THE IMPACT OF UNCONVENTIONAL MONETARY POLICY ON FINANCIAL MARKETS, CREDIT MARKETS AND FINANCIAL STABILITY

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ABSTRACT

In response to the 2008 financial crisis, the Federal Reserve initially responded by reducing the federal funds rate. However, by December 2008 this rate had reached the zero lower bound (ZLB). With economic conditions still deteriorating, the Federal Reserve used unconventional monetary policy in the form of Large-Scale Asset Purchases (LSAPs) to rescue financial institutions and lower a range of long-term interest rates. The intention was to stimulate economic activity and promote recovery. The purpose of this dissertation is to analyze the effects of LSAPs from three perspectives. First, we evaluate how LSAPS impacted financial markets; second, we determine how they impacted credit markets; and lastly, we evaluate how they impacted the Federal Reserve and banks' balance sheets. In the second chapter we find that LSAPs had a positive effect on the stock prices of some financial sectors, such as primary dealers, commercial banks and broker dealers. However, the effects were not as statistically significant for nonfinancial sectors, such as construction, real estate and auto manufacturing. In the third chapter, using an ARDL methodology, we find that lower long-term interest rates

helped boost consumer and mortgage credit markets but not business credit. Despite some improvements in credit market conditions, the results show that given the size of LSAPs the effects were relatively weak. In the fourth chapter we document how the composition of the Federal Reserve and banks' balance sheets changed as a result of LSAPs. It is clear that most of the liquidity injections remained as excess reserves, though we find an upper bound on how much of these injections went into new loans and deposits relative to cash or excess reserves or a cash-like assets. We discuss alternative ways that LSAPs could have mattered, such as through rebuilding banks' balance sheets. Even though the liquidity injections may not be able to stimulate economic recovery they may help rebuilt and strengthen financial institutions. Restoring financial stability was beneficial for avoiding a complete collapse of systemically important financial institutions.

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INTRODUCTION

1.1 Introduction

The "Great Recession" that started in December 2007 and ended in June 2009 was sparked by a global financial crisis that was the most severe since the Great Depression (Stiglitz, 2010; Reinhart and Rogoff, 2008). It was caused in particular by excessive leverage, widespread trading of risky security instruments between financial institutions, and an increased willingness of lenders to assume risk, ultimately leading to the burst of a housing bubble due to reckless lending by certain institutions.

Following excessive risk taking by global financial institutions and the subsequent meltdown in the US subprime mortgage market, the US financial market was paralyzed by uncertainty (Astley et al., 2009; Covitz et al., 2013). The economic climate worsened when primary dealer Lehman Brothers collapsed, further shaking the confidence in the integrity of the financial system and leading to substantial increases in interest rate spreads (Taylor, 2009; Mishkin, 2011a). As a result of the instability in the financial system and sharp increase in risk aversion, stock prices collapsed (Watkins, 2014) and credit availability froze (Lenza et al., 2010) during that period. The difficulties experienced by major US financial institutions soon spread to the wider economy. The

consequence was a severe decrease in economic growth and an increase in unemployment unparalleled since the Great Depression (Astley et al., 2009). Indeed, the unprecedented "credit crunch" left many major financial institutions unable to raise funds for their own operations, to lend to other commercial banks and to extend financing to industries and households. In the face of this liquidity crisis, the risk of collapse of the US financial sector threatened devastating consequences both at home and abroad.

The financial paralysis and the economic woes caused by the 2007 financial crisis led to a decrease in demand and a decrease of the inflation rate below the Federal Reserve's target. These decreases led the Federal Reserve to act with the intention of ensuring financial stability at least in the short run, and of restoring economic growth (Gagnon et al., 2010) as well as employment in the long run. The initial response by the Federal Reserve relied on a conventional monetary policy by cutting short-term interest rates in an effort to stimulate borrowing, investment and spending (Taylor, 2009).

The federal funds rate is one of the most influential short-term interest rates in the US economy. It affects monetary and financial conditions, which in turn have significant impacts on the broader economy.[1] With the federal funds rate approaching the zero lower bound (ZLB), monetary authorities could not lower it further. As the crisis worsened, concerns arose regarding the effectiveness of monetary policy in such an economic context. When the interest rate reaches the ZLB, money and bonds become perfect substitutes. As a result, people prefer to hold money and consequently monetary injections by the Federal Reserve will be hoarded and will not stimulate spending and investment. Some economists described such a situation as a "liquidity trap" also called it

[1]Definition from Investopedia: Federal Reserve Funds Rate, `http://www.investopedia.com/terms/f/FederalReservefundsrate.asp`.

"liquidity hoarding," and explained why in such a situation the traditional monetary policy actions taken by the central bank may become ineffective at fighting recessions (Krugman, 2000).

While some economists believe that a liquidity trap can occur and this limits the potency of monetary policy, others have argued that the constraint imposed by the ZLB can be overcome. One of the instruments that can be used by monetary authorities when the interest rate is at the ZLB is the purchase of long-term assets in order to decrease long-term interest rates and boost asset prices therefore increasing liquidity in the short run (Gagnon et al., 2011). Even before the crisis, policymakers argued that monetary policy could remain effective even at the ZLB (Hancock and Passmore, 2011). The argument was that the central bank can purchase a wide variety of assets through open-market operations (King, 1999; Bernanke, 2002), hence the transactions do not have to be limited to short-term government securities.

Empirically, other tools to enhance the potency of monetary policy, were explored taking into account the lessons learned from the Japanese deflationary experience from 1990 to 2006. These included zero interest rate commitments, quantitative easing and asset purchase programs or credit easing (Bernanke et al., 2004). In the United States, the Federal Reserve selected large scale asset purchases (LSAPs) as the unconventional monetary policy tool of choice for combatting the prolonged consequences of the financial crisis and the ineffectiveness of the traditional monetary policy instruments. Note that LSAPs are more commonly referred to as Quantitative Easing (QE) in the US. However, unlike "pure quantitative easing," LSAPs are not only an expansion of the central bank's balance sheet it is also a change in its composition and structure.

1.2 Monetary Policy when the Short-Term Interest Rate is at the ZLB

1.2.1 The Unconventional Monetary Policy Debate

The traditional interest rate channel is the standard transmission mechanism described by the ISLM model (Mishkin, 1996). According to this channel, expansionary monetary policy will lead to a decrease in real interest rates, which in turn lowers the cost of capital and therefore leads to an increase in investment spending by both businesses and households, which will cause output to rise. In the textbook description, if interest rates reach the zero-lower bound then money and bonds become perfect substitutes and thus monetary policy is no longer effective because expansionary monetary policy will not stimulate demand (Auerbach and Obstfeld, 2005). This view of monetary policy in a liquidity trap has been subject to much debate.

In the recent context of LSAPs, some economists described an alternative view. They believe that the Federal Reserve can target long-term interest rates by purchasing assets with longer maturities. Essentially, by changing the supply of these assets the Federal Reserve can have a direct effect on their yields (Gagnon et al., 2010).

As a result, monetary policy can cause changes in the money supply through the purchase of a wider variety of assets, which will lead to changes in portfolio behavior and in turn to changes in relative asset prices across a spectrum of assets, and this will cause an increase in demand and output (D'Amico et al., 2012). Supporters of the recent unconventional monetary actions (Bernanke, 2012; Yellen, 2014) assumed that monetary policy can still be effective at the ZLB because it can purchase assets other than short-term, government securities to stimulate liquidity and to trigger the portfolio

rebalancing channel (more detail on this channel in the next section). Indeed, LSAPs were intended to reduce long-term interest rate and therefore boost the demand for assets as well as goods and services that depend on these interest rates.

Other economists have expressed some skepticism regarding the effectiveness of unconventional monetary policy. They describe the interest rate as exogenous and the money supply as endogenous (that is, interest rates determine the money supply)(Lavoie, 2004). Moreover, these economists believe that modern financial systems are credit based. This means that banks accommodate all creditworthy borrowers, and it is the equilibrium interest rate in the credit market that determines the money supply, therefore the money supply is endogenous. The central bank can alter the interest rate, which is exogenous, to increase or decrease the equilibrium level of loans and therefore the money supply. In addition, some economists believe that agents are guided by "animal spirits" and make decisions under conditions of uncertainty about the future. Animal spirits or expectations guide decisions of economic agents who may not respond as the central bank expected if they anticipate poor economic conditions in the future.

The idea that expectations play a role in the response of households and businesses to policy announcements means that even if the central bank increases liquidity it may not necessarily lead to increased bank lending. This is especially true when economic recovery is sluggish and the economic downturn prolonged (Rochon and Rossi, 2010). Hence, during economic downturns, characterized for example by low investment and difficult access to credit, long-lasting liquidity trap may emerge (Palacio-Vera, 2010). According to these economists, considerable fiscal policy measures are required to overcome a liquidity trap, otherwise the economy may remain in a liquidity trap for long periods (Rochon and Rossi, 2010).

1.2.2 Transmission Channels of Monetary Policy at the ZLB

The literature on unconventional monetary policy usually describes three transmission channels of monetary policy:

1. The Broad Portfolio Rebalancing Channel
2. The Interest Rate Channel
3. The Signaling Channel

The broad portfolio rebalancing channel works through the impact of central bank operations on the composition of private sector portfolios (Borio and Disyatat, 2010). This channel relies on the assumption that assets are imperfect substitutes, which means that the sellers of the assets will choose to rebalance their portfolios by purchasing assets with similar characteristics to the ones they sold . Therefore if the central bank changes the relative supply of certain assets, it will trigger investors to change the composition of their portfolio and alter their behavior (Gagnon et al., 2010).

The portfolio balance channel is normally associated with the work of Tobin (Tobin, 1961; Tobin and Brainard, 1963; Tobin, 1969), who showed how changes in asset supplies lead to changes in financial asset prices when there is imperfect substitutability between financial assets (Joyce et al., 2011). These ideas were later picked up by other authors (Brunner and Meltzer, 1973; Friedman and Schwartz, 1963). The portfolio rebalance channel has several implications. First the prices and yields of the assets purchased by the central bank will be affected and second, due to the rebalancing process, a larger range of assets will also see their prices and yields change.

The mechanisms underlying the portfolio rebalance theory are the scarcity channel

and the duration channel (See Theoretical Framework of Chapter 1). By purchasing large volumes of assets from its counterparties, the Federal Reserve hopes to trigger the portfolio rebalancing process described above. This process is thought to boost economic activity by spreading over to the yields of a range of assets. Indeed, changes in relative yields of purchased assets cause investors to shift their holdings towards close substitutes searching for higher prospective returns. These effects spread across the yield curve through increases in the prices of long-term assets and bonds held by financial intermediaries, which also causes a wealth effect. Moreover, the purchases of long-term securities affect financial conditions by reducing borrowing costs. Both effects reinforce each other to stimulate the economy (Jouvanceau, 2016).

The second channel is the interest rate channel. This channel has traditionally been separated into two separate channels: the balance sheet channel and the bank lending channel (Bernanke and Gertler, 1995). The balance sheet channel describes how interest rate changes induced by the Federal Reserve lead to changes in the interest rate burden on households and firms and therefore alters their net worth, causing a change in their ability to spend and borrow. The changes to spending in turn affect aggregate demand and output (Bernanke and Blinder, 1988). For example, in the case of expansionary monetary policy, the Federal Reserve decreases the interest rate which alleviates the interest rate burden on borrowers and therefore increases their net worth, allowing them to increase borrowing and/or spending which will boost aggregate demand. The bank lending channel focuses on how changes in interest rates induced by the Federal Reserve lead to changes in the supply of loans by the banking sector to bank-dependent borrowers (Kashyap and Stein, 1994). For example, expansionary monetary policy would reduce the opportunity cost of holding deposits, which increases the availability of funding sources, causing banks to increase lending (Gambacorta and Marques-Ibanez, 2011). This channel is especially relevant in the case of the US, where the Federal Reserve did not practice

"pure quantitative easing." Quantitative easing usually refers to purchases by the central bank of government securities, in order to alter the size of the central bank's balance sheet. LSAPs on the other hand also included a change in the composition of the Federal Reserve's balance sheet in order to stimulate credit markets. For this reason, Bernanke (2009) coined the term "credit easing" to describe the case of the US and the range of lending programs and securities purchases undertaken the by the Federal Reserve (Borio and Disyatat, 2010).

Considering that US credit markets became frozen in 2008, the Federal Reserve had to try to design policies that could ease the crunch and provide support to systemically important financial institutions and mortgage markets. Two sectors were specifically targeted. The first was the non-bank sector. Following the collapse of Lehman Brothers, it became apparent that other large and systemically important financial institutions were facing severe difficulties. As a result, the Federal Reserve focused on alleviating the tightening credit conditions by supplying them with funds through new discount windows and accepting a wider range of collateral (Borio and Disyatat, 2010). The second sector targeted by the Federal Reserve was the mortgage market. In order to provide support to mortgage lending and housing markets, the Federal Reserve bought mortgage-backed securities backed by Government Sponsored Entreprises (GSEs) (Borio and Disyatat, 2010). The goal of these purchases was the reduce the cost of mortgage related credit and to increase the availability of credit intended to purchase homes.

The last channel is the signaling channel. Although this dissertation does not test for the signaling channel, it is important to note that the description of this channel relies on the idea that animal spirits and expectations are important determinants of the effectiveness of monetary policy. This channel places much importance on the communications or announcements of future operations made by the central bank (Joyce

et al., 2011). Communication by the central bank regarding the operations it plans to undertake can play an important role in the transmission of monetary policy. They can influence public expectations about key factors that influence the market valuation of an asset (Meier, 2009). The factors include the relative scarcities of different assets, the expectations about the future course of monetary policy and the risk and liquidity profile of certain assets. If the central bank has credibility, it can use it to influence the decisions made by economic agents so they can support the policy decisions of the central bank. However, even if the Federal Reserve injects liquidity into the balance sheets of it counterparties, there is no guarantee that these funds in turn will increase lending, especially if the economic outlook appears glum. The central bank can use signaling as a "coordinating device for market expectations" (Borio and Disyatat, 2010). Unfortunately, only a few studies have looked at the effectiveness of signaling at the zero lower bound (Chehal and Trehan, 2009; Williams, 2011).

1.2.3 Contribution to the Debate on Unconventional Monetary Policy

This dissertation will test two of the transmission channels. In chapter 2, using the portfolio rebalance channel, we will test whether or not the large-scale asset purchases undertaken by the central bank increased stock prices. Specifically using an event study, the abnormal returns of several sectors[2] are computed to evaluate whether or not LSAP announcements caused stock prices to increase. If the findings indicate that LSAPs did increase stock prices then the notion of liquidity trap does not necessarily render monetary policy ineffective.

In chapter 3, using the interest rate channel, we will test whether or not the unconventional monetary policy actions undertaken by the Federal Reserve eased credit

[2]The sectors that were selected were among the Federal Reserve's targets.

market conditions. There exists a large body of literature on the impact of LSAPs on long-term interest rate. Most studies find that LSAPs did succeed in lowering long-term interest rates (Hancock and Passmore, 2011; Swanson, 2011; Neely, 2015; Gagnon et al., 2011). This chapter goes one step further by examining whether or not the decrease in long-term interest rates caused credit to increase as the Federal Reserve and theory dictate. Evidence in favor of the interest rate channel would again indicate that there are policies the Federal Reserve could use even when the short-term interest rate is near the zero lower bound.

In chapter 4, analyzing the balance sheets of the Federal Reserve and financial institutions, we will identify whether or not the liquidity injections from LSAPs reached the broader economy. If we find that banks held on to the liquidity injections this would indicate that LSAPs could not have promoted credit as the funds remained on the balance sheets of banks. Such a finding would confirm some of the skepticism regarding LSAPs. The central bank can inject liquidity through open-market operations but it cannot control how the liquidity is used by banks. If there are no creditworthy lending opportunities or if credit demand is weak due to poor economic conditions then financial institutions will hold on to the funds and they will not reach the broader economy.

1.3 The Pre-Crisis Era

1.3.1 The Rise of the Shadow Banking System

The recent financial crisis highlighted the growing and key role played by the shadow banking sector for the functioning of the economy. This sector performs the function of efficiently channeling funds to individuals or corporations with worthy investment opportunities by collecting and processing information and funds (Mishkin, 2008). Before

we elaborate on the role and development of the shadow banking sector, it is useful to start with a presentation of the functioning of the US financial system in the years leading up to the crisis in order to understand the position of shadow banks in the system.

Traditionally, under the standard banking system, most of the financial intermediation is performed by banks who obtain funds from lenders (savers) in the form of deposits and redistribute a fraction of their deposits to borrowers in the form of loans (Noeth and Sengupta, 2011). In this bank-based model banks' functions such as credit intermediation and liquidity transformation are performed without recourse to capital or money markets acting as intermediaries. However, since the 1980s with the rise of financial market deregulation and financial innovation, the standard financial model of originate-and-hold has become one of originate-repackage-and-distribute, also called securitization.

Securitization refers to the practice of parcelling and selling loans to investors. The first step is to form diversified portfolios of mortgages and other types of loans, corporate bonds, and other assets like credit card receivables. The next step is to slice these portfolios into different tranches. These tranches are then sold to investor groups with different appetites for risk (Brunnermeier, 2009). Securitization is intended to disperse risks associated with bank lending so that deep-pocketed investors who were better able to absorb losses would share the risks. But in reality, securitization worked to concentrate risks in the banking sector (Adrian and Shin, 2010c). The popularity of securitization stemmed from the general idea that the use of specialized intermediaries would improve the flow of financial information and thus make the financial system more transparent without increasing costs. Moreover, securitization implies shifting loans from banks' balance sheets to the capital markets. This not only reduces the level of risk of a bank's balance sheet, but also frees up bank capital to create more loans (Crotty, 2009).

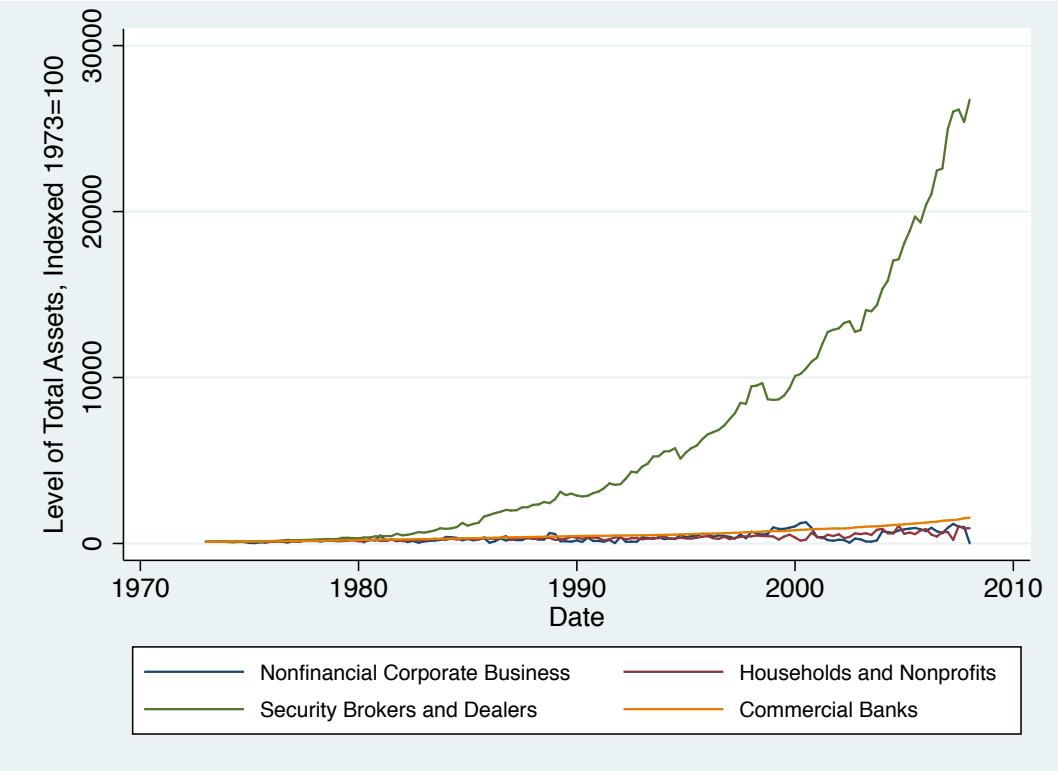

Figure 1.1. Growth of Assets of Four Sectors in the US

Figure 1.1 charts the total assets of four sectors in the United States:the household sector, the nonfinancial corporate sector, the commercial banking sector, and the security broker-dealer sector. The assets have been indexed to January 1973. We see that the rapid increase in the securities sector began around 1980, at the same time as the takeoff in the securitization of residential mortgages. This is an indication that the traditional banking system (such as commercial banks) was not growing as fast as the market-based system (such as broker dealers) that can use capital markets to conduct their operations off their balance sheets, thereby freeing more capital to extend credit. The data is from the U.S. Flow of Funds from the Federal Reserve.

In this new market-based model, banks can use capital markets to conduct operations off their balance sheets, thereby freeing more capital to extend credit while complying formally with, but effectively circumventing, banking regulations. Ultimately, the new banking model implied that many bank operations, usually conducted on banks' balance sheets were increasingly occurring in capital markets to the extent banks no longer held-on to the loans they originated but traded them on the capital markets. From Figure 1.1 it is apparent that the market-based system became more important starting in the 1980s. Since early 1990s the growth of assets of the security broker dealers sector has been much greater than that of households, the commercial banks and

the non-financial corporate sector because they were more actively involved in securitization. Within the market-based financial system, shadow banks have served a critical role (Adrian and Boesky, 2012). Since the early 1990s, the shadow banking system has become larger than the traditional banking system. It was largest in 2008, which marked the peak in the financial crisis.

The justification behind this market-based bank model is that a securitization-based credit intermediation process has the potential to increase the efficiency of credit intermediation (Adrian and Boesky, 2012). The reason is that securitization reduces the cost of credit creation by relying on more specialized intermediaries. Under the new model, the processes of credit creation and liquidity transformation were no longer performed only by banks (as in the bank-based model), but instead they were performed through a chain of specialized non-bank financial intermediaries, in multiple steps. Together these multiple financial intermediaries make-up the shadow banking system. Formally, shadow banks are defined as "financial intermediaries that conduct functions of banking without access to central bank liquidity or public sector guarantees" (Adrian and Shin, 2010c). A more complete definition is provided by Deloitte Center for Financial Services (2013), which calls them "a market-funded, credit intermediation system involving maturity and/or liquidity transformation through securitization and secured-funding mechanisms. It exists at least partly outside of the traditional banking system and does not have government guarantees in the form of insurance or access to the central bank." This definition makes apparent the role in securitization in modern financial systems. The shadow banking system refers to unregulated activities by regulated institutions.[3] In addition, the rise of the shadow banking system had some implications for the conduct of monetary policy. The Federal Reserve had to purchase a new type of asset, that is the

[3]The definition is provided by Investopedia at `http://www.investopedia.com/terms/s/shadow-banking-system.asp`.

purchase of reverse repurchase agreements to influence the overnight interest rates in the shadow banking system which used repurchase agreements to fund its assets (Ratnovski and Claessens, 2014).

1.3.2 The Rise in Securitization

In order to understand why the rise of securitization was one of the triggers of the 2007 financial crisis, it is important to note that most of the securitization process was conducted by the unregulated shadow banking system. A brief description of the sequential steps performed by each specific type of shadow bank and the specific funding technique they use is given below:[4]

1. Loan Origination, such as for auto loans, student loans, mortgages and other loans, is originated by regulated commercial banks and unregulated financial firms.

2. Loan warehousing and pooling are conducted by a warehouse bank that acts as an aggregator by buying loans from one or more originators and then pooling the loans.

3. The pooled loans are then sold to an administrator, usually a subsidiary of a large commercial or investment bank, which creates a special purpose vehicle (SPV) to hold the loans.

4. The SPV issues securities against loans held in its portfolio.

5. The securities issued by the SPV are then sold by an investment bank.

6. Investors purchase the securities.

[4]This description is from "Shadow Banking". Pozsar et al.(2012).

