國 立 政 治 大 學 經 濟 學 系 研 究 所

博士學位論文

歐盟國家之貨幣與通膨

The money and inflation in European union countries

指導教授：吳中書　博士

洪福聲　博士

研究生：謝衣鳳　撰

中 華 民 國　一 ○ 八　年　七　月

Acknowledgements

My deepest gratitude goes first and foremost to Professor Wu, Chung-Shu, my supervisor, for his profound knowledge in economics and being instructive in offering advices for this dissertation. Without him, it would have been impossible for this dissertation to reach its present form.

Also, I would like to express my heartfelt gratitude to all the teachers who guided me into the field of Economics, especially Professor Hung, Fu-Sheng. In addition, I am also deeply indebted to all the oral defense committee members for their precious suggestions.

Finally, I am grateful for my beloved family for their love and indefinite confidence in me. I also would like to thank my friends and fellow classmates who offer kind help to help me overcome all the difficulties throughout the years of study.

ii

Abstract

After the 2008 global financial crisis beginning in the U.S., the major economies have been infected by the global systematic financial turmoil. In that case, major monetary authorities have taken preemptive unconventional monetary policies immediately after the interest rate policy fail to keep financial market functioning. Unconventional monetary policy is usually considered as balance sheet policy in peacetime. Recently, a vast of literatures concerning the effects of balance sheet policy shocks reveal that balance sheet policy shocks affected the output and price level positively. Rather, we find that the monetary base and broad money in European Union countries grew disproportionately after the crisis.

In this paper, we apply two panel data models to estimate the inflation effects in European Union countries. We have several findings. First, ECB coordinated central banks to conduct large-scale assets purchase in the euro area, but balance sheet policy has affected these countries differently. Moreover, the Panel VAR results shows that the inflation effect of the mean group is smaller than the results of most empirical literatures. Besides, each individual European Union country responds to balance sheet policy shocks with heterogeneous inflation effects. In addition, some EU countries, such as Belgium, Cyprus, Denmark, Spain, Ireland, Italy, Luxembourg, Poland, Slovenia, and Slovakia, even show deflation replies. Lastly, empirical results of panel data indicate that inflation and monetary base growth rate reveals a significant negative relation, while inflation and M3 growth rate has a positive relation.
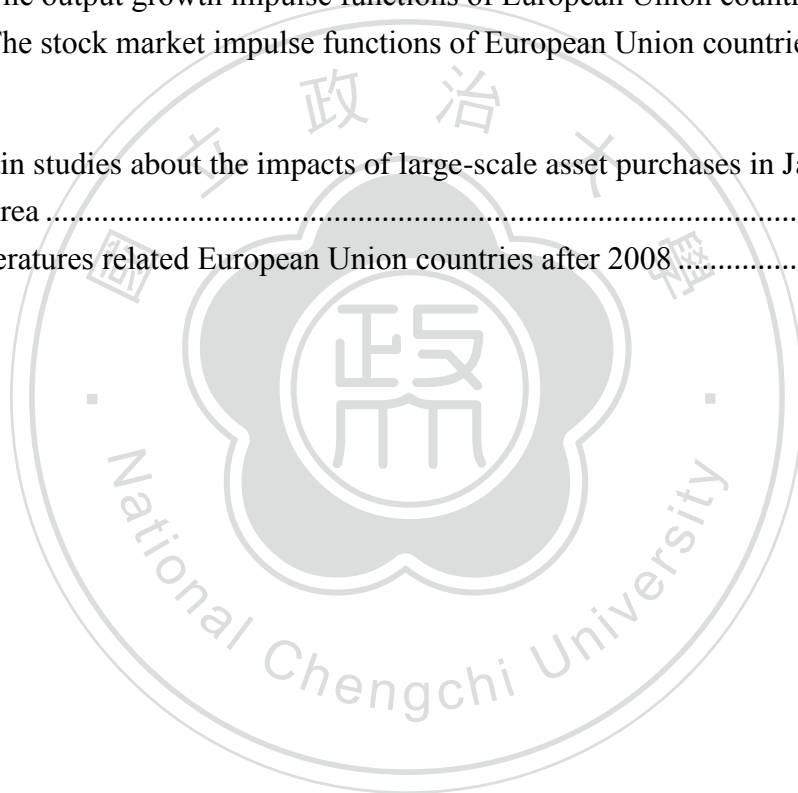
Keywords: Unconventional monetary policy, balance sheet policy, inflation

Contents

Figures and Tables

Chapter 1. Introduction

1.1 Monetary policies since global financial crises

In 2008, the subprime mortgage crisis started in the United States, and then spread out worldwide, leading to a global financial cataclysm. Major monetary authorities faced a serious situation that easing monetary policy, which set the targets of overnight interest rate in the interbank market to nearly zero, failed to help financial system function due to the credit crunch after the subprime mortgage crisis. Meanwhile, these monetary authorities also adopted unconventional monetary policy, such as lending private sector and the government directly, and outright purchasing the government bonds and corporate debt, in order to sustain economic and financial stability. Recently, considerable attentions have been paid to the evidence that these unconventional measures could effectively lower the yields of the government bonds and driver the investor to riskier assets. Meanwhile, central bankers tried to stabilize the financial system by injecting abundant capitals to the private sector through large-scale assets purchasing programs.

The 2008 financial crisis in U.S. originated from the high leverage of housing mortgage in commercial banks and financial institutions in the private sector, which caused to asset price bubble in U.S. Fed used two-pillar monetary policy, i.e., unconventional measure of large scale asset purchasing program and conventional measure of forward guidance, to stable the international and domestic financial markets and stimulate economic activities. Although ECB and major central banks of European union countries adopted unconventional measures to prevent the

6

international systematical risks from transmitting through trade and financial channels, the downswing of global economic situation, major investors of commercial banks and financial institutions in the private sector still lacked of confidence in the future prospects of European countries due to the weakening of economic activities after the severe recession since 2008. The sovereign debt piled up after governments adopted countercyclical fiscal policy as sovereign debts continued to increase in advanced and developed countries.

Fiscal policies are an important aspect concerning these crises; however, in this dissertation we focus on the relationship between money and inflation engendered from monetary policies.

1.2 The empirical facts of monetary policies in major economies during financial crises

From the perspective of quantity theory, the change rate of money growth causes proportional change rate of inflation. However, the empirical studies, such as Lucas (1980), Sargent and Surico (2011), and Grauwe and Polan (2005) indicate that the ratio of money growth and inflation is approximately more equivalent in the early 19th century than that at the end of 19th century. Furthermore, Grauwe and Polan (2005) indicates that in the sample period from 1966 to 1999, different proportions between the change of money growth and inflation come from the differences in inflation intensity in their sample countries, which means the relation between money and inflation is more proportional in the group of high-inflation countries than the group of low-inflation (less than 10

7

percent per annum). During this special period of time since 2008, major economies adopted unconventional measure of balance sheet policy, such as large-scale asset purchases, to increase liquidity by injecting money into the real economy. However, it was hard to perceive the "monetary phenomenon" proposed by Friedman (1963) in the real economies. The rest of this section, the implement of unconventional monetary policy of Japan, U.S. and Euro Area will be discussed in order.

Quantitative easing (QE) was first introduced in Japan; however, the unconventional monetary policy by Japanese monetary authorities did not bail Japan out of deflation, which lasted for two decades. From the QE experience of Japan after asset bubble crisis during 1990's, Bank of Japan (BOJ) conducted interest rate policy first, and shifted to balance sheet policy QE after the zero interest rate policy (ZIRP) failed to stimulate the weak Japanese economy. The BOJ adopted quantitative easing to relieve monetary and financial conditions, but Shizume (2018) illustrates the BOJ data of annual change of balance sheet and 3-year-average GDP deflator between 1892 to 2017 shows that the annual change rate of BOJ balance sheet seems unrelated to the annual change rate of GDP deflator since 1992. It also reveals that the change of balance sheet, whether increase or decrease, does not affect the inflation. In addition, the GDP deflation curve, compared to the previous periods, became smooth from 1987 to 2017, especially volatile during the wartime.

There are controversies as to whether Japanese QE is ineffective in stimulating the weak economy and consequently rise the price level. One stream of literatures, such as Eggertsson and Woodford (2004); Krugman (2000); Svensson (2003), attributes the unavailing of BOJ quantitative

easing to liquidity–trap theory, another stream of literatures, such as Cargill (2000), Ito (2006), Okina and Shiratsuka (2003), attributes the deficiency of monetary policy to the independence gap of BOJ, and the other stream of literature, such as Bernanke (2000), Hamada and Okada (2009); McKinnon and Ohno (2001), attributes the Japanese prolonged stagnation to monetary exchange rate policy.

The Federal Reserve started large-scale asset purchasing programs by buying mortgage-backed securities and treasury notes from November 2008 since the global financial crisis, which is the beginning of Fed quantitative easing process. In Figure 1, it shows the money and inflation of the United States since 2007. From Jan. 2008 to May 2017, it illustrates the US monetary base amount increased 4.45 times; however, the annual growth rate of US CPI was 4.28% in Jan. 2008 and dropped to 1.87% in May 2017. In addition, the indicator of monetary base growth and the indicator of M2 (money supply) growth grow asymmetric as Figure 1 illustrated. Obviously, the increase of monetary base growth does not lead to proportional increase of money supply, and the indicator of inflation maintains flat in the low level. The amount of monetary base increased by 345% in about 10 years, but the amount of M2 was only increased by 80.47% in the same period.

In contrast with the large-scale asset purchasing process of Fed, BOJ quantitative easing seems less effective. Japan implemented quantitative easing from Mar. 2001 to Mar. 2006, and Koo (2011) illustrates that the change of monetary base amount was raised to approximately 65%, but the quarterly growth rate of core CPI remained in the range from negative to
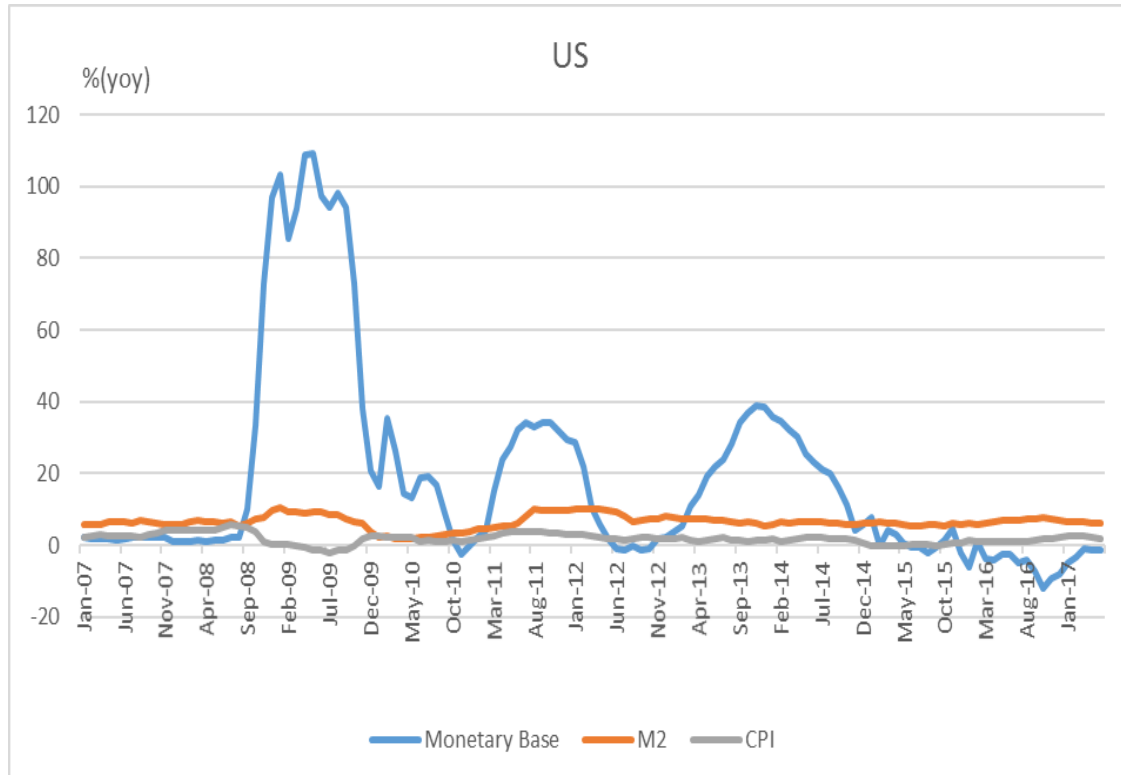
US

%(yoy)

Notes: Monetary Base is adjusted monetary base, M2 is M2 money stock which
　　　 seasonally adjusted, and CPI is Consumer Price Index: Total all items for U.S.,
　　　 all indicators are presented as growth rate of same period previous year, monthly
　　　 data.

Sources: Federal Reserve Bank of St. Louis, and Datastream.

Figure 1 The money and inflation of U.S. 2007–2017

around zero. It is worth mentioning that the Japan banks' lending was even
decreased by approximately 13% after BOJ implemented quantitative
easing, whereupon M2 was increased by merely 9%. As illustrated in
Figure 2, it is found that the growth rate of CPI was climbing before the
global financial crisis and slump below zero after the crisis erupted. The
increase of monetary base does not lead to the increase of money supply
M2; besides, the indicator of monetary base was stable before the 2008
crisis, but started to climb after BOJ conducted comprehensive monetary
easing policy in Oct. 2010. The indicator of inflation took a leap with a
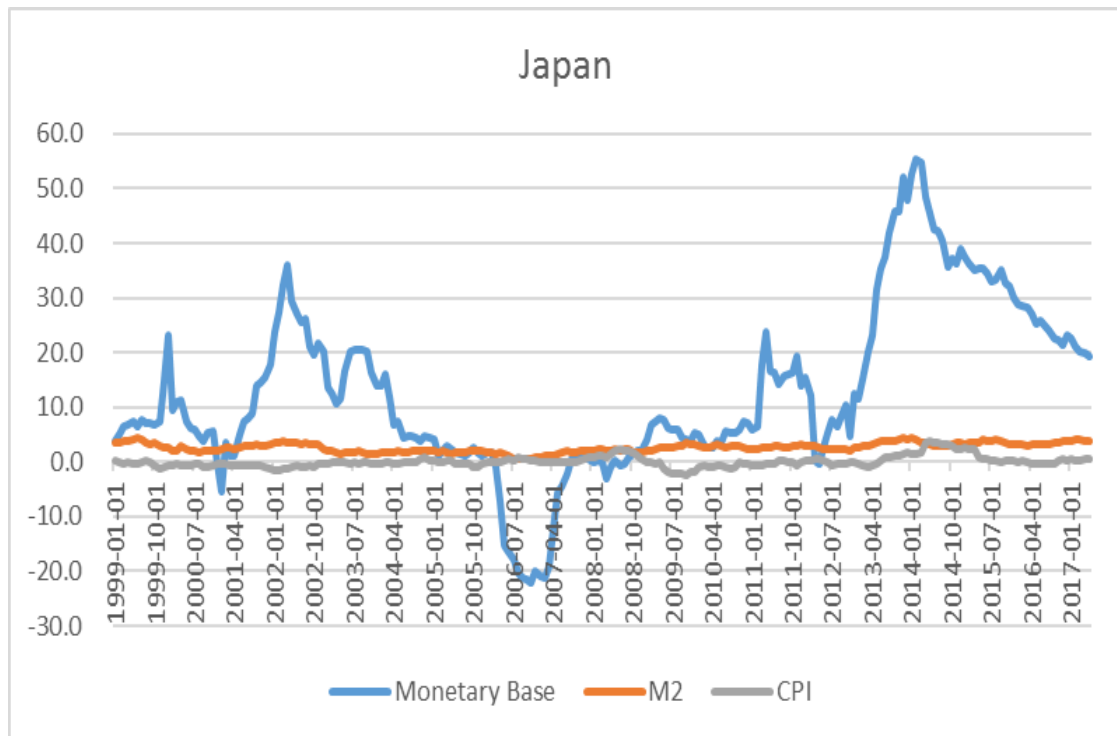
10

Japan

Notes: Monetary Base is adjusted monetary base, M2 is M2 money stock which seasonally adjusted, and CPI is Consumer Price Index: Total all items for Japan, all indicators are presented as growth rate of same period previous year, monthly data.

Sources: Bank of Japan, and Federal Reserve Bank of St. Louis.

Figure 2 The money and inflation of Japan 1999–2017

dramatic increase in monetary base growth rate after the earthquake took place in March 11th 2011; however, the indicator of inflation began to decrease after BOJ conducted a new unconventional measure – quantitative and qualitative easing (QQE) in Apr. 2013.

Following the 2008 financial crisis, the European sovereign debt crisis took place in early 2010. The central bankers of European Union adopted intensive unconventional monetary measure to remedy severe economic
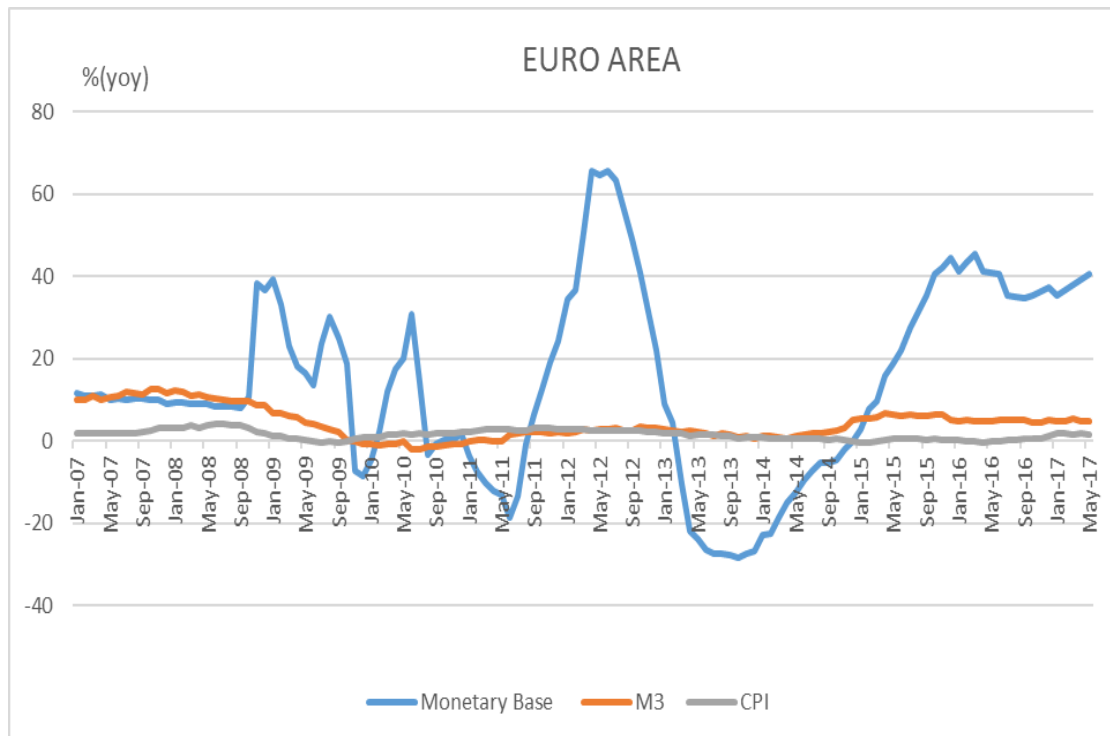
EURO AREA

Notes: Base money is seasonally adjusted Base money, M3 is monetary aggregate M3, and CPI is Consumer Price Index: Total all items for Euro Area. all indicators are presented as growth rate of same period previous year, monthly data.

Sources: European Central Bank, and Federal Reserve Bank of St. Louis.

Figure 3 The money and inflation of Euro Area 2007–2017

and financial situations[1]. Figure 3 demonstrates that the CPI growth rate in the euro zone stood at around 4% in Jun. 2008, but dropped to -0.7% in Jul. 2009; the CPI growth rate subsequently remained at constantly low level from Jul. 2009 to Nov. 2011. ECB conduct the interest rate policy and balance sheet policy in turns during this period.[2] After Nov. 2011, the inflation indicator of euro area was on the process of gradually decreased until Dec. 2014. ECB started to conduct the negative interest rate policy

---

[1] See Appendix Table I. It lists the major monetary measures of US., Japan and Euro area after 2008 global financial crisis.

[2] See Appendix Table I.

12

after governing council lowered the interest rate of deposit facility under zero on 11th June 2013, and started the asset purchase program (APP) on 1st September 2014. ECB announce to expand the asset purchase program twice on 22nd Jan. 2015 and 2nd Jun. 2016, which enlarge the amount of asset purchase and broaden the target assets.

From the money and inflation data of major economies, it is found that the indicators of broad money growth, M2 or M3, are not in accordance with the rising of monetary base growth. It reveals that major monetary authorities expand the monetary base by conducting unconventional monetary measures to maintain the liquidity of financial system, but did not produce proportional money supply in the real economy. Koo (2015) also indicates that these unconventional monetary measures implemented by major central banks fail to stimulate real economy, owing to the contraction of real economic activities after the rapid increase of economy growth. The balance sheet recession may lead to the investment shrinkage in the private sector and unable to produce the sufficient money supply through the lending channel of private financial sector into the real economy. In tradition, monetary authorities increase money supply by money multiplier created when commercial banks lend to households and firms. Once the process of the money creation is obstructed, these unconventional monetary measures may not affect the real economic activities and thereby has less effects on the output and inflation. Thus, those major economies launching unconventional monetary policy after the crises do not induce the pressure of inflation.

Recently, a vast of literatures, such as Peersman (2011), Hausken and Ncube (2013), Gambacorta et al. (2014), and MacDonald (2017), discuss

the effects of major economies implementing balance sheet policy, which consider euro area a single sample or merely focus on several critical economies, such as U.K, Sweden et al., and overlook countries in euro area have different circumstances of national economic and financial condition, balance of trade, government revenue, and expenditure. Besides, there are some literatures, such as Casiraghi et al. (2013), and Fratzscher et al. (2016) et al., that are concerned on the effects of ECB balance sheet policy, but omit the non-euro countries, especially non-euro European Union (EU) countries. Moreover, some literatures, such as Boeckx et al. (2014), Bluwstein and Canova (2016), Kuchařčuková et al. (2016); Moder (2017) et al., that focus the effects of balance sheet policy on few European countries but omit the heterogeneities of the other countries.

Based on the Treaty on Functioning of the European Union and the Statute of the European System of Central Banks and of the European Central Bank, European Central Bank (ECB) cooperate with the national central banks of countries adopting the euro to maintain the euro-area price stability.[3] Meanwhile, ECB also works with central banks of all EU member countries under the European System of Central Banks (ESCB) which is in charge of the intra-ESCB cooperation.[4] In the single market framework, each EU country guarantees the free movement of most goods, services, money and people; although every non-euro EU country has its own monetary policies, whether conventional or unconventional, the tight connections through trade link and remittance flows within euro area

---

[3] Based on the Treaty on the Functioning of the European Union and the Statute of the European System of Central Banks and of the European Central Bank, The ECB was funded as the center of the Eurosystem and the ESCB for the single monetary policy of EU.

[4] The ESCB comprises the ECB and the national central banks (NCBs) of all EU Member States whether they have adopted the euro or not.

countries make it extraordinary affected by the balance sheet policy from countries which implement unconventional monetary measure.

In the next section, we will discuss the money and inflation outlook of European Union countries.

1.3 Some money and inflation outlook of European Union countries after 2008

This section follows on from the previous section, which outlined the money and inflation facts about European Union countries. Compared to the euro area money statistics (in Figure 3), we review the statistics of five euro-area countries, Portugal, Ireland, Italy, Greece, and Spain, which experience unprecedented pressure of sovereign debts default due to weakened economic output after late 2008, budget deficit and high-level debts. In Figure 4, the indicator M3 of these five countries started to decrease after subprime mortgage crisis. In May 2017, the total amount of broad money M3 of Greece lowered as half as the amount in Jan. 2008, and this result was owning to different monetary policies.

