Θέμα διπλωματικής:

«Spillover effects of unconventional monetary policy on international bond markets»

ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ

ΤΜΗΜΑ ΧΡΗΜΑΤΟΟΙΚΟΝΟΜΙΚΗΣ & ΤΡΑΠΕΖΙΚΗΣ ΔΙΟΙΚΗΤΙΚΗΣ

Ονοματεπώνυμο φοιτητή: Δεληγιάννης Γιώργος

Επιβλέπων καθηγητής: . Μαλλιαρόπουλος, Καθηγητής

Μέλη Επιτροπής: Γ. Διακογιάννης, Καθηγητής

Ν. Κουρογένης, Επίκουρος Καθηγητής

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Abstract

This thesis examines the unconventional monetary policies that have been implemented during the last two decades and focuses on their potential spillover effects on bond yields. It describes what unconventional monetary policy is, as well as why Central Banks resorted to it. The definitions of the most popular tools of UMP are provided, as well as a timeline record of how UMP has been implemented by the FED in the US and the ECB in the euro area. Additionally, we focus on spillovers of UMP on emerging market economies (EMEs), but also on the so-called “spill-backs” from EMEs to advanced economies. In the empirical study, we examine bond yields of 12 European countries during a period of 95 months and how these are affected through the various transmission channels of UMP. The results show that all three channels (PB, signaling, liquidity) are effective, with the signaling channel being the most effective. We find that the ECB has indeed managed to maintain the crisis and point out the risk for countries with high idiosyncratic risk, in case the asset purchase program stops.

Spillover effects of unconventional monetary policy on international bond markets

This thesis examines the unconventional monetary policies that have been implemented during the last two decades and focuses on their potential spillover effects on bond yields.

The first chapter describes what unconventional monetary policy is, or rather what it consists of up to date, as well as why Central Banks resorted to it. The definitions of the most popular tools of UMP are provided, as well as a timeline record of how UMP has been implemented by the FED in the US and the ECB in the euro area.

The second chapter examines how these basic tools of UMP are implemented and how they affect the economy. Then, a definition of a spillover is provided and we describe how these occur. Additionaly, we focus on spillovers of UMP on emerging market economies (EMEs), but also on the so-called “spill-backs” from EMEs to advanced economies. And lastly, we mention the main points of the IMF’s report on the effects of QE in the euro area.

The third chapter provides the methodology and the statistical background that was used for the empirical study.

The fourth chapter contains the empirical study. We examine bond yields of 12 countries during a period of 95 months and how these are affected through the various transmission channels of UMP. The results are analyzed and compared both with the theoretical background and with previous studies’ findings.

The fifth chapter includes the summarized conclusions of this thesis.

Contents

1.1 Why Unconventional Monetary Policy

We are all aware of what monetary policy does; its first goal is to maintain financial stability, meaning the avoidance of economic crises, and, beyond that main goal, to achieve macroeconomic stability. This secondary goal is often translated to relatively low inflation rates accompanied by a satisfactory growth rate along with low unemployment rates. Other goals might occur, such as the maintenance of currency rates or dealing with large current account balance deficits, however the primary ones are those mentioned above.

When a crisis occurs, monetary policymakers will try to boost the economy. To this purpose, there are three basic tools at their disposal; the minimum reserve ratio, the central bank rates (lending, deposit and interbank real rates) and the monetary base. All three are used to affect money supply in the economy according to each period's targets. For reasons of simplicity, we will examine what happens if central banks attempt to tackle a crisis by altering the interest rates. The effect of the use of the other two tools would be quite similar.(Antzoulatos 2010, Begg,Dornbusch, 2004)

To inspire the economy during a recession, monetary policymakers would attempt to lower the interest rates, thus making lending cheaper and more accessible to firms and households, motivating them to invest a larger portion of their funds. However, if these interest rates are already near zero, they cannot be much further decreased, or people would lose the incentive to deposit or invest their money. Zero rates would lead the economy to a liquidity trap, as households would keep their surplus funds locked away.

1.2 Reasons conventional monetary policy was proved ineffective

Before the financial crisis of 2007–8, the intellectual and empirical foundations of monetary policy appeared secure and its implementation robust. The aim of monetary policy was to achieve low and stable inflation, the policy framework was inflation targeting, the instrument was a short-term interest rate at which the central bank provided funds to banks or the interbank market and the impact of this official rate on market rates and the wider economy was reliably quantified. Within this framework, the setting of interest rates was done judgmentally using a wide variety of macroeconomic signals, but in a manner that could be approximated with reference to so-called Taylor rules, whereby interest rates responded more than one for one to changes in inflation and also responded to fluctuations in the output gap. This effectively summarizes what constituted conventional monetary policy amongst the mature economies. Its operation led to an effective and predictable use of monetary policy and a largely successful pursuit of low inflation.(Joyce 2012)

The financial crisis and its aftermath of the worst global recession since the 1930s poses a number of challenges for monetary policy and central banks. While conventional monetary policy achieved low and stable inflation, it did not prevent asset market bubbles from occurring. Pre-crisis, a significant literature examined the role of monetary policy in containing asset market bubbles. An influential line of thought suggested that the main aim of monetary policy should be to contain inflation, that ex ante it is far from clear that bubbles can be identified or dealt with by monetary policy and that it may be more effective to use monetary policy to mop up the aftermath of a burst bubble than use it to tackle its build-up.

This view has been widely challenged since the financial crisis. Central banks now have a much greater focus on financial stability in addition to targeting inflation. But by Tinbergen's Law, if an authority has N policy targets it needs at least N policy instruments, so we have seen central banks augment their arsenal of policy instruments with macroprudential tools (see for instance in

the UK, the creation of a Financial Policy Committee to run macroprudential policy alongside the Monetary Policy Committee and a strengthening of capital adequacy and liquidity rules through Basel III.) The aim of these policies is to achieve financial stability and prevent or at least moderate asset market bubbles.

The other main challenge to this pre-financial crisis consensus has been the ability of conventional monetary policy to mop up in an aftermath of a financial crisis and stimulate the economy into sustainable recovery. There is a variety of issues to be considered here. The first is that of the zero lower bound on nominal interest rates. The depth of the recession in many countries meant that Taylor rules would recommend negative nominal interest rates but market interest rates are effectively bounded by zero (or close to zero) because agents can always hold non-interest bearing cash. With the interest rates that central banks can set at or close to zero, other interest rates or forms of monetary policy needed to be considered. The second problem occurred due to the disruption of the financial system itself. Given the scale of losses incurred in the aftermath of the bubble bursting, the solvency of many banks and borrowers were called into question. The result was that the usually reliable relationship between changes in official interest rates and market interest rates broke down, again leading central banks to consider other forms of intervention. Related to this were fears that banks were holding onto funds to improve their viability rather than on-lending to the private sector, requiring some central banks to intervene with the direct provision of credit.

The result was that conventional monetary policy proved ineffective – the usual official rate could not be changed in line with the Taylor rule; it did not impact market rates in the expected way and problems with financial intermediation meant that the usual monetary transmission mechanism was not working. While central banks hold onto the belief that when recovery occurs, conventional monetary policy and macroprudential tools will achieve price and financial stability jointly, the challenge is to aid the economy in its recovery so as to reach that point. This is the challenge facing central banks

and why they have turned to unconventional monetary policy. (Joyce, Miles, Scott, Vayanos 2012)

1.3 Unconventional monetary policy

Unconventional monetary policy takes many forms, as it is defined by what it is not rather than what it is. In some cases (for instance Denmark), it involves the use of negative interest rates. Some commentators advocate suspension or changes to inflation targets. The more common forms of unconventional monetary policy involve massive expansion of central banks' balance sheets and attempts at influencing interest rates other than the usual short-term official rates. For instance, the Federal Reserve implemented policies known as 'credit easing' when they purchased mortgage-backed securities. The purchase of these securities meant that the Fed now held more assets and so its balance sheet expanded. The purchase of these assets also provided liquidity to a market that had dried up in the wake of the financial crisis and helped lower mortgage interest rates directly and provided credit lines to an important part of the economy. The Federal Reserve has also implemented 'Operation Twist'. In this case the size of the balance sheet of a central bank is not affected but the central bank tries to influence non-standard interest rates. In Operation Twist, the Fed sells short-term government bonds and uses the proceeds to buy long-term bonds. Because its sales and purchases are of equal amount, the balance sheet of the central bank is unaffected but through its purchase of long-term bonds, it drives up their price and lowers long-term interest rates.

The most high-profile form of unconventional monetary policy has been Quantitative Easing (QE). The phrase was first applied to Japan as it dealt with the bursting of a real estate bubble and the deflationary pressures that followed in the 1990s. Conventional monetary policy operates by affecting short-term interest rates through open market operations. By either buying or selling securities from the banking system, they influence the level of reserves

that banks hold in the system. In normal times, these fluctuations in the volume of reserves are merely a by-product and are not a focus or target of policy itself. Instead, fluctuations in reserves are a means to achieve desired changes in interest rates. The phrase ‘Quantitative Easing’ was introduced to signal a shift in focus towards targeting quantity variables. With interest rates at their Zero Lower Bound, the Bank of Japan aimed at purchasing government securities from the banking sector and thereby boosting the level of cash reserves the banks held in the system. The hope was that by targeting a high enough level of reserves, eventually this would spill over into lending into the broader economy, helping drive asset prices up and remove deflationary forces.

The central banks of the US, the Euro area and the UK have all followed Japan in adopting policies that have led to substantial increases in their balance sheets, although there are significant differences both amongst themselves and with Japan in terms of how they have implemented QE and other unconventional policies. The Bank of England has overwhelmingly bought UK government bonds from the non-bank private sector through its QE operations; the Fed has bought US Treasuries but also large quantities of agency debt and agency-backed mortgage backed securities. The differences between the assets bought by the Fed and the Bank of England are in fact not so great, because the bulk of the mortgage-backed securities are guaranteed by the US agencies, which are in effect government agencies. The expansion of the European Central Bank (ECB) balance sheet has come about largely through repo operations – that is, the provision of loans (many long term) in exchange for collateral (much of which are bank loans and not government bonds).

The ECB operations are different from the central bank purchases analyzed in most of the literature on QE and credit easing. Indeed, in many ways, they are a response to a different problem than that faced by the Fed in the US and the Bank of England. Stresses within the euro area, particularly in 2011 and into 2012, led to a steady and very substantial outflow of euro deposits from banks in some of the peripheral countries and into banks in other euro-area

countries. That caused a major imbalance within the euro-area banking system – essentially a form of bank run on many institutions. The magnitude of these imbalances became reflected in the so-called Target system imbalances operated by the ECB (Sinn and Wollmershauser, 2011). The ECB long-term repo operations were designed to alleviate the acute funding difficulties that were generated.

The Bank of England and the Fed asset purchase operations were not designed to handle a liquidity problem within the banking system. Rather, they were designed to affect the yields (or prices) on a wide range of assets – particularly on bonds issued to finance lending to companies and households. (Joyce et al. 2012)

1.4 Types of unconventional monetary policy

Following the extreme credit market disturbances in the fall of 2008, the Federal Reserve initiated two types of unconventional policies: forward guidance about future interest rates and announcements of a novel program to purchase large quantities of long-term securities to improve credit market conditions.