Through this process of credit intermediation, shadow banks are able to transform risky, long-term instruments (e.g. subprime mortgages) into seemingly less risky short-term, bond-like instruments without following the regulations that traditional commercial banks are subject to. For banks to expand their balance sheets they must find new borrowers. Initially, the pool of borrowers is made-up of "prime borrowers."[5] However, after banks have used the potential of all their resources to meet the credit demands of these borrowers, if they want to expand further their balance sheet and profit, they need to mobilize additional resources to fund their operations and allow them to offer credit to additional borrowers. This is what the securitization process described above does. Once these resources have been made available to the banks, the returns that can be generated from additional lending encourage them to lower their lending standards in order to lend more and reach to "subprime borrowers." As a result of this type of banking model, banks can increase the supply of credit in the economy by augmenting their leverage (Adrian and Shin, 2010a) through borrowing outside the banking system (Adrian and Boesky, 2012).

The rapid rise of securitization as a means of credit intermediation and the extension of loans to risky borrowers set the scene for the 2007 financial crisis. This type of context was described by Minsky's theory of financial crises. He explained that as the economy and the financial system expand, overoptimism increases, and conventions about the appropriate level of debt and risk begin to change (Minsky, 1992). This leads to rising asset prices and increased speculation. As expectations and overconfidence lead to changes in the perception of risk, the financial system becomes increasingly fragile (Minsky, 1977). This lays the foundation for Minsky's financial instability hypothesis.

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[5]A prime borrower is someone who is considered a below-average credit risk. A prime borrower is considered likely to make loan payments on time and likely to repay the loan in full. The definition is from `http://www.investopedia.com/terms/p/prime-borrower.asp`

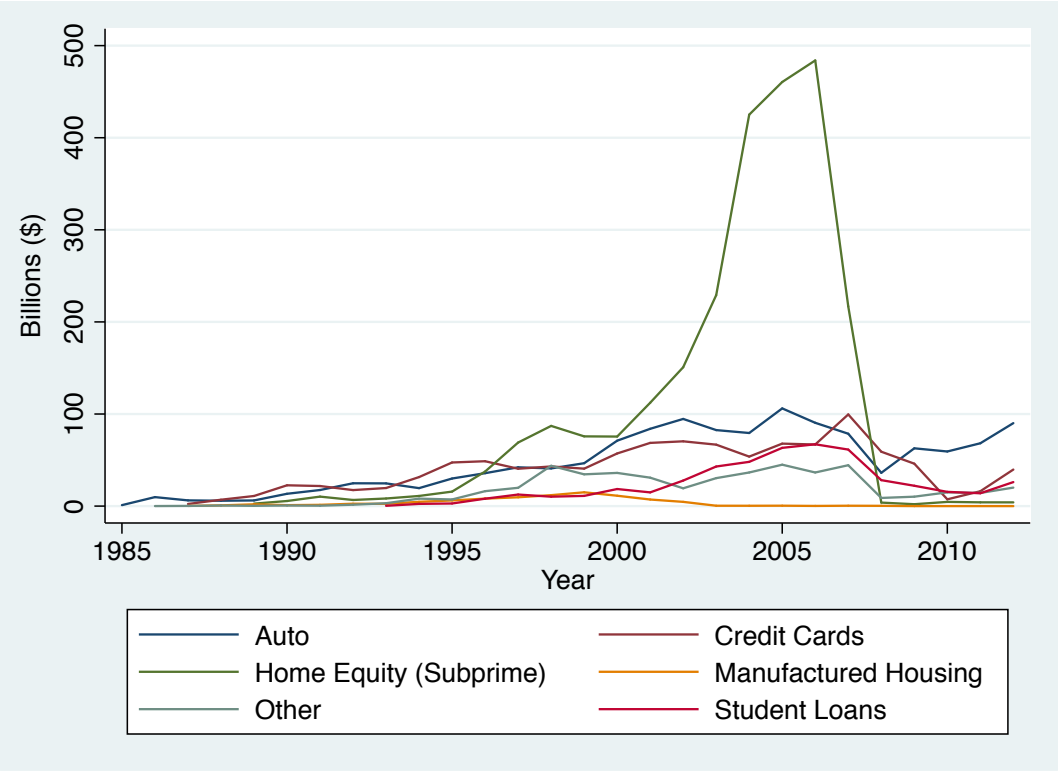

Figure 1.2. New Issuance of Asset Backed Securities from 2000 to 2009.

Figure 1.2 shows the flow of new credit from the issuance of asset backed securities. The most dramatic fall is in subprime mortgages but the credit supply of all categories, ranging from auto loans to student loans also collapsed. This reflects the credit crunch of the 2008 financial crisis that originated in the subprime mortgage market but quickly spread to other sectors. This explains why the crisis became characterized by a credit crunch where all sectors were having difficulty borrowing funds. The data is from Securities Industry and Financial Market Association.

As a stable financial system moves to an unstable system dominated by speculative behavior. Financial instability is therefore described as endogenously generated and developments in the financial sector lead to disruptions in the real economy (Minsky, 1977). This is very similar to what happened in the MBS market during the 2007 financial crisis. According to Figure 1.2, the new issuance of asset backed securities grew rapidly between March 2000 and the summer of 2007. It then declined rapidly as the crisis began. However, more important than the sheer size of the securities sector, is the behavior of the banking sector and how it reacted to shifts in market conditions.

1.3.3 Cheap Credit and the Housing Boom

As was mentioned previously, the rise in popularity of securitized products ultimately led to a flood of cheap credit and a lowering of lending standards. According to the new banking model, banks faced only the risks of holding loans for some months until the risks were passed on, so they had little incentive to carefully approve loans and monitor them (Brunnermeier, 2009). Mortgage brokers offered mortgages "under the premise that background checks are unnecessary because house prices could only rise, and a borrower could thus always refinance a loan using the increased value of the house" (Brunnermeier, 2009).

At this point, the economy entered a positive feedback loop in which increased demand and purchasing power by traditional home buyers and mortgage borrowers fed the increase in securitization and asset bundling, resulting in more loan creation under increasingly aggressive lending terms by financial institutions but with increased risk-taking behavior. Problems began when the persistently low interest rates spurred investors to search for yields, therefore investing in higher-yield assets, while underestimating the additional risk involved with dealing with such assets.[6] This search for yield is at the root of the drastic loosening of lending standards, especially mortgage underwriting standards (Rajan, 2011) that left investors over-exposed and susceptible to major losses in case the risk materialized. This risk was more likely to be realized for investors dealing with mortgage related financial instruments of increasingly poor quality, making these types of assets riskier (Bordo and Meissner, 2012). The increase in home values fueled consumer spending in particular through increasing home equity debt, as easy borrowing and lending in the housing sector spilled to other sectors of the

[6] A reduction in the policy rate boosts asset and collateral values, which in turn can modify bank estimates of probabilities of default and volatilities.

economy and a wider range of loans became easier to access. By this point, the economy was experiencing a positive feedback loop of credit creation and increasing consumption contributing to boost economic activity. For a while it appeared that depression economics was a worry of the past.

By early 2007, signs of a "liquidity bubble" or "credit bubble" became apparent. However, observers were reluctant to bet against the bubble because of the profit opportunities associated with the rise in housing prices. Citigroup's former chief executive officer, Chuck Prince, summed up the situation on July 10, 2007 by referring to Keynes's analogy between bubbles and musical chairs (Nakamoto and Wighton, 2007): "When the music stops, in terms of liquidity, things will be complicated. But as long as the music is playing, you've got to get up and dance. We're still dancing." Loosening credit standards, combined with the vulnerability of banks to liquidity evaporation, ultimately unfolded into the crisis that began in December 2007.

1.3.4 Liquidity and Leverage

Given the credit intermediation process described above and the banks' weakening screening process of borrowers, when the economy entered a downturn, the low-quality loans could either be on the balance sheets of large financial institutions or in special purpose vehicles (SPVs) that they sponsor. This is because the bad loans create low-quality financial instruments as securitization, which involves repackaging loans into securities cannot create securities of better quality than the underlying loans. It is worth noting that although the financing investors will ultimately incur the losses, the large financial intermediaries will see their liquidity evaporate and suffer losses as well. This is because investors will stop purchasing and under-value the toxic assets being sold by financial intermediaries due to a lack of pricing transparency and thus increase

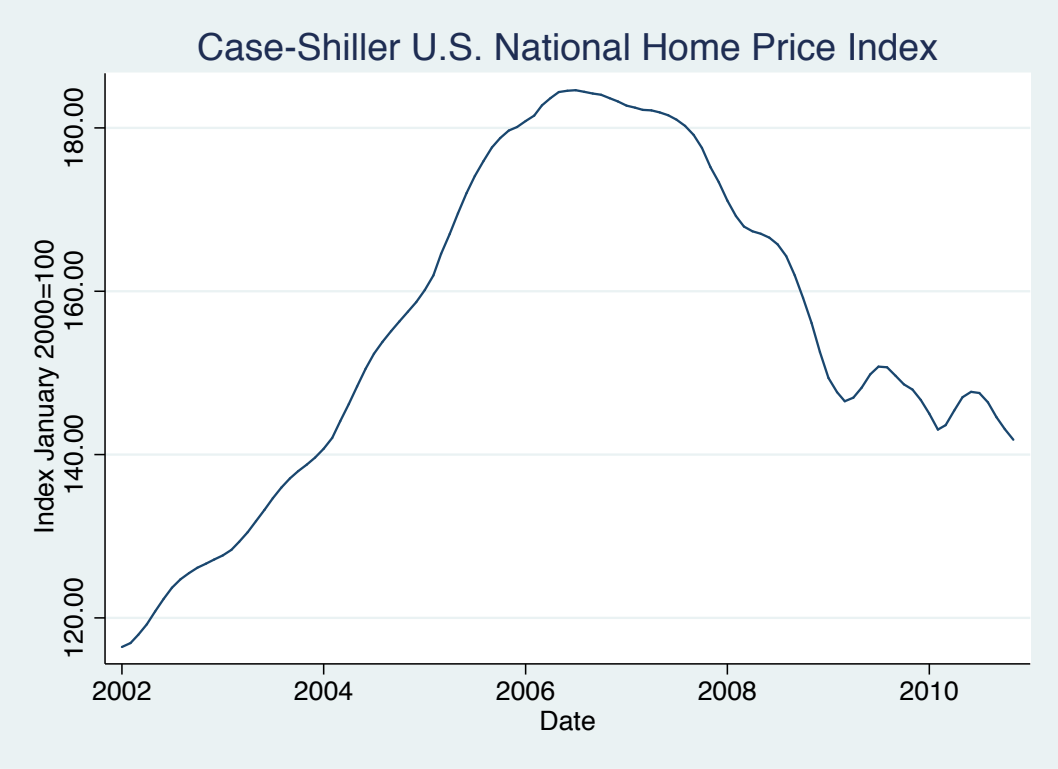

Figure 1.3. Housing Prices

Figure 1.3 plots the Case-Shiller US national home price index. This index tracks house prices in the US. An increase in the index indicates that house prices are increasing and vice-versa. It is apparent that in the years leading up to the crisis house prices we rising dramatically. Not surprisingly they eventually formed a housing bubble that burst and triggered the 2008 financial crisis. The data comes from the S&P Dow Jones Indices LLC.

uncertainty regarding their worth, triggering a downward spiral. This is one explanation behind the severity of the recent financial crisis. The largest losses were experienced by large and systemically important financial institutions (who carried directly or through SPVs a majority of the toxic assets) and this threatened the whole system given the crucial role of the securitization process. It should be noted, however, that during the years preceding the crisis, the frequency and volume of loan defaults especially in the subprime mortgage market, started to cause liquidity to vanish from the system (Adrian and Shin, 2010a) and should have been taken as a forewarning.

The sudden decrease in liquidity caused financial institutions to face higher costs

of borrowing and triggered a sharp swing in in their level of leverage (Adrian and Shin, 2008). Past observations indicate that fluctuations in leverage resulting from shifts in funding conditions are closely associated with periods of financial booms and busts (Adrian and Shin, 2008a). Moreover, the leverage ratio of financial institutions started to increase sharply starting in 2001. Generally, a rise in leverage is associated with the onset of a financial crisis. Financial crises are preceded by marked increases in leverage and are subsequently followed by sharp deleveraging. In the context of the recent financial crisis, the financial institutions' attempts to reduce their leverage caused them to reduce their lending. The decrease in lending caused credit to dry up in capital markets and by the end of summer 2007, the US economy entered a credit crunch.

1.4 The Crisis

Eventually, home prices stalled as credit started to dry up and many households experienced falling real incomes (US Bureau of Economic Analysis). From Figure 1.3, the slow decline in housing prices started in 2006, it accelerated in 2007 and by 2009 housing prices had fallen by over 30% since their peak in 2006. The increase in subprime mortgage defaults was first noted in February 2007. On May 4, 2007, UBS shut down its internal hedge fund because it experienced $125 million of subprime-related losses (Brunnermeier, 2009). Later that month, Moody's announced that more subprime securities were put on "downgrade review," indicating that it was likely these tranches would be downgraded in the near future. This review led to a deterioration of the prices of mortgage-related products. Credit conditions worsened in June and July 2007, as Moody's, Standard & Poor's and Fitch signaled further rating downgrades of other tranches.

As a result of these concerns about securitized instruments and an erosion of confidence in the reliability of ratings, the market for short-term asset-backed commercial

paper began to dry up in July 2007. In August 2007, the French bank BNP Paribas froze redemptions to three investment funds because it could no longer accurately value securitized instruments. Following this event, it became even more apparent that financial institutions were experiencing liquidity problems as money market participants had become reluctant to lend to each other, as reflected in rising interest rate spreads.

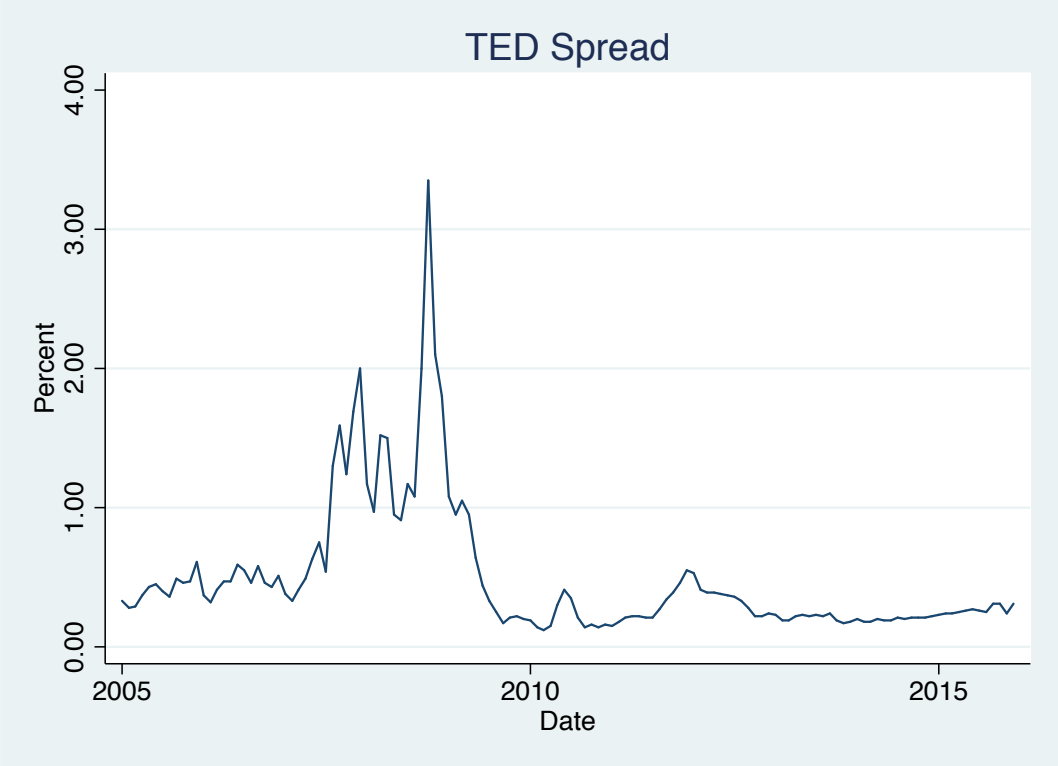

Figure 1.4. TED Spread

Figure 1.4 plots the TED spread. The TED spread is the difference between the interest rates on contracts for Eurodollars and on short-term U.S. Treasury Bill. The Ted spread can be used as an indicator of credit risk. This is because U.S. T-bills are considered risk free while the rate associated with the Eurodollar futures is thought to reflect the credit ratings of corporate borrowers. As the Ted spread increases, default risk is considered to be increasing, and investors will have a preference for safe investments. We can see that the TED spread peaked prior to the recent financial crisis. The source of the data is the Federal Reserve Bank of St.Louis.

The TED spread is presented in Figure 1.4, this spread is the difference between the risky LIBOR rate and the risk-free US Treasury bill rate. In times of uncertainty, banks charge higher interest for unsecured loans, which increases the LIBOR rate (Brunner-

meier, 2009). Moreover, banks value first-rate collateral, which pushes down the Treasury bill rate, a phenomenon called "flight-to-quality." It follows that the TED spread widens in time of liquidity crisis. As we can see in Figure 1.4, the TED spread peaked in September 2008. It started to decrease in December 2008, right after the first round of LSAP (more detail to follow). In addition, various conduits and special purpose vehicles continued to experience downgrades.

As a result, over-leveraged financial institutions, which were mostly made up of the largest financial institutions (mainly primary dealers), became exposed to trillions of dollars in poor quality mortgage-related securities and derivatives positions and began to experience losses due to defaults on subprime mortgages derivatives. These institutions stopped lending and attempted to consolidate their positions by distributing the riskier assets to other financial agents. Since these institutions were major financial players, it was only a matter of time before the credit crunch in the mortgage markets spread to other sectors of the financial market.

As the uncertainty regarding the quality and the value of these mortgage collateralized securities became apparent (Covitz et al., 2013), financial institutions who transacted with these types of assets saw their balance sheets become crippled as a result of the accumulation of these illiquid assets, notably asset-backed securities (Giannone et al., 2012). At this point the positive feedback loop (rising housing prices reducing mortgage loans risk, leading to expansion of mortgage loans, resulting in growing securitization, with more liquidity for the banks, which increased their leverage, and further increasing housing prices, etc.), became a negative one (rising default on mortgage leading to loss of value of derivatives, leading to a dry-up of liquidities which were based on sale of derivatives by the banks, leading to deleveraging and contraction of mortgage credits, leading to a decrease in housing prices, consequently increasing defaults on mortgages).

With increasing bad mortgage debt, falling housing prices, contraction of credit supply to the general economy, and declining economic conditions, spending slowed down and GDP and employment fell dramatically (Bordo, Bordo). Figure 1.2 shows the reversal of the positive feedback loop occurring in 2007.

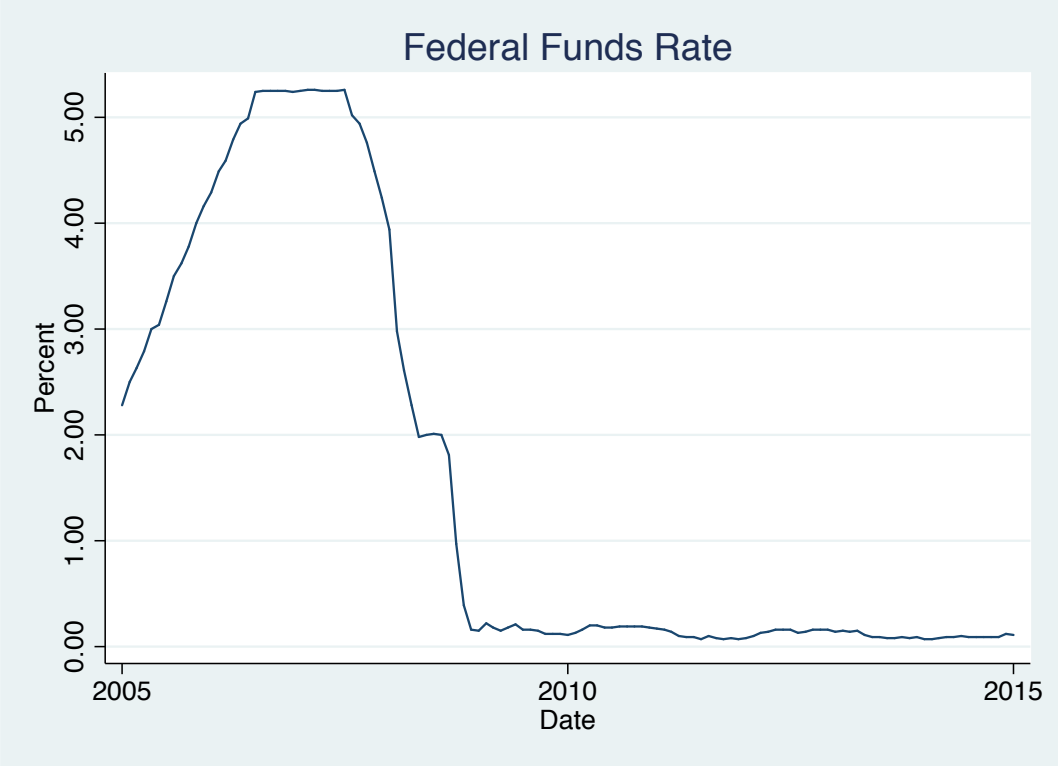

Figure 1.5. Federal Funds Rate

Figure 1.5 plots the Federal funds rate. This is the rate that the Federal Reserve uses to conduct conventional monetary policy. When the Federal Reserve lowers the federal funds rate this signal expansionary monetary policy, when it increases the federal funds rate this translates into contractionary monetary policy. As we can see by late 2008 the federal funds rate had reached the zero lower bound leading the Federal Reserve to start using unconventional monetary policy in order to further ease economic conditions. The data is from the Board of Governors of the Federal Reserve System.

The crisis worsened with the failure and subsequent rescue of investment bank Bear Stearns by JP Morgan in March 2008, shedding light on the apparently contagious fragility of the financial sector. As market activity came to a standstill, it became more apparent that other large financial institutions were at risk of failing. This posed a serious threat for both US and international financial markets, and as a result the Federal

Reserve adopted unconventional monetary policy actions intended to help primary dealer banks restore the liquidity of their illiquid assets on their balance sheets and therefore restore their capacity to extend credit to other institutions and the economy.

1.5 The Response of the Federal Reserve

1.5.1 Conventional Monetary Policy Actions

In order to alleviate the credit crunch (or liquidity crunch) the Federal Reserve first used conventional monetary policy by reducing the federal funds rate. As Figure 1.5 reveals, the first reduction occurred in September 2007: the Federal Reserve lowered the federal funds rate by 50 basis points (Cecchetti et al., 2006). By December 2008, the Federal Reserve had progressively lowered the federal funds rate to a band of 0-0.25% as the economic climate worsened. Such monetary policy actions by the Federal Reserve would traditionally be classified as aggressive. Unfortunately, during the financial crisis conventional monetary policy actions were not enough. As the financial crisis reached its peak in early 2009 the Federal Reserve had already started using large scale asset purchases to rescue financial institutions.

1.5.2 Creating New Discount Windows

In normal times, the Federal Reserve's asset purchases are almost exclusively short-term government bonds and government-sponsored debt. However, the severity of the recent financial crisis triggered by a collapse of the housing market led the Federal Reserve to purchase mortgage backed securities (MBS)[7] as well. The purpose of the

[7]MBS are securitized financial assets as they are bundles of a large number of mortgages together into a pool of which shares are then sold. Owners of the securities receive a share of the payments made by the homeowner who borrowed the funds (Cecchetti et al., 2006).

creation of the new discount windows was to ease liquidity pressures in the "repo market." Specifically, in a repo market transaction, the holder of a security acquires funds by selling that security to another financial market participant with the agreement to repurchase the security at a pre-agreed price on a pre-determined date (Adrian et al., 2009).