In general, the broad money is decreasing gradually in comparison with the conditions before the crises, even though the national central banks indeed expanded the monetary base by balance sheet policy. This implies the fact that the effects of unconventional monetary policy were neutralized in countries suffered from or were under the threats of sovereign debt defaults. Clearly, the different economic and fiscal conditions make the heterogeneities of the money statistics within euro-area countries, even under single monetary authority. On the other hand,

15

those non-euro countries but later joined European Union – the single market framework reveal the different money statistics.
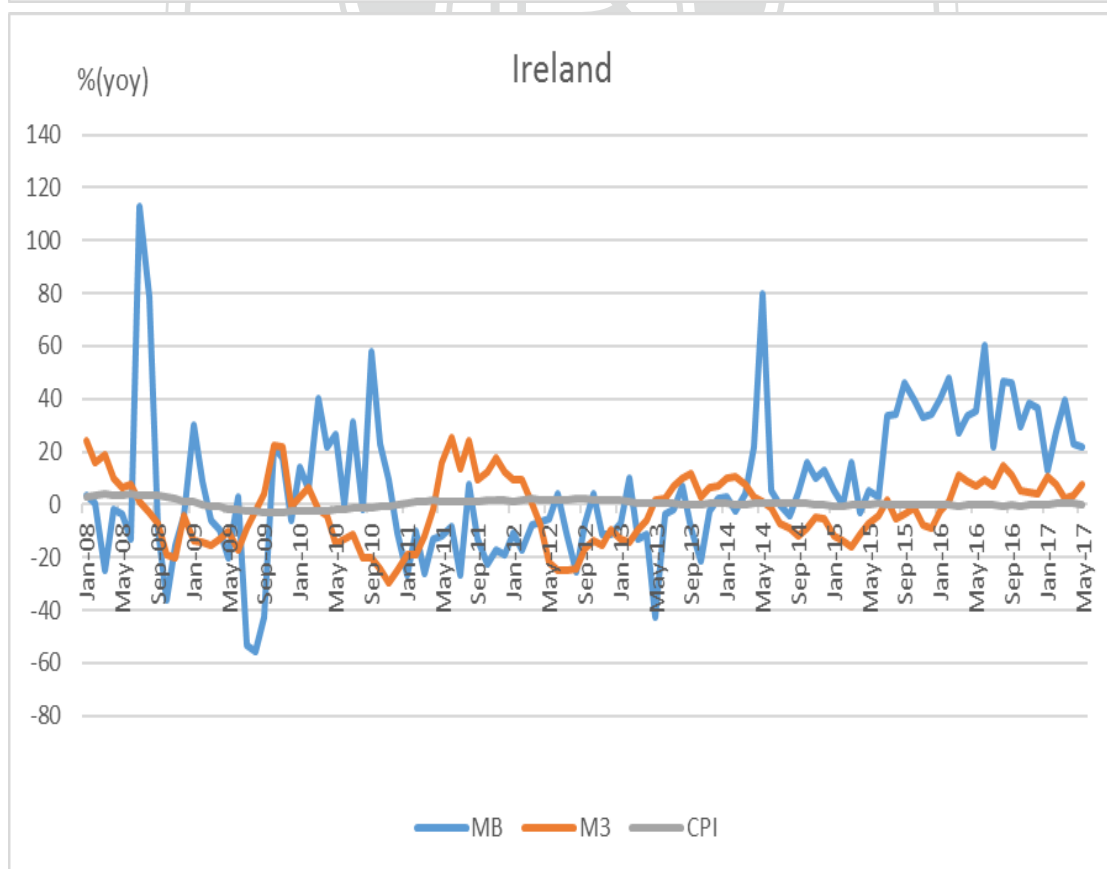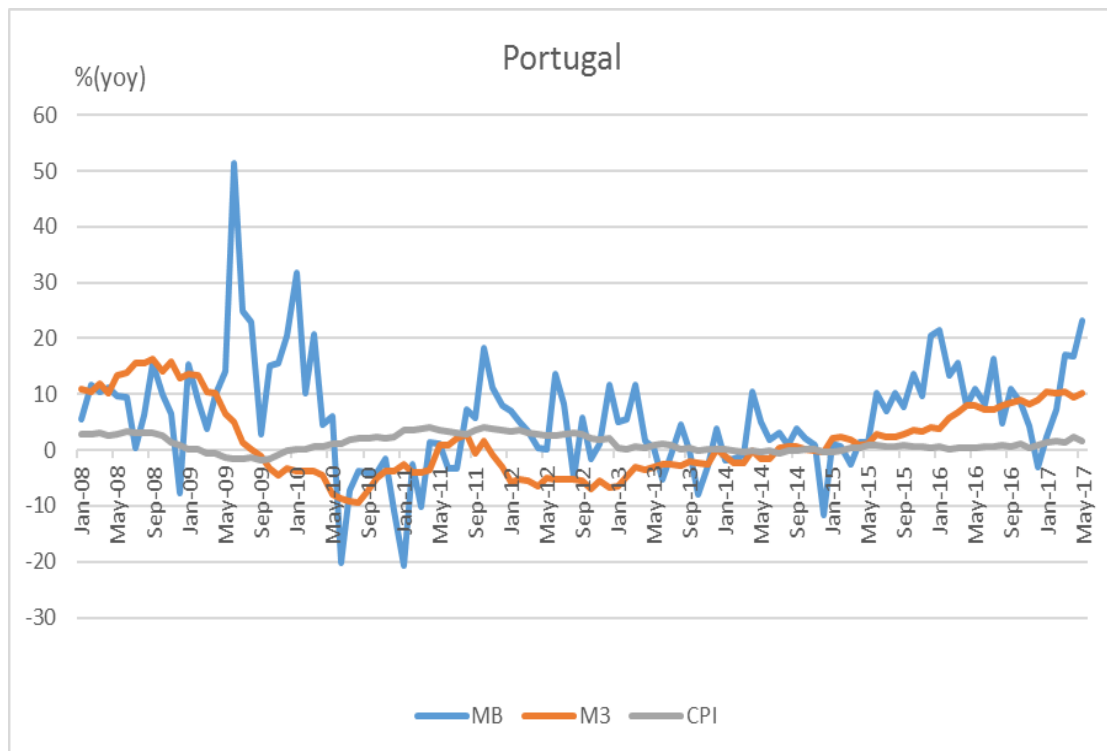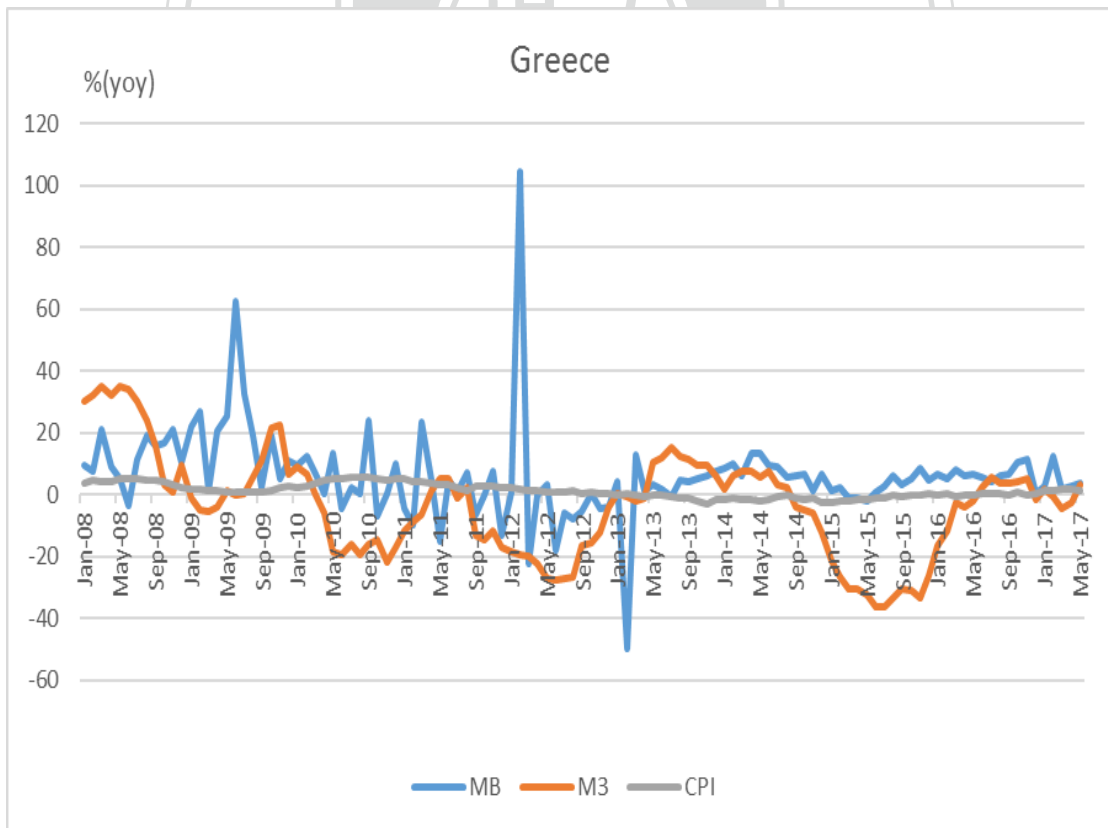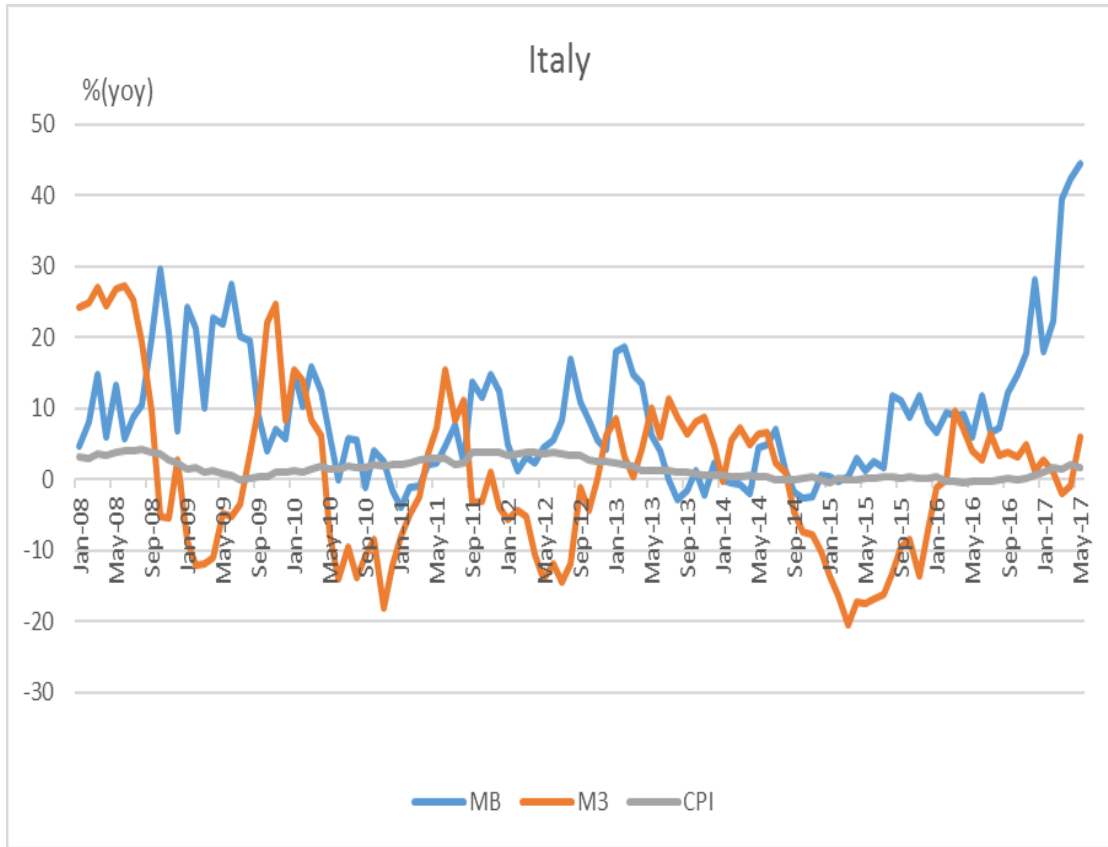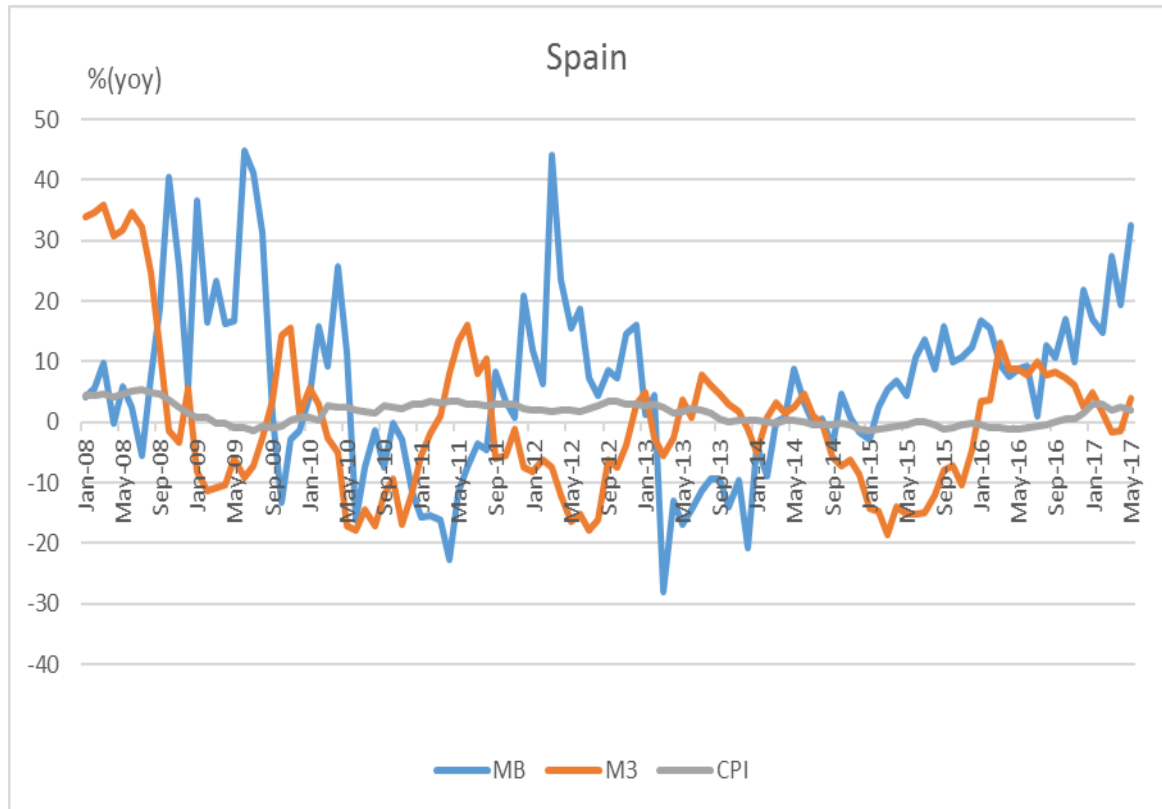
Portugal
%(yoy)

Ireland
%(yoy)

Italy

%(yoy)

MB — M3 — CPI

Greece

%(yoy)

MB — M3 — CPI

17

%(yoy)

Spain

Notes: CPI is All-items HICP, all indicators are presented as growth rate of same
period previous year, monthly data.
Source: Datastream, and Eurostat.

Figure 4 The money and inflation of PIIGS 2008 - 2017[5]

Figure 5 shows that the money and inflation statistic of central
European countries (CEC), the Czech Republic, Hungary, and Poland. It
illustrates that monetary base of Czech and Poland increased rapidly after
ECB conducted zero interest rate policy while the indicator of Hungary
increase after ECB proceeding securities market program. The indicator of
M3 was in a higher level than monetary base before the rapidly rise of
monetary base.[6] Corresponding to other major economies, the rapid
increase of monetary base; however, does not cause the proportional

---

[5] PIIGS is an acronym for five euro-area countries, i.e. Portugal, Ireland, Italy, Greece, and Spain.
[6] See Appendix Table I. It lists the major monetary measures of US., Japan and Euro area after 2008
global financial crisis.

18

Czech

Hungary

19

Poland

Notes: CPI is All-items HICP, all indicators are presented as growth rate of same
period previous year, monthly data.

Source: Datastream, and Eurostat.

Figure 5 The money and inflation of CEC 2008 – 2017

increase of money supply. Another group of money statistics, Finland and Luxembourg, is illustrated in Figure 6.[7] Compared to euro-area indicator of monetary base in Figure 3, the expansion of monetary base on this group are extremely large than other euro-area countries. The growth rate of Finland's monetary base reached its all-time peak of 300% after sovereign debts crisis; its overall scale of monetary base increased by 9.32 times after the ECB began its zero-interest rate policy. Similarly, growth rate of Luxembourg's monetary base reached its peak of 500%, while the overall scale of its monetary base grew by 12.13 times before the crises.

---

[7] The rest of money and inflation figures of individual European Union countries are collected in the appendices.

20

Notes: CPI is All-items HICP, all indicators are presented as growth rate of same
period previous year, monthly data.

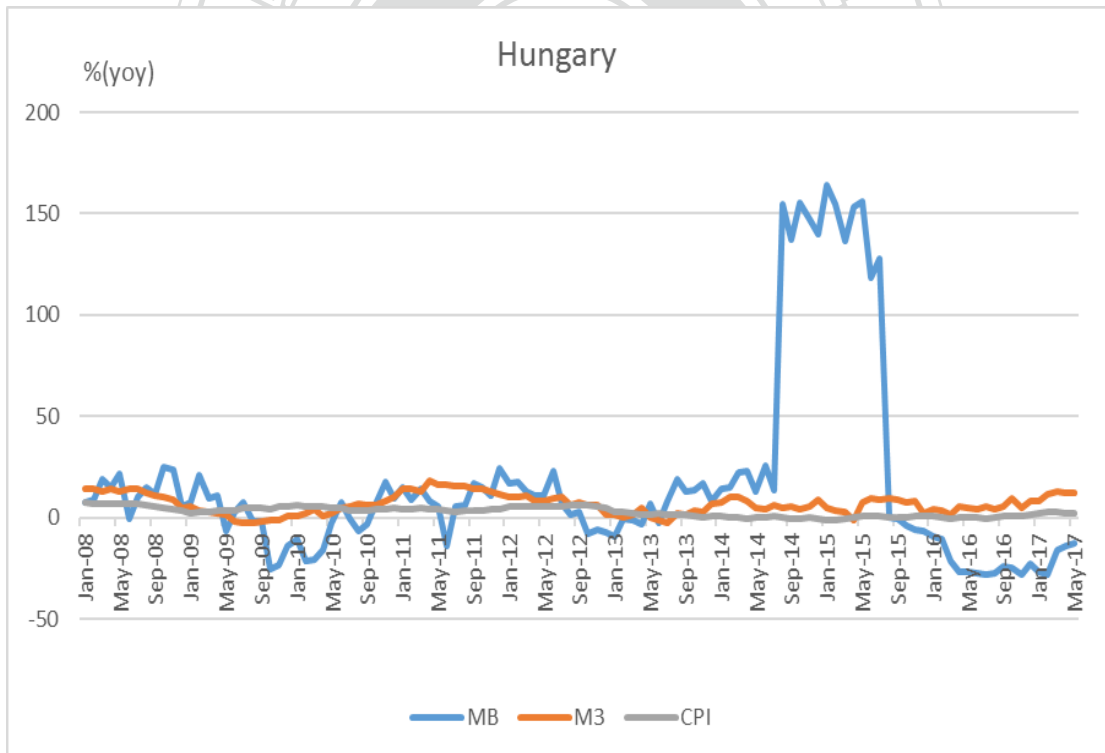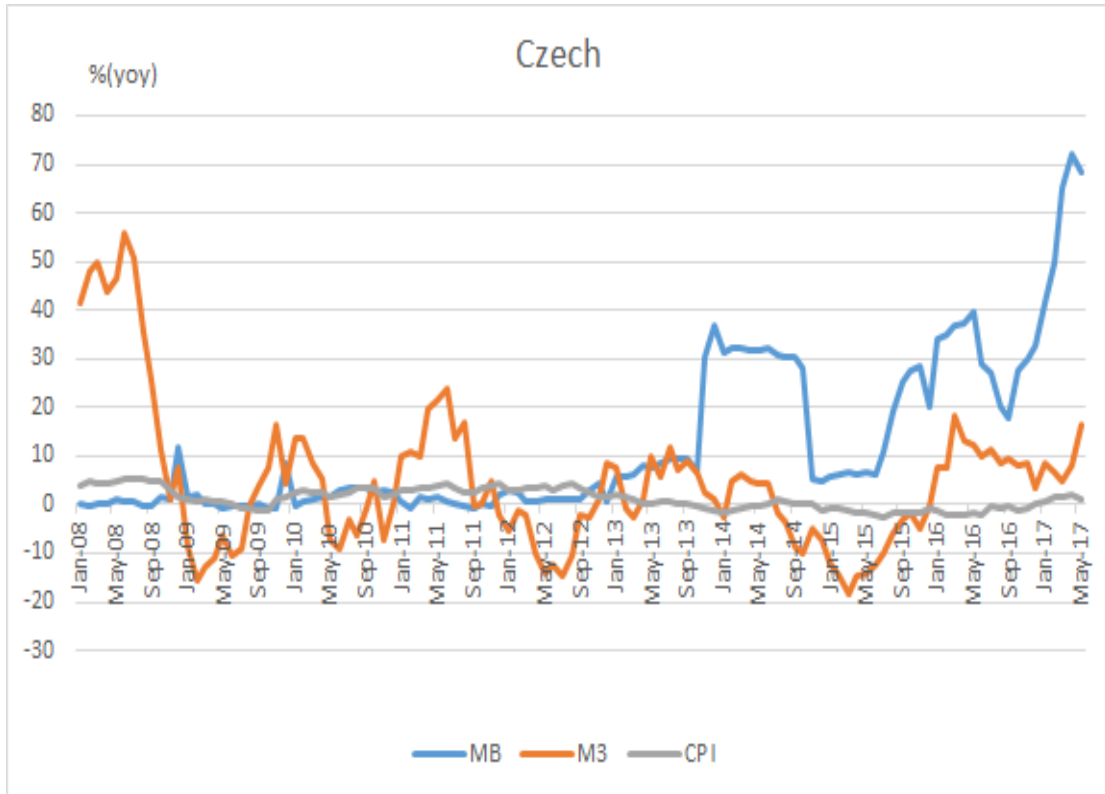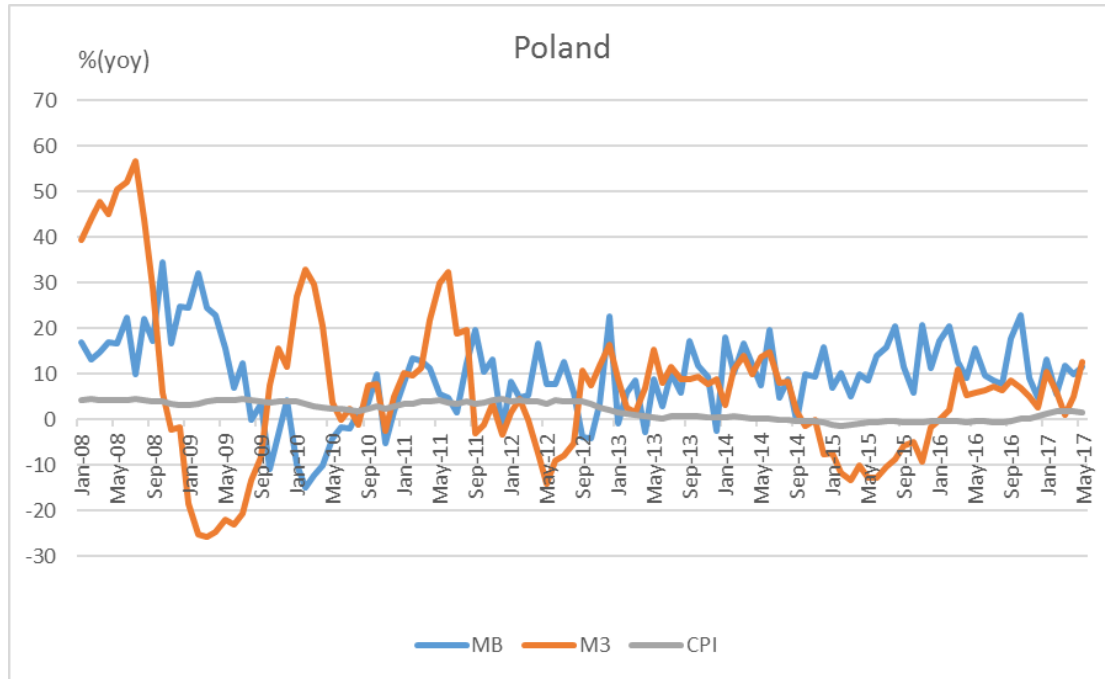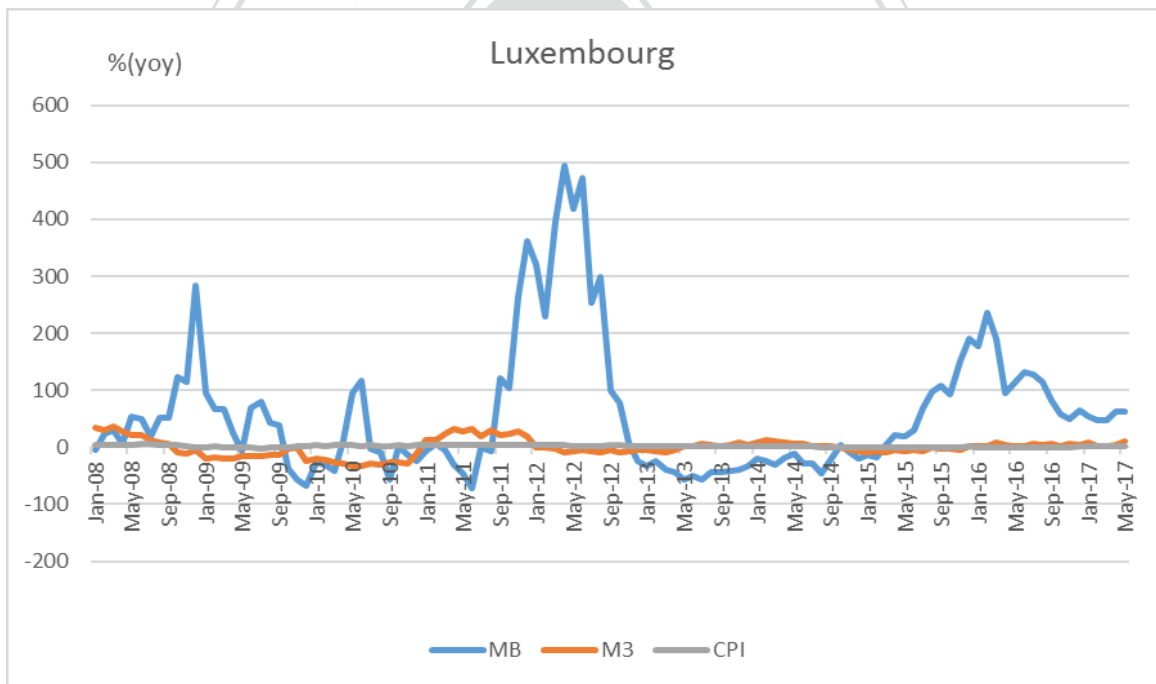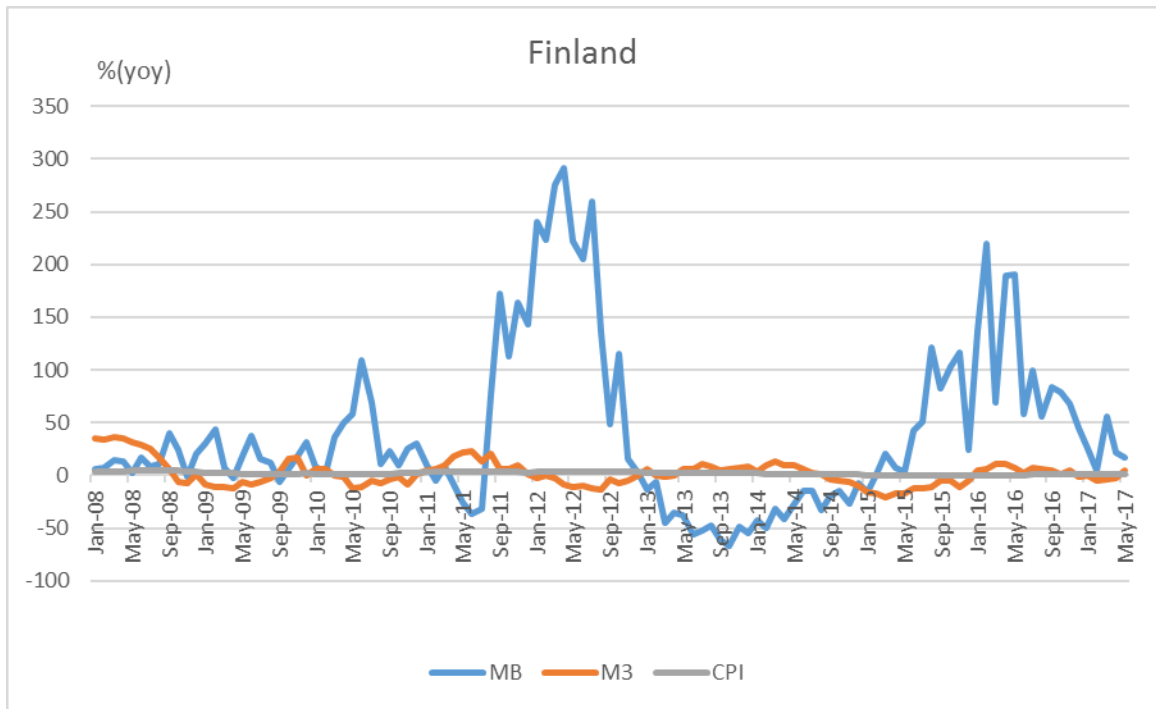Source: Datastream, and Eurostat.

