transmission channels of US UMP. They show that signalling effect is strong for US and Canada and portfolio balance effect dominates for Germany and Australia. Bowman et al. (2015) employs a VAR model to analyze announcement effects of US UMP and find that it reduces bond yields in EM economies. Tillmann (2016) proposes a Qual VAR model to find out the impact of US QE on EM financial indicators and find significant impact on exchange rate, bond and equity prices. The influence of QE1 on bond yields is limited compared to QE2 and QE3.

Since we model domestic government bond interest rates of EM economies in this study, it is useful to provide a brief literature about the determinants of sovereign interest rates. Earlier literature regarding the pricing of government bonds in EM countries focus on the determinants of spreads relative to some ‘‘safe’’ bond, most often US bonds. These are the bonds denominated in foreign currency. Edwards (1984), Uribe and Yue (2006), Baldacci et al. (2008), Dailemi et al. (2008), Ciarlone et al. (2009), Ebner (2009), Hilscher and Nosbusch (2010), Comelli (2012), Martinez et al. (2013) and Csonto (2014) are among some of these studies. These studies in general find out that both country macroeconomic fundamentals and global factors such as ample liquidity and world interest rates affect bond spreads in EM economies.

Even though there are several studies about the determinants of government bond spreads in EM economies, there is a scarcity of work on the drivers of domestically

issued bond yields despite their growing importance. Peiris (2010) performs a panel study of 10 EM countries and estimate the effect of 1 percent increase in budget deficit to GDP ratio on bond yields as 20 bps. Model results show that other significant determinants of bond yields include policy interest rate, foreign ownership in bond market and inflationary expectations. Baldacci and Kumar (2010) use data from 31 advanced and developing countries for 1980–2008 period. They show that the rise in central bank policy rate, higher budget deficit and debt stock increase sovereign bond yield. Jaramillo and Weber (2013) use panel threshold model to analyze the determinants of domestic government interest rates. Results imply that when global risk aversion is low country specific fundamentals such as inflation and growth are the most important drivers of bond yield. On the other hand, when risk aversion is high, fiscal deficit and government debt take the center stage. Miyajima et al. (2015) show that central bank policy rate, output growth and fiscal balance are leading determinants of local currency bond yields in EM economies.

3.3. METHODOLOGY AND DATA

Panel time series analysis has become more and more popular in the last two decades due to the availability of large macro datasets. Early literature on panel data ignored cross section dependence of errors and assumed homogenous slopes. Studies in this tradition typically used fixed and random effect estimators that perform instrumental variable tecnique and the generalized methods of moments (GMM) estimators of Arellano and Bond (1991) and Arellano and Bover (1995). These models only allow intercept parameter to change among countries. This heterogeneity is very limited and is not very realistic. One important contribution has been the introduction of first generation panel estimators which allow heterogeneity in the slopes such as Mean Group (Pesaran and Smith, 1995), Pooled Mean Group (Pesaran et al. 1999) and Fully Modified OLS (Pedroni, 2000). Although these estimators allow for heterogeneity, they are inconsistent when cross sectional dependence is present (Neal, 2015). Another contribution to the literature has been the development of estimators which allow for both heterogeneity and cross section dependence. These include Common Correlated

Effects (Pesaran, 2006) and Augmented Mean Group (Eberhardt and Bond, 2009; Eberhardt and Teal, 2010) estimators.

In our study, we use monthly data that covers the period from 2006:1 to 2015:12 for 17 emerging market economies according to data availability. The countries we use in the study are: China, Brazil, Hungary, Colombia, Czech Republic, Indonesia, Mexico, Malaysia, Turkey, South Africa, Korea, Philippines, Poland, Thailand, India, Singapore and Taiwan. Data for industrial production and consumer price index are taken from WorldBank Global Economic Monitor database. Data for budget deficit, debt stock and current account deficit are obtained from World Economic Outlook Database. Domestic government bond yield, central bank interest rate, VIX Index, ten year US sovereign interest rate and quantitative easing variables are received from Bloomberg.

This section proceeds in four steps. First, we test whether cross sectional dependence is present. Second, panel unit root test is conducted to detect the nature of stationarity of our variables. Third, we test for slope heterogeneity. Fourth, Augmented Mean Group (AMG) estimator is employed to model long term domestic sovereign interest rate in EM countries and analyze the effect of QE on long term government interest rates.

3.3.1. Cross Section Dependence

Early studies on panel data econometrics assumed cross section independence and first generation estimators, cointegration and panel unit root tests have been used extensively. Hovewer, cross section dependence has become more and more common due to strong interdependencies between countries due to globalization and common shocks such as economic crises and oil shocks. First generation estimators, panel unit root and cointegration tests that assume cross-sectional independence are inadequate and may lead to significant size distortions, misleading inference and inconsistent estimators in case cross-section dependence exists (Chudik and Pesaran, 2013). Therefore, we need to test whether cross section dependence exists and use second generation tests and estimators in case there is cross section dependence.

There are a number of tests developed for cross section dependence and we use two of them that are common in the literature. First one is Pesaran's (2004) CD test. CD test

can be used when cross sectional dimension (N) is larger than time series dimension (T). Pesaran (2004) argue that this test is robust when structural breaks and unit roots exist. The CD test statistic put forward by Pesaran (2004) is calculated as follows:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right) \sim N(0,1) \qquad i,j = 1,2,3,\dots\dots,N \qquad (1)$$

where $\hat{\rho}_{ij}$ is the sample estimate of the pairwise correlation of the residuals obtained by OLS. Second cross section dependence test we employ is Bias Adjusted LM test developed by Pesaran et al. (2008). It is applicable in case number of cross section units (N) is small compared to the time dimension (T) and can be employed even when CD test is inconsistent. The test is calculated as:

$$LM^{*} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\hat{\rho}_{ij}\right)\frac{(T-k)\hat{\rho}_{ij}^{2}-E(T-k)\hat{\rho}_{ij}^{2}}{Var(T-k)\hat{\rho}_{ij}^{2}} \qquad (2)$$

We report both of these test statistics but since we have a time series panel (N=17, T=120), we prefer to use Bias Adjusted LM test. Results of the CD and Bias Adjusted LM tests are provided in table 8.

Table 8. Cross-Section Dependence Test Results

Variable	**CD Test**	**Bias Adjusted LM Test**
GIR	42.94***	896.3***
CBI	13.81***	888.1***
INF	13.24***	869.4***
IND	24.69***	872.5***
CAD	14.64***	899.8***
BDEF	57.72***	902.0***
DEBT	36.15***	901.0***

*, **, *** show significance level at the 10%, 5% and 1%. Null hypothesis is no cross-sectional dependence for both tests. GIR denotes domestic government bond yield, CBI is central bank policy rate, INF is year-on-year headline inflation rate, IND is year-on-year growth of industrial production, CAD is current account deficit to GDP, BDEF is budget deficit to GDP and DEBT implies gross debt stock to GDP ratio.

According to Table 8, both tests reject the null hypothesis at 1 percent for all series under consideration. Both tests imply that cross section dependence exists. Therefore, we have to use second generation unit root tests and estimator which allows cross section dependence.

3.3.2. Unit Root test

Testing for unit roots has been common practice in empirical studies both when time series and panel data is used. Tests for panel data are relatively more recent and several tests have been proposed in the last two decades. As cross section dependence exists in the data, we employ second generation CIPS (Pesaran, 2007) panel unit root test which allows cross section dependence and is used extensively in the empirical literature.

In this unit root test, ADF regression is augmented with the lag of cross sectional mean and its first difference. The equation for the test is provided below.

$$y_{i,t} = \alpha_i + \gamma_i y_{i,t-1} + \cdots \ldots \delta_{i0}\bar{y}_t + \delta_{i1}\bar{y}_{t-1} + \cdots .. + \delta_{ip}\bar{y}_{t-p} + \epsilon_{i,t} \qquad (3)$$

In order to get CIPS statistic, equation 3 is converted to first difference and individual ADF statistics ($CADF_i$) are calculated for cross sections. We obtain CIPS statistic as:

$$CIPS = \frac{\sum_{i=1}^{N} CADF_i}{N} \qquad (4)$$

The null hypothesis shows the unit root and critical values are provided by Pesaran (2007). Table 9 shows the results of the test. According to CIPS test results, government interest rate, central bank policy rate, inflation rate and growth of industrial production are stationary in their level form[3]. Budget deficit, public debt stock and current account deficit as percent of GDP are found to be I(1).

