

Central Bank Functions and the Unconventional
Operations and Their Effectiveness During the Financial
Crisis in 2007-2012
A Literature Review

Economics

Master's thesis

Ossi Krankkala

2016



Aalto University
School of Economics

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OPERATIONS AND THEIR EFFECTIVENESS DURING THE
FINANCIAL CRISIS IN 2007-2012

– A LITERATURE REVIEW

Master's thesis
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07.06.2016
Economics

Approved by the Head of the Economics Department xx.xx.2016 and awarded the
grade

1.examiner

2.examiner



Aalto University
School of Economics

KESKUSPANKKIEN TEHTÄVÄ JA NORMAALISTA
POIKKEAVAT TOIMENPITEET SEKÄ NIIDEN TEHOKKUUS
TALOUSKRIISISSÄ VUOSIEN 2007 JA 2012 VÄLILLÄ

– KIRJALLISUUSKATSAUS

Pro gradu -tutkielma
Ossi Krankkala
07.06.2016
Taloustiede

Taloustieteen laitoksen johtaja hyväksynyt xx.xx.2016 ja antanut arvosanaksi

1.arvostelija

2.arvostelija

Keskuspankkien tehtävä ja normaalista poikkeavat toimenpiteet sekä niiden tehokkuus talouskriisissä vuosien 2007 ja 2012 välillä

Kirjallisuuskatsaus

Tutkielman tavoitteet

Tämän tutkielman tavoitteena on ollut selvittää USA:n keskuspankin, Euroopan keskuspankin ja Englannin keskuspankin normaalista poikkeavat toimenpiteet talouskriisin aikana vuosien 2007 ja 2012 välillä ja toteutettujen toimenpiteiden tehokkuus. Samalla on selvitetty syitä kriisiin syntyyn, miksi normaalista poikkeaviin toimenpiteisiin ryhdyttiin ja miksi eri keskuspankkien toimenpiteet ovat osittain olleet erilaisia.

Aineisto ja tutkimusmenetelmät

Tutkimusmenetelmänä on ollut kirjallisuuskatsaus. Aineistona on käytetty alan kattavaa kirjallisuutta.

Tulokset

Kriisin alkuvaiheessa keskuspankit tekivät suhteellisen säädyllisiä hienosäätöjä vallitseviin normaaleihin operaatioihinsa. Pää tavoite oli tarjota pankeille heidän tarvitsemaansa likviditeettiä. Lehman Brothersin konkurssin jälkeen pankkien välinen lainananto heikentyi huomattavasti ja keskuspankit käänsivät katseensa korkoerojen pienentämiseen. Kun keskuspankit laskivat pää ohjauskorkonsa käytännön nolnaan, he alkoivat kasvattaa taseitaan ostamalla omaisuuseriä. Vaikka normaalista poikkeavat toimenpiteet auttoivat välttämään finanssisektorin täydellisen sulamisen, niiden tehokkuus ei ole täysin selvä ja tulevaisuuden tutkimusta rahapolitiikan välittymisen mekanismista omaisuuserien arvoihin ja tulevaisuuden odotuksiin on tarvittavaa.

Avainsanat: keskuspankki, talouskriisi, rahapolitiikka, epätavallinen rahapolitiikka, setelirahoitus, määrällinen keventäminen, laadullinen keventäminen, ohjauskoron likviditeettiloukku, Euroopan keskuspankki, USA:n keskuspankki, Englannin keskuspankki

Central bank functions and the unconventional operations and their effectiveness during the financial crisis in 2007-2012

A literature review

Thesis objectives

The objective of this thesis has been to find out the unconventional operations by the Federal Reserve Bank, the European Central Bank and the Bank of England during the financial crisis in 2007-2012 and the effectiveness of these operations. Other related topics have been the reasons behind the crisis, the need for the unconventional operations and why there have been some differences between the unconventional operations among the central banks.

Material and research method

Research method has been literature review. The material used consists of a comprehensive set of economic literature.

Results

During the early stages of the financial crisis the central banks made relatively modest adjustments to their conventional operations. The main object was to provide necessary liquidity to the banks. After the collapse of Lehman Brothers the interbank lending became severely impaired and the central banks turned their focuses on narrowing key interest rate spreads. When the central banks lowered their key interest rates to floor level they started to expand their balance sheets through asset purchases. While the unconventional operations helped in avoiding a complete meltdown of the financial sector their effectiveness is not completely clear and further research about transmission mechanism from monetary policy to asset prices and expectations is much needed.

Keywords: central bank, financial crisis, monetary policy, unconventional operations, quantitative easing, qualitative easing, zero lower bound, the European Central Bank, the Federal Reserve, the Bank of England

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1 INTRODUCTION

Central banks have two primary objectives: price stability and financial stability. Price stability is achieved by a long-run positive but a low inflation level. Financial stability is achieved by a well-functioning financial infrastructure. Central banks use monetary policy tools, usually open market operations, to control inflation levels, and credit policy tools, usually interest rates adjustments of deposit facilities and collateral requirements for a sound financial system. These “normal time” conventional methods will be addressed in chapter 2 so that the unconventionality of the crisis operations can be fully distinguished.

In 2007 the financial crisis started from the bursting of the USA: s housing market bubble. Next symptom was the frozen of the interbank lending, which eventually led to a worldwide financial crisis. Reasons behind the crisis and the progression of the crisis will be briefly addressed in chapter 3.

After that I will turn to the unconventional operations that central banks needed to take in order to avoid a full collapse of the financial markets and the economy. These unconventional operations, why they were needed, how they were implemented and how effective were they against their goals are the main subject of this thesis.

In the early stages of the financial crisis the central banks made relatively modest adjustments to their conventional operations in order to provide liquidity to the markets and to secure the financial stability of the markets by expanding their normal lending operations to banks. Even though, there were some differences in the implementations the responses demonstrated more similarities than differences. The differences originated from having different environments and restrictions, different structures of the financial systems and institutional arrangements of the central banks.

The bank-based nature of the euro area meant that the European Central Bank’s (the ECB’s) existing framework were fairly sufficient to manage the early money market tensions. The market-based nature of US-markets meant that the Federal Reserve (the FED) had to create new facilities so that it could offer the much needed liquidity to the markets. Although the UK is also considered a market-based economy, the Bank of England (the BoE) coped by extending its existing operations and the bank created only one new facility.

Following the collapse of Lehman Brothers, in September 2008, the tensions in financial markets intensified. All three central banks focused on containing and narrowing spreads, of key interest rates, in order to avoid the interbank markets from freezing up completely. In

the early stages of the financial crisis the central banks had already started to cut aggressively their short-term interest rates in order to ease liquidity conditions and to foster economic activity. The FED hit the zero-lower-bound of its main interest rate in December 2008, the BoE in March 2009 and the ECB in May 2009. The zero-lower-bound is essentially the floor of the main interest rate of a central bank, from where the interest rate cannot be lowered any further – meaning that the main tool for price stability is temporarily lost. This meant that the central banks needed to shift from conventional methods (interest rate adjustment) to unconventional methods (the usage of the size and composition of their balance). At this time the policies of the FED and BoE diverged from that of the ECB. The FED and the BoE acted on bond markets by buying mortgage-backed-securities and Treasury bonds; while the ECB expanded further its lending operations to euro area banks.

In 2010 the euro area faced a new kind of crisis, sovereign debt crisis, when the possibility of some of its member countries sovereign debt default emerged (notably Greek). The ECB purchased sovereign bonds of euro area countries in distress to contain “excessive” risk premia and to restore the transmission mechanism of monetary policy. At the same time the FED and the BoE bought AAA rated Treasury bonds in order to lower long-term benchmark yields. At the beginning of 2012 these extraordinary measures led to a situation where the FED and the BoE had more than tripled their balance sheets, while ECB had more than doubled its balance sheet.

According to most academic research central bank interventions, during the early liquidity injection phase of the crisis, had a statistically significant impact on easing stresses in unsecured interbank markets. While the central banks liquidity provisions lowered LIBOR spreads and calmed the financial markets they still were not enough to stop the crisis for good.

The general conclusion, in academic research, is that the later asset purchase programs implemented by the central banks have largely succeeded in providing additional policy stimulus and the long-term interest rates have declined substantially, even though the effectiveness of these programs have diluted with time. Also the exit strategies from these unconventional operations pose a possible problem.

After brief introduction to central banking in chapter 2 and to the progression of the financial crisis in chapter 3, I will turn to the unconventional operations and to the reasons why they were needed in chapter 4. In chapter 5 I will present the actual unconventional operations that the FED, the ECB and the BoE embarked on to. Chapter 6 is dedicated to the research

results in the academic literature about the effectiveness of these unconventional operations by the three central banks and in chapter 7 I will present the conclusions.

2 CENTRAL BANK CONVENTIONAL FUNCTIONS

2.1 The purpose of central banks

In this thesis I will concentrate on three major central banks: The European Central Bank (ECB), The Federal Reserve (FED) and The Bank of England (BoE). The main focus of the thesis will be in the unconventional or unusual operations of the three central banks, mentioned above, during the financial crisis, but in this chapter I will briefly go through the normal or usual operations of central banks so that the unconventionality of the operations during the crisis will be distinguished properly.

While the central banks each have their own stated missions, duties and tasks, they have two similar primary objectives: price stability and financial stability (Bordes & Clerc 2010). Price stability basically means a low and a decent inflation level in a country or a currency union in the long-run. Stable prices give more accurate information about the values of inputs and outputs, thus making the economy less distorted. This leads to more efficient allocation of resources, fosters saving, capital formation, reduces real interest rates, increases incentives to invest and prevents an arbitrary redistribution of wealth and income as a result of unexpected inflation or deflation (The European Central Bank, 2011a). In the end stable prices help countries to achieve maximum output growth and maximum employment (Board of Governors of the Federal Reserve System 2005).

According to Casu and others (2006) price stability, low and stable inflation level, is usually the most important long-term monetary target of a central bank. Two of the three central banks have even a specific inflation target. The BoE has an annual inflation target (2% p.a. in 2011) to meet set by the government (The Bank of England, 2011b). The ECB states that its primary objective is to maintain price stability and it aims at inflation rates of below but close to 2% p.a. (The European Central Bank, 2011c). The FED's mission is: "to promote sustainable growth, high levels of employment and stability of prices" (Casu and others, 2006, 153) but price stability is seen as an essential pre-condition for achieving the two other goals.

Monetary policy tools are used in order to ensure price stability. The main monetary policy tools of central banks are: open market operations, discount windows (or standing facilities) and reserve requirements (see more in chapters 2.2-2.5). These tools determine the key interest rates which control the price level or inflation.

According to the BoE financial stability entails: “Detecting and reducing threats to the financial system as a whole. Such threats are detected through the Bank’s surveillance and market intelligence functions. They are reduced by strengthening infrastructure, and by financial and other operations, at home and abroad, including, in exceptional circumstances, by acting as the lender of last resort” (The Bank of England, 2011a). According to the ECB financial stability refers to smooth functioning of the payment and securities clearing and settlement systems. The smooth functioning is crucial for: a sound currency and for the conduct of monetary policy, the functioning of financial markets, and the maintenance of banking and financial stability (The European Central Bank, 2011b).

Tools for ensuring financial stability are credit policy, which consists in modifying the credit structure, and interest rate policy, which consists of adjusting the interest rates of the marginal lending and deposit facilities (Bordes & Clerc 2010).

According to Bordes and Clerc (2010) there is a separation principle which states that the two main objectives of central banks, price stability and financial stability, must be treated individually and each of the objective must be assigned a specific instrument. Monetary policy instruments for the price stability and market operations for the financial stability. According to the separation principle there must be no interference between the implementation of these two tools. The reason for this is that the interest rates are not the right instrument when dealing with problems like liquidity and/or solvency because: they are ineffective for that purpose, such use may be inconsistent with price stability and the anchoring of inflation expectations and it may also be a source of moral hazard. The moral hazard becomes active if economic agents draw the conclusion that by abandoning the separation principle the central bank has switch its key goal from medium-term price stability to very short-term financial stability. This perception likely causes the banks to behave more riskily, as they delegate their management of liquidity to the central bank and become less involved in forecasting their own future liquidity needs. Especially, if banks are no longer possible to refinance their operations in the money market, they become exclusively dependent on central bank financing, and if they perceive that they have unlimited liquidity from the central bank, their incentive in managing their own future liquidity needs is lowered and they become more inclined for risky investment opportunities. The major central banks have acted according to the principle earlier, but during the most recent financial crisis central banks all around the world have not only dropped their main interest rate levels close to zero (some have even implemented negative interest rates), but have had to find others ways to better the drastic situation.

According to Bordes and Clerc (2010) behind the separation principle there has been implicit assumption that financial imperfections are limited to the banking liquidity market and affect neither the securities market nor the credit market. The crisis has shown that these financial imperfections and their consequences have been underestimated in the event of a major shock and the separation principle need to be re-examined. They provide two possible solutions: ending the separation principle by introducing concerns about financial stability into monetary policy or maintaining the separation principle and expanding the range of instruments currently available to the central bank to ensure financial stability, which would no longer be identified only with money markets.

2.2 Tools or instruments of monetary policy

In order to achieve the long-term target, price stability, a central bank must have short-term operational targets. These short-term operational targets are usually short-term interest rates, commercial bank reserves or exchange rates. Often the operational targets are complemented by intermediate targets such as a certain level of long-term interest rates or broad money growth (Casu and others, 2006).

Nowadays central banks use indirect instruments in implementing their monetary policy such as open market operations, discount windows and reserve requirements instead of exercising direct controls over bank operations by setting limits either to the quantity of deposits and credits or to their prices (Casu and others, 2006). In the following chapters I will shortly explain the main monetary policy tools.

2.2.1 Open market operations

According to Casu and others (2006) open market operations are the most commonly used indirect monetary policy instruments in developed economies. In an open market operation a central bank operates in the market and purchases or sells debt securities (usually government securities, such as Treasury securities, in the case of FED) to the non-bank private sector. If a central bank sells a debt security it absorbs money from the markets thus the money supply decreases and interest rates increases (all other things being equal). When a central bank purchases debt securities from the market it injects money to the markets, thus the money supply increases and interest rates decreases. As a result, of these purchases and sells, a central bank influences the portfolio of assets held by the private sector.

The main attractions of using open market operations to influence short-term interest rates are:

- they are initiated by the monetary authorities who have complete control over the volume of transactions;
- open market operations are flexible and precise – they can be used for major or minor changes to the amount of liquidity in the system;
- they can easily be reversed;
- open market operations can be undertaken quickly

(Casu and others, 2006, 119)

The FED uses U.S. Treasury and federal agency securities in its open market operations, because for open market operations to work effectively, the FED must be able to buy and sell quickly, at its own convenience and in whatever volume it desires so that all the benefits of open market operations can be achieved. These securities trade in a broad, highly active market that can accommodate the transactions without distortions or disruptions to the market itself (Board of Governors of the Federal Reserve System 2005). The key interest rate that the FED affects via its open market operations is the federal fund rate, the rate at which depository institutions lend balances at the Federal Reserve to other depository institutions overnight.

According to Casu and others (2006) the BoE manage its short-term interest rate using so-called repo rate. In a repo transaction a private sector agent sells a security to the BoE with an agreement to repurchase the security back at a pre-determined price and date. These repo transactions are cash loans and securities are used as collaterals. Also the BoE can make outright purchases of bills with a discount rate equal to the repo rate. This way the BoE is capable to handle any shortage of liquidity in the market by forcing the market to raise funds from it at its repo rate. The repo rate determines the short-term money supply and short-term interest rates throughout the economy as the repo rate is the marginal cost of funds for the private sector agents.

The ECB has five types of open market instruments. The most important instrument is reverse transactions, which are applicable on the basis of repurchase agreements or collateralised loans. The ECB may also make use of outright transactions, issuance of debt certificates, foreign exchange swaps and collection of fixed-term deposits (The European Central Bank, 2011d).

2.2.2 Discount windows and standing facilities

According to Casu and others (2006) the discount window and standing facilities are the second most important monetary policy tools for central banks. These tools allow eligible banking institutions to borrow money from a central bank to meet short-term (usually overnight) liquidity needs. The borrowing has a cost equal to an existing discount rate. By changing this discount rate a central bank can influence the demand for the short-term money thus affecting the short-term money supply and short-term interest rates in the economy.