Figure 6 The money and inflation of Finland and Luxembourg
2008 – 2017

These empirical facts of money are obviously counterintuitive, but

21

take whole euro area as single sample would overlook the heterogeneities between individual European Union countries. Rather, there are less literatures investigating the reasons why euro area countries, which adopting unconventional monetary policy, but encounter heterogeneities of inflation. In this study, we propose an alternative way to assess the more information of the effects of central bank balance sheet policy from these heterogeneities of European Union countries.

1.4 Research Motivation and Method

As discussed above, the U.S. model of implementing unconventional monetary policy seems effective in stimulating economic activities from the great recession after the subprime mortgage crisis. In 29th October 2014, the FOMC announced the end of large-scale asset purchasing program and prepared for the normalized stance of monetary policy. In 16th December 2015, it was the first time that FOMC increased the target range of federate fund rate since the crisis. On the contrary, the BOJ went through two process of unconventional monetary policy in two decades, which conducted quantitative easing from 2001 to 2006, and conducted the quantitative and qualitative monetary easing (QQE) from 2013 until now. As a result, Japanese still struggle to dispose of the "era of deflation."

In preceding two sections, we discuss the money and inflation statistics of euro area and individual European Union countries. When we take individual country out of the whole euro area, the money and inflation statistics reveals the dissimilarities from the overall statistics. These dissimilarities also exist in the comparison of preceding section (as shown

in the Figures). Obviously, the global financial crisis was transmitted through trade links, capital flows, and commodity prices, and consequently, each individual European Union country was influenced differently due to its circumstance, fiscal policy and some countries conducting its own monetary policy. However, the balance sheet policies conducted by ECB may affected these European Union countries in different degrees.

The ECB is the core of all the national central banks that coordinates and conduct the "single" monetary policy, whether conventional or unconventional. However, individual countries have different circumstances of government revenue and expenditure, balance of trade, and economic conditions. The effects of balance sheet policies differ in the heterogeneous European economies. Because of this, we use a panel vector autoregression (PVAR) model to highlight the cross-country dimensions of individual European Union countries, and hope to shed some light on the relationship between money and inflation during economic downturns.

In the first part of estimation, we expand the application of panel vector autoregression (VAR) model of Gambacorta et al. (2014) from the original eight economies to include twenty-eight EU countries. The model designed is beneficial to use less macroeconomic variables by panel technique for exploiting the cross-country feature to acquire more empirical analysis. In particular, Gambacorta et al. (2014) emphasizes on the high degree of commonality existing in monetary policies implemented, financial market dynamics, and business cycles of the eight major economies in their studies. However, the dissimilarities existing in all aspects as mentioned above, especially dealing with 28 sample countries of European Union.

23

As the result, we find that the commonality is not the requirement for this model set and heterogeneities existing in each individual country on the way of recovery from these financial crises, beyond the regional statistics. On the whole, macro variables setup of this model depicts critical collective factors of these finance crises and make the analysis tractable. It is found that balance sheet policy shock leads to significant but very small rise in output growth and inflation, the peak value in the mean group estimation is 0.007% and 0.0016%, respectively. These results are smaller than Euro Area results of Gambacorta et al. (2014), and we find individual country impulse function of inflation fluctuating divergently to reply balance sheet policy shocks.

Secondly, we use the panel data models additionally to examine the correlated variables with inflation in literatures in order to discover the crucial factors inducing the heterogeneity of inflation. In panel data model, we find that monetary base has counterintuitive relation with the inflation of each country. In some EU countries, the monetary base even has negative relation to inflation. The remainder of paper is organized as follows. The following section presents the related literatures. The succeeding sections discuss the econometric model and the results. The final section concludes and discusses implications of the results for theoretical modelling and policy.

Chapter 2. Literature Review

Since the 2008 global financial crisis, the policy rates have reached the effective lower bounds, and central balance sheets have replaced the interest rates as the main policy instrument. It is also called the unconventional monetary policy, distinguished from the conventional interest rate policy; moreover, using central banker balance sheets to influence monetary and financial condition usually involves large-scale asset purchases, thus entitled quantitative easing as well. BOJ was the first fulfillment of quantitative easing while interest rate policy is invalid to stimulate the economy and stop the deflation after Japanese asset price bubble. From the empirical experience, balance sheet policy does not necessarily decouple with interest rate policy. Federal Reserve, Bank of England and ECB are the examples. During central bankers fulfilled balance sheet policy after the crisis, the policy rates of these countries were still positive.[8]

In European Union member countries, most monetary authorities, such as ECB, BOE, and Riksbank, expand the size of monetary base by large scale assets purchase, and consequently increase the currency, central bank liabilities and deposits, the liquidity in the financial system, but does not increase the lending and money supply in the private sector. This process, as quantitative theory suggested, might result in the phenomenon that too much money chasing too few goods; yet, the inflation does not

---

[8] Borio and Disyatat (2010) indicates that unconventional monetary policy is "not really unconventional" essentially. There are some reasons. First, the key feature of balance sheet policies is that they can be entirely decoupled from the adjustment of target interest rates. Second, unconventional monetary policy is just central bank operation targeted a specific market segment chosen.

come up with expansionary of monetary base. Literatures indicate that central banks act as the purchaser-of-the-last-resort to acquire the unreceptive government debt by private capital market lead to hyper-inflation (Fischer et al.,2002). However, the European Union countries after the global financial crisis are not the case.

The Effects of balance sheet policy implemented in European Union countries are divergent, which not endangered by the high inflation. As we discussed in the preceding chapter, the imbalance between monetary base and money supply may result in that soaring inflation disappeared while major monetary authorities expanded their balance sheet by acquiring extremely large-scale assets in both public and private sectors. In the following chapter, we firstly review literatures about the effects of Japan, and U.S. balance sheet policies conducting, and then scrutinize those literatures concerning the European countries balance sheet policy implemented after the financial crises erupted.

2.1 The effects of balance sheet policy after the crises: approaches and empirical evidences

There are several approaches in studying the effects of balance sheet policy on macroeconomic variables. Among them is the dynamic stochastic general equilibrium based (DSGE-based) model, the examples of this stream are Gertler and Karadi (2013), Chen et al. (2012), and Cova et al. (2015). Others, such as DSGE-based models with counterfactual analysis, adopted an estimated shadow rate describing the relations between different yields and policy rates. The example are, Cova et al. (2015) and Wu and Xia (2016). Second approach is vector autoregression

(VAR) model with varieties of specification. Our estimation belongs to this classification. The examples are, Gambacorta et al. (2014), Weale and Wieladek (2016), and Michaelis and Watzka (2017). As well, a branch of VAR literatures are adopted shadow rate to describe different macroeconomic circumstances, such as Hausman and Wieland (2014), Wu and Xia (2016), and Kucharčuková et al. (2016). The other approaches are based on the large-scale macroeconomic model consisting of estimated equations for specific economy and supported by national central bank, such as Q-JEM. (Kan et al.,2016)

We find that literatures concerning the relationship between money and inflation after 2008 normally discuss the impact of balance sheet policy conducting on inflation. Therefore, we draw some attentions on this strand of literatures. In Table 1, we list most literatures concerning the balance sheet policy conducting, and results of the macroeconomic effects. Literatures reveal a general agreement with that the balance sheet policy is effective on the recovery of economic activities. From the money and inflation outlook of major economies and European union countries, monetary authorities deploy the tools unprecedentedly, however the growth of output and inflation are stubbornly low. In particular, Haldane et al. (2016) conduct a SVAR estimation from 2008 to 2015, which consisted of UK, US, Japan, Euro Area, Sweden, and Canada, and the output as well as inflation effects after imposing balance sheet policy reveal negative in some economies, such as Euro Area, Japan, Sweden, and Canada. Haldane et al. (2016) indicate that the effects of central bank balance sheet expansion vary over time, and the spillovers effects are stronger in the advanced economies through the financial market channels.

27

Table 1 Main studies about the impacts of large-scale asset purchases in Japan, US and Euro Area

Study	Countries/ Data set	Time span	Methods	Results description (Peak impact of GDP and CPI)
Japan				
Hausman and Wieland (2014)	Japan	1996:Q1 to 2012:Q4	VAR and forecast-based counterfactuals	Abenomics has an effect of 1.1 to 1.8% on 2013 GDP growth.
Kan et al. (2016)	Japan	2012:Q4 to 2013:Q1; predicting 2014 to 2015	Q-JEM	CPI is increased by 0.3 to 1.5% GDP is increased by 0.6 to 4.2%
De Michelis and Iacoviello (2016)	Japan	1974:Q1 to 1993:Q4; 1994:Q1 to 2015:Q2	VAR	Inflation is increased by 0.8% (analysis of 2% inflation target of BOJ announcement).
Michaelis and Watzka (2017)	Japan	1996:Q1 to 2015:Q3	TVP-VAR	After 1% QE shock, Core CPI is increased by 0.21% (ZIRP), 0.17%(QE1), and 0.23%(Abe), respectively. After 1% QE shock, GDP increased by 0.58% (ZIRP), 0.45%(QE1), and 0.34%(Abe), respectively.
US				
Baumeistera and Benati (2012)	US and UK	1965 to 2011 (simulation for 2009)	TVP-SVAR	GDP growth is increased by 0.9 % Inflation is increases by 0.5 %
Gertler and Karadi	US	QE1 and QE2	DSGE-based	For QE1: GDP is increased by 3.5%

(2013)			counterfactual	Inflation is increased by 4 % For QE2: GDP is increased by about 1% Inflation is increased by 1.5 %
Weale and Wieladek (2016)	US and UK	Mar 2009 to May 2014	Bayesian VAR	(US)Asset purchase shocks: GDP is increased by 0.58% CPI is increased by 0.62%
Meinusch and Tillmann (2016)	US	August 2007 to March 2013.	Qual-VAR	GDP is increased by 0.1% Inflation is increased by 0.1-0.2%
Euro Area				
Mouabbi and Sahuc (2019)	Euro Area	2014:Q1 to 2017:Q2	DSGE-based model with a set of shadow interest rates	GDP is increased by 1.09% Inflation(year-on-year) is increased by 0.61%
Cova, Pagano, and Pisani (2015)	Euro Area, China, Japan, US, and rest of the world	2015:Q1 to 2016:Q3	DSGE-based model	For euro area, GDP is increased by 1.4% Inflation is increased by 0.8%
Multiple countries analysis				
Haldane et al. (2016)	UK, US, Japan(J), and Euro Area(EA),	For Japan: (QE1) April 2001 to July 2008; (QE2) August 2008 to February	Structural VAR	After 1% QE shock, CPI is increased by -0.1% (CA), 0.1%(EA), 0.45% (to -0.1) % (JQE1), 0.85%(JQE2), -0.18% (SW), 0.025%(UK), and 0.32%(US), respectively. After 1% QE shock, real GDP is increased by -0.8% (CA),

29

| | Sweden(SW), | 2015 | | -0.04 %(EA), 0.38% (J-QE1), -0.1%(to 0.1) %(J-QE2), |
| | Canada(CA) | For others: March 2009 to February 2015 | | 0.04 (to -0.25) % (SW), 0.1%(UK), and 0.35%(US), respectively. |

Note: Q-JEM was large-scale macroeconomic model of Japan's economy consisting of more than two hundred equations, which is estimated to fit historical data to capture key characteristics of the Japanese economy. For Michaelis and Watzka (2017), the results are estimated under three scenarios, which are in zero interest rate policy, quantitative easing, and Abenomics since late 2012.

Source: Borio and Zabai (2018), and Dell'Ariccia et al. (2018).
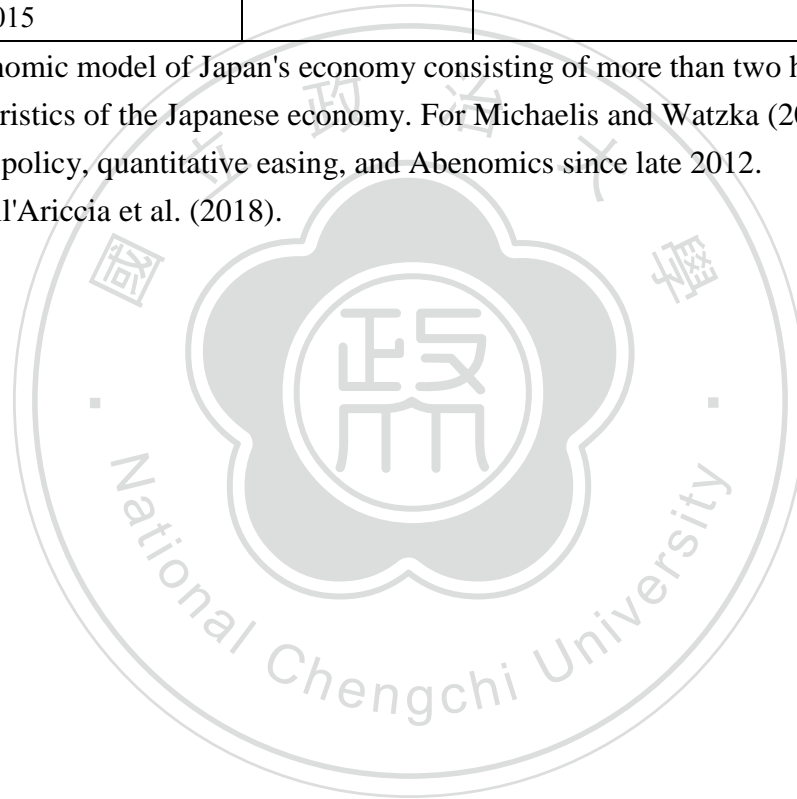
They also illustrated that the overall scale of BOJ's balance sheet assets reached 80% of Japan's nominal GDP and 32% of Japanese government's outstanding debt in 2016 due to Japan's quantitative easing. On the other hand, US Fed's large-scale asset purchases made its balance sheet assets reach 30% of the US nominal GDP and 25% of the US government debt. As a result, Fed has ceased the large-scale asset purchase program, and Quantitative and Qualitative Easing of BOJ is still on-going.

2.2 Literatures related European Union countries

Literatures are limited concerning the relation of money and inflation after the 2008 financial crises. Only four papers discuss the output and inflation effects of the periphery European Union countries from the spillovers of ECB balance sheet policy. This stream of literatures is listed in Table 2. Before scrutinizing each of these papers, we found that the commonality of these papers is the existence of economic interdependence which proved by empirical evidences. Maćkowiak (2006) indicates the economic interdependence exists between euro and non-euro countries in European Union, by demonstrating that ECB interest rate policy (in Germany) has notable spillovers into Czech, Hungary and Poland (CHP). The interest policy of Germany comprises one-third of external effect of CHP real output, nearly half external effect on the price level in Czech and for more than two-thirds in Hungary and Poland. In addition, Hájek and Horváth (2016) indicate that monetary contraction in euro countries drags down the economic growth in all European Union countries, and lead to price levels decreasing gradually in these countries. Besides, industrial

production, CPI and oil price shocks in the euro countries also results in real economic responses in the all EU countries.

Returning to related literatures about the money and inflation in the European Union countries, Bluwstein and Canova (2016) examine both financial and macroeconomic variables with a combination of ECB conventional and unconventional monetary policy shock. In particular, international spillovers of ECB monetary policy occur in the non-euro countries among European Union, and there exist cross-country heterogeneities. They indicate that the macroeconomic effects of balance sheet policy are not identical to euro and non-euro countries. In euro countries, balance sheet measures have ambiguous effects on inflation, but these measures have greater effects on inflation of those non-euro countries. In particular, the output responses are more obvious in advanced non-euro countries – Sweden, Norway, Denmark and Switzerland. On the contrary, the inflation responses of these four countries to balance sheet policy shocks are negative while the inflation responses of rest non-euro countries, CEE and SEE, are positive. Besides, they argue that real exchange regime responses of nine non-euro EU countries are negative appreciation.[9] That says, the exchange rate transmission channel is activated.

---

[9] CEE is abbreviation of Central Eastern European countries. In Bluwstein and Canova (2016), Poland and the Czech Republic are grouped in CEE. SEE abbreviation of Southeastern European countries. In Bluwstein and Canova (2016), Hungary, Romania, and Bulgaria are grouped in SEE.

Table 2 Literatures related European Union countries after 2008

Study	Countries/ Data set	Time span	Methods	Results description (Peak impact of GDP and CPI, and others.)
Bluwstein and Canova (2016)	Advanced countries include Sweden, Norway, Denmark, Switzerland, CEE include Poland, Czech, and SEE include Hungary, Romania, Bulgaria	Dec. 2008 to May 2014, mixed monthly and weekly data	Bayesian mixed-frequency SVAR	Output effects: Advanced countries is large than euro area; besides, CEE is insignificant, and SEE is negative. Inflation effects: CEE and SEE are positive and advance countries are negative.
Kucharčuková et al. (2016)	Euro Area, Czech, Hungary, Poland, Denmark, Sweden, UK	Jan. 2000 to Jul. 2015	VAR	Output effects: Output responses are slow and limited. Inflation effects: Inflation responses are mainly unaffected. Exchange rate effects: Exchange rates respond more quickly, and there is a significant depreciation of non-euro countries which boosts the export.
Moder (2017)	SEE countries include Albania, Bosnia and Herzegovina (BIH), Bulgaria, Croatia,	Jan. 2008 to Dec. 2015, Monthly data	BVAR	Euro area UMP spillover- Output effects: Albania, insignificant; BIH -0.01%; Bulgaria, positive; Croatia 0.05%; Macedonia, negligible; Montenegro 0.05%; Romania, insignificant; and Serbia 0.05%.

	the Republic of Macedonia, Montenegro, Romania and Serbia			Inflation effects: Albania 0.02%; BIH 0.02%, Bulgaria 0.3%; Croatia 0.03%; Macedonia 0.05%; Montenegro, positive; Romania 0.04%; Serbia 0.07%.
Horvath and Voslarova (2017)	CECs include the Czech Republic, Hungary and Poland	Jan. 2008 to 2014, Monthly data	PVAR	Output effects: approximately increase by 11–14% Inflation effects: approximately increase by 2%
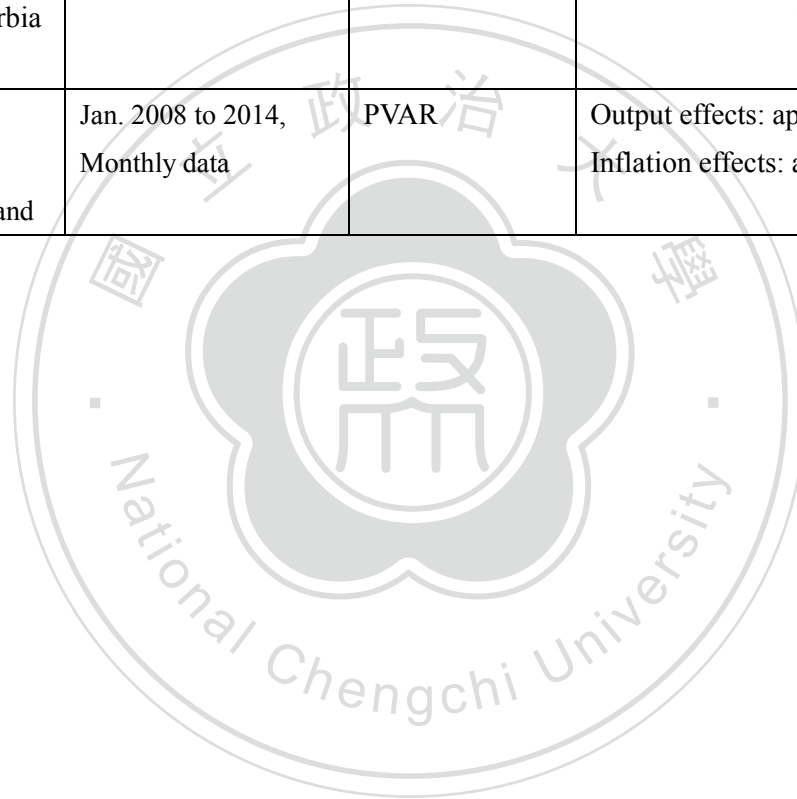
Kucharčuková et al. (2016) indicates that six non-euro countries, including the Czech Republic, Hungary, and Poland (three Central European countries), Sweden and UK (two euro opt-out countries) and Demark (participating in ERM II), respond to ECB balance policy shock divergently, and smaller in comparison with the response to the conventional interest rate policy. More precisely, they indicate that balance sheet policy of ECB does not affect inflation and output significantly; however, it indeed affects the exchange regime quickly. Their conclusion of insignificant inflation and output effects is opposite to the finding of Bluwstein and Canova (2016).