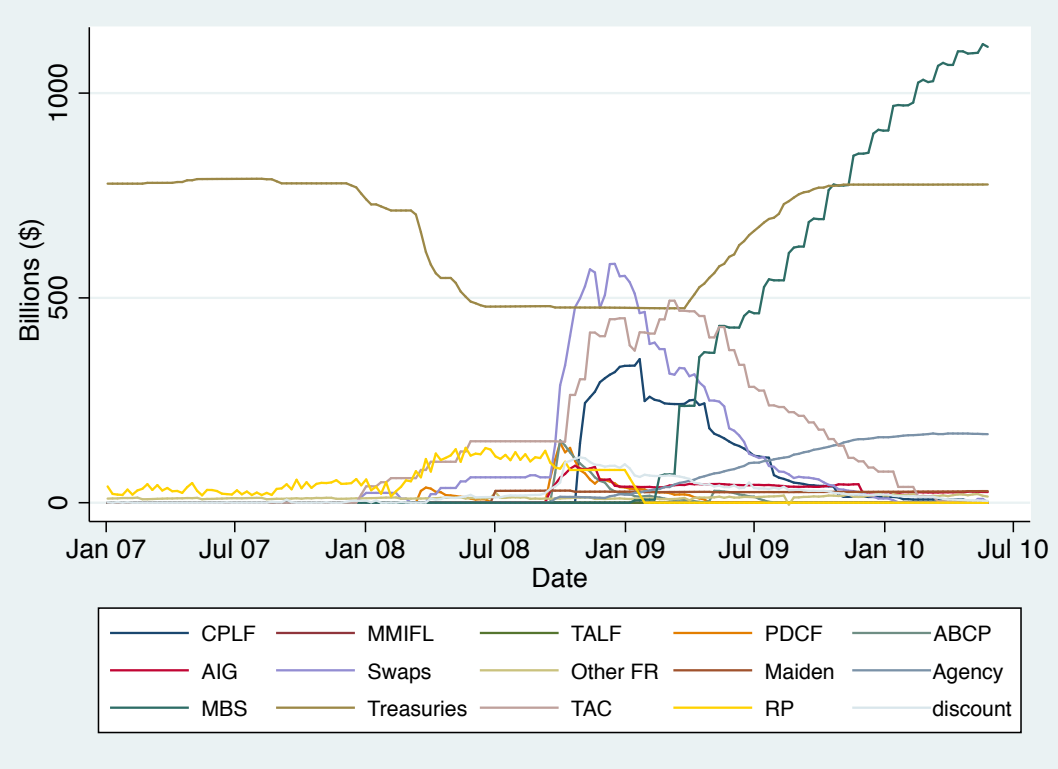

Figure 1.6. Change in Assets of the Federal Reserve

Figure 1.6 shows the Federal Reserve assets, in billions of dollars from Jan 3, 2007 to Aug 4, 2010. The items are the following: Maiden 1: net portfolio holdings of Maiden Lane LLC; MMIFL: net portfolio holdings of LLCs funded through the Money Market Investor Funding Facility; TALF: loans extended through Term Asset-Backed Securities Loan Facility; AIG: sum of credit extended to American International Group, Inc. plus net portfolio holdings of Maiden Lane II and III; ABCP: loans extended to Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility; PDCF: loans extended to primary dealer and other broker-dealer credit; discount: sum of primary credit, secondary credit, and seasonal credit; swaps: central bank liquidity swaps; CPLF: net portfolio holdings of LLCs funded through the Commercial Paper Funding Facility; TAC: term auction credit; RP: repurchase agreements; MBS: mortgage-backed securities held outright; agency: federal agency debt securities held outright, and Treasury currency outstanding; other FR: Other Federal Reserve assets; treasuries: U.S. Treasury securities held outright. The data is from the Federal Reserve's H.4.1 series. As we can see the composition of the Federal Reserve's balance sheet has changed since the start of the Federal Reserve. The Federal Reserve has extended the type of assets on its balance sheet. Prior to the crisis the Federal Reserve held mostly Treasuries. Since the start of LSAPs, the Federal Reserve's balance sheet also holds agency securities and MBS. The choice of assets that the Federal Reserve purchased was based on the sectors that experienced the most difficulty. By removing MBS the Federal Reserve hoped to alleviate the strains in the market for those assets as well as to remove some of the illiquid assets that plagued banks' balance sheets. The data is from the Federal Reserve's H.4.1 series.

In September 2008, Lehman Brothers, a primary dealer, was days away from declaring bankruptcy and the liquidity conditions in the repo market became strained. Lenders were concerned about the riskiness of MBSs amongst other assets and the collapse of Lehman Brothers threatened the viability of other primary dealers who were also major financial players. After the failure of Lehman Brothers, other primary dealers experienced more difficulties in obtaining funding in capital markets as lenders imposed higher haircuts on repos and became more selective in the type of securities they would accept as collateral. Given these constraints, the primary dealers relied on the Federal Reserve as their source of funding.

The Federal Reserve created new lending programs that provided short-term liquidity directly to the private sector (Mishkin, 2009) .[8] Starting in December 2007, the Federal Reserve provided significant amount of liquidity to the largest financial institutions that owned most of the illiquid assets. This new source of funds was injected into the economy through three rounds of LSAPs. The Federal Reserve lending reached $140 million in October 2008 (Adrian and Shin, 2008a). This allowed troubled financial institutions to improve their liquidity and refinance illiquid assets thereby avoiding a "fire sale" of these assets. Some of the new facilities targeted depository institutions and primary dealers directly.[9] Simply forcing banks to dispose of the "toxic" or illiquid assets would have added to the prevailing downward pressure on asset prices, further reducing the amount of private collateral available and further eroding the already weakened capital position of these banks, ultimately destabilizing domestic and international

[8]These new facilities include the Money Market Investor Funding Facility (MMIFF), the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF), the Commercial Paper Funding Facility (CPFF), the Primary Dealer Credit Facility (PDCF), the Term Securities Lending Facility (TSLF), and the temporary liquidity swap arrangements between the Federal Reserve and foreign central bank.

[9]The Federal Reserve was already using the traditional discount window, the additional discount window facilities are: Term Auction Facility (TAF), Primary Dealer Credit Facility (PDCF), and the Term Securities Lending Facility (TSLF).

financial markets (Giannone et al., 2012). As Figure 1.6 shows, lending by the Federal Reserve through the discount windows started to increase after January 2009. However, once the first round of LSAPs occurred, the use of the discount windows stabilized and the Federal Reserve's assets became mostly made up of mortgage backed securities and Treasury securities. In this context the new windows fulfilled one of their main purposes: to provide funding to primary dealers in time of financial disruptions.

1.5.3 Using Large Scale Asset Purchases

In addition to creating new discount windows, in an effort to restore the liquidity of the banking sector and to promote lending by banks, the Federal Reserve used three rounds of LSAPs between 2008 and 2012 to stabilize the financial system and to decrease long-term yields and interest rates (see Figure 1.7). The chronology of LSAPs is as follows: The first round of LSAPs began in November 2008, when the Federal Reserve announced its intention to purchase $100 billion in GSE debt[10] and $500 billion in agency MBS. Later in December 2008, the Federal Reserve chairman Ben Bernanke suggested in a speech, that the Federal Reserve intended to extend LSAPs to Treasuries and expected the Federal Reserve funds rate to stay low "for some time."

This marked a change in policy because so far the Federal Reserve's purchases had been focused on mortgage related securities. By January 2009, the Federal Reserve was ready to expand LSAPs and buy Treasury Bills and in March, the Federal Reserve purchased $300 billion in long-term securities and an additional $750 and $100 billion

[10]GSEs are privately held corporations with public purposes created by the US Congress to reduce the cost of capital for certain borrowing sectors of the economy. Members of these sectors include students, farmers and homeowners. GSEs carry the implicit backing of the U.S. Government, but they are not direct obligations of the U.S. Government. For this reason, these securities will offer a yield premium over Treasuries. Examples of GSEs include: Freddie Mac, Fannie Mae and Ginnie Mae.(Investopedia, `http://www.investopedia.com/terms/g/gse.asp.`

in MBS and GSE debt. In August 2009, the FOMC announced the end of all purchases by the end of October but, in September it declared that the agency debt and MBS purchases would finish by the end of the first quarter of 2010. By November LSAPs had been downsized as agency debt purchases finished at $175 billion. In August 2010, the Federal Reserve announced that it would maintain its balance sheet and reinvest principal payments from LSAPs in Treasuries. This marked the end of what became known as LSAP I.

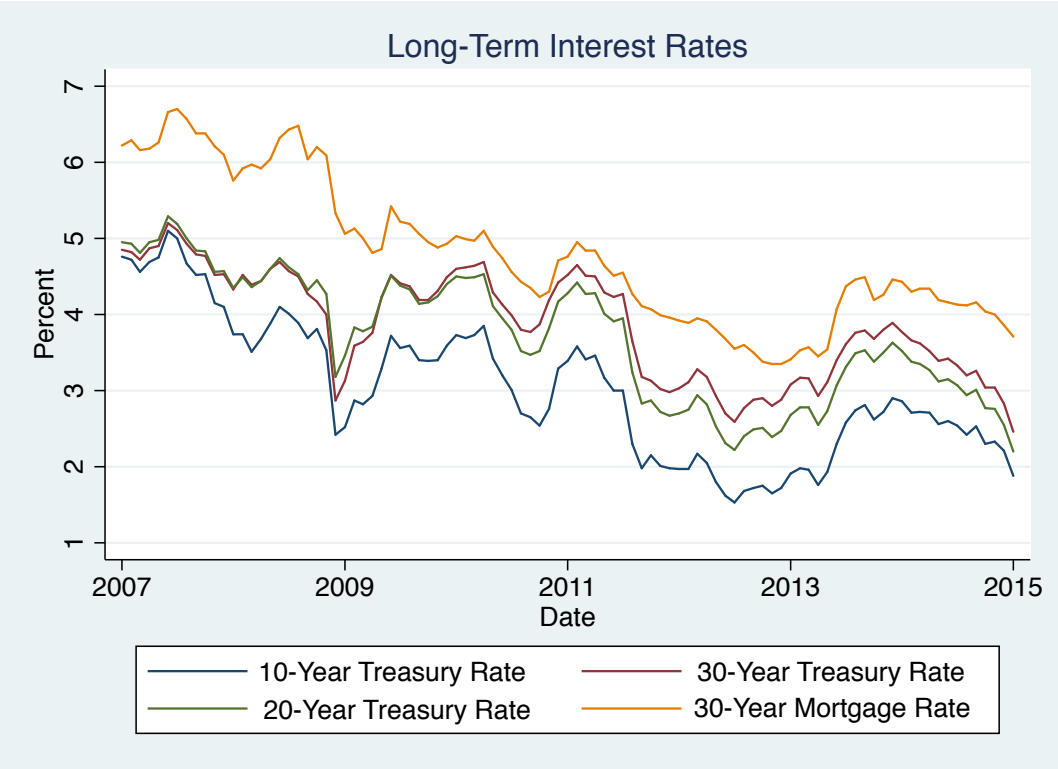

Figure 1.7. Long-Term Interest Rates

Figure 1.7 plots several long-term interest rates including the 30-year conventional mortgage rate. As we can see the Federal Reserve was successful at reducing long-term interest rates through LSAPs. A wide variety on long-term interest rates that the Federal Reserve targeted decreased once LSAP started. This was the goal of LSAP in the hopes of easing economic conditions and promoting recovery. The data is from the Board of Governors of the Federal Reserve System.

Unfortunately, by the second half of 2010, the financial market faced turmoil once again and the economy remained lethargic (Fawley and Neely, 2013). This prompted

a second round of LSAPs that began in August 2010, when Bernanke suggested in a speech the extension of LSAPs "should further action prove necessary." Bernanke reiterated his position in September 2010. Finally in November 2010, a statement by the FOMC announced the Federal Reserve's intention to purchase an additional $600 billion in Treasury Bills. LSAP II was intended to lower the long-term real interest rate and to maintain the level of inflation consistent with the Federal Reserve's mandate. LSAP II ended in June 2011, while the Federal Reserve continued to reinvest principal payments.[11]

Despite this monetary easing, recessionary fears and weaknesses in the financial market re-emerged; this resulted in the Federal Reserve undertaking the Maturity Extension Program and Reinvestment Policy or "Operation Twist" in August 2011. During this program, the Federal Reserve sold $400 billion in short-term Treasury Bills with remaining maturities of 3 years of less while purchasing $400 billion in long-term Treasury Bills with remaining maturities of 6 to 30 years. At the same time, it announced that MBS and agency debt principal payments would no longer be reinvested in Treasury Bills, but instead in MBS. This combination of sales and purchases of assets with different maturities was intended to "twist" the yield curve, by reducing long-term interest rates relative to short-term interest rates, and not to increase the monetary base (Fawley and Neely, 2013). In August 2012, Bernanke acknowledged that "the stagnation of the labor market in particular is a grave concern" and that "the Federal Reserve will provide additional policy accommodation as needed." (Bernanke, 2012). This marked the beginning of LSAP III.

[11]The Federal Reserve reinvested principal payments in order to keep its holdings of securities and preserve the size of its balance sheet and therefore the monetary base.

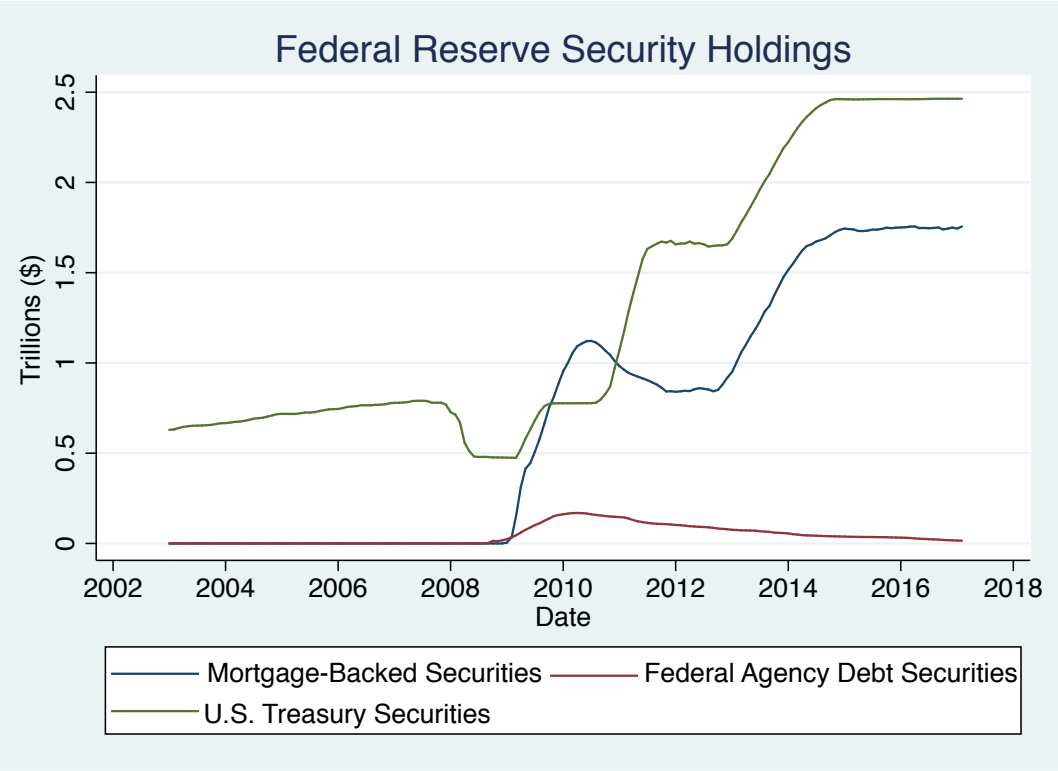

Figure 1.8. Federal Reserve Security Holdings

Figure 1.8 plots the security holdings of the Federal Reserve. While the Federal Reserve used to hold Treasury securities. As a result of LSAPs it now holds a large quantity of mortgage-backed securities and Federal agency securities. The Federal Reserve included these nontraditional assets in its purchases in order to alleviate the credit crunch that stemmed from the subprime mortgage market. The data is from the Board of Governors of the Federal Reserve System.

In August 2012, the third round of LSAPs was officially announced and consisted of an additional monthly purchase of $40 billion of MBS as long as the labor market remained weak. Finally, in December 2012, the Federal Reserve announced the expansion of LSAP III and its intention to purchase $45 billion of long-term Treasury Bills per month. However, it was no longer going to sterilize purchases through the sale of short-term Treasury Bills. Therefore, the purchases made under Operation Twist would continue and the monetary base would expand at the same time. This was the last LSAP action taken by the Federal Reserve. Figure 1.8 and Figure 1.9 show how the composition of the Federal Reserve's balance sheet changed as a result of the three rounds of

LSAPs. Prior to LSAP I, the Federal Reserve did not hold any agency debt securities or mortgage-backed securities. Furthermore, each round of LSAPs is reflected in the step-like increase in the holding of Treasury securities and mortgage-backed securities (see Figure 1.8).

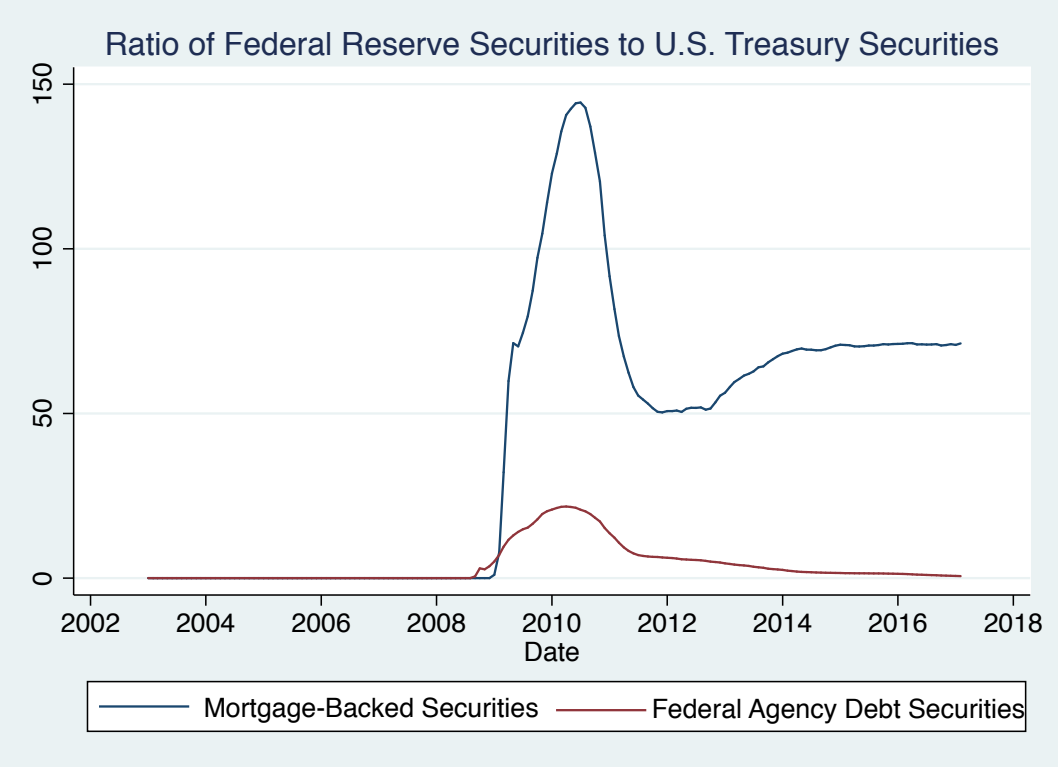

Figure 1.9. Shares of Security Holdings

Figure 1.9 plots the share of mortgage-backed securities and Federal agency debt securities to US Treasuries held by the Federal Reserve. The Federal Reserve held almost exclusively Treasury securities on its balance sheet prior to the crisis. However, since the start of LSAPs, it holds other types of riskier assets. It even held more US mortgage-backed securities than US Treasuries in 2010. This reflects the first round of LSAP. The second round did not include the purchase of mortgage-backed securities and agency debt but the later spike in 2012 reflects LSAP3 which was open ended and did include the purchase of mortgage-backed securities. The data is from the Board of Governors of the Federal Reserve System.

The above discussion reveals that LSAPs in general were first concerned with rescuing financial institutions and later on concerned with lowering long-term interest rates, through changes in the composition and size of the Federal Reserve's balance sheet, in an effort to promote lending and restore "normal" banking operations, including financial

intermediation. As Figure 1.7 indicates, long-term interest rates did decrease including the 30-year conventional mortgage rate. The greater availability of bank liquidity with lower rates should theoretically boost aggregate demand and therefore employment, which should encourage economic recovery as it is widely recognized that increases in bank lending to the private sector will boost economic growth in the years that follow (Takáts and Upper, 2013). According to a recent dataset released by the Bank of International Settlements on credit to the private non-financial sector,[12] household credit as a share of GDP increased faster than corporate credit and became a larger component of total credit to the non-financial private sector than corporate credit in the early 1990s. In the 1980s, household credit was about 45% of GDP while corporate credit was about 50 percent of GDP. By the mid-2000s, household credit was over 90 percent of GDP and corporate credit 80 percent of GDP. However, following their peak in early 2008, credit as a share of GDP significantly decreased for both households and corporations, with households experiencing the sharpest drop. More recently, credit appears to bounce back but the percentage of credit as a share of GDP remains well below its pre-recession level. Whether or not LSAPs helped alleviate the credit crunch by increasing lending or by slowing the fall in lending is a question that remains to be explored.

1.5.4 Why Were The Monetary Policy Actions of The Federal Reserve Labelled "Unconventional"?

The monetary policy actions described above were deemed unconventional because the counterparties and the policy instruments used by the Federal Reserve were unprecedented. Unlike in normal times, liquidity was provided against a much wider range of collateral and to a broader set of counterparties. It was after the failure of primary

[12]The data and its description can be found at `www.bis.org/statistics/credtopriv.htm`

dealer Lehman Brothers,[13] in September 2008, that the Federal Reserve created a standing credit facility for its primary dealers, in order to exert additional downward pressure on long-term interest rates. This represented an unconventional policy decision as the Federal Reserve traditionally implemented its monetary policy decisions through specific banking sector counterparties.

Moreover, expanding its set of counterparties to include institutions that carried most of the bad mortgage debt on their balance sheets meant that the Federal Reserve was targeting a specific segment of the economy, where the crisis originated. Traditionally, monetary policy has not been implemented with a specific segment of the economy in mind. However, the economic climate of the Great Recession and sluggish recovery were far from traditional and therefore the central bank expanded its set of counterparties to include investment banks or non-commercial banks. The hope was that by alleviating the burden on large financial institutions and bypassing the damaged banking sector, the Federal Reserve could help speed up the recovery by improving liquidity conditions. Such a divergence from conventional monetary policy was necessary in the context of the recent US experience as the financial sector including the banking sector had slowly been changing since the mid-1980s.

Although lending to financial institutions and providing liquidity to important credit markets may be perceived as consistent with the Federal Reserve Reserve's role to act as a "lender of last resort" or market maker, the LSAPs on the other hand were far from conventional. They not only targeted a reduction of interest rates along a wider range of maturities to stimulate economic activity (Roache and Rousset, 2013), but also

[13]Bernanke (2012) argued that Lehman was allowed to fail because it was less exposed to counterparty risk and the Federal Reserve lacked the legal authority to rescue it.

provided liquidity to a wider range of central bank counterparties that had not traditionally transacted with the Federal Reserve (Lenza et al., 2010).