The Federal Reserve Banks offer three discount window programs to depository institutions: primary credit, secondary credit, and seasonal credit, each with its own interest rate. All discount window loans are fully secured. Under the primary credit program, loans are extended for a very short term (usually overnight) to depository institutions in generally sound financial condition. Depository institutions that are not eligible for primary credit may apply for secondary credit to meet short-term liquidity needs or to resolve severe financial difficulties. Seasonal credit is extended to relatively small depository institutions that have recurring intra-year fluctuations in funding needs, such as banks in agricultural or seasonal resort communities. The discount rate charged for primary credit (the primary credit rate) is set above the usual level of short-term market interest rates. (Because primary credit is the Federal Reserve's main discount window program, the Federal Reserve at times uses the term "discount rate" to mean the primary credit rate.) The discount rate on secondary credit is above the rate on primary credit. The discount rate for seasonal credit is an average of selected market rates (The Federal Reserve, 2011a).

The ECB has two standing facilities which aim to provide and absorb overnight liquidity, signal the general monetary policy stance and bound overnight market interest rates. The first one is called Marginal lending facility, allowing counterparties to obtain overnight liquidity from the National central banks (NCBs) of the union against eligible assets. The interest rate on the marginal lending facility normally provides a ceiling for the overnight market interest rate. The second one is Deposit facility, allowing counterparties to make overnight deposits with the NCBs. The interest rate on the deposit facility normally provides a floor for the overnight market interest rate (The European Central Bank, 2011e).

The BoE has Operational standing facilities (OSFs). The OSFs allow participating institutions to deposit reserves with or borrow reserves directly from the Bank on a bilateral basis throughout each business day. The operational standing lending facility takes the form of an overnight repo transaction against high-quality, highly-liquid collateral. The

operational standing deposit facility takes the form of an unsecured deposit with the Bank. On those terms, the OSFs are available in unlimited size (The Bank of England, 2006).

2.2.3 Reserve requirements

The FED defines the reserve requirements as the amount of funds that a depository institution must hold in reserve against specified deposit liabilities (The Federal Reserve, 2011b). When a bank (a depository institution) needs to put some of its liquid assets into a reserve account (usually at a central bank's account) it has lower level of assets available to its own processes, for example for loans to be granted for its customers, thus money is drawn away from the money markets. By changing the reserve requirements level a central bank can affect the short-term interest rate strongly and the change will affect immediately all the banks at the same time (Casu and others, 2006, 122).

Nowadays central banks use rarely the reserve requirement as a monetary policy tool compared to the open market operations and the discount window (Casu and others, 2006, 122). It is difficult to make small changes in money supply using the reserve requirements, because the required reserve ratio is generally expressed as a percentage of banks liabilities. For example the FED's reserve requirements are such as 3% of liabilities for banks with liabilities ranging from \$10.7 million to \$58.8 million and 10% for liabilities over \$58.8 million (The Federal Reserve, 2011b). Also an increase in the reserve requirements can cause unexpected liquidity problems for banks, because central banks do not usually pay any interest on the reserve assets, thus affecting banks potential profits. Various central banks have altogether eliminated the reserve requirements from their set of monetary policy tools, because it gives depository institutions a disadvantage against other financial institutions, which are not required to hold reserves in the central bank (for example insurance companies).

The BoE used compulsory reserve requirements most of the post-war period, but abandoned it as a monetary policy tool in the late 1970s as especially as a result of the processes of deregulation and innovation, and introduced a compulsory cash ratio deposit, which amounts to 0.15% of all UK-based banks' and building societies' eligible liabilities (The Bank of England, 2016).

Today's reserve requirements of central banks can be seen less of a monetary policy tool and more of an instrument that decreases the banks risk taking and makes them more solvent.

2.3 Lender of last resort

In its role as a lender of last resort (LOLR), the central bank will provide reserves to a bank, financial institution or in rare cases to some other too-big-to-fail-institution experiencing serious financial problems. Usually banks need to seek central bank help due to either a sudden withdrawal of banks funds by vast amount of depositors or to a situation where the bank has embarked on highly risky operations and thus cannot find liquidity anywhere else (i.e., no other institution will lend to a bank considered near collapse). Central bank will extend credit to an illiquid bank to prevent its failure only in exceptional situations and in doing so it also carries out a 'macro' function by preventing potential financial panics. However, the central bank cannot guarantee the solvency of every banking institution in a country. This is because it could encourage bankers to undertake undue risk and operate imprudently, especially if banks knew that they would always be bailed out (by taxpayers' money) if they were to become insolvent. In other words the security of the LOLR function could induce or increase moral hazard in banks' behavior (Casu and others, 2006, 124-125).

3 BUILDUP OF THE FINANCIAL CRISIS 2007-2009

In this chapter I will briefly go through the reasons behind the financial crisis. In short the financial crisis started from bursting of the USA's housing market bubble. Then it shifted into a credit crunch between banks, which in the end caused a worldwide financial crisis and the biggest central banks of the world had to take actions never seen before in order to avoid further meltdown of the financial markets.

Frank and Hesse (2009, 3) argues that while the reasons behind the financial crisis can be seen as a combination of imbalances in the global economy, structural weaknesses in the financial system and a severe relaxation of lending, one of its main manifestations has been the partial dysfunction of the interbank money markets.

3.1 The US housing markets

According to Brunnermeier (2009) the main reason for the buildup of the housing bubble in the U.S. was the fact that the economy was experiencing a low interest rate environment. Brunnermeier (2009) argues that the Federal Reserve had adopted a lax interest rate policy, because they feared a deflationary period after the bursting of the internet bubble and thus did not counteract in order to avoid the housing bubble. Laubach & Williams (2015) argue that the natural rate of interest has fallen to, and remained at, historically very low levels near zero ever since the Great Recession (1929), even in times when the economy close to fully recovered from it. This suggests that the Federal Reserve's monetary policy was not the cause for low interest environment, but instead, mainly due to low GDP growth rates and low inflation levels, the natural interest rate had fallen to low levels many decades earlier.

According to Brunnermeier (2009) there were large capital inflows from abroad, especially from Asian countries, who bought U.S. securities both to peg the exchange rates at an export-friendly level and to hedge against a depreciation of their own currencies against the dollar, a lesson learned from the Southeast Asian crisis of the late 1990s. Brunnermeier (2009) argues that these capital flows contributed also to the buildup of the housing bubble.

According to Sarkar (2009) the crisis started with declines in US housing prices and the associated rise in delinquencies on subprime mortgages. When the housing prices fell, homeowners found them in a situation where the mortgages payments amounted for more than the price of the underlying house. The fact that the homeowners were only liable for the underlying house, in their mortgage agreement, made it profitable for them to let their mortgage expire and let the bank have the house. At the same time due to the fact that interest

rate were low the homeowners could take a new more affordable mortgages for a better houses (remember that the house-prices were still falling). Banks were willing to give out mortgages because through securitization and collateralization they could sell the mortgages off from their balance sheets and shift the associated risks for the buyer, usually to an investment bank.

3.2 New banking environment and innovative financial instruments

According to Adrian & Shin (2010) the U.S. financial system underwent a far-reaching transformation in the 1980s with the takeoff of securitization in the residential mortgage market. Until the early 1980s, banks and savings institutions were the dominant holders of home mortgages. However, with the emergence of securitization, banks sold their mortgage assets to institutions that financed these purchases by issuing mortgage-backed-securities (MBSs). Especially the Government-Sponsored-Enterprise (GSE) mortgage pools became the dominant holders of residential mortgage assets. The securitization process for mortgages picked up in the late 1990's leading to situation where 60% of mortgages in U.S. were securitized in mid-2008 (Blanchard, 2009, 6). At the end of 2008, U.S. household-sector mortgage liabilities amounted to approximately \$10.6 trillion. Two-thirds of this was held market-based and only one-third was held by commercial banks, savings institutions and credit unions (Adrian & Shin, 2010, 1-2).

The securitization process has not been solely used in residential mortgage markets. The same process have been used to other types of lending as well, including consumer loans such as those for credit card and automobile purchases, as well as commercial real estate or corporate loans. The ever increasing demand for securitized products has caused a growth in the market-based activity in the capital markets and the need for financial intermediaries. By the end of the second quarter of 2007 (just before the crisis began), the assets held by institutions that fund themselves mainly by issuing securities (i.e., total market-based assets) were larger than the total assets that commercial banks, saving institutions and credit unions held in their balance sheets (Adrian & Shin, 2010, 3).

Also the securities-sector (broker-dealer) had grown roughly 800-fold since 1954 (before collapsing in the crisis), while in the same time the three other major sectors: the household-sector, the nonfinancial-corporate-sector and the commercial-banking-sector, had grown only 80-fold combined in the United States – ten times less (Adrian & Shin, 2010, 5).

Using Lehman Brothers as an example Adrian and Shin (2010, 7) points out that the balance sheets of securities firms (usually investment banks or a broker-deal-house) entailed a lot of short-term items. The two largest classes of assets of Lehman Brothers were (a) long positions in trading assets and other financial inventories and (b) collateralized lending, which often were overnight. Astonishing was the fact that of a total balance-sheet size of \$691 billion cash holdings amounted to only \$7.29 billion (1,05%). Much of the liabilities side entailed items of short-term nature, including collateralized borrowing (including repos), short positions (financial instruments and other inventory positions sold but not yet purchased). Long-term debt was only 18% of total liabilities.

Adrian and Shin (2010, 7) argues that broker-dealers balance sheets serve as a barometer of overall funding conditions in a market-based financial system, because the ultimate supply of securitized credit to the real economy is often channeled through them. When the crisis hit the value of derivatives, which included securitized products, started to deteriorate. The large amounts that banks held these products caused the credit crunch between the banks (or other financial institutions), when nobody could be sure how much their counterparties had exposed to these unhealthy products.

From the Lehman Brothers example one can draw a conclusion that there was a lot crisscross ownership between the securities firms, remembering that two big accounts in Lehman Brothers balance sheet were collateralized–lending and –borrowing. In fact Brunnermeier (2009, 80) states that in 2007 the Wall Street investment banks were rolling over one-quarter of their balance sheets every night, which in fact was twice as much (half of their balance sheet) in 2000.

In the meantime when securitization increased connectedness across financial institutions globalization increased connectedness of financial institutions across countries. According to Blanchard (2009, 7) there was a steady increase in foreign claims by banks from the major five advanced countries, an increase from \$6.3 trillion in 2000 to \$22 trillion by June 2008. Blanchard (2009, 8) adds that other important factors behind the crisis were the increase in leverage and a number of holes in regulation. Banks were allowed to reduce required capital by moving assets off their balance sheets in so called “structured-investment-vehicles” (SIVs). In 2006, for example, the value of the off-balance sheet assets of Citigroup, \$2.1 trillion, exceeded the value of the assets on the balance sheet, \$1.8 trillion. These SIVs were funded through the issuance of short term asset-backed-commercial-paper (ABCP) in order to take advantage of higher yields resulting from ABCP than from longer term investments,

but in the same time this kind of funding exposed them to an inherent maturity mismatch between their assets and liabilities (Frank & Hesse, 2009, 6)

Acharya and Richardson (2008) argue that the primary culprit for the financial crisis was the fact that financial institutions did not follow the business model of securitization by transferring the credit risk from their balance sheets to capital market investors. Financial institutions (like Citigroup, UBS and Merrill Lynch) held large amounts of MBSs tied to nonprime mortgages at the time of their defaults, which led to huge losses as the values of these securities tumbled.

In the end the interconnectedness of the biggest players in the securities markets and the short-term nature of their balance sheet caused the liquidity squeeze, or credit crunch, in the markets, when the underlying items in the derivatives (house price in a mortgage-backed-security) lost their values. Banks and other financial institutions became wary of each other when they could not be sure of the value of the items in the balance sheet accounts of their counterparties – everybody's creditworthiness was in question.

3.3 Credit crunch and bankruptcies of large financial companies

According to Barajas and others (2010) the collapse of lending has been one of the most severe consequences of the current financial crisis. In their research they found that in US private sector credit from commercial banks slowed from annual rates of 8 percent or greater from 2003 through the first quarter of 2008, to just over 2 percent by the end of 2008, and thereafter had negative growth for the first time in the decade. For non-bank institutions the consequences were even more pronounced. In late 2009 the growth rates contracted in nominal terms by over 11 percent, while in early 2004 the growth rates had been as high as 19 percent (Barajas and others, 2010, 3).

According to Frank and Hesse (2009, 6-7) the increasing uncertainty with financial institutions exposure to and the value of the underlying mortgage-backed-assets, investors became unwilling to roll over the corresponding ABCP in the markets. This caused a pressure to the banks to rescue those that they had sponsored by providing liquidity and by taking their respective assets onto their own balance sheets – so that their own reputation would not deteriorate. This re-absorption of assets caused the lending within the interbank

money markets to be curtailed for reasons of liquidity and credit risk. Liquidity reasons caused increases in key interest rate spreads, for example in the Libor-OIS spreads (London Interbank Offered Rate - Overnight Indexed Swap, which can be seen as a measure of health of the whole banking system), especially at longer maturities. This was due to the need for hoarding of funds in order to cover further contingent liabilities following asset price declines, subsequent marking-to-market of securities and forced liquidations. As noted earlier the increasing credit risks came from rising counterparty risk due to the uncertainty of the banks' exposure to troubled assets (interbank lending is unsecured).

According to Frank and Hasse (2009) Francesco Giavazzi gives an alternative explanation in his own research for the widening of the Libor spreads - the existence of predatory banks. According to this theory predatory banks are not willing to lend excess cash, because in a crisis situation they can benefit more by simply not lending and hoarding funds, thus letting other banks to fail. By doing so the predatory bank can later buy the assets of a distress (or bankrupt) bank at a depressed prices – and maybe also increase their own market share.

Above-mentioned reasons led to a situation where many financial institutions found them in a bad financial state. According to Brunnermeir (2009, 84) a small German bank, IKB, was the first European victim of the subprime crisis. In July 2007, its conduit was unable to roll over asset-backed commercial paper and IKB proved unable to provide the promised credit line, though it avoided a bankruptcy through a rescue package involving public and private banks. First distressed firm in U.S. was American Home Mortgage Investment Corp., which announced its inability to fund lending obligations on July 31st 2007, and it subsequently declared bankruptcy on August 6th. Following an event on August 9th, 2007, when the French bank BNP Paribas froze redemptions for three investment funds, citing its inability to value structured products, a variety of market signals showed that money market participants had become reluctant to lend to each other – exacerbating the credit crunch in the financial markets. According to Cecchetti (2008) the BNP Paribas –case made financial firms worldwide to start question the values of collaterals they used in their daily businesses. This in turn lead to hoarding of cash assets and cessation of interbank lending and caused severe liquidity constraints for many financial institutions.

According to Brunnermeir (2009, 88) the first big American corporation that faced difficulties was investment bank Bear Stearns. In March 2008 it experienced worsening conditions in the financial markets: deterioration of its assets prices, distress of a Carlyle Capital, an Amsterdam-listed hedge fund, whose creditor Bear Stearns was and illicit rumors

of Bear Stearns financial state in the markets. Due to the fact that Bear Stearns was considered too interconnected – too-big-to-fail, it had 150 million trades spread across various counterparties, officials of The Federal Reserve of New York brokered a deal where JPMorgan Chase acquired Bear Stearns for \$236 million, or \$2 per share (a year before the stock had traded at around \$150). Furthermore the government-sponsored-agencies (GSE), Fannie Mae and Freddie Mac, which securitized a large fraction of U.S. mortgages and had about \$1.5 trillion in bonds outstanding, faced so bad financial troubles that in September 7th the government officials had to put them in federal conservatorship (Brunnermeir, 2009, 88-89). In 14th of September 2008 Merrill Lynch, an investment bank, announced that it had sold itself to Bank of America. In 15th of September Lehman Brothers, the fourth largest investment bank of U.S., announced its bankruptcy (Brunnermeir, 2009, 89). After the stock price of AIG, a large international insurance company, had dropped more than 90% on 16th of October, the Federal Reserve quickly organized a bailout of \$85 billion in exchange for an 80 percent equity stake of AIG, but the bailout had to be extended by a further \$37 billion in October and another \$40 billion in November (Brunnermeir, 2009, 89-90).

Also, in late-2007, the crisis hit the UK, when Northern Rock, a significant retail bank and a mortgage lender, first faced extra pressures from its creditors and subsequently had a bank run of 11% of the bank's total retail deposits, in a three days' time. As a first measure it received financial support from the Bank of England (BoE), but when a suitable buyer could not be found from the private sector, the UK government took the bank into "temporary public ownership" in February 2008.

According to Klyuev and others (2009) the bankruptcy of Lehman Brothers and the near-failure of several other major financial institutions in the fall of 2008, collapsed aggregated demand and froze key credit markets. Disruptions in the transmission mechanism, from policy rates to private borrowing rates and real economy rates, caused commercial banks to tighten their lending standards considerably. Nonbank lending became virtually to a halt and access to credit for households and businesses was severely curtailed as the banks increased their margins and collateral requirements in order to avoid further losses.