Moder (2017) has a dissimilar results concerning the exchange rate effect of ECB balance sheet policy spillover, and indicates that the exchange regime did not shield from spillovers of ECB unconventional monetary policy. In particular, ECB balance sheet policy affect output and price of South-eastern European countries, especially in prices. Likewise, Horvath and Voslarova (2017) concur with Moder's finding. They find that ECB unconventional monetary policy had affected economies of CECs greatly. The peak output responses of CECs to ECB balance sheet policy shocks are around 11 – 14%, while the price responses are around 2%.

As listed in Table 1, existing literatures usually regard euro area as single economy in the discussions of the inflation and output effects of balance sheet policy shocks. It is difficult to discuss these effects by each individual country. As to European Union countries, existing literatures, Gambacorta et al. (2014), Weale and Wieladek (2016), and Haldane et al. (2016), only adopted countries, like UK, Sweden, for individual analyses. This may overlook the dissimilarities of the inflation responses of

35

individual countries to the expansion of central bank asset which is linked with the expansion of monetary base. As we mentioned in Chapter 1, the money and inflation indicators reveal disproportionate in not only major economies but also the small economies of European Union countries since late 2008, and the heterogeneities of the inflation responses may provide us more information about the imbalance between the money and inflation.

Chapter 3. Empirical processes and results

3.1 European Union Cross-Countries Evidence: Panel Vector Autoregression

In this estimation, we aim to clarify the relations between heterogeneities of individual country inflation response to the balance sheet policy since late 2008. We use the panel VAR model with stochastic volatility to outline macroeconomic variables to balance sheet policy shock over time.[10] Our empirical approach follows Gambacorta et al. (2014). The advantages of this model are, firstly to identify common economic factors to all economies in the economic depression after financial crises, and secondly to use mean group estimator that allows cross-country heterogeneity and does not require the identical structures and dynamics of the economies in the VAR model.[11] This is particularly important because it allows us to consider different responses across countries to the shock of balance sheet policy measures.

The Panel vector autoregression (VAR) model is estimated as following equation:

$$Y_{i,t} = \alpha_i + A(L)_i Y_{i,t-1} + B_i \varepsilon_{i,t} \tag{1}$$

where $Y_{i,t}$ is a vector of the following endogenous variables for each European Union country i in time t :

---

[10] As Gambacorta et al. (2014) indicated, structural VAR have been extensively used to analyze the macroeconomic effects of monetary policy. For instance, structural VAR are applied in Bernanke and Blinder (1992), Strongin (1995), Bernanke and Mihov (1998), and Christiano et al. (1999) to study the United States; Peersman and Smets (2003), the euro area.

[11] However, this model does not capture the cross-country spillover effects of balance sheet policy measure. In that case, the balance sheet policy shocks for those countries, which not adopting unconventional monetary policy, originate from the open operations of national central banks.

1. $\text{RGDP}_{i,t}$：the nature log of seasonally adjusted real GDP,

2. $\text{CPI}_{i,t}$：the nature log of seasonally adjusted consumer price index;

3. $\text{TA}_{i,t}$：the nature log of seasonally adjusted central bank total assets;

4. $\text{SI}_{i,t}$：the nature log of seasonally adjusted stock market price index.[12]

α_i is a vector of constants for each European Union country i, $A(L)_i$ is a matrix polynomial of the lag operator L, and B_i is the contemporaneous impact matrix of mutually uncorrelated disturbances ε_i for countries $i = 1, \dots, \text{N}$.

The specification of this model simplifies and explains the features in the period conducting balance sheet policy, which includes: (i) the aggregate output and prices to capture the macroeconomic dynamics, (ii) the assets holdings by the central banks at the zero lower bound, and (iii) the major stock market index of each country to capture the financial market turmoil.[13] In addition, we expand the analysis of Gambacorta et al. (2014) by examining balance sheet expansions of central bank in a broader set of sample countries and across a broader span of sample period from January 2008 to May 2017, and twenty-eight European Union countries, i.e., namely Germany (BD), Belgium (BG), Bulgaria (BL), Croatia (CT), Cyprus (CP), Czech (CZ), Denmark (DK), Estonia (EO), Spain (ES), Finland (FN), France (FR), Greece (GR), Hungary (HN), Ireland (IR), Italy (IT), Latvia (LV), Lithuania (LN), Luxembourg (LX), Melta (MT),

---

[12] All the data in this paper is gathered from the Data Stream. About decomposing quarterly real GDP data in order to parallel available monthly monetary data, we use Eviews software (time-series frequency conversion function) to convert quarterly data to monthly data, and choose cubic type of low to high frequency method.

[13] Haldane et al. (2016) demonstrated that QE has an upward pressure on the price of corporate bonds and equities, while put a downward pressure on the exchange rate. Furthermore, there is one stream of literature after the crisis proves that unconventional monetary policy surprise affected the stock returns. (Glick and Leduc 2012, Wright 2012, Rogers et al. 2014)

Netherlands (NL), Austria (OE), Poland (PO), Portugal (PT), Romania (RM), Sweden (SD), Slovak Republic (SX), Slovenia (SJ), and United Kingdom (UK).[14] Data were taken from national central banks as well as Datastream. We use data of European union countries which consist of 19 Euro countries and 9 non-euro countries in this dissertation.[15] The domestic economies of non-euro countries have high degree of economic interdependence with the ECB monetary policy.[16]

As Gambacorta et al. (2014) suggested, a balance sheet policy shock is identified as an exogenous alteration to central bank balance sheet. The variables are set as policy-makers conduct the monetary measures. In order to accomplish this, we use a mixture of zero and sign restriction on the impact matrix B of equation (1). We adopted the sign identification restrictions which has been proposed to produce the impulse responses by means of implied signs.[17] In our model, we disentangle real economy from balance sheet policy and other financial shocks without imposing a notable impact from the responses of macro-variables by using the mixture restrictions, in order to leave the output and inflation responses open as they are the research inquiries in this estimation. The sign identification assumptions are outlined in Table 3. Conformed to the reference model, we

---

[14] Bluwstein and Canova (2016) state the onset of ECB unconventional monetary in Dec. 2007 when ECB proceeding €271.6 billion reciprocal currency agreement, whereas our sample period starts from Jan. 2008 to Jun. 2017. We find that most of UMP literatures use early 2008 as the beginning of the sample date period.

[15] From official website of EU, the non-euro area member countries are Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Sweden. Member countries negotiate an opt-out from the EU legislation are UK and Denmark.

[16] See literatures, such as Dibooglu and Kutan (2001), Fidrmuc and Korhonen (2003), Laxton and Pesenti (2003), Fidrmuc (2004), and Golinelli and Rovelli (2005).

[17] The mixture of zero and sign restrictions have been conducted by Canova and De Nicolo (2002) and Uhlig (2005) before. By using mixture restrictions, the permissible impulse function is decreased; consequently, it enhances the identification of balance sheet policy shock.

assume the identifying sign restrictions as following. First, it is assumed that impact of shocks to the central bank balance sheet on output and consumer prices is only one lagged. While the same period impact on output and consumer prices is restricted to be zero, the alteration to both variables are allowed to have an instantaneous impact on the balance sheet and stock market volatility.[18]

Secondly, recent literatures suggested that open market operation of securities purchase, such as conducting balance sheet policy, would increase the price of equities, thereby we assume that the balance sheet policy shock would lift the stock market index.[19] These restrictions are bound for only one month after the balance sheet policy shock. Based on the usual lag-length selection criteria, one lags of the endogenous variables are used in the estimations.[20]

Table 3

Zero and sign restrictions of a balance sheet policy shock

Output	Prices	Stock market Index	Central bank assets
log real gdp	log CPI	log SI	log TA
0	0	≥ 0	> 0

Our model is estimation in following steps. First, each equation of

---

reduced-form in the VAR model is estimated at each single country level taking into consideration the correlation among the residuals of the same endogenous variable across 28 countries, i.e. the correlation between all countries output residuals, between all price residuals, between all stock market index residuals, and between central bank balance sheet residuals. Second, we identify the balance sheet policy shocks of each individual economy by using the identification of restrictions in Table 3. Followed by the model designed of Gambacorta et al. (2014), since the shocks in equation (1) are mutually orthogonal, $E(\varepsilon_t \varepsilon'_t) = I$, the variance-covariance matrix Ω of an individual country VAR system is equal to $BQQ'B'$, where B is the Choleski decomposition of Ω, and Q an orthonormal matrix of the form:

$$Q = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & Cos(\theta) & -Sin(\theta) \\ 0 & 0 & Sin(\theta) & Cos(\theta) \end{bmatrix} \qquad (2)$$

with $QQ'=I$. Due to B is the Choleski factor of Ω, variations to output and prices will affect balance sheet and stock market immediately, while the contemporaneous impact of the third and fourth shocks in the system on output and prices is restricted to be zero. As the result, one of them is a variation to the stock market index and the other an exogenous shift to the central bank balance sheet, which disentangled by the sign restrictions. Then, we draw a random θ in the range $[0, \pi]$, where the θ is the same for all countries, and generate the corresponding impulse function for each individual economy:

$$R_{t+k} = A(L)^{-1} BQ(\theta)\varepsilon_t \qquad (3)$$

The requirement of Gambacorta et al. (2014) is that the two remaining

41

shocks satisfy the sign restrictions for all countries simultaneously with the condition $R_{t+k}^{SI} \geq 0$ and $R_{t+k}^{TA} > 0$, and then keep the draw. Otherwise, the draw is rejected. However, we relax the condition of satisfying the sign restriction for all countries to for mean group in order to have enough impulse functions. In accordance with the setting of Gambacorta et al. (2014), we have to repeat the draw by the bootstrapping until having 5000 mean group impulse response functions, and average the impulse response function from the individual economies to get a mean group impulse response function of European Union countries. Even though we relax the requirement, our sample countries are too many to completing the draw.[21] Consequently, we record the 16th and 84th percentiles of this practice in the figures.[22] The mean group PVAR impulse function was shown in the Figure 7. The impulse function indicates that the overall European Union balance sheet policy shocks enlarges the central bank balance sheet about 0.06% which in line with reference model, and diminish to 0.01% about 35 months in our model.[23]

In addition, output growth and inflation reply to the shocks with a slight upsurge, and the summits are 0.008% and 0.006% respectively. On the other hand, stock market index growth, denoted the financial system, is more sensitive to the balance sheet policy shocks with an instantaneous

---

[21] As a result, we take off the data group of Czech and Estonia for completing 5,000 impulse response functions for the rest of countries.

[22] As Gambacorta et al. (2014) suggested, the impulse response bands should not be understood as conventional confidence bands since equation (3) reflects model uncertainty by the draw of θ; as well as the sampling uncertainty by the bootstrapping draw. However, the sign restrictions literatures, such as Giordano et al. (2007) and Bénétrix and Lane (2009), usually consider the 16th and 84th percentiles of the impulse respond distribution as the confidence interval.

[23] Gambacorta et al. (2014) indicate that the ECB unconventional monetary policy shock is characterized by an increase in the euro area central bank balance sheet of about 2.5% that diminish to 0.4% after about 4 months from their impulse function.

upright response, and its summit is about 0.3%. Our mean group PVAR results are in line with literatures, which revealing both output growth and inflation are affected by the shocks, but extremely small.[24]

Output growth

Inflation

---
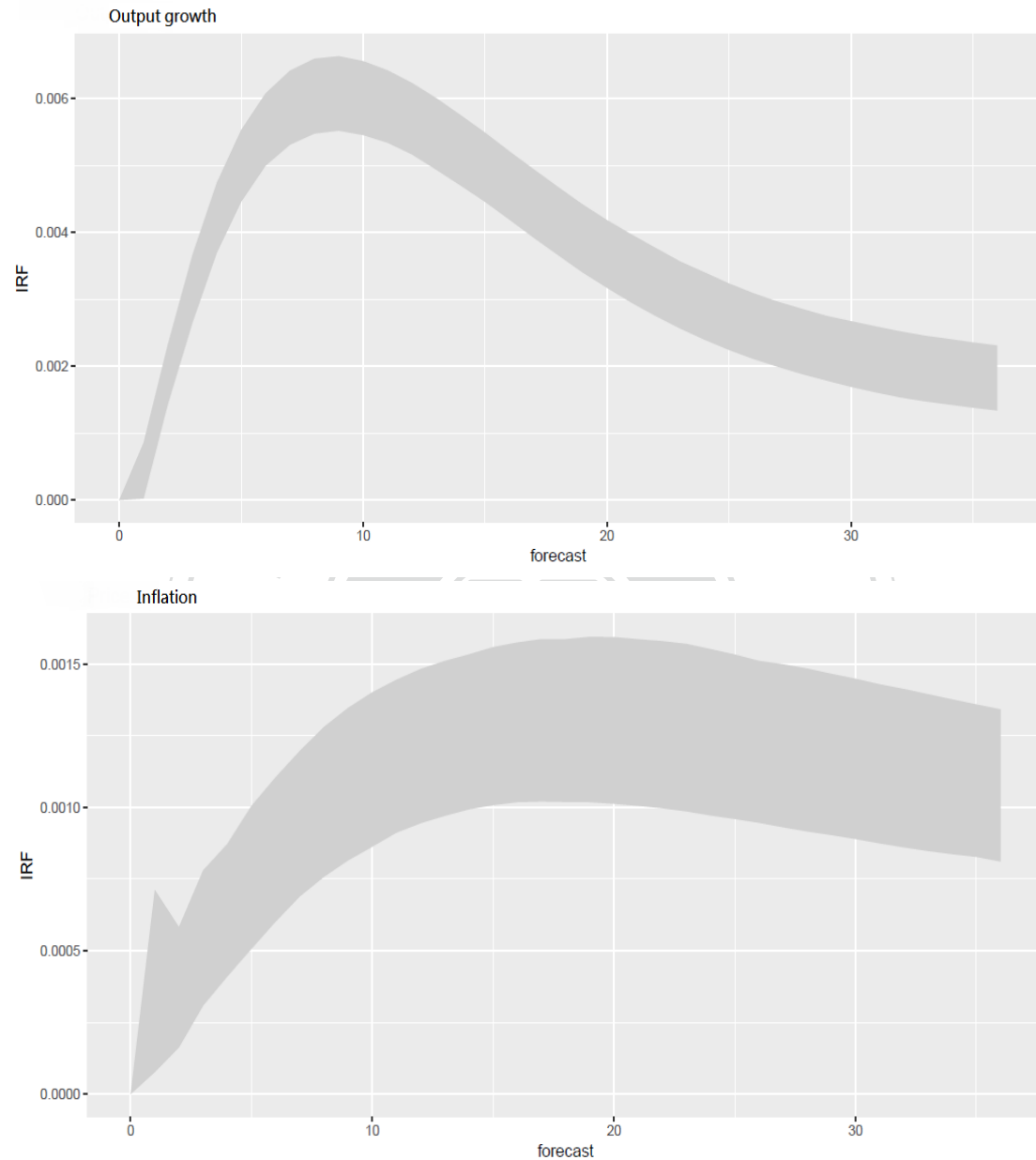
[24] See literatures, such as Baumeister and Benati (2010), Gertler and Karadi (2011), Kapetanios, Mumtaz et al. (2012), Gambacorta et al. (2014), Pesaran and Smith (2016), and Weale and Wieladek (2016).
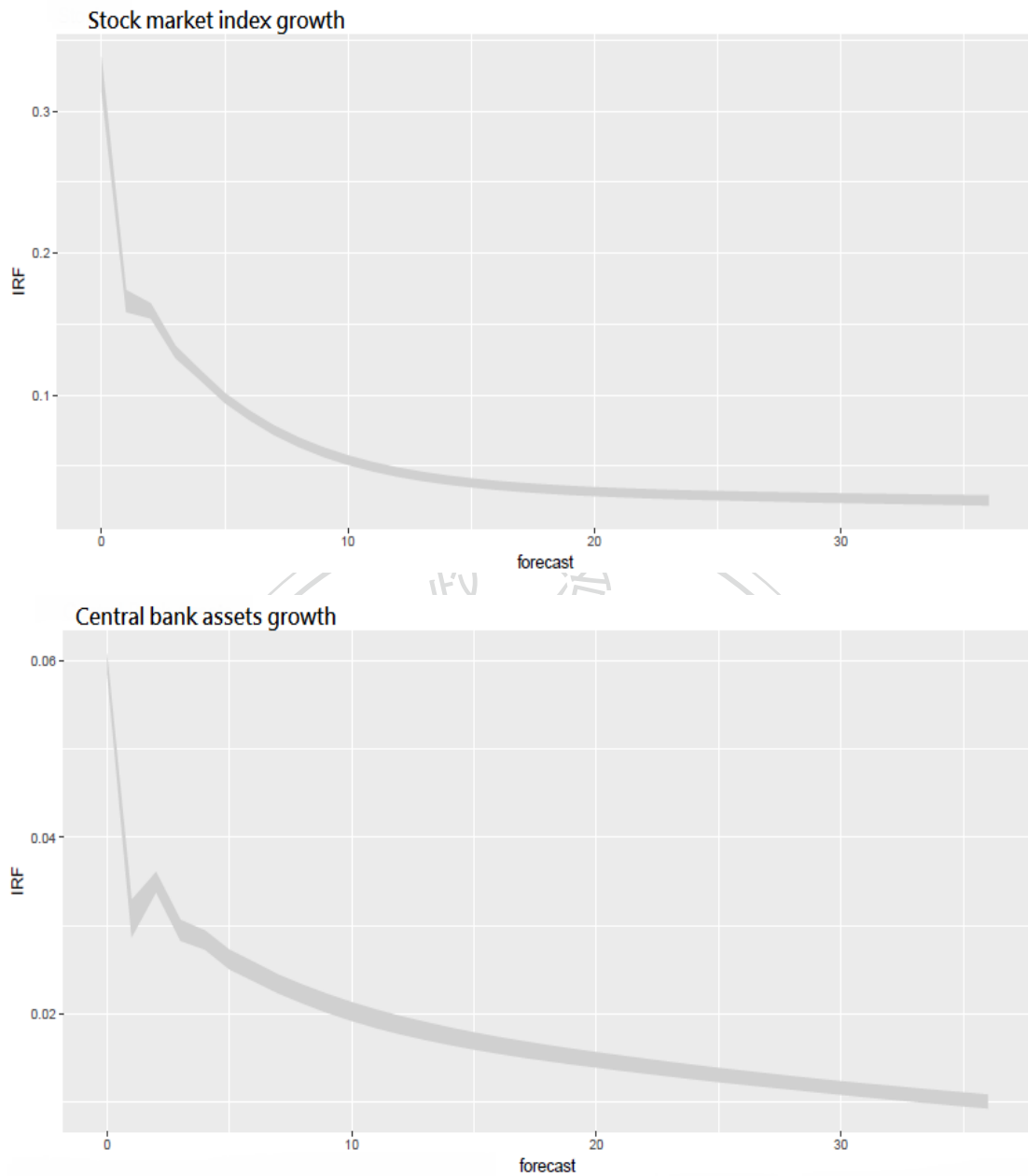
Note: Horizon is monthly, and the shadow area is the 16th and 84th bootstrap percentiles.
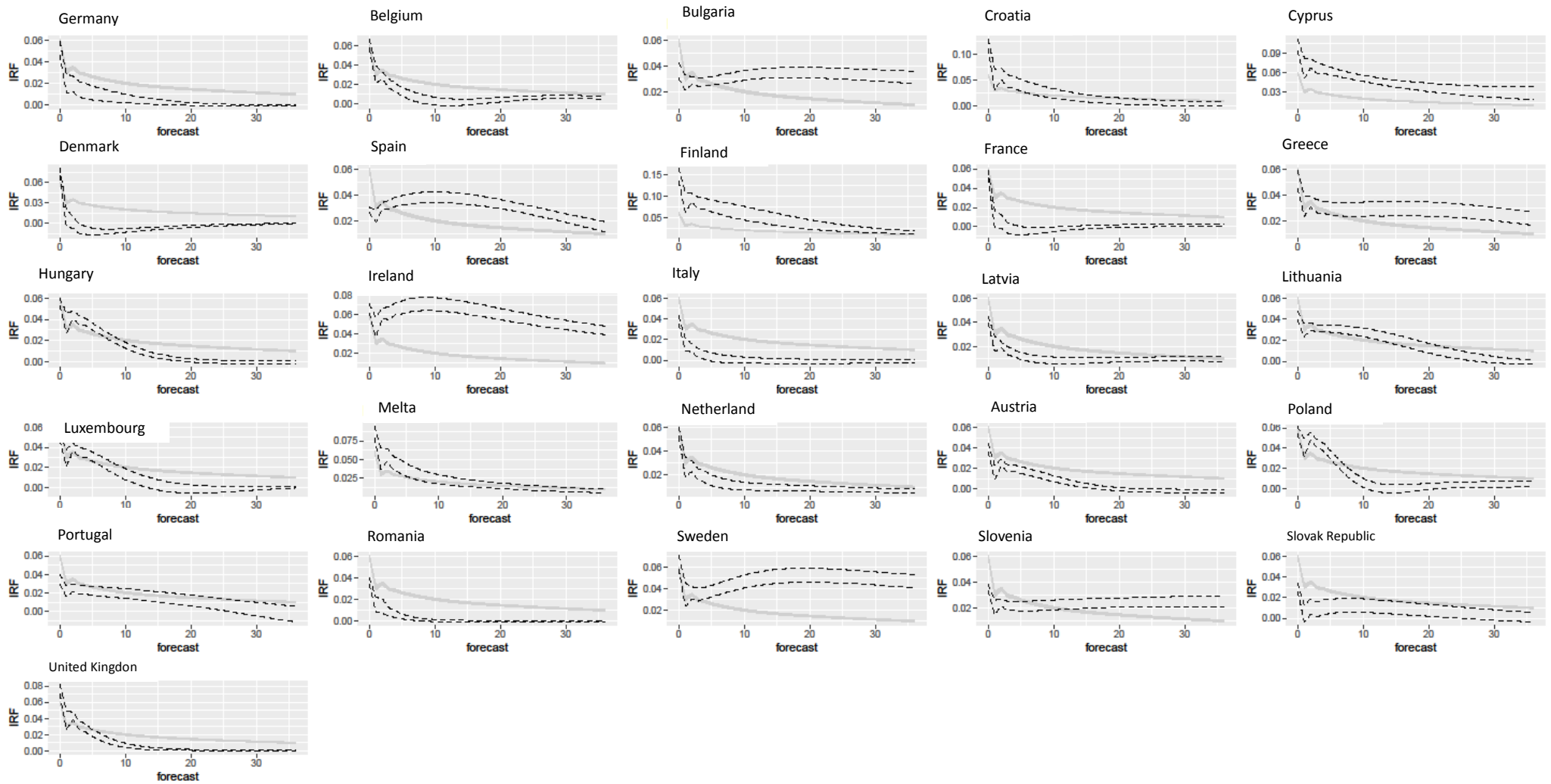
Figure 7 The mean group impulse function

To inspect the individual country impulse responses, each country has balance sheet increase for answering the shocks, however with divergent degree. The advance economies of euro area, i.e., Germany, France, and Netherlands, response to the balance sheet policy measures with higher

44

increase than the mean group Panel VAR impulse response and also fade out faster (about 2 to 20 months) than the mean group impulse function. Those euro countries which suffer sovereign debt crises, i.e. Cyprus, Spain, Greece, Ireland, Italy and Portugal, have dissimilar increase of central bank balance sheet assets responding to shocks, some are higher while some are lower, but their impulse responses do not fade out, yet maintaining higher than the benchmark impulse response. The opt-out countries of European Union, UK and Denmark, UK has 8% increase while Denmark with 7% increase responding to the shock, and their impulse responses disappear with faster speed, about 10 months in UK and one month in Denmark.

In this study, we focus on the inflation effects. The inflation responds to balance sheet policy shock with an 0.15% increase in the mean group impulse function, reaching the peak after 17 months and returning to baseline after 35 months.[25] The inflation effects of balance sheet policy are indeterminate from the mean group impulse response, where the rise of inflation is insufficient. The individual country impulse function of our PVAR results reveals the heterogeneous inflation response cross-country. The inflation impulse responses of advanced economies are divergent. The inflation effect of balance sheet policy shock to Germany is at the range from 0.1 to -0.1%, whereas inflation effect of Germany is negligible but lasts more than 35 months. In Belgium, the impulse function indicates that CPI declines to -0.8% in response to the balance sheet policy shocks,

---

[25] Gambacorta et al. (2014)) indicates that the impact on prices is a temporary effect with a peak increase of 0.08 % while the impact of interest rate shocks on the price level is found to be very sluggish with a peak only after about 2 years or even later.

45

Note: Horizon is monthly, the dotted area is the 16th and 84th bootstrap percentiles of individual country, and the shadow area is the 16th and 84th bootstrap percentiles of mean group.