On December 16, 2008, and March 18, 2009, the Federal Reserve provided "forward guidance" about the federal funds rate target. More specifically, it announced that economic conditions would likely warrant exceptionally low levels of the funds rate for "some time" and "an extended period," on the respective dates.

On November 25, 2008, the Federal Reserve announced that it would purchase up to $100 billion of government-sponsored enterprise (GSE) debt and up to $500 billion in agency mortgage-backed securities (MBS) to reduce risk spreads on GSE debt and mitigate turmoil in the market for housing credit. On March 18, 2009, the Federal Open Market Committee (FOMC)

announced that the Fed would purchase an additional $750 billion of agency MBS, an additional $100 billion in agency debt, and $300 billion of longer-term Treasury securities. Kohn (2009) calls these purchases “large-scale asset purchases” (LSAP). (Neely, 2015)

1.5.1 More on FED’s unconventional monetary policy

In December 2008, the Federal Open Market Committee (FOMC) lowered the target for the federal funds rate to a range of 0 to 25 basis points. With its traditional policy instrument set as low as possible, the Federal Reserve faced the challenge of how to further ease the stance of monetary policy as the economic outlook deteriorated. The Federal Reserve responded in part by purchasing substantial quantities of assets with medium and long maturities in an effort to drive down private borrowing rates, particularly at longer maturities. These large-scale asset purchases (LSAPs) have greatly increased the size of the Federal Reserve’s balance sheet, and the additional assets may remain in place for years to come.

To be sure, the Federal Reserve undertook other important initiatives to combat the financial crisis. It launched a number of facilities to relieve financial strains at specific types of institutions and in specific markets. In addition, in an attempt to provide even more stimulus, it used public communications about its policy intentions to lower market expectations of the federal funds rate in the future. All of these strategies were designed to ease financial conditions and to support a sustained economic recovery. Over time, though, the credit extended by the liquidity facilities has declined and the dominant component of the Federal Reserve’s balance sheet has become the assets accumulated under the LSAP programs.

The decision to purchase large volumes of assets came in two steps. In November 2008, the Federal Reserve announced purchases of housing agency debt and agency mortgage-backed securities (MBS) of up to $600

billion. In March 2009, the FOMC decided to substantially expand its purchases of agency-related securities and to purchase longer-term Treasury securities as well, with total asset purchases of up to $1.75 trillion, an amount twice the magnitude of total Federal Reserve assets prior to 2008.1 The FOMC stated the increased purchases of agency-related securities should "provide greater support to mortgage lending and housing markets" and that purchases of longer-term Treasury securities should "help improve conditions in private credit markets." (Gagnon 2011)

1.5.2 More on ecb's unconventional monetary policy

Following the 2007–9 financial crisis, the euro zone was further hit by the sovereign debt crisis that started in Greece and spread to other member countries. The debt crisis led to the fragmentation of the single financial market and resulted in important differences in credit conditions across the euro-zone states. The situation was further deepened by the negative feedback loop between the sovereign distress and bank insolvency. Indeed, euro-zone banks were heavily exposed to sovereign debt, while euro-zone governments bore the responsibility of rescuing their banking systems. The European Central Bank (ECB) faced the difficult task of restoring monetary transmission to support the economy in these exceptional circumstances. However, the traditional monetary tool—the ECB main refinancing rate—was not effective in equalizing the borrowing conditions across the euro zone and stabilizing the malfunctioning interbank market. Therefore, the ECB implemented several unconventional monetary policies to attain its goals. (Szczerbowicz 2015)

This section presents the ECB's unconventional policies, their theoretical foundations, and the objectives they were meant to attain. We regroup unconventional policies into two categories: (i) exceptional liquidity provisions (three-year LTROs, the fixed-rate full-allotment procedure, and setting the

deposit rate to zero) and (ii) asset purchases (sovereign bond and covered bond purchase programs).

Exceptional Liquidity Provisions

Significant tensions appeared on the euro-zone interbank market at the onset of the subprime crisis. The general uncertainty concerning banks' balance sheet health led to the increase in the spread between the risky interbank rate (Euribor) and the riskless rate. The euro-zone sovereign debt crisis further impaired the money-market functioning, as the banks held important amounts of risky sovereign debt issued by periphery euro-zone countries.

The ECB reacted very promptly to the tensions on the interbank market and implemented several additional liquidity measures. In this paper, we focus on the impact of the strongest ECB liquidity innovations: announcements of the fixed-rate full-allotment procedure (FRFA) and the three-year refinancing operations (three-year LTROs). We also consider the announcement of setting the ECB deposit rate to zero, as it was the first time the ECB hit this limit.

The fixed-rate procedure with full allotment was also a part of the ECB's non-standard toolbox. Traditionally, open-market operations were conducted through variable-rate tenders. Under the FRFA procedure, banks could satisfy all their liquidity needs at an interest rate specified in advance (the interest rate on the main refinancing operations). After Lehman Brothers collapsed, the ECB introduced the FRFA procedure for all open-market operations and for foreign liquidity swaps. First, late on October 8, 2008, the ECB announced that all weekly main refinancing operations (MROs) would be carried out through a fixed-rate tender procedure with full allotment. On October 13, 2008, it decided to provide unlimited dollar funding in coordinated action with the Federal Reserve. Two days later, on October 15, 2008, the ECB announced an FRFA procedure for its LTROs. The ECB decided to return to a

variable-rate tender procedure in the regular three-month LTROs in March 2010, but the Greek debt crisis forced it to resume the FRFA procedure in the regular LTROs on May 10, 2010. By ensuring banks' continued access to liquidity, the ECB intended to offset liquidity risk in the market.

Since 2007 the ECB has implemented other exceptional liquidity measures: gradual lengthening of the maturity of the LTROs up to one year. These liquidity provisions are very close to standard monetary measures and were often expected by the market participants. However, on December 8, 2011, the ECB took an unprecedented measure to conduct three-year LTROs as a fixed-rate procedure with full allotment. The first three-year LTRO was offered on December 21, 2011, and the second on February 29, 2012. The banks borrowed more than €1 trillion, which covered their immediate funding needs and prevented them from selling assets and curtailing some types of lending. The three-year LTROs were incomparable in length to other liquidity measures and considerably increased the credit risk on the ECB balance sheet.

The main objective of the ECB exceptional liquidity provisions was to restore the smooth functioning of the interbank market, as this aspect was crucial for extending credit to firms and households. The liquidity measures can be effective in stabilizing the interbank market for several reasons. A liquidity shortage has a negative impact on financial institution lending capabilities and may result in a credit crunch. Liquidity-constrained banks excessively hoard liquidity for precautionary reasons and proceed to fire sales of assets, affecting negatively their prices. By ensuring funding liquidity, the ECB's unconventional measures diminish these adverse effects. They also reduce banks' uncertainty with respect to funding liquidity of other market participants and therefore diminish counterparty risk premiums.

Despite unlimited liquidity being available, the interbank market was still not functioning. In order to overcome banks' reluctance to lend to each other, the ECB lowered its deposit rate to 0 percent on July 5, 2012. While the markets expected a cut in the deposit rate on that day, the move to zero was a surprise. This measure was not a strictly unconventional measure, but it was

the first time that the ECB hit the zero bound, and it was perceived as moving into “new territory.” While not a liquidity measure per se, it was aimed at reinforcing the existing liquidity tools by encouraging banks to lend available money in the interbank market and not store it at the ECB.

Purchases of Assets

In a period of financial distress, the central bank can modify the composition of its assets by purchasing the securities that suffer from temporary liquidity problems or are undervalued by financial markets. This policy is sometimes called “credit easing.” The purchases can be sterilized by disposal of the other central bank assets (“pure credit easing”) or be a part of the central bank balance sheet expansion (“quantitative easing”).

The effectiveness of credit easing is based on the “portfolio rebalancing effect”: when securities are not perfect substitutes, reducing the quantity of selected assets available for private investors increases their prices and diminishes yields by suppressing the risk premia (Bernanke 2010). The portfolio rebalancing effect is controversial from a theoretical point of view. A representative-agent model of Eggertsson and Woodford (2003) predicts no effect for such operations on price level or output. However, replacing a representative agent that has no preference between markets and assets with heterogeneous agents can also provide rationale for central bank asset purchasing. In the preferred-habitats model of Vayanos and Vila (2009), the interest rates of all maturities are determined through the interaction between risk-averse arbitrageurs and investor clienteles with preferences for specific maturities. In this framework, the central bank purchases of long-term Treasuries can lower the long term yields because they create a “scarcity effect” that arbitrageurs cannot eliminate. Moreover, the purchases can be effective, as they shorten the average maturity of government debt and therefore the duration risk held by arbitrageurs.

i) Sovereign Bond Purchases

The Greek sovereign debt crisis in spring 2010 triggered a fire sale of some euro-zone government bonds. The ECB announced on Sunday, May 9, 2010 the Securities Market Programme (SMP) as a part of European Union efforts to stabilize the euro. The program was designed to purchase sovereign bonds and therefore to “ensure depth and liquidity in those market segments which are dysfunctional”. The SMP was from the start a source of division within the ECB. Critics said that the ECB was overstepping its mandate by buying public debt in secondary markets and that the bond purchases would increase the inflationary pressures as well as undermine the ECB’s credibility. However, the ECB insisted that the SMP was temporary and merely aimed at improving the transmission of the monetary policy. In order to distinguish the SMP from the U.S.-style quantitative easing and to ensure that the monetary policy stance was not affected, the ECB decided to sterilize these purchases via specific operations designed to reabsorb the injected liquidity. Another notable difference between the SMP and the Federal Reserve sovereign bond purchases is that the ECB gave no details on the amount of bonds to be purchased, their origin, or how long it intended the program to last. The purchases stopped unofficially in January 2011, but the intensity of the euro-zone crisis and the risk of contagion to Italy and Spain made the ECB resume the program in August 2011. The ECB bought €219.5 billion of euro-zone government bonds within the SMP.