According to Lenza and others (2010) the financial turmoil became apparent in mid-2007. While the problems were initially confined to markets for asset-backed-securities in the United States, market tension had become widespread by early 2008. Eventually spreads

between secured and unsecured money markets rates rose to unprecedented levels in the US, UK and euro area, and interbank transactions volumes for longer maturities fell to low levels.

While the severity of the crisis is quite clear by now, the unconventional actions that the central banks had to take and the effectiveness of these actions has not yet been discussed. In the next chapter (4) I will discuss how unconventional operations differ from conventional operations and why central banks needed to take these steps. In chapter 5 I will look into what actual unconventional operations central banks have made and in chapter 6 I will discuss the effectiveness of these operations.

4 UNCONVENTIONAL CENTRAL BANK OPERATIONS

4.1 Before financial crisis

Joyce and others (2012) argue that before the crisis “the intellectual and empirical foundations of monetary policy appeared secure and its implementation robust” (F271). Central banks operated mainly through influencing their short-term interest rates in order to achieve their inflation targets and achieving maximum output in the economy. According to Joyce and others (2012), while using this framework the mature economies succeeded largely in the pursuit of low inflation and the operations taken by central banks were effective and the outcomes of such operations were predictable, this kind of conventional monetary policy did not prevent asset market bubbles from occurring (F271). This is as the same to say that, while conventional monetary policy has proven effective to the first central bank primary objective (price stability), it has not been as effective to the second primary objective (financial stability) (see more in chapter 2).

Chung and others (2011) argue that there was consensus among researchers that the zero lower bound (ZLB) of central banks main interest rates would probably not pose a problem, as long as central banks aimed for an inflation rate of about 2 percent. The ongoing financial crisis has proven that consensus wrong and Chung and others (2011) argue that there were problems in many of the macroeconomic models (uncertainty about model parameters and latent variables, models were based on the Great Moderation period and the propagation mechanisms embedded in standard models were insufficient to generate sustained periods of policy being stuck at the ZLB).

There were, already before the crisis, some that thought that the ZLB could cause a liquidity trap for the central banks. For example Krugman (1998) argued that injecting monetary base into the economy would have no effect, if monetary base and bonds would be viewed as perfect substitutes by the private sector. A temporary increase in money supply would not raise prices, because the public would not expect it to be sustained.

4.2 Zero lower bound of interest rate

In the early stages of the financial crisis the central banks started aggressively to cut their already low short-term interest rates in order to ease liquidity conditions and to foster economic activity. According to Bajaras and others (2010) the FED embarked on a series of

interest rate cuts starting already in August 2007. By December 2008 The FED had hit its zero-lower-bound (ZLB) by setting the interest rate at a range 0-0,25% and could not lower it anymore without it becoming a negative one (Wright, 2012).

According to Joyce and others (2012) a ZLB-problem arises, when economic theory suggests that interest rates should become negative ones, but cannot, because economic agents can always hold non-interest bearing cash. According to Agarwal and Kimball (2015) by issuing cash money (paper and coins) the government is guaranteeing a zero nominal interest rate for economic agents, over all horizons, thus creating a floor level for its own interest rate at zero.

Joyce and others (2012) tells us that when the central banks had hit the lower bounds of their main nominal interest rates, there was a disconnection between official rates and market rates. This meant that, in order to address the disconnection, central banks needed to shift from the conventional method of setting a price (policy rate) to unconventional methods, the usage of their balance sheet and increasing its size and composition to address the problem. Also Klyuev and others (2009) argue that the reduction of policy rates close to effective lower bounds proved insufficient in stimulating the economy and actions outside the normal open-market-operations needed to be taken in order to stabilize financial markets and to prevent a severe and prolonged contraction in real economy.

According to Bini Smaghi (2009) also the transmission channel of monetary policy became severely impaired after Lehmann Brothers failure. For instance, spread between the three-month Euribor and the overnight interest rate EONIA, which would in normal times be on average around 10 basis points, rose to an all-time high of 156 basis points on 13th of October 2008 (Bini Smaghi, 2009). This was a sign that market liquidity had virtually dried up and there was a loss of confidence among market participants that threatened to have a lasting effect on the euro area money market.

4.3 Moving from conventional- to unconventional operations

As the central banks conventional monetary policy methods (short-term interest rate) were impaired, due to lowering the interest rate effectively to a zero lower bound, new unconventional solutions needed to be made. The increasing market spreads of key interest rates needed to be addressed by some other than conventional methods in order to help the

deteriorating market conditions. As to what is conventional and what is unconventional varies according to source. According to Borio and Disyatat (2009) the debate concerning the issue has been complicated by the use of different definitions and conflicting views of mechanism at work.

Borio and Disyatat (2009) refer to unconventional methods when central banks actively use their balance sheet to affect directly market prices and conditions, thus distinguishing “balance sheet policies” from the conventional “interest rate policies”.

On the other hand Lenza and others (2010) state that central banks already, during the conventional times, provided support to financial markets through changing the composition of their balance sheets in various ways. For them the unconventional aspect of balance sheet usage came after the Lehman Brothers incident, as central banks’ balance sheets increased tremendously. Therefore Lenza and others (2010) distinguish conventional methods and unconventional methods by a timeline: before- and after the failure of Lehman Brothers in September 2008, in order to address central bank operations that focused on addressing the financial crisis.

Borio and Disyatat (2009) also point out that balance sheet policies have been used in “normal times” in foreign exchange intervention, where central banks have purchased or sold foreign currencies in order to influence exchange rates separately from the interest rate policies.

According to Halton & Wolman (2012, 1) the FED’s unconventional methods during the ongoing crisis fall into three general areas: “increasing the size of the Fed’s balance sheet; altering the composition of its balance sheet; and providing increasingly detailed guidance about the likely future path of policy”.

According to Panetta and others (2009, 1) during the crisis central banks have offered help to banks using three methods: (i) capital injections to strengthen banks’ capital base; (ii) explicit guarantees on liabilities to help banks retain access to wholesale funding; and (iii) purchases or guarantees of impaired legacy assets to help reduce banks’ exposure to large losses. These measures have been taken in order to insure financial stability. Other measures, like BoE’s quantitative easing programs, had also other objectives like price stability (as concerns over undershooting the 2% inflation target emerged) and increasing the growth rate of the GDP as the economic activity was contracting.

According to Klyuev and others (2009, 7), when policy rates are close to the zero bound, central banks can provide additional monetary stimulus through four complementary means: (1) committing to keep the policy rates low for a longer period, (2) providing broad liquidity to financial institutions, (3) lowering risk-free rates through the purchase of Treasury securities and (4) providing loans to nonfinancial corporations by purchasing private assets or to pledge particular types of assets as collateral to obtain central bank loans.

Usually in academic literature [e.g. Goodfriend (2009), Borio & Disyatat (2009) and Shiratsuka (2009)] the unconventional methods have been divided to quantitative easing (or credit policy) and qualitative easing (or credit easing). Using these methods, central banks change the size and composition of their balance sheets, in order to secure the stability of financial markets and to facilitate corporate financing (Shiratsuka, 2009, 9). During the current financial crisis the distinction between quantitative easing and credit easing has become harder as central banks have emerged in operations where elements from the two methods have been used as hybrids (see chapter 5).

According to Borio & Disyatat (2009) the implementation of monetary policy has two core elements: signaling the policy stand and operations that involve the use of central banks' balance sheet (sometimes referred as liquidity management operations). Quantitative easing and credit easing belong to the latter category. Orderly and accurately signaling is an important task of central banks in all times. Long-term rates are essentially the expected future short-term rates and by openly and believably signaling its monetary strategy central banks can affect these expectations.

Next I will briefly explain the two most commonly referred unconventional methods in academic literature (quantitative easing and credit easing) and signaling. In chapter 5 I will be covering the actual unconventional operations that have been used during the financial crisis by the largest central banks.

4.3.1 Quantitative easing or credit policy

According to Lenza and others (2010) central banks are using a policy named quantitative easing, when they increase their balance sheets by acquiring more “conventional assets” (usually government bonds) from the market. By doing so the portfolio of assets held by the

central bank is not altered. In other words, the size of the balance sheet is increased, but the composition is not.

According to Bini Smaghi (2009) the objective of quantitative easing is to narrow the market spreads in financial markets. This in turn would lead to lessening the liquidity shortage and causing an increase in economic activity at all levels, by making external financing more available to all market participants.

According to Bini Smaghi (2009) quantitative easing has traditionally focused on buying long-term government bonds from banks. The idea is that when long-term government bonds yields decrease so will also other long-term interest rates. Thus the cost of acquiring long-term capital in the financial market is lowered to all agents. Bini Smaghi (2009, chapter 4.1) continues: “if long-term interest rates were to fall, this would stimulate longer-term investments and hence aggregate demand, thereby supporting price stability.”

According to Bini Smaghi (2009) quantitative easing is only effective when a central bank has reached its zero lower bound of interest rate and it does not pay interest on reserves. If not the additional liquidity provided to banks, through the bought of government bonds, might be stuck in the financial sector. This could happen if banks would hold the newly received liquidity in their reserves at the central bank as they would receive interest payments for the reserves. When interest payments on reserves are zero or close to zero (during the current crisis some rates have even become negatives), banks incentive to park the excess reserves with the central bank is little or none. Bini Smaghi (2009, chapter 4.1) continues: “soundness of the financial system is critical to the success of quantitative easing. When banks stop intermediating loans, this policy no longer works”. Klyuev and others (2009) suggests that banks might still want to keep these excess reserves at the central bank, even when there is no interest on reserves, if they do not have profitable lending opportunities or they desire to have ready access to liquidity due to an uncertain economic and financial backdrop, making quantitative easing ineffective even at a central banks zero lower bound.

4.3.2 Qualitative easing or credit easing

According to Lenza and other (2010) central banks embark to a qualitative easing (or credit easing (CE)) when the overall size of the balance sheet is left untouched but the composition is altered by acquiring “unconventional assets”. These purchases, or rather trades, are made

using the “conventional assets” leading to an outcome where the size of the balance sheet is not affected.

According to Bini Smaghi (2009) the objective of credit easing is to provide liquidity to certain market segments that are in distress through the purchase of commercial paper, corporate bonds and asset-backed securities. By interacting directly with the private sector central banks can bypass any discrepancies in the financial markets. As central banks deal directly with the private sector the risk profile of their balance sheet will be affected – central banks’ credit risk will increase (Bini Smaghi, 2009).

When financial markets are in a distress and lending policies are tightened (for instance due to heightened counterparty credit risk, uncertainty regarding an institution’s own short-term financing needs, uncertainty regarding the value of a firm’s assets that could be used as collateral and the limited supply of high-quality collateral), central banks can alleviate the problem by expanding their operations to a wider set of financial institutions, increasing the accepted maturities of instruments and enlarging the pool of accepted collaterals (Klyuev and others, 2009).

According to Borio and Disyatat (2009, 14) central banks may help loosen credit constraints, lower external finance premia and revive private sector intermediation by acquiring assets, simply standing ready to do so, or accepting them as eligible collateral.

According to Lenza and others (2010) choosing whether to enlarge the set of counterparties or stay in the traditional path (solely deal with banks) reflects a key conceptual choice in the design of nonstandard measures. Central banks can either replace / by-pass a market that is impaired (by dealing directly with private market) or alternatively re-activate private market activity (by dealing with banks). The former means most often offering credit easing to private sector.

4.3.3 Signaling and forward guidance

Nowadays, it is widely accepted that central banks’ communication about the objectives of monetary policy, the monetary policy strategy, the economic outlook, and the outlook for future policy decisions will influence the market expectations of future rates, thus the whole economy – making communication policy a key instrument in the central banker’s toolkit

(Blinder and others, 2008). These communications are usually referred to as central bank signaling and forward guidance.

According to Borio and Disyatat (2009) even during “normal times” the announcement of “policy rate” (signaling the key interest rate) is the most essential central bank operation and liquidity management operations (the actual adjustment of the interest rate or balance sheet operations) are designed exclusively to help make that interest rate effective. Borio and Disyatat (2009, 2-3) continue: “As such, liquidity management operations play a purely technical and supportive role. They neither impinge upon, nor contain any information relevant to, the overall stance of policy”.

The signaling and forward guidance remains at least as important central bank tool in a financial crisis, if not even becoming more crucial due to increasing uncertainty in the financial markets.

Hausken & Ncube (2013) argue that central banks’ can signal a commitment of keeping interest rates low for a longer period by announcing large-scale asset purchases of long-term assets (in quantitative easing the assets would be long-term government bonds). This would prevent central banks from raising interest rates later; otherwise they would see huge losses on the assets they purchased. Hausken & Ncube (2013, 5) continue: “the signaling channel is expected to affect interest rates across the yield curve with effects depending on bond maturities”.

According to Borio & Disyatat (2009, 13) central banks’ operations and communications influence public expectations about key factors in an asset’s market valuation. Furthermore, by announcing that the central bank is prepared to engage in operations involving illiquid assets, it may have a spillover effect to other asset markets as well – thus helping the whole economy. Central bank can also influence market expectations by making an explicit commitment to hold the short-term interest rates at virtually zero for a longer period of time, if it succeeds in credibly extending its commitment duration, it can reduce longer-term interest rates (Shiratsuka, 2009, 13).

Filardo & Hofmann (2014) argue that central banks can provide additional stimulus to economy at the zero-lower-bound by committing to keep policy rates lower for longer than is priced into markets, and also reduce uncertainty, thereby lowering interest rate volatility and possibly also risk premia. They distinguish forward guidance to three different forms: (i) qualitative, where guidance is provided without any details about the policy rate path or

timetable, (ii) calendar-base, where the guidance is provided with specified time horizon and (iii) threshold-based, where the guidance is linked to specific quantitative economic thresholds (for example unemployment rate).

Central banks face a trade-off when using forward guidance between the strength of the commitment and future policy flexibility. If the commitment is perceived believably, by the market participators, its likely impact on financial market expectations and future economic decisions are stronger, but at the same time the central banks hands are tied to the road it has announced and it cannot brake the commitment, or else it risks losing its credibility.

Other risks of forward guidance consist of: misinterpretation by the public, central bank reputation risks and financial stability risks. If the public interprets the commitment differently than what the central bank has intended, there can be adverse effects. One type of reputation risk can arise when the central bank uses a calendar-based forward guidance in a time of uncertainty. Any deviations from the preannounced timetable might be perceived as a breach of the commitment, even if conditions change unexpectedly and demand the focus and possible alterations in central bank operations. Financial stability risks could arise from forward guidance if financial markets would become narrowly focused on certain aspects of a central bank's forward guidance, then a broader interpretation or recalibration of the guidance could lead to disruptive market reactions.

In the next Chapter (5) I will cover the actual unconventional operations that the three big central banks have embarked on to. In chapter 6 I will discuss how the unconventional operations have fared against their objectives.

5 UNCONVENTIONAL OPERATIONS BY THE THREE CENTRAL BANKS DURING THE CRISIS

When it became clear that conventional operations were not enough for dealing with the crisis, central banks embarked to unconventional operations in a way that has never been seen before.

At first the measures taken were relatively modest adjustments of central bank conventional operations in order to secure the financial stability of the markets. According to Joyce (2012) many central banks expanded their normal lending operations to banks by lending at longer horizons and by broadening the eligible collateral accepted. The innovations in the procedures had two inter-related objectives: to support interbank intermediation in the money market and to introduce the necessary liquidity into banks' balance sheets without increasing the balance sheets of the central banks (Lenza and others, 2010, 14). In order to achieve these objectives central banks needed to be able to offer a sufficiently large volume of liquidity and have a facility to do so for all desired counterparties.

Even though there were differences, in the first steps of dealing with the crisis among the central banks, the responses demonstrate more similarities than differences (Shiratsuka, 2009). The differences originated from central banks having different environments and restrictions, different structures of the financial systems and institutional arrangements of the central banks. Lenza and others (2010) concur by arguing that the similarities of the responses more than outweigh the differences, which reflect only the cross-national variations in financial structures. For instance, it is often considered, that the US and the UK have a market-based financial system while in Europe there is a bank-based financial system [e.g. Lenza and others (2010) and Fawley & Neely (2013)]. The Eurosystem have relied more to banks as sources of external funds rather than markets or other financial intermediaries (a bank-based financial system), this being the cause why the ECB opted to deal primarily through the banking system (with its regular operational counterparts) rather than extending its facilities to a wider range of counterparties in the manner of the FED (Lenza and others, 2010, 7). In fact, already before the crisis, the ECB had almost 2000 credit institutions (of which around 300 regularly participated), which were eligible for bidding in ECB's weekly operations, compared to the FED that had only around 20 primary dealers eligible to bid at its daily tenders (Lenza and others, 2010, 15)

Also, already before the crisis, the ECBs pool of eligible collateral included broader range of assets compared to the FED and the BoE.