Figure 8 The central bank asset impulse functions of European Union countries
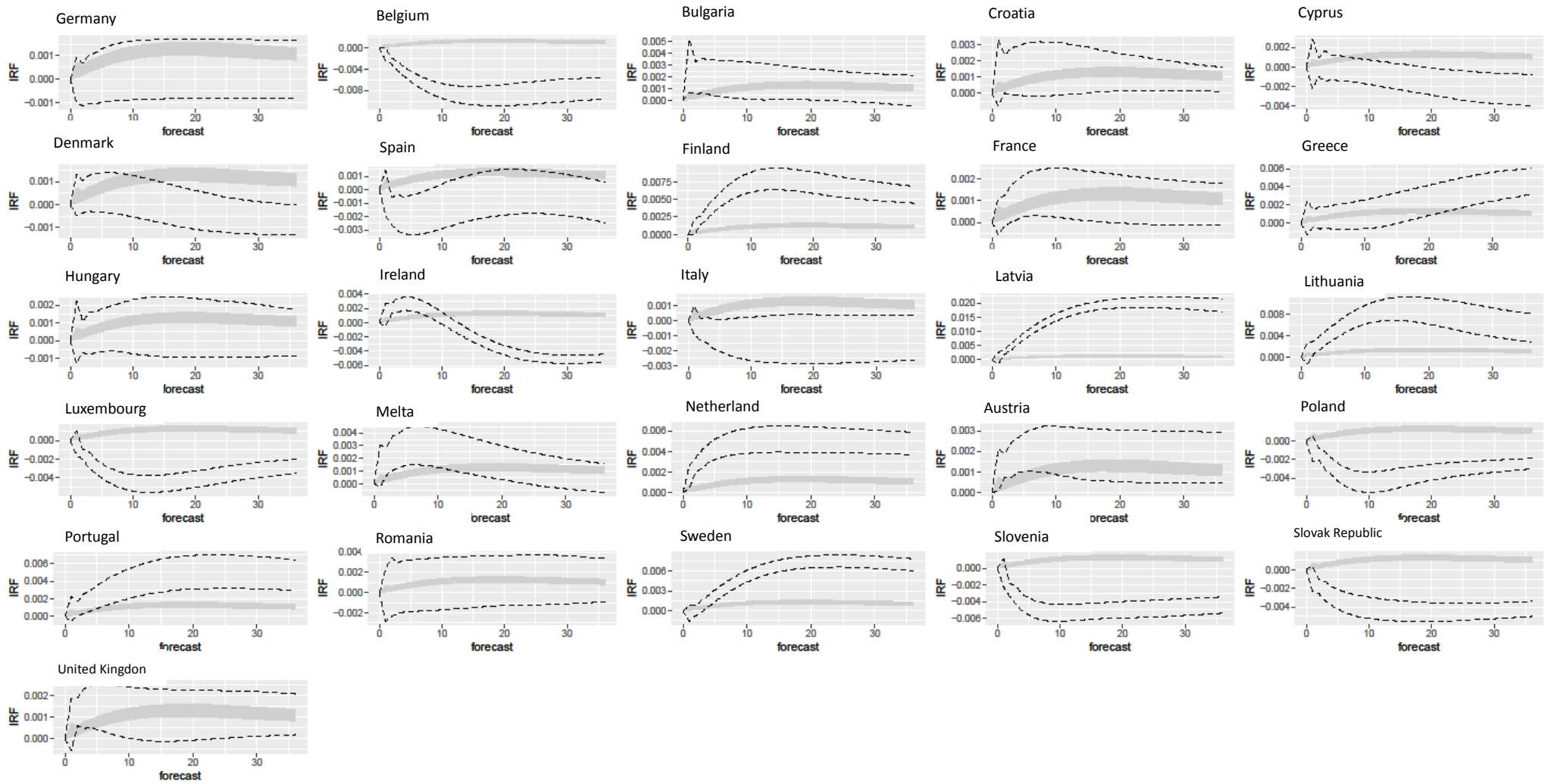
46

Note: Horizon is monthly, the dotted area is the 16th and 84th bootstrap percentiles of individual country, and the shadow area is the 16th and 84th bootstrap percentiles of mean group.

Figure 9 The inflation impulse functions of European Union countries

47

Note: Horizon is monthly, the dotted area is the 16th and 84th bootstrap percentiles of individual country, and the shadow area is the 16th and 84th bootstrap percentiles of mean group.

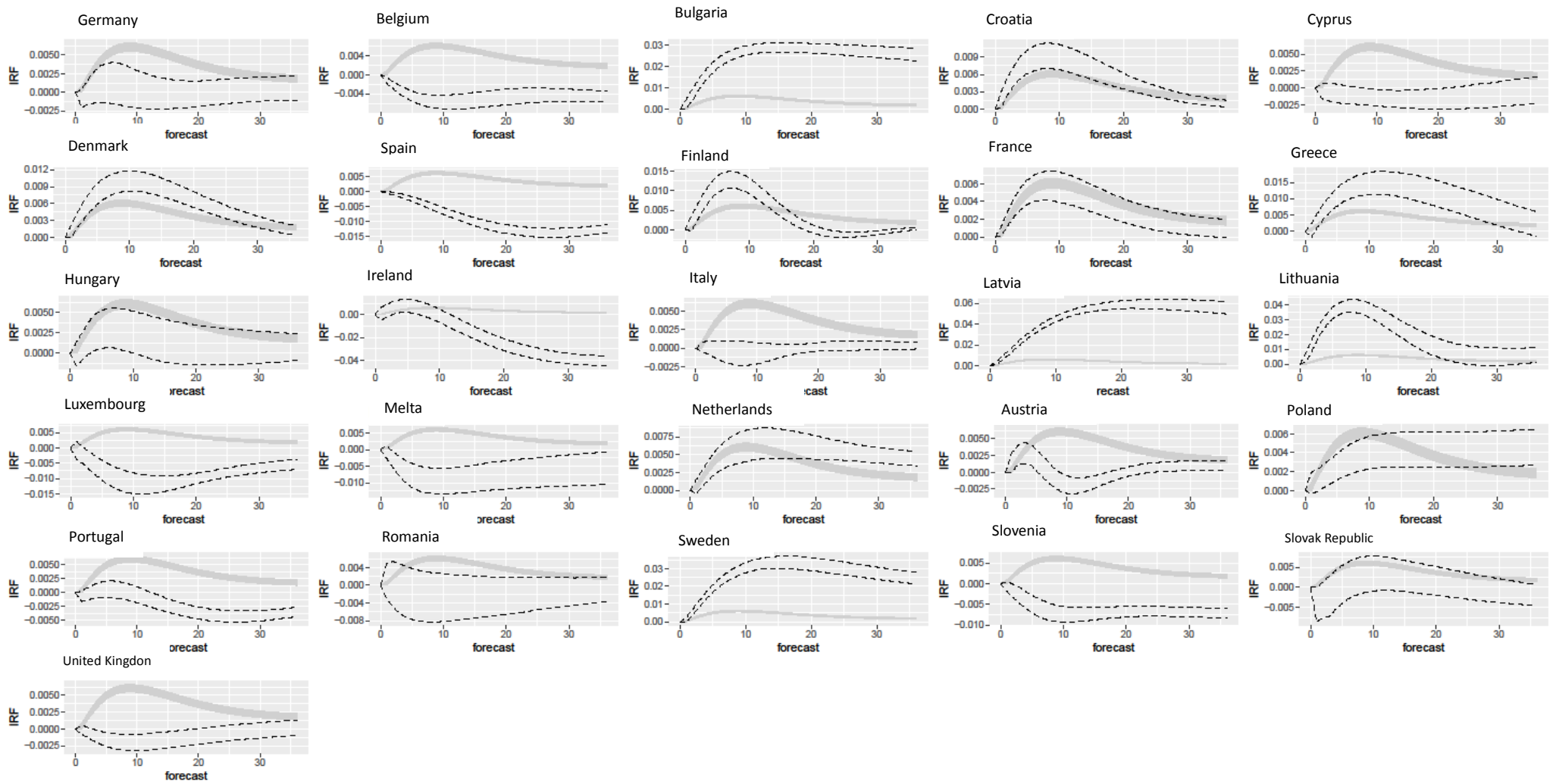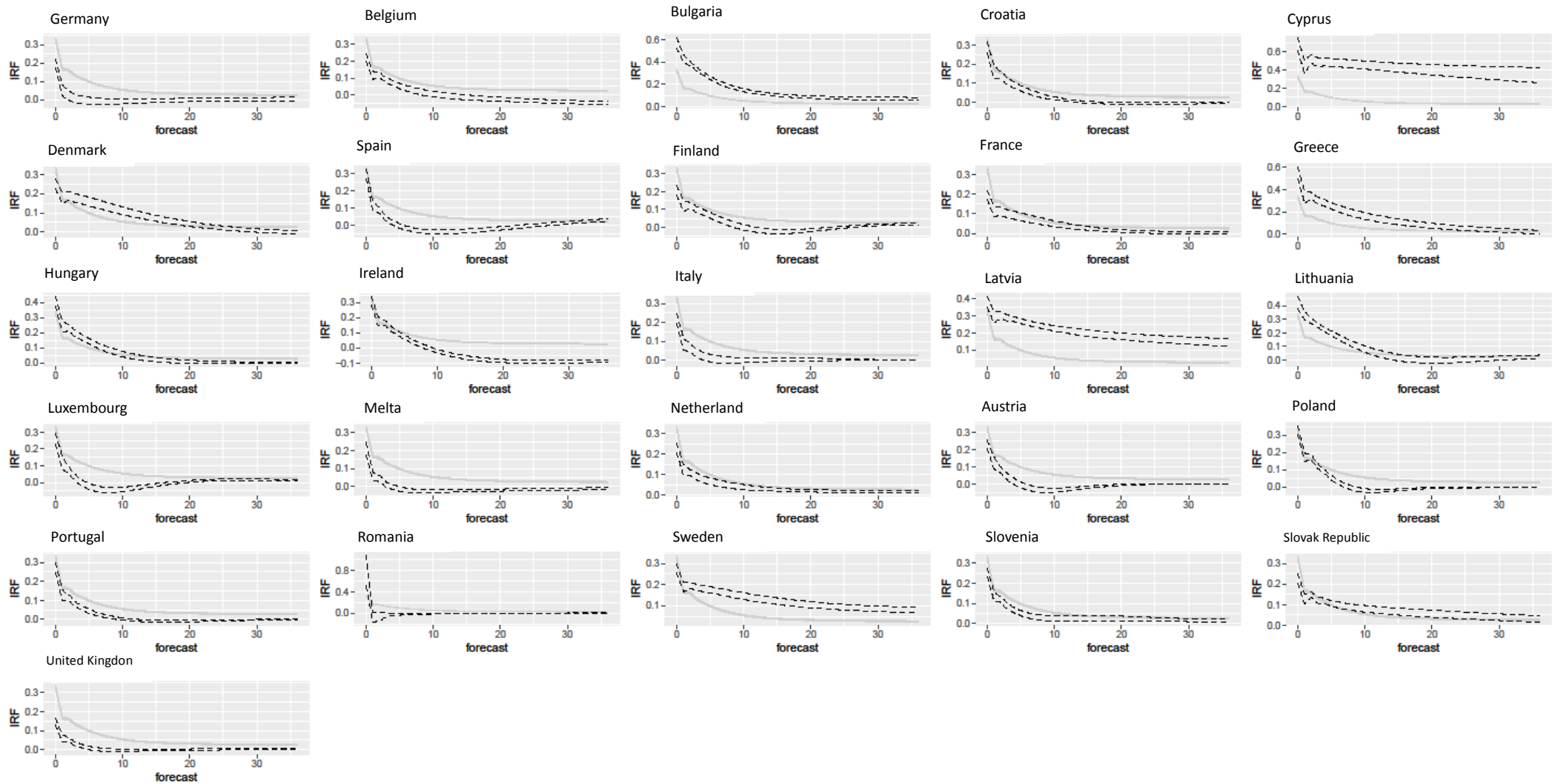Figure 10 The output growth impulse functions of European Union countries

48

Note: Horizon is monthly, the dotted area is the 16th and 84th bootstrap percentiles of individual country, and the shadow area is the 16th and 84th bootstrap percentiles of mean group.

Figure 11 The stock market impulse functions of European Union countries

nearby country – Luxembourg has similar reaction as its CPI decreases to 0.4% about 10 months later. The CPI hits the bottom about 15 months later, and return to the baseline about 35 months. On the contrary, the impulse response of France and Netherlands are different. The impulse response of France attains the peak of 0.2% about 7 months and return to the baseline around 20 months later. Netherlands reaches the peak of 0.6% about 15 months, and return to baseline about 25 months later.

The countries undergoing European sovereign debt crisis results in three completely different cases. The inflation impulse responses of Spain and Italy lower to -0.3% after hitting the bottom for 5 months, whereas Italy hits the bottom after 10 months. Cyprus and Ireland respond to balance sheet policy shocks with a short upsurge after 1 to 3 months, then the responses lower to -0.4% and -0.6% respectively and gradually. For Greece and Portugal, they respond to the shocks with a rise of CPI to the peak of 0.65% after 15 months and 35 months respectively. About the recently joined member countries, Latvia was notable that its inflation replies to the shocks with an escalation to 2%, the highest upsurge response among the EU countries.[26] Lithuanian CPI answers to the shocks with an increase of 0.8% about 12 months later, while Malta with an increase of 0.4% after 5 months. Slovenia and Slovakia respond with decadent inflation levels, where Slovenian bottom is -0.6% and Slovakian is -0.4%.

The replies of UK and Denmark, owning to their opt-out of the single currency agreement, are dissimilar. The inflation level of UK respond to

---

[26] From official website of ECB, we define the recently joined euro area countries as those entry euro area after the onset of euro at Jan. 1st 2002. Slovenia adopted euro at Jul. 11rd 2006. Then, Cyprus and Malta adopted euro at Jul. 10st 2007. Later, Slovakia and Estonia joined at Jul. 8th 2008 and Jul. 13th 2010 respectively. At the last, Latvia and Lithuania respectively joined euro area at Jul. 9th 2013 and Jul. 23th 2014.

shocks with an upsurge to 0.25% after 4 months and return to baseline after 10 months, while Denmark responding the shocks with a short ambiguous upsurge and decreasing gradually to -0.1% about 20 months later. For the newly EU member country, Bulgaria answer the shocks with an instant upsurge to 0.5% and return to zero about 10 month later, while the peak of Romania is 0.4% and lasting for more than 35 months.[27] The central European Countries, i.e., the Czech Republic, Hungary and Poland, conduct interest rate policy and do not adopt euro. The Polish inflation response decrease to -0.5% about 10 months later, after the shocks imposed, while the Hungary react to the shocks with an indefinite inflation rise.

It is notable that the results of inflation impulse function revealing that the balance sheet responses of non-euro area countries to the balance sheet policy shocks are no less than euro countries. Although the mean group impulse function in figure 9 exhibits the response of overall national central bank assets to balance sheet policy shock are 0.06% in the peak, the non-euro country responses, from the individual EU country impulse functions, are no less than euro country responses. Even the non-euro countries which did not adopt balance sheet policy have the same degree of responses. As we mentioned early, balance sheet policy is "conventional" open market operation of central banks. The results uncover that the central bank assets of non-euro countries also have instant responses after the crisis.

---

[27] From official website of EU, we define the newly EU member countries are Bulgaria, Romania and Croatia. Bulgaria and Romania joined at Jan. 1st 2000, and then Croatia join at Jul. 1th 2013.

3.2 European Union Cross-Countries Evidence: Panel Data Results

Next, we use panel data model to further look into the relations between inflation and variables, which constituting the PVAR model in the preceding section. We prefer panel data in fixed-effect model for several reasons. First, we aim to investigate the cross-countries heterogeneous responses to the expansionary of monetary base, a cross-sectional estimation is more adequate. Second, a fixed-effect model is more sufficient to detect the individual attribute of the cross-section observations to one specific focus which is allowed to be correlated with the explanatory variable and have the power to explain the outcome of estimation. As we shown in the first chapter, the indicators of monetary base and broad money M3 was increasing disproportionately. The empirical evidence is counterintuitive. In particular, Grauwe and Polan (2005) run a cross-country estimation, which using yearly data, and find a significant almost proportional relation between money growth rate and inflation, especially in those high-inflation countries. Even though theoretical literatures emphasize the tight relationship between price level and money supply, Koo (2011) further suggest that the gap between money supply (M3) and monetary base is expanded in major economies after the onset of the crisis, is owing to balance sheet recession which are triggered by the private sector debt minimization.[28]

Meanwhile, conventional monetary policy is not decoupled when central bankers of EU countries deal with the financial turmoil. It is needed

---

[28] As Anderson (2006) indicate that the monetary base is carelessly defined by some authors as currency held by the public plus the cash reserves of banks in his draft. Such definitions may lead to confusion, and a correct definition must include all base money held by banks, not solely the portion held to satisfy regulatory reserve requirements.

to use interest rate observations as explanatory variables. Besides, there are 4 variable constructing the benchmark PVAR model, CPI is the dependent variable of panel data and the rest of variables are placed as explanatory variables. In the preceding estimation, we apply the model of Gambacorta et al. (2014) to 28 EU countries for a longer sample period and have the impulse response functions after the balance sheet policy shocks. We do not find the effects of balance sheet policy shock conspicuous in the longer span data set. Instead, we find that the peak values of responses are smaller, but more persistent in our model in the longer time span. As discussed in the first chapter, inquiries arise with regard to the causal relations between the disproportionate money supply increase and the easing inflation pressure after injecting massive high-power money into financial system. Thus, we estimate a fixed-effect model by using monthly observations of 28 countries data. The fixed-effect model is specified as follow:

$$ln\text{CPI}_{i,t} = \beta_0 + \beta_1 ln\text{RGDP}_{i,t} + \beta_2 ln\text{MB}_{i.t} + \beta_3 ln\text{M3}_{i,t} +$$
$$\beta_4 ln\text{TA}_{i,t} + \beta_5 ln\text{SI}_{i,t} + \beta_6 ln\text{PR}_{i.t} + \epsilon_{i,t} \tag{4}$$

where CPI is consumer price index, RGDP representing real GDP, MB representing monetary base, M3 representing board money, TA representing total assets, SI representing stock market price index, PR representing policy rate, $\beta_1 \cdots \beta_6$ are parameters to be estimated, and ε is an error term. All data were taken from national central banks and Datastream.[29] Before the estimated, we use the LLC and ADF-Fisher test for all the variables of 28 countries, i.e., CPI, RGDP, MB, M3, TA, SI, and

---

[29] The observations of variable MB are gather from DataStream, some are monetary base, base money, or money supply M0 which are sum of currency in circulation plus the outstanding amounts of liabilities of financial institutions which having moneyness or liquidity in board definition, and all the time series of variables are computed first difference and fit to the model.

53

PR. The twenty-eight series of each variable have rejected the hull hypothesis of unit root. The twenty-eight series of each variable have conducted first order different before the test. The results of estimation are summarized in Table 4. The coefficients are quite small but in accordance with the results of Panel VAR estimation, which reveal negligible. The coefficient of output is higher than other explanatory variables, and coefficient of industrial production is much smaller than real GDP. Empirical findings indicate proportional relationship between output and inflation in the long-run, whereas our results do not reveal this inverse relation.[30]

Table 4

Inflation and money panel data results of European Union countries, 2008-2017

Fixed-effects regression					
Number of observations = 3,164					
Number of groups = 28					
R-sq:				$F_{(6,3130)} = 32.55$	
within = 0.0587				Prob > F = 0.0000	
between = 0.1591				corr(u_i, Xb) = -0.5605	
overall = 0.0452					
CPI	Coef.	Std. Err.	P>|t|	[95% Conf. Interval]	
RGDP	**0.053634*****	0.0107652	0.000	0.0325261	0.074741
MB	**-0.00101****	0.0004116	0.014	-0.0018195	-0.0002056
M3	0.001938	0.0015231	0.203	-0.0010482	0.0049247
TA	**0.00548****	0.002467	0.026	0.0006433	0.0103176
SI	**0.000393***	0.0002211	0.076	-0.0000404	0.008265
PR	**0.000503*****	0.000038	0.000	0.0004286	0.0005775
cons	**0.000477*****	0.0000777	0.000	0.000324	0.0006289

Note: *** indicates statistical significance of the 1% level; ** indicates statistical significance of the 5% level; * indicates statistical significance of the 10% level.

---

[30] Literatures, such as Barro (1995) and Grauwe and Polan (2005), indicates that inflation and money growth rate are proportional.

Another finding is that the coefficient of monetary base growth rate is negative, which indicate an inverse relationship between monetary base growth rate and inflation. Although the negative coefficient of MB is quite small, the implicit inference that the more monetary base leads to the negative effect to consumer prices is counterintuitive to quantity theory. The coefficient of MB is -0.001 while the coefficient of M3 is 0.002; clearly, both coefficients are very small. However, there are only 12 countries showing negative MB coefficient while the rest of EU countries showing the positive coefficient in the individual fixed effect results. In order to recheck this relationship, we further estimate the following fixed effect panel models:

$$ln\text{CPI}_{i,t} = \beta_0 + \beta_7 ln\text{MB}_{i,t} + \epsilon_{i,t} \qquad , \tag{5}$$

$$ln\text{CPI}_{i,t} = \beta_0 + \beta_8 ln\text{M3}_{i,t} + \epsilon_{i,t} \tag{6}$$

The empirical results of the fixed effect panel models are summarized in the Table 5. Form this table, it is found that a weak negative correlation between monthly monetary base growth rate and the fixed effect, but a weak positive correlation between monthly broad money M3 and the fixed effect (the correlation coefficients for MB and M3 are -0.02 and 0.41, respectively.) The negative and significant coefficient of MB implies that expansion of monetary base has a negative relation to inflation. This further explains statistic findings of major economies in chapter one that the implementation of balance sheet policy expands the monetary base by purchasing large scale of government debts, corporate bonds and securities; however, the expansion of monetary base does not consequently affect inflation.

55

Even though the growth rate of monetary base has negative relation with inflation, it is difficult to jump to conclusion that the money has a negative relation with inflation. In comparison, the fixed-effect outcome of each individual country demonstrates a positive coefficient between M3 growth rate and inflation. In both panel data model, the coefficient of M3 shows weak positive relation with inflation. Although broad monetary aggregate M3 is identical with the conventional view that ample monetary aggregates cause the inflation rise, the growth rate of broad money M3 leads to an extremely smaller proportional increase in inflation than other empirical findings.

Table 5 Empirical results of MB Fixed Effects

MB Fixed-effects (within) regression					
Number of observations = 3,164					
Number of groups = 28					
CPI	Coef.	Std. Err.	P>|t|	[95% Conf. Interval]	
MB	**-0.0007927*****	0.0004184	0.058	-0.0016132	0.0000277
_cons	**0.0012497*******	0.0000534	0.000	0.001145	0.0013544
M3 Fixed-effects (within) regression					
Number of observations = 3,164					
Number of groups = 28					
CPI	Coef.	Std. Err.	P>|t|	[95% Conf. Interval]	
M3	0.0005817	0.0015604	0.709	-0.0024779	0.0036413
_cons	**0.0012362*******	0.000053	0.000	0.0011322	0.0013402

Note: *** and * indicates statistical significance at the 1% level and 10% level, respectively.

In addition, literatures concerning the balance sheet policy indicate that monetary base had increased rapidly after the onset of large-scale purchase, but broad money M3 was not conformed to the expansion of

monetary base. The explanations of this deviation between monetary base and broad money are disputable. Some arguments suggest the excessive monetary base only facilitate the liquidity of financial system but is not capable of increasing equal amount of broad money during the interest rate hitting the lowest bound. Another possibility would be that balance sheet policy only helped sustain the stability of financial system but fail to stimulate the money demand of the economy system. (Ito and Mishkin, 2006; Kucharčuková et al.,2016; Orlowski,2015)

Besides, the disparity between monetary base and broad money M3 in major economies became larger after the crises, which means monetary base growing faster than M3. The disparity also took place in Japan after the asset bubble crisis. During the same period, BOJ conducted quantitative easing and purchased trillions of yen in long-term government debts, but Japan still overcame severe deflation. (Ito and Mishkin,2006; Koo,2011) On a more theoretical level, the fact that central bankers purchase large-scale of assets regardless of government debts, corporate bonds, or securities et al. are effective in increasing the high-power money, but are ineffective in producing sufficient money supply by money multipliers. The reverse relation between coefficient of monetary base and broad money M3 in our study further implies this interpretation.

Based on the empirical results of both panel data models, we make the following conclusions. Firstly, after 2008 global financial crises, the monetary base has a negative relation to inflation; on the contrary, M3 reveals a positive relation. Secondly, we also find the coefficient of central bank total asset is small in the panel data result of equation (4). Furthermore, the interest rate policy has a positive coefficient related to the

57

inflation during observation period of central banks conducting unconventional monetary measures.