1.6 Dissertation Essays

LSAPs had several goals: to avoid the collapse of the financial sector and to restore households and businesses' access to credit in order to stimulate demand, growth and ultimately, employment (Yellen, 2014). Given the economic context during the recent crisis and during the prolonged recovery, when the Federal Reserve was focused on large-scale asset purchases and deployed unconventional monetary policy instruments and considering how unprecedented the use of these instruments was, the purpose of our research will be to:

1. Determine if LSAPs favored primary dealer stock prices relative to average shareholders and other economic sectors.

2. Analyze how LSAPs impacted the demand for different types of credit.

3. Establish how LSAPs affected the balance sheet of the Federal Reserve and financial institutions in order to determine if they reached the broader economy.

The second chapter of this dissertation will focus on the relationship between LSAPs and stock prices. Specifically, this essay will test if LSAPs benefitted the stock prices of primary dealers and of other sectors in the economy such as construction, real estate and commercial banks. The value added of this essay is that first, it will provide evidence regarding the potency of monetary policy on stock prices at the zero-lower bound. Second, it will establish the relative benefits experienced by different sectors of the economy as a result of LSAPs. Consequently, we will establish if Federal Reserve counterparties

benefitted more compared to other sectors. If we find that the counterparties benefited more than the rest of the economy this would indicate that LSAPs may have been more effective to stabilize large financial institutions rather than economic growth.

The third chapter of this dissertation will focus on the relationship between LSAPs and credit markets. Specifically, this essay will test if the decrease in long-term interest rates triggered by LSAPs impacted credit markets in the way described by policymakers. The value added of this essay is that first, it will provide evidence regarding the potency of monetary policy on credit markets at the zero lower bound. Second, it moves beyond the impact of LSAPs on long-term interest rates by analyzing how LSAPs affected consumer, mortgage and business credit.

The fourth chapter of this dissertation will focus on the impact of LSAPs on the Federal Reserve's balance sheet and on banks' balance sheets. This chapter will focus on tracing the liquidity injections into the balance sheet of the Federal Reserve and financial institutions. The value added of this chapter is that first if we find that most of the liquidity injections were kept on the balance sheet of financial institutions or in the form of excess reserves then it is unlikely that LSAPs could have had a large impact on the broader economy. Second, it will also allow us to evaluate if LSAPs allowed the crippled financial institutions to rebuilt their balance sheets and hopefully become more stable. This could reveal another channel of unconventional monetary policy through banks' balance sheets.

Chapter 2

DID SHAREHOLDERS BENEFIT FROM LARGE SCALE ASSET PURCHASES?

2.1 Introduction

Before the 2007-2008 financial crisis, there appeared to be a consensus regarding the role and implementation of monetary policy. Monetary policy worked as a stabilization tool, and its instrument was the short-term interest rate, also called the federal funds rate. In addition, the impact of a change in the federal funds rate on market rates and on the wider economy had been reliably established and quantified (Joyce et al., 2012). However, in December 2007, the US stock market began to plunge because of the turmoil experienced by financial markets. In accordance with conventional monetary policy, the Federal Reserve lowered the federal funds rate between September 2007 and December 2008 until it reached the zero lower bound (ZLB). By October 2008, the stock market persisted on its downward trajectory despite short-term interest rates maintained at the ZLB. The solvency of many institutions and borrowers came into question. Struggling financial institutions, in some cases on the verge of collapse, encountered problems with financial intermediation and sought liquidity to resume normal operations (Adrian and Shin, 2014). Both the ZLB and the impediments to intermediation weakened the con-

ventional transmission channels of monetary policy (Joyce et al., 2012). Consequently, the Federal Reserve opted to use unconventional monetary policy (UMP) in the form of large-scale liquidity injections into the balance sheets of a new expanded set of counterparties. These entities included large financial institutions, some of which carried low-quality mortgage debt on their balance sheets. The purpose of this paper is to examine if these unconventional and unprecedented monetary policy actions undertaken by the Federal Reserve to lower long-term interest rates and alleviate the economic burdens caused by the Great Recession benefited shareholders, and if so, which sectors' shareholders benefited most.

The implications of a ZLB interest rate environment for monetary policy have already been examined both theoretically and empirically with the Japanese experience. In Keynesian theory, it meant that any additional increases in the money supply would not lower the interest rate further, rendering conventional monetary policy actions ineffective. Such a situation is known as a liquidity trap. In a liquidity trap, because money and bonds become perfect substitutes, members of the public can simply choose to hold the central bank's monetary injections as currency "under their mattresses," which prevents money from stimulating economic activity (Fawley and Neely, 2013). However, others such as Mishkin (1996) argued that the constraint imposed by the ZLB could be overcome by focusing on increasing liquidity and particularly by purchasing long-term assets in order to decrease long-term interest rates. The economic context that prevailed during the 2007-2008 financial crisis led the Federal Reserve to pursue such an unconventional monetary policy strategy by conducting large-scale asset purchases (LSAPs). Theoretically, LSAPs could overcome the ineffectiveness of monetary policy by targeting specific markets and/or interest rates rather than by simply expanding the quantity of money and targeting short-term interest rates (Bernanke and Reinhart, 2004). It is worth noting that the actions of the Federal Reserve differed from those

implemented by the Bank of Japan, the Bank of England, and the European Central Bank. Indeed, although Japan used quantitative easing (QE) which increased the size of the central bank's balance sheet, the United States used both quantitative and credit easing (CE) which altered both the size and the composition of the Federal Reserve's balance sheet. The goal of this unconventional monetary policy in the United States was to lower longer-term interest rates (QE) and stimulate lending by banks (CE) in order to stimulate aggregate demand.

In theory, LSAPs affect stock prices through the signaling channel and the portfolio rebalancing theory introduced by Tobin (1969). The portfolio rebalancing theory assumes that money and assets are imperfect substitutes and that financial markets are segmented. Using these assumptions, it describes how purchasing various specific assets from its primary dealers (or counterparties) allows the Federal Reserve to increase the amount of liquidity available (and the size of its balance sheet), and cause the price of the purchased assets to increase and their yields to decrease relative to other assets. This leads market participants to rebalance their portfolios by seeking nonpurchased assets with similar or higher returns to those the central bank purchased, as investors search for yield. The desire to hold assets with higher yields motivates market participants to buy a broader range of nonpurchased assets to rebalance (or recreate) their portfolios. This causes the price of these nonpurchased assets to rise. Thus, rebalancing causes the increase in price of purchased assets to spillover into other asset classes with higher returns, including common stocks, and therefore raises stock prices (Gagnon et al., 2011). As a result, the effects of LSAPs should boost economic activity (Friedman, 1968; Watkins, 2014).

However, the recent US experience with LSAPs has led to skepticism regarding the effectiveness of this monetary policy transmission mechanism. The recovery has been

slow, and economic activity took several years after the end of the recession to recover to its pre-recession levels. However, it appears that despite the sluggish recovery of output and employment, the financial market—specifically, stock prices—has bounced back since 2009. The NYSE Composite Index, an index reflecting the performance of a wide range of stock prices, has shown an upward trend since the introduction of LSAPs. This raises the question of whether the theoretically positive relationship between LSAPs and stock prices applied in the context of the US financial crisis and if it explains the faster recovery of some financial institutions. While analyzing this relationship, I wondered if the institutions that directly acquired funds from the Federal Reserve (primary dealers) showed more notable improvements in their stock prices compared to the stock prices of other sectors of the economy, such as real estate, construction, commercial banks, consumer services, and others, thereby indicating that the transmission mechanisms described in the theory did not work as potently as expected.

Using an event study this paper finds that primary dealers did benefit from trading proximity with the Federal Reserve and that other financial sectors including commercial banks, broker dealers and consumer services also benefited from LSAPs. Moreover, looking at nonfinancial sectors, there is evidence that the real estate, homebuilding and auto manufacturing sectors also experienced abnormal returns, although more modest, as a result of LSAPs. This paper looks at the impact of the individual rounds and finds that LSAP I was the most powerful round. Comparing the impact of the different rounds, this paper concludes that unconventional monetary policy conducted at the zero-lower bound is most efficient when monetary announcements are a surprise, when the liquidity injections are large and involve the purchase of MBS, and when the announcements of the Federal Reserve are clear and transparent. In order to better understand these findings, a better understanding of the mechanisms behind LSAPs are helpful.

A close examination of the mechanisms and effects of monetary policy in the context of LSAPs starts with the Federal Reserve's financial intermediaries. To implement its new monetary policy plan, the Federal Reserve bought specific asset types on the Open Market Desk from its primary dealers. The Federal Reserve's primary dealers are banks and securities broker-dealers with larger broker subsidiaries that trade in US government securities with the Federal Reserve Bank of New York (FRBNY) on behalf of the Federal Reserve. These financial institutions must usually meet certain liquidity and quality requirements and provide the Federal Reserve with a steady and reliable flow of information regarding their operations and world market developments.[1] These primary dealers were expected to use the funds provided by the Federal Reserve to affect the real economy by extending credit, creating money, buying stocks, holding funds, or simply by conducting normal business operations. Ultimately, primary dealers have a significant influence over financial markets. Therefore, it is not surprising that primary dealers represent the largest financial institutions as well as the markets' largest group of borrowers (Adrian et al. 2009). In this paper, I attempt to (1) determine if the stock prices of primary dealers' shareholders showed abnormal returns because of LSAPs; and (2) discern if the stock prices of other sectors, both financial and nonfinancial, showed abnormal returns as a result of LSAPs.

The context of the 2007-2008 financial crisis provided a new scenario with which to test the relationship between monetary policy and stock prices when the short-term interest rate is at the ZLB. Some studies documented the impact of quantitative easing in the Japanese context and found QE to have no major impact beyond its signaling effect, mostly because the Bank of Japan (BoJ) did not show enough commitment to the policy (Ugai, 2007; Krugman et al., 1998; Krugman, 2000; Eggertsson and Woodford, 2003).

[1]Definition from US Department of the Treasury. Available at `http://www.treasury.gov/resource-center/data-chart-center/quarterly-refunding/Pages/primary-dealers.aspx`

Moreover, unconventional monetary policies such as LSAPs had not been used previously in the United States. Because the data on the effects of the last round of LSAPs have been released only recently, a small but growing number of researchers have hinted at the impact of LSAPs and financial intermediation on macroeconomic variables in the United States during the 2007-2008 financial crisis. However, to date, no attempts have been made to compare how the Federal Reserve's actions affected its primary dealers and other shareholders in the US economy. This research contributes to the literature by providing an analysis of whether monetary policy events or shocks like those experienced during LSAPs caused stock returns to react. In addition, the study establishes whether abnormal returns were higher in the case of the Federal Reserve's primary dealers. In this paper, I conduct several event studies using data from targeted financial and nonfinancial sectors of the economy, including primary dealer banks, consumer services, commercial banks, real estate, homebuilding, and construction in order to establish if LSAPs caused abnormal returns for each sectors.

The remainder of the paper is organized as follows: In section 2.2, I present the theoretical and empirical relationship between monetary policy and stock prices using conventional and unconventional monetary policy tools. Using this framework, section 2.3 provides details on the data used to conduct the analysis. Section 2.4 presents the event study methodology and the robustness checks. Section 2.5 presents the findings and their implications and section 2.6 concludes.

2.2 The Relationship between Monetary Policy and Stock Prices

2.2.1 Conventional Monetary Policy

The relationship between monetary policy and stock prices when interest rates are above the zero lower bound has been explored at length and the evidence describes several transmission channels between monetary policy and stock prices.

The traditional channel of monetary policy is the interest rate channel. Sprinkel (1964) examined the relationship in the United States from 1918 to 1960 and found that by influencing interest rates, the Federal Reserve could influence stock prices. Assets such as stocks are priced as the discounted sum of future dividend payments (Lucas, 1978; Rapach, 2001). Therefore, by lowering the federal funds rate, the Federal Reserve induces a fall in yields across the yield curve, decreasing the discount factor at which future dividend payments are evaluated. Bernanke and Kuttner (2005) found evidence of this channel in a study of daily data from FOMC decisions between 1989 to 2002. They concluded that a 25 basis-point cut in the federal funds rate led to a 1% increase in stock indexes that same day. Rigobon and Sacks (2003) reached a similar conclusion using a VAR model from 1994 to 2001. They found that a 25 basis-point increase in the short-term interest rate resulted in a 1.7% decline in the S&P 500.

Hamburger, Kochin and Brunie (1972) confirmed the existence of this channel and also found evidence of a second channel: the bank lending channel. According to this mechanism, monetary policy can affect stock prices through changes in consumption and investment (Brunie et al., 1972). In this case, expansionary monetary policy increases banks' total reserves including excess reserves. Rather than having reserves sitting idly with the Federal Reserve, banks would prefer to loan out excess reserves in order to earn interest (Keister and McAndrews, 2009). This increases the quantity of bank loans

available to consumers and businesses, boosting investment and consumer spending. This has a positive effect on firms' future cash flows and therefore increases stock prices (Thorbecke, 1997).

2.2.2 Unconventional Monetary Policy

The channels described above have been evaluated in a traditional interest rate environment, when the short-term interest rate that the Federal Reserve targets is above the zero lower bound. However, monetary policy can also influence stock markets when interest rates are at the zero-lower bound. In this context the Federal Reserve uses unconventional monetary policy tools, such as asset purchases, to influence asset prices. There have not been many opportunities to analyze this relationship but it has been described in the literature using the signaling channel and the portfolio rebalancing channel.

According to the signaling channel, Federal Reserve announcements provided investors with information regarding the future path of short-term interest rates (Krishnamurthy and Vissing-Jorgensen, 2011; Woodford, 2012; Campbell et al., 2012). Assuming investors are forward-looking, Federal Reserve announcements should have an impact on investors' expectations and thus on financial markets. The potency if this channel depends on investors' perception of the Federal Reserve's credibility. If the Federal Reserve is believed to be credible, then so are Federal Reserve policy announcements. Given the intentions of the Federal Reserve, investors will form expectations and make decisions that influence stock market developments.

A credible central bank can see its policy actions amplified if the public acts in a way that reinforces its policy decisions and therefore its desired outcomes. The signaling

channel can be a powerful tool when the short-term interest rate is above the zero lower bound and when it is at the zero lower bound.

According to the portfolio rebalancing channel, asset purchases by the Federal Reserve trigger investors to rebalance their portfolios; as the yields on the purchased asset classes decrease, investors will adjust their holdings of other assets (including stocks) according to the Federal Reserve's monetary policy stance (Tobin, 1969; Gertler and Karadi, 2011; Curdia and Woodford, 2011). For example, in the case of LSAPs, the purchases induced by the Federal Reserve were expected to cause investors to rebalance their portfolios in favor of assets that either had higher yields than the assets they currently held in their portfolios or that resembled the assets that were removed from their balance sheets in order to recreate their portfolio profiles pre-LSAPs. Thus, the portfolio rebalancing process causes a broad range of asset prices, including stock prices, to increase (Bauer and Rudebusch, 2013; Gagnon et al., 2011; Joyce et al., 2011; Vayanos and Vila, 2009; Hancock and Passmore, 2011).

2.2.2.1 The Duration Effect

Behind the portfolio rebalancing theory are two mechanisms: the duration effect and the scarcity effect. In the context of LSAPs, the unconventional monetary policy actions of the Federal Reserve were designed to target long-term interest rates. They are key determinants of purchasing and investment decisions and thus economic activity. Long-term interest rates are made up of two components: (1) the investor's expectations regarding the average level of short-term risk-free interest rates and (2) the risk premium. The risk premium is the expected additional income demanded by investors for holding the riskier longer-term asset. In the case of Treasury securities, the term premium is the most important component of the risk premium (Gagnon et al., 2011); it reflects the

reluctance of investors to hold the interest rate risk that comes with holding an asset with a longer duration. In other words, "the term premium is the additional return investors require, over and above the average of expected future short-term interest rates, for accepting a fixed long-term yield" (Gagnon et al., 2011).

The purchase of long-term assets are intended to alter the risk premium by removing aggregate duration risk from private sector portfolios and thus reducing long-term yields. The risk premium on a bond of maturity t can be measured as the product of the duration of a maturity t bond and the aggregate duration risk borne by the bond market investor (Gagnon et al., 2011). Therefore, LSAPs, which decrease aggregate duration risk, reduce the yield on a broad range of securities that use aggregate duration risk to measure their risk premia. Because many securities have lower risk premia, a wide range of bonds show a decrease in their yields (Vinals et al., 2013). The changes in yields trigger investors to rebalance their portfolios according to their preferences.

2.2.2.2 The Scarcity Effect

The second effect is the scarcity effect, which is associated with the preferred-habitat literature (Vayanos and Vila, 2009; Joyce et al., 2012). The scarcity effect relies on the assumption that investors have different objectives and therefore prefer to hold different types of securities with different maturities. Essentially, different investors have specific preferences for different segments of the yield curve; thus, financial markets are segmented. This pattern, emphasizing the imperfect substitutability of assets was originally described by Tobin (1959). The scarcity effect is described in the literature as a mechanism through which a lower supply of a certain type of asset will cause the price of that asset and of assets with similar maturities to increase, thus lowering their yields (Joyce et al., 2012). LSAPs by the Federal Reserve reduced the amount of purchased

assets that the private sector held, triggering investors who held the purchased assets to rebalance their portfolios by purchasing assets with characteristics similar to those of the purchased assets. Consequently, LSAPs reduced the yields on purchased assets and other similar assets. The effects of the scarcity were more localized than were the effects in the duration channel. In the case of the duration channel, the assets purchased by the Federal Reserve and other assets with similar maturities experienced lower returns as a result of LSAPs; this led to differences in relative asset returns and caused investors to rebalance their portfolios in favor of assets with higher returns.

The scarcity effect and the duration effect explain why spillover occurs from one class of Federal Reserve purchased assets to other nonpurchased asset classes and why yields decrease for a range of longer-term assets as a result of LSAPs (D'Amico et al., 2012; He et al., 2010; Gagnon et al., 2010; Watkins, 2014). As mentioned, both effects assume that the market is segmented and that assets are imperfect substitutes. Using these assumptions, the two channels present two paths through which asset purchases by the Federal Reserve lead to decreases in the yields of the purchased assets and show how this effect spreads to other types of assets. The scarcity effect shows that a decrease in the stock of specific types of securities with particular maturities in the hands of private investors leads to a decrease in yields of these securities. The duration effect shows how the Federal Reserve's removal of long duration risk from the market leads to lower yields across a wide range of assets. In both cases, the decrease in the yield of purchased assets causes investors to rebalance their portfolios towards assets with higher yields. This alters the yield of a wider range of assets that were not purchased, such as stocks and corporate bonds that have higher yields (Patrabansh et al., 2014).

The reduced yields on the purchased assets create a prospective excess demand for other types of assets with higher yields such as bonds and preferred stocks. As

investors rebalance their portfolios in favor of assets with higher yields, the markets for both purchased and nonpurchased assets adjust, changing the price of one asset type relative to the other. Consequently, when a group of investors builds the demand for a particular type of asset, it prompts an adjustment of financial market prices, which induces investors to acquire securities with higher expected returns, such as equity (D'Amico et al., 2012). In the case of LSAPs, lower prospective returns on agency debt, agency MBS, and Treasury securities should cause investors to shift some of their portfolios into assets such as corporate bonds and equities, causing an increase in the prices of these assets. In fact, LSAPs greatly increased the size of the Federal Reserve's balance sheet and lowered the supply of the targeted assets. This effect on asset supply and the various maturities associated with these assets should allow the duration and scarcity mechanisms to emerge, causing the rate of return of the assets purchased by the Federal Reserve to decrease, leaving investors to seek assets with higher returns, such as stocks, to rebalance their portfolios, thereby bidding up the assets' prices. That is how LSAPs are expected to stimulate economic activity, through linkages with broad array of asset prices (Gagnon et al., 2011).

2.2.3 The Role of Financial Intermediaries in Unconventional Monetary Policy

In order to overcome the constraints of the zero lower bound, the Federal Reserve did not just expand the range of assets it purchased to target specific sectors, it also expanded its set of counterparties or primary dealers (Clouse et al., 2014). Conventional models typically do not place enough importance on financial markets and primary dealers. These models treat financial intermediaries as passive players used by the central banks to implement monetary policy. However, their central role in the 2007-2008 financial crisis has sparked recent interest in analyzing how these institutions affect different

macroeconomic variables. Some researchers have claimed that in light of the financial crisis, the importance of primary dealers needs to be reevaluated. Adrian and Shin (2008a) noted that primary dealers originate and make markets for securitized products, the availability of which determines the credit supply for consumers and nonfinancial firms. Adrian and Shin (2008a) found that fluctuations in the size of primary dealers' balance sheets, including those of major financial institutions, appear to signal changes in future real activity more accurately than do the balance sheets of the commercial bank sector. This means that the information contained in primary dealers' balance sheets is more informative regarding underlying financial conditions because they signal the marginal availability of credit.

Some studies describe that creating privileged groups of large financial institutions can be detrimental to the general economy. Three main concerns have been cited regarding primary dealers. First, offering primary dealers a liquidity "safety net" through the Federal Reserve can encourage risky behavior on their part (Adrian and Shin, 2008). Knowing that the Federal Reserve will rescue them in case of financial distress, dealer banks may not manage their operations prudently. Moreover, LSAPs expose the Federal Reserve to more risk. Purchases of long-term debt involve duration, which leads to market risk, and thus need careful management. In addition, risks exist on the side of the central bank—once the economy strengthens and long-term yields rise, the Federal Reserve will unwind LSAPs. This unwinding will probably lead to the disposal of purchased assets, which will likely be associated with losses for the Federal Reserve. The concern is that the financial independence of the Federal Reserve may come into question, and along with it, its operational autonomy. This risk is more likely to occur if the economy is emerging from a period of prolonged financial distress (Borio and Disyatat, 2010), as was the case with the 2007-2008 financial crisis.

The second concern is with regulation issues. Because primary dealers purchase securities at auction from the Federal Reserve Bank of New York, their relationship is commercial rather than regulatory (Jickling, 2010). In March 2008, in an attempt to supply liquidity to the financial system, the Federal Reserve established the Primary Dealer Credit Facility to make short-term loans to primary dealers against a variety of collateral. However, the primary dealers included investment banks, firms that were regulated by the Security Exchange Commission (SEC), not the Federal Reserve. This may have led to gaps in supervision.

The third concern is a moral hazard issue. Although primary dealers are expected to act as intermediaries and transmit monetary policy decisions to the rest of the economy, there is ultimately no guarantee that these banks will do so. Dealer banks can delay raising equity and therefore stimulating the real economy because they know they can rely on the Federal Reserve for borrowing (Adrian and Shin, 2008a; Jagtiani and Brewer, 2009). Moreover, it is also possible for the primary dealers to divert LSAPs funds to benefit their own operations by offering high bonuses and dividends to employees and shareholders. Lastly, primary dealers can use liquidity injections by the Federal Reserve to rebuild their balance sheets rather than extend credit to consumers and businesses (Berrospide, 2012).

This paper contributes to the literature by evaluating the relationship between LSAPs and stock prices in the context of the recent US recession and during a period of unconventional monetary policy actions. The particular context of the recent financial crisis, specifically the zero-lower bound environment, provides some valuable insights into the nature of the relationship between monetary policy and stock prices and allowed me to establish whether the relationship held even when the Federal Reserve targeted long-term interest rates instead of short-term interest rates constrained by the ZLB.

2.2.4 Evaluating the Impact of Large-Scale Asset Purchases on Stock Prices After 2008

Empirically, the most commonly used methodology for the analysis of stock market behavior has been the event study methodology. The primary use of event study methodology is to study the behavior of security prices around specific events and the reaction of security prices to such events (Binder, 1998). Event studies have been in common use for over 40 years. Ball and Brown (1968) and Fama et al., (1969) are generally credited with the seminal work and popularity of this methodology to identify abnormal stock performance (Corrado, 2011). Most of the early event studies focused on the examination of security price behavior in response to earning announcements, stock split announcements, and mergers and acquisitions events (Binder, 1998). More recently, event studies have focused on testing the efficient market hypothesis (markets incorporate all available information) and on examining the impact of a specific event or a set of events on shareholder wealth (Binder, 1998).