The euro-zone debt crisis continued in the beginning of 2012 as the critical financial standing of Spanish banks was revealed. The concerns about their solvency and in general the solvency of the Spanish government made the sovereign yields in the euro-zone periphery increase rapidly, as market participants were pricing in the possibility of some countries leaving the Monetary Union. As a response, ECB President Mario Draghi announced in July 2012 that the central bank would do “whatever it takes to save the euro.” On September 6, 2012, the ECB announced the sovereign bond purchasing program—Outright Monetary Transactions (OMT)—and at the same time

officially terminated the SMP. The objective of the new program, like the objective of the SMP, was to repair the monetary policy transmission mechanism and restore homogeneous credit conditions throughout the euro zone. More precisely, the purchases of euro-zone periphery sovereign debt were intended to reduce the risk premia related to fears of the reversibility of the euro. Despite the shared objective, the OMT was different from the SMP in several aspects. First, the maximum maturity of bonds purchased was set to three years, whereas the SMP concerned longer-term bonds. Second, there was a conditionality attached to participating in the OMT: the ECB would only purchase sovereign debt of a given country if its government complied with a full or precautionary macroeconomic adjustment program set by the European Financial Stability Facility (EFSF) or the European Stability Mechanism (ESM). Third, the ECB decided to forgo its seniority status with respect to private creditors. Finally, once the country met the access conditions, the ECB would intervene without limits, whereas the SMP was always presented as “temporary” and “limited,” which was hardly reassuring for investors. The ECB has not purchased any sovereign bonds within OMT since the announcement of the program.

ii) Covered Bond Purchases

Covered bonds are securities issued by credit institutions to assure their medium- and long-term refinancing. They are collateralized by a dedicated pool of loans, typically mortgage loans and public-sector loans, and remain on the lender’s balance sheet. They are seen as safer than other bank bonds, because they give investors a claim on the credit institution itself and on the cover pool of collateral as well. At the end of 2007 covered bonds were the most important privately issued bond segment in Europe’s capital markets (ECB 2008). Despite their initial resilience to the financial turmoil that started in August 2007, this market dried up after Lehman Brothers collapsed in September 2008, as investors turned to government bonds and other less risky assets. To prevent a credit crunch, the ECB announced on May 7, 2009 that it would purchase €60 billion of euro-denominated covered bonds issued

in the euro zone. This decision was surprising for the markets which were expecting the rate cut and the lengthening of the lending program but not the purchases of private debt, which were perceived as a change in strategy. The objectives of the Covered Bond Purchase Programme (CBPP1) were the following: promoting the ongoing decline in money-market term rates; easing funding conditions for credit institutions and enterprises; encouraging credit institutions to maintain and expand their lending to clients; and improving market liquidity in important segments of the private debt securities market.

At the end of June 2010, the ECB stopped the covered bond purchases, but as the sovereign crisis deepened in autumn 2011, it proceeded to further measures supporting the covered bond markets. On October 6, 2011 it announced the second Covered Bond Purchase Programme (CBPP2) of €40 billion in favor of euro-denominated covered bonds in both primary and secondary markets.

Chapter 2

2.1 How forward guidance and asset purchases work

Forward guidance and asset purchases can potentially affect asset prices through three channels: liquidity, signaling, and PB. The liquidity channel can raise asset prices to the extent that official asset purchases improve market liquidity by providing a consistent buyer. As such, the liquidity channel is likely to have been the least important for the unconventional policy effects, as it would be operative only very early in the sample (Joyce et al. (2011), Gagnon et al. (2011a, 2011b)).

The signaling channel affects long-term interest rates through expected overnight rates. If forward guidance or asset purchase announcements reduce expectations of the future federal funds rate—perhaps due to weaker growth forecasts—then the average expected overnight rate will decline and reduce long-term interest rates.

The PB effect takes place when investors have to replace the assets that the Central Bank buys from them. If the CB buys some long-term government bonds from the market, these investors would look for similar assets to invest into as substitutes in their portfolios. Therefore, the CB pushes money into the market, which investors should preferably opt to put in other long-term assets such as corporate bonds, thus making lending for companies more accessible, boosting the overall economy.(Neely 2015)

However, Fed announcements may also provide new information about the current state of the economy. Such a fourth channel, or what may be dubbed confidence channel, can affect portfolio decisions and asset prices by altering the risk appetite of investors. For instance, a Fed LSAP announcement may be understood by markets as indicating that conditions are worse than previously expected, hence triggering a flight to safety (e.g. Neely 2010).

Two key points need to be emphasized. First, the four channels discussed above are by no means mutually exclusive, but several channels may be at work simultaneously. Second, the way non-US portfolio allocations and asset prices are affected by Fed announcements and operations depends on how foreign assets are considered by investors. For instance, whether a flight-to-safety phenomenon leads to a flight out of non-US bonds depends on the degree to which such securities are considered "safe" by US investors. (Fratzscher, Lo Duca, Straub, 2013)

Several papers have empirically investigated the relative importance of these channels for LSAPs. Gagnon argues that PB channel effects produced the great majority of the yield changes from U.S. LSAP. Similarly, Joyce argue that U.K. bond purchases were also effective through the PB channel. Hamilton and Wu also support a large PB effect. Bauer and Rudebusch (2011), however, claim that the signaling channel accounts for 30 to 65 percent of the total impact, rather than the 30 percent suggested by their interpretation of Gagnon et al.'s (2011a) analysis. Krishnamurthy and Vissing-Jorgensen (2011) find both signaling effects and a unique demand for safe long-term assets that might be considered a PB effect. In addition, these authors argue that inflation expectations affect interest rates.

The Fed's unconventional policies in 2008-2009 consisted of two instances of forward guidance in FOMC statements and LSAP. The intention of the policy was to increase the availability and affordability of credit—especially for housing—with the ultimate goal of stimulating real activity by reducing medium- and long-term U.S. interest rates.

Several papers focus on domestic effects of asset purchase programs. Gagnon et al.'s (2011a, 2011b) event study finds that LSAP announcements reduced U.S. long-term yields (see also Kohn (2009) and Meyer and Bomfim (2010)). Joyce et al. (2011) find that the Bank of England's quantitative easing program had quantitatively similar bond yield effects as those found by Gagnon et al. (2011a, 2011b) for the U.S. program.

In addition to influencing U.S. yields, the unconventional policies could affect international asset prices through the signaling and PB channels. The signaling channel implies that the forward guidance or asset purchases would reduce expected future interest rates. On the other hand, the PB channel implies that a purchase of U.S. assets would tend to push down the excess yields on those securities and those of substitutes, until a new equilibrium is reached.

Neely(2010) finds that the unconventional policies significantly reduced the 10-year nominal yields of Australia, Canada, Germany, Japan, and the United Kingdom and also depreciated the USD versus the currencies of those countries. Also, he states that the observed asset price behavior is approximately consistent with the expected effects of an asset purchase in a simple PB model under the assumption of long-run purchasing power parity.

2.2 How Large-Scale Asset Purchases (LSAPs) Affect the Economy

The primary channel through which LSAPs appear to work is by affecting the risk premium on the asset being purchased. By purchasing a particular asset, a central bank reduces the amount of the security that the private sector holds, displacing some investors and reducing the holdings of others, while simultaneously increasing the amount of short-term, risk-free bank reserves held by the private sector. In order for investors to be willing to make those adjustments, the expected return on the purchased security has to fall. Put differently, the purchases bid up the price of the asset and hence lower its yield. This pattern was described by Tobin (1958, 1969) and is commonly known as the “portfolio balance” effect. (Gagnon 2011)

Note that the portfolio balance effect has nothing to do with the expected path of short-term interest rates. Longer-term yields can be parsed into two components: the average level of short-term risk-free interest rates expected over the term to maturity of the asset and the risk premium. The former

represents the expected return that investors could earn by rolling over short-term risk-free investments, and the latter is the expected additional return that investors demand for holding the risk associated with the longer-term asset. In theory, the effects of the LSAPs on longer-term interest rates could arise by influencing either of these two components. However, the Federal Reserve did not use LSAPs as an explicit signal that the future path of short-term risk-free interest rates would remain low. In fact, at the same time that the Federal Reserve was expanding its balance sheet through the LSAPs, it was going to great lengths to inform investors that it would still be able to raise short-term interest rates at the appropriate time. Thus, any reduction in longer-term yields instead has likely come through a narrowing in risk premiums.

For Treasury securities, the most important component of the risk premium is referred to as the “term premium,” and it reflects the reluctance of investors to bear the interest rate risk associated with holding an asset that has a long duration. The term premium is the additional return investors require, over and above the average of expected future short-term interest rates, for accepting a fixed, long-term yield. The LSAPs have removed a considerable amount of assets with high duration from the markets. With less duration risk to hold in the aggregate, the market should require a lower premium to hold that risk. This effect may arise because those investors most willing to bear the risk are the ones left holding it. Or, even if investors do not differ greatly in their attitudes toward duration risk, they may require lower compensation for holding duration risk when they have smaller amounts of it in their portfolios.

In addition to the effect of removing duration and hence shrinking the term premium across all asset classes, Federal Reserve purchases of agency debt and agency MBS might be expected to have an additional effect on the yields on those assets through other elements of their risk premiums. For example, these assets may be seen as having greater credit or liquidity risk than Treasury securities. In addition, the purchases of MBS reduce the amount of prepayment risk that investors have to hold in the aggregate. Prepayment risk on MBS causes the duration of MBS to shrink when interest rates decline and rise when interest rates increase. These changes in duration imply that MBS

have negative convexity: compared with the price of a non-callable bond with the same coupon and maturity, MBS prices rise less when rates fall and decline more when rates rise. Given this undesirable profile and the cost of hedging against it, investors typically demand an extra return to bear the negative convexity risk, keeping MBS rates higher than they would otherwise be. The LSAPs removed a considerable amount of assets with high convexity risk, which would be expected to reduce MBS yields.

These portfolio balance effects should not only reduce longer-term yields on the assets being purchased but should also spill over into the yields on other assets. The reason is that investors view different assets as substitutes and, in response to changes in the relative rates of return, they will attempt to buy more of the assets with higher relative returns. In this case, lower prospective returns on agency debt, agency MBS, and Treasury securities should cause investors to seek to shift some of their portfolios into other assets such as corporate bonds and equities and thus should bid up their prices. It is through the broad array of all asset prices that the LSAPs would be expected to provide stimulus to economic activity. Many private borrowers would find their longer-term borrowing costs lower than they would otherwise be, and the value of long-term assets held by households and firms, and thus aggregate wealth, would be higher.

The effects described so far would be caused by LSAP-induced changes in the stock of assets that is held by the public. Moreover, to the extent that investors care about expected future returns on their assets, today's asset prices should reflect expectations about the future stock of assets. Thus, a credible announcement that the Federal Reserve will purchase longer-term assets at a future date should reduce longer-term interest rates immediately. Otherwise, investors could make excess profits by buying the assets today to sell to the Federal Reserve in the future.

There may also be effects on the prices of longer-term assets if the presence of the Federal Reserve as a consistent and significant buyer in the market enhances market functioning and liquidity. The LSAP programs began at a point of significant market strains, and the poor liquidity of some assets

weighed on their prices. By providing an ongoing source of demand for longer-term assets, the LSAPs may have allowed dealers and other investors to take larger positions in these securities or to make markets in them more actively, knowing that they could sell the assets if needed to the Federal Reserve. Such improved trading opportunities could reduce the liquidity risk premiums embedded in asset prices, thereby lowering their yields.

This liquidity, or market functioning, channel, which is distinct from the portfolio balance channel, appears to have been important in the early stages of the LSAP programs for certain types of assets. For example, the LSAP programs began at a point when the spreads between yields on agency-related securities and yields on Treasury securities were well above historical norms, even after adjusting for the convexity risk in MBS associated with the high interest rate volatility at that time. These spreads in part reflected poor liquidity and elevated liquidity risk premiums on these securities. The flow of Federal Reserve purchases may have helped to restore liquidity in these markets and reduced the liquidity risk of holding those securities, thereby narrowing the spreads of yields on agency debt and MBS to yields on Treasury securities and reducing the cost of financing agency-related securities.