Table 9. Panel Unit Root Test Results

	CIPS Test				
	Intercept	Intercept + trend	Intercept		Intercept + trend
GIR	-2.047**	-0.929	**ΔGIR**	-19.43***	-19.19***
CBI	-1.585*	1.864	**ΔCBI**	-16.71***	-16.18***
INF	-2.905***	-1.104	**ΔINF**	-19.15***	-18.86***
IND	-7.459***	-7.866***	**ΔIND**	-20.16***	-20.17***
BDEF	-0.027	-3.018***	**ΔBDEF**	110.8***	69.7***
DEBT	-0.507	-0.237	**ΔDEBT**	-1.895**	-0.568
CAD	0.638	-0.481	**ΔCAD**	-4.173***	-1.997**

*, **, *** show significance at 10%, 5% and 1%.

[3] Since the variables do not have a trend, we take into consideration unit root test results with only intercept.

Hovewer, since the data period we cover includes the global economic crisis of 2008-09, structural breaks are highly probable. Although we normally expect budget deficit and current account to GDP ratios to be I(0), we find them I(1). Therefore, we use panel unit root KPSS test (PANKPSS) introduced by Carrion-i-Silvestre et al. (2005) which allows both cross section dependence and structural breaks. Carrion-i-Silvestre et al. (2005) employ the model below:

$$y_{it} = \beta_{it} + \delta_i t + u_{it} \qquad i = 1,2,\dots,N \quad t = 1,2,\dots,T \qquad (5)$$

$$\beta_{it} = \sum_{k=1}^{m_i} \varphi_{i,k} D(T_{b,k}^i)_t + \sum_{k=1}^{m_i} \theta_{i,k} DU_{i,k,t} + \beta_{i,t-1} + \varepsilon_{i,t} \qquad (6)$$

Where $D(T_{b,k}^i)_t$=1 for $t = T_{b,k}^i$+1, 0 elsewhere and $DU_{i,k,t}$=1 for $t > T_{b,k}^i$, 0 elsewhere. $T_{b,k}^i$ implies the kth break for the ith cross section T. Null hypothesis is stationarity of the variable. Results provided in table 10 imply that budget deficit and current account deficit to GDP ratio I(0).

Table 10. Panel KPSS Test Results

Variable	Test Statistics	P Value
BDEF (hom)	-1.52	0.936
BDEF (het)	-0.89	0.814
CAD (hom)	-1.61	0.946
CAD (het)	-0.11	0.543
DEBT (hom)	1.49	0.067
DEBT (het)	1.63	0.051

Notes: Bootstrap critical values used since cross section dependence exists. Hom and het in brackets refer to test statistics under homogeneity and heterogeneity of long run variance, respectively.

We employ Ng-Perron (2001) unit root test to investigate whether cross-sectionally invariant variables are stationary. The results are presented in Table 11 and show that VIX index is stationary while other variables are I(1). Therefore, we use first difference for these variables.

Table 11. Ng-Perron Unit Root Test Results

Variable	MZa	MZt	MSB	MPT
VIX	-9.80**	-2.21**	0.23**	2.52**
USIR	1.74	-0.77	0.44	11.73
ΔUSIR	-50.33***	-5.01***	0.10***	0.50***
BOND	-6.61	-1.81	0.27	13.80
ΔBOND	-17.34***	-2.94***	0.17***	1.42***
BS	-9.90	-2.23	0.22	9.20
ΔBS (BF)	-22.60***	-3.36***	0.15***	1.09***

*, **, *** show significance level at 10%, 5% and 1%. VIX is VIX index, USIR is US 10 year sovereign interest rate, BOND is total amount of bonds held by Federal Reserve, BS is the ratio of bond stock held by Fed to total amount of bonds, BF is the change in BS in the related period.

3.3.3. Slope Homogeneity Test

Many empirical studies that use panel data assume homogeneous slope and only unit-specific intercepts show heterogeneity. Hovewer, as Pesaran and Smith (1995) and many others point out, the assumption of slope homogeneity is usually inappropriate. Monte Carlo studies imply that homogeneous slope estimators can be seriously biased and produce inconsistent and misleading results when slope heterogeneity is present (Chudik and Pesaran, 2015). Therefore, it is vital to test for slope homogeneity and employ estimators that are robust to slope heterogeneity in case slope homogeneity is rejected.

In order to test slope homogeneity, we use the test introduced by Pesaran and Yamagata (2008) that allows cross sectional dependence. Pesaran and Yamagata (2008) slope homogeneity test uses the test statistics below:

$$\hat{S} = \sum_{i=1}^{N} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right)' \frac{X'X}{\hat{\sigma}_i^2} \left(\hat{\beta}_i - \hat{\beta}_{WFE}\right) \qquad (7)$$

$$\tilde{\Delta} = N^{\frac{1}{2}} (2k)^{\frac{-1}{2}} \left(N^{-1}\hat{S} - k\right) \qquad (8)$$

$$\tilde{\Delta} = N^{\frac{1}{2}} (2k)^{\frac{-1}{2}} \left(N^{-1}\tilde{S} - k\right) \qquad (9)$$

The mean and variance bias adjusted version of $\tilde{\Delta}$ and $\tilde{\Delta}$ are provided below:

$$\tilde{\Delta}_{adj} = N^{\frac{1}{2}} \left(Var(\hat{z}_{iT})\right)^{\frac{-1}{2}} \left(N^{-1}\hat{S} - k - E(\hat{z}_{iT})\right) \qquad (10)$$

$$\tilde{\Delta}_{adj} = N^{\frac{1}{2}}(Var(\tilde{z}_{iT}))^{\frac{-1}{2}}\left(N^{-1}\tilde{S} - k - E(\tilde{z}_{iT})\right) \qquad (11)$$

Where $\hat{\beta}_i$ is obtained by estimation of equation 7 without common factor (f_t) in the form of deviations from mean for every cross section. $\hat{\beta}_{WFE}$ refers to weighted fixed effects estimators and weights are formed using $\hat{\sigma}_i$. $\overline{X}$ is the matrix consisting of explanatory variables in the form of deviations from mean. Table 12 provides the results of the slope homogeneity test. Since test statistics are larger than critical values, null hypothesis of slope homogeneity is rejected.

Table 12. Slope Homogeneity Test Results

	Value
$\boldsymbol{Swamy\ \tilde{S}}$	1,149.6***
$\tilde{\boldsymbol{\Delta}}$	899.1***
$\tilde{\boldsymbol{\Delta}}_{\boldsymbol{adj}}$	947.3***
$\tilde{\boldsymbol{\Delta}}$	57.0***
$\tilde{\boldsymbol{\Delta}}_{\boldsymbol{adj}}$	0.50

*, **, *** show that test statistics are significant at the 10%, 5% and 1% significance level, respectively. Null hypothesis is slope homogeneity.

3.3.4. Interest Rate Model

Slope homogeneity and cross-sectional dependence tests imply that the series have cross-sectionally dependent errors and slope heterogeneity. Therefore, we use Augmented Mean Group (AMG) estimator that allows for cross section dependence and slope heterogeneity[4]. Consider the following panel model:

$$y_{it} = \beta_i x_{it} + u_{it} \qquad (12)$$

$$\text{where} \quad u_{it} = \alpha_{1i} + \lambda_i f_t + \varepsilon_{it} \qquad (13)$$

$$x_{it} = \alpha_{1i} + \lambda_i f + \varphi_i g_t + e_{it} \qquad (14)$$

[4] We prefer Augmented Mean Group (AMG) estimator over Common Correlated Effects (CCE) estimator because CCE estimator employs cross-sectional averages of dependent and explanatory variables as regressors and this creates data problems when there are cross sectionally invariant variables in the model. Bond and Eberhardt (2013) put forward that AMG estimator perform similar with CCE estimator.

Where x_{it} and y_{it} are observables, β_i is country specific slope parameter, u_{it} implies unobservables and ε_{it} the error term. α_{1i} shows group fixed effects that capture time invariant heterogeneity. f_t is unobserved common factor with heterogeneous factor loadings λ_i and show cross section dependence and time variant heterogeneity. The estimation is conducted in three steps. First, the model is augmented with time dummies and first difference OLS is estimated. This gives the coefficients of time dummies and is referred common dynamic process. Second, group-specific regression model is augmented either with an explicit variable or a unit coefficient imposed on each group member by substracting the estimator from the dependent variable. Third, group specific model parameters are averaged across the panel. Bond and Eberhardt (2013) find that AMG estimator perform similar with Common Correlated Effects (CCE) estimator in terms of bias and root mean squared error.

In our benchmark specification, the dependent variable y_{it} is ten year local sovereign interest rate of the related country. The independent variables x_{it} are grouped in three parts: country specific variables that affect government bond yield, common global variables that influence all of the countries and quantitative easing variables.