Given that the purpose of this paper was to compare how LSAPs benefited different sectors including primary dealers, an event study methodology was suitable for conducting the analysis. By using an event study to examine changes in stock returns around official announcements regarding asset purchases, we implicitly assume that our event study includes all announcements that affect LSAP expectations, this also means that expectations are affected only by LSAPs and not other channels. Our second assumption is that markets are efficient so all effects on stock returns occur when market participants update their expectations (on the announcement days) and not when the actual purchases take place.[2]

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[2]These assumptions are made in Gagnon et al. (2010), they are necessary because we do have a direct measure of LSAP expectations

Specifically, in this paper, using stock prices to compute stock returns and incorporating an event study methodology, I determine if the stock returns of the primary dealers increased more than did the stock returns of other LSAPs-targeted sectors. I compute the test statistics for these abnormal returns to determine if the increased stock returns were statistically significant. I expected to find that primary dealers experienced positive abnormal returns as a result of LSAPs and that these abnormal returns were statistically significant. Additionally, I expected the other sectors to benefit but more modestly because they did not benefit from the same trading proximity to the Federal Reserve. Such results would indicate that the portfolio rebalancing channel of monetary policy was weaker than the Federal Reserve anticipated. If the results indicate that primary dealers experienced abnormal returns that were much larger than the abnormal returns of other financial and nonfinancial sectors this would point to the portfolio rebalancing channel not spreading to other sectors. Instead it would mean that the effects of LSAPs remained concentrated in the sector that received the liquidity injections directly.

Event studies using a market model residual method with daily stock data commonly appear in the literature (Brown and Warner, 1980; Seiler, 2004; Campbell et al., 1997). The procedure to conduct an event study starts with an Ordinary Least Square (OLS) regression of the daily returns of each security in the sample against the yields from a market index. The estimates of the constant and coefficient obtained from the regression are then used to generate a time series of return predictions, and ultimately, a time series of excess returns. Specifically, the individual excess returns computed using the OLS regression are compared to the daily and cumulative abnormal returns using a t test, which reports the statistical significance of the abnormal returns relative to the period under examination.

2.3 Data

2.3.1 Sources

This paper uses data from the Wharton Research Data Service (WRDS). This database provides access to a wide variety of data across multiple disciplines including accounting, banking, economics, finance, insurance, marketing, and statistics.[3] WRDS is compiled from independent sources that specialize in specific historical data. Some of its sources include S&P Capital IQ, NYSE, Center for Research in Security Prices (CRSP), and Thomson Reuters.

Typically, event studies use daily stock market trading data accessed through WRDS, which provides access to the Center for Research in Security Prices (CRSP) data published by the University of Chicago. CRSP is the primary database used for academic research on stock prices and trading volume. It is renowned for its expertise in building and maintaining historical academic research-quality stock market databases. The CRSP US stock databases are a unique research resource characterized by unmatched breadth and depth. They include CRSP's unique permanent identifiers, which provide clean and accurate back-testing, research utilizing time series and event data, performance measurement, benchmarking, and securities analysis.[4]

2.3.2 Data Description

The analysis in this paper uses daily stock price data. Because the methodology used in this paper is an event study, the regression estimates computed from one pe-

[3]Wharton Research Data Service. n.d. About WRDS. Available at `http:wrds-web.wharton.upenn.edu/wrds/about/.`

[4]Center for Research in Security Prices (CRSP). CRSP US Stock Databases. Available at `http://www.crsp.com/products/research-products/crsp-us-stock-databases.`

riod (estimation window) are used to compute the abnormal returns in another (event window). Therefore, a long estimation window was needed to get accurate results in the case of the primary dealer banks' abnormal returns. The length of the estimation window should be the same for each company included in the group. The stock return data for the estimation window started on July 16, 1999, and ended on September 30, 2008, producing 2,317 total observations. If the event window is also included we have 3,387 observations or data from July 16, 1999 to December 12, 2012.

In order to compute the abnormal returns of a group of firms relative to a stock market index, the returns of the chosen market index and the companies of interest were needed. The stock market index used was the New York Stock Exchange Composite Index (NYSE) because it included more of the companies needed for the event study, compared to other stock indexes such as the S&P 500. Determining if LSAP event dates affected primary dealer stock returns more favorably than the stock market index required data on the prices of primary dealers' stocks. These data were available from Wharton Research Data Service. The same was done for the firms in the other sectors.

The CRSP database included historical prices for primary dealer banks and many other firms in a variety of economic sectors. In the context of this paper, the stock prices for nine primary dealers were used. Because of data limitations, not all primary dealers could be included; therefore, this study used the following primary dealers: Goldman Sachs, J.P. Morgan, Bank of America, HSBC, Morgan Stanley, Barclays, Credit Suisse, and Citigroup. These nine dealer banks were not only the largest but also the most influential primary dealer banks. At the time of this study, they controlled many bank subsidiaries, both domestically and abroad and were considered to be market makers. This CRSP database was used to compute the abnormal stock returns experienced by other sectors, using the stock prices of the firms included in each sector. The results from

the different sectors were compared in order to determine (1) which group experienced abnormal returns resulting from LSAPs and (2) which sector had the largest abnormal returns resulting from LSAPs.

2.3.3 Variables

The stock market index chosen for this analysis was the New York Stock Exchange Composite Index (NYSE). Because of the importance of the market model, the market index selection was of considerable importance in conducting this event study. (More details are provided in section 4.) In this paper, the NYSE Composite Index was used because LSAP events affected stocks traded on a variety of stock exchanges, making this broader index appropriate for the analysis (compared to the S&P 500). Moreover, the NYSE Composite Index measures "the performance of all stocks listed on the New York Stock Exchange. The NYSE Composite Index includes more than 1,900 stocks, of which over 1,500 are US companies. Its breadth therefore makes it a much better indicator of market performance than narrow indexes that have far fewer components. The weights of the index constituents are calculated on the basis of their free-float market capitalization. The index itself is calculated on the basis of price return and total return, which includes dividends.[5] Such a value-weighted index is generally preferable because it reflects more accurately a portfolio likely to be held by investors, and it is less biased, compared to an equal-weighted index (Canina et al., 1998).

As mentioned previously, my analysis required the stock returns for the firms whose abnormal returns were being computed. For this reason, I first selected the relevant sectors for the analysis. Second, I grouped the firms traded on the NYSE that belonged

[5]Investopedia. n.d. NYSE Composite Index. Available at `http://www.investopedia.com/terms/n/nysecompositeindex.asp`.

to these sectors, and finally, I collected the necessary stock return data, making sure that the estimation windows all had the same length. The analysis was conducted on two groups. The first was composed of sectors belonging to the finance industry. By comparing how different financial sectors performed, I was able to establish if primary dealers benefited more, compared to other financial sectors. The second group was composed of sectors outside the finance industry that were also targeted by LSAPs. By computing the abnormal returns of these sectors, I was able to establish if the finance industry experienced higher returns from LSAPs. Putting together the results from both groups, I was able to establish if primary dealer shareholders benefited most from LSAPs, compared to other shareholders.

The first group included the following sectors:

- **Primary Dealer Banks:** This group consisted of the Federal Reserve's counterparties. These financial institutions were the largest financial institutions, and as such, had a strong influence on other financial institutions and the financial markets in general.

- **Consumer Services:** This group consisted of companies engaged in personal loan services, such as credit card services, mortgage lenders and brokers, consumer leasing providers, such as for automobiles, and personal and student loan services. The sector excluded lease financing of commercial equipment classified in Financials-Specialty and consumer brokerage and investment services classified in Investment Services.[6]

- **Brokers and Dealers:** This group consisted of companies engaged in financial advising and selling firm products and services to members of the investing public.[7]

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[6]New York Times. 2016. Consumer services. Available at `http://markets.on.nytimes.com/research/markets/usmarkets/industry.asp?industry=55113`

[7]Financial Services. n.d. Bankers and dealers. Available at `http://www.financialservices.org/uploadedFiles/FSI_Content/Docs/Advocacy/Backgrounder_Independent-Broker-Dealer.pdf`.

• **Commercial Banks:** This group consisted of financial institutions that provided services, such as accepting deposits, giving business loans and auto loans, mortgage lending, and basic investment products like savings accounts and certificates of deposit.[8]

The second group included the following sectors:

• **Real Estate:** This group consisted of organizations primarily engaged in renting or leasing real estate to others; managing real estate for others; selling, buying, or renting real estate for others; and providing other real estate-related services, such as appraisal services.

• **Homebuilding:** This group consisted of companies engaged in the construction of residential homes, mobile homes, and prefabricated homes. The industry included centralized homebuilding operations in which work was channeled to specialized contractors. The homebuilding industry excluded homebuilding and improvement fixtures such as plumbing supplies, doors, and window frames classified in Construction and hotel and office building construction classified in Engineering and Construction.

• **Construction:** This group consisted of companies engaged in preparation of land and construction, alteration, and repair of buildings, structures, and other real property.[9]

• **Auto Manufacturing:** This group consisted of companies that produced passenger cars and lightweight trucks.

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[8]Investopedia. n.d. Commercial bank. Available at `http://www.investopedia.com/terms/c/commercialbank.asp`

[9]Business Dictionary. n.d. Construction. Available at`http://www.businessdictionary.com/definition/construction.html`

2.3.4 Summary Statistics

In this section, I present the summary statistics. The summary statistics are divided into two samples. The first started on July 19, 1999, and ended on October 31, 2008; the second sample included LSAPs. As shown in Table 2.1, the data included the number of firms, the mean stock price, the standard deviation of the stock price, the mean return, and the mean market capitalization for each sector.

Table 2.1: Summary Statistics

Pre-LSAP Period:				
Sector	Mean Stock Price	Mean Stock Return	SD of Stock Return	Mean Market Cap
Primary Dealers	61.28	0.03	0.02	78,993.2
Commercial Banks	35.07	0.07	0.01	10,417
Banker-Dealers	26.38	0.06	0.02	2,410.6
Consumer Services	38.53	0.04	0.02	15,530.8
Real Estate	26.45	0.05	0.02	547.1
Homebuilding	59.92	0.08	0.02	2,077.1
Construction	32.31	0.05	0.03	6,718.2
Auto Manufacturing	39.83	0.02	0.02	58,960.7
Pre-LSAP Period:				
Sector	Mean Stock Price	Mean Stock Return	SD of Stock Return	Mean Market Cap
Primary Dealers	54.37	0.04	0.03	74,238
Commercial Banks	43.08	0.08	0.02	15,384.6
Banker-Dealers	25.88	0.05	0.02	3,476
Consumer Services	41.98	0.07	0.03	14,984.2
Real Estate	27.05	0.04	0.03	712.2
Homebuilding	57.80	0.09	0.03	2,026.5
Construction	30.89	0.08	0.04	8,565.2
Auto Manufacturing	38.33	0.04	0.02	64,133.7

Note: All the data is from CRSP. It includes the closing price, the number of shares outstanding expressed in millions of dollars and returns computed using the data on price. Market capitalization is computed as price times number of shares outstanding, it is expressed in millions of dollars. The pre-LSAP period is from July 16, 1999 to September 30, 2008 and the period including LSAPs is from July 16, 1999 to December 12, 2012.

The mean stock price appears to show that except for consumer services, real estate, and commercial banks the mean stock price dropped when the LSAP period was included. The drop was most likely caused by the economic turmoil that was just beginning in November 2008. Commercial banks' mean stock prices increased from $35.07 to $43.08, for the real estate sector from $26.45 to $27.05, and for consumer services the stock price increased from $38.53 to $41.98. Therefore, it appears that banks that performed traditional banking activities such as receiving deposits and lending to households and businesses (unlike investment banks) showed the largest increase in the mean stock price. In addition, it is worth noting that the sector with the highest mean stock price was the primary dealer sector. The mean stock prices for the period that did not include LSAPs compared to the period that included LSAPs was $61.28 and $54.37, respectively. The sector with the second highest mean stock price was homebuilding, $59.92 without LSAPs compared to $57.80 with LSAPs. Primary dealers experienced the largest drop in mean stock price. This was an indication that the sectors with the largest drops in mean stock prices were those most closely related to sophisticated banking activity. These sectors were most affected by the liquidity shortage that started in 2008, which caused them to experience losses as investors became alarmed by the growing complexity of mortgage-backed financial instruments.

Next, I discuss the change in the standard deviations of the stock prices. As shown in Table 2.1, adding the period from October 2008 to December 2012 increased the standard deviations for all except homebuilding, auto manufacturing, and the NYSE Composite Index. The increase in the standard deviations is indicative of increased volatility, showing that the stock price deviated more from its mean value once the LSAP period was added. This increased volatility can be explained in part by the increased turmoil occurring in financial markets from the end of 2008 to the end of 2012. Alternatively, the higher standard deviations may have occurred because stock

prices reacted more to the changes in financial markets with the implementation of LSAPs. However, this increased volatility was not necessarily indicative of worsening stock prices and deteriorating financial conditions for the sectors. Indeed, it is impossible to determine whether LSAPs increased the volatility of stock prices or if they rescued financial markets by helping them avoid a much larger increase in stock price volatility and a larger decrease in mean stock price. This is especially true given that most sectors showed only a slight increase in the standard deviations of the stock prices. For example, the standard deviation for real estate ranged from 10.78 to 11.86; for construction, the standard deviation ranged from 12.93 to 13.27. In addition, the standard deviation for the market index went from 1381.29 to 1268.51, showing that the volatility of most stocks included in the NYSE Composite Index decreased. Again, the stock price of primary dealers showed the largest increase in standard deviation, from 22.21 to 31.39. The second largest increase in volatility was for commercial banks, which increased from 8 to 11.75. Thus, it seems that in terms of stock price volatility, the financial crisis and the policy responses affected firms involved in banking activities more than it did other sectors.

With respect to the stock returns, it seems that more sectors experienced higher stock returns when the LSAP period was included in the sample than experienced mean stock price increases. Indeed, primary dealers' stock returns increased from 0.036% to 0.037%; homebuilding stock returns increased from 0.080% to 0.088%; consumer services stock returns increased from 0.043% to 0.070%; auto manufacturing stock returns increased from 0.022% to 0.038%; and commercial banks' stock returns increased from 0.069% to 0.074%. These increases indicate that despite increased volatility, most sectors still benefited from higher returns. This is particularly interesting given that the NYSE Composite Index stock return decreased. This discrepancy means that although most stock returns decreased, the returns for the sectors in this analysis increased. This

could potentially be a result of LSAPs helping the targeted sectors and therefore raising stock returns.

From the summary statistics, in a comparison of the pre-LSAP sample to the sample that included LSAPs, the financial sectors (e.g., primary dealers) seem to have experienced the greatest change in mean stock price, standard deviation, and stock return, relative to nonfinancial sectors. This could be because the financial sectors were also those with the greatest market capitalization. Primary dealers had the greatest market capitalization[10] at \$74,238, a very large value, especially considering that only nine of the primary dealers were included in the market capitalization measure. This considerable market capitalization indicates that primary dealers are amongst the largest financial institutions. For example, commercial banks had the second largest market capitalization at \$15,530. This sector included more financial institutions, and yet the market capitalization was smaller than that of primary dealers. As noted previously, financial sectors had the largest market capitalization, but they were also more affected by the financial crisis.

2.4 Methodology

2.4.1 The Event Study Approach

In order to evaluate how LSAPs affect stock returns using data on stock prices, I used an event study methodology. The core elements of a typical event study have not changed much over time. The methodology relies on the same principles used in the seminal work of Fama et al. (1969) and Ball and Brown (1968), who conducted a stock-split event study (Kothari and Warner, 1997). The key hypothesis being tested

[10] All market capitalization numbers are in millions of dollars

in this study was whether an event would have an impact on the value of a firm or firms. Although the foundations of the event study approach have not changed, some improvements have been made. First, with the greater availability of data, many event study researchers now use higher frequency data (e.g., intraday, daily) in their analysis, providing more precise computations of the abnormal returns; therefore, modern event studies are more informative about the effects of announcements. Second, new, more sophisticated methods of measuring abnormal returns have been developed (Kothari and Warner, 2007).

A large body literature supports the use of event studies to evaluate LSAPs' impacts on macroeconomic variables. So far, studies on the impact of LSAPs have focused on how they affected interest rates or asset yields (Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011; Campbell et al., 2012; Joyce et al., 2012). However, some recent studies have used event studies to evaluate the impact of LSAPs on financial markets (Roache and Rousset, 2013; Glick and Leduc, 2012).

Event studies are popular in finance and economics because they are "one of the most successful empirical technique for isolating the price impact of the information that is contained in corporate events" (Kothari and Warner, 2007). This means that event studies isolate announcements and focus on the response of firm returns (e.g., earnings announcements, FOMC announcements, issue of new debt or equity). Specifically, event studies show how the returns of a specific firm or group of firms react on the day of the event and on the days that surround it. The usefulness of this methodology relies on the assumption that financial markets are efficient, and therefore the response of stock prices to an event will be immediate and persistent (MacKinlay, 1997).

2.4.2 Event Study Methodology

Several steps are necessary to perform an event study:

1. Identify or define the date on which the market received the announcement associated with the event of interest. In addition, select the sample of firms or stocks to be included in the study. Traditionally, these firms should have some similarities and thus will most likely react to the event in a similar way. This step determines the event date and the sample.

2. Identify the timeline of the event study. Before proceeding with the analysis, it is crucial to first identify the test period (or the event window) and the estimation period (or the estimation window). The impact of an event on returns is measured during the test period, which usually includes some periods before and after the event date. Most researchers use short event windows to conduct their analyses, such as one day before and after; thus, the event window is composed of three periods (Lummer and McConnell, 1989; Small et al., 2007). Some researchers choose longer event windows that cover months (Ritter, 1991; Hertzel et al., 2002). However, the event window must be shorter than the estimation window. In such studies, complications occurred in terms of data availability and event contamination. Having a long event window required having a much longer estimation window, and such large datasets were not always available. Moreover, a long event window increased the chance that the abnormal returns around the event date were driven by other factors in the economy that affected returns. Indeed, a longer event window meant that new information could arrive and influence returns; therefore, the effects of the event of interest were no longer isolated (MacKinlay, 1997). In terms of the estimation window, although no method currently exists to determine the appropriate length, it should be reasonably long. For example, using daily data, Lummer

and McConnell (1989) used 150 days, Small et al. (2007) used 225 days, and Brown and Warner (1985) used 239 days. The length of the estimation window is important because it serves as a benchmark to compare stock returns during the event window-the "abnormal times"-and stock returns during the estimation window, or "normal times." In short, the estimation window should be long enough so that the parameters obtained over that period can serve as adequate proxies to conduct out-of-sample modeling (detail on this topic appears in the next section). In the case of certain events, such as takeovers, for example, it is possible that the estimation period is specified to occur after the event window.

3. Once the timeline and the sample of the event have been established, the next step is to estimate the expected return for each sample stock over the estimation period. This step facilitates determination of parameters estimates that are not influenced by the event and thus reflect "normal" time estimates. These estimates are then used to measure the expected returns during the event window and to compare them to the actual returns of the security.

4. The next step involves computing the abnormal (or excess) returns. Following from equations (2.7) and (2.8), both the actual and the expected returns are needed to compute the excess returns. In the following section, two methods for computing expected returns are presented. Depending on the frequency of the data, this step results in the measurement of abnormal returns (AR) for specific firms during a specific period. If the data are daily, the magnitude of these single-day excess returns can be attributed to the announcement of the event. Further, the set of individual abnormal returns can be aggregated across firms to cumulative abnormal returns (CAR) and then averaged over several firms to find the average abnormal return (AAR) and over several periods to find the cumulative average abnormal return (CAAR).

5. The last step involves hypothesis testing to test the significance of the abnormal returns found using AR, CAR, AAR, or CAAR. The results of the hypothesis tests establish whether the response of the returns was caused by the event and not luck.

2.4.3 Implementation of the Event Study Methodology

2.4.3.1 Benchmark Model of Normal Returns

The event study method consists of estimating the abnormal returns of securities in response to an event. This type of event study proceeds in three steps. The first step is to compute the normal return of a commodity using either the constant-mean return model or the market-price model. In the second step, the abnormal returns are computed (by comparing actual returns to expected returns). Finally, the statistical significance of the abnormal returns is evaluated. Accordingly, the event window was the period over which I evaluated the existence and significance of abnormal returns in response to an event. I measured the normal returns, which were the expected returns if the event had not occurred. This event window usually consisted of the event date and a few days before and after. The shorter the event window, the less likely commodity prices would be contaminated by other factors that influenced price changes.

Several methods can be employed to measure the normal returns. The two most popular are the constant-mean return model and the market-price model. The two models are similar except for the method used to estimate the expected returns. Before I describe each method, note that because the purpose of event studies is to evaluate an event's impact on security prices, the model must identify the impact of the event on security prices over and above normal market functioning (Kozicki et al., 2011). For this reason, many event studies rely on the fact that the actual return of a security can be decomposed into two components: the expected or normal returns and the abnormal

returns. For firm i at time t in the event window the actual return is:

$$R_{it} = E[R_{it}|X_t] + \xi_{it} \tag{2.1}$$

where, $E[R_{it}|X_t]$ are the normal returns or the expected returns unconditional on the event but conditional on other information, X_{it} is the conditioning information (i.e., the mean return or the market return) at time t and ξ_{it} are the abnormal returns or the unexpected component of returns (Brown and Warner, 1980).[11]

Using the preceding return decomposition, the constant-mean model assumes that the mean return of a commodity is constant through time, and therefore, it can be expressed as follows:

$$R_{it} = E[R_{it}|X_t] + \xi_{it} \tag{2.2}$$

where,

$$E[R_{it}|X_t] = \mu \tag{2.3}$$

and thus:

$$R_{it} = \mu + \xi_{it} \tag{2.4}$$

where, $E[R_{it}|X_t]$ are the normal returns over the estimation window, which is a time period that precedes the event window (it does not have to be the period immediately before the event; in fact, there is often a time gap between the estimation window and the event window), and μ is the constant mean return of the commodity. Moreover, the abnormal returns can be computed as the difference between the normal returns and the mean of the commodity's return.

[11]They are called abnormal returns because they are the unexplained component of the commodity return that is due to an abnormal event that is not captured by the model (MacKinlay, 1997)

The second model to estimate normal returns is the market-price model. This model relies on the assumption that commodity returns are jointly normally distributed to specify the relationship between the market index and the return of any other given security as linear. Consequently the linear relationship can be expressed as follows:

$$R_{it} = E[R_{it}|X_t] + \xi_{it} \tag{2.5}$$

where the return of security i at time t is equal to the sum of the expected and unexpected returns. Simple rearranging results in:

$$\xi_{it} = R_{it} - E[R_{it}|X_t] \tag{2.6}$$

According to this equation, the abnormal return of security i at the time of event t can be measured as the difference between its actual return and its expected return. However, unlike the constant-mean model, the expected returns are estimated using regression analysis (rather than being proxied by the mean as was described previously).

In order to estimate the normal expected returns, OLS is a consistent and efficient estimation procedure (MacKinlay, 1997). Using the OLS estimation procedure to measure abnormal returns facilitates the statistical analysis of the abnormal returns (details appear in the following section). The OLS estimation of the abnormal returns in event period τ (τ can be the entire event window or a subsample) can be expressed more formally in the following way:

$$E[R_{i\tau}|X_\tau] = \alpha_i + \beta_i R_{m\tau} \tag{2.7}$$

and thus, the following regression model:

$$R_{i\tau} = \alpha_i + \beta_i R_{m\tau} + \xi_{i\tau} \tag{2.8}$$

where $R_{i\tau}$ is the actual return on commodity i, $R_{m\tau}$ is the market return, τ denotes a period of time in the event window, and $\xi_{i\tau}$ is the disturbance term of the market model or the abnormal returns.[12] The regression is estimated over the estimation window in order to compute estimates of α and β. This step is important for the analysis because the estimation window is assumed not to overlap with the event window, and therefore the parameter estimates it generates are not affected by the event. Consequently, from the regression analysis described, and given the assumptions of the model, the measure for the abnormal return estimates is:

$$\xi_{i\tau} = AR_{i\tau} = R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau} \tag{2.9}$$

Equation (2.9) shows that the abnormal returns $AR_{i\tau}$ of commodity i during the event window can be computed as the difference between the actual commodity returns and its expected returns, which are measured using the parameter estimates from Equation (2.9).