Another asset for which the market functioning channel was important in the early stages of the LSAP programs is older Treasury securities, which had become unusually cheap relative to more recently issued Treasury securities with comparable maturities. Such differences would normally be arbitraged away, but investors and dealers were reluctant to buy the older securities because their poor liquidity meant that they might be difficult to sell. However, after the Federal Reserve began buying such bonds, the yield spreads narrowed to normal levels.

Overall, LSAPs may affect market interest rates through a combination of portfolio balance and market functioning effects. Although the effects on market functioning appear to have been important at the start of the LSAPs when financial markets were unusually portfolio balance effect. The lack of significant movements in interest rates around the times that each component

of the LSAP programs was wound down suggests that market functioning was no longer impaired and that the Federal Reserve presence in the market had little additional effect beyond that through its portfolio holdings.

2.3 Spillover effects of Unconventional Monetary Policy; How?

While most of the debate has focused on the effects of QE on the US economy, foreign policy-makers – in particular in emerging markets– argued that QE policies have created excessive global liquidity and caused an acceleration of capital flows to EMEs. In turn, this capital flow surge is widely blamed for appreciation pressures on EME currencies and a build-up of financial imbalances in EMEs. (Fratzscher et al. 2013)

Fed measures in the early phase of the crisis (QE1) were highly effective in boosting bond and equity prices, especially in the US, and led to US dollar appreciation. Conversely, QE2 boosted equity prices worldwide and led to US dollar depreciation. Yet Fed policies functioned in a pro-cyclical manner for capital flows to EMEs and in a counter-cyclical way for the US. QE1 triggered a portfolio rebalancing across countries out of emerging markets (EMEs) into the US, while QE2 triggered rebalancing in the opposite direction. This finding may be interpreted as lending support to the concerns expressed by policymakers in EMEs.

Second, the impact of Fed operations, such as Treasury and MBS purchases, on portfolio allocations and asset prices dwarfed that of Fed announcements. This result underlines the importance of the market repair and liquidity functions of Fed policies. Third, there is no evidence that FX or capital account policies helped countries shield themselves from spillovers. Heterogeneity in the response to Fed policies is related to country risk.

As Fratzscher states, “EMEs have been adversely affected by pro-cyclical effects of QE policies, inducing capital outflows from EMEs when capital is

scarce and pushing capital into EMEs, driving up asset prices and exchange rates, when they already experience high capital inflows through other sources. Yet, the findings also indicate that foreign policy-makers are not innocent bystanders. The empirical results show that part of the effect of QE policies on foreign economies is related to risk, and that sound domestic policies and strong domestic institutions help insulate countries from US monetary policy spillovers. Thus there may indeed be a case both for domestic policy reforms as well as for more coordination at the global level in order to deal with policy spillovers and externalities."(Fratzscher 2013)

2.4 Quantitative Easing and Spillovers to Emerging-Market Economies: Transmission Channels

QE may affect cross-border capital flows, asset prices and economic activity through several channels that are not mutually exclusive, since some may be at play simultaneously:

(i) Portfolio-balance channel: QE involves the purchase of longer-duration assets such as government bonds and mortgage-backed securities. These purchases reduce the supply of such assets to private investors, compressing the term premium, which, in turn, increases the demand for all substitute assets, including emerging-market assets, as investors turn to riskier assets in search of higher expected risk-adjusted returns. Such portfolio rebalancing lowers risk premiums, boosts asset prices and lowers yields in EMEs, effectively easing their financial conditions.

(ii) Signaling channel: If QE is taken as a commitment by the Federal Reserve to keep future policy rates lower than previously expected, the risk-neutral component of bond yields may decline. Large interest rate differentials with respect to EMEs will be expected to persist, which, in turn, prompts carry trades and capital flows into EMEs.

(iii) Exchange rate channel: The portfolio flows discussed above could result in a depreciation of the U.S. dollar. This would act as a drag on U.S. demand for foreign-produced goods and services relative to those produced domestically. Consequently, emerging-market exports could be negatively affected.

(iv) Trade-flow channel: QE would boost the demand for emerging-market exports, since it supports domestic demand in the United States. This may fully or partially offset the negative effect from the exchange rate channel on emerging-market exports.(Lavigne, Sarker, Vasishtha 2014)

A standard two-country Mundell–Fleming model (Mundell 1963) predicts that a home country's monetary policy easing—typically due to an increase in money supply—has a positive impact on home output and leads to home currency depreciation. This has two offsetting impacts on the foreign country's output, one negative through the home country's currency depreciation (thus exerting beggar-thy-neighbor effects) and the other positive through home output expansion (thus boosting demand for foreign country exports). Theory does not predict which impact between the two will dominate. If the home-currency depreciation impact dominates then the foreign country's output declines, while if the home-output expansion impact dominates then foreign output rises.

Monetary expansion also has impacts on home and foreign consumer prices, even though home and foreign goods and services prices are assumed to be rigid in the short run. Consumer prices are an average of each country's domestic goods price and imported goods and services prices. Home-currency depreciation increases the home-currency price of imported goods and services and, thus, raises the home consumer price index (CPI). In the foreign country, in contrast, it decreases the foreign-currency price of imported goods and, thus reduces the CPI. This means that the real value of a consumption basket declines in the home country and rises in the foreign country for given levels of output.

So, even when home monetary expansion has a negative net (or beggar-thy-neighbor) impact on the foreign country's output, this tends to be offset (at least partially) by a rise in real consumption in the foreign country—generated by an improvement in the foreign terms of trade. When home monetary expansion does not have a negative impact on foreign output, the foreign country clearly gains. The benefit of home monetary expansion for the home country tends to be offset (at least partially) by a decline in real consumption—generated by a deterioration in the home terms of trade.

These impacts work only in the short run where home and foreign goods and services prices are fixed. In the long run, monetary expansion raises the home goods price sufficiently to restore the same level of the real exchange rate as before monetary expansion. Real output returns to its potential level in each country. If home monetary expansion is implemented together with structural reforms to raise potential output, any possible negative impact of home monetary expansion on foreign output is likely to be offset by a permanent increase in home output.

The Dornbusch "overshooting" extension (Dornbusch 1976) of the Mundell–Fleming model provides additional insight. This model has two important theoretical implications. First, a change in monetary policy can create large fluctuations in asset prices, particularly exchange rates. For example, a home country's monetary expansion can cause the exchange rate to overshoot in the short run: the exchange rate depreciates instantly and sharply and then appreciates gradually toward a new long-run equilibrium level that is still depreciated relative to the initial level. Second, an expectation of a future monetary policy change can induce changes in asset prices today, such as exchange rates and stock prices, as financial markets are forward-looking. For example, an expectation of future monetary expansion in the home country can cause its exchange rate to depreciate instantly, even though today's monetary policy is unchanged.

Thus asset price volatility—due to overshooting and driven by expectations—reflects the inherent forward-looking nature of financial markets, which

constantly re-price assets in response to new information, including expected changes in the future monetary policy stance. (Masahiro Kawai 2015)

Following LSAPs, the U.S. term premium and long-term interest rates fall, making ROW long-term bonds more attractive relative to their U.S. counterparts. The resulting portfolio reallocation also drives down the term premium in the ROW, and leads to an appreciation in their currency, which pushes the ROW inflation and policy rates downward. The decline in ROW long-term yields is mostly driven by the decline in the term premium rather than expected policy rates, however. (Thus, quantitative results would be similar if the ROW is also assumed to be facing the zero lower bound so that the ROW policy rate cannot decline as well.) Lower rates stimulate domestic demand in the ROW, while their real exports increase due to higher incomes in the United States. Nevertheless, the ROW's imports increase more than their exports due to the appreciation in the ROW currency, leading to an overall deterioration in their trade balance.

International spillover effects become larger as the ROW holds a larger share of long-term U.S. bonds in their portfolios prior to the announcement of LSAPs in the United States. Spillover effects also increase as the substitutability between short- and long-term portfolios decreases, or as the substitutability between long-term foreign and home bonds increases. Also, U.S. asset purchases that generate the same output effect as U.S. conventional monetary policy have larger international spillover effects. This is because portfolio balance effects appear to be stronger under unconventional policy, and foreigners' U.S. bond holdings are heavily weighted toward long-term bonds. (Sami Alpanda and Serdar Kabaca, 2015)

In fact, having a better understanding of the international implications of quantitative easing is equally important for policymakers in emerging economies, so as to better cope with the challenges implied by such policies. There are two dominant views on likely cross-border effects. The first view, typically held by economies which have implemented such policies in order to revive the domestic economy, sees no major impact or externalities on emerging economies. If there is any effect, this view holds, stronger domestic

growth spurred by quantitative easing would promote a more stable global macro and financial environment, and increase demand for exports by the emerging economies, thereby bringing major benefits to the global economy. The other view, held in many emerging economies, suggests that such policies could depreciate the domestic currency and inflate already significant risk-adjusted interest rate differentials vis-à-vis other economies, leading to potentially large capital inflows, credit growth, and consumer and asset price inflation pressures in these economies.

Nevertheless, the cross-border effects of the different stages of quantitative easing may have changed over time as the growth prospects of the advanced and emerging economies diverged. Initially, quantitative easing may have contributed to alleviating acute global funding difficulties and stabilizing credit markets at a time of raging financial crisis and severe global recession. It may have helped stem large capital outflows and prevent a sustained decline in exports from emerging economies, by strengthening trade credit and supporting demand in the advanced economies. However, at a later stage, while emerging economies returned to solid growth, the latest actions, e.g. the US Federal Reserve asset purchases starting in November 2010, have been perceived as less benign, what with a two-speed global recovery, and already-rising CPI and asset price inflation pressures in the emerging economies. These actions were perceived to have encouraged speculative capital inflows and raised currency appreciation pressures, further increasing risks of overheating, inflation and asset market excesses in the emerging economies.

In the short run, US quantitative easing policy not only stimulated the US domestic economy, but also boosted asset prices globally and helped stabilize the financial markets following the global financial crisis. In particular, it had an expansionary impact on a broad range of assets across the world, including equity prices, government and corporate bond yields and CDS spreads. In addition, it helped the US domestic real economy recover.