Term structure of interest rates theory states that long-term government bond interest rates consist of expected future short-term interest rates and a term premium. Central bank rate is one significant variable which affects both short-term interest rate and expected future rates. Policy rate hike increases long-term yield by bumping up actual short-term rate and expected future rates. Since we do not have enough information on expected policy rates, we use current central bank interest rate as proxy. Output growth and inflation are other crucial determinants of government bond yields. Higher inflation and growth rates tend to boost short and long term rates. Inflation is used to control for Fisher effect and output growth is included to control for the cyclical position of the country. Interest rates are usually procyclical but higher growth may also lower interest rates through lower risk premia. We use annual change of consumer price index as inflation and year-on-year growth in industrial production as a proxy for economic activity. Current account balance to GDP ratio is employed to control for external vulnerabilities and currency risk. Deterioration in current account balance is expected to

increase risks and push government interest rates up. As for fiscal variables, we use budget deficit and debt stock to GDP ratio. There is a broad literature that shows government interest rates and spreads going up as budget deficit and debt stock rises. In line with the literature, we use the indicator for budget deficit in level form and debt stock in first difference form.

As for the common global variables, following previous studies including Comelli (2012) and Csonto (2014), we use ten year US government interest rate and VIX index. Ten year US interest rate is used as a measure of global liquidity conditions and shows global financing conditions costs. Since a lower 10 year US bond yield is associated with ample global liquidity, we expect a positive relation with bond yields in EM economies due to surging risk appetite for EM asset when returns in advanced economies fall. VIX is an index that refers to average option implied volatility on S&P500 index and is an indicator for global uncertainty and risk appetite. The coefficient of VIX index is expected to be positive since a rise in risk aversion increases of EM debt securities.

The literature shows that both announcements regarding quantitative easing programs and actual purchases of Federal Reserve affect interest rates. Therefore, to investigate the impact of US QE on sovereign bond yields in EM economies, we include both actual bond purchases of Federal Reserve in the related period in billions of dollars and dummy variables to analyze announcement effects. We build 3 different dummy variables for QE1, QE2 and QE3 so as to find announcement effects of the programs seperately. Dummy variables take value one in months when Fed announces or expands a QE program. Details of the announcement dates for the programs are provided in table 13 below.

Table 13. US Quantitative Easing Announcements

Date	Program	Event	Content
11/25/2008	QE1	FOMC statement	LSAP announced
12/1/2008	QE1	Bernanke speech	Suggest extending QE to Treasuries
1/28/2009	QE1	FOMC statement	Fed ready to expand QE program
3/18/2009	QE1	FOMC statement	Initial LSAP expanded
8/10/2010	QE2	FOMC statement	Plan to reinvest GSE and MBS in Treasuries
8/27/2010	QE2	Bernanke speech	Role for additional QE seen
9/21/2010	QE2	FOMC statement	Willingness to provide more accomodation
10/12/2010	QE2	FOMC minutes	Need for additional accomodation
11/3/2010	QE2	FOMC statement	Announcement of QE2
8/22/2012	QE3	FOMC minutes	Additional accomodation warranted
9/13/2012	QE3	FOMC statement	QE3 announcement
12/12/2012	QE3	FOMC statement	QE3 expanded

Source: Fawley and Neely (2013)

3.4. EMPIRICAL RESULTS

Table 14 presents benchmark model results. We first estimate a parsimonious model (column 1) where only country specific explanatory variables are contained (global common and QE variables are excluded).

The results in column 1 show that central bank rate, inflation and budget deficit are significant determinants of long term domestic government bond yield in EM economies. Accordingly, 1 percentage point rise in policy rate increases sovereign bond yield by about 37 bps. 1 percent deterioration in budget deficit to GDP ratio boosts government interest rates by 11 bps. Industrial production, current account deficit to GDP ratio and change in public debt stock to GDP ratio are not significant. In the second model (column 2) we also include global common variables (VIX index and 10 year US bond yield) in addition to country specific variables. Results are similar with the first model. VIX index is not significant and the impact of 1 percentage point rise in US ten year government bond yield on EM bond interest rate is about 50 bps. This shows the importance of US government bond yield as a determinant of interest rates in emerging markets. Third model (column 3) includes QE variables in addition to country

specific and global common variables. Results imply that bond purchases of Federal Reserve are a significant determinant of EM government bond yield. According to the model, 100 billion dollars worth of bond purchases lower government bond yield in EM economies by about 20 bps on average. Announcements of QE programs also lead to the fall of EM bond yields. However, only the announcements related to QE3 is found to be significant.

Table 14. Baseline Model for Domestic Government Interest Rates

Explanatory Variables	Model 1	Model 2	Model 3
Central Bank Rate	0.372***	0.396***	0.384***
	(0.063)	(0.059)	(0.057)
Inflation	0.096***	0.054***	0.070***
	(0.035)	(0.019)	(0.021)
Industrial Production	0.003	-0.001	0.001
	(0.003)	(0.005)	(0.003)
Budget Deficit	-0.109*	-0.158**	-0.158**
	(0.066)	(0.075)	(0.077)
Current Account Deficit	-0.032	-0.030	-0.039
	(0.037)	(0.044)	(0.030)
ΔDebt Stock	-0.229	-0.259	-0.329
	(0.167)	(0.196)	(0.166)
VIX Index		0.005	0.005
		(0.006)	(0.006)
ΔUS Interest Rate		0.494***	0.539***
		(0.069)	(0.098)
Bond Purchases			-0.002***
			(0.001)
QE1			-0.102
			(0.105)
QE2			-0.075
			(0.080)
QE3			-0.937***
			(0.178)
Constant	3.448***	3.151***	3.226***
	(0.531)	(0.475)	(0.510)

***, **, * show significance at the 1%, 5% and 10% confidence levels. Standard errors are reported in parentheses.

Table 15 below gives the impact of QE by countries. Results show that the effect of bond purchases is significant and highest for Indonesia, Brazil and South Africa. Announcement effect of QE3 on government bond yield is strongest for Turkey, Indonesia, Colombia and Brazil.

Table 15. Impact of QE by Countries

Country	Bond Purchases	QE1	QE2	QE3
Brazil	-0.0049**	0.236	0.746**	-1.689***
China	-0.0007	0.007	-0.239	-0.279
Hungary	-0.0034*	0.789***	0.181	-1.232**
Colombia	-0.0016	0.333*	0.182	-1.711***
Czech Republic	0.0072***	-0.246	-0.213	-0.210
Indonesia	-0.0096***	-0.536	0.527	-1.923***
Mexico	-0.0010	-0.455***	-0.217	-1.339***
Malaysia	-0.0016**	-0.046	-0.206	-0.605***
Turkey	-0.0046	-1.681***	0.222	-2.137*
South Africa	-0.0048***	-0.100	-0.172	-1.493***
Korea	-0.0006	-0.266	-0.247	-0.299
Philippines	-0.0032	0.258	-0.164	-0.546
Poland	0.0018**	0.153	0.33	-0.651***
Thailand	-0.0022**	-0.434***	-0.287	-0.672**
India	-0.0019**	-0.470***	0.189	-0.639***
Singapore	0.0007	-0.306**	-0.166*	-0.724***
Taiwan	0.0001	0.138	-0.055	-0.409***

***, **, * show significance at the 1%, 5% and 10% confidence levels.

3.5. ROBUSTNESS ANALYSIS

In this part, we perform several robustness exercises to test the model results. First, instead of the bond purchases variable, we use an alternative QE variable that is the ratio of bond purchases in the related period to total amount of bonds available. Column 1 in table 16 presents the results and show that the alternative QE variable is also a significant determinant of government bond interest rate in EM countries.

In the analysis, there exists one important complication. US bond yield and VIX index are influenced by QE policies. Hence, QE impacts government bond yields in EM economies both directly and also through subdued US bond interest rates and lower VIX. Hence, quantitative easing variables in the model might not totally contain the effect of QE on EM government interest rate. If the coefficients of QE variables are significant, they give us a conservative estimate about the effect of QE on EM government interest rate. In order to address this problem, we first lag VIX index and 10 year US bond yield by one (columns 2) and two (column 3) periods and then we exclude them (column 4). Major goal of this exercise is to check whether coefficients of QE variables become larger and significance changes. Hovewer, these exercises do not

have a significant effect and thus do not provide any evidence that QE variables do not fully contain the effect of QE on EM government interest rates.