Chapter 4. Conclusion

In this dissertation, we conduct two panel estimations to examine the macroeconomic effects of balance sheet policy in European Union countries over the crisis period. Some EU countries adopt unconventional monetary policies, such as euro area, UK and Sweden, while the others don't. Some EU countries adopt euro while the others keep their own national currencies. However, literatures normally regard the whole euro area as a single statistical sample unit when discussing the macroeconomic responses after implementing balance sheet policy. This omits the fact that each country of euro area has different economic and financial conditions, balance of trade, government revenue, and expenditure; consequently, effects of balance sheet policy vary in EU country. Employing panel techniques highlights cross-country dimension of individual country responses, and allows cross-sectional heterogeneity and cross-sectional dependence in comparison with the overall results. This is also one of the contributions of this paper.

This paper has several contributions. Firstly, this model exhibits the cross-country heterogeneities of economic responses to the balance sheet policy shocks after the global financial crisis, as we stated above. Secondly, the results of the mean group Panel VAR model show that balance sheet policy overall has a significant positive effect on inflation, but the effect is small. Compared with Gambacorta et al. (2014), their peak value is 0.1% (the peak value) while our inflation response to balance sheet policy is 0.0015%, which is much smaller. The differences in our results due to either the various sample group countries, or various sample period spans,

or both. The inflation effects of balance sheet policy are not as large as concerned. In results of EU country impulse responses, some countries show even declined inflation responses to balance sheet policy shocks, such as Belgium, Cyprus, Denmark, Spain, Ireland, Italy, Luxembourg, Poland, Slovenia, and Slovakia. We use the consumer prices index of each individual country which ignoring the effects of exchange rate for those non-euro countries, the influence of exchange rate regime is not in the scope of our research. Moreover, the empirical results of Haldane et al. (2016) show that the inflation effects of asset purchase shock in ECB are far smaller than those in US. In particular, the inflation effects of some schemes reveal negative in response to the asset purchase shocks. Their conclusions also explain that the experience of Fed asset purchasing has better results than that of ECB.

Thirdly, the positive coefficient between the growth rate of monetary base and inflation could not be found as demonstrated in traditional literatures. This may probably be owing to the mistake of our data compilation, different data span, or a special period of time that monetary base and inflation reveal this relation. However, this result might alleviate concerns of monetary authorities regarding the upsurge of inflation accompanying with the fulfillment of balance sheet policy. From the monetary theoretical view, the expansion of monetary base may help the liquidity in the financial system, and encourage the real economic activities through money multiplier. Furthermore, monetary authorities conducting large-scale assets purchases are effective in increasing the high-power money, but are ineffective in producing sufficient money supply from our estimate results. Goodhart (2017) also indicates the causal direction of

money multiplier equation, which had been given by Friedman and Schwartz (1963), was collapsed during the financial crises since 2008. Alternatively, Koo (2015) attributes this to "balance sheet recession" in which corporates and households try to deleverage after the financial crises took place. The process of debt minimization reduced demand in the economies, which leads to severe recessions.

Finally, the increase of monetary base acts as a stabilizing force in financial system, but does not affect the macroeconomic variables. The coefficient between interest rate and inflation reveal a significant positive relation, which is counterintuitive, but in line with the impairment of interest rate policy in the zero-interest-rate circumstance after the crisis. In the estimation of Kucharčuková et al. (2016), they infer that the reason that the unconventional monetary measures did not affect the inflation directly because balance sheet policy is not essentially the easing monetary policy. The large-scale asset purchase of central bank can maintain the financial market function properly. Empirical results of our model also show that rising inflation is not the inevitable consequence of rapid monetary base increase. From the results of panel VAR model, the macroeconomic variables of individual EU countries respond to the increase of monetary base ambiguously. When the interest hit the lower bound, monetary authorities have no choice but to increase the monetary base even if it does not produce an effective increase of money demand while borrowing money can be free.

In terms of further research, it would be worthwhile to investigate the monetary transmission mechanism and channels of monetary policy after 2008 global financial crisis during which major central bankers

purchase large-scale asset in order to inject high-power money to the monetary system. Bernanke and Gertler (1995) suggest that monetary policy have a marked impact on GDP and price by the credit channel working through both non-financial borrower (firms and households) and bank balance sheet channel. Correspondingly, Ciccarelli et al. (2015) find that the effects of GDP and inflation to the monetary policy shock are amplified through credit channels by conducting a panel VAR model of 10 Euro area countries and a multivariate linear regression model of U.S. Rather, Koo (2015) suggests that the decreasing lending indicators of major economies due to the process in which the private sector minimizes debt after the economic bubble bursting. In the process of debt minimization, two scenarios arise that fail to simulate real economy through channels of monetary policy when central bankers conduct unconventional monetary policy. First, lenders offer ultra-low interest rates to borrowers who lack investment opportunity. Second, lenders offer ultra-low interest rates only to high-rated borrowers. Thus, controversies still exist regarding channels of monetary policy vis-a-vi the large-scale asset purchase. These are the suggestion for further researches.

62

APPENDIX A

Table of Monetary measures of US., Japan and Euro area after 2008 global financial crisis.

Date	Program	Policy	Description
Federal Reserve			
Nov. 25, 2008 (Initial LSAP Announcement)	LSAP1	Balance sheet policy	The Federal Reserve announces its intention of purchase up to $100 billion in agency debt securities and up to $500 billion in agency mortgage-backed securities.
Dec. 16, 2008	Forward Guidance	Interest rate policy/ State-based guidance	The FOMC lowers the target of Federal funds rate from range 0 to 0.25%, and keep Federal funds rate in the exceptionally low levels.
Mar. 18, 2009	LSAP 1	Balance sheet policy	The FOMC announces the expansion of LSAP1 to a total sum of $1.25 trillion of mortgage-backed securities, as well as the $200 billion of debt securities and $300 billion of longer-term Treasury securities.
Nov. 3, 2010	LSAP2	Balance sheet policy	The FOMC announces a second LSAP program which purchase an additional $600 billion of longer-term Treasury securities.
Aug. 9, 2011	Forward Guidance	Interest rate policy/ Calendar-based guidance	The FOMC announces to keep the federal funds rate at exceptionally low levels until mid-2013.
Sep. 21, 2011	MEP	Balance sheet policy	The FOMC announces MEP which it will buy $400 billion in Treasury securities with a remaining maturity of 6 to 30 years and sell equally $400 billion of Treasury securities with a

63

Date	Program	Policy	Description
			remaining maturity of 3 years or less.
Jan. 25, 2012	Forward Guidance	Interest rate policy/ Calendar-based guidance	The FOMC announces the extension of low Federal rate to at least late 2014.
Jun. 20, 2012	MEP	Balance sheet policy	The FOMC extends the ongoing MEP until the end of 2012 at the current pace of buying around $45 billion of longer-term Treasury securities per month, and selling or redeeming the shorter-term Treasury securities at the same time.
Sep. 13, 2012	Forward Guidance	Interest rate policy/ Calendar - based guidance	In connection with the launch of LSAP3, the FOMC indicates the exceptionally low federal funds rate is at least through mid-2015.
Sep. 13, 2012	LSAP3	Balance sheet policy	The FOMC announces the third LSAP program, consisting of open-ended purchases of mortgage-backed securities for $40 billion per month. Fed also increases in the holdings of longer□term securities for around $85 billion per month to conjunct with the ongoing MEP.
Dec. 12, 2012	Forward Guidance	Interest rate policy/ State-based guidance	The FOMC announces to keep the federal funds rate between 0 to 0.25 percent, and to maintains this exceptionally low range at least when the unemployment rate is above 6.5 %, inflation expectations continue to anchored below 2.5 %.

Date	Program	Policy	Description
Dec. 18, 2013	LSAP program reduction	Balance sheet policy	The FOMC announces to taper its purchases of MBS and longer-term Treasuries monthly of $35 billion and $40 billion, respectively. Fed would start to reduce asset purchase in the further meetings.
Dec. 18, 2013	Forward Guidance	Interest rate policy/ State-based guidance	The FOMC announces to maintain the present target range of federal funds rate.
Oct. 29, 2014	Announce the end of the LSAP	Balance sheet policy	The FOMC conclude its asset purchase program this month, but the reinvesting policy of maturing securities is maintained.
Oct. 29, 2014	Forward Guidance	Interest rate policy	The FOMC states that the federal fund rate remains on the target range from 0 to 0.25% for a considerable time after the end of APP this month.
Dec. 17, 2014		Balance sheet policy	The Fed announces the normalized stance of monetary policy is coming soon.
Mar. 18, 2015	Forward Guidance	Interest rate policy	The FOMC changes the stance and replaces the indication that such increase will be appropriate when the FOMC "has seen further improvement in the labor market and is reasonably confident that inflation will move back to its 2 percent objective over the medium term" with the statement that "remains unlikely" at the next FOMC meeting.
Jul. 29, 2015	Forward Guidance	Interest rate policy	The FOMC shifts the guidance allude to "further improvement in the labor market" to "some further

Date	Program	Policy	Description
			improvement."
Oct. 28, 2015	Forward Guidance	Interest rate policy	The FOMC changes the condition "how long it will be appropriate to maintain the target range" to "whether it will be appropriate to raise the target range at its next meeting."
Dec. 16, 2015	Forward Guidance	Interest rate policy	This is first time that the FOMC increase the target range since the financial crisis. The FOMC suggests that "the stance of monetary policy maintains accommodative after this increase." The FOMC also expects that it would continue its reinvestment policy and warrant only gradual increase in the federal funds rate while economic conditions evolve.
Dec. 16, 2015		Balance sheet policy	The FOMC increases the target range from its effective lower bound, meanwhile the FOMC also announce its remaining reinvestment policy "until normalization of the level of the federal funds rate is well under way."
Apr. 5, 2017		Balance sheet poliy	The FOMC suggests that "most participants preferred to phase out or cease reinvestments of both Treasury securities and agency MBS," and judged the Committee's reinvestment policy would appropriately change later this year.
Mar. 15, 2017	State-based guidance	Interest rate policy	The FOMC statement of "only gradual increases" on the future

Date	Program	Policy	Description
			expectation of the federal funds rate is shifted to "gradual increases." Besides, the statement now emphasizes the Committee's "symmetric inflation goal" instead of its "inflation goal."
Bank of Japan			
Oct. 31, 2008	Interest rate policy	State-contingent guidance	BOJ lower the target rate for the uncollateralized overnight call rate by 20 basis point to 0.3%, and basic loan rate to 0.5% (25 basis points reduced).
Dec. 19, 2008	Interest rate policy	State-contingent guidance	BOJ lower the target rate for the uncollateralized overnight call rate by 20 basis point to 0.1%, and basic loan rate to 0.3% (20 basis points reduced).
Oct. 5, 2010	CME	Balance sheet policy	BOJ will purchase assets about 35 trillion yen, which consisting of long-term government bonds, treasury discount bills, commercial paper, asset-backed commercial paper, corporate bonds, ETFs and J-REITs, and fixed-rate funds-supplying operation against pooled collateral. The amount of the fixed-rate funds-supplying-operation is about 30 trillion yen.
Oct. 5, 2010	State-contingent guidance	Interest rate policy	BOJ encourage the uncollateralized overnight call rate to maintain about 0 to 0.1%, which is the virtually zero interest rate policy until the medium to long-term price stability is in sight, and no accumulation of financial imbalances at the same

Date	Program	Policy	Description
			time.
Feb. 14, 2012	Enhancement of monetary easing	Balance sheet policy	BOJ announces to enhancing monetary ease by pursuing 15-trillion-yen new funds of asset purchase program and 5-trillion-yen fixed-rate funds-supplying operation against pooled collateral. BOJ increase the total amount of CME by 20-30 trillion yen by the end of 2012.
Feb. 14, 2012	State-contingent guidance	Interest rate policy	BOJ announces "its virtually zero interest rate policy" which based on the medium- to long-term price stability.
Dec. 20, 2012	Enhancement of monetary easing	Balance sheet policy	BOJ announces to enhancing monetary ease by pursuing 36-trillion-yen new funds of asset purchase program and 17-trillion-yen loan support program for over 12 months and 24 months respectively. BOJ increase the total amount of CME by 38 – 53 trillion yen.
Jan. 22, 2013	Interest rate policy	State-contingent guidance	BOJ announces "its virtually zero interest rate policy" which based on the medium- to long-term price stability. The target for price stability aimed at 2% , year-on-year rate of CPI.
Apr. 4, 2013	QQE	Balance sheet policy	BOJ introduces the QQE which will increase twofold of the monetary base and the amounts of JGBs as well as ETFs in two years, and more than twofold of the average remaining maturity of JGB purchases. The monetary base will increase 60-70 trillion

Date	Program	Policy	Description
			yen annually.
Oct. 31, 2014	Expansion of QQE	Balance sheet policy	BOJ will conduct 80-trillion-yen money market operation annually, which 10-20 trillion yen more than the past.
Jan. 29, 2016	QQE with a negative interest rate	State-contingent guidance	BOJ announces the three-tier System of negative interest rate policy with the expansion of QQE.
Sep. 21, 2016	QQE with yield curve control	Mixed policies.	BOJ introduces the new policy framework which consisting of two important features, one is "yield curve control" that BOJ control short-term and long-term interest rates; another one is "inflation-overshooting commitment" that BOJ expands monetary base until year-on-year rate of CPI exceeding 2 %.
European Central Bank			
Dec. 12, 2007	Reciprocal currency agreement	Balance sheet policy	The measures designed The total amount of reciprocal currency agreement reaches 271.6 billion euro until now.
Mar. 28, 2008	LTROs	Balance sheet policy	ECB announce to conduct supplementary LTROs with a maturity of six months as well as three months. Monthly LTROs is unchanged. The total amount of six-month LTROs is 50 billion euro, and of three-month LTROs is 100 billion euro.
Dec. 4, 2008	State-contingent guidance	Interest rate policy	The ECB announces to reduce interest rates of the main refinancing operation, the marginal lending facility, and the deposit facility by 75 basis points, starting from 10 Dec. 2008.

Date	Program	Policy	Description
Jul. 2, 2009	CBPP1	Balance sheet policy	The Eurosystem started to conduct CBPP1 on 2nd July 2009, and this program completed on 30th June 2010. The total amount of CBPP1 is 60 billion euro.
May 10, 2010	SMP	Balance sheet policy	The ECB announces that central banks of Eurosystem conduct securities purchase for interventions in the euro area public and private debt securities markets. The total amount of SMP is about 60 billion euro.
Nov. 3, 2011	CBPP2	Balance sheet policy	The Eurosystem started to conduct a CBPP2 on 3rd November 2011, and this program completed on 31st October 2012. The total amount of CBPP2 is 16.4 billion euro.
Dec. 8, 2011	VLTROs	Balance sheet policy	ECB announces to conduct two VLTROs of 36-month maturity and early repayment option after one year. This measure starts on 14 Dec. 2011, and is expected to support bank lending and money market activity.
Sep. 6, 2012	OMT	Balance sheet policy	ECB decided to conduct OMT in the secondary markets o of sovereign bonds in the euro area in order to secure the transmission mechanism and singleness of monetary policy in the euro area. Countries which applying to European stability mechanism will are eligible to have their debt purchased unlimitedly by ECB in the secondary market.
Jul. 4, 2013	Open-end	Interest rate	ECB announces that the key

Date	Program	Policy	Description
	guidance	policy	interest rates will "remain at present or lower levels for an extended period of time".
Jun. 5, 2014	NIRP	Interest rate policy	ECB announces to decrease the key interest rates, and the interest rate of deposit facility is first time lower under the zero to -0.1%. This interest rate cut effective on 11th Jun. 2011.
Sep. 1, 2014	APP/ABSPP and CBPP3	Balance sheet policy	ECB decides to begin buying non-financial private sector assets. The APP consists of two categories, which are ABSPP, CBPP3, and the purchase pace is 60 billion euro per month until Sep. 2016. ABSPP implement：The Eurosystem purchases a broad portfolio of simple and transparent asset-backed securities under ABS purchase program. CBPP3 implement: The Eurosystem purchase a broad portfolio of euro-denominated covered bonds issued by MFIs domiciled in the euro area under a new covered bond purchase program.
Jan. 22, 2015	Expanded APP/PSPP	Balance sheet policy	ECB expands APP to comprise bonds issued by euro area central governments, agencies and European institutions, which was under PSPP. PSPP implement: The ECB purchases public sector securities of nominal and inflation-linked central government bonds and bonds issued by recognized agencies, regional and local governments,

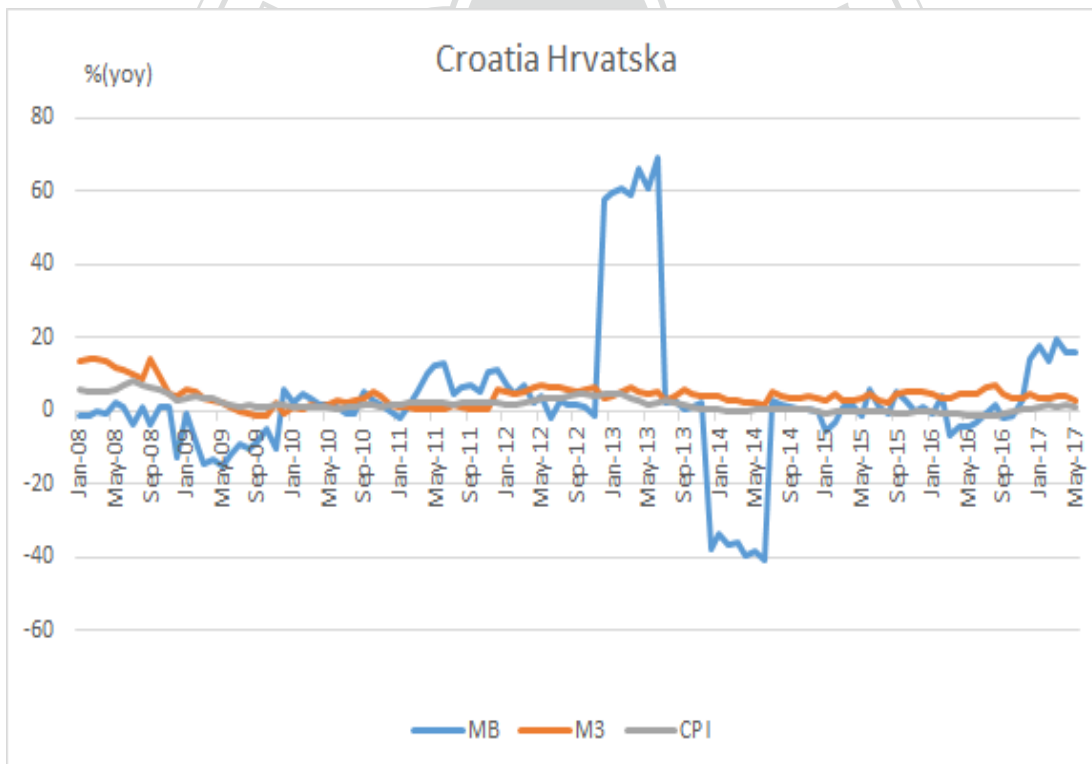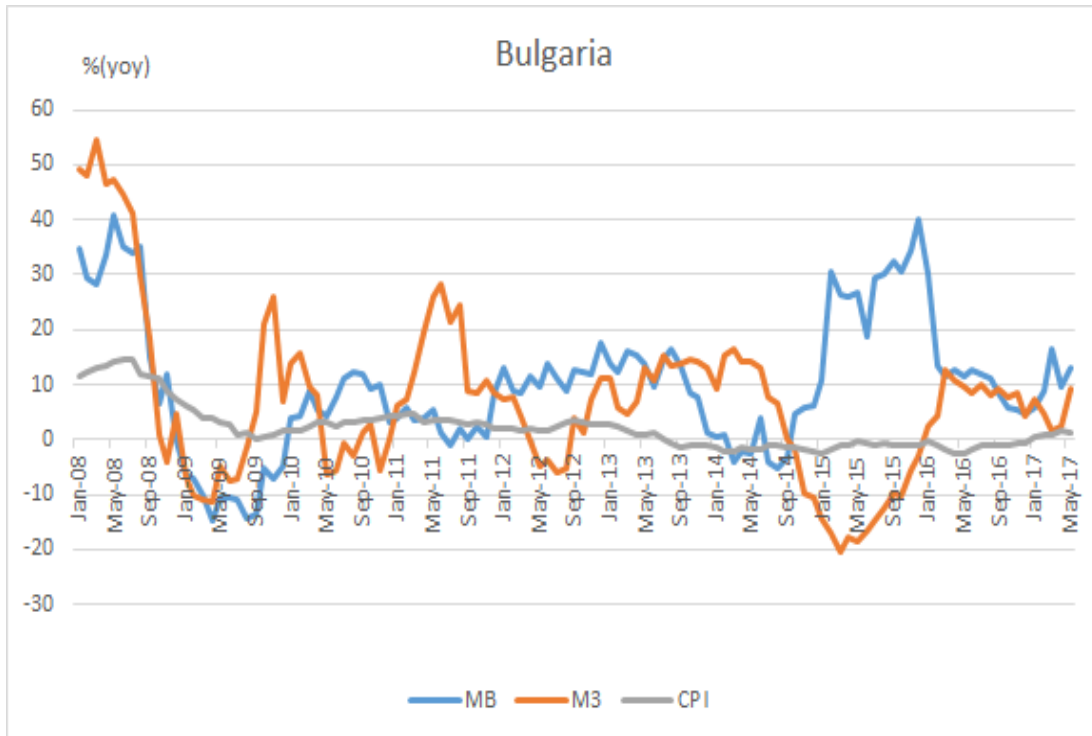| Date	Program	Policy	Description
			international organizations located in the euro area.
Jun. 2, 2016	Expanded APP/CSPP	Balance sheet policy	The Eurosystem started to conduct a CSPP on 9th June 2016, and this program completed on 19th December 2018. The total amount of CBPP2 is 17.7 billion euro.