However, the international spillovers in the longer run differed across economies. Lowering the term spread of the US Treasury bond yield raised

equity prices significantly in the advanced economies, but the expansionary impact on growth and inflation was only around half of the effect on the US domestic economy. We find no evidence of capital inflow pressure or rapid credit growth in the advanced economies. In contrast, the effect on emerging economies was in general stronger and more diverse. For some economies, such as Hong Kong, Brazil and Argentina, the expansionary impact was greater than the domestic effects of US quantitative easing. US monetary easing has typically led to high capital inflow pressures, rapid domestic credit growth and inflationary pressures in some economies. The longer-run impact depended on the different ways in which each economy reacted or adjusted to the US policy shock, and was in part determined by its economic and financial structure, policy framework, and capital control and exchange rate regimes. We find that the sign and size of the medium-run impact differed across economies, implying that the costs and benefits of US quantitative easing policies have been unevenly distributed between the advanced and emerging economies (Qianying Chen, Andrew Filardo, Dong He and Feng Zhu 2011)

2.5 “Spillbacks” from Emerging-Market Economies to Advanced Economies

Some policy-makers in emerging markets have argued that the negative effects of QE on their economies would ultimately “spill back” to advanced economies (Rajan 2014). Indeed, since EMEs represent a large and rising share of the global economy, there is growing evidence of spillbacks from EMEs to advanced economies, primarily through trade, financial and commodity-price channels. Specifically, weak economic activity in EMEs may lead to softer demand for advanced-economy exports, as well as lower equity and commodity prices. Preliminary analysis conducted by the IMF suggests that spillback effects from EMEs tend to be modest, but could be larger in crisis periods. In addition, the effects are larger for countries or regions with greater trade exposure to EMEs, such as Japan and the euro area (IMF

2014). Moreover, major advanced-economy commodity exporters, such as Canada and Australia, may be negatively affected by lower prices for commodities due to slowing growth in EMEs that are major consumers of commodities. (Robert Lavigne, Subrata Sarker and Garima Vasishtha 2014)

2.6 IMF's assessment of QE in the euro area

The ECB's QE had an immediate impact on financial conditions and expectations. The initial market impact was stronger and broader than expected, with higher inflation expectations (expectations channel), lower term spreads across the euro area (portfolio rebalancing and signaling channels), a weaker euro (exchange rate channel), higher equity prices (asset price channel), an improvement in consumer and business confidence (broader confidence channel), and easier lending conditions (credit channel). While the recent surge in bond market volatility has unwound some earlier gains in asset prices, financial conditions are still easier than before.

The full impact on the real economy will take time to materialize. International experience with QE suggests that peak effects on growth could take between two to eight quarters and on inflation between three to 16 quarters (IMF, 2013b). Engen and others (2015) estimate that the response of unemployment and inflation to the Fed's QE policies since early 2009 peaks in 2015 and 2016, respectively. In particular, a credit recovery typically takes more time, especially if banks' asset quality is still weak (IMF, 2015).

Despite recent market corrections, term spreads remain low in selected countries and in the euro area as a whole. Core countries' term spreads, however, have reverted to near their levels in September 2014. Initial declines were sizeable across the board, particularly given already low yields (relative to that of US and the UK government bonds). Given the price cap on negative rates, purchases initially focused on the longer end, strengthening the decline

in term spreads. This decline reflected a combination of factors including expected short-term interest rates (signaling) and term premia (as a result of both the duration and scarcity effects given the long maturity of purchases). QE has also successfully signaled lower expected short-term interest rates. The announced program was larger than expected and practically open-ended, signaling the ECB's willingness to keep monetary policy accommodative until price stability is achieved. This has strengthened forward guidance and pushed short-term interest rates deeply into negative territory for maturities up to three years.

Looking ahead, portfolio rebalancing in Europe will likely depend on the reaction of different types of sellers. As of mid-2014, domestic private sector investors in the euro area held about 40 percent of their own government's debt securities, compared to about 60 percent in the U.K. and the U.S. and about 82 percent in Japan at the start of their QE episodes. There is wide variation across countries in Europe, with domestic residents holding about 25–30 percent of their own bonds in France and Germany, and about 60 percent in Italy and Spain. The euro area aggregation, however, treats intra-EA holdings as foreign investment. After controlling for cross-country holdings within the EA, non-EA private sector investors held about 9 percent of the total, roughly comparable to other advanced economies, while other central banks account for most of non-EA holdings Several factors could prompt these players to change their portfolios:

1)Global reserve management changes could generate large flows. Since the crisis, the euro's share in global reserves has been declining (22 percent in 2014). If negative rates prompt central banks and the private sector to further reduce their euro allocations, this could lead to additional euro weakening.
2)Domestic non-bank resident holders (such as pension funds, mutual funds and insurance companies) could diversify into foreign safe assets or other riskier domestic assets. Given statutory and regulatory requirements, European pension funds and insurance companies, which currently account for roughly 14 percent of total securities holdings, could opt for safe foreign assets (i.e., U.S. government bonds), contributing to further weakening of the

euro. On the other hand, a shift to riskier domestic assets would lower the private cost of borrowing.

3)*Since the beginning of this year, euro area banks have sold about 4 percent of domestic government and other euro area government debt, accounting for roughly 16 percent of securities holdings.* If banks continue to sell, they could increase lending, as indicated by the ECB's April 2015 *Bank Lending Survey* (BLS), or find other investments. According to the BLS, banks indicated that they have used the additional liquidity mainly for granting loans, particularly to non-financial corporations (NFCs) and for refinancing maturing debt and Eurosystem funding. Only a small percent of banks indicated that they have purchased other marketable assets. In both cases, this would comprise portfolio balancing towards greater risk-taking, which would support growth and ultimately inflation.

With the announcement of QE, European stock prices surged, catching up with other advanced economies. The initial surge, driven by declines in risk premia and the weaker euro, was partly reversed, with inflows to equity markets slowing down more recently. Looking ahead, equity prices could rise further if QE generates higher inflation, confidence, and growth. In other QE episodes, equity prices continued to rise well after the QE launch, in some cases more than doubling.

Higher asset prices support spending by boosting wealth and collateral values:

Wealth effects. The generally low share of equity holdings by households is likely to limit the initial wealth effects stemming from higher stock prices (less so for households in Belgium and Germany given their larger holdings of bonds and equities). The overall impact on consumption will also depend on house prices, with households in countries with higher real estate ownership rate (Spain, Portugal and Italy) benefiting more than core countries. However, these wealth effects might be mitigated by cyclical weaknesses in the demand for housing and oversupply in some countries. Overall, past empirical evidence suggests that while financial wealth effects are large, their impact on economy is limited given their limited share in wealth (ECB, 2013; Sousa, 2009).

Increased collateral values. Higher asset values mean lower leverage, strengthening corporate balance sheets, and banks' assessment of credit risks. Higher real estate prices would also increase collateral valuations, supporting the credit channel.

Exchange rate channel

The euro has also depreciated substantially since mid-2014, despite recent corrections.

As of May 2015, the euro has declined by 7 percent in nominal effective terms since September 2014. Factors affecting the recent movement in the exchange rate include: (i) the divergent outlook for monetary policy stance among advanced economies; (ii) possible shifts to U.S. assets by European long-term investors; and (iii) asset sales and shifts in reserve allocation away from the euro area. Overall, market expectations based on various indicators, including euro risk reversals, speculative positions, and correlation-weighted currency indices, suggest that the euro could weaken further going forward.

A weaker euro will support exports and inflation but the impact will differ across the euro zone. Broadly, the strength of the impact would depend on the degree of openness and trade elasticities. Excluding intra-euro area trade, exports and imports are about 30 percent of euro area GDP (similar to the U.S. and Japan, but lower than the U.K.). There is, however, cross-country heterogeneity, with Germany relatively more open than Italy, Spain and France. On the other hand, according to the European Commission's estimates, elasticities of exports with respect to exchange rate are higher for countries with negative external debt positions, such as Portugal, Italy, and Spain (European Commission, 2015).

Inflation expectations and confidence channels

Inflation expectations at all-time horizons have improved. Before the announcement of QE on January 22, inflation expectations across the board were on a declining trend (text figures). With QE, the secular decline in inflation expectations has been reversed, and the inflation outlook has improved, with the distribution of consensus forecast for 2016 inflation narrowing and shifting to the right. This is similar to the effect that QE has had elsewhere in anchoring inflation expectations. In the U.S. and the U.K., QE was launched early on during the global financial crisis, helping keep inflation

expectations anchored. In Japan, inflation expectations picked up only after the BoJ's QQE was combined with a comprehensive package of fiscal and structural policies.

Confidence has also improved. As expectations of QE intensified in late 2014 and oil prices fell, the decline in confidence indicators since early 2014 was reversed. These broader confidence effects could be quite powerful. For example, to the extent that QE leads to an improved economic outlook, it might release pent-up demand and bring forward spending, creating a positive feedback loop. Some of this more general improvement in confidence may also push up asset prices, by reducing risk premia.

Credit channel

Financial conditions have improved, while fragmentation has declined.

QE has reduced wholesale funding costs as portfolio rebalancing effects have led to a compression of bank bond yields. The improvement in bank funding conditions since 2012 has recently translated into declines in deposit and lending rates. In particular, the dispersion between the core and selected countries has disappeared for deposit rates and shrunk considerably for lending rates. In addition, the divergence in deposit flows to banks has diminished, Target 2 imbalances have narrowed, and the decline in cross-border banking flows has slowed down. Nevertheless, it is still more expensive to borrow in selected countries, particularly in real terms, and deposit and bank flows have not recovered to pre-crisis levels.

Credit constraints have eased.

Credit demand has picked up and the contraction of credit to the private sector has nearly ended. The ECB's asset purchases have led to an easing of credit standards and terms as banks expect a boost to profitability due to capital gains, according to the Bank Lending Survey in April. Furthermore, with declining corporate bond yields, overall borrowing costs for firms have also fallen. Nevertheless, low inflation continues to keep real rates high affecting in particular more indebted countries.

With the euro area largely a bank-based economy, the credit channel has been the main transmission channel of monetary policy to the real economy.

The euro area is not, however, exceptional in its bank financing. Both the U.K. and Japan have a very large share of financial intermediation through banks, but QE has worked there, through a combination of channels. In addition to channels discussed earlier, the ECB's asset purchases will support bank lending through lower lending rates, improved bank balance sheets and the corporate balance sheet channel through improved collateral values, higher expected growth, and lower leverage.

However, credit recoveries after QE typically take more time.

In Japan (2001) and the U.S. (2008), credit picked up only two to three years after financial sector problems were dealt with. Even with sounder financial systems, credit could still respond slowly (e.g., Japan (2010) and the UK (2009), mainly due to weak investment demand.

In the euro area, high NPLs remain an obstacle to a credit recovery.

The ECB's *Comprehensive Assessment* (CA) revealed high NPLs in several banking systems, with considerable variation among countries. High NPLs result in lower profitability and tie up substantial amounts of capital that could otherwise be used for new lending (Aiyar and others 2015). Rising asset prices and an improved outlook are likely to increase credit demand, including through higher collateral values and higher expected earnings, providing an opportunity for banks to restart lending. But weak bank balance sheets and the large private sector debt overhang will likely hold back investment and credit demand.

Spillovers to the global economy are positive, particularly from higher domestic demand.

Further euro depreciation initially hurts the euro area's immediate neighbors and other advanced economies, but as domestic demand picks up negative spillovers diminish over time. Higher domestic demand in the euro area on the other hand would have immediate positive spillovers for most regions. However, the discussion captures mostly trade-related spillovers and does not take into account fully financial spillovers to other countries stemming from lower long-term yields.

Empirical studies suggest that longer-term spillovers to neighboring countries are positive.