Table 16. Robustness Analysis-1

Explanatory Variables	Model 1	Model 2	Model 3	Model 4
Central Bank Rate	0.381***	0.376***	0.369***	0.365***
	(0.057)	(0.055)	(0.058)	(0.063)
Inflation	0.082***	0.086***	0.102***	0.112***
	(0.027)	(0.030)	(0.035)	(0.035)
Industrial Production	-0.001	0.001	0.002	0.002
	(0.004)	(0.003)	(0.003)	(0.002)
Budget Deficit	-0.154**	-0.134*	-0.114	-0.131*
	(0.075)	(0.076)	(0.075)	(0.069)
Current Account Deficit	-0.048	-0.061**	-0.047*	-0.028*
	(0.040)	(0.026)	(0.026)	(0.029)
ΔDebt Stock	-0.393	-0.326	-0.294	-0.337
	(0.152)	(0.161)	(0.186)	(0.099)
VIX Index	0.005			
	(0.006)			
VIX Index (t-1)		0.007		
		(0.006)		
VIX Index (t-2)			-0.003	
			(0.004)	
US Interest Rate	0.558***			
	(0.101)			
US Interest Rate (t-1)		0.724***		
		(0.123)		
US Interest Rate (t-2)			-0.244***	
			(0.086)	
Bond Purchases		-0.0002	-0.002***	-0.0016**
		(0.001)	(0.001)	(0.001)
Bond Purchases/Total Bonds	-0.127*			
	(0.065)			
QE1	-0.097	-0.055	-0.129	-0.202
	(0.102)	(0.102)	(0.130)	(0.154)
QE2	-0.087	-0.008	-0.017	-0.040
	(0.082)	(0.067)	(0.060)	(0.066)
QE3	-1.206***	-1.103***	-0.767***	-0.859***
	(0.213)	(0.207)	(0.164)	(0.174)
Constant	3.231***	3.436***	3.475***	3.499***
	(0.513)	(0.513)	(0.540)	(0.576)

***, ** and * show significance at the 1%, 5% and 10% significance levels, respectively. Standard errors are reported in parentheses.

In addition to bond purchases, we can also analyze the impact of mortgage backed securities (MBS) purchases of Fed. First model in table 17 (column 1) implies that MBS purchases is not a significant determinant of EM interest rates. The announcements regarding the tapering of the asset purchase program in May and June 2013 had a strong impact on financial markets. We also want to know whether changing the sample period of the study have a pronounced impact on the coefficients and significance of the variables. In this context, we use the sample period from 2006:1 to 2013:4. Results in table 17 (column 2) points out that the change in the coefficients and significance is only negligible.

Another complication is that some of the explanatory variables in our analysis may be endogenous. For instance, the rise in EM government bond yield may increase central bank policy rate, inflation and budget deficit. To solve this problem, we employ lagged variables for presumed endogeneous variables as instrument and current variables for presumed exogeneous variables[5]. Model results in table 17 (column 3) shows that using one lag of endogenous variables as instrument do not have a considerable influence on model results. Using two lags of the endogenous variables leads only to a limited rise in the coefficient of bond purchases variable and announcement effect of QE3 (table 17, column 4).

[5] Presumed endogenous variables are central bank interest rate, inflation rate, growth rate of industrial production and budget deficit to GDP ratio. Presumed exogenous variables are current account deficit to GDP ratio, change in debt stock to GDP ratio, VIX index, 10 year US government interest rate and QE variables. Changing endogeneous variables do not have an important effect on model results.

Table 17. Robustness Analysis-2

Explanatory Variables	Model 1	Model 2	Model 3	Model 4
Central Bank Rate	0.376***	0.431***	0.191***	0.137***
	(0.051)	(0.065)	(0.059)	(0.061)
Inflation	0.066***	0.074**	0.072***	0.079***
	(0.019)	(0.036)	(0.024)	(0.030)
Industrial Production	0.001	0.004	0.001	0.003
	(0.003)	(0.003)	(0.005)	(0.002)
Budget Deficit	-0.168**	-0.076	-0.154*	-0.138
	(0.074)	(0.066)	(0.092)	(0.095)
Current Account Deficit	-0.039	-0.001	-0.071	-0.096**
	(0.044)	(0.068)	(0.051)	(0.042)
ΔDebt Stock	-0.176	-0.069	-0.221	-0.161
	(0.191)	(0.167)	(0.155)	(0.165)
VIX Index	0.005	0.010**	0.017	0.018*
	(0.006)	(0.005)	(0.009)	(0.010)
US Interest Rate	0.545***	0.545***	0.580***	0.583***
	(0.110)	(0.082)	(0.133)	(0.131)
Bond Purchases	-0.003***	-0.0016**	-0.0032***	-0.0036***
	(0.001)	(0.001)	(0.001)	(0.001)
MBS Purchases	0.001			
	(0.001)			
QE1	-0.078	-0.042	-0.188**	-0.196***
	(0.078)	(0.089)	(0.093)	(0.093)
QE2	-0.026	-0.004	-0.100	-0.055
	(0.097)	(0.092)	(0.068)	(0.071)
QE3	-1.253***	-0.703***	-1.219***	-1.669***
	(0.212)	(0.128)	(0.271)	(0.354)
Constant	3.332***	3.388***	3.477***	4.907***
	(0.514)	(0.544)	(0.564)	(0.640)

***, ** and * show significance at the 1%, 5% and 10% confidence levels, respectively. Standard errors are reported in parentheses.

3.6. CONCLUSION

This study contributes to the literature by modelling local government interest rates in EM countries and analyzing the effect of US QE policies on EM government bond interest rates. Since we detect cross section dependence and slope heterogeneity, we use Augmented Mean group (AMG) estimator that is robust to cross section dependence and slope heterogeneity. The analysis of the heterogenous nature of international transmission mechanism of QE policies is a considerable contribution.

The analysis conducted show that local sovereign bond interest rate in EM economies is determined by country specific variables, global common and QE variables. These findings are consistent with the previous studies. More specifically, central bank interest rates, inflation and budget deficit in the country, 10 year US bond interest rate, announcements about the QE programs and actual bond purchases of Fed affect EM government bond yields significantly. The results are not homogenous and vary by country. On average, among QE announcements only those regarding QE3 program are found as significant determinant of EM goverment bond interest rate. According to model results, MBS purchases in US have no significant impact on EM bond yields. The results are robust to several different specifications.

The results of the study once again show how important are global financial conditions and unconventional monetary policies implemented by Fed for emerging market economies. We find that asset purchases of Fed have international spillover effects and lower EM government bond yields. Future work in this area can analyze the probable declining marginal effectiveness of QE policies.

CONCLUSION

The use of unconventional monetary policies by advanced country central banks has become more widespread especially after the global crisis of 2008-09. Upon reaching zero lower bound on interest rates, central banks started to conduct UMP and in the course of time these policies have become the new normal in terms of monetary policy application. Monetary policies of major advanced-country central banks have increasingly relied on unconventional policies.

Unconventional monetary policies have both domestic and international spillover effects. As a result of their increasing importance, it has been more and more critical to empirically analyze and understand the transmission mechanism of unconventional monetary policies and effects of them on the economy. So far, many of the studies in the related literature have focused on domestic spillover effects of these policies and the studies related to international spillovers remain relatively rare. This study intends contribute to the existing literature by investigating the effects of Federal Reserve (Fed) bond purchases on economic indicators of selected EM countries.

In this study, we first explain the definition and history of quantitative easing, provide country experiences with QE, describe the transmission mechanism of quantitative easing and the channels through which it influences the economy and present the literature survey about the effects of QE on major economic variables. After these informative parts, we proceed to two empirical studies regarding the effects of QE on EM economies. In the first empirical study, we use panel vector auto regression (PVAR) model to analyze the effect of bond purchases by Federal Reserve (Fed) on major economic indicators in emerging market economies. Model results imply that there is both short and long run relation between Federal Reserve bond purchases and EM macroeconomic variables. There exists a long run cointegration relationship between bond purchases and EM macro indicators. Impulse response analysis shows that bond purchases by Fed reduce government bond yields and inflation, put upward pressure on real exchange rate and stimulate economic activity. The impact on inflation is found to be temporary while it is permanent on output. We also examine the effects of MBS purchases by Fed and find out that they have a meaningful effect on industrial

production, inflation and exchange rate but no effect on government interest rates. Furthermore, according to the analysis, unconventional monetary policies of European Central Bank (ECB) and Bank of Japan (BoJ) also have crucial effects on emerging market economies. Policies of ECB and BoJ that lead to balance sheet expansion cause lower government interest rates and inflation, but they have no effect on industrial production. The results are robust to many different specifications.

In the second empirical study, we employ Augmented Mean Group (AMG) estimator that is robust to cross section dependence and heterogeneity to investigate the impact of QE announcements and actual purchases by Fed on government bond yield in EM economies. This work contributes to the literature both by modelling long term domestic government interest rate in EM countries and analyzing the effect of QE policies of Fed on EM bond yields. The results are not homogenous and vary from country to country. The analysis of the heterogeneous nature of international transmission mechanism of QE policies is a considerable contribution to the literature. Model results imply that country-specific variables such as central bank interest rates, inflation and budget deficit are leading determinants of long term local government bond interest rates in EM countries. Furthermore, 10-year US bond yield, announcements regarding asset purchase programs and bond purchases of Fed also influence EM bond yields. According to model results, among three asset purchase programs, only the announcements regarding QE3 program are found as significant determinant of EM bond yields. MBS purchases in US do not have a significant effect on EM bond interest rate. A number of robustness exercises demonstrate that model results are robust to different specifications.