In the final step, once the abnormal returns for the event window were estimated, I used hypothesis testing to test if these returns were significantly different from zero. In the event study literature, the focus has almost always been on testing the mean of the distribution of the abnormal returns. Typically, the null hypothesis showed whether the mean abnormal returns in period τ of the event window were equal to zero. In order to

[12]The description of the model is from Kozicki, Santor and Suchanek (2011)

compute the mean abnormal returns over a sample of firms and for several periods, the abnormal return observations derived from Equation (2.9) were aggregated (MacKinlay, 1997).

Thus far, only abnormal returns for individual observations have been discussed; however, such measures may not capture the whole impact of the event on security prices. It is possible to examine whether a firm's abnormal returns for periods surrounding and including the event date were equal to zero. This is useful if the event was partially anticipated (Kothari and Warner, 2007) or if it was a multiple-period event window (MacKinlay, 1997). In this case, the effects of the event on returns will appear in the pre-event period. In addition, it may useful to estimate the abnormal returns using the post event period because it will provide some insight into the efficient market hypothesis (Kothari and Warner, 2007). The measure to estimate abnormal returns over multiple periods for an individual firm is the cumulative average residual method (CAR). This method facilitates an estimate of the abnormal returns of a firm over several event periods. Thus, instead of including only the abnormal returns on the event date, the abnormal returns for some period around the event date can be estimated. The CAR starting at time τ_1 through time τ_2 is measured as the sum of the abnormal returns for each period:

$$CAR(\tau_1, \tau_2) = \sum_{\tau=\tau_1}^{\tau_2} AR_\tau \tag{2.10}$$

Next, it is possible to aggregate the abnormal returns across multiple firms to evaluate if a particular group of firms experienced abnormal returns. The most popular measure of aggregation across securities and time is the average abnormal return measure (AAR). This measure allows the researcher to determine if a particular event is, on

average, associated with a change in security returns for a group of firms. More formally, for a sample of N securities, the cross-sectional mean abnormal return for any period τ is:

$$AAR_{\tau} = \frac{1}{N}\sum_{i=1}^{N} AR_{i\tau} \tag{2.11}$$

Indeed, the average abnormal return measure (AAR) serves as a measure of the average total impact of a particular event across all the securities in the event window or one of its samples (MacKinlay, 1997).

Finally, I also aggregated across securities and time by summing the average abnormal returns for N firms over τ in the event window. This measure is the cumulative average abnormal return (CAAR):

$$CAAR_{\tau_1,\tau_2} = \sum_{\tau=\tau_1}^{\tau_2} AAR_{\tau} \tag{2.12}$$

Note that τ in this case contains several periods contained in the event window. Together, the AAR and the CAAR represent the aggregate effect on the abnormal returns, especially if the event not only had an impact on the event day but also on the days included in the event window (Serra, 2004). So far, I have presented several measures of abnormal returns for specific event days, across a group of firms, across time, and across both firms and time; however, these measures do not indicate if the abnormal returns were statistically significant. Without establishing the statistical significance of the abnormal return measures, I cannot say with certainty that the abnormal response of the returns were the result of the event. Unless the measures are statistically significant, the abnormal responses could be attributed to luck (Benninga, 2008).

2.4.4 The Statistical Significance Of Abnormal Returns

So far, I have described event studies as an analysis intended to identify stock market responses to various event types. However, besides identifying whether a stock price responds, event studies can also specify if the response to an individual shock is statistically significantly different from zero and thus not the result of other factors at work in the economy.

In order to test if the event was the cause of the abnormal returns, I used hypothesis testing. Specifically, at all stages of the analysis, I tested whether the measures of abnormal returns (AR, CAR, AAR, CAAR) were significantly different from zero.

In order to test the statistical significance I use hypothesis testing where the null hypothesis indicates no abnormal returns within the event window; and the alternative hypothesis shows that there are abnormal returns within the event window. The parametric test statistics that will allow me to either reject or accept the null hypothesis are based on the classic t test (Yolsal, 2011). The traditional t test relies on the assumption that the average abnormal returns are normally, independently, and identically distributed through time (Kozicki et al., 2011). Thus, the test statistic is:

$$t_{AR,CAR} = \frac{AR_{it}}{\sigma_{AR_{it}}} \tag{2.13}$$

where $\sigma_{AR_{it}}$ is the true standard deviation of the abnormal returns. Unfortunately, because it is unknown, I used the standard deviation from each firm in the market model σ_{ϵ_i} as an approximation. The estimation standard deviation and the event standard deviation will move toward equality with a larger sample. In addition AR_{it} could be CAR_{τ_1,τ_2}, AAR_{τ}, or $CAAR_{\tau_1,\tau_2}$ in which case the test statistic becomes:

$$t_{AAR,CAAR} = \frac{AAR_t}{\sigma_{AAR}} \tag{2.14}$$

where σ_{AAR} is the true standard deviation of the abnormal returns for all the securities over the entire event window.[13] Similarly to the previous test statistics the estimated standard deviation from the market model is used as an approximation.

From the preceding discussion, it is clear that event study analysis requires a clear identification of certain parameters. The first are the event dates to be studied, and the second is the length and position of both the event and estimation windows. To capture the implications of the event, the choice of length for the event window should be based on whether some information leakage existed before the event and on whether capital markets may have needed some time to adjust after the event. The choice of estimation period depends on which period prior to the event was considered "normal," meaning that the returns on the stock moved similarly, compared to the reference market; further, the choice of estimation period depends on data availability (Benninga, 2008).

2.4.5 Empirical Approach: An Event Study on the Reaction of Stock Prices to LSAP News

Before presenting the results of the event study, I present a brief description of the parameters specific to this event study. I discuss the event dates, followed by an explanation of the choice and length of the estimation and event windows.

[13]The standard deviation used for the t test of the CAARs has to be adjusted for the number of days in the event window

LSAP I	
Date	Announcement
November 25, 2008	The Federal Reserve will purchase "up to $100 billion in GSE direct obligations" and "up to $500 billion in MBS." —**(H)**
December 16, 2008	The FOMC "stands ready to expand its purchases of GSE debt and MBS" and is also "evaluating the potential benefits of purchasing long-term securities." —**(S)**
January 28, 2009	The FOMC "is prepared to purchase longer-term Treasury securities." —**(S)**
March 18, 2009	The FOMC "anticipates...exceptionally low levels of the federal funds rate for an extended period." It will also purchase "up to an additional $750 billion of agency mortgage-backed securities," "up to $100 billion" in agency debt, and "up to $300 billion of longer-term Treasury securities over the next six months." —**(H)**
August 12, 2009	The FOMC "decided to gradually slow the pace of Treasury purchases" ("up to" language with reference to Treasury purchases is also removed) —**(S)**
September 23, 2009	The FOMC "will gradually slow the pace of agency MBS purchases" ("up to" language with reference to agency MBS purchases is also removed) —**(S)**
November 4, 2009	The FOMC "will purchase...about $175 billion of agency debt" ("up to" language with reference to agency debt is also removed) —**(H)**
LSAP II	
Date	Announcement
August 10, 2010	The FOMC will reinvest "principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury securities." —**(H)**
August 27, 2010	In a speech, Chairman Bernanke announces that "additional purchases of longer-term securities... would be effective in further easing financial conditions." —**(S)**
September 21, 2010	The FOMC "is prepared to provide additional accommodation if needed." —**(S)**
November 3, 2010	The FOMC "intends to purchase a further $600 billion of longer-term Treasury securities by the end of the second quarter of 2011, a pace of about $75 billion per month." —**(H)**

MEP	
Date	Announcement
August 9, 2011	The FOMC announced that it will "maintain its existing policy of reinvesting principal payments from its security holdings." The Committee will regularly "review the size and composition of its securities holdings and is prepared to adjust those holdings as appropriate." —**(S)**
September 21, 2011	The FOMC "intends to purchase, by the end of June 2012, $400 billion of Treasury securities with remaining maturities of 6 years to 30 years and to sell an equal amount of Treasury securities with remaining maturities of 3 years or less." —**(H)**
June 20, 2012	The FOMC "decided to continue through the end of the year its program to extend the average maturity of its holdings of securities." An accompanying statement by the Federal Reserve Bank of New York clarified that this continuation will "result in the purchase, as well as the sale and redemption, of about $267 billion in Treasury securities by the end of 2012." —**(H)**

LSAP III	
Date	Announcement
August 22, 2012	The FOMC announced that "additional monetary accommodation is likely." —**(S)**
September 13, 2012	The FOMC announced the launch of a new $40 billion per month, open-ended, purchasing program of MBS. —**(H)**
December 12, 2012	The FOMC announced the purchase of longer-term securities at a pace of $45 billion per month. —**(H)**

2.4.5.1 Identifying the Event Dates

Although to date, no studies have analyzed how LSAP announcements affect stock prices, several studies have used an event study methodology to identify how announcements that contained new information about LSAPs affected interest rates (Gagnon et al., 2011; Hancock and Passmore, 2011; Krishnamurthy and Vissing-Jorgensen, 2011).

This paper uses the LSAP event dates already identified in the literature. The complete list of dates is provided below:[14]

2.4.5.2 Identifying the Estimation Window and the Event Window

Note that the dates have also been separated between "hard" events and "soft" events. The hard announcements include LSAP amounts and/or a clear LSAP timeline while the soft event include rumors or hints regarding the future course of monetary policy. The next step was to identify the estimation and event windows. As mentioned previously, the estimation window should be as long as possible in order to approximate more accurately the returns during normal times and traditionally has the same length for all firms included in the sample (MacKinlay, 1997; Benninga, 2008). The estimation window started on July 19, 1999, and ended on September 30, 2008, for a total of 2,315 days. It should be noted that the length of the estimation window and each firm's market capitalization caused the sample of firms in each sector to exclude some firms from consideration.

Specifically, because in this event study, I analyzed how the stock prices of firms from different sectors responded to LSAP announcements, I needed stock market data from several firms grouped according to the different sectors. Unfortunately, because of data limitations, not all the firms from each sector could be included in the event study. In some cases, the stock market data of the firm did not begin until a date after the start of the estimation window; in such a case, the firm was not included in the sample. However, in most of those cases, the start date was after the start of LSAPs.

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[14]The dates and announcement formulation are from Woodford, M. 2012. "Methods of Policy Accommodation at the Interest-Rate Lower Bound." Paper presented at The Changing Policy Landscape. Jackson Hole Economic Symposium. Federal Reserve Bank of Kansas City. The dates were selected following an extensive survey of the literature and of FOMC announcements.

Moreover, many of the firms that were not included in the sample had a small market capitalization relative to those that were. In general, the firms that were included in the sample had the largest market capitalization, meaning they were good representative samples of each sector under consideration.

The event window was five days long, with two days before the event date and two days after the event date. The event window should be relatively short in order to make sure that the movements in the stock prices can be attributed to Federal Reserve announcements regarding LSAPs. The reason I included two days before the event was because I sought to determine if some anticipation effects occurred as shareholders anticipated Federal Reserve news. If there were anticipation effects, I would have expected the abnormal returns in the days preceding the event to be positive, similar in magnitude to the abnormal returns on the day of the event, and statistically significant. I included two days after the event to evaluate how long it took for the effects of the announcement to disappear and to allow for lagged reactions to the announcements by some market participants.

2.5 Results

2.5.1 Financial Sector Abnormal Returns

The results presented in the Table 2.2 show that although both financial and nonfinancial sectors experienced abnormal returns, some sectors had greater abnormal returns than others. In addition, each round of LSAPs and the MEP had a different impact on abnormal returns. According to Table 2.2, the results from the primary dealer sector indicate that overall primary dealers experienced positive abnormal returns from LSAPs. Looking at the AARs we see that they are statistically significant at the 1% level and

positive on the day before the event (1.00%), on the day of the event (1.72%)and two days after (0.52%). Moreover, the CAARs are also statistically significant at the 1% level, they also point to LSAPs having a positive impact on the stock returns of primary dealers. On the day of the announcement the CAAR was 2.79% and two days after it was 2.40%. Other than the primary dealer sector, the commercial bank sector also experienced some positive abnormal returns. As Table 2.2 shows, the overall abnormal returns (both the AARs and the CAARs) were positive and statistically significant at the 1% level for commercial banks but not as large as for primary dealers. Overall, the AAR was 0.91% and the CAAR was 2.45% on the day of the event. The last financial sector that benefited from LSAPs overall was consumer services. The abnormal returns are statistically significant at the 1% level. The AAR was 1.16% two days before the event and 0.87% on the day of the event so there was an impact on their stock returns even though it was smaller than for primary dealers and commercial banks. Looking at the overall impact of LSAPs is informative but taking a closer look at the effects of the individual rounds, and their differences, can provide some insights into the most effective design for this type of unconventional monetary policy.

The two rounds that caused the largest abnormal returns for the financial sectors were LSAP I and the MEP. As Table 2.2 shows, primary dealers experienced positive abnormal returns from LSAP I announcements. Both the AAR and the CAAR were statistically significant at the 1% level and positive starting two days before the event onward. The CAAR remained positive two days after the event and reached 6.15%, the AAR was 3.83% but became negative the day after. The other financial sectors also experienced abnormal returns as a result of LSAP I. Commercial banks had AAR of 1.17%, broker-dealers of 1.15% and consumer services of 1.07% and in all three cases there was some anticipation as the AARs were positive on the days preceding the event. However, the effects are short-lived as the AARs become negative on the day after the

event. The CAARs tell a similar story, in the case of primary dealers and commercial banks the CAARs are 7.09% and 4.66%, they remain high until the end of the event window. The effects are more short-lived for broker-dealers and consumer services. LSAP II and LSAP III did not have an impact. These rounds probably did not lead to abnormal returns because they were smaller than LSAP I and in the case of LSAP II it did not include the purchase of MBS. Another reason is that those rounds were anticipated. The Federal Reserve had hinted prior to the start of those rounds that further monetary easing was expected.

The findings are different for the MEP. The abnormal returns (both the AARs and the CARRs) are statistically significant at the 1% level but they are often negative. The AARs are positive on the day of the event for primary dealers (0.98%), commercial banks (2.34%) and consumer services (2.36%). However, they are negative on the day before and on the day after and they return to positive two days after the event. The CAAR are not statistically significant on the day of the event. This means that the round of LSAPs that was the largest and included the purchase of both MBS and Treasury securities positively affected the stock returns of the financial sectors; however, the rounds that included only Treasury securities or attempted to twist the yield curve did not have as strong an effect. Another important consideration is that LSAP II and the MEP were more anticipated than LSAP I. From this and considering that LSAP II and the Maturity Extension Program were intended to lower long-term interest rates or flatten the yield curve (which proves to be less profitable than a steeper yield curve for banks who act as intermediaries), it was not unexpected that these rounds did not have as much of an effect, or had a negative effect compared to the rounds that were intended to target specific segments of the market that were experiencing (and leading to) most of the liquidity problems. Moreover, the MEP started during a time when the financial stress index spiked and recessionary fears had resurfaced. This would have hindered the

positive effects of LSAPs on stock prices. Evidence from primary dealers and the other financial sectors reveals that LSAPs had a considerable positive impact on stock prices overall, but the largest round that included agency debt and MBS purchases was more powerful.

The findings for the financial sector indicate that of the sectors under consideration, primary dealer banks experienced the greatest positive abnormal returns from LSAP announcements. This can be most likely be explained by the role that primary dealers play as direct counterparties with the Federal Reserve and because they are the largest financial institutions. Other than primary dealers, commercial banks also experienced some positive abnormal returns from LSAP announcements. Large liquidity injections most likely alleviated liquidity concerns that plagued many banks' balance sheets and improved overall market confidence and therefore boosted stock prices.

Table 2.2: Abnormal Returns for the Financial Sector

	AAR (T Stat)				CAAR (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
Overall								
-2	0.08 (0.48)	0.97*** (6.53)	0.02 (0.11)	1.16*** (4.81)	0.08 (–0.48)	0.97*** (6.53)	0.02 (0.11)	1.16*** (4.81)
-1	1.00*** (6.23)	0.59*** (3.94)	0.17 (0.80)	-0.32 (-1.31)	1.07*** (3.35)	1.55*** (5.24)	0.19 (0.46)	0.85 (1.75)
0	1.72*** (10.74)	0.91*** (6.12)	0.22 (1.04)	0.87*** (3.61)	2.79*** (5.81)	2.45*** (5.53)	0.41 (0.65)	1.71*** (2.37)
1	-0.91*** (-5.71)	-1.53*** (-10.34)	-1.24*** (-5.91)	-1.01*** (-4.18)	1.88*** (2.94)	0.92 (1.56)	-0.83 (–0.99)	0.71 (0.73)
2	0.52*** (3.22)	0.81*** (5.46)	0.78*** (3.74)	0.42* (1.73)	2.40*** (2.99)	1.73*** (2.34)	-0.05 (-0.04)	1.12 (0.93)

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Table 2.2 – continued from previous page

	AAR (T Stat)				CAAR (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
LSAP I								
-2	0.66*** (2.63)	2.27*** (9.84)	0.54* (1.64)	2.25*** (5.98)	0.66*** (2.63)	2.27*** (9.84)	0.54* (1.64)	2.25*** (5.98)
-1	2.60*** (10.43)	1.23*** (5.32)	0.52 (1.60)	-0.32 (-0.86)	3.25*** (-6.53)	3.49*** (7.58)	1.06 (1.62)	1.93** (2.56)
0	3.83*** (15.35)	1.17*** (5.07)	1.15*** (3.51)	1.07*** (2.83)	7.09*** (9.47)	4.66*** (6.74)	2.21** (2.25)	2.99*** (2.65)
1	-1.39*** (-5.57)	-1.13*** (-4.92)	-1.28*** (-3.90)	-0.72* (-1.93)	5.70*** (5.71)	3.52*** (3.83)	0.93 (0.71)	2.27 (1.50)
2	0.45* (1.82)	-0.18 (-0.78)	0.00 (0.01)	-0.84** (-2.22)	6.15*** (4.93)	3.34*** (2.90)	0.93 (0.57)	1.43 (0.76)
LSAP II								
-2	-0.53 (-1.60)	-0.22 (-0.72)	-0.03 (-0.08)	0.36 (0.72)	-0.53 (-1.60)	-0.22 (−0.71)	-0.03 (−0.08)	0.36 (0.71)
-1	-0.52 (-1.56)	0.99*** (3.26)	0.49 (1.13)	1.10** (2.22)	-1.05 (-1.58)	0.78 (1.27)	0.46 (−0.53)	1.46 (1.47)
0	-0.39 (-1.19)	-0.17 (-0.55)	-0.69 (-1.59)	-0.32 (-0.65)	-1.44 (-1.45)	0.61 (0.67)	-0.23 (−0.18)	1.14 (0.76)
1	-0.27 (-0.82)	-1.22*** (-3.99)	-0.76* (-1.76)	-0.69 (-1.39)	-1.71 (-1.30)	-0.61 (−0.50)	-0.99 (−0.57)	0.45 (0.22)
2	0.17 (0.52)	0.20 (0.66)	0.01 (0.02)	0.24 (0.48)	-1.54 (-0.93)	-0.41 (-0.27)	-0.98 (−0.46)	0.68 (0.27)
MEP								
-2	-1.28*** (-3.36)	0.37 (1.04)	-0.99** (-1.98)	0.55 (0.95)	-1.28*** (-3.35)	0.37 (1.04)	-0.99** (−1.99)	0.55 (0.95)
-1	-0.69* (-1.81)	-1.14*** (-3.24)	-1.47*** (-2.95)	-2.45*** (-4.26)	-1.97*** (-2.59)	-0.77 (−1.10)	-2.46*** (−2.46)	-1.90* (−1.65)
0	0.98*** (2.58)	2.34*** (6.65)	-0.29 (-0.58)	2.36*** (4.11)	-0.99 (−0.86)	1.56 (1.48)	-2.75* (-1.83)	0.46 (0.26)
1	-1.9*** (-4.99)	-3.79*** (-10.78)	-2.88*** (-5.76)	-2.41*** (-4.19)	-2.89* (−1.89)	-2.23 (-1.58)	-5.63*** (−2.82)	-1.95 (−0.85)
2	1.79*** (4.69)	4.45*** (12.66)	3.91*** (7.83)	3.77*** (6.55)	-1.10 (−0.57)	2.23 (-1.27)	-1.72 (−0.69)	1.82 (0.63)

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Table 2.2 – continued from previous page

	AAR (T Stat)				CAAR (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
LSAP III								
-2	0.89** (2.33)	0.10 (0.30)	-0.09 (-0.18)	0.30 (0.53)	0.89** (2.32)	0.10 (0.30)	-0.09 (–0.18)	0.30 (0.52)
-1	0.96** (2.51)	0.26 (0.73)	0.55 (1.11)	-0.06 (-0.11)	1.84** (2.42)	0.36 (0.51)	0.46 (0.47)	0.24 (0.21)
0	0.35 (0.93)	0.29 (0.831)	-0.23 (-0.46)	0.52 (0.90)	2.19* (1.92)	0.65 (0.62)	0.24 (0.16)	0.76 (0.44)
1	0.33 (0.87)	-0.60* (-1.71)	-0.15 (-0.31)	-0.70 (-1.22)	2.53* (1.66)	0.05 (0.04)	0.08 (0.04)	0.05 (0.02)
2	-0.16 (-0.41)	0.27 (0.77)	0.51 (1.02)	0.23 (0.40)	2.37 (1.25)	0.32 (0.18)	0.59 (0.24)	0.28 (0.09)

Note: The event study uses daily data from CRSP. The estimation window is from July 16^{th} 1999 to September 30^{th} 2008. The event window begins 2 days before the event and ends 2 days after. Abnormal returns are computed as the difference between actual returns and expected returns. The expected returns are estimated using the market-price model that relies on OLS regression analysis. The Average Abnormal Returns (AAR) are the average of the abnormal returns over all the events in each round of LSAPs. The Cumulative Average Abnormal Returns (CAAR) are the sum of the AAR. All returns are expressed in percentage. The t-statistics are in parentheses.

2.5.2 Nonfinancial Sector Abnormal Returns

Table 2.3 shows that the effects of LSAPs on the nonfinancial sectors were weaker compared to the financial sectors. Overall, LSAPs did not have an effect on any of the nonfinancial sectors except for homebuilding with AAR of 1.62% that is statistically significant at the 1% level on the event day. As we mentioned previously looking at the individual rounds provides more insights into LSAPs. If we look at LSAP I, it did have a positive effect in the case of real estate, homebuilding and auto-manufacturing. The AARs are positive and statistically significant at the 1% level the day before the event, on the day of the event and the day after. They become negative two days after the event. Homebuilding was most affected, the AAR was 4.15% on the day of the event, in the case of auto-manufacturing it was 1.08%. However, the day after the event, the auto-

manufacturing sector has abnormal returns of 1.60% compared to 1.05% in the case of homebuilding and 0.95% for real estate. The results for real estate and homebuilding can be explained by the fact that these sectors were targeted through the purchase of MBS. The goal of purchasing non-Treasury securities was to stimulate the housing market and in the case of LSAP I this seems to have been successful.

The CAARs also indicate that LSAP I had the largest impact on abnormal returns for the homebuilding and auto-manufacturing sectors. Looking first at the homebuilding sector, the CAARs in the case of LSAP I were statistically significant at the 5% level and positive on the day before the event, on the day of the announcement (statistically significant at the 1% level) and for the following day (statistically significant at the 10% level). On the day of LSAP I announcements the CAAR reached 2.86% and the following day it was 3.15%. Similar results were found for auto manufacturing, the CAARs are statistically significant at the 10% level on the announcement day and statistically significant at the 1% level for two days following the event day. On event day they are 2.09% and they reach 3.70% two days after. The greater effects of LSAP I are most likely due to the types of assets that were purchased, the size of the round and the monetary surprise. The purchased assets included MBS which would help the real estate sector and the homebuilding sector and they were much larger than in the case of LSAP III which also involved the purchased of MBS.