In particular the pass-through from the euro area inflation rate to EE and some of the Nordic countries is relatively high (Arnold and others, 2015; Iossifov and Podpiera, 2014). As domestic demand and inflation in the euro area picks up, its neighbors are also likely to see higher inflation and greater demand for their products. (IMF 2015)

3. Methodology

3.1 The models

3.1.1 Dynamic Panel GMM – first differences - Arellano&Bond

A panel has the form

Xit, i=1,2…N, t=1,2…T

where i is the individual dimension and t is the time dimension. A general panel data regression model is written as yit=α+β´Xit+uit. Different assumptions can be made on the precise structure of this general model. Two important models are the fixed effects model and the random effects model. The fixed effects model is denoted as

$y_{it}=\alpha+\beta'X_{it}+u_{it}$

$u_{it}=\mu_i+v_{it}$

μ_i are individual-specific, time-invariant effects (for example in our panel of countries this could include gdp, credit ratings, sovereign debt, growth etc.) and because we assume they are fixed over time, this is called the fixed-effects model. The random effects model assumes in addition that

$\mu_i \sim iid(N,\sigma_\mu^2)$

$v_i \sim iid(N,\sigma_v^2)$

that is, the two error components are independent from each other.

Dynamic panel data describe the case where a lag of the dependent variable is used as regressor:

$y_{it}=\alpha+\beta'X_{it}+\gamma y_{it-1}+u_{it}$

The presence of the lagged dependent variable introduces endogeneity, so estimators like Arellano–Bond estimator or Blundell and Bond that use instruments must be used.

The following model examines the impact of the ECB's Public Sector Purchase Program on bond yields in a panel dataset of 12 countries for 28 months, spanning from 09/2014 to 12/2016. Each t-value since Mar-15 represents a date on which the ECB applied a purchase.

Yit=β1Yi,t−1+β2PSPPit+β3DUMMYit+uit. (1)

In equation (1) above Y_{it} is i-country's bond yield at time t and Y_{it-1} is its lagged value (autoregressive term). $PSPP_{it}$ is a matrix of the components of the PSPP, meaning the outright sovereign bond purchases per country. $DUMMY_{it}$ is a matrix where each element consists of two multipliers(a x b); first multiplier is the announcement dummy, being zero for all days, except for the period between two days before the announcement and the implementation day; and the second multiplier is a country-ratings dummy. AAA equals 1, AA equals 2 and so on, so that larger numbers show worse credit rating. Obviously, the dummy takes prices of zeros outside the "announcement period", whereas during this period, the higher its price, the worse creditworthiness it shows. This is because the assumption we make is that announcements affect more severely countries with low credit rating and higher bond yields. The econometric method used is GMM in first differences, using Arellano-Bond estimator.

Why the Arellano – Bond GMM estimator?

Several econometric problems may arise from estimating equation (1):
1. The asset purchases variables in $PSPP_{it}$ are assumed to be endogenous. Because causality may run in both directions, these regressors may be correlated with the error term.

2. Time-invariant country characteristics (fixed effects), such as macroeconomic performance (indebted countries), may be correlated with the explanatory (independent) variables. The fixed effects are contained in the error term in equation (1), which consists of the unobserved country-specific effects, v_i, and the observation-specific errors, e_{it}: $uit=vi+eit$ (2).

3. The presence of the lagged dependent variable Y_{it-1} gives rise to autocorrelation.

4. The panel dataset has a short time dimension ($T=12$) and a larger country dimension ($N=28$).

To solve **problem 1** (and problem 2) one would usually use fixed-effects instrumental variables estimation (two-stage least squares or 2SLS). However, the first-stage statistics of the 2SLS regressions would probably show that the instruments were weak. With weak instruments the fixed-effects IV estimators are likely to be biased in the way of the OLS estimators. (OLS is biased and inconsistent, because of the lagged variable, even if the v_{it} are not serially correlated. Since Y_{it} is a function of μ_i, so is Y_{it-1}.) Therefore, I decided to use the Arellano – Bond (1991) difference GMM estimator first proposed by Holtz-Eakin, Newey and Rosen (1988). Instead of using only other exogenous instruments, lagged levels of the endogenous regressors in Y_{it} are also added.

This makes the endogenous variables pre-determined and, therefore, not correlated with the error term in equation (1).

To cope with **problem 2** (fixed effects) the difference GMM uses first-differences to transform equation (1) into

$$Y_{it}=\beta_1 Y_{i,t-1}+\beta_2 PSPP_{it}+\beta_3 DUMMY_{it}+ u_{it} \quad (3).$$

(In general form the transformation is given by: $y_{it}=\alpha\Delta y_{it-1}+\Delta' x_{it}\beta+ u_{it}$.)

By transforming the regressors by first differencing the fixed country-specific effect is removed, because it does not vary with time. From equation (2) we get

$$u_{it}= v_i+ e_{it}$$

or

$u_{it}-u_{i,t-1}=(v_i-v_i)+(e_{it}-e_{i,t-1})=e_{it}-e_{i,t-1}$.

The first-differenced lagged dependent variable (**problem 3**) is also instrumented with its past levels.
Finally, the Arellano – Bond estimator was designed for small-T large-N panels (**problem 4**), to get rid of the μ_i and then use IVs. In large-T panels a shock to the country's fixed effect, which shows in the error term, will decline with time. Similarly, the correlation of the lagged dependent variable with the error term will be insignificant (see Roodman, 2006). Arellano-Bond cures this limitation and allows for testing using relatively small-T large-N panels. (Arellano&Bond,1991; Holtz, Newy, Rosen 1988)

3.1.2 Panel GMM with cross-section system SUR instruments

The following model examines the impact of the ECB's Public Sector Purchase Program on bond yields in a panel dataset of 12 countries for 28 periods of time, spanning from 09/2014 to 12/2016. Each t-value represents a date on which the ECB applied a purchase.

$$Y_{it}=c+\beta_1 Y_{i,t-1}+\beta_2 PSPP_{it}+\beta_3 DUMMY_{it}+u_{it}. \quad (1)$$

In equation (1) above Y_{it} is i-country's bond yield at time t and Y_{it-1} is its lagged value. $PSPP_{it}$ is a matrix of the components of the PSPP, meaning the amounts of each purchase per country. $DUMMY_{it}$ is a matrix where each element consists of two multipliers(a x b); first multiplier is the announcement dummy, being zero for all days, except for the period between two days before the announcement and the implementation day; and the second multiplier is a country-ratings dummy. AAA equals 1, AA+ equals 2, AA equals 3 and so on, so that larger numbers show worse credit rating (i.e. higher credit risk). Obviously, the dummy takes prices of zeros outside the "announcement period", whereas during this period, the higher its price, the worse

creditworthiness it shows. This is because the assumption we make is that announcements, e.g. that the ECB will intervene to support sovereign bond valuations thus suppressing yields and spreads, are expected to affect more severely countries with low credit rating and higher bond yields, due to their stronger reaction to (a) strengthening investor confidence and (b) 'hunt-for-yield' conditions that may arise as a result of higher liquidity.

The econometric method used is panel GMM, using SUR instruments (explained below). The exogenous instruments include; the constant c, expressing country-specific effects, second and third lagged values of Yit, ESI (-2,-3), EXP_, HICP(-1,-2), VOL_. ESI is an economic sentiment index, formulated by the confidence in each country's economy's prospects expressed by consumers, retailers, producers etc of the same country. It has been proven (Georgoutsos, Migiakis 2013) that expectations about a country's economic conditions affect its bond yields and spreads. HICP stands for historical index consumer prices and is a measure of inflation. This is relevant, because inflation affects the term premia and, consequently, bond yields. VOL is each country's stock market volatility, calculated as monthly rolling standard deviation of daily returns(more specifically, we calculate daily returns for the entire period, then we get the standard deviation of T=22 observations and we roll it over the rest of the sample). Lastly, EXP is the expected PSPP amount per country, assuming that the total amount of the PSPP will be allocated according to each country's capital key. In other words, EXP=(contribution in ECB's capital by NCBi / ECB capital) x PSPP.

A seemingly unrelated regression (SUR) system comprises several individual relationships that are linked by the fact that their disturbances are correlated. Such models have found many applications. For example, demand functions can be estimated for different households (or household types) for a given commodity. The correlation among the equation disturbances could come from several sources such as correlated shocks to household income. Alternatively, one could model the demand of a household for different commodities, but adding-up constraints leads to restrictions on the parameters of different equations in this case. On the other hand, equations explaining some phenomenon in different cities, states, countries, firms or

industries provide a natural application as these various entities are likely to be subject to spillovers from economy-wide or worldwide shocks. As such, to examine the spillover effects of unconventional monetary policy among the euro area countries' bond yields, the SUR system appears to be a most suitable choice.

There are two main motivations for use of SUR. The first one is to gain efficiency in estimation by combining information on different equations. The second motivation is to impose and/or test restrictions that involve parameters in different equations.(Moon&Peron,2006). Zellner (1962) provided the seminal work in this area, and a thorough treatment is available in the book by Srivastava and Giles (1987). A recent survey can be found in Fiebig (2001)

There are two more regressions in this thesis, which are both also dynamic panel GMM, in first differences, using the Arellano-Bond estimator. For these, to avoid repetition, I will simply provide the equation and explain the variables. The first one is

$$Y_{it}=\beta_1 Y_{i,t-1}+\beta_2 TARGET_{it}+u_{it}. \quad (3)$$

Where the new variable TARGET is the balance of each country's NCB, in the Target accounts with the rest of the Eurosystem NCBs. A negative (positive) value of this figure mainly illustrates (among others) the liquidity that this country's banks has absorbed from (provided to) the Eurosystem (ELA, MROs, LTROs, TLTROs etc). Thus, the Target balance has negative values, when a country's banking community absorbs liquidity, and positive values for countries where commercial banking money flows in and there is, therefore, little need for extra liquidity. In other words, the higher the TARGET value, the less liquidity a country has absorbed from the Eurosystem.

The second one is

$$Y_{it}=\beta_1 Y_{i,t-1}+\beta_2 TARGET_{it}+(\beta 3DUMMY1+\beta 4DUMMY2\ldots)+u_{it} \quad (4)$$

where each dummy represents a period of one month, spanning overall from Jan-09 to Dec-16. These are econometric dummies, rather than economic

ones, measuring the period effect of each month on bond yields. This means that for this model, if a certain period comes up as statistically significant, it would indicate that the events of the respective month, including announcements and implementations of new measures, have had an effect on bond yields in total.

4. Empirical study-Regressions

Regression 1

Dependent Variable: YIELD_
Method: Panel Generalized Method of Moments
Transformation: First Differences

Sample (adjusted): 2009M01 2016M11
Periods included: 95
Cross-sections included: 12
Total panel (unbalanced) observations: 1139
White period instrument weighting matrix
White period standard errors & covariance (d.f. corrected)
Instrument specification: @DYN(YIELD_,-2,-3)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD_(-1)	0.993678	0.061461	16.16757	0.0000
TARGET_	4.84E-06	1.42E-06	3.400484	0.0007

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	-0.032822	S.D. dependent var	0.345434

S.E. of regression	0.490200	Sum squared resid	273.2166
J-statistic	11.98288	Instrument rank	12
Prob(J-statistic)	0.286204		

This regression shows that, based on equation (4) from the models described above, bond yields are both affected by the previous period's levels of yields and by the amount of liquidity absorbed. Both coefficients are statistically significant, with P-values equal to 0.0000 and 0.0007 respectively. The autoregressive term's coefficient is, as expected, positive, as is the liquidity's. This means that the higher a target balance is, the higher the bond yields for a specific country. Remember, countries that are in need for extra liquidity have negative values of TARGET. Therefore, this regression indicates that the more liquidity a country absorbs, the more its bond yields are going to decline.