Results of two empirical studies we have conducted are parallel to existing literature and show the importance of global financial conditions and unconventional monetary policies implemented by Fed for EM economies. Asset purchases of Fed are found to create international spillover effects both on real and financial indicators of EM countries. The results also contribute to the policy making process of central banks and provide crucial lessons for central bankers. In addition to international spillovers, QE policies also cause spillback effects on the countries implementing these policies since EM economies represent a large share in the global economy. Therefore, central bankers

should take into account and pay more attention to both spillover and spillback effects of unconventional monetary policies in their policy making process.

BIBLIOGRAPHY

Ahmed, S., A. Zlate (2014), Capital Flows to Emerging Market Economies: A Brave New World?, *Journal of International Money and Finance*, *48*, 221-248.

Albu, L.L., R. Lupu, A.C. Călin, O.C. Popovici (2014a), The Effect of ECB's Quantitative Easing on Credit Default Swap Instruments in Central and Eastern Europe, *Procedia Economics and Finance*, 8, 122-128.

Albu, L.L., R. Lupu, A.C. Calin, O.C. Popovici (2014b), Estimating the Impact of Quantitative Easing on Credit Risk through an ARMA-GARCH Model, *Romanian Journal of Economic Forecasting*, 17(3), 39.

Altavilla, C., D. Giannone, M. Lenza (2014), The Financial and Macroeconomic Effects of OMT Announcements, *CEPR Discussion Papers*, No. 10025.

Arellano, M., S. Bond (1991), Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *The Review of Economic Studies*, 58(2), 277-297.

Arellano, M., O. Bover (1995), Another Look at the Instrumental Variable Estimation of Error-Components Models, *Journal of Econometrics*, 1(68), 29-51.

Baldacci, E., S. Gupta, A. Mati (2008), Is It (Still) Mostly Fiscal? Determinants of Sovereign Spreads in Emerging Markets, *IMF Working Papers*, 259, 1-23.

Baldacci, E., M.S. Kumar (2010), Fiscal Deficits, Public Debt and Sovereign Bond Yields, *IMF Working Papers*, 184, 1-28.

Baltagi, B. (2013), *Econometric Analysis of Panel Data*, Fifth Edition, John Wiley & Sons.

Barroso, J.B.R., L.A.P. Silva, A.S. Sales (2015), Quantitative Easing and Related Capital Flows into Brazil: Measuring its Effects and Transmission Channels Through a Rigorous Counterfactual Evaluation, *Journal of International Money and Finance*, 9(2), 165-212.

Bauer, M.D., C.J. Neely (2014), International Channels of the Fed's Unconventional Monetary Policy, *Journal of International Money and Finance*, 44, 24-46.

Bauer, M.D., G.D. Rudebusch (2014), The Signaling Channel for Federal Reserve Bond Purchases, *International Journal of Central Banking*, 10(3), 233-289.

Baumeister, C., L. Benati (2013), Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound, *International Journal of Central Banking*, 9(2), 165-212.

Beirne, J., L. Dalitz, J. Ejsing, M. Grothe, S. Manganelli, F. Monar,B. Sahel, M. Susec, J. Tapking, T. Vong (2011), The Impact of the Eurosystem's Covered Bond Purchase Programme on the Primary and Secondary Markets, *ECB Occasional Paper*, 122.

Belke, A., W. Orth, R. Setzer (2010), Liquidity and the Dynamic Pattern of Asset Price Adjustment: A Global View, *Journal of Banking & Finance*, 34(8), 1933-1945.

Bernanke, B.S. (2009), Speech Given at the LSE, 15 January 2009.

Bernanke, B.S. (2012), Monetary Policy Since the Onset of the Crisis. *Federal Reserve Bank of Kansas City Economic Symposium*, Jackson Hole, Wyoming, Vol. 31.

Bernanke, B.S., A.S. Blinder (1992), The Federal Funds Rate and the Channels of Monetary Transmission, *American Economic Review*, 82(4), 901-921.

Bernanke, B.S., M. Gertler (1995), Inside the Black Box: The Credit Channel of Monetary Policy Transmission, *The Journal of Economic Perspectives*, 9(4), 27-48.

Bernanke, B.S., V.R. Reinhart (2004), Conducting Monetary Policy at Very Low Short-Term Interest Rates, *American Economic Review*, 94(2), 85-90.

Bernanke, B.S., V.R Reinhart, B.P. Sack (2004), Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment, *Brookings Papers on Economic Activity*, 2004(2), 1-100.

Bond, S., M. Eberhardt (2013), Accounting for Unobserved Heterogeneity in Panel Time Series Models, Nuffield College, University of Oxford, mimeo.

Bowman, D., F. Cai, S. Davies, S. Kamin (2015a), Quantitative Easing and Bank Lending: Evidence from Japan, *Journal of International Money and Finance*, 57, 15-30.

Bowman, D., J.M. Londono, H. Sapriza (2015b), US Unconventional Monetary Policy and Transmission to Emerging Market Economies, *Journal of International Money and Finance*, 55, 27-59.

Brana, S., M.L. Djigbenou, S. Prat (2012), Global Excess Liquidity and Asset Prices in Emerging Countries: A PVAR Approach, *Emerging Markets Review*, 13(3), 256-267.

Breedon, F., J.S. Chadha, A. Waters (2012), The Financial Market Impact of UK Quantitative Easing, *Oxford Review of Economic Policy*, 28(4), 702-728.

Bridges, J., R. Thomas (2012), The Impact of QE on the UK Economy–Some Supportive Monetarist Arithmetic, *Bank of England Working Paper*, No. 442.

Bruno, G. S. (2005), Estimation and Inference in Dynamic Unbalanced Panel-Data Models with a Small Number of Individuals, *Stata Journal*, 5(4), 473.

Brunner, K., A.H. Meltzer (1973), Mr. Hicks and the" Monetarists", *Economica*, 40(157), 44-59.

Cagala, T., U. Glogowsky (2014), Panel Vector Autoregressions for Stata (xtvar).

Carrera, C., R. Gondo, F. Pérez-Forero, N. Ramírez-Rondán (2014), Effects of the US Quantitative Easing on the Peruvian Economy, *Banco Central de Reserva del Perú*, No. 2014-17.

Carrera, C., F.P. Forero, N. Ramirez-Rondan (2015), Effects of the US Quantitative Easing on Latin American Economies, *Peruvian Economic Association*, No. 2015-35.

Carrion-i-Silvestre, J.L., T.D.B. Castro, E. López-Bazo (2005), Breaking the Panels: An Application to the GDP Per Capita, *Econometrics Journal*, 8(2), 159-175.

Chen, H., V. Cúrdia, A. Ferrero (2012a), The Macroeconomic Effects of Large-scale Asset Purchase Programmes, *The Economic Journal*, 122(564), F289-F315.

Chen, Q., A.J. Filardo, D. He, F. Zhu (2012b), International Spillovers of Central Bank Balance Sheet Policies, *BIS Papers*, No.66, 230-74.

Chen, J., T.M. Griffoli, R. Sahay (2014), Spillovers from United States Monetary Policy on Emerging Markets: Different This Time?, *IMF Working Paper*, No. 14/240.

Chen, Q., A. Filardo, D. He, F. Zhu (2016), Financial Crisis, US Unconventional Monetary Policy and International Spillovers, *Journal of International Money and Finance*, Volume 67, October 2016, 62–81.

Christensen, J.H., G.D. Rudebusch (2012), The Response of Interest Rates to US and UK Quantitative Easing, *The Economic Journal*, 122(564), F385-F414.

Chudik, A., M.H. Pesaran (2013), Large Panel Data Models with Cross-Sectional Dependence: A Survey, *Federal Reserve Bank of Dallas Working Paper*, No. 153.

Chudik, A., M.H. Pesaran (2015), Common Correlated Effects Estimation of Heterogeneous Dynamic Panel Data Models with Weakly Exogenous Regressors, *Journal of Econometrics*, 188(2), 393-420.

Chung, H., J.P. Laforte, D. Reifschneider, J.C. Williams (2011), Estimating the Macroeconomic Effects of the Fed's Asset Purchases, *FRBSF Economic Letter*, No 3.

Chung, H., J.P. Laforte, D. Reifschneider, J.C. Williams (2012), Have We Underestimated the Likelihood and Severity of Zero Lower Bound Events?, *Journal of Money, Credit and Banking*, 44(s1), 47-82.