Note: The Abbreviations as follows. LSAP stands for larger scale asset purchase, MEP stands for maturity extension program, CME stands for comprehensive monetary easing, ETFs stands for exchange-traded funds, J-REITs stands for Japan real estate investment trusts, QQE stands for quantitative and qualitative monetary easing, JGB stands for Japanese government bond, ETF stands for exchange-traded funds, LTRO stands for longer-term refinancing operation, CBPP1 stands for first covered bond purchase program, SMP stands for securities markets program, CBPP2 stands for second covered bond purchase program, VLTRO stands for very long term refinancing operation, OMT stands for outright monetary transactions, NIRP stands for negative interest rate policy, ABS stands for asset-backed securities, ABSPP stands for asset-backed securities purchase program, APP stands for asset purchase program, CBPP3 stands for covered bond purchase program, PSPP stands for public sector purchase program.
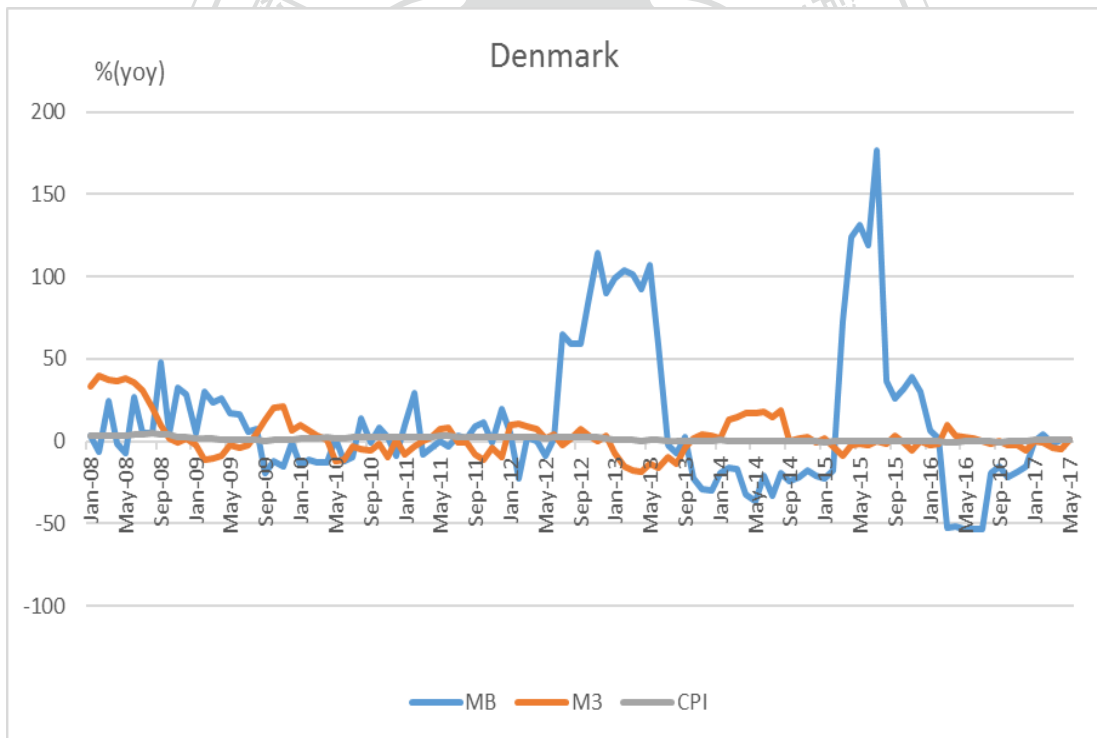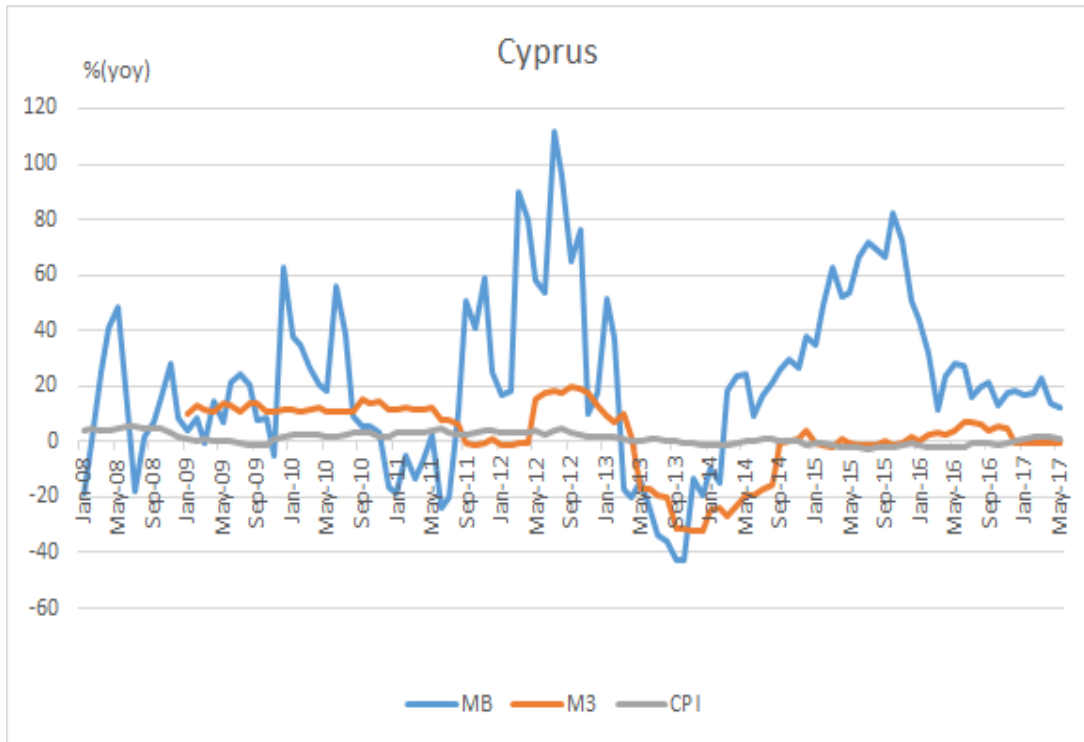
Sources: US compilation is based on the Federal Reserve website – Timelines of Policy Actions and Communications, Borio and Zabai (2018), Bauer and Neely (2014). Japan compilation is based on the Bank of Japan website – The Bank of Japan's Policy Measures during the Financial Crisis and Asset Purchase Program, Borio and Zabai (2018), Bauer and Neely (2014), Nakaso and Rate (2017), Shizume (2018). ECB compilation is based on ECB website – monetary policy decisions, Borio and Zabai (2018).
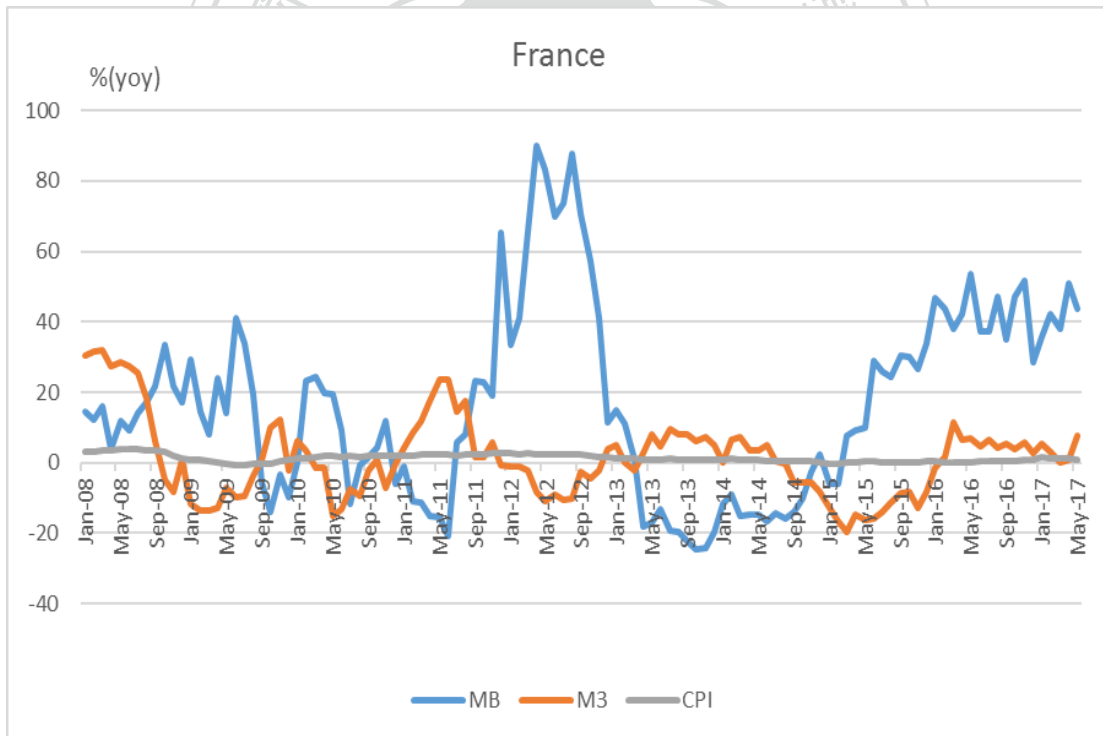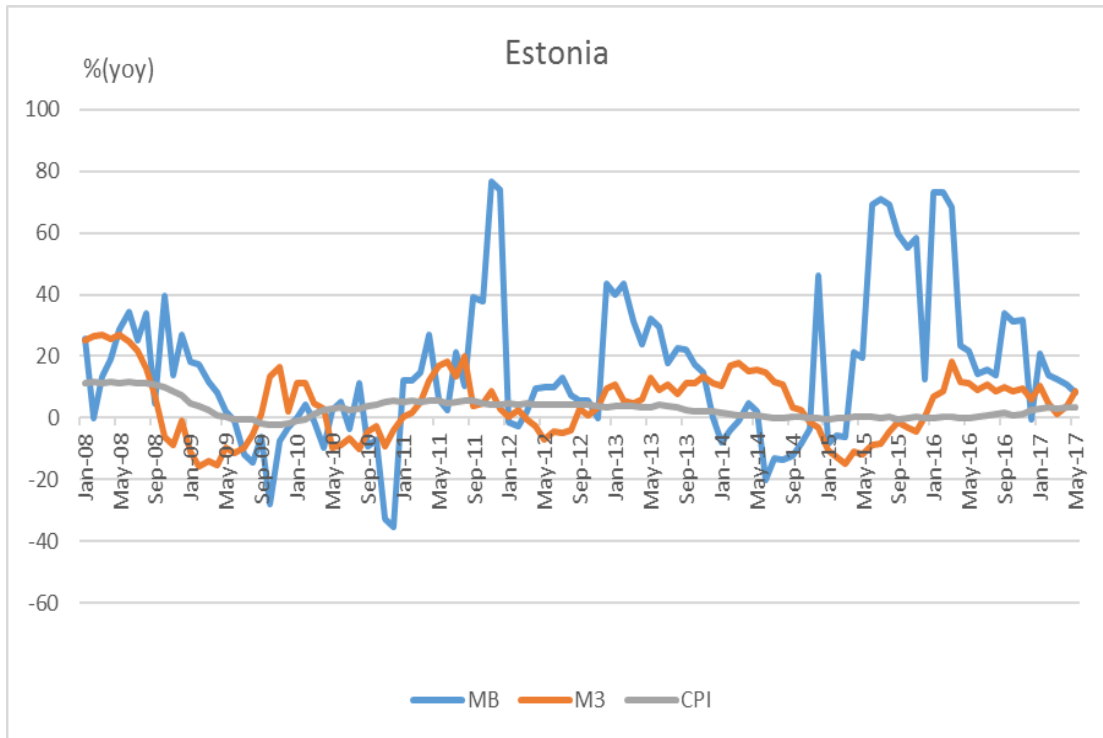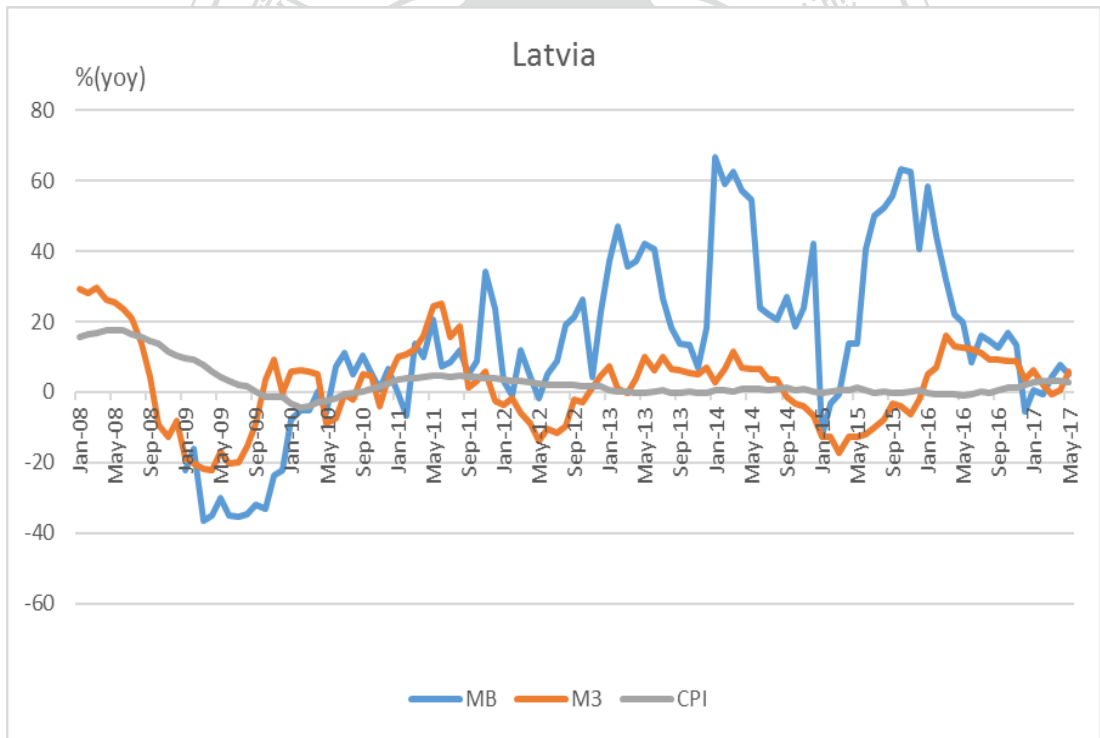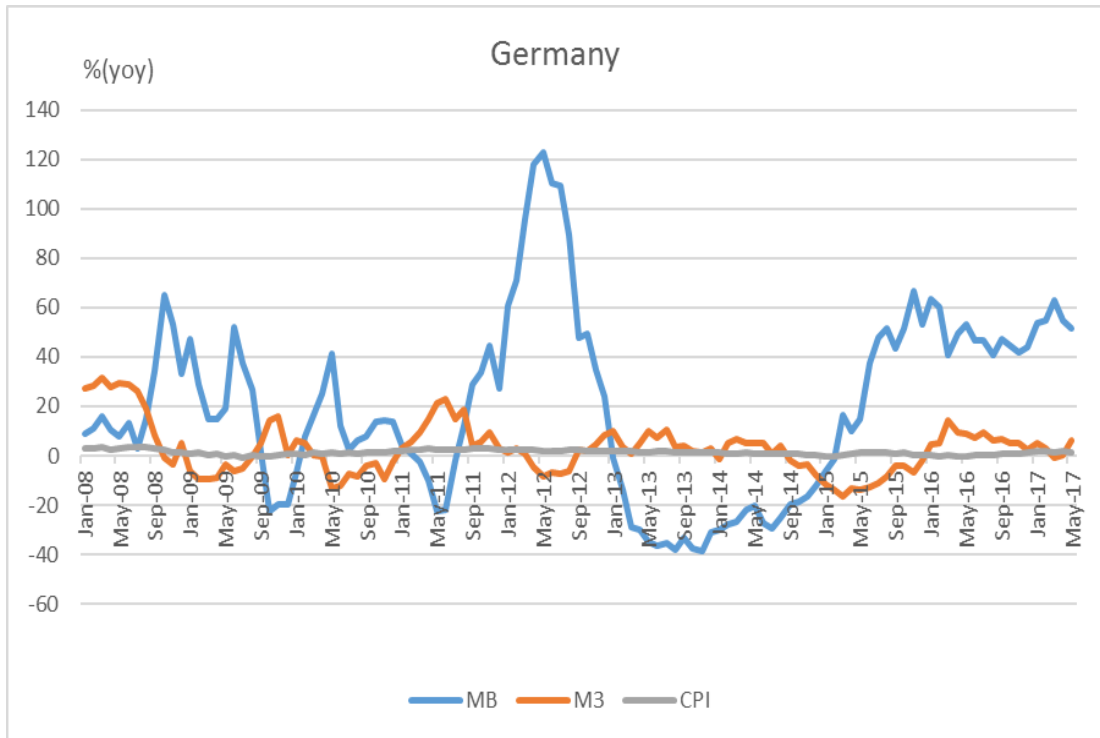
APPENDIX B

The Figure of the money and inflation statistic of European Union countries (18 countries)

Austria

Belgium

Bulgaria

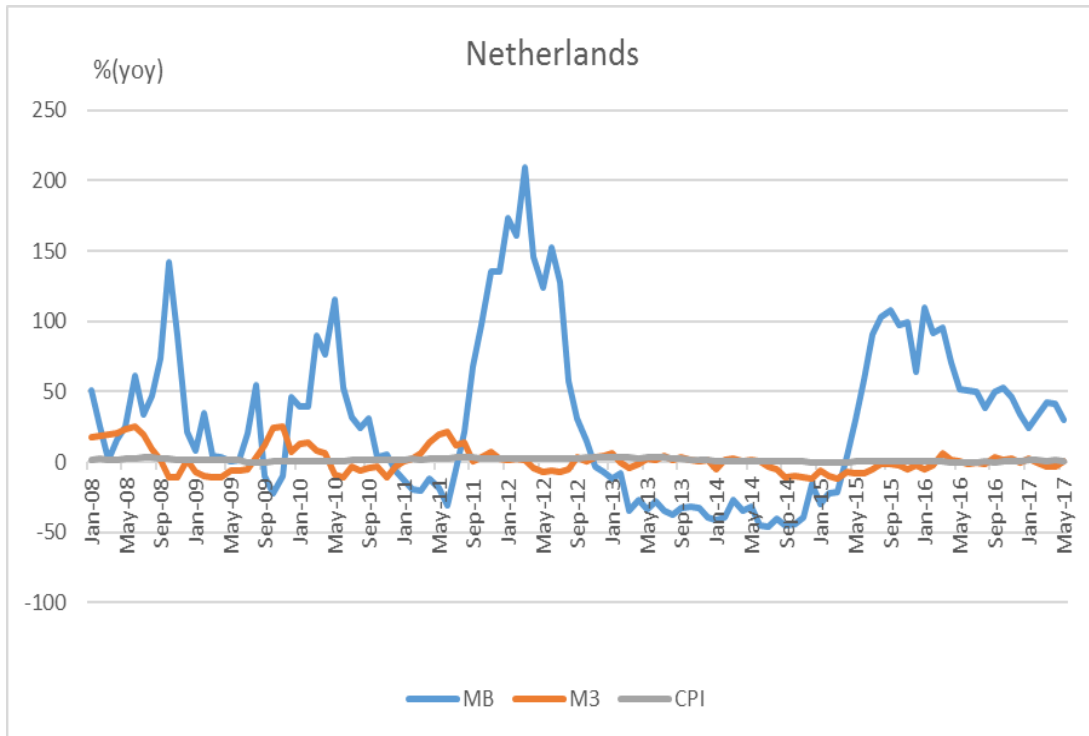Croatia Hrvatska

74

Cyprus

Denmark

75

Estonia

France

76

Germany

%(yoy)

MB   M3   CPI

Latvia

%(yoy)

MB   M3   CPI

Lithuania

Malta

78

Netherlands

Romania

79

Slovak Republic

%(yoy)

MB M3 CPI

Slovenia

%(yoy)

MB M3 CPI

80

Sweden
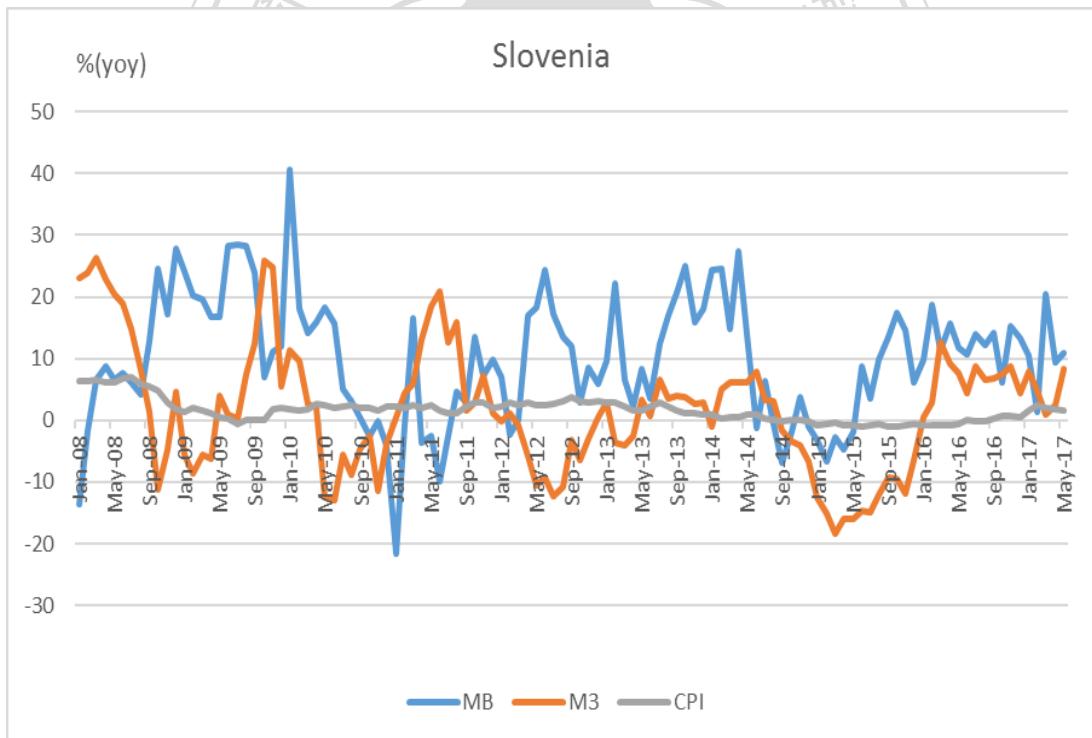
%(yoy)

MB — M3 — CPI

United Kingdon
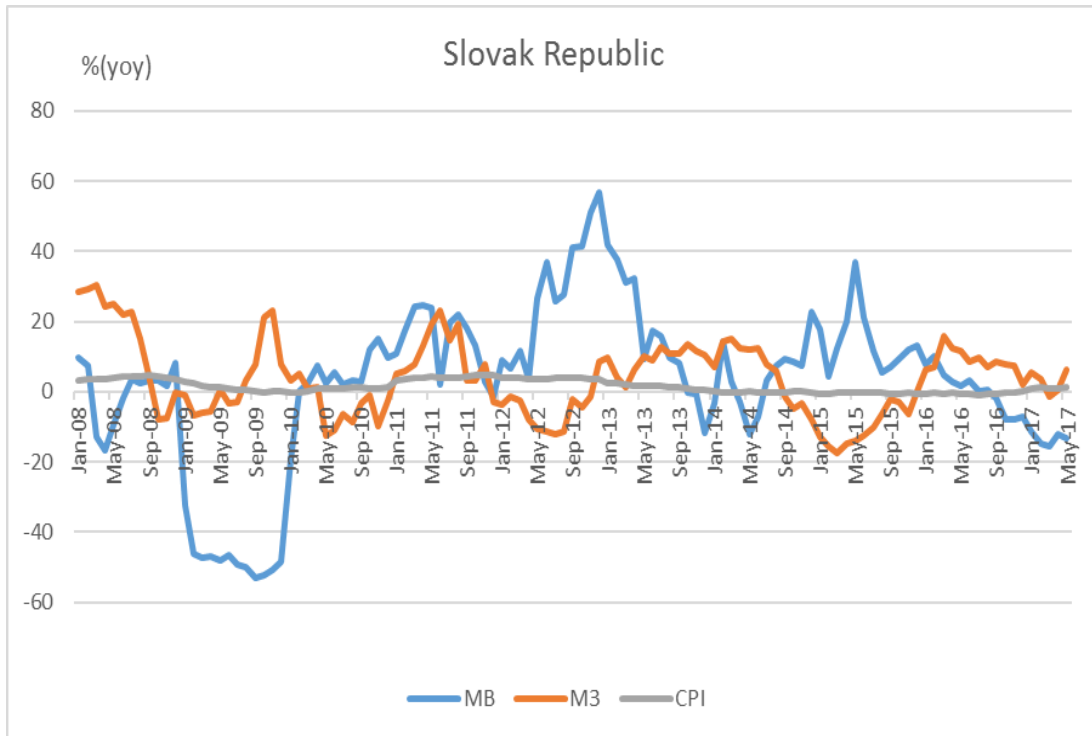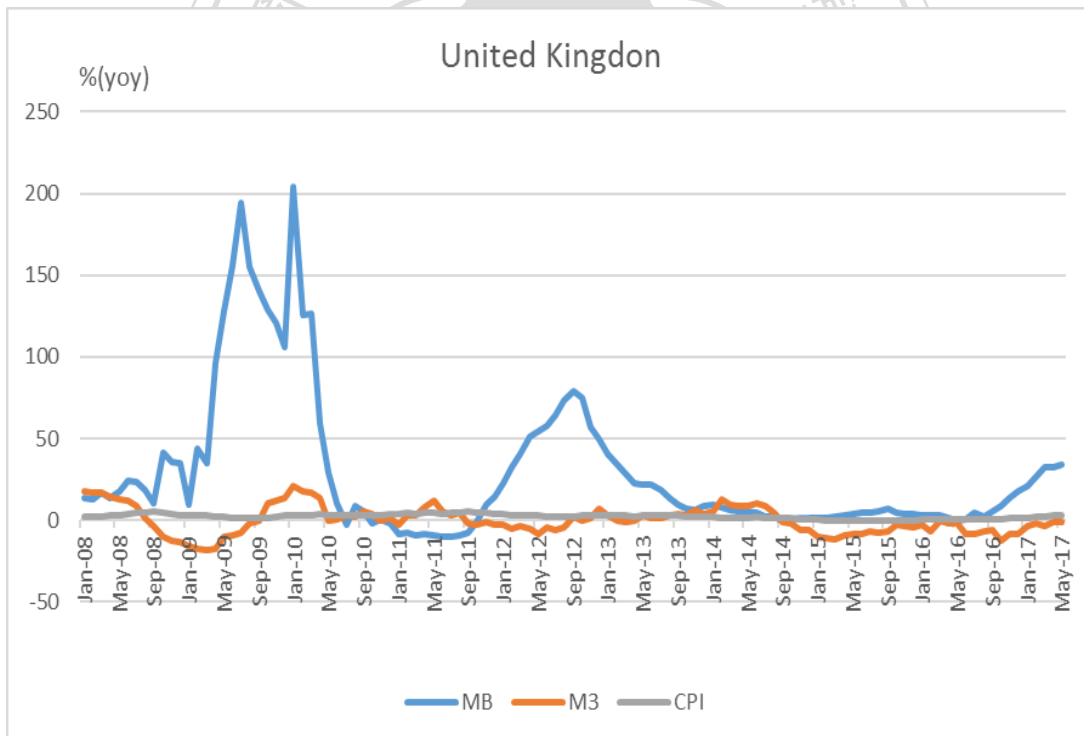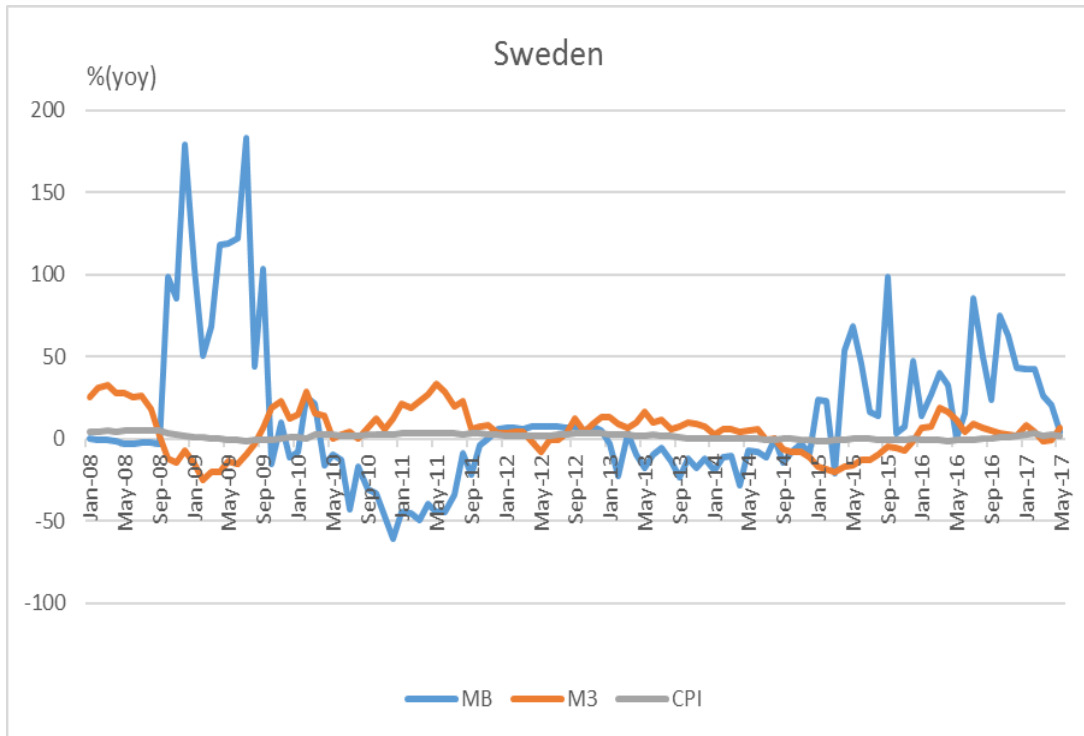
%(yoy)