Based on this finding, we can claim that the liquidity operations of the ECB indeed had an effect on decreasing bond yields and easing economic conditions for countries facing financial outflows, albeit a small one (coeff=4.84E-06). Literature suggests that the liquidity channel is effective mainly in the beginning of its implementation, so we are going to re-run this regression using period dummies this time.

Regression 2

Dependent Variable: YIELD_
Method: Panel Generalized Method of Moments
Transformation: First Differences

Sample (adjusted): 2009M01
2016M11 Periods included: 95
Cross-sections included: 12
Total panel (unbalanced) observations: 1139
Difference specification instrument weighting matrix
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Instrument specification: @DYN(YIELD_,-2,-3) @LEV(LTRO) @LEV(MRO) @LEV(@SYSPER)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD_(-1)	0.930089	0.018107	51.36571	0.0000
TARGET_	1.85E-07	6.67E-07	0.277334	0.7816
@LEV(@ISPERIOD("2009M01"))	0.569215	0.060518	9.405762	0.0000
@LEV(@ISPERIOD("2009M02"))	0.404343	0.096109	4.207122	0.0000
@LEV(@ISPERIOD("2009M03"))	-0.446402	0.099763	-4.474621	0.0000
@LEV(@ISPERIOD("2009M04"))	0.023436	0.055439	0.422731	0.6726
@LEV(@ISPERIOD("2009M05"))	0.057254	0.038624	1.482348	0.1386
@LEV(@ISPERIOD("2009M06"))	0.316679	0.039631	7.990756	0.0000
@LEV(@ISPERIOD("2009M07"))	-0.488341	0.058079	-8.408240	0.0000
@LEV(@ISPERIOD("2009M08"))	-0.000637	0.104665	-0.006083	0.9951
@LEV(@ISPERIOD("2009M09"))	0.094241	0.062862	1.499172	0.1341
@LEV(@ISPERIOD("2009M10"))	-0.011019	0.015271	-0.721587	0.4707
@LEV(@ISPERIOD("2009M11"))	0.040012	0.018756	2.133277	0.0331
@LEV(@ISPERIOD("2009M12"))	-0.032184	0.027008	-1.191662	0.2337
@LEV(@ISPERIOD("2010M01"))	0.224191	0.039560	5.667153	0.0000
@LEV(@ISPERIOD("2010M02"))	-0.214720	0.070066	-3.064539	0.0022
@LEV(@ISPERIOD("2010M03"))	-0.050379	0.103781	-0.485434	0.6275
@LEV(@ISPERIOD("2010M04"))	0.052072	0.052934	0.983721	0.3255
@LEV(@ISPERIOD("2010M05"))	0.166298	0.103396	1.608351	0.1081
@LEV(@ISPERIOD("2010M06"))	-0.299335	0.127559	-2.346643	0.0191
@LEV(@ISPERIOD("2010M07"))	0.298316	0.110987	2.687845	0.0073
@LEV(@ISPERIOD("2010M08"))	-0.164064	0.159850	-1.026363	0.3050
@LEV(@ISPERIOD("2010M09"))	-0.211878	0.203526	-1.041040	0.2981
@LEV(@ISPERIOD("2010M10"))	0.401747	0.065498	6.133693	0.0000

@LEV(@ISPERIOD("2010M11"))	-0.012259	0.068681	-0.178490	0.8584
@LEV(@ISPERIOD("2010M12"))	0.465421	0.094644	4.917615	0.0000
@LEV(@ISPERIOD("2011M01"))	-0.465503	0.136391	-3.412991	0.0007
@LEV(@ISPERIOD("2011M02"))	0.041190	0.065528	0.628584	0.5298
@LEV(@ISPERIOD("2011M03"))	0.024625	0.076618	0.321400	0.7480
@LEV(@ISPERIOD("2011M04"))	0.127160	0.057909	2.195874	0.0283
@LEV(@ISPERIOD("2011M05"))	-0.187247	0.057946	-3.231429	0.0013
@LEV(@ISPERIOD("2011M06"))	-0.124270	0.082876	-1.499470	0.1341
@LEV(@ISPERIOD("2011M07"))	0.283246	0.087718	3.229066	0.0013
@LEV(@ISPERIOD("2011M08"))	-0.204934	0.183033	-1.119656	0.2631
@LEV(@ISPERIOD("2011M09"))	-0.555021	0.224534	-2.471882	0.0136
@LEV(@ISPERIOD("2011M10"))	0.419268	0.182112	2.302254	0.0215
@LEV(@ISPERIOD("2011M11"))	0.431990	0.147949	2.919854	0.0036
@LEV(@ISPERIOD("2011M12"))	0.308818	0.157132	1.965342	0.0496
@LEV(@ISPERIOD("2012M01"))	-0.863048	0.199803	-4.319498	0.0000
@LEV(@ISPERIOD("2012M02"))	0.062501	0.257544	0.242680	0.8083
@LEV(@ISPERIOD("2012M03"))	-0.162205	0.337167	-0.481082	0.6306
@LEV(@ISPERIOD("2012M04"))	0.213651	0.106296	2.009959	0.0447
@LEV(@ISPERIOD("2012M05"))	0.054577	0.066217	0.824206	0.4100
@LEV(@ISPERIOD("2012M06"))	-0.024623	0.252656	-0.097458	0.9224
@LEV(@ISPERIOD("2012M07"))	0.041303	0.370596	0.111450	0.9113
@LEV(@ISPERIOD("2012M08"))	-0.044951	0.277812	-0.161804	0.8715
@LEV(@ISPERIOD("2012M09"))	-0.007409	0.242727	-0.030525	0.9757
@LEV(@ISPERIOD("2012M10"))	-0.196442	0.190047	-1.033651	0.3015
@LEV(@ISPERIOD("2012M11"))	0.020749	0.095395	0.217509	0.8279
@LEV(@ISPERIOD("2012M12"))	-0.034600	0.063778	-0.542500	0.5876
@LEV(@ISPERIOD("2013M01"))	0.120579	0.061323	1.966306	0.0495
@LEV(@ISPERIOD("2013M02"))	0.149170	0.100931	1.477942	0.1397
@LEV(@ISPERIOD("2013M03"))	-0.114630	0.124998	-0.917055	0.3593
@LEV(@ISPERIOD("2013M04"))	0.031207	0.166611	0.187305	0.8515
@LEV(@ISPERIOD("2013M05"))	-0.369913	0.168105	-2.200490	0.0280
@LEV(@ISPERIOD("2013M06"))	0.626704	0.094328	6.643873	0.0000
@LEV(@ISPERIOD("2013M07"))	0.076147	0.090073	0.845387	0.3981

@LEV(@ISPERIOD("2013M08"))	-0.373954	0.051537	-7.256089	0.0000
@LEV(@ISPERIOD("2013M09"))	0.279602	0.059021	4.737340	0.0000
@LEV(@ISPERIOD("2013M10"))	-0.333949	0.046765	-7.141021	0.0000
@LEV(@ISPERIOD("2013M11"))	-0.084667	0.042623	-1.986415	0.0472
@LEV(@ISPERIOD("2013M12"))	0.168435	0.049876	3.377106	0.0008
@LEV(@ISPERIOD("2014M01"))	0.079021	0.036270	2.178724	0.0296
@LEV(@ISPERIOD("2014M02"))	-0.416978	0.113340	-3.679012	0.0002
@LEV(@ISPERIOD("2014M03"))	0.216979	0.110962	1.955431	0.0508
@LEV(@ISPERIOD("2014M04"))	-0.033896	0.065444	-0.517944	0.6046
@LEV(@ISPERIOD("2014M05"))	0.017592	0.066066	0.266277	0.7901
@LEV(@ISPERIOD("2014M06"))	-0.050904	0.057377	-0.887181	0.3752
@LEV(@ISPERIOD("2014M07"))	0.012938	0.026819	0.482413	0.6296
@LEV(@ISPERIOD("2014M08"))	0.033053	0.036335	0.909685	0.3632
@LEV(@ISPERIOD("2014M09"))	-0.237376	0.057946	-4.096517	0.0000
@LEV(@ISPERIOD("2014M10"))	0.207961	0.034639	6.003612	0.0000
@LEV(@ISPERIOD("2014M11"))	0.157531	0.050550	3.116319	0.0019
@LEV(@ISPERIOD("2014M12"))	-0.358045	0.081367	-4.400353	0.0000
@LEV(@ISPERIOD("2015M01"))	0.128419	0.066167	1.940818	0.0525
@LEV(@ISPERIOD("2015M02"))	-0.165108	0.053016	-3.114279	0.0019
@LEV(@ISPERIOD("2015M03"))	0.168286	0.084389	1.994159	0.0464
@LEV(@ISPERIOD("2015M04"))	-0.039892	0.079715	-0.500434	0.6169
@LEV(@ISPERIOD("2015M05"))	0.346157	0.025615	13.51391	0.0000
@LEV(@ISPERIOD("2015M06"))	0.131604	0.048334	2.722818	0.0066
@LEV(@ISPERIOD("2015M07"))	0.087170	0.080179	1.087191	0.2772
@LEV(@ISPERIOD("2015M08"))	-0.715636	0.041007	-17.45151	0.0000
@LEV(@ISPERIOD("2015M09"))	0.511127	0.039100	13.07244	0.0000
@LEV(@ISPERIOD("2015M10"))	-0.445066	0.032831	-13.55627	0.0000
@LEV(@ISPERIOD("2015M11"))	0.295062	0.039469	7.475755	0.0000
@LEV(@ISPERIOD("2015M12"))	-0.231610	0.051265	-4.517924	0.0000
@LEV(@ISPERIOD("2016M01"))	0.375372	0.031860	11.78176	0.0000
@LEV(@ISPERIOD("2016M02"))	-0.374106	0.038301	-9.767448	0.0000
@LEV(@ISPERIOD("2016M03"))	0.069540	0.021611	3.217737	0.0013
@LEV(@ISPERIOD("2016M04"))	0.038143	0.059978	0.635945	0.5250

@LEV(@ISPERIOD("2016M05"))	0.238335	0.045309	5.260172	0.0000
@LEV(@ISPERIOD("2016M06"))	-0.246820	0.029171	-8.461215	0.0000
@LEV(@ISPERIOD("2016M07"))	-0.197445	0.035293	-5.594512	0.0000
@LEV(@ISPERIOD("2016M08"))	0.162744	0.030658	5.308439	0.0000
@LEV(@ISPERIOD("2016M09"))	0.120048	0.021375	5.616334	0.0000
@LEV(@ISPERIOD("2016M10"))	-0.040765	0.027522	-1.481147	0.1389
@LEV(@ISPERIOD("2016M11"))	0.258705	0.054310	4.763474	0.0000

Effects Specification

Cross-section fixed (first differences)
Period fixed (dummy variables)

Mean dependent var	-0.032822	S.D. dependent var	0.345434
S.E. of regression	0.397836	Sum squared resid	164.9208
J-statistic	585.6297	Instrument rank	285
Prob(J-statistic)	0.000000		

As we see from this regression, the TARGET variable loses its significance if we take into account all events that have taken place during the sample's period; this is done by the period- dummies which are are inserted into the model. So, this estimation reveals which events have significantly caused movements of sovereign bond yields. As one examines the months that are statistically significant, according to the respective dummies' p-values, the connection gets clear..