Ciarlone, A., P. Piselli, G. Trebeschi (2009), Emerging Markets' Spreads and Global Financial Conditions, *Journal of International Financial Markets, Institutions and Money*, 19(2), 222-239.

Comelli, F. (2012), Emerging Market Sovereign Bond Spreads: Estimation and Back-Testing, *Emerging Markets Review*, 13(4), 598-625.

Csontó, B. (2014), Emerging Market Sovereign Bond Spreads and Shifts in Global Market Sentiment, *Emerging Markets Review*, 20, 58-74.

Curdia, V., M. Woodford (2011), The Central-Bank Balance Sheet as an Instrument of Monetary Policy, *Journal of Monetary Economics*, 58(1), 54-79.

Cúrdia, V., A. Ferrero (2013), How Stimulatory Are Large-Scale Asset Purchases?, *FRBSF Economic Letter*, 22, 1-5.

Dahlhaus, T., K. Hess, A. Reza (2014), International Transmission Channels of US Quantitative Easing: Evidence from Canada, *Bank of Canada Working Paper*, No. 14-43.

Dailami, M., P.R. Masson, J.J. Padou (2008), Global Monetary Conditions Versus Country-Specific Factors in the Determination of Emerging Market Debt Spreads, *Journal of International Money and Finance*, 27(8), 1325-1336.

D'Amico, S., W. English, D. López-Salido, E. Nelson (2012), The Federal Reserve's Large-scale Asset Purchase Programmes: Rationale and Effects, *The Economic Journal*, 122(564), F415-F446.

D'Amico, S., T.B. King (2013), Flow and Stock Effects of Large-Scale Treasury Purchases: Evidence on the Importance of Local Supply, *Journal of Financial Economics*, 108(2), 425-448.

Doh, T. (2010), The Efficacy of Large-Scale Asset Purchases at the Zero Lower Bound, *Federal Reserve Bank of Kansas City Economic Review*, 95(2), 5-34.

Duca, M.L., G. Nicoletti, A.V. Martinez (2016), Global Corporate Bond Issuance: What Role for US Quantitative Easing?, *Journal of International Money and Finance*, 60, 114-150.

Eberhardt, M., S. Bond (2009), Cross-Section Dependence in Nonstationary Panel Models: A Novel Estimator, *University Library of Munich*, Germany, No. 17692.

Eberhardt, M., E. Teal (2010), Productivity Analysis in Global Manufacturing Production, Oxford University, *Department of Economics Discussion Paper Series*, 515.

Ebner, A. (2009), An Empirical Analysis on the Determinants of CEE Government Bond Spreads, *Emerging Markets Review*, 10(2), 97-121.

Edwards, S. (1984), LDC Foreign Borrowing and Default Risk: An Empirical Investigation, 1976-80, *The American Economic Review*, 74(4), 726-734.

Engen, E.M., T. Laubach, D. Reifschneider (2015), The Macroeconomic Effects of the Federal Reserve's Unconventional Monetary Policies, *Federal Reserve Finance and Economic Discussion Series*, 2015-005.

Eser, F., B. Schwaab (2016), Evaluating the Impact of Unconventional Monetary Policy Measures: Empirical Evidence from the ECB′s Securities Markets Programme, *Journal of Financial Economics*, Volume 119, Issue 1, 147-167.

Fawley, B.W., C. J. Neely (2013), Four Stories of Quantitative Easing, *Federal Reserve Bank of St. Louis Review*, 95(1), 51-88.

Fic, T. (2013), The Spillover Effects of Unconventional Monetary Policies in Major Developed Countries on Developing Countries, *DESA Working Paper*, No. 131.

Friedman, B.M. (1978), Crowding Out Or Crowding In? The Economic Consequences of Financing Government Deficits, *NBER Working Paper*, No.284.

Friedman, M. (1997), Rx for Japan: Back to the Future, *Wall Street Journal*, December 17, A22.

Fratzscher, M., M.L. Duca, R. Straub (2013), On the International Spillovers of US Quantitative Easing, *ECB Working Paper*, No. 1557.

Gagnon, J., M. Raskin, J. Remache, B. Sack (2011), The Financial Market Effects of the Federal Reserve's Large-Scale Asset Purchases, *International Journal of Central Banking*, 7(1), 3-43.

Gambacorta, L., B. Hofmann, G. Peersman (2014), The Effectiveness of Unconventional Monetary Policy at the Zero Lower Bound: A Cross-Country Analysis, *Journal of Money, Credit and Banking*, 46(4), 615-642.

Gertler, M., P. Karadi (2011), A Model of Unconventional Monetary Policy, *Journal of Monetary Economics*, 58(1), 17-34.

Gertler, M., P. Karadi (2013), QE 1 vs. 2 vs. 3...: A Framework for Analyzing Large-Scale Asset Purchases as a Monetary Policy Tool, *International Journal of Central Banking*, 9(1), 5-53.

Georgiadis, G. (2016), Determinants of Global Spillovers from US Monetary Policy, *Journal of International Money and Finance*, Volume 67, 41–61.

Georgiadis, G., J. Gräb (2016), Global Financial Market Impact of the Announcement of the ECB's Extended Asset Purchase Programme, *Journal of Financial Stability*, 26, 257-265.

Ghysels, E., J. Idier, S. Manganelli, O. Vergote (2014), A High Frequency Assessment of the ECB Securities Markets Programme, *ECB Working Paper*, No. 1642.

Gilchrist, S., E. Zakrajšek (2013), The Impact of the Federal Reserve's Large-Scale Asset Purchase Programs on Corporate Credit Risk, *Journal of Money, Credit and Banking*, 45(s2), 29-57.

Gilchrist, S., D. López-Salido, E. Zakrajšek (2015), Monetary Policy and Real Borrowing Costs at the Zero Lower Bound, *American Economic Journal: Macroeconomics*, 7(1), 77-109.

Girardin, E., Z. Moussa (2011), Quantitative Easing Works: Lessons from the Unique Experience in Japan 2001–2006, *Journal of International Financial Markets, Institutions and Money*, 21(4), 461-495.

Glick, R., S. Leduc (2012), Central Bank Announcements of Asset Purchases and the Impact on Global Financial and Commodity Markets, *Journal of International Money and Finance*, 31(8), 2078-2101.

Glick, R., S. Leduc (2013), The Effects of Unconventional and Conventional US Monetary Policy on the Dollar, *Federal Reserve Bank of San Francisco Working Paper*, No. 2013-11.

Greenwood, R., S. Hanson, J.C. Stein (2010), A Gap-Filling Theory of Corporate Debt Maturity Choice, *The Journal of Finance*, 65(3), 993-1028.

Hamilton, J.D., J.C. Wu (2012), The Effectiveness of Alternative Monetary Policy Tools in a Zero Lower Bound Environment, *Journal of Money, Credit and Banking*, 44(s1), 3-46.

Hancock, D., W. Passmore (2011), Did the Federal Reserve's MBS Purchase Program Lower Mortgage Rates?, *Journal of Monetary Economics*, 58(5), 498-514.

Harrison, R. (2012), Asset Purchase Policy at the Effective Lower Bound for Interest Rates, *Bank of England Working Paper*, No. 444.

Hattori, M., A. Schrimpf, V. Sushko (2016), The Response of Tail Risk Perceptions to Unconventional Monetary Policy, *American Economic Journal: Macroeconomics*, 8(2), 111-136.

Hilscher, J., Y. Nosbusch (2010), Determinants of Sovereign Risk: Macroeconomic Fundamentals and the Pricing of Sovereign Debt, *Review of Finance*, 14(2), 235-262.

Ho, S.W., J. Zhang, H. Zhou (2014), Hot Money and Quantitative Easing: The Spillover Effect of US Monetary Policy on Chinese Housing, Equity and Loan Markets, *Federal Reserve Bank of Dallas Globalization and Monetary Policy Institute Working Paper*, No. 211.

IMF (2013a), Global Financial Stability Report: Transition Challenges to Stability, *World Economic and Financial Surveys*, October 2013.

IMF (2013b), Global Impact and Challenges of Unconventional Monetary Policies, *IMF Policy Paper*, 7 October.

IMF (2014), IMF Multilateral Policy Issues Report-2014 Spillover Report, *IMF Policy Paper*, 29 July.

Jaramillo, L., A. Weber (2013), Bond Yields in Emerging Economies: It Matters What State You Are In, *Emerging Markets Review*, 17, 169-185.

Joyce, M., A. Lasaosa, I. Stevens, M. Tong (2011), The Financial Market Impact of Quantitative Easing in the United Kingdom, *International Journal of Central Banking*, 7(3), 113-161.

Joyce, M., D. Miles, A. Scott, D. Vayanos (2012), Quantitative Easing and Unconventional Monetary Policy–an Introduction, *The Economic Journal*, 122(564), F271-F288.