According to Lenza and others (2010) these differences meant that while ECBs existing framework were fairly sufficient to manage the early money market tensions, the FED had to make several changes in its operational framework and the BoE extended its operations and created one new facility (Special Liquidity Scheme).

Following the collapse of Lehman Brothers, in September 2008, the tensions in financial markets intensified. All three central banks (FED, ECB and BoE) focused on containing and narrowing spreads, of key interest rates, in order to avoid the interbank markets from freezing up completely (Lenza and others, 2014). At this time the policies of the FED and BoE diverged from that of the ECB. The FED and the BoE acted on bond markets (buying mortgage-backed-securities and Treasury bonds); while the ECB expanded its lending operations to euro area banks (Fratzscher and others, 2014).

In 2010 the euro area faced a new kind of crisis, sovereign debt crisis, when the possibility of some of its member countries sovereign debt default emerged (notably Greek). There was a substantial outflow of euro deposits from banks in some of the peripheral countries and into banks in other euro-area countries, which caused a major imbalance within the euro-area banking system (Joyce and others, 2012). The ECB purchased sovereign bonds of euro area countries in distress to contain “excessive” risk premia and to restore the transmission mechanism of monetary policy. At the same time the FED and the BoE bought AAA rated Treasury bonds in order to lower long-term benchmark yields. The implementations of these purchases varied also as the FED pre-announced the scale and the pace of purchases for several months ahead, the BoE increased the ceiling of its purchases gradually, and the ECB decided about purchases, on day to day basis, in response to the deterioration of market conditions.

Lenza and others (2010) argue that the measures taken by the three central banks, during the crisis, embodied both changes in sizes and the compositions of their balance sheets, and while the means varied across the central banks, the outcome was one where elements of both quantitative and qualitative easing were employed.

One of the differences in financial structures were the fact that the ECB had always had a larger balance sheet than either the FED or the BoE, and therefore needed not the same

proportional increase for it (Lenza and others, 2010, 7). At the beginning of 2012 the FED and the BoE had more than tripled their balance sheets, while ECB had more than doubled its balance sheet, leading to situation where the size of the ECB's balance sheet was a little under 30% relative to euro-area GDP for 2011, while the BoE and FED balance sheets were about 20% of their respective national GDP measures (Joyce, 2012). The non-standard monetary policy measures have had only a moderate impact on the composition of the ECB's balance sheet compared to the FED and the BoE (Pattipeilohy and others, 2013).

5.1 The Federal Reserve (FED) unconventional operations

The Federal Reserve System is large institution that consists of 12 different banks and committees like the Board of Governors of the Federal Reserve System and the Federal Open Market Committee (Wallace, 2013). For the sake of simplicity in this thesis I will refer to the Federal Reserve, or simply the FED, when expressing any action taken by any part of the Federal Reserve System.

According to Sarkar (2009) in late 2007 and early 2008 the FED first addressed the financial crisis, in traditional role as a lender of last resort, by offering short-term liquidity to sound financial institutions. According to Williams Brown and others (2011) this consisted of modification of the existing discount window, the creation of new facilities (TAF, TSLF and PDCF), establishing a dollar swap line to foreign central banks and an emergency loan to avert a disorderly failure of Bear Stearns (see chapter 3.3).

According to Sarkar (2009) the second state involved the provision of liquidity directly to borrowers and investors in key credit markets. After the collapse of Lehman Brothers on 15th of September 2008 the FED embarked to several new liquidity programs to provide support for key funding markets, such as the commercial paper and the asset-backed security markets (Williams Brown and others, 2011). Williams Brown and others (2010) argue that, while the earlier emergency programs represented relatively modest extensions of the FED operations, these newer programs incorporated more novel design features and targeted new market participants with which the FED had not historically acted with (see chapter 5.1.2). Barajas and others (2010) go even further by stating, that the focus of overall policy began

to move beyond liquidity provision and toward direct injection of capital. One example of this was the creation of Troubled-Asset-Relief-Program (TARP), worth 700\$ billion, by the U.S. Treasury on October 3rd, 2008 (Williams Brown and others, 2011). TARP's primary initiative was Capital-Purchase-Program (CPP), which was created in October 2008 in order to stabilize the financial markets and the banking system. By the time of the CPPs' closure on December 31st 2009 the Treasury had invested 205\$ billion in 707 different financial institutions (Williams Brown and others, 2011, 14). The U.S. Treasury operates under the US Government and its actions can be considered as fiscal policy – and as such are outside the scope of this thesis.

According to Sarkar (2009) the FED's third operation involved the purchases of longer-term securities such as mortgage-backed-securities. The FED announced on November 25th 2008 that it would purchase up to \$500 billion of agency mortgage-backed securities to support the housing market and the broader economy (Williams Brown and others, 2011). This was the FED's first Large-Scale-Asset-Purchase (LSAP) program (see chapter 5.1.4) and others would follow.

The assistance provided to Bear Stearns was not the only case, when the FED offered direct help to financial institutions in distress. Three other cases came where the FED considered an institution to be too-big-to-fail type of and that their failures would pose systemic risk to the whole financial markets. In chapter 5.1.3 I will look into those three institutions (AIG, Citigroup and Bank of America)

5.1.1 Liquidity programs for financial firms

The earliest actions that the FED took addressing the crisis was the cutting of the federal fund rate (the key interest rate of its open market operations) starting in August 2007 (Barajas and others, 2010). At the same time the FED made modifications to its discount window. According to Williams Brown and others (2011) on August 17 2007 FED reduced the discount rate of the discount window by 50 basis points and extended lending term from overnight to up to 30 days. It soon became clear that these actions were not enough in dealing with the freezing of the interbank lending.

According to Goodfriend (2009) banks found substantial credit risk in lending to each other mainly due to uncertainty of counterparty risk, worsening liquidity of collaterals used in their trades and the uncertainty of overall future functioning of the financial markets. In order to avoid credit risk, banks started to shorten the maturity of the loans they provided and started to increase their margins or haircuts (the difference between the market value of an asset used as loan collateral and the amount of the loan), which can be considered as the price of the loan.

According to Williams Brown and others (2011) on December 12th 2007 the FED announced the creation of Term-Auction-Facility (TAF) to address these continuing disruptions in the interbank lending markets. TAF auctioned loans approximately every 2 weeks and the available funds started from \$20 billion per an auction but as the demand increased the available funds were increased and after the collapse of Lehman Brothers the limit was increased to \$300 billion per auction.

Through the TAF the FED was able to auction loans to many eligible institutions at once, with an auction-determined interest rate. In the normal discount window the FED acted with a single counterpart at a time, and the usage of the discount window could have signaled signs of distress of the institution for its creditors, thus questioning its solvency. Also by auctioning collectively rather than individually meant that institutions could obtain funds at an interest rate set by auction instead of at a premium set by the FED. Furthermore, the TAF borrowers did not receive loan funds until 3 days after the auction, thus the usage did not question the institutions' solvency as much as in the normal discount window, where the institutions received the funds immediately, thus signaling severe funding pressures of the institution in question.

According to Goodfriend (2009) the FED financed TAF loans with funds acquired by selling Treasury securities from its portfolio, thus altering only the composition of its balance sheet and not the size; as such these actions can be considered as credit easing (see chapter 4.3.2). According to Williams Brown (2011) yet another benefit of TAF compared to the normal discount window was that the collectivity aspect of the program made it easier for the FED to predict its own funding needs. The final TAF auction was held on March 8 2010 (Williams Brown and others, 2011, 228).

According to Williams Brown and others (2011) in 2007 and 2008, the FED opened temporary dollar swap lines with 14 foreign central banks (including the ECB and the BoE) to enhance the ability of these central banks to provide U.S. dollar funding to financial

institutions in their jurisdictions. In a typical swap line transaction, the FED exchanged dollars for the foreign central bank's currency at the prevailing exchange rate, and the foreign central bank agreed to buy back its currency at this same exchange rate at an agreed upon future date; thus the foreign central banks assumed the risk of losses on these dollar loans and they also paid interest on these loans. These actions were taken because the FED worried that that continuing tension in dollar funding markets abroad could further exacerbate tensions in the U.S. funding markets (Williams Brown and others, 2011, 19).

According to Williams Brown and others (2011) on March 11th 2008 the FED announced the creation of the Term-Securities-Lending-Facility (TSLF) to help address growing strains in the repurchase agreement markets, and the first TSLF auction was held on March 27th, 2008. As stated before the lenders were requiring higher haircuts for less liquid securities and they were also becoming reluctant to lend against mortgage-related securities. As a result, many borrowing financial institutions had to rely on higher quality collateral, such as Treasury securities and a shortage of such high-quality collateral emerged. Through TSLF, primary dealers (a designated group of broker-dealers and banks, that transact with FED in its conduct of open market operations, and significant participants in the repurchase agreement markets) were able to temporarily (usually 28 days) exchange illiquid assets for more liquid Treasury securities through competitive auctions up to \$200 billion worth of Treasury securities (Williams Brown and others, 2011, 237). In TSLF schedule 1 (bi-weekly auctions) accepted securities included: Treasury securities, agency debt, and agency mortgage-backed-securities and in schedule 2 (weekly auctions), after the collapse of Lehman Brothers, even broader range of asset types were included, such as highly rated private MBS (Williams Brown and others, 2011, 238).

The Fed used a tri-party repurchase agreement system, in which both parties to the repurchase agreement must have cash and collateral accounts at the same tri-party agent (a clearing bank), for TSLF transactions with participating dealers. The tri-party agent made sure that the collateral pledged was sufficient and met the eligibility requirements and appraised the value of the collateral for all participants. The usage of this kind tri-party system was reasoned by FED for several advantages it provided: the Treasury securities remained within the closed tri-party system, they were safely returned to the FED upon maturity of the loan, the tri-party banks were able to facilitate the daily repricing and application of haircuts for of a wide range of collateral types and the clearing banks were

able to act in tight time constraints (Williams Brown 2011, 238). The FED relied on two clearing banks: JP Morgan Chase & Co. and Bank of New York Mellon.

According to Williams Brown and others (2011, 238) for the first time during this crisis, the Federal Reserve Board invoked section 13(3) of the Federal Reserve Act to authorize the extension of credit to non-depository institutions - in this case, the primary dealers. The TSLF program expired on February 1st 2010. As TSLF changed only the composition of FED balance sheet it can be seen as credit easing program.

According to Williams Brown and others (2011) in March, 2008, the investment bank Bear Stearns was facing financial problems and on March 13th it notified the FED that it would likely have to file for bankruptcy protection unless the FED provided the firm an emergency loan. The FED feared that the failure of Bear Stearns could have had serious adverse impacts on financial markets, including the repurchase agreements markets, and might have threatened the liquidity and solvency of other large institutions.

First, on March 14th, the FED provided a \$12.9 billion loan to Bear Stearns through JP Morgan Chase Bank (JPMC), the largest bank subsidiary of JP Morgan Chase & Co, to provide time for potential acquirers to assess Bear Stearns's financial condition (Williams Brown, 2011) and time for the FED to prepare a new liquidity program called Primary Dealer Credit Facility (PDCF) (Williams Brown and others, 2011, 23).

JPMC emerged as the only viable acquirer and on March 16th 2008 the FED announced that it would lend up to \$30 billion against certain Bear Stearns's assets to facilitate JPMC's acquisition of Bear Stearns (Williams Brown and others, 2010, 180). An external audit firm, Ernst & Young, was hired to conduct the estimation of Bear Stearns assets and it concluded that the fair price was \$2 per share. The share had traded at \$150 less than a year before (Brunnermeir, 2009, 88) and according to Williams Brown (2011) Bear Stearns board members and shareholders thought JPMC's offer to purchase the firm at \$2 per share was too low and threatened to vote against the merger, raising concerns for the deal.

According to Williams Brown and others (2011) the terms between the FED and JPMC were renegotiated and on March 24th a new special purpose vehicle (SPV) was created in the form of Maiden Lane LLC. Maiden Lane LLC purchased Bear Stearns's assets with loans from the FED (\$28.82 billion) and JPMC (\$1.15 billion). The FED's part of the loan was senior, meaning that JPMC would bear the possible first losses up to the worth of its part of the loan (\$1.15 billion). Also JPMC would only begin receiving payments on this loan after the FED

had received full principal and interest on its senior loan. Furthermore, the FED would accrue any gains beyond the \$30 billion initial financing (Goodfriend, 2009).

According to Goodfriend (2009) the FED stepped out of its conventional methods by distributing a loan to an investment bank in a distress (Bear Stearns). In normal times the FED have only offered loans (through the discount window) to depository institutions that were in sound financial condition, held balances at the FED and against good and liquid collaterals. In the case of Bear Stearns all above mentioned criteria were violated. Goodfriend (2009) argues that the seniority of its part of the loan and the receiving of gains above \$30 billion meant that the Fed had all of the upside of the asset valuations and all but a small fraction of the downside.

This was again a credit easing program as the FED financed its loan to Maiden Lane LLC by selling Treasury securities (Goodfriend, 2009).

According to Williams Brown and others (2011) at the same time as one team was working on Bear Stearns case, another was working for the launch of Primary Dealer Credit Facility (PDCF) and on March 16th 2008 the creation of the program was announced. PDCF provided overnight collateralized loans to the primary dealers, through same kind of tri-party system as TSLF program (see above). Eligible PDCF collateral initially included collateral eligible for open-market operations as well as investment-grade corporate securities, municipal securities, and asset-backed securities, including mortgage-backed-securities and later (after the collapse of Lehman Brothers) were expanded to include also all securities eligible to be pledged in the tri-party repurchase agreements system, including noninvestment grade securities and equities.

According to Williams Brown and others (2011, 214) TSLF and PDCF were both created to help funding challenges faced by the primary dealers, but they also had key differences. PDCF provided cash loans rather than loans of Treasury securities and accepted a broader range of collateral than those eligible for TSLF. PDCF was a standing facility that primary dealers could access as needed, rather than bi-weekly or weekly as in TSLF. While TSLF loaned Treasury securities for terms of about 1 month, PDCF made overnight loans, which was more suitable for the needs of primary dealers.

According to Williams Brown and others (2011) on September 21st the FED extended PDCF eligible counterparts to include the U.S. and London broker-dealer subsidiaries of Merrill Lynch & Co., Goldman Sachs Group Inc., and Morgan Stanley to provide support to these subsidiaries as they became part of bank holding companies that would be regulated by the Federal Reserve System. Also in November 2008, as part of a package of federal government

assistance to stabilize Citigroup Inc. (see chapter 5.1.3), the Federal Reserve Board authorized an extension of PDCF assistance to the London affiliate of Citigroup's primary dealer. Williams Brown and others (2011, 215) continues: "a key difference was that the FED accepted collateral denominated in foreign currencies from the London-based affiliates, and it applied higher haircuts to this foreign-currency denominated collateral". PDCF program expired on February 1st 2010 (Williams Brown, 2011).

5.1.2 Direct lending to borrowers and investors

This subsection and the next (5.1.3) are mostly based on the comprehensive work about FED's actions during the crisis by Williams Brown and others (2011).

The bankruptcy of Lehman Brothers in September 2008 triggered an intensification of the financial crisis. Firstly the FED modified the terms for its existing liquidity programs (TAF, TSLF, PDCF and swap lines) to address the worsening conditions. As mentioned above TSLF- and PDCF-eligible collateral was expanded, TSLF auctions were held more frequently and PDCF eligible counterparties were expanded. On September 29th the FED also announced that the amount of funds available in each TAF auction cycle would be doubled from \$150 billion to \$300 billion, and a \$330 billion expansion of the swap line arrangements would be made.

In response to the collapse of Lehman Brothers the FED took more drastic actions in dealing with the crisis. While the earlier liquidity and emergency programs were relatively modest extensions of FED systems and operations, the new programs incorporated more novel design features and they targeted new market participants with which the FED had not historically transacted with. In contrast to earlier programs, the Reserve Banks provided loans to intermediary entities (a financial institution or a Special Purpose Vehicle) to help channel support to strained funding markets rather than to address the entities' liquidity needs. As in the case of the earlier programs these new programs needed to be designed and launched under extraordinary time constraints as the market conditions were rapidly deteriorating. In late 2008 the FED launched four new programs (AMLF, CPFF, MMIFF and TALF) to help the worsening situation in the financial markets and below I will shortly present those.