Despite some success for the first round, the other rounds did not have a similar effect. Just like for the financial sector, LSAP II and LSAP III had no effect (except for homebuilding) and in the case of the MEP, when the AARs were statistically significant, they were often negative. For example, on the day of MEP announcements, the AAR for the construction sector was -1.37% and statistically significant at the 10% level, for the real estate sector the AAR was -2.88% and statistically significant at the 1%

level, for the homebuilding sector AAR was -0.98% and statistically significant at the 1% level, and the auto manufacturing sector the AAR was -1.21% and statistically significant at the 5% level. It is worth noting that two days after the event date in all four sectors, the AARs became positive, reaching 1.96% in real estate, 1.72% in construction, 1.50% in the auto manufacturing sector, and 1.28% for the homebuilding sector (all were statistically significant at the 1% level except for construction that was significant at the 5% level). This means that the effects of the MEP took more time to be reflected in stock prices than in the case of the financial sector. I expected the MEP to have a positive effect on stock prices of the nonfinancial sector because lower long-term interest rates should encourage households to take out loans, or repay existing debt which depend on longer-term interest rates. The negative effects of the MEP could be attributed to the difficult economic conditions of the time. Even though the turmoil in financial markets had mostly subsided, the economy was recovering very slowly and recessionary fears resurfaced around MEP announcements. It is also possible that the Federal Reserve's announcements regarding LSAP signaled that the economy was still facing some difficulties. This could also explain why the results for LSAP II and LSAP III indicate that those rounds were not as effective at raising stock prices. Looking at LSAP II, both the AAR and the CAAR are often not statistically significant or if they are they are (in the case of homebuilding) the abnormal returns tend to be negative. For the real estate sector, LSAP II was not statistically significant on any of the event days. This is also true for construction and auto-manufacturing; very few event days are statistically significant.

These findings indicate that like in the financial sector, not all the nonfinancial sectors benefitted from LSAPs in the same way. The homebuilding and real estate experienced the largest abnormal returns especially during LSAP I. This finding can be explained by the size and surprise of that round. LSAP I targeted MBS as well as

Treasury securities, it was intended to reduce the cost and increase the availability of credit for home purchases as well as to support the housing market in general. The liquidity injections improved conditions in the mortgage lending and housing markets, benefiting real estate and homebuilding. The results indicate that widening the range of assets purchased by the Federal Reserve to target specific troubled sectors does support these sectors. Therefore the purchases of MBS and agency debt were successful in fostering improved conditions in the housing market as intended. Unfortunately, the auto manufacturing and construction sector did not experience the same benefits. The differences between sectors can most likely be explained by the fact that the purchased assets were more closely related to the functioning of the real estate and homebuilding sectors and by the fact that auto-manufacturing may be more sensitive to on medium-term interest rates than long-term interest rates.

These findings are similar to the results of the financial sector. Indeed, the nonfinancial sectors experienced some benefits from LSAP I but overall, the effects of LSAPs on nonfinancial sector stock prices were weak. This means that the portfolio rebalancing channel worked in the case of the Federal Reserve counterparties and commercial banks but its effects were weaker for the other sectors including nonfinancial. Essentially, evidence from this paper indicates that the mechanisms described by monetary theory regarding the impact of monetary policy on asset prices when short-term interest rate are at the zero lower bound were not as strong as expected.

Table 2.3: Abnormal Returns for the Nonfinancial Sector

	AAR (T Stat)				CAAR (T Stat)			
	Real Estate	Home Building	Construction	Auto	Real Estate	Home Building	Construction	Auto
Overall								
-2	0.09 (0.37)	-0.56*** (-3.53)	-0.26 (-0.83)	-0.17 (-0.70)	0.09 (0.36)	-0.56*** (-3.53)	-0.26 (-0.70)	-0.17*** (-2.65)
-1	0.21 (0.86)	0.68*** (4.28)	0.10 (0.31)	0.42* (1.73)	0.30 (0.62)	0.12 (0.38)	-0.17 (0.52)	0.25 (-0.92)
0	-0.33 (-1.32)	1.62*** (10.11)	-.015 (-0.47)	0.32 (1.32)	-0.02 (-0.03)	1.74*** (3.62)	-0.31 (0.78)	0.56 (0.40)
1	0.34 (1.41)	-0.08 (-0.50)	-0.36 (-1.15)	0.65*** (2.68)	0.33 (0.33)	1.66*** (2.59)	-0.67 (1.26)	1.21*** (3.09)
2	-0.33 (-1.34)	-0.57*** (-3.55)	0.03 (0.1)	0.01 (0.04)	0.01 (0.00)	1.09 (1.36)	-0.64 (-0.64)	1.21 (1.00)
LSAP I								
-2	0.16 (0.42)	-1.96*** (-7.88)	-1.09** (-2.24)	-0.31 (-0.84)	0.16 (0.42)	-1.96*** (-7.88)	-1.09** (-2.23)	-0.31 (-0.84)
-1	1.50*** (3.89)	0.67*** (2.69)	0.62 (1.26)	1.33*** (3.54)	1.66** (2.15)	-1.29*** (-2.59)	-0.47 (-0.49)	1.01 (1.35)
0	0.30 (0.80)	4.15*** (6.64)	0.29 (0.59)	1.08*** (2.88)	1.97* (1.70)	2.86*** (3.82)	-0.76 (-0.52)	2.09* (1.86)
1	0.95** (2.47)	0.29 (-1.18)	1.05** (2.15)	1.60*** (4.27)	2.92* (1.89)	3.15*** (3.16)	0.28 (0.14)	3.70*** (2..46)
2	-0.72* (-1.88)	-1.68*** (-6.73)	-0.07 (-0.14)	0.01 (0.01)	2.20 (1.14)	1.47 (1.18)	0.21 (0.09)	3.70** (1.97)
LSAP II								
-2	0.29 (0.57)	0.85*** (2.58)	-0.66 (-1.02)	-0.05 (-0.10)	0.29 (0.57)	0.85*** (2.58)	0.65 (1.02)	-0.05 (-0.10)
-1	-0.25 (-0.49)	1.89*** (5.72)	0.13 (0.20)	0.08 (0.16)	0.04 (0.04)	2.74*** (4.14)	0.79 (0.61)	0.03 (0.03)
0	-0.10 (-.019)	-0.91*** (-2.76)	0.82 (1.28)	-0.04 (-0.08)	-0.05 (-0.03)	1.83* (1.85)	1.61 (0.83)	-0.01 (0.00)
1	0.11 (0.22)	0.13 (-0.39)	-1.09* (-1.69)	0.02 (0.05)	0.06 (-0.03)	1.96 (1.48)	0.52 (0.20)	0.01 (0.00)
2	-0.38 (-0.75)	-0.23 (-0.69)	-0.48 (-0.74)	-0.45 (-0.91)	-0.32 (-0.13)	1.73 (1.05)	0.05 (0.01)	-0.44 (-0.18)

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Table 2.3 – continued from previous page

	AAR (T Stat)				CAAR (T Stat)			
	Real Estate	Home Building	Construction	Auto	Real Estate	Home Building	Construction	Auto
MEP								
-2	-0.44 (-0.75)	0.55 (1.43)	-0.55 (-0.74)	-0.36 (-0.63)	-0.44 (-0.75)	0.55 (1.43)	-0.55 (-0.74)	-0.36 (-0.63)
-1	-1.57*** (-2.66)	-0.48 (-1.26)	-1.35* (-1.81)	-1.09* (-1.90)	-2.01* (-1.71)	0.07 (0.09)	-1.90 (-1.28)	-1.45 (-1.26)
0	-2.88*** (-4.89)	-0.98*** (-2.58)	-1.37* (-1.84)	-1.21** (-2.11)	-4.89*** (-2.77)	-3.27 (-0.80)	-3.66 (-1.46)	-2.66 (-1.55)
1	-0.72 (-1.23)	-2.12*** (-5.57)	-2.30*** (-3.09)	-0.25 (-0.43)	-5.61** (-2.38)	-5.57** (-2.00)	-5.97* (-1.87)	-2.91 (-1.27)
2	1.96*** (3.32)	1.28*** (3.35)	1.72** (2.31)	1.50*** (2.61)	-3.65 (-1.24)	-1.77 (-0.93)	-3.85 (-1.03)	1.41 (-0.49)
LSAP III								
-2	0.19 (0.32)	-0.30 (-0.77)	0.73 (0.98)	0.20 (0.36)	0.19 (0.32)	-0.30 (-0.77)	0.73 (0.98)	0.20 (0.36)
-1	-0.39 (-0.66)	0.28 (0.72)	0.28 (0.38)	0.25 (0.43)	-0.20 (-0.17)	-0.02 (0.03)	1.02 (0.68)	0.45 (0.39)
0	0.44 (0.75)	1.68*** (4.42)	0.11 (0.15)	0.55 (0.95)	0.24 (0.14)	1.66 (1.45)	1.13 (0.51)	1.00 (0.58)
1	0.32 (0.55)	0.81** (2.13)	-0.72 (-0.96)	0.14 (0.25)	0.57 (0.24)	2.47 (1.62)	0.41 (0.14)	1.14 (0.50)
2	-1.64*** (-2.79)	-0.27 (-0.71)	-0.74 (-1.00)	-0.90 (-1.56)	-1.07 (-0.36)	2.20 (1.15)	-0.33 (-0.09)	0.24 (0.09)

Note: The event study uses daily data from CRSP. The estimation window is from July 16^{th} 1999 to September 30^{th} 2008. The event window begins 2 days before the event and ends 2 days after. Abnormal returns are computed as the difference between actual returns and expected returns. The expected returns are estimated using the market-price model that relies on OLS regression analysis. The Average Abnormal Returns (AAR) are the average of the abnormal returns over all the events in each round of LSAPs. The Cumulative Average Abnormal Returns (CAAR) are the sum of the AAR. All returns are expressed in percentage. The t-statistics are in parentheses.

2.5.3 The Impact of Hard Announcements Compared to Soft Announcements

With the previous results in mind, we decided to separate the announcements into hard and soft announcements. The hard announcements involve the mention of actual

LSAP amounts while the soft announcements reflect hints or more subtle announcements regarding the expected path of monetary policy. The results are presented in Tables 2.4 and 2.5 In the case of the financial sector, we see that separating the events leads to more pronounced abnormal returns. In the case of hard events for LSAP I all the AARs are positive on the events days and in the case of primary dealers and commercial banks there is some anticipation.[15] We also notice that the average abnormal returns of primary dealers are the largest at 3.01% compared to 2.95% for commercial banks, 2.27% for broker-dealers and 1.36% for consumer services (all the AARs are statically significant at the 1% level). Once again the abnormal returns are short-lived as they become negative the day after the announcement. The results are different in the case of soft events. They are not as significant but they seem to have been more anticipation. They also have short-lived effects as they no longer have an impact the day after the event. The only financial sector that benefits from both hard and soft announcement is the primary dealer sector. They experience positive and statistically significant at the 1% level, average abnormal returns of 2.89% on the announcement day. Similarly to the previous results, even when the announcements are separated it seems that LSAP II and LSAP III had no effect on stock returns. These rounds were greatly anticipated and therefore were not monetary policy surprises, this means that financial markets had time to adjust prior to the announcement.

The effects of hard events are also more pronounced in the case of the MEP. We noted previously that the MEP had both positive and negative effects on stock returns. By separating the announcements we can see that the results in Table 2.2 are driven by the response to hard announcements. Indeed, the abnormal returns in the case of soft

[15]The evidence of some anticipation especially in the case of financial sectors such as primary dealers may indicate that there were some leaks. In April 2017, some evidence surfaced that the Chairman of the Federal Reserve of Richmond, Jeffrey Lacker, had leaked information to a hedge fund adviser

announcements are smaller than for hard announcements. For example, on hard event days, the commercial bank sector experienced AARs of 3.86% that were statistically significant at the 1% level, while on soft event days they did not have an effect. The effect was also greater on the day preceding the event and for the two days following. The same can be said for broker-dealers and consumer services. On hard event days, the average abnormal returns for consumer services reached 4.01% and was statistically significant at the 1% level, compared to no effect for soft announcements. For broker-dealers, when the AARs are statistically significant they are always more responsive in the case of hard announcements. Moreover, the positive and negative effects we noted in Table 2.2 follow the change that we see in the case of hard announcements. The rounds of unconventional monetary that had the greatest effect on stock returns (LSAP I and the MEP) provide evidence that announcements that are more transparent in the sense that they mention actual liquidity injection amounts and/or their timeline are more powerful than hints regarding changes in monetary policy.

Turning to the nonfinancial sector, separating the announcements provides a different picture of how LSAPs affected the stock returns of some sectors. From Table 2.5, we see once again that the hard announcements seem to have more impact than the soft announcements. In the case of LSAP I, the average abnormal returns for the hard announcements are more statistically significant and more responsive than when the announcements are not separated. For example, the average abnormal returns in the real estate sector are 1.42% on hard event days and statistically significant at the 1% level while they do not respond when the events are not separated. They are also consistently higher in the homebuilding and auto manufacturing sectors. For the auto manufacturing sector on hard event days the AAR is 1.88% and statistically significant at the 1% level and they day after they are 4.65% and significant at the 1% level while they are 1.08% and 1.60% when the events are considered together. Similarly to the financial

sector, the hard announcements tend to generate greater abnormal returns indicating that the response to soft announcements is pushing the returns to be more moderate. This is supported by the fact that the soft announcements are more often than the hard announcements not statistically significant. Other than for homebuilding, LSAP II and LSAP III did not have an effect on stock returns.

Turning to the MEP, similarly to LSAP I the average abnormal returns are more sensitive to hard announcements. According to Table 2.5, the soft announcements often did not have an impact on the average abnormal returns. The AARs are all statistically significant on hard event days and on the days before and after, this is not the case for soft announcements, that tend to be statistically significant after the announcement day. The abnormal returns experienced by both the financial and the nonfinancial sectors as a result of hard announcements, provide further evidence in favor of the portfolio rebalancing channel. Both targeted and non-targeted sectors experienced abnormal returns as a result of large-scale asset purchase announcements but when the announcements include clear news regarding the amount and the timeline, the response is even more notable.

Table 2.4. Abnormal Returns for the Financial Sector by Event Type

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
LSAP I								
-2	1.80*** (4.73)	4.91*** (13.97)	0.90* (1.82)	1.01** (2.03)	-0.65 (-1.59)	0.28* (0.92)	0.65 (1.30)	3.97*** (6.91)
-1	2.65*** (6.96)	1.75*** (4.98)	0.99** (2.28)	-0.80 (-1.61)	1.80*** (4.43)	0.83*** (2.73)	0.37 (0.75)	0.28 (0.48)
0	3.01*** (7.90)	2.95*** (8.40)	2.27*** (5.25)	1.36*** (2.73)	2.89*** (7.53)	-1.21*** (3.98)	-0.65 (-1.30)	0.71 (1.25)

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Table 2.4 – continued from previous page

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
1	-0.75** (-1.96)	0.48 (1.36)	-2.60*** (-6.02)	-1.14** (-2.29)	-1.69*** (-4.12)	-2.34*** (-7.69)	0.53 (1.05)	-0.02 (-0.03)
2	-0.04 (-0.10)	-0.09 (-0.25)	-0.24 (-0.55)	-0.28 (-0.55)	0.83** (2.04)	0.25 (-0.81)	0.28 (0.55)	-1.61*** (-2.79)
LSAP II								
-2	-0.78* (-1.68)	-0.73* (-1.69)	-0.61 (-1.00)	1.17* (1.66)	-0.27 (-0.58)	0.29 (0.68)	0.54 (0.88)	-0.45 (-0.64)
-1	-0.35 (-0.74)	1.05** (2.43)	1.16* (1.89)	1.25 (1.78)	-0.68 (-1.46)	0.94** (2.18)	-0.18 (−0.29)	0.95 (1.35)
0	-1.00** (-2.13)	0.60* (1.66)	-1.06* (-1.73)	0.39* (0.55)	0.20 (0.44)	-0.94** (-2.22)	-0.32 (−0.53)	-1.04 (-1.48)
1	-1.10** (-2.36)	0.86** (-2.00)	0.08 (0.13)	-1.55** (-2.20)	0.56 (1.20)	-1.57*** (-3.65)	-1.60*** (−2.62)	0.17 (0.24)
2	-0.03 (-0.06)	-0.29 (-0.67)	0.49 (0.80)	0.25 (0.36)	0.37 (0.80)	0.69 (1.60)	-0.47 (−0.77)	0.22 (0.31)
MEP								
-2	-0.77 (-1.65)	1.16*** (2.70)	-0.75 (-1.22)	1.20* (1.70)	-2.30*** (-3.50)	-1.23** (-2.01)	-1.47* (−1.70)	-0.75 (-0.94)
-1	-1.83*** (-3.94)	2.72*** (6.30)	-2.59*** (-4.23)	-4.09*** (-5.81)	-1.60** (2.43)	-3.07*** (-5.10)	0.76 (0.87)	0.84 (1.05)
0	1.13** (2.43)	3.86*** (8.97)	0.01 (0.02)	4.01*** (5.69)	0.91 (1.39)	-0.71 (-1.17)	-0.87 (-1.01)	-0.94 (-1.18)
1	2.56*** (5.40)	-4.50*** (-10.45)	-3.23*** (-5.27)	-2.88*** (-4.09)	-0.07 (-0.11)	-2.37*** (-3.89)	-2.19** (-2.53)	-1.47* (-1.83)
2	2.82*** (-6.04)	4.84*** (11.23)	4.90*** (8.00)	4.43*** (6.29)	0.23 (0.34)	3.68*** (6.05)	1.94** (2.24)	2.45*** (3.05)

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Table 2.4 – continued from previous page

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services	Primary Dealers	Commercial Banks	Broker Dealers	Consumer Services
LSAP III								
-2	0.92** (1.97)	0.59 (1.37)	-0.14 (-0.23)	0.53 (0.75)	0.82 (1.24)	-0.86 (-1.42)	0.02 (0.02)	0.30 (0.52)
-1	0.48 (1.02)	0.24 (0.57)	0.42 (0.69)	0.26 (0.37)	1.91*** (2.89)	0.28 (0.46)	0.81 (0.94)	0.24 (0.21)
0	0.40 (0.86)	0.65 (1.51)	-0.17 (-0.27)	0.61 (0.87)	0.26 (0.39)	-0.43 (-0.70)	-0.35 (-0.41)	0.76 (0.44)
1	0.62 (1.33)	-0.49 (-1.14)	0.20 (0.32)	-0.79 (-1.12)	-0.25 (-0.37)	-0.82 (-1.34)	-0.85 (-0.99)	0.05 (0.02)
2	0.11 (0.24)	-0.08 (-0.19)	0.17 (0.28)	-0.31 (-0.43)	-0.70 (-1.05)	0.98 (1.60)	1.18 (1.37)	0.28 (0.09)

Note: The event study uses daily data from CRSP. The estimation window is from July 16^{th} 1999 to September 30^{th} 2008. The event window begins 2 days before the event and ends 2 days after. Abnormal returns are computed as the difference between actual returns and expected returns. The expected returns are estimated using the market-price model that relies on OLS regression analysis. The Average Abnormal Returns (AAR) are the average of the abnormal returns over all the events in each round of LSAPs. All returns are expressed in percentage. The t-statistics are in parentheses.

Table 2.5. Abnormal Returns for the Nonfinancial Sector by Event Type

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Real Estate	Home Building	Construction	Auto	Real Estate	Home Building	Construction	Auto
LSAP I								
-2	1.00** (1.98)	-5.46*** (-14.33)	-0.12** (-0.15)	-0.46 (-0.80)	-0.96 (-1.63)	0.66** (1.99)	-1.82*** (-2.83)	-0.21 (-0.41)
-1	1.95*** (3.93)	4.53*** (11.89)	0.63 (0.85)	1.39** (2.43)	1.67*** (2.81)	-2.22*** (-6.74)	0.60 (0.94)	1.28** (2.58)
0	1.42*** (2.79)	6.11*** (16.03)	-1.15 (-1.55)	1.88*** (3.28)	-1.18** (-2.00)	2.68*** (8.12)	0.36 (0.56)	0.48 (0.97)
1	0.97* (1.91)	2.25*** (5.91)	3.61*** (4.85)	4.65*** (8.12)	0.92** (1.96)	-1.17*** (-3.56)	-0.87 (-1.36)	-0.68 (-1.37)
2	-0.56 (-1.10)	-2.66*** (-6.97)	-0.01 (-0.01)	1.99*** (3.48)	-0.94 (-1.60)	-0.95*** (-2.87)	-0.12 (-0.18)	-1.50 (-1.58)

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Table 2.5 – continued from previous page

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Real Estate	Home Building	Construction	Auto	Real Estate	Home Building	Construction	Auto
LSAP II								
-2	0.41 (0.57)	-0.06 (-0.13)	0.53 (0.59)	-0.44 (-0.63)	0.17 (0.24)	1.77*** (3.78)	0.78 (0.86)	0.34 (0.48)
-1	-0.10 (-0.14)	2.83*** (6.07)	0.83 (0.91)	0.15 (0.21)	-0.60 (-0.83)	0.94** (2.02)	-0.56 (-0.62)	0.01 (0.02)
0	-0.25 (-.35)	1.81*** (3.88)	0.01 (0.01)	0.30 (0.43)	0.05 (0.07)	-0.01 (-0.02)	1.63* (1.79)	-0.38 (-0.54)
1	0.33 (0.46)	1.17** (2.50)	-0.36 (-0.40)	0.51 (0.73)	-0.10 (-0.14)	-0.91* (-1.95)	-1.82** (-2.00)	-0.47 (0.67)
2	-0.57 (-0.79)	0.25 (0.52)	-0.87 (-0.95)	-0.09 (-0.13)	-0.19 (-0.27)	-0.71 (-1.52)	-0.08 (-0.09)	-0.81 (-1.15)
MEP								
-2	0.26 (0.35)	-0.74 (-1.58)	-0.88 (-0.96)	0.33 (0.47)	-1.84* (-1.81)	-2.90 (4.39)	0.11 (0.09)	-1.74* (-1.76)
-1	1.92*** (2.65)	-0.74*** (-1.59)	3.28*** (3.60)	-2.32*** (-3.32)	-0.88 (-0.86)	-0.04 (-0.05)	2.52* (1.95)	1.39 (1.40)
0	-3.69*** (5.11)	-1.52*** (-3.25)	1.72* (1.89)	-1.43** (-2.04)	-1.26 (-1.23)	-0.20 (-0.30)	0.67 (0.52)	-0.77 (-0.67)
1	-1.02 (-1.42)	-3.29** (-7.04)	-1.97** (-2.17)	2.10*** (2.99)	-0.11 (-0.10)	-0.12 (-0.18)	-2.96** (-2.30)	-0.97 (-0.98)
2	2.32*** (3.22)	1.17 (2.51)	2.55*** (2.80)	1.99*** (2.84)	1.95* (1.90)	1.64** (2.48)	0.05 (0.04)	0.50 (0.52)

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Table 2.5 – continued from previous page

	AAR (Hard Events) (T Stat)				AAR (Soft Events) (T Stat)			
	Real Estate	Home Building	Construction	Auto	Real Estate	Home Building	Construction	Auto
LSAP III								
-2	0.97 (1.35)	0.51 (1.10)	1.50* (1.65)	0.24 (0.34)	-1.38 (-1.35)	-1.91*** (-2.89)	-0.81 (-0.63)	0.13 (0.14)
-1	0.07 (0.09)	1.16** (2.49)	0.45 (0.50)	0.44 (0.63)	-1.29 (-1.27)	-1.50** (-2.27)	-0.06 (-0.04)	-0.14 (-0.15)
0	-0.14 (-0.19)	1.32*** (2.82)	0.56 (0.62)	1.09 (1.55)	1.61 (1.58)	2.41*** (3.66)	-0.78 (-0.61)	-0.54 (-0.55)
1	0.01 (0.01)	1.07** (2.28)	-0.36 (-0.39)	0.58 (0.83)	0.95 (0.93)	0.30 (0.46)	-1.43 (-1.11)	-0.74 (-0.75)
2	-1.46** (-2.03)	-0.81* (-1.74)	-0.59 (-0.65)	-0.96 (-1.36)	-2.00** (-1.97)	0.81 (1.23)	-1.05 (-0.81)	-0.77 (-0.78)

Note: The event study uses daily data from CRSP. The estimation window is from July 16^{th} 1999 to September 30^{th} 2008. The event window begins 2 days before the event and ends 2 days after. Abnormal returns are computed as the difference between actual returns and expected returns. The expected returns are estimated using the market-price model that relies on OLS regression analysis. The Average Abnormal Returns (AAR) are the average of the abnormal returns over all the events in each round of LSAPs. All returns are expressed in percentage. The t-statistics are in parentheses.