Joyce, M., M. Tong (2012), QE and the Gilt Market: a Disaggregated Analysis, *The Economic Journal*, 122(564), F348-F384.

Kandrac, J., B. Schlusche (2013), Flow Effects of Large-Scale Asset Purchases, *Economics Letters*, 121(2), 330-335.

Kapetanios, G., H. Mumtaz, I. Stevens, K. Theodoridis (2012), Assessing the Economy-Wide Effects of Quantitative Easing, *The Economic Journal*, 122(564), F316-F347.

Karras, G. (2013), Asymmetric Effects of Monetary Policy With or Without Quantitative Easing: Empirical Evidence for the US, *The Journal of Economic Asymmetries*, 10(1), 1-9.

Kawai, M. (2015), International Spillovers of Monetary Policy: US Federal Reserve's Quantitative Easing and Bank of Japan's Quantitative and Qualitative Easing, *Asian Development Bank Institute*, No. 512.

Keynes, J.M. (1936), *The General Theory of Interest, Employment and Money*, Palgrave Macmillan.

Kiendrebeogo, Y. (2016), Unconventional Monetary Policy and Capital Flows, *Economic Modelling*, 54, 412-424.

Kim, S. (2001), International Transmission of US Monetary Policy Shocks: Evidence from VAR's, *Journal of Monetary Economics*, 48(2), 339-372.

Kimura, T., D.H. Small (2006), Quantitative Monetary Easing and Risk in Financial Asset Markets, *The B.E. Journal of Macroeconomics*, 6(1), 1-54.

Kohn, D.L. (2009), Monetary Policy in the Financial Crisis, At the Conference in Honor of Dewey Daane, Nashville, Tennessee.

Kozicki, S., E. Santor, L. Suchanek (2011), Unconventional Monetary Policy: The International Experience with Central Bank Asset Purchases, *Bank of Canada Review*, 2011(Spring), 13-25.

Krishnamurthy, A., A. Vissing-Jorgensen (2011), The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy, *NBER Working Paper*, No. 17555.

Krugman, P. (2005), Is Fiscal Policy Poised for a Comeback?, *Oxford Review of Economic Policy*, Volume 21, Issue 4, 515-523.

Lavigne, R., S. Sarker, G. Vasishtha (2014), Spillover Effects of Quantitative Easing on Emerging-Market Economies, *Bank of Canada Review*, 2014(Autumn), 23-33.

Lenza, M., H. Pill, L. Reichlin (2010), Monetary Policy in Exceptional Times, *Economic Policy*, 25(62), 295-339.

Li, C., M. Wei (2013), Term Structure Modeling with Supply Factors and the Federal Reserve's Large-Scale Asset Purchase Progarms, *International Journal of Central Banking*, 9(1), 3-39.

Lim, J.J., S. Mohapatra (2016), Quantitative Easing and the Post-Crisis Surge in Financial Flows to Developing Countries, *Journal of International Money and Finance*, Volume 68, 331–357.

Lyonnet, V., R. Werner (2012), Lessons From the Bank of England on 'Quantitative Easing'and Other 'Unconventional' Monetary Policies, *International Review of Financial Analysis*, 25, 94-105.

MacDonald, M. (2017), International Capital Market Frictions and Spillovers from Quantitative Easing, *Journal of International Money and Finance*, Volume 70, 135–156.

Maddala, G.S., S. Wu (1999), A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test, *Oxford Bulletin of Economics and Statistics*,61(S1), 631-652.

Martinez, L.B., A. Terceño, M. Teruel (2013), Sovereign Bond Spreads Determinants in Latin American Countries: Before and During the XXI Financial Crisis, *Emerging Markets Review*, 17, 60-75.

Matsuki, T., K. Sugimoto, K. Satoma (2015), Effects of the Bank of Japan's Current Quantitative and Qualitative Easing, *Economics Letters*, 133, 112–116.

Meaning, J., F. Zhu (2011), The Impact of Recent Central Bank Asset Purchase Programmes, *BIS Quarterly Review*, December 2011.

Meier, A. (2009), Panacea, Curse, or Nonevent? Unconventional Monetary Policy in the United Kingdom, *IMF Working Paper*, No. 09/163.

Meinusch, A., P. Tillmann (2016), The Macroeconomic Impact of Unconventional Monetary Policy Shocks, *Journal of Macroeconomics*, Volume 47, Part A, 58–67.

Meltzer, A.H. (1995), Monetary, Credit and (Other) Transmission Processes: A Monetarist Perspective, *Journal of Economic Perspectives*, 9(4), 49–72.

Mishkin, F.S. (1995), Symposium on the Monetary Transmission Mechanism, *Journal of Economic Perspectives*, 9(4), 3–10.

Mishkin, F. S. (1996), The Channels of Monetary Transmission: Lessons for Monetary Policy, *NBER Working Paper*, No. 5464.

Miyajima, K., M.S. Mohanty, T. Chan (2015), Emerging Market Local Currency Bonds: Diversification and Stability, *Emerging Markets Review*, 22, 126-139.

Modigliani, F., R. Sutch (1966), Innovations in Interest Rate Policy, *The American Economic Review*, 56(1/2), 178-197.

Modigliani, F., R. Sutch (1967), Debt Management and the Term Structure of Interest Rates: An Empirical Analysis of Recent Experience, *The Journal of Political Economy*, 75(4, Part 2), 569-589.

Moore, J., S. Nam, M. Suh, A. Tepper (2013), Estimating the Impacts of US LSAP's on Emerging Market Economies' Local Currency Bond Markets, *Federal Reserve Bank of New York Staff Report*, No. 595.

Morais, B., J.L., Peydro, C. Ruiz (2015), The International Bank Lending Channel of Monetary Policy Rates and QE: Credit Supply, Reach-for-Yield, and Real Effects, *World Bank Policy Research Working Paper*, No 7216.

Morgan, P. (2011), Impact of US Quantitative Easing Policy on Emerging Asia, *Asian Development Bank Institute Working Paper*, No. 321.

Mundell, R.A. (1963), Capital Mobility and Stabilization Policy Under Fixed and Flexible Exchange Rates, *The Canadian Journal of Economics and Political Science*, 29(04), 475-485.

Neal, T. (2015), Estimating Heterogeneous Coefficients in Panel Data Models with Endogenous Regressors and Common Factors, *Working Paper*.

Neely, C.J. (2015), Unconventional Monetary Policy Had Large International Effects, *Journal of Banking & Finance*, 52, 101-111.

Ng, S., P. Perron (2001), Lag Length Selection and the Construction of Unit Root Tests with Good Size and Power, *Econometrica*, 69(6), 1529–1554.

Pattipeilohy, C., J.W. Van den End, M. Tabbae, J. Frost, J. Haan (2013), Unconventional Monetary Policy of the ECB During the Financial Crisis: An Assessment and New Evidence, *Netherlands Central Bank Working Paper*, No. 381.

Pedroni, P. (2000), *Fully Modified OLS for Heterogeneous Cointegrated Panels, Nonstationary Panels, Panel Cointegration and Dynamic Panels*, 15, 93–130.

Peersman, G. (2011), Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area, *ECB Working Paper*, No. 1397.

Peiris, S.J. (2010), Foreign Participation in Emerging Markets' Local Currency Bond Markets, *IMF Working Paper*, No 10/88.

Peng, C.L.H. (2011), Quantitative Easing, Liquidity Spillover and Emerging Markets Inflation, *Finance & Economics*, 10, 008.

Pesaran, M.H. (2004), General Diagnostic Tests for Cross Section Dependence in Panels, *Institute for the Study of Labor Working Paper*, No. 1240.

Pesaran, M.H. (2006), Estimation and Inference in Large Heterogeneous Panels with a Multifactor Error Structure, *Econometrica*, 74(4), 967-1012.

Pesaran, M.H. (2007), A Simple Panel Unit Root Test in the Presence of Cross-Section Dependence, *Journal of Applied Econometrics*, 22, 265-312.

Pesaran, M.H., Y. Shin, R.P. Smith (1999), Pooled Mean Group Estimation of Dynamic Heterogeneous Panels, *Journal of the American Statistical Association*, 94(446), 621-634.

Pesaran, M.H., R.P Smith (1995), Estimating Long-run Relationships from Dynamic Heterogeneous Panels, *Journal of Econometrics*, 68(1), 79-113.

Pesaran, M.H., R.P. Smith (2016), Counterfactual Analysis in Macroeconometrics: An Empirical Investigation into the Effects of Quantitative Easing, *Research in Economics*, 70(2), 262–280.

Pesaran, M.H., T. Yamagata (2008), Testing Slope Homogeneity in Large Panels, *Journal of Econometrics*, 142(1), 50-93.