On September 19th, 2008, the FED created the Asset-Backed-Commercial-Paper-Money-Market-Mutual-Fund-Liquidity-Facility (AMLF) to provide liquidity support to money market mutual funds (MMMF), which were facing redemption pressures and to promote liquidity in the asset-backed-commercial-paper (ABCP) markets and AMLF became operational on September 22nd.

MMMFs are mutual funds, which invest in high-quality, short-term debt instruments such as commercial paper, Treasury bills and repurchase agreements. MMMFs differ from other investment companies as they seek to maintain a stable net asset value per share (market value of assets minus liabilities divided by number of shares outstanding), typically \$1 per share. Although, they are not covered by federal deposit insurance, many investors view MMMFs as a safe alternative to bank savings accounts, and MMMFs provide higher yields. According to Williams Brown and others (2011) after the failure of Lehman Brothers a large MMMF, the Reserve Primary Money Fund, suffered losses on holdings of Lehman Brothers commercial paper and the net asset value of the fund dropped below its target value of \$1 per share, causing concerns for many investors about potential losses on their investments on MMMFs and they started a large wave of redemption requests as they sought to limit their potential exposures to the financial sector. Normally the fund would have been able to meet redemption demands by drawing on their cash reserves or selling assets, including ABCP, into liquid markets, however these markets were strained as interest rates on ABCP spiked in September 2008. The FED feared that if the MMMFs would choose to sell assets at a discount or reduce their purchases of ABCP to meet the extraordinary demands on their liquidity, the stress in the ABCP market could be exacerbated.

Through AMLF the FED quickly authorized loans to discount window eligible depository institutions and their primary dealer affiliates to purchase ABCP from MMMFs, thus providing MMMFs the option to sell ABCP at amortized cost—the carrying value of the investment in the MMMF’s accounting records—rather than at deeply discounted prices. AMLF was intended to help MMMFs to raise cash in a way that would not worsen market stresses. AMLF’s design relied on intermediary borrowers as MMMFs had limited ability to borrow directly from the Federal Reserve System because of statutory and fund-specific limitations on fund borrowing. As the returns from eligible ABCP were higher than the interest rate on AMLF loans, the intermediaries had an incentive to participate. Williams Brown (2011) speculate: “by fostering liquidity in the ABCP market and money markets more generally, the AMLF may have encouraged MMMFs to continue to purchase ABCP as they would have the option to later pledge the ABCP to AMLF”.

AMLF did not apply haircuts and accepted only highly rated ABCP as collateral, because overcollateralization would have been inconsistent with policy objectives to quickly and effectively provide liquidity support to MMMFs. Also the FED wanted that the MMMFs could sell their ABCPs at book value, because a price below that could have created further incentives for MMMF shareholders to redeem their shares as MMMFs would suffer losses for its assets. To add incentives for the intermediary borrowers the FED authorized nonrecourse lending, where in the case of losses on the ABCP collateral, the borrower could surrender the ABCP to the FED and choose not to repay its loan. AMLF expired on February 1st, 2010.

On October 7th 2008 the FED authorized the creation of the Commercial-Paper-Funding-Facility (CPFF) to provide liquidity to U.S. issuers of commercial paper and the program became operational on October 27th.

Commercial paper, which can be unsecured or asset-backed, is an important source of short-term funding for U.S. financial and nonfinancial businesses. Unsecured commercial paper is priced by credit rating of the issuing institution, while asset-backed-commercial-paper (ABCP) is collateralized by assets and therefore is a secured form of borrowing.

After the collapse of Lehman Brothers commercial paper markets generally ceased to function properly; the volume of commercial paper outstanding declined, interest rates on longer-term commercial paper increased significantly, and increasing amounts of commercial paper were issued on an overnight basis as MMMFs and other investors became reluctant to purchase commercial paper at longer-dated maturities. The FED concluded that disruptions in the commercial paper markets, combined with tension in other credit markets, threatened the broader economy as many large commercial paper issuers promoted the flow of credit to households and businesses. The FED established CPFF in order to eliminate much of the risk that commercial paper issuers faced, and to encourage investors to continue or resume their purchases of commercial paper at longer maturities.

CPFF worked as follows: the FED created a special-purpose-vehicle (SPV), that received a loan from the FED, and then the SPV directly purchased new issues of eligible ABCP and unsecured commercial paper with the loan it had received.

Through the CPFF the FED made aggregate purchases of \$738.3 billion (Wilson & Wu, 2011). The program was closed on February 1st 2010.

On October 21st, 2008, the FED authorized the Federal Reserve Bank of New York (FRBNY) to work with the private sector to create the Money Market Investor Funding Facility (MMIFF) in order to provide additional liquidity support to money market mutual funds (MMMF), and the program became operational on November 24th, but as it happened MMIFF was the only program that was never used. MMIFF closed on October 30th 2009. Through MMIFF the FED were standing ready to purchase a broader range of short-term debt instruments held by MMMFs, including certificates of deposit and bank notes. In contrast to other programs MMIFF SPVs were set up and managed by private sector entities. The FED was ready to lend up to \$540 billion to the MMIFF SPVs, which could have facilitated the purchase of up to \$600 billion of assets from eligible funds, but as mentioned above the program was never used.

On November 24 2008 the FED authorized the creation of the Term-Asset-Backed-Securities-Loan-Facility (TALF) in order to increase credit availability and support economic activity by facilitating renewed issuance in securitization markets (about securitization process see chapter 3.2). In contrast to earlier programs, establishment of TALF took time, due to refining program terms and conditions and considerations on how to leverage vendor firms to best achieve the programs policy objectives, and the program became operational, only several months later of its announcement, on March 17th 2009.

The reasons for the establishment of TALF were the continued disruption of the ABS markets combined with other ongoing stresses in the credit markets that presented a significant risk to financial stability. The value of many asset-backed-securities (ABS) had dropped precipitously, bringing originations in the securitization markets to a virtual halt, thus making access of credit more difficult to households and small businesses.

Through TALF any eligible U.S. company (a broad range of institutions ranging from depository institutions to U.S.-based investment funds), that owns eligible collateral, could get nonrecourse 3- or 5-year loans. The FED estimated that broad participation in TALF would facilitate the program goal of encouraging the flow of credit to consumers and small businesses, and in order to prevent participation by borrowers that might pose fraud or reputational risk, the FED required all prospective TALF borrowers to approach the program through one of the primary dealers or other firms that acted as TALF agents. The FED had multiple layers of loss protection: TALF collateral had to be rated AAA or its equivalent, TALF loans had to be over-collateralized through haircut requirements, a special-purpose-vehicle (SPV) received a portion of the interest income earned (when a borrower chose not

to repay the loan, this accumulated excess interest income could be used to purchase collateral surrendered by the borrower) and if the excess interest income accumulated by the SPV was insufficient to purchase the surrendered collateral, the U.S. Treasury initially committed to lend up to \$20 billion of TARP funds to the SPV for any such purchases.

According to Williams Brown and others (2011, 223-224): “TALF-eligible collateral included U.S. dollar-denominated ABS with one of the following underlying credit exposures: auto loans, student loans, credit card loans, equipment loans, “floorplan” loans, insurance premium finance loans, small business loans fully guaranteed as to principal and interest by the U.S. Small Business Administration, receivables related to residential mortgage servicing advances (servicing advance receivables), or commercial mortgage loans”.

TALF was expired on June 30th, 2010.

5.1.3 Support for specific institutions

This subsection is mostly based on Williams Brown and others, 2011.

In late 2008 and early 2009, the FED provided assistance to avert the failures of three institutions that it determined to be systemically significant; American International Group, Inc. (AIG), Citigroup, Inc. (Citigroup), and Bank of America Corporation (Bank of America)

In September 2008 the FED determined, that there was a reasonable possibility for AIG to fail and this would have posed systemic risk to financial markets. On September 16th 2008, one day after the Lehman Brothers bankruptcy announcement, the FED provided a revolving-credit-facility (RCF) of up to \$85 billion in order to help AIG meet its obligations. Despite the creation of AIG RCF, that provided AIG and its subsidiaries a revolving loan to address strains on their liquidity, AIG’s difficulties continued and even worsened.

The FED acted firstly by creating securities borrowing facility (SBF) to provide up to \$37.8 billion of direct funding support to a securities lending program operated by certain AIG domestic insurance companies. From October 8th through December 11th the FED provided cash loans to certain AIG domestic life insurance companies, collateralized by investment grade debt obligations. In November 2008, in order to further strengthen AIGs financial condition and once again avert its failure the FED created two SPVs (Maiden Lane II LLC and Maiden Lane III LLC), that purchased certain AIG-related assets. Also the Treasury

purchased \$40 billion in shares of AIG preferred stock and used the cash from the sale to pay down a portion of AIG's outstanding balance from the AIG RCF.

In March 2009 the FED and the Treasury announced plans to further restructure AIG's assistance, by reducing the debt owed by AIG on the AIG RCF by \$25 billion (in exchange for FED's receipt of preferred equity interests totaling \$25 billion in the two SPVs) and by providing additional liquidity to AIG by extending credit via purchasing a contemplated securitization of income from certain AIG life insurance operations.

On November 23rd 2008 the FED provided a lending commitment to Citigroup as part of a package of coordinated actions by the FED, the Treasury and the Federal Deposit Insurance Corporation (FDIC), in order to avert a disorderly failure of the company, because they were concerned that the failure of a firm of Citigroup's size and interconnectedness would have had systemic implications.

The FED agreed to lend against the residual value of approximately \$300 billion of Citigroup assets if losses on these assets exceeded certain thresholds, but later the FED determined that it would be unlikely that losses on the Citigroup assets would reach the amount at which FED would be obligated to provide a loan and eventually the FED never provided a loan to Citigroup under this lending commitment. At Citigroup's request, the Treasury, the FDIC, and FED agreed to terminate this loss-sharing agreement in December 2009. As part of the termination agreement, Citigroup agreed to pay a \$50 million termination fee to the FED.

On January 15th 2009 the FED authorized a lending commitment to Bank of America as part of a coordinated effort with the Treasury and the FDIC to assist an institution that the agencies determined to be systemically important. While discussion about Citigroup's lending commitment happened in a fast timetable (during a weekend), discussions with Bank of America about a possible similar arrangement occurred over several weeks, starting in late December 2008, at a time when Bank of America was not facing imminent failure and there were also congressional hearings about the case.

The difficulties of Bank of America originated from the merger with the distress institution Merrill Lynch and the expectations about larger-than-anticipated losses from the merger. Following the completion of Bank of America's acquisition of Merrill Lynch on January 1st, 2009 the FED and the other agencies agreed to provide a loss-sharing agreement on selected Merrill Lynch and Bank of America assets to assure markets that unusually large losses on these assets would not destabilize Bank of America. On September 21st the FED and the

agencies terminated the agreement in principle to enter into a loss-sharing agreement with Bank of America, as it happened the agreement was never finalized and any loans under this lending commitment was never provided. Bank of America paid \$57 million compensation to the FED for its expenses in arranging this commitment line.

5.1.4 Large-scale asset purchases (LSAP)

According to Fawley & Neely (2013) on November 25th 2008 the FED announced plans to purchase \$100 billion in government-sponsored-enterprise (GSE) debt and \$500 billion in mortgage-backed-securities (MBS) issued by those GSEs in order to support the housing credit markets and eventually the broader economy. By purchasing agency MBS with longer maturities (generally 30 years) the FED could lower long-term interest rates for mortgages and thereby support the housing market and other financial markets more generally (Williams Brown and others, 2011). On March 18th 2009 the Fed announced additional purchases of \$100 billion in GSE debt, \$750 billion in MBS, and \$300 billion in long-term Treasury securities (Fawley & Neely, 2013).

Above mentioned programs are referred to as the FED's first large-scale asset purchase (LSAP) program (for example D'Amico and others, 2012) or the first Quantitative Easing program (QE1) (for example Fawley & Neely, 2013). According to Haltom & Wolman (2012) LSAPs can lower market interest rates through two channels: portfolio rebalance channel (LSAPs change the relative supply of assets available to investors and thereby have the potential to change asset prices and interest rates) and signaling channel (announcement of LSAPs programs can alter the expectations of a central banks future actions and the duration of these actions, thus affecting the long-term interest rates). According to Wright (2012) the ultimate motivation for these purchases was to try to lower the interest rates being paid by households and businesses, so as to support consumption and investment spending. The program executed its final purchases in March 2010 and settlement was completed in August 2010 (Williams Brown and others, 2011).

According to Fawley & Neely (2013) the United States faced a worrisome disinflationary trend (inflation dipped toward 1 percent) and real economy activity still remained sluggish by the second half of 2010. On August 10th, the Fed announced that it would maintain the size of its balance sheet by reinvesting the principal payments of the first LSAP into longer

term Treasury securities and also signaled that it was considering further asset purchases in order to alleviate the problems. According to D'Amico and others (2012) the FED embarked on its second LSAP program by purchasing \$600 billion longer term Treasury securities from November 2010 to June 2011. Fawley & Neely (2013, 73) calls the program QE2 and argue that “this program was explicitly designed to lower long-term real interest rates and increase the inflation rate to levels deemed more consistent with the Fed’s mandate from Congress”. According to Fawley & Neely (2013, 74) the FED announced, on September 21st 2011, that it would purchase \$400 billion worth of long-term Treasury securities in a Maturity Extension Program (MEP). The program was financed by selling of \$400 billion worth of short-term Treasury securities and had a nickname “Operation Twist”, because by replacing short-term assets with long-term assets the FED aimed to “twist” the yield curve and thus the program did not expand monetary base (the quantity of currency and bank reserves in the economy). At the same time the FED also announced that it would begin reinvesting maturing MBS and agency debt in MBS rather than Treasuries.

As U.S. nonfarm payrolls grew significantly slower than expected during the spring and summer of 2012 the FED announced on June 20th that it would extend its MEP program through the end of the year, and the additional purchases were expected to be \$267 billion (Fawley & Neely, 2013, 75).

According to Fawley & Neely (2013) the FED started its third round of quantitative easing (QE3) on September 13th, 2012 by announcing that it would purchase \$40 billion MBS per month and continue the purchases as long as necessary without affecting the price stability. These purchases were motivated by a point of view that the mortgage-finance markets were dysfunctional and the purchases would stimulate housing sector and thus the economy as whole (Fisher, 2014).

On December 12th 2012 the FED also altered also its MEP program. The FED would continue to purchase long-term Treasury securities worth \$45 billion per month, but the purchases would no longer be sterilized through the sale of short-term Treasury securities, thus the FED started again expanding the monetary base through this program.

5.2 The European Central Bank (ECB) unconventional operations

Cour-Thimann & Winkler (2013) distinguish three phases of the financial crisis that required different responses from the ECB's. The first phase, global financial crisis, began after the bankruptcy of Lehman Brothers in September 2008, when the health of major banks worldwide was in question and the interbank lending froze. The second phase, euro area sovereign debt crisis, started in early 2010, when the possibility of Greek sovereign debt default emerged. The third phase, the re-intensification of the euro area sovereign debt crisis, started in mid-2011.

According to Lenza and others (2010), already before above mentioned phases, the ECB was in the vanguard of acting to address the initial emergence of money market tensions, by conducting a number of large fine tuning operations, starting in early August 2007, within its existing framework. The ECB did not need the same kind of creation of new liquidity programs as the FED (see chapter 5.1.1), because the ECB were already acting with large number of counterparties, and was allowing the use of broad range of collaterals. The only exception was the dollar swap line, created by the FED, in which the ECB participated (see chapter 5.1.1).

After the collapse of Lehman Brothers in September 2008 it became clear that further actions needed to be made. As spreads of key rates were widening the ECB reacted on October 15th by announcing, that it would lend as much as banks wanted at a fixed-rate, against an expanded set of collaterals with its new fixed-rate tender full-allotment program (FRFA) (see chapter 5.2.1).

The ECB also introduced new 6-month long-term-refinancing-operations (LTROs) in addition to its 3-month LTROs.

Furthermore, according to Fawley & Neely (2013) the ECB started to cut its primary policy rate, the main refinancing rate, from 4.25 percent in October 2008 and hit its subsequent lower-bound in May 2009 when the interest rate was set to 1 percent. [Actually the ECB later cut this interest rate even more and eventually in 2016 it was set to zero percent (The European Central Bank, 2016)].

According to Fawley & Neely (2013) on May 7th 2009, when concerns over counterparty risk continued to plague European interbank markets, the ECB embarked to its first Covered-Bonds-Purchase-Program (CBPP) (see chapter 5.2.2).