For example, the period from Jan-09 to March-09 includes the nationalization of Ireland's Anglo Irish Bank, amid fears it could collapse. According to the coefficients being positive for Jan and Feb and then negative for Mar, bond yields rose the first two months, only to fall again (coeffs are also about equal

with each other) when turmoil stopped. It is normal for investors to feel threatened at times of crises and turn to safer investments, such as bonds, increasing total demand, thus raising bond prices and lowering bond yields.

Similarly, the period from Jun-09 to Jul-09 is the period between the announcement and the implementation of CBPP1 (Covered Bond Purchase Program) of the ECB.

The period from Jan-10 to Feb-10 includes the adoption of the savings plan in Greece that put the country under surveillance, as well as Spain's announcement of entering a 3y austerity plan to save 50bn. Bond yields seem to rise in Jan and then decrease again in Feb, after an agreement was reached.

From Jun-10 to Jul-10 we have the period between the announcement and the implementation of the SMP and the EFSF, which ran the opposite course; markets responded to the news as a positive address to the European sovereign-debt crisis and so bond yields decreased on the announcement and then stabilized on the implementation.

In Oct-10 Ireland's debt reaches record 32% of GDP due to their banks rescue and this pushes uncertainty and bond yields higher. A little later, from Dec-10 to Jan-11, there are talks and agreement on Ireland's austerity package. Yields fall again after the agreement is reached.

Similarly, during the period from Apr-11 to May-11, Portugal agrees on its austerity program of 78bn.

In Jul-11 Greece agrees on new bailout of 159 bn. Since it is the first country to need a second straight bailout, bond yields rise accordingly.

Between Sep-11 and Nov-11 there are several relative events; CBPP2 is announced and implemented, as well as talks about the PSI began in November. Markets again responded with the announcement in Sep, pushing bond yields down, and then stabilize on implementation of the CBPP2.

In Jan-12, ECB buys Italian and Spanish bonds, after debt and solvency issues become obvious. Bond yields decrease significantly here, as the market is reassured.

In Apr-12, we have the agreement on the Greek PSI terms.

May-13 and Jun-13 are also significant, and they are the period in which the ECB discussed and finally implemented its bank rate cut to 0.5% and its ELA rate cut to 1%. Similarly with other ECB's liquidity measures and asset purchases, bond yields fell in May and stopped their trend in June.

There is a period between Aug-13 and Mar-14, where all months are statistically significant, with both positive and negative values. In Aug-13 we had the first announcement since 2011 that Eurozone GDP was increasing. The fact that Europe was starting to escape the crisis formed positive expectations of putting an end to the sovereign-debt problems and created a downward trend on bond yields. The reason was that investors discounted the relief of pressure both on economies with fiscal issues (e.g. Greece) and on economies with bank solvency issues (e.g. Spain). Meanwhile, the ECB further reinforced liquidity measures, such as the loan-level initiative, based on which the Spanish –mainly- banks could use mortgage loans as collateral to absorb liquidity from Jan-14 and on.

However, what is most striking when someone goes through these results is the period from Sep-14 to Dec-16. This is a span of 27 months that seem to be statistically significant in total. We are going to examine this period separately, as it is the exact period when the ECB started to consider and implement its asset purchases programs, another form of unconventional monetary policy, largely expanding its balance sheet in order to meet its mandate to retain price stability and combat low inflation and growth. In Sep-14 we first have the ABSPP and the CBPP3 programs, and in Jan-15 and Mar-15 we have the announcement and the implementation of the PSPP program, respectively. Note that the PSPP was the first action by the ECB to purchase sovereign bonds.

Regression 3

Dependent Variable: YIELD_
Method: Panel Generalized Method of Moments
Transformation: First Differences

Sample: 2015M01 2016M12
Periods included: 24 Cross-
sections included: 10
Total panel (balanced) observations: 240 Difference
specification instrument weighting matrix
Instrument specification: @DYN(YIELD_,-2,-3) @DYN(DYIELD_,-2,-3)
@DYN(EXP_,0,-1)
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD_(-1)	0.591083	0.048401	12.21221	0.0000
PSPPABS_	-1.08E-05	5.96E-06	-1.815774	0.0707
DUMMYPSPP_*RATINGS_	-0.027317	0.006319	-4.323186	0.0000

Effects Specification

Cross-section fixed (first differences)

Mean dependent var	-0.008979	S.D. dependent var	0.244071
S.E. of regression	0.290346	Sum squared resid	19.97931
J-statistic	210.7066	Instrument rank	97

Prob(J-statistic) 0.000000

Regression 4

Dependent Variable: YIELD_
Method: Panel GMM EGLS (Cross-section SUR)

Sample: 2014M09 2016M12
Periods included: 28 Cross-
sections included: 12
Total panel (balanced) observations: 336 Cross-
section SUR instrument weighting matrix Linear
estimation after one-step weighting matrix
White cross-section standard errors & covariance (d.f. corrected)
Instrument specification: C YIELD_(-2) YIELD_(-3) ESI_(-1) ESI_(-2) EXP_
HICP_(-1) HICP_(-2) VOL_
Constant added to instrument list

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.271090	0.063305	4.282260	0.0000
YIELD_(-1)	0.812941	0.051752	15.70845	0.0000
PSPPABS_	-5.46E-06	1.42E-06	-3.843714	0.0001
DUMMYPSPP_*RATINGS_	-0.135773	0.078519	-1.729173	0.0847

Effects Specification

Cross-section fixed (dummy variables)

Weighted Statistics			
		Mean dependent	
R-squared Adjusted	0.922990	var	1.667925
R-squared S.E. of	0.919632	S.D. dependent var	3.902088
regression Durbin-	1.171660	Sum squared resid	440.6645
Watson stat	1.843225	J-statistic	2.133331
Instrument rank	20	Prob(J-statistic)	0.830406

Unweighted Statistics			
		Mean dependent	
R-squared	0.841176	var	1.088491
Sum squared resid	31.30636	Durbin-Watson stat	1.691649

As we can see from these two regressions' results, bond yields are highly dependent both on past yield levels and PSPP outright sovereign bonds purchases, but also on the announcements of ECB's intentions. If we focus on the results, we observe that past yield levels positively affect current yields, with coefficients of 0.591083 and 0.812941 respectively. Both these coefficients are statistically significant, with a p-value of 0.000 in both regressions. This is an expected result that complies with the theoretical background of the relationship between these two variables.

Moving forward, PSPPABS coefficient is in both models negative and statistically significant, with values of -1.08E-05 and -5.46E-06 respectively, and p-values equal to 0.0707 and 0.0001. The negative coefficient means that every time the ECB decides to apply a bond purchase from investors, these bonds' yields decrease. Indeed, this is also an expected result, since such a course of action by the ECB would have resulted, based on financial textbooks, in a similar-bond price increase -due to increased demand, as investors would most probably like to replace the bonds they sold to the ECB with similar, in terms of return and maturity, ones- and, consequently, a decrease in these bonds' yields. This is what we described above as portfolio rebalancing.

The dummy coefficient is negative and statistically significant, as well. Its respective values are -0.027317 and -0.135773, with p-values of 0.0000 and 0.0847. This is also reasonable, as it stems from the same mechanism that we described above, using the extra assumption that markets predict future shifts and events, and act in advance, as soon as the information is available. According to this assumption, once the announcement is made, investors immediately reform their portfolios rather than waiting for the measure to be implemented.

The most interesting result, however, is the relative size of the last two coefficients. Quite interestingly, the PSPPABS coefficient is way smaller than the DUMMYPSPPRATINGS coefficient. This shows that the announcement had a vastly larger impact on bond yields than the implementation itself. The regressions claim that the signaling effects from the ECB's unconventional monetary policy, and the PSPP asset purchase program in particular, outweigh the portfolio balance effects of the actual implementation. This result comes in support of earlier studies, such as Bauer and Rudebusch (2011) and Krishnamurthy and Vissing-Jorgensen (2011).

Looking at the actual yields according to dates, one can easily observe, as also the IMF stated in its report on the European QE, that right after the announcement on January 2015, bond yields began to fall sharply for the next period, only to stabilize on the implementation on March 2015, when the first

purchases occurred. Indeed, our model explains perfectly the observed changes on bond yields.

Some further notes on the statistical support of the model; the R-squared of the model is 0.922990 and the adjusted R-squared is 0.919632, meaning that the explanatory variables explain about 92% of the bond yields' volatility. The Durbin-Watson statistic is 1.843225, very close to 2, showing no signs of autocorrelation in the residuals, proving our choice of GMM estimators to be the right one. The small sum of squared residuals indicates tight fit to the data. Lastly, j-statistic of the Sargan test for overidentification has a p-value of 0.830406, therefore we reject the null hypothesis, meaning that the model functions properly.

5. Conclusions

This thesis described the tools of what is widely called in literature "unconventional monetary policy". Forward guidance and asset purchases by the central banks have been the main points of focus. We also described the main channels through which UMP is transmitted, which include the liquidity channel, the signaling effect (affecting the expected short-term rates component of bond yields), and the portfolio rebalancing effect (affecting term premia).

We empirically tested the liquidity channel in terms of reducing bond yields, using the yields of 12 countries in the euro area across the last 7 years, and found a statistically significant relationship between liquidity absorbed by a country and its sovereign bond yield. Adding period dummies to the model, we found that further specific events are responsible for shifts in bond yields rather than liquidity alone. Examining the statistically important period of the ECB's asset purchases (ABSPP,CBPP3, and mainly PSPP), we found a statistically significant relationship both between the purchases and bond yields (portfolio rebalancing effect) and between the respective announcements and bond yields (signaling effect).

The relative size of the coefficients showed that the signaling effect is significantly more important than the portfolio balance effect, meaning that the market discounts future events and acts as soon as the information is available. Indeed, comparing our model results with the actual figures, we observe that bond yields decreased sharply on the announcement and stabilized on the actual transaction, without falling any further. With PSPP being practically open-ended and given the expressed willingness of the ECB to keep monetary policy accommodative, expected short-term rates should remain low, keeping the signaling channel effective.

To generalize these conclusions, it is also evident that the ECB has helped containing the crisis. By the actions of unconventional monetary policy that it has taken, including the liquidity tools, the forward guidance concerning its

future plans and the asset purchases and expansion of its balance sheet, the ECB has managed to decrease and then stabilize sovereign bond yields and inject liquidity into the economy, supporting growth prospects and combating low inflation in the Eurozone.

Lastly, based on our model and comparing to actual values of bond yields, it has to be noted that in the case of some countries where the idiosyncratic risk is high, such as Portugal and Italy, a possible stop of the asset purchases program would leave them vulnerable to increased costs of borrowing.

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