Pesaran, M.H., A. Ullah, T. Yamagata (2008), A Bias-Adjusted LM Test of Error Cross-Section Independence, *Econometrics Journal*, 11, 105–127.

Rajan, R. (2015), Competitive Monetary Easing: Is It Yesterday Once More?, *Macroeconomics and Finance in Emerging Market Economies*, 8(1-2), 5-16.

Rogers, J.H., C. Scotti, J.H. Wright (2014), Evaluating Asset-Market Effects of Unconventional Monetary Policy: A Multi-Country Review, *Economic Policy*, 29(80), 749-799.

Romer, C.D., D.H. Romer, S.M Goldfeld, B.M. Friedman (1990), New Evidence on the Monetary Transmission Mechanism, *Brookings Papers on Economic Activity*, 1990(1), 149-213.

Rosa, C. (2012), How Unconventional Are Large-Scale Asset Purchases? The Impact of Monetary Policy on Asset Prices, *FRB of New York Staff Report*, No. 560.

Oda, N., K. Ueda (2007), The Effects Of The Bank Of Japan'S Zero Interest Rate Commitment And Quantitative Monetary Easing On The Yield Curve: A Macro-Finance Approach, *The Japanese Economic Review*, 58(3), 303-328.

Schenkelberg, H., S. Watzka (2013), Real Effects of Quantitative Easing at the Zero Lower Bound: Structural VAR-Based Evidence from Japan, *Journal of International Money and Finance*, 33, 327-357.

Sims, C.A. (1980), Macroeconomics and Reality, *Econometrica*, 48(1), 1-48.

Sims, C.A., J.H Stock, M.W Watson (1990), Inference in Linear Time Series Models with Some Unit Roots, *Econometrica*, 58(1), 113-144.

Smaghi, L.B. (2009), Conventional and Unconventional Monetary Policy, Keynote Lecture at the International Center for Monetary and Banking Studies.

Sonmezer, S. (2014), Niceliksel Gevşeme Politikalarının Türk Finansal Piyasaları Üzerindeki Kısa Vadeli Etkileri, *Maliye Finans Yazıları*, 1(101).

Sousa, J., A. Zaghini (2008), Monetary Policy Shocks in the Euro Area and Global Liquidity Spillovers, *International Journal of Finance & Economics*, 13(3), 205-218.

Stroebel, J., J.B. Taylor (2012), Estimated Impact of the Federal Reserve's Mortgage-Backed Securities Purchase Program, *International Journal of Central Banking*, 8(2), 1-42.

Swanson, E.T. (2011), Let's Twist Again: A High-Frequency Event-Study Analysis of Operation Twist and Its Implications for QE2, *Brookings Papers on Economic Activity*, 2011(1), 151-188.

Swanson, E.T., J.C. Williams (2014), Measuring the Effect of the Zero Lower Bound on Medium-and Longer-Term Interest Rates, *The American Economic Review*, 104(10), 3154-3185.

Szczerbowicz, U. (2015), The ECB Unconventional Monetary Policies: Have They Lowered Market Borrowing Costs for Banks and Governments?, *International Journal of Central Banking*, 11(4), 91-127.

Taylor, J.B. (1995), The Monetary Transmission Mechanism: An Empirical Framework, *The Journal of Economic Perspectives*, 9(4), 11-26.

Thornton, D.L. (2012), Evidence on the Portfolio Balance Channel of Quantitative Easing, *Federal Reserve Bank of St. Louis Working Paper Series*, No. 2012-015.

Tillmann, P. (2016), Unconventional Monetary Policy and the Spillovers to Emerging Markets, *Journal of International Money and Finance*, 66, 136-156.

Tobin, J. (1961), Money, Capital and Other Stores of Value, *The American Economic Review*, 51(2), 26-37.

Tobin, J. (1963), *An Essay on the Principles of Debt Management*, Cowles Foundation for Research in Economics at Yale University.

Tobin, J. (1969), A General Equilibrium Approach to Monetary Theory, *Journal of Money, Credit and Banking*, 1(1), 15-29.

Ueda, K. (2012), The Effectiveness of Non-Traditional Monetary Policy Measures: The Case of the Bank of Japan, *Japanese Economic Review*, 63(1), 1-22.

Ugai, H. (2007), Effects of the Quantitative Easing Policy: A Survey of Empirical Analyses, *Monetary and Economic Studies*, 25(1), 1-48.

Uribe, M., V.Z. Yue (2006), Country Spreads and Emerging Countries: Who Drives Whom?, *Journal of International Economics*, 69(1), 6-36.

Voutsinas, K., R.A. Werner (2011), New Evidence on the Effectiveness of Quantitative Easing in Japan, *Center for Financial Studies Working Paper*, No. 2011/30.

Weale, M., T. Wieladek (2016), What Are the Macroeconomic Effects of Asset Purchases?, *Journal of Monetary Economics*, 79, 81-93.

Westerlund, J. (2008), Panel Cointegration Tests of the Fisher Effect, *Journal of Applied Econometrics*, 23(2), 193-233.

Williams, J.C. (2011). Unconventional Monetary Policy: Lessons From the Past Three Years, *FRBSF Economic Letter*, 31.

Woodford, M. (2011), Simple Analytics of the Government Expenditure Multiplier, *American Economic Journal: Macroeconomics*, 3(1), 1-35.

Woodford, M. (2012), Methods of Policy Accommodation at the Interest-Rate Lower Bound, Presented at the Jackson Hole Symposium, "The Changing Policy Landscape," August 31-September 1, 2012.

Wright, J.H. (2012), What Does Monetary Policy Do to Long-term Interest Rates at the Zero Lower Bound?, *The Economic Journal*, 122(564), F447-F466.

Yun, L.Z.Z. (2013), Does American QE Monetary Policy Affect China's Inflation? An Empirical Analysis Based on SVAR Model, *Studies of International Finance*, 8, 001.

APPENDIX 1. Ethics Board Waiver Form

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
ETHICS BOARD WAIVER FORM FOR THESIS WORK

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
TO THE DEPARTMENT PRESIDENCY OF ECONOMICS

Date: 25/11/2016

Thesis Title / Topic: International Transmission Mechanism of Unconventional Monetary Policy

My thesis work related to the title/topic above:

1. Does not perform experimentation on animals or people.
2. Does not necessitate the use of biological material (blood, urine, biological fluids and samples, etc.).
3. Does not involve any interference of the body's integrity.
4. Is not based on observational and descriptive research (survey, measures/scales, data scanning, system-model development).

I declare, I have carefully read Hacettepe University's Ethics Regulations and the Commission's Guidelines, and in order to proceed with my thesis according to these regulations I do not have to get permission from the Ethics Board for anything; in any infringement of the regulations I accept all legal responsibility and I declare that all the information I have provided is true.

I respectfully submit this for approval.

25/11/2016
Date and Signature

Name Surname:	Mesut TÜRKAY
Student No:	N12149793
Department:	Economics
Program:	Ph.D.
Status:	☐ Masters ☒ Ph.D. ☐ Integrated Ph.D.

ADVISER COMMENTS AND APPROVAL

Prof. Dr. Timur Han GÜR

APPENDIX 2. Originality Report

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
THESIS/DISSERTATION ORIGINALITY REPORT

HACETTEPE UNIVERSITY
GRADUATE SCHOOL OF SOCIAL SCIENCES
TO THE DEPARTMENT OF ECONOMICS

Date: 25/11/2016

Thesis Title / Topic: International Transmission Mechanism of Unconventional Monetary Policy

According to the originality report obtained by myself/my thesis advisor by using the Turnitin plagiarism detection software and by applying the filtering options stated below on 25/11/2016 for the total of 112 pages including the a) Title Page, b) Introduction, c) Main Chapters, and d) Conclusion sections of my thesis entitled as above, the similarity index of my thesis is 7 %.

Filtering options applied:

1. Approval and Decleration sections excluded
2. Bibliography/Works Cited excluded
3. Quotes excluded
4. Match size up to 5 words excluded

I declare that I have carefully read Hacettepe University Graduate School of Social Sciences Guidelines for Obtaining and Using Thesis Originality Reports; that according to the maximum similarity index values specified in the Guidelines, my thesis does not include any form of plagiarism; that in any future detection of possible infringement of the regulations I accept all legal responsibility; and that all the information I have provided is correct to the best of my knowledge.

I respectfully submit this for approval.

25/11/2016
Date and Signature

Name Surname:	Mesut TÜRKAY
Student No:	N12149793
Department:	Economics
Program:	Ph.D.
Status:	☐ Masters ☒ Ph.D. ☐ Integrated Ph.D.

ADVISOR APPROVAL

APPROVED.

Prof. Dr. Timur Han GÜR