The euro area sovereign debt crisis started in early 2010, when acute market expectations emerged about a possible Greek sovereign debt default, with a further risk of impact on sovereign debts of Ireland, Portugal, and even Spain and Italy (Cour-Thimann & Winkler, 2013). As a response On May 10th 2010 the ECB announced the Securities Markets Programme (SMP) (See chapter 5.2.3), under which it would buy sovereign debt of its member countries in distress from the secondary market (Fawley & Neely, 2013).

As a response to the re-intensification of the euro area sovereign debt crisis in mid-2011, the ECB reactivated the SMP in July 2011 and later, in the summer of 2012, replaced the program via creation of a new program called Outright-Monetary-Transactions (OMT) (see chapter 5.2.4) (Fawley & Neely, 2013). Under OMT the ECB was allowed to purchase unlimited quantity of sovereign bonds (Fratzcher and others, 2014). Also, in December 2011, the ECB introduced very long-term refinancing operations (VLTROs) with a maturity of 3-years.

Fawley & Neely (2013) argue that the financial crisis, sovereign debt crisis, and banking problems in Europe are intimately linked. As the financial crisis created a recession, tax revenues decreased and public spending increased. This significantly worsened already existing budget problems and increased the risk associated with European debt. When countries sovereign debt became riskier, the solvency of private banks (they held substantial quantities of sovereign debt) were compromised and counterparty risks increased in the interbank lending. The possibility of bank failures posed risk for further increases in sovereign debts as governments were the insurers of bank deposits.

5.2.1 Fixed-rate tender full-allotment program (FRFA)

According to Fawley & Neely (2013, 57) on October 10th 2008 the 3-month Euribor/OIS (overnight indexed swap) spread hit an all-time high 198 basis point, reflecting significant perception of counterparty risk in the money markets. Also on October 13th spread between

the three-month Euribor and the overnight interest rate EONIA rose to an all-time high of 156 basis points (Bini Smaghi, 2009). These spreads reflected a sharp rise in perceived counterparty risk, illiquidity of assets and particular tight financing conditions for longer maturity assets in the money markets.

The ECB responded, with its first measure of quantitative easing, on October 15th 2008, by announcing a new fixed-rate tender full-allotment program (FRFA). Under this program the ECB offered unlimited quantity of funds at a fixed-rate (the main refinancing rate of the ECB), rather than a fixed quantity of funds through biddings – the way the ECB acted conventionally (Fawley & Neely, 2013). The accepted set of collaterals used in these FRFA transactions were also widened to include securities (other than ABS) rated BBB or higher (Lenza and others, 2010).

By offering unlimited quantity at a fixed-rate the ECB provided certainty about the quantity and price of the available central bank liquidity, and also the ECB avoided the difficulty of determining the adequate amount of funds to be offered (Lenza and others). According to Fratzscher and others (2014) reduced liquidity costs and uncertainty and a longer liquidity planning horizon were expected to encourage banks to continue providing credit to the economy.

The ECB implemented the FRFA liquidity provision through its usual lending procedures, main refinancing operations (MROs) and longer-term refinancing operations (LTROs). MROs had two weeks maturity and LTROs had three months maturity (Fawley & Neely, 2013). In addition, already in March 2008, the ECB had introduced supplementary long-term refinancing operation (SLTROs), with a maturity of six months and later in May 2009 the ECB introduced a twelve month SLTRO. Also in December 2011, when the sovereign debt crisis in euro area intensified, the ECB introduced “very” long term refinancing operations (VLTROs) with three year maturity (Fratzscher and others, 2014).

Between April 2008 and October 2011, the ECB conducted twenty SLTROs with six month maturity and in the largest one the ECB allotted €50 billion worth of loans. The ECB conducted four twelve month SLTROs between June 2009 and December 2011 and in the biggest one the ECB allotted around €442 billion. The ECB had two VLTROs, where it allotted around €1019 billion in total (Fratzscher and others, 2014).

According to Cour-Thimann & Winkler (2013) all above mentioned non-standard measures were tailored to the specific, bank-based financial structure of the euro area, and their goal was to support the liquidity and funding of the banks, thus increasing the whole economic activity of the euro area.

5.2.2 Covered bond purchase program (CBPP)

According to Fawley & Neely (2013) despite the ECB's relaxed lending procedures, concerns over counterparty risks persisted and by early 2009 the interbank lending had dried up. On May 7th 2009 the ECB responded by introducing covered bond purchase program (CBPP) - its first asset purchase program.

Covered bonds are long-term debt securities that are issued by banks to refinance loans to the public and private sectors, often in connection with real estate transactions. Unlike mortgage-backed securities covered bonds have the specific legal characteristic of "double protection" (Cour-Thimann & Winkler, 2013). In the event of a default of covered bond the bondholders have recourse to the issuer of the bond, as well as the underlying collateral pool and the issuer bank is required to hold the underlying collateral on their balance sheet. Banks usually hold long-term loans in their asset side of balance sheet and on-demand deposits on their liabilities side. By issuing long-term covered bonds banks can alleviate the maturity mismatch and in the euro area the markets for covered bonds had grown strongly in the years before the crisis (Fawley & Neely, 2013). According to Cour-Thimann & Winkler (2013) covered bonds had become a primary source of funding for banks in large parts of the euro area. After the bankruptcy of Lehman Brothers these markets became seriously impaired.

In its first CBPP on May 7th the ECB committed to purchase €60 billion in covered bonds gradually over the period between June 2009 and June 2010, or roughly 2.5 percent of the outstanding bonds. The CBPP program was intended as a credit easing program for reviving the impaired covered bonds markets. Jean-Claude Trichet, then president of the ECB, stated that he expected "automatic sterilization" as the covered bond purchases would commensurately reduce demand for the elastically supplied LTROs, and by so would not increase the balance sheet of the ECB (Fawley & Neely, 2013). During the first phase of

CBPP a total of 422 different bonds were purchased, 27% in the primary market and 73% on the secondary markets (Beirne and others, 2011).

In the fall of 2011 the re-intensification of the euro area sovereign debt crisis became clear and on October 6th 2011 the ECB responded by announcing that it would purchase €40 billion worth of euro-denominated covered bonds - its second round of CBPP. By the end of the program in October 2012 the ECB had bought only €16.4 billion worth of covered bonds, mainly due to a lack of covered bond issuance (Bibow, 2015).

5.2.3 Securities markets programme (SMP)

According to Fawley & Neely (2013) in May 2010, the escalating sovereign debt crisis disrupted European financial markets, and according to Fratzscher and others (2014) this hampered the ECB's monetary policy transmission mechanism. In response, On May 10th, the ECB announced direct purchases of government bonds (of its member countries) in secondary markets under newly created Securities Markets Programme (SMP). The ECB committed to hold the government bonds until maturity, but did not commit to roll over the portfolio as these bonds matured. Also the liquidity created by bond purchases was meant to be sterilized via weekly liquidity absorbing operations, so that the monetary base would not be affected – making this program more a credit easing operation than a quantitative easing operation. The scope and size of the interventions were to be determined on a daily basis, without any predetermined public target in terms of price or quantity.

In the first round of SMP the purchases were limited to Greek, Portuguese and Irish Government bonds, but in the second round as the sovereign debt crisis re-intensified, in August 2011, the Italian and Spanish government bonds were also included to the program. When market conditions improved in early 2012 the ECB stopped purchasing government bonds. In February 2012 the ECB held around €220 billion of sovereign bonds of countries experiencing financial stress (Fratzscher and others, 2014). The program was officially deactivated in September 2012, at the time of an introduction of a new program called Outright Monetary Transactions (OMT) (see below).

5.2.4 Outright monetary transactions (OMT)

Even though the conditions in euro area sovereign debt markets were improved in early 2012, the problems yet again re-appeared in the summer of 2012. When the solvency of Spain and Italy became unsure, the viability of the euro came into question and the possibility of euro area break up arose. The ECB responded on September 6th 2012, with the announcement of a new program called Outright Monetary Transactions (OMT). Under OMT the ECB were allowed to purchase unlimited quantity of government bonds (up to the three year maturity bucket) issued by countries under a European Stability Mechanism (ESM) macroeconomic adjustment programme or a precautionary programme (Enhanced Conditions Credit Line) (Fratzscher and others, 2014). With OMT the ECB meant to correct some issues that persisted in SMP, for example in SMP there were concerns regarding the distorted incentives for governments to adopting sound policies. Even though OMT was meant to be the main tool fighting against the euro area break up, it has not been used, and even the legality of its usage has been discussed in courts (for a more thorough discussion see Siekmann and others, 2015).

5.3 The Bank of England (BoE) unconventional operations

The financial crisis became evident in the UK when Northern Rock, a significant retail bank and a substantial mortgage lender, announced on September 13th 2007 that it had asked for and received emergency financial support from the BoE. Earlier in August rumors about the bank's insolvency had caused a massive withdrawal of deposits. In three days around £3 billion of deposits, or around 11% of the bank's total retail deposits, were withdrawn from its accounts (Llewellyn, 2009).

Shin (2009) argues that this was no ordinary bank run. According to him the financial damage to the firm had been done well before the run by its retail depositors. Northern Rock had an apparently solid asset book and virtually no subprime lending, but its' heavy reliance on nonretail funding and the highly leveraged structure of the firm (high assets/equity ratio) caused extra pressures to its funding, when creditors started to demand higher haircuts and extra margin calls, due to the worsening interbank atmosphere. Usually a firm would have sold some of its assets in order to meet the margin calls, but as Northern Rock's assets were illiquid long-term mortgages it was not able to meet these margins, and eventually this led to its demise.

First the BoE was forced to act as a lender of last resort for Northern Rock, in order to avoid further panic in the already stressed financial markets. On September 17th 2007 the government of the UK stepped up and announced guarantee arrangements in respect of all existing retail savings in, and certain existing wholesale liabilities of, Northern Rock. After failed attempts to secure a buyer in the private sector the government took the bank into “temporary public ownership” in February 2008 and by doing so socialized the credit risk of the bank. Later another British bank, Bradford and Bingley, were also nationalized and furthermore the government has taken substantial equity stakes in several other British banks as part of their re-capitalization program.

Other government programs, during the crisis, included: Credit Guarantee Scheme (CGS), where banks were allowed to issue debt guaranteed by the government, and Asset Protection Scheme (APS), where the government provided insurance against non-performing assets (Edmonds, 2016). Even though the government operated through the BoE with these programs, they can be seen as fiscal policy operations – and as such are outside the scope of this thesis.

The BoE’s first responses, as was the case with all the central banks, were the cutting of its main interest rate (official bank rate). According to Joyce and others (2011a) the BoE cut the interest rate by 3 percentage points during last quarter of 2008 and further 1.5 percentage points in early 2009. In early March 2009 the BoE hit its lower bound when the interest rate was set to 0,5%. The BoE also extended the range of collateral it would accept in its regular three-month long-term repo operations (John and others, 2012).

According to Lenza and others (2010) in April 2008 the BoE introduced a new facility, Special Liquidity Scheme (SLS), in order to allow banks to swap some of the illiquid assets on their balance sheets (notably ABS) for liquid Treasury bills (see chapter 5.3.1).

After the collapse of Lehman Brothers the BoE engaged in multiple rounds of quantitative easing in order to lower yields on long-term assets, to foster economic activity and to offset deflationary pressures (see chapter 5.3.2). During the first quantitative easing program (QE1) the BoE bought £200 billion of domestic private and public assets, the vast majority of which were medium to long-term gilts. The BoE had its second quantitative easing program (QE2) between October 2011 and May 2011, with further purchases worth of £125 billion and its third program (QE3), with further purchases worth of £50 billion that started in July 2012.

On July 13th 2012 the BoE and the HM Treasury co-launched Funding for Lending Scheme (FLS) in order to provide liquidity to those banks and building societies that offered loans to the real economy (see chapter 5.3.3).

5.3.1 Special liquidity scheme (SLS)

According to John and others (2012) the BoE launched the Special Liquidity Scheme (SLS) on April 21st 2008 in order to help banks funding and liquidity problems that had emerged from US housing markets. Some of the asset-backed-securities markets had started to freeze already in the second half of 2007. Banks had used these markets for funding part of their balance sheets, by packaging mortgage loans and other assets into securities, which could be sold to investors, including other banks, or used as a collateral for borrowing cash (for more see chapter 3.2). The freezing of these markets led to a situation, where banks had illiquid assets in their balance sheet and their ability and willingness to lend money to individuals and businesses became hampered. The BoE feared, that without correcting the liquidity problems, banks might further curtail their lending to each other, and, more importantly, to the wider economy. Through SLS banks could exchange their high quality but illiquid assets (asset-backed-securities) for more easily tradable assets (Treasury bills) that banks could, for example, use in repo markets. SLS was intended as a temporary measure in order to give banks time to strengthen their balance sheets and diversify their funding sources.

According to John and others (2012) SLS was based on number of key design principles. By offering Treasury bills, for up to three years, the BoE provided banks certainty about their liquidity for a long period, and by doing so the confidence in their financial positions was also enhanced. SLS was specifically designed to deal with the already existing assets on banks' balance sheets and not to finance new lending directly. For that reason only loans existing before December 31st 2007 ("legacy assets") were eligible. Initially the BoE set a six month pre-determined drawing period ("drawdown window") for the SLS. In this period banks were allowed to enter into new collateral swaps but once closed no new drawings could be made. It was considered that this would be long enough of a period in order to allow banks to package up portfolios of legacy loans into a form that would be accepted in the Scheme. After the collapse of Lehman Brothers the BoE extended the "drawdown window" to January 30th, 2009, due to increased stress in the financial markets.

In SLS the BoE protected itself firstly by the collateral swap aspect itself. The credit risk remained with the banks and their shareholders, as the banks were required to update daily the value of the collateral used, either by providing more assets or to return some of the Treasury bills borrowed. Secondly the BoE required that banks provided assets with a value greater than that of the Treasury bills borrowed (a haircut over the value of the Treasury bill), so that in a case of a counterparty default the BoE would be more likely to receive full value of the loan. Thirdly, because of the size of the scheme compared to BoE's capital, the Her Majesty's Treasury (HMT) indemnified all losses above the acquired fees from the scheme. These aspects meant that the public sector would have been exposed to losses only if all three following conditions were met: the counterparty bank defaulted, the value of collateral provided by that counterparty fell after the default by more than the size of the haircuts applied; and the resulting exposure exceeded the total buffer of retained SLS fee income. As it turned out none of the counterparties defaulted and none above mentioned losses were recorded by the time of the end of the scheme (John and others, 2012, 59).

The BoE accepted only high quality securities, rated AAA by two or more of Fitch, Moody's, and Standard & Poor's, as collateral in the SLS. After the approval of the security the BoE assigned a value to the security. This valuation was made using market prices, when available, and if not then the BoE used its own pricing models. Next the BoE determined the appropriate haircut for the security, by using a standard "base" haircut for the asset type and haircut add-ons to protect against additional risks, including those that may have been specific to that security.

According to John and others (2012) at the end of scheme the BoE held securities with a nominal value (market value) of £287 billion. The BoE's own valuation of these same securities was approximately £242 billion and the BoE would have been prepared to lend £190 billion worth of Treasury bills, implying an average haircut of 22%. The actual market value of lent Treasury bills was £185 billion, which was more than twice the size of the BoE's balance sheet prior to the financial crisis. The £5 billion gap reflected the fact that some counterparties preferred to over-collateralize their drawings slightly, in order to reduce the operational costs of having to post extra margin if small price fluctuations reduced the value of their collateral (John and others (2012)).

The SLS ended on January 30th 2012 and all drawings under the Scheme were repaid before the Scheme closed (Edmonds, 2016).

According to John and others (2012) experiences gained from SLS and the whole financial crisis encouraged the BoE to make changes for its normal operating procedures and facilities. In October 2008 it separated its bilateral Standing Facilities into Operational Standing Facilities (OSFs) and a Discount Window Facility (DWF). The DWF was a new permanent bilateral liquidity insurance facility, from which counterparties (if solvent and viable) could borrow at prices and conditions determined in advance, usually against collateral. Also in June 2010 the BoE replaced extended long-term repo (ELTR) operations with indexed long-term repo (ILTR) operations. Furthermore, in December 2011, the BoE announced the potential availability of an Extended Collateral Term Repo (ECTR) facility. Experiences gained from SLS, about collateral features, were greatly beneficial in the establishment of above mentioned facilities and operations. John and others (2012) argue that these formalized facilities gave counterparties more clarity about the terms and conditions on which liquidity is available from the central bank – and thus helped the future planning of banks. At the same time these alterations constituted a significant change in the way the BoE uses its balance sheet to provide liquidity support, and are now a permanent part of its operations.