MB — M3 — CPI
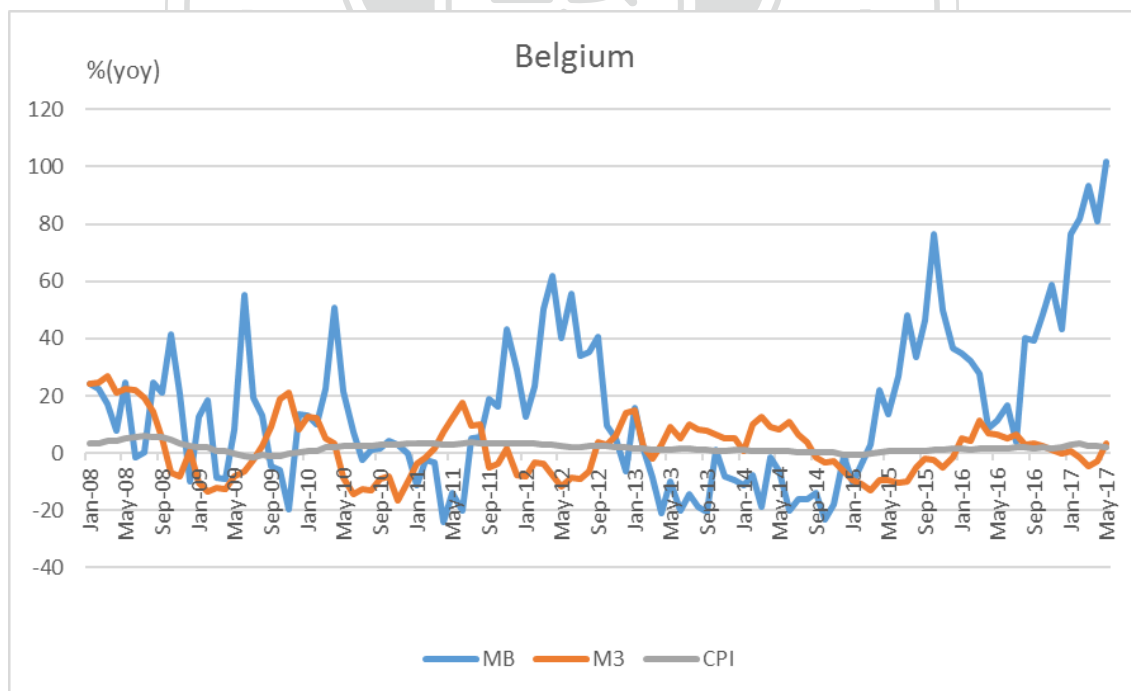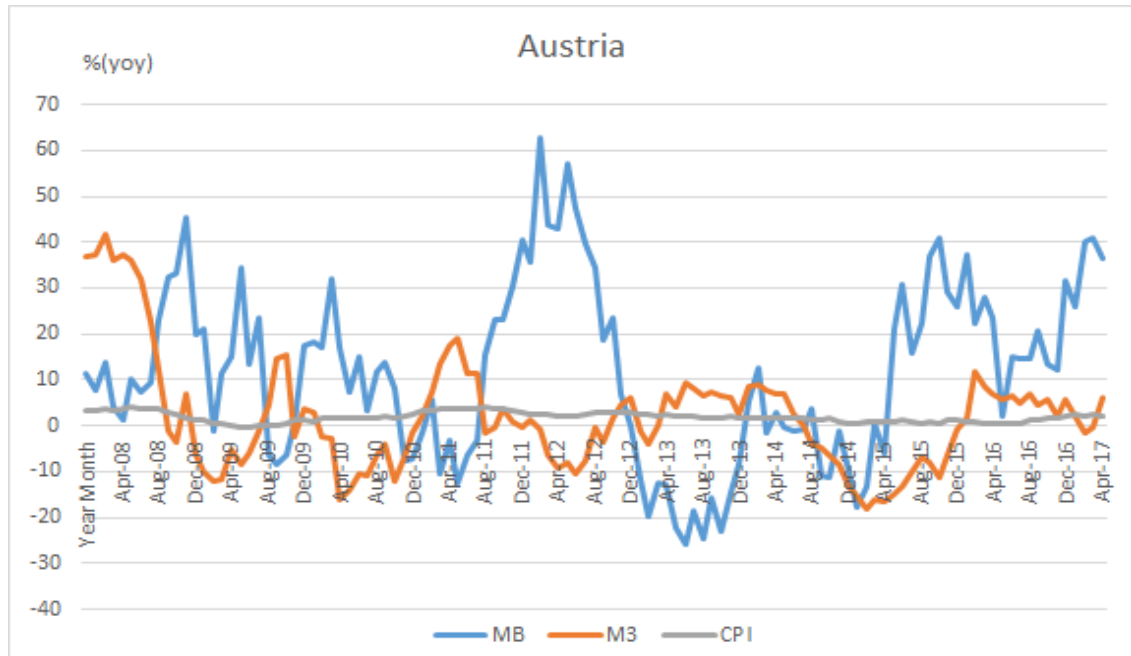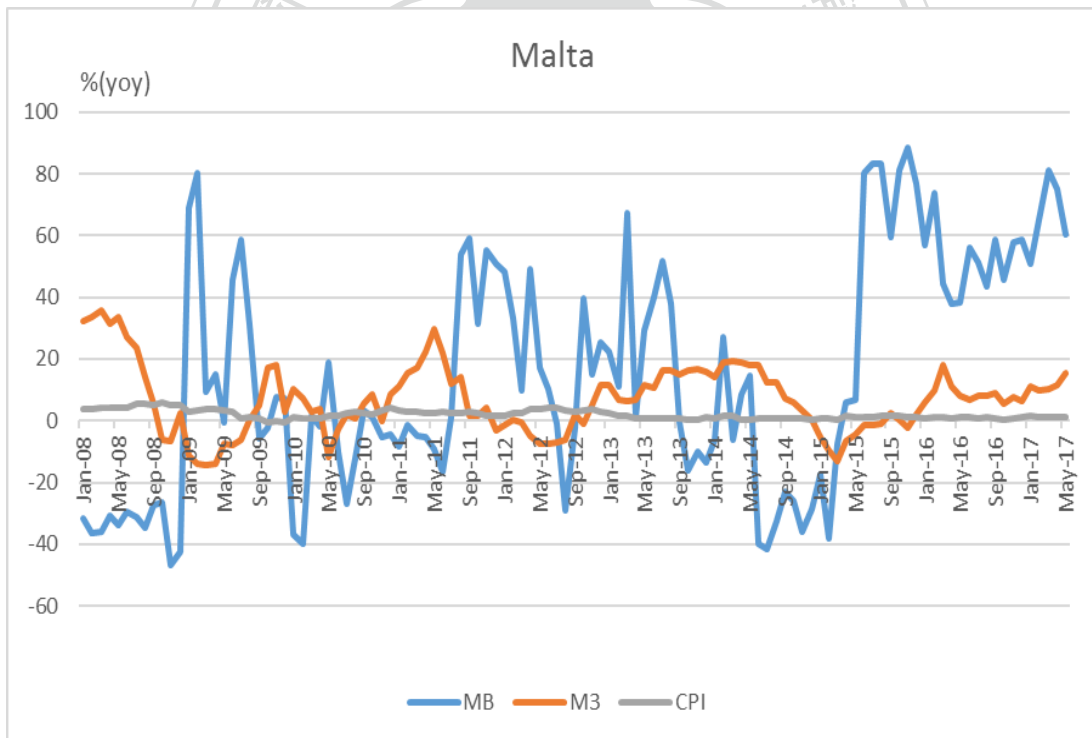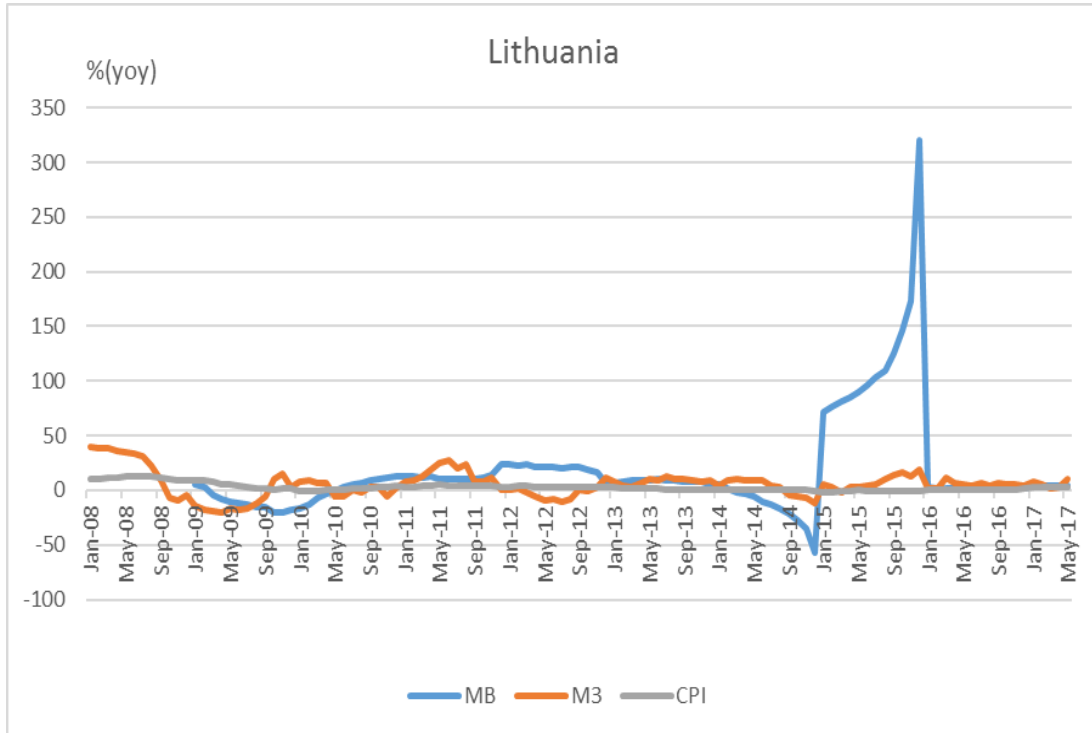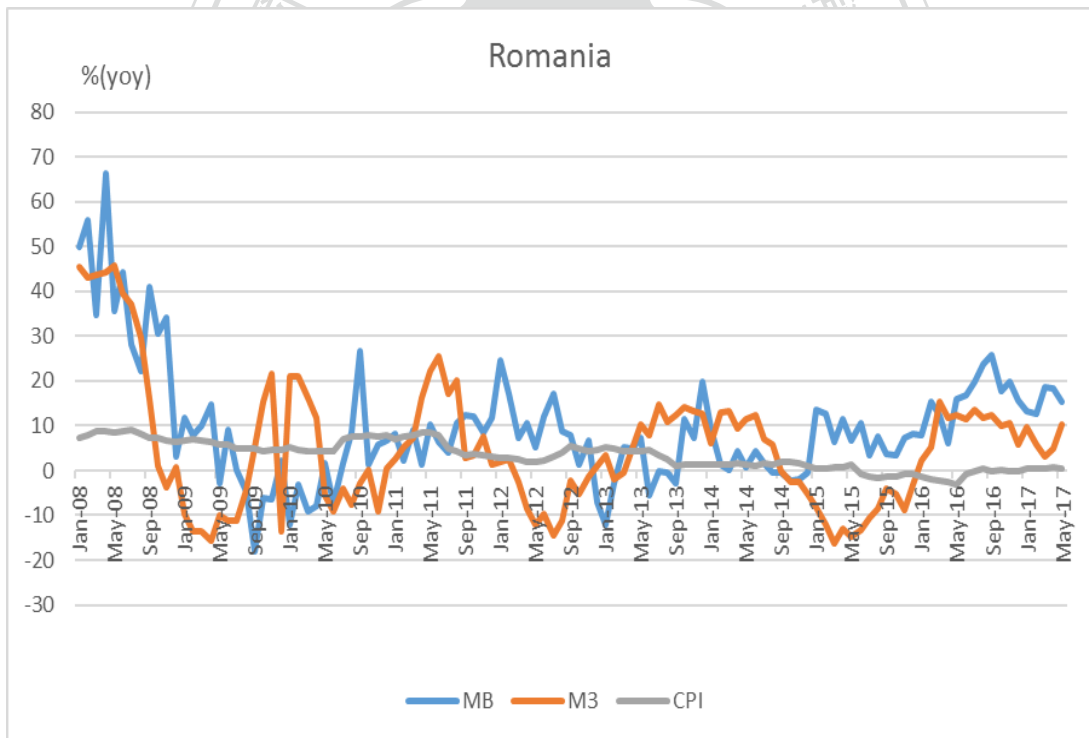
Source: Datastream, and Eurostat.

Notes: CPI is All-items HICP, all indicators are presented as growth rate of same period previous year, monthly data.

Reference

Bénétrix, Agustın S. and Philip R. Lane. 2009. "Fiscal Shocks and the Real Exchange Rate." *IIIS Discussion*, Paper 286.

Bauer, Michael D. and Christopher J. Neely. 2014. "International Channels of the Fed's Unconventional Monetary Policy." *Journal of International Money and Finance*, 44, 24-46.

Baumeistera, Christiane and Luca Benati. 2012. "Unconventional Monetary Policy and the Great Recession: Estimating the Macroeconomic Effects of a Spread Compression at the Zero Lower Bound." Bank of Canada, Working Paper No. 2012-21.

Bernanke, Ben 2000. "Japanese Monetary Policy: A Case of Self-Induced Paralysis?" *Japan's Financial Crisis and Its Parallels to US Experience, Special Report*, 13, 149-66.

Bernanke, Ben S and Mark Gertler. 1995. "Inside the Black Box: The Credit Channel of Monetary Policy Transmission." *Journal of economic Perspectives*, 9(4), 27-48.

Bluwstein, Kristina and Fabio Canova. 2016. "Beggar-Thy-Neighbor? The International Effects of Ecb Unconventional Monetary Policy Measures." *International Journal of Central Banking*, 12(3), 69-120.

Boeckx, J.; M. Dossche and G. Peersman. 2014. "Effectiveness and Transmission of the Ecb's Balance Sheet Policies." National Bank of Belgium, Working Paper No. 275.

Borio, Claudio and Anna Zabai. 2018. "Unconventional Monetary Policies: A Re-Appraisal," *Research Handbook on Central Banking.* Edward Elgar Publishing,

Cargill, Thomas F. 2000. "What Caused Japan's Banking Crisis?," *Crisis and Change in the Japanese Financial System.* Springer, 37-58.

Casiraghi, Marco; Eugenio Gaiotti; Maria Lisa Rodano and Alessandro Secchi. 2013. "The Impact of Unconventional Monetary Policy on the Italian Economy During the Sovereign Debt Crisis." Banca d'Italia Occasional Papers, No. 203 (2013).

Chen, Han; Vasco Cúrdia and Andrea Ferrero. 2012. "The Macroeconomic Effects of Large-Scale Asset Purchase Programmes." *The Economic Journal*, 122(564), 289-315.

Ciccarelli, Matteo; Angela Maddaloni and José-Luis Peydró. 2015. "Trusting the Bankers: A New Look at the Credit Channel of Monetary Policy." *Review of Economic Dynamics*, 18(4), 979-1002.

Cova, Pietro; Patrizio Pagano and Massimiliano Pisani. 2015. "Domestic and International Macroeconomic Effects of the Eurosystem Expanded Asset Purchase Programme. ." Bank of Italy. Economic Working Papers No. 1036.

De Michelis, Andrea and Matteo Iacoviello. 2016. "Raising an Inflation Target: The Japanese Experience with Abenomics." *European Economic Review*, 88, 67-87.

Dell'Ariccia, Giovanni; Pau Rabanal and Damiano Sandri. 2018. "Unconventional Monetary Policies in the Euro Area, Japan, and the United Kingdom." *Journal of economic Perspectives*, 32(4), 147-72.

Eggertsson, Gauti B. and Michael Woodford. 2004. "Policy Options in a Liquidity Trap." *American Economic Review*, 94(2), 76-79.

Fischer, Stanley; Ratna Sahay and Carlos A. Végh. 2002. "Modern Hyper-and High Inflations." *Journal of Economic literature*, 40(3), 837-80.

Fratzscher, Marcel; Marco Lo Duca and Roland Straub. 2016. "Ecb Unconventional Monetary Policy: Market Impact and International Spillovers." *IMF Economic Review*, 64(1), 36-74.

Gambacorta, Leonardo; Boris Hofmann and Gert 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), 615-42.

Gertler, Mark and Peter 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.

Goodhart, CAE. 2017. "The Determination of the Money Supply: Flexibility Versus Control." *The Manchester School*, 85, 33-56.

Grauwe, Paul De and Magdalena Polan. 2005. "Is Inflation Always and Everywhere a Monetary Phenomenon?" *The Scandinavian Journal of Economics*, 107(2), 239-59.

Haldane, Andrew G.; Matt Roberts-Sklar; Chris Young and Tomasz Wieladek. 2016. "Qe: The Story So Far." Bank of England, Staff Working Paper No.624.

Hamada, Koichi and Yasushi Okada. 2009. "Monetary and International Factors Behind Japan's Lost Decade." *Journal of the Japanese and International Economies*, 23(2), 200-19.

Hausken, Kjell and Mthuli Ncube. 2013. *Quantitative Easing and Its Impact in the Us, Japan, the Uk and Europe*. Springer.

Hausman, Joshua K. and Johannes F. Wieland. 2014. "Abenomics: Preliminary Analysis and Outlook." *Brookings Papers on Economic Activity*, 2014(1), 1-63.

Horvath, Roman and Klara Voslarova. 2017. "International Spillovers of Ecb's Unconventional Monetary Policy: The Effect on Central Europe." *Applied Economics*, 49(24), 2352-64.

Ito, Takatoshi. 2006. "Japanese Monetary Policy: 1998–2005 and Beyond." *Monetary*

Policy in Asia: Approaches and Implementation*, Bank for International Settlements, 105-32.

Ito, Takatoshi and Frederic S Mishkin. 2006. "Two Decades of Japanese Monetary Policy and the Deflation Problem," *Monetary Policy with Very Low Inflation in the Pacific Rim, Nber-Ease, Volume 15.* University of Chicago Press, 131-202.

Kan, Kazutoshi; Yui Kishaba and Tomohiro Tsuruga. 2016. "Supplementary Paper Series for the" Comprehensive Assessment"(3): Policy Effects since the Introduction of Quantitative and Qualitative Monetary Easing (Qqe)-- Assessment Based on Bank of Japan's Large-Scale Macroeconomic Model (Q-Jem)." *Bank of Japan, Working Paper Series 16-E-15.*

Koo, Richard. 2011. "The World in Balance Sheet Recession: Causes, Cure, and Politics." *Real-world economics review,* 58(12), 19-37.

Koo, Richard C. 2015. *Escape from Balance Sheet Recession and the Qe Trap*. Wiley Online Library.

Krugman, Paul. 2000. "Thinking About the Liquidity Trap." *Journal of the Japanese and International Economies*, 14(4), 221-37.

Kucharčuková, Oxana Babecká; Peter Claeys and Bořek Vašíček. 2016. "Spillover of the Ecb's Monetary Policy Outside the Euro Area: How Different Is Conventional from Unconventional Policy?" *Journal of Policy Modeling*, 38(2), 199-225.

Lucas, Robert E. 1980. "Two Illustrations of the Quantity Theory of Money." *The American Economic Review*, 70(5), 1005-14.

MacDonald, Margaux. 2017. "International Capital Market Frictions and Spillovers from Quantitative Easing." *Journal of International Money and Finance*, 70, 135-56.

McKinnon, Ronald and Kenichi Ohno. 2001. "The Foreign Exchange Origins of Japan's Economic Slump and Low Interest Liquidity Trap." *World Economy*, 24(3), 279-315.

Meinusch, Annette and Peter Tillmann. 2016. "The Macroeconomic Impact of Unconventional Monetary Policy Shocks." *Journal of macroeconomics*, 47, 58-67.

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

Michaelis, Henrike and Sebastian Watzka. 2017. "Are There Differences in the Effectiveness of Quantitative Easing at the Zero-Lower-Bound in Japan over Time?" *Journal of International Money and Finance*, 70, 204-33.

Moder, Isabella. 2017. "Spillovers from the Ecb's Non-Standard Monetary Policy

Measures on South-Eastern Europe." European Central Bank, ECB Working Paper, No. 2095.

Mouabbi, Sarah and Jean-guillaume Sahuc. 2019. "Evaluating the Macroeconomic Effects of the Ecb's Unconventional Monetary Policies." *Journal of Money, Credit and Banking*, 51(4), 831-58.

Nakaso, Hiroshi and Potential Growth Rate. 2017. "Evolving Monetary Policy: The Bank of Japan's Experience." *Speach at Federal Reserve Bank of New York*.

Okina, Kunio and Shigenori Shiratsuka. 2003. "Japan's Experience with Asset Price Bubbles: Is It a Case for Inflation Targeting?" *Asset price bubbles: implications for monetary, regulatory, and international policies, MIT Press, Cambridge, Massachusetts*.

Orlowski, Lucjan T. 2015. "Monetary Expansion and Bank Credit: A Lack of Spark." *Journal of Policy Modeling*, 37(3), 510-20.

Peersman, Gert. 2011. "Macroeconomic Effects of Unconventional Monetary Policy in the Euro Area." European Central Bank, ECB Working Paper, No. 1397.

Sargent, Thomas J and Paolo Surico. 2011. "Two Illustrations of the Quantity Theory of Money: Breakdowns and Revivals." *American Economic Review*, 101(1), 109-28.

Shizume, Masato. 2018. "Historical Evolution of Monetary Policy (Goals and Instruments) in Japan: From the Central Bank of an Emerging Economy to the Central Bank of a Mature Economy." *Handbook of the History of Money and Currency*, 1-30.

Svensson, Lars EO. 2003. "Escaping from a Liquidity Trap and Deflation: The Foolproof Way and Others." *Journal of economic Perspectives*, 17(4), 145-66.

Uhlig, Harald. 2005. "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure." *Journal of Monetary Economics*, 52(2), 381-419.

Weale, Martin and Tomasz Wieladek. 2016. "What Are the Macroeconomic Effects of Asset Purchases?" *Journal of Monetary Economics*, 79, 81-93.

Wu, Jing Cynthia and Fan Dora Xia. 2016. "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound." *Journal of Money, Credit and Banking*, 48(2-3), 253-91.