5.3.2 Asset purchase facility (APF) and quantitative easing programs

According to Fawley & Neely (2013) HMT announced on January 19th 2009 the establishment of the Asset Purchase Facility (APF), which was to be operated by the BoE. At first the BoE was authorized to purchase up to £50 billion in high quality private sector assets, in order to help the liquidity problems in the financial markets. These purchases were meant to be matched by sales of short-term UK government securities (gilts), making this a credit easing program at that stage. Ultimately the BOE did not purchase large quantities of private assets, and at the peak, in the second quarter of 2009, it held less than £3 billion worth of private assets, or 6 percent of the £50 billion ceiling (Fawley & Neely, 2013, 67). On March 5th 2009 the program shifted from credit easing to quantitative easing (QE), when the BoE announced that it would purchase £75 billion worth of gilts (with residual maturities of between five and twenty-five years) financed by central bank reserves (expanding the

monetary base), and later, in November, increased the ceiling further to £200 billion. On August 6th 2009 the BOE announced, that it would expand purchases into gilts with remaining maturities of 3 to 5 years and 25-plus years to accommodate the increased size of the purchases. On February 4th 2010 the first stage of purchases (QE1) ended, when the BOE announced that any new purchases would be financed through Treasury issuance instead of central bank reserves.

According to Bridges & Thomas (2012) the ultimate goal of the QE was to stimulate demand by lowering external financing costs and boosting asset prices for all agents, and thus bringing about higher output growth and offset deflationary pressures. According to Joyce (2012) the Bank of England's Monetary Policy Committee was worried, that without the QE program, there would be substantial risk that inflation would undershoot the BoE's 2% target in the medium term. As mentioned above the BoE had lowered its main interest rate to 0,5% in the early March – causing deflationary pressures. The BoE's first QE program almost quadrupled the UK monetary base within a few months as bond purchases replaced longer-term reverse repos (Fawley & Neely, 2013).

The second stage of purchases, or QE2, began on October 6th 2011, when the BoE raised the asset purchase ceiling to £275 billion and announced that central bank reserves would again fund any new purchases. The ceiling was lifted to £325 billion on February 9th 2012 and to £375 billion on July 5th 2012 (Fawley & Neely, 2013).

Gross domestic product (GDP) contractions and concerns over undershooting the inflation target were main motives for these purchases. In late 2012, at the close of the program, the BoE held £360 billion in gilts and only £100 million in corporate bonds.

5.3.3 Funding for lending scheme (FLS)

According to Churm and others (2015) on July 13th 2012 the BoE and the HM Treasury co-launched Funding for Lending Scheme (FLS). They argue that while there is potentially a fiscal policy element (it is overseen by a joint Bank of England/HM Treasury Oversight Board) in the scheme, it mostly can be seen as BoE's unconventional monetary operation, as the scheme is fully operated by the BoE and is operationally similar to other monetary policy operations such as the ECB's Longer-Term Refinancing Operations (LTRO) and

targeted LTROs (TLTROs). They further justify this categorization by stating: “We therefore interpret this form of governance as simply reflecting a desire for joined up policy making given the exceptional challenges facing the UK economy at the time, and the desire of the Bank to seek and receive assurance that the objectives of the Scheme lay within its remit” (Churm and others, 2015, 4).

FLS was created in order to lower the high level of bank funding costs and give banks and building societies incentives to sustain or expand their lending to the UK households and companies. Access to the Scheme was directly linked to how much each bank and building society lend to the real economy and as an incentive to lend more the available amount to borrow were tied to the overall lending of the bank (or building society) and the cost was also lowered to those how lend more.

Under the scheme the BoE lent funds for a bank (or building society) up to four years against collateral (in the form of loans to businesses and households and other assets) and a fee. Each participant was able to borrow an amount up to 5% of its stock of existing loans to the UK non-financial sector (the real economy) as at end-June 2012, plus any expansion of its lending during a “reference period” from that date to the end of 2013. The price was dependent on the banks’ net lending between June 30th 2012 and the end of 2013. For banks maintaining or expanding their lending over that period, the fee was 0.25% per year on the amount borrowed.

Outstanding drawings at the end of the first phase of the scheme, in January 2014, were \$41.9bn (Churm and others, 2015, 2).

As the program only altered the composition of the BoE’s balance sheet it can be seen as a credit easing operation.

6 ASSESSMENT OF THE IMPLEMENTED UNCONVENTIONAL OPERATIONS

In this chapter I present the research results relating to the effectiveness of the unconventional operations during the financial crisis by the three central banks (the FED, the ECB and the BoE). These researches have been made using different methods and models (event study analysis, time-varying parameter structural model, panel structural vector autoregressive model, dynamic stochastic general equilibrium model etc.), that are beyond the scope of this thesis, thus I will leave the details about them out and will only present the findings of the researches.

Assessment of the effectiveness of the unconventional operations is difficult for many reasons. For example transmission mechanisms to the economy are complex and opaque, impact of individual operations are difficult to isolate and it is difficult to estimate what would have happen if the actual actions were not taken. Also different research methods and models can give contradictory results, as they incorporate different assumptions and parameters.

According to Klyuev and others (2009) the first measures (liquidity injections) taken by the central banks eventually were successful in reducing term premiums in money market rates and increased the availability of short-term financing that led to a steep reductions in LIBOR-, repurchase-, and commercial paper (CP) -rates and their risk premiums, as well as a narrowed foreign exchange swap basis.

Frank & Hesse (2009) concur by stating that, in the first phase of the crisis, central bank interventions had a statistically significant impact on easing stress in unsecured interbank markets. But while the central bank actions lowered LIBOR spreads and calmed the financial markets they still were not enough to stop the liquidity crisis for good. Also the design and the implementation of these liquidity operations created new risks, as banks and other financial firms took a protective put on central bank liquidity and benefited from the upside of the yield differential, the associated risks increasingly transferred to the public sector.

Klyuev and other (2009) argue that while central bank efforts primarily stabilized the banking system, still not enough capital were raised to adequately support lending and the economic recovery. In early 2009 bank lending to the private nonfinancial sector decelerated rapidly in the Euro area and the United States, and turned even negative in the United Kingdom.

According to Wu (2014) the general conclusion is that the unconventional monetary policies implemented by the central banks have largely succeeded in providing additional policy stimulus and the long-term interest rates have declined substantially in response to various asset purchasing policies and forward guidance.

The early quantitative easing were the most successful as they provided new information that had an effect on future expectations and thus had an impact on asset prices and yield spreads. The information concerning the later programs was already in some extent in the expectations of market agents and those programs tended to have a much weaker effect.

6.1 Assessment of the effectiveness of the early liquidity programs

The most persisting view in academic literature is that central banks' liquidity support programs provided must needed help to the stressed money markets and eventually helped to bring down the soaring spreads between secured and unsecured interest rates.

At first the FED's early liquidity programs (TAF, TSLF and AMLF) had a stabilizing, calming and comforting effect on the stressed money markets and some researchers found that the spreads between secured and unsecured interest rates in the money markets were somewhat narrowed. Most likely at this time the liquidity part of the spread problem was lifted but the increasing credit part (counterparty risk) was not addressed. Evidence of this is the fact that while the spreads lowered the economic magnitudes were not very large. The later programs (CPFF and TALF) focused on specific credit problems and the spreads declined more effectively.

The ECB's liquidity programs provided significant comfort and support to the banking sector, which led to narrowing of money market spreads and eventually brought cheaper loans for consumers, house buyers and businesses.

There has virtually been no research of the effectiveness of the BoE's Special-Liquidity-Scheme, but the high volume of trade through the program can be considered a sign of success.

6.1.1 The FED's new liquidity facilities

In this subsection I will address the effectiveness of the new facilities that the FED established in the early stages of the crisis that I presented in chapters 5.1.1 and 5.1.2. The researches about this subject provide a clear evidence of how difficult economic research can be. The lack of counterfactual evidence (what would have happened without these programs), the usage of different models and different assumptions of transmission mechanisms has led to contradictory results.

Most often the academic literature agrees that the FED's early operations (liquidity provision through new facilities) had a stabilizing effect to the money markets [e.g. Artuc & Demiralp (2010), Griffiths and others (2011) and Hooper and others (2009)]. In the case of TAF-program Thornton (2011) even questions this by hypothesizing that market participants revised up their expectations of the seriousness of the financial crisis in the wake of TAF announcement (and the announcements of other central banks relating their programs), and thus worsened the conditions.

Hooper and others (2009) found evidence that TAF was statistically effective in reducing LIBOR-OIS spread, while TSLF was not. Frank & Hesse (2009) also found evidence that TAF was helpful in compressing LIBOR spreads, while noting that the economic magnitudes were not very large. On the other hand Taylor & Williams (2008) found no empirical evidence that TAF reduced spreads and Thornton (2011) suggests that TAF appears to have had little or no effect on the 3-month LIBOR/T-bill spread.

Hooper and others (2009) found that the announcement of the auction (for TAF and TSLF) was the key event influencing the market, not the release of the auction funds. Frank & Hesse (2009) concur by stating that the actual implementation is insignificant, highlighting possible market efficiencies with regard to information arrival and processing. This means that the announcement has an effect on expectations but at the time of the implementation the expectations already include all the information regarding the program.

Griffiths and others (2011) argue that the money market tensions were not a symptom of liquidity problems but credit problems (counterparty risk problem) and the liquidity-

injections by the FED through TAF, TSLF and AMLF provided only limited results. On the contrary by making loans to specific commercial paper issuers through CPFF (and thus becoming a major investor and a credit insurer) the FED's actions had the desired effect and the spreads declined dramatically. This suggests that the impact of the crisis on the commercial paper market was not a market-wide problem, but instead was concentrated to specific credit-quality issues of commercial papers. By using LIBOR-OIS spreads as evidence, Taylor (2010) suggests that the misdiagnosis (liquidity vs. credit/counterparty) and the subsequent liquidity-injections through TAF even had a prolonging effect on the crisis. According to Sarkar (2009) liquidity- and credit risks were both important influences during the crisis, but at different stages and to different degrees. At the beginning of the crisis liquidity risks were dominant, but later when the crisis intensified the credit risks became more important. He argues that FED's liquidity programs were effective at the early stages of the crisis, when lack of liquidity was driving asset prices down, but the programs became less effective once the counterpart credit risks started to take hold.

The research done by Adrian and others (2011) provides evidence that CPFF was successful in narrowing spreads. Over the period of October 2008 and December 2009 the one-month AA-rated financials spread declined from 188 basis points to 38 basis points and the ABCP spread declined from 256 basis points to 86 basis points. Meanwhile, the spread for A2/P2 commercial paper, which was not eligible for the CPFF, rose from 483 basis points to 503 basis points. Also the facility generated roughly \$5 billion in net income and as these profits were transferred to the Treasury, they ultimately helped reducing the financial burden, of the crisis, on taxpayers.

According to Allen & Moessner (2010) the FED's dollar swap lines were very effective in relieving US dollar liquidity stresses in foreign exchange markets and these swap lines helped avoiding further global financial instability and worsening of the recession. Especially FED's quickly fund provision, flexible raising of limits in times of extra stress and provision of necessary large amounts contributed to the effectiveness of the swap lines. No losses were incurred for the swap lines.

Agarwal and others (2010) argue that TALF succeeded in offering a liquidity backstop and leverage to investors in the ABS markets (and commercial asset-backed securities markets), which facilitated issuance of new ABS and allowed holders of ABS products to borrow by

putting up these products as collateral at a given price. Increase in market liquidity helped spreads in core ABS classes, such as credit card and prime auto, to fall back to levels similar to those seen before the bankruptcy of Lehman Brothers. Besides satisfying the liquidity needs, TALF provided an important guarantee of a maximum price of liquidity that generated a crucial backstop against irrational fears that were lowering the values of assets in the market.

Ashcraft and others (2012) concur about the success of TALF by stating that the program made an important contribution to preventing the securitization markets from shutting down entirely and abruptly and eventually restored pricing levels that were compatible with continued credit intermediation through the securitization channel.

According to Campbell and others (2011) TALF calmed investors about US ABS markets rather than subsidizes or certified the particular securities that were funded by the program, suggesting that TALF had substantially stronger effects at the market level than at the security level. As the market bounced back, from been virtually halt, increasing amounts of new ABS issuance, even without TALF support, were witnessed (Agarwal and others, 2010).

While TALF was successful in reviving securitization markets, it did not prevent a significant collapse in the amount of credit intermediation (credit provision by both banks and nonbank investors). Ashcraft and others (2012) argue that the dramatic decline in securitization is due to lower demand for credit and in part to a reduction in the supply of credit by lenders, each related to the severe economic downturn.

According to Adrian and others (2009) the key indicator for the success of PDCF was the changes in the credit default swap spreads of the firms that had access to the facility. Their research found that these spreads fell for the primary dealers for roughly three months following the creation of the PDCF – suggesting that the program was indeed successful.

6.1.2 The ECB's FRFA program

Pattipeilohy and others (2013) work give a comprehensive view on the academic literature of ECB's unconventional operations (besides their own research). The overall conclusion (in the literature) is that the ECB's liquidity support significantly reduced money market rates (spreads) and thereby supported financial transmission and the economy.

According to Lenza and others (2010) FRFA program provided significant comfort and support to the banking sector and increased financial stability in the euro area, especially after the extremely difficult market conditions that followed from the failure of Lehman Brothers. Angelini and others (2009) argue that that the special longer term refinancing operations started to have a dampening effect on the interbank spread (unsecured vs. secured) only after the collapse on Lehman Brothers.

According to Hausken & Ncube (2013), after the announcement of FRFA, short-term EAGB (euro area government bonds) yields fell by more than 10 basis points and short-term OIS rates fell by more than 18 basis points. EAGB yields at longer maturities, however, increased substantially around the event by about 20 basis points. This reflected the fact that through FRFA the ECB provided only short-term liquidity and the expectations adjusted to that.

Abbassi & Linzert (2011) found in their research that the ECB's net increases in outstanding open market operations, starting from October 2008 (announcement of FRFA), led to a 100 basis point decline in Euribor rates. Euribor is essentially the unsecured money market rate that determines short-term loans and deposit rates for households and businesses. Lenza and others (2010) found that the ECB's liquidity provisions had large and positive effects on consumer loans and loans for housing purchases, while the effects on loans to non-financial corporations became positive only after a delay.

Cihak and others (2009) found that the lengthening of the maturity of monetary policy operations (LTROs) and the provision of funds at the fixed rate reduced money market term spreads and facilitated the pass-through from policy to market rates. Angelini and others (2009) argue that the ability of the ECB to steer money market rates (short-term) via standard channels of monetary policy (adjustment of short-term interest rates) was partly weakened, but the effective use of liquidity operations compensated for the loss and even influenced longer maturity money market rates (3-month, 6-month and 12-month).

Frank & Hesse (2009) found that the announcement of the LTROs by the ECB had a statistically significant effect on EU Libor-OIS spreads, although the economic magnitude was small. Later LTROs had even less of an effect.

6.1.3 The BoE's SLS program

There has virtually been no research of the effectiveness of SLS. From John and others (2012) one can suggest that the high volume of trade through SLS is an evidence of the success of the program. At the peak (at the end of January 2009) a face value of £185 billion of Treasury bills had been lent by the BoE for a period of up to three years. The large scale and long maturity liquidity support that BoE offered through the SLS gave banks time to strengthen their balance sheets and diversify their funding sources – exactly as it was meant to do. Also the program gave insight to the BoE about the problems in its existing discount window facilities, which led to the creation of new permanent facilities and adjustment of existing operations (see chapter 5.3.1).

6.2 Assessment of the effectiveness of the quantitative easing programs

According to Wu (2014) the general conclusion is that the unconventional monetary policies implemented by central banks during the most recent crisis have largely succeeded in providing additional policy stimulus, after short-term interest rates become constrained by the zero lower bound, and the long-term interest rates have declined substantially in response to various asset purchasing policies and forward guidance.

The transmission mechanism of such policies has not yet been fully clarified and the relative importance of signaling- and portfolio rebalance –effects (for more see chapter 5.1.4) remain as a subject of academic and policy debate. Also the empirical analysis has revealed a complicated transmission mechanism when forward guidance and quantitative easing programs are used together. Forward guidance can lead to a gradual extension of market's projected length of the holding period of the QE-programs assets, thereby generating a far more persistent effect for the QE-program. At the same time the continuance of QE purchases can help to enhance the credibility of the forward guidance and guide the market's expectations of future short-term interest rates. These two types of policies are intimately intertwined, supporting each other in lowering both the term premiums and public's expectation of future short-term interest rates.

The understanding of transmission mechanisms is also important for the exit strategies from quantitative easing programs. If the central banks intend to return to conventional monetary policies (and frameworks) they need to unload the assets they have acquired, during their

quantitative easing programs, back to the markets. Without knowing the impact of these asset releases there can be adverse consequences, for example the asset prices might fall back to crisis levels. Wu (2014) argues that policy transparency is vital in minimizing unnecessary market turbulence and in ensuring a timely and smooth exit of the unconventional monetary policy stimuli.

Transmission mechanism and exit strategies are interesting and important for future research, but as there are no comprehensive studies and conclusions yet, I will not cover them any further in this thesis.

In the next subsections I will present the research results concerning the effectiveness of quantitative easing programs during the financial crisis by the FED, the ECB and the BoE, in that order.

6.2.1 The FED's LSAP programs

A number of studies have found that the FED's LSAP, or quantitative easing, programs provided additional policy stimulus after short-term interest rates become constrained by the zero lower bound, and they were successful in lowering significantly nominal interest rates on bonds (Treasury, agency and corporate) and mortgage-backed securities, and eventually lowered longer-term private borrowing rates.

Gagnon and others (2011) found, using two models with different methods and data, that the first LSAP (or QE1), reduced ten-year term premium by 30-100 basis (with most estimates in the lower and middle thirds of this range) and had an even more powerful effect on longer term interest rates on agency debt and agency MBS. The latter was due to removing high risk assets from private portfolios and the provision of liquidity to high stressed markets. Chen and others (2015) suggest that purchasing US Treasuries to lower the term spread may be a weak tool, and reducing risk premia by acquiring private-sector assets is much more potent.

D'Amico & King (2013) studied the \$300 billion purchase of Treasury securities, during the first LSAP (or QE1), and found that the program reduced yields by an average of about 30 basis points over the life of the program, and had a further temporary reduction of 3.5 basis points, in yields in the sector of the purchase, on the days when purchases occurred. D'Amico

and others (2012) found, using different methodology and sample data, that the \$300 billion purchase of Treasury securities reduced longer-term Treasury yields by about 35 basis points and the \$600 billion purchase, during second LSAP (or QE2), had about 45 basis reduction effect.

According to the research done by Krishnamurthy & Vissing-Jorgensen (2011) the QE1 significantly reduced yields on intermediate and long-maturity bonds. They argue that the yields on 5 to 10 years bonds decreased by a range of 20 to 40 basis points. The yields of long-term safe assets, including Treasuries, agencies and highly-rated corporate bonds benefited greatly from the QE1, and the 10-year Treasury yield had even a reduction of, as high as, 160 basis points. Riskier bonds such as lower grade corporate bonds and MBS had lower reduction rates on their yields. They also found that QE1 increased inflation expectations (10-year expected inflation increased in a range of 96-146 basis points), but reduced inflation uncertainty.

Krishnamurthy & Vissing-Jorgensen (2011) found that the \$600 billion Treasury purchases, during QE2 (or second LSAP), lowered yields of 5-year bonds by 11 to 18 basis points and yields of 10-year bonds by 11 to 12. Low-default risk 10-year bonds had an additional decrease of 5 to 10 basis points in their yields. Inflation expectations for 10-year horizon were increased by 5 to 16 basis points, suggesting that real rates fell for all borrowers. Furthermore they found that FED's announcements affected rates. When the FED announced, on August 9th 2011, that it would likely keep the federal fund rate at low levels for at least through mid-2013, the Treasury rates (with maturities from 3 to 30 years) declined by 12 to 20 basis points.

Announcement of the maturity extension program (MEP), which was the second part of QE2, substantially decreased interest rates across the board. Declines, of 23 basis points for 30-year MBS, 7 bps for 10-year Treasury and 2 bps for 10-year agency and a decline between 15 and 17 bps for corporate rates from the long Aaa to Baa, were witnessed on the day after the announcement.

Wu (2014) argues that while LSAP programs were successful during the first two phases (QE1 and QE2) its effectiveness was significantly reduced during the third phase (QE3). The problems aroused from the fact that the FED did not explicitly specify the details about the program, which led to excessive market speculations. Uncertainty especially about the length of the holding period of these LSAP assets and the exact purchase amounts added extra risks

to market expectations, and subsequently, in mid-May 2013, caused a 100 basis point jump in 10-year Treasury, that surprised both the market and policy makers.

Hausken & Ncube (2013) also found evidence that the effectiveness of quantitative easing programs in the US diminished over time. According to them the 10-year Treasury yield dropped cumulatively by about 130 basis points over the events related to the QE1, but the yield fell only about 20 basis points around the QE2-related announcements, and even rose slightly around QE3-related announcements. Furthermore they argue: “On average, more than 80 % of the cumulative decline in Treasury yields is attributable to the first round of QE, while the subsequent unconventional monetary policies only contribute less than 20 % to the cumulative change in interest rates” (Hausken & Ncube, 2013, 38).

6.2.2 The ECB's CBPP, 3-year LTRO, SMP and OMT programs

Fratzscher and others (2014) estimate that, at the end of September 2012, without ECB policy interventions yields in Italy and Spain would have been higher by around 300 basis points, and yields in highly rated euro area countries would have been 5 basis points higher. They argue that ECB policies contributed to the decrease in sovereign bond spreads between the low rated and highly rated euro area countries and lowered market fragmentation. Also equity prices would have been lower by around 10% without ECB's unconventional monetary policy interventions.

Fratzscher and others (2014) found that yields in Germany, Finland, Austria and the Netherlands were the least affected by ECB policies and yields in distressed euro area countries (Italy, Spain, Greece, Portugal and Ireland) were the most affected, suggesting that that the impact of ECB policies on yields in the euro area were stronger in countries with lower sovereign ratings. While the impact on yields diverged, the impact on equity prices was more homogeneously positive across the whole euro area. Furthermore the ECB unconventional policies had positive spillovers to global markets by increasing equity prices and lowering risk aversion and credit risk of sovereigns and global banks.

Beirne and others (2011) argue that the first CBPP was effective in improving the overall funding situation for financial institutions in the euro area and in the UK and also alleviated some of the pressure on euro area banks to rely on the Eurosystem's liquidity providing

operations. According to them the program reactivated issuance of covered bonds, increased primary market activity in previously underdeveloped or smaller market jurisdictions or segments (such as Italy, Portugal, Greece, Austria and specific bonds in the Netherlands) and revived, at least temporarily, segments that had suffered severely from the financial crisis.

The announcement of the program led to tightening of covered bonds spreads (against a risk-free benchmark) for most euro area. For example the spread of German covered bonds lowered 7 basis points on the day of the announcement and declined in the following week at an average pace of 3 basis points per day. Overall the first CBPP had a dampening effect on euro area covered bond yields of approximately 12 basis points. As the sovereign debt crisis became evident in 2011, the benefits in spread declines started to be offset by the upward pressures on yields, for the countries affected by the sovereign debt crisis.

According to Fahr and others (2011) through the first CBPP the ECB succeeded in lowering the cost of financing in a specific financial market segment, which was important for banks' financing needs.

Hausken & Ncube (2013) found that the launch of the first CBPP compressed the spread between EAGB yields and OIS rates to some extent, but failed to encourage decline in interest rate levels. Both EAGB yields and OIS rates increased substantially for almost all maturities around the announcement event, reflecting rising expectations about future interest rates. After the implementation the ECB announced they intent to hold the purchased covered bonds until maturity. This announcement caused a slight decline in interest rates on the long end, but marginal increase in those at the short end, leading to an unclear understanding of the transmission mechanisms involved.

Hausken & Ncube found that the both CBPP programs together reduced the term premium in EAGB yields significantly, but at the same time market rates increased due to upward revision of the expected future short rates in response to the global financial crisis as well as the European sovereign debt crisis.

Gibson and others (2015) found that the CBPP programs appear to have modestly raised covered bond prices.

Fratzscher and others (2014) found that the supplementary and very long LTRO (SLTRO and VLTRO) loans (as well as SMP purchases) had a positive impact on yields and equity prices across the euro area. In early 2010 SLTROs led to a cumulated decline of 10-year government bond yields by 24 basis points in Italy and Spain, and by 5 basis points in highly

rated euro area countries (for example Finland, Germany, Austria and the Netherlands). They also boosted equity returns by around 4% in the whole euro area. The two VLTRO loans, in late-2011 and early-2012, led to a cumulated decline of 10-year government bond yields by 52 basis points in Italy and Spain, while in highly rated euro area countries yields went down by 6 basis points. VLTROs also affected positively to broad equity indexes (+5%) and bank equity prices (+10%) across the whole euro area.

Hausken & Ncube (2013) found contradictory evidence. According to their research the introduction of 12-month SLTROs and 3-year VLTROs failed to reduce interest rates. On the contrary, EAGB yields on the long end of the curve increased substantially. They argue that this was likely caused by the dramatic increase in yields of government bonds of those countries with high credit and liquidity risks such as Greece, Ireland, and Portugal.

Szczerbowicz (2012) found that early lengthening of LTROs (to 6-month and 12-month) had relatively little effect on money market spreads, but the introduction of 3-year LTROs (VLTROs) diminished spreads significantly. The Euribor-OIS spread was reduced by 24 basis points, Euribor-Repo by 20 basis points and Euribor-German Treasury bill by 6 basis points.

According to Fratzscher and others (2014) SMP related announcements led to a cumulated 121 basis points decrease in the 10-year sovereign yields of Italy and Spain, while they did not affect yields of highly rated euro area sovereign debts. In Italy and Spain SMP announcements positively impacted the main equity indexes by 7% and bank equity prices by 15% and bank equity prices also increased in highly rated euro area countries by around 6%.

SMP purchases lifted equity prices further and were effective in temporarily lowering sovereign debt yields and decreased market fragmentation. They found that SMP purchases decreased government bond yields in Italy and Spain by around 70 basis points and main equity indexes and bank equities went up by around 5% in Italy and Spain and by around 10% in highly rated euro area countries.

Altavilla and others (2014) found that OMT announcements had a sizeable impact on financial markets. The 2-year bond yields in Italy and Spain were reduced about 200 basis points and 10-year bond yields approximately 100 basis points. The longer yields had a smaller impact, because the policy measure explicitly focused on yields of bonds with remaining maturity up to three years. The highly rated euro area countries (for example

German and French) bond yields were largely unaffected. Also the announcements had statistically significant and economic relevant spill-over effects on credit and economic growth in Italy and Spain with some relatively limited effects in France and Germany.

According to Fratzscher and others (2014) the announcement of OMT program was sufficient to calm markets. Later OMT related announcements led to a cumulated 74 basis points decline in 10-year government bond yield in Italy and Spain, while bond yields in highly rated euro area countries increased by 10 basis points. Also equity indexes in Italy and Spain increased by around 9% and bank equity prices went up by around 14%, while the increases in highly rated euro area countries were smaller, but still positive.

Fratzscher and others (2014) argue that while ECB unconventional policies mainly affected financial markets in the euro area, especially OMT and SMP programs had positive spillovers to global markets by increasing equity prices (both broad equity indexes and banking indexes).

6.2.3 The BoE's quantitative easing programs and FLS

There is an overall consensus in the academic literature that BoE's quantitative easing programs and FLS had a significant and persistent impact on gilt yields and some positive effects to GDP and inflation.

Joyce and others (2011b) found that BoE's first quantitative easing program (QE1) lowered medium to long-term government bond yields by about 100 basis points.

Daines and others (2010) found that the impact on government bond yields of QE1 varied significantly across the term structure. The largest impact of 120 basis points decrease were with 15- to 20-year maturity government bonds spreads.

Kapetanios and others (2012) have a cautious estimate that the QE1 had a peak effect on the level of real GDP of around 1,5% and a peak effect on annual CPI inflation of about 1,25%.

Churm and others (2015) found that the QE2 lowered 5- and 10-year yield spreads of government bonds by 45 basis points. They also found that QE2 together with the initial phase of FLS boosted GDP in UK by around 0,5%–0,8% and had a positive effect on inflation around 0,6%, at its peak.

7 CONCLUSIONS

The objective of this thesis has been to find out what kind of unconventional operations the three central banks (the FED, the ECB and the BoE) made during the crisis in 2007-2012, why they were made and how effective these operations were.

In the early stages, besides the conventional interest rate cuts, the central banks provided liquidity to the stressed money markets. The FED's early liquidity programs (TAF, TSLF and AMLF) had a stabilizing, calming and comforting effect on the money markets and some researchers found that the spreads between secured and unsecured interest rates were somewhat narrowed.

As the liquidity part of the spread problem was taken care of through the FED's early liquidity programs, the credit risk (counterparty risk) still remained and intensified further especially after the collapse of Lehman Brothers, in September 2008. As the FED addressed these credit risks through its later liquidity programs (CPFF and TALF) the spreads declined more effectively.

The ECB's liquidity programs (FRFA and 6-month LTROs) provided significant comfort and support to the banking sector, which led to narrowing of money market spreads and eventually brought cheaper loans for consumers, house buyers and businesses. Although there has virtually been no research of the effectiveness of the BoE's special liquidity scheme it probably provided much needed liquidity to the markets and gave insight of leaks in BoE's existing discount facilities.

While the central banks liquidity provisions lowered spreads and calmed the financial markets they still were not enough to stop the crisis for good.

By May 2009 all three central banks had hit the zero-lower-bound of their interest rates and needed to consider other monetary policy tools. The FED was first to embark into an asset purchase program. Its first LSAP program (or QE1) started with an announcement already in November 2008. The FED bought \$1,750 billion worth of long-term Treasury, GSE and mortgage-backed bonds via the program. The goal was to lower long-term interest rates for mortgages and thereby support the housing market and ultimately to lower the interest rates paid by households and businesses, so as to support consumption and investment spending. A number of studies found that the program was successful in lowering long-term interest rates. The FED had two other LSAP programs (QE2 and QE3). These programs likely lowered long-term interest rates further, but with a diminished effect.

The BoE had two quantitative easing programs (QE1 and QE2) where it purchased long-term government bonds (gilts) and some high quality private sector assets. The first one was announced in January 2009. The ultimate goal of these purchases was to stimulate demand by lowering external financing costs and boosting asset prices for all agents, and thus bringing about higher output growth and offset deflationary pressures. At the close of the program in late 2012 the BoE held £360 billion in gilts and only £100 million in corporate bonds. In July 2012 the BoE launched a credit easing program, funding-for-lending-scheme, where it lent funds for banks. The program was meant to lower the high level of bank funding costs and give banks and building societies incentives to sustain or expand their lending to the UK households and companies. There is an overall consensus in the academic literature that BoE's quantitative easing programs and FLS had a significant and persistent impact on gilt yields and some positive effects to GDP and inflation.

While the FED and the BoE acted on bond markets the ECB expanded further its lending operations to euro area banks. In May 2009 the ECB started its first asset purchase program, covered-bonds-purchase-program (CBPP), in order to revive the impaired covered bonds market. The announcement of the program led to tightening of covered bonds spreads (against a risk-free benchmark) for most euro area.

In 2010 the euro area faced a new kind of crisis, sovereign debt crisis, when the possibility of some of its member countries sovereign debt default emerged (notably Greece). Through a new program, securities-markets-programme (SMP), the ECB purchased sovereign bonds of euro area countries in distress to contain "excessive" risk premia and to restore the transmission mechanism of monetary policy. SMP announcements and purchases decreased yield spreads in distress countries bonds, while they did not affect yields of highly rated euro area sovereign debts. Main equity prices were positively affected all around euro area.

As the euro area sovereign debt crisis re-intensification in mid-2011 the ECB first re-activated SMP program and later replaced it with a new program, outright-monetary-transactions (OMT). Under OMT the ECB was allowed to purchase unlimited quantity of sovereign bonds. OMT again lowered the yield spreads for countries in distress, while the highly rated euro area countries yields were largely unaffected. The announcement of the program was sufficient to calm the markets even though no purchases were made. The introduction of 12-month SLTROs and 3-year VLTROs had a positive impact on yields and equity prices across the euro area.

Although, there is evidence that the unconventional operations have, to some extent, achieved their objectives they are not yet fully understood. Only when the central banks have effectively returned to conventional methods the unconventional operations can be comprehensively estimated. The transmission mechanism from unconventional operations to asset prices and expectations remain at least partially unclear and as a subject of debate. Also the importance of forward guidance cannot be underestimated especially related to exit strategies and using it together with large-scale asset purchases. Above mentioned subjects are for future research.

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