2.5.4 Implications for Unconventional Monetary Policy and Stock Market Returns

Overall, LSAPs and the separate rounds caused positive and statistically significant abnormal returns for most of the financial sectors; however, overall the nonfinancial sectors (with the exception of homebuilding) experienced more modest if any benefits from LSAPs. In addition, the positive abnormal returns were often larger for the financial sector especially primary dealers and commercial banks. Despite being more favorable to some of the financial sectors overall, when we look more closely at the individual rounds we notice that the LSAP rounds that included the purchases of agency debt and MBS impacted the homebuilding, the real estate and the auto manufacturing sectors although not always positively especially in the case of the MEP. Another important finding is that LSAPs were most advantageous to the primary dealer and commercial

bank sectors. This means that the portfolio rebalancing channel worked in the case of the Federal Reserve counterparties but its effects were weaker for the other sectors. This finding is in line with the Federal Reserve intending to strengthen a weakened financial sector through LSAPs.

Moreover, the results from this paper and the addition of systemically important financial institutions as Federal Reserve counterparties are clear indications that one of the goals of LSAPs was to prevent the total collapse of the financial sector. This goal seems to have been achieved, and the positive impact of LSAPs was demonstrated by the increase in large banks' stock returns. Unfortunately, it seems that the effects did not ripple out to other sectors and instead remained concentrated mostly within the sector that benefited from trading proximity with the Federal Reserve. Indeed, with regards to the effectiveness of the monetary policy actions undertaken by the Federal Reserve to cushion the impact of the financial crisis on other sectors, the conclusions are mixed and broadly in line with the literature. The first round had a positive impact on stock returns, the MEP had a mixed effect with the AARs being positive on event days but LSAP II and LSAP III had no effect. The lack of impact from LSAP announcements on the stock returns of some sectors has been observed in the literature (Joyce et al., 2011; Kozicki et al., 2011; Coibion et al., 2012; Rosa, 2012). This paper provides evidence that the validity of the portfolio rebalancing theory is limited. For the rebalancing theory to be deemed fully valid, the impact of LSAPs on stock returns should have been similar for the various sectors of the economy—the impact on the primary dealers was expected to spread to the rest of the economy through rebalancing. Separating the events into hard and soft announcements mitigates this finding as the average abnormal returns are higher when the event includes a clear timeline and the amount of the liquidity injections.

The abnormal returns from this chapter reflect the speculative behavior of stock returns. We see that in the case of the unexpected rounds like LSAP I, the abnormal returns are positive up until the announcement day and they turn negative the next day. This speculative behavior in stock returns is also known as "buy the rumor, sell the news." This means that the rumor of a big announcement will drive stock returns up but the actual news will have the opposite effect. This explains why the abnormal returns decrease right after the announcement. The MEP also reflects this phenomenon, on the day of the announcement the abnormal returns are positive and they turn negative the next day. To a lesser extent this speculative behavior is also reflected in the rounds that were expected such as LSAP II and LSAP III. The abnormal returns are not statistically significant because traders had already adjusted to the announcement even though it came at a later date. Overall, the impact of LSAPs on stock returns is mixed. However, it seems that the results of LSAP I are the most promising. If we compare the different rounds, we notice that LSAP II was anticipated, much smaller than LSAP I and included only the purchase of long-term Treasuries. The MEP had both positive (for financials) and negative (for nonfinancials) effects on stock returns but it was not a true round of LSAP and it was intended to twist the yield curve rather than just lower long-term interest rates. Lastly, LSAP III included MBS purchases but it was open ended and smaller than LSAP I. From this comparison it appears that the size, the composition and the surprise of LSAP are important determinants for its success.

2.5.5 Implications for Monetary Policy Conducted at the Zero-Lower Bound:

This paper also has implications for the conduct of monetary at the zero lower bound. It seems that monetary policy conducted at the zero lower bound may not be as effective as the theory described. The first step of the transmission channel that links the Federal Reserve with its counterparties was successful. However, the rest of

the transmission mechanisms were much weaker and did not spread to the rest of the economy as sectors further removed from trading with the Federal Reserve did not experience abnormal returns that were as high (this is true for both financial and nonfinancial sectors). It is possible that the effects of LSAPs did not spread as anticipated to all the sectors because the economy had experience a severe downturn that impacted financial markets, followed by a slow recovery.

The failure of primary dealers to act as transmitters has been documented in the literature (Williamson, 2008; Ledoit, 2011; Jagtiani and Brewer, 2009). For example, Coibion et al. (2012) stated, "If some agents frequently trade in financial markets and are affected by changes in the money supply prior to other agents, then an increase in the money supply will redistribute wealth toward those agents most connected to financial markets." Considering that primary dealers are the largest financial institutions in the United States, they are also most connected to financial markets. The unconventional monetary policy actions used by the Federal Reserve were intermediated by primary dealers, and because the market for assets such as MBS and corporate bonds depends on the financial health of these intermediaries, their role in the transmission channel was essential. Given the severity of the recent financial crisis it is possible that the balance sheets of these institutions had been weakened or that a lack of confidence in the market prevented normal operations to resume. Although LSAPs were often discussed as a credit policy they had the dual goal of also supporting struggling, large and systemically important financial institutions. In Chapter 3, we find that LSAPs did not impact credit markets to the same extent as they impacted financial markets. The results from Chapter 4 explain these findings. In Chapter 4 we provide detailed evidence that LSAPs actually strengthened the balance sheets of primary dealers. We also find that the liquidity injections were mostly hoarded by primary dealers. This explains why despite the increase in the monetary base, there has not been an increase in the money

supply. The results from Chapter 4 reinforce the results from Chapter 2, the effects of LSAPs were concentrated within the financial sector and more particularly primary dealer banks. The effects did not ripple out enough to restore credit markets to their pre-LSAP activity level.

2.6 Conclusion

In conclusion, the impact of Large-Scale Asset Purchases on stock market returns is mixed. Financial sectors did experience abnormal returns and this is especially true of the sector trading directly with the Federal Reserve: primary dealers. Although other financial and nonfinancial sectors also benefitted from LSAP I, that is the largest round that included the purchase of MBS. The results from this paper seem to indicate that despite the success of LSAPs at lowering long-term interest rates and increasing some stock returns, the design of this type unconventional monetary policy tool has to be carefully crafted. According to the findings of this paper, the size, the composition, the surprise and the transparency of the rounds are important considerations for large-scale asset purchases.

Given the mixed success of LSAPs, it is worth discussing whether their implementation was optimal or if it could have benefited from increased flexibility. The recent implementation of LSAPs included an announcement by the Federal Reserve regarding the type, the timing, and the quantity of the assets it planned on purchasing. This announcement was followed by the Federal Reserve simply carrying out those decisions (Gagnon et al., 2010). The Federal Reserve appeared fully committed to a predetermined future course of action. However, the efficiency of the Federal Reserve may have increased if it had exhibited more flexibility in response to economic conditions. Unexpected changes in the economic environment cannot be ruled out even when the Federal

Reserve is committed to its policy announcements. For this reason, monetary authorities may consider adopting an approach that allows greater responsiveness to economic and financial conditions (Bullard, 2010). Increased responsiveness of monetary policy according to incoming information would allow the Federal Reserve to adopt a more active monetary policy to accommodate shocks and remain effective during periods of near-zero interest rates. However, flexible monetary policy also has a drawback: It may undermine the credibility of the Federal Reserve. As mentioned previously, the credibility of a central bank can amplify the effects of monetary policy. If agents are unclear of the central bank's intended policy path, they are less likely to respond to Federal Reserve policy news appropriately, thus making monetary policy less influential. Increased communication and transparency from the Federal Reserve seems to mitigate this problem as announcements that include a clear timeline and the amount of the purchases have a greater impact on the stock returns.

In 2008, considering the economic climate, interest rates at the zero lower bound, and the failure of primary dealer Lehman Brothers, it seems the Federal Reserve had few options at its disposal—if not to rescue the financial system, at least to avoid a catastrophic collapse of financial markets. The economy, already in a fragile state, would have most likely plunged into a depression if the Federal Reserve had not been creative with its unconventional monetary policy actions. Even though some LSAP rounds did not stimulate the stock returns of all sectors in the economy, the Federal Reserve ultimately acted as a lender of last resort, injecting liquidity into the economy through dealer banks to avoid further damage. Therefore, in sum, the effects of LSAPs may have initially been overestimated and its impact on stock returns may not have been as predicted. However, LSAPs also helped the financial system remain afloat and prevented economic conditions from worsening.

Because the financial crisis was global, the Federal Reserve was not the only central bank adopting unprecedented monetary actions during the 2007-2008 financial crisis. In 2001, the Bank of Japan also began using unconventional monetary policy in the form of adopting a higher target for bank reserves. In 2008, the European Central Bank announced its first measure of quantitative easing: It would lend as much as banks wanted at a fixed-rate (as long as the banks had collateral). The European Central Bank also expanded the list of eligible collateral. Finally, in 2009, the Bank of England reluctantly engaged in traditional LSAPs and established the Asset Purchase Facility (APF) to purchase private assets in order to ease specific credit conditions. Given these different forms of unconventional monetary policy actions, future research should try to determine which type of unconventional monetary policy was most effective. Another interesting question is whether LSAPs would have affected US stock returns if the quantity of assets purchased by the Federal Reserve had been greater.

Chapter 3

DID LOWER LONG-TERM INTEREST RATES STIMULATE DEMAND FOR CREDIT?

3.1 Introduction

The 2007 financial crisis began with the burst of the housing market bubble, triggered by rising mortgage defaults resulting from the excessively relaxed lending policies of financial institutions. The losses experienced by financial institutions, particularly the systemically important ones, shook the confidence in financial markets, which caused liquidity to dry up. Financial institutions at all stages of intermediation experienced serious liquidity problems and could no longer provide or acquire credit from other economic agents. The freeze in credit markets or the "credit crunch" was a major contributor to the slow-down in economic activity and rising unemployment. The events surrounding the beginning of the recent crisis (see overarching introduction for more details) point to the recent crisis being both an economic and a financial crisis. For this reason, any policy intervention would have to help to restore stability in the financial sector as well as improve credit terms and conditions in order to increase growth and lower unemployment.

The initial response of the Federal Reserve was conventional. It lowered its target

interest rate in an attempt to stimulate borrowing, investment and spending (Woodford, 2012). However, in December 2008 the federal funds rate hit the zero lower bound (ZLB). With economic conditions still deteriorating, the Federal Reserve decided to further ease monetary policy by targeting long-term interest rates. This is why it decided to use its own balance sheet as a tool for monetary policy. The use of alternative monetary policy by the Federal Reserve in order to overcome the ZLB raises important questions regarding the effectiveness of monetary policy when short-term interest rates hit that limit.

In Chapter 2, the change in the size and the composition of the Federal Reserve's balance sheet triggered the economic mechanisms linking Large Scale Asset Purchases (LSAPs) to stock prices (i.e. scarcity and duration channels). In this chapter, the change in the size and composition of the Federal Reserve's balance sheet trigger the interest rate channel or bank lending channel of monetary policy. Theoretically it is that channel that links LSAPs to credit markets. Its mechanisms were explicitly explained by Chairman Janet Yellen.[1] Chairman Yellen explained that LSAPs were intended to lower long-term interest rates, in order to boost credit which in turn, would stimulate investment and consumption by businesses and households, which in turn would boost aggregate demand and output and ultimately, employment. The mechanisms described by Chairman Yellen refer to the interest rate channel of monetary policy. Two mechanisms are behind this transmission channel: the balance sheet channel and the bank lending channel.

Under the interest rate channel, liquidity injections and changes in the interest rate, induced by the Federal Reserve, lead to changes in both lenders and borrowers balance sheets (and income statements) and therefore influences credit demand and

[1]See "The Economic Outlook and Monetary Policy" (2015) by Janet Yellen `http://www.federalreserve.gov/newsevents/speech/yellen20151202a.htm`

supply. According to these two channels, monetary policy in the form of large-scale liquidity injections and low interest rates, affects how easily banks and other financial institutions can raise funds available for lending and therefore their loan supply, it also makes credit cheaper and alleviates the debt burden of economic agents (Kashyap and Stein, 1994). Through both effects, a decrease in the interest rate should stimulate credit markets by increasing credit demand and supply (Kashyap and Stein, 1994). Essentially, LSAPs were supposed to alleviate both solvency and liquidity problems of financing institutions that caused financial market freeze and in turn, reduce credit market frictions by lowering long-term interest rates. By injecting large volumes of liquidity into the balance sheets of a select group of weakened financial institutions (extending its set of counterparties), the Federal Reserve acted as a market maker, hoping to ease the stress on these institutions and encourage them to resume normal business activities including supplying credit to other financial institutions and the broader economy.

Theoretically QE and credit easing policies can be implemented independently from each other. However, they are expected to be more effective when used together (Stone et al., 2011). The Federal Reserve combined the two instruments when designing LSAPs. This means that both the size and the composition of the Federal Reserve's balance sheet were altered. The choice between pure QE or pure credit easing or a mix depends on the state of the economy and on the desired degree of flexibility. When facing a financial and economic crisis a mixed policy can be more successful as it addresses several problems simultaneously. Quantitative easing can restore liquidity to the system and specifically the most troubled financial institutions, while credit easing can help boost credit supply and therefore economic activity, by repairing the channels of credit intermediation (Bernanke and Reinhart, 2004).

Prior to the recent crisis, the Bank of Japan (BoJ) attempted to implement a policy

of Quantitative Easing (QE). This policy resembles credit easing policies such as LSAPs because both involve the use of the central bank's balance sheet for monetary policy when the interest rate is at the ZLB. Despite some differences, the BoJ's QE policy was the most significant implementation of large-scale central bank purchases and it is the monetary policy episode that most resembles the current Federal Reserve policy. In Japan, between 2001 and 2006 the central bank was battling deflation, falling output and financial instability. The response by the BoJ deviated from its traditional policy actions because the target rate was at the ZLB. The BoJ injected large amounts of central bank reserves into the economy. This involved the purchase of government securities as well as allowing a wider range of entities to borrow at the official target rate (Kimura et al., 2003). More recently, the Bank of England and the European Central Bank have also used some form of liquidity injections to stimulate economic activity in response to the financial crisis.

As mentioned before, LSAPs were primarily concerned with lowering long-term interest rates, in an effort to promote lending and restore "normal" banking operations, including financial intermediation. This chapter examines how and if the change in the size and the composition of the Federal Reserve's balance sheet aiming at lowering long-term interest rate under LSAPs impacted credit. It will seek to determine if the large-scale asset purchases undertaken in late 2008 by the Federal Reserve were successful in increasing consumer credit, mortgage credit and business credit, through lower long-term interest rates, and therefore helped to stabilize the economy by boosting output and employment. This chapter will be using data from all three round of LSAPs. It will evaluate if, as a whole, LSAPs did facilitate lending by reducing interest rates. This chapter will also determine if LSAPs improved households and businesses' access to credit, thereby helping sustain consumption and investment demand and therefore promoting economic recovery. The findings of this chapter will provide some evidence

regarding the effectiveness of the unconventional monetary policy actions of the Federal Reserve.

This chapter contributes to the literature on whether the decrease in long-term interest rates caused by LSAPs helped ease credit conditions. A growing body of literature exists on the impact of LSAPs on a variety of interest rates. Recent empirical evidence suggests that LSAPs did decrease not only long-term interest rates but also a range of shorter-term interest rates that matter for household and business credit decisions (Gagnon et al., 2010; Joyce et al., 2011; Bauer and Rudebusch, 2013). However, there exist few studies that analyze the wider impacts of LSAPs on the economy. Only a few studies have attempted to move one step beyond that and analyze the effects of LSAPs on output (Peersman, 2011; Chung et al., 2012b; Joyce et al., 2011) and other macroeconomic variables. Unfortunately, these studies were only able to analyze the effects of LSAP1 and, as described above, all three rounds of LSAPs are important when measuring the impacts of this unconventional monetary policy. This chapter will use data from all three round of LSAPs, to shed some light on how the unconventional monetary policy actions of the Federal Reserve impacted consumer credit, mortgage credit and business credit during the financial crisis. Using four different long-term interest rates related to each credit market to measure monetary policy, three different credit variables, and measures of expectations and economic activity, this chapter will determine whether the decrease in long-term interest rates stimulated any of these credit variables. The findings of this chapter will provide empirical evidence on both the effectiveness of the interest rate channel of monetary policy and the effectiveness of LSAPs in easing credit conditions. The results can provide some guidance to policymakers on what are the most efficient monetary policy actions during times of financial crisis and when the financial sector strongly influences the transmission channels of monetary policy.

The chapter is organized as follows: section 3.2 presents the conceptual framework, it reviews the relevant branches of the literature and presents the theoretical foundation for our approach by presenting the interest rate channel of monetary policy; section 3.3 describes the data used to conduct the analysis; section 3.4 presents the ARDL methodology used to test our hypothesis as well as the preliminary and robustness tests required; section 3.5 presents the main findings and section 3.6 concludes.

3.2 Theory and Conceptual Framework

3.2.1 Literature Review

3.2.1.1 Implications of the ZLB for Conventional Monetary Policy

Since late 2008, the short-term interest rate has been at the ZLB, making it impossible for the Federal Reserve to further ease monetary policy as economic conditions kept deteriorating. Starting on September 18, 2007, and ending on December 16, 2008, the federal funds rate target was reduced from 5.25% to a range between 0% and 0.25% (Marc, 2014). The decision to maintain the federal funds rate at the ZLB is unprecedented and causes conventional open market operations as described by Keynesians to become ineffective in providing stimulus to the real economy.

The ZLB has important implications for monetary economic theory. Given that interest rates cannot be significantly negative, the Federal Reserve can no longer rely on its traditional policy instrument and must use another instrument to boost economic activity. In the case of the financial crisis, it appears that the Federal Reserve opted to use its own balance sheet to conduct monetary policy. This took the form of large-scale asset purchases that alter both the size and the composition of the Federal Reserve's balance sheet. The goal is ultimately to reduce long-term interest rates in order to

increase aggregate demand in a similar fashion as the short-term interest rate (Kiley, 2012; Woodford, 2012; Gagnon et al., 2010).

The difference between the impact of short-term interest rates and long-term interest rates on the real economy has been analyzed in the literature and most studies find that short-term interest rate may be more effective because they not only affect aggregate demand but they are also supposed to guide long-term interest rates (Andrés et al., 2004; Chen et al., 2012). However, this does not mean that if the short-term interest rate fails to guide the long-term interest rate as expected (as was the case during the recent crisis) that policy measures designed by the Federal Reserve to reduce the long-term interest rate cannot be effective. In fact, many models account for different interest rates, and some models assume that households and firms are restricted when it comes to trading in the full set of available financial assets. Therefore the different interest rates affect different spending decisions (Kiley, 2012). Moreover, when long-term interest rates decrease it causes the cost of borrowing of "big ticket" items and other productive assets to decrease as well. This leads to an increase in the demand for loans as households are more willing to buy durable goods and services and firms are in a better position to purchase assets to expand their business activities, such as property and equipment.

Before discussing the theories that link monetary policy to credit markets, a brief presentation of the long-term interest rate and of its components is provided followed by some empirical evidence that supports the popular view that LSAPs decreased long-term interest rates.

Following the collapse of Lehman Brothers, the short-term interest rate was almost constrained by the zero lower bound (ZLB), a consequence of the expansionary monetary policy actions of the Federal Reserve prior and at the onset of the crisis. In this context, the Federal Reserve could no longer rely on its traditional monetary policy tool, the

federal funds rate and instead had to use unconventional monetary policy tools. The theoretical reasoning behind the use of LSAPs relies on the assumption that any long-term interest rate can be decomposed as follows:

$$y_{t,t+n} = \overline{y}_{t,t+n} + RP_{t,n} \tag{3.1}$$

where, $y_{t,t+n}$ is the expected real yield at time t on an n-year bond, $\overline{y}_{t,t+n}$ is the average expected overnight rate (short-term) over the next n years at time t, $RP_{t,n}$ is the risk premium on an n-year bond at time t (Fawley and Neely, 2013; Wu, 2014; Stein, 2014). As was described in the second chapter, the central bank can aim at altering any component. In the U.S., LSAPs were intended to reduce the risk premium which is influenced in great part by the term premium. By first announcing its intentions and targeting specific long-term assets, the Federal Reserve hoped that through the portfolio rebalancing channel that includes the duration channel and the scarcity channel, as well as through the signaling channel (or forward guidance) it could lower the term premium and therefore alter the yield and the price of both purchased and non-purchased assets (Gagnon et al., 2010; Bauer and Rudebusch, 2013). The decrease in a wide range of interest rates induced by LSAPs should then stimulate credit.

Recent studies generally find that LSAPs helped reduce long-term interest rates. The empirical literature uses several methodologies and data samples to investigate the relationship between LSAPs and long-term interest rates. The preferred methodology in the literature, which allows for the effects of asset purchases to be isolated, is event studies. This entails measuring changes in yields in a very narrow time window (usually one day) around an official announcement related to bond purchases.[2] Two themes

[2]The description of event studies is from the IMF Report: "Unconventional Monetary Policies-Recent Experience and Prospects" (2013).

emerge from this research. First, although individual estimates differ, this analysis consistently finds that asset purchases have sizeable effects on a variety of long-term interest rates. Second, there remains a great deal of uncertainty about the magnitude of these effects and their impact on the broader economy. For example, Krishnamurthy-Vissing-Jorgensen (2011) finds that LSAP1 and LSAP2 reduced interest rates on long-term Treasuries, Agency bonds, and highly-rated corporate bonds. In addition, the impact on MBS rates is large only when LSAP involves the purchase of MBS. They estimate that on average the rates were decreased by 15 basis point. Bauer and Rudebusch find a similar impact from LSAP1 and LSAP2 of 16 basis point. Gagnon et al. (2011) also use an event study to conclude that LSAP1 had meaningful and long-lasting impact on longer-term interest rates on a range of securities and that those effects reflected a lower risk premia. On average they estimate a reduction of 30 basis points. D'Amico and King (2013) also estimated the impact of Treasury securities purchases during LSAP1 and found that the reduction in long-term Treasury rates was persistent and of 100 basis point on average. Hancock and Passmore (2011) conduct a similar event study but on MBS purchases and they find that the announcements of LSAPs reduced mortgage rates by about 85 basis points.

3.2.1.1.1 Overcoming the Zero-Lower Bound: Alternative Monetary Policy Tools

Conventional monetary policy relies on the short-term interest rate to conduct monetary policy. However, once the federal funds rate reaches the ZLB, policymakers have to rely on different monetary policy tools. As was mentioned previously, the recent unconventional monetary policy actions of the Federal Reserve provide evidence that central banks can successfully place downward pressure on yields of a wide range of

longer-term securities not just the short-term rate (Chabot and Herman, 2013). This is especially relevant in the context of recent policy considerations. The recent use of the long-term yields and in turn interest rates, as the tool for monetary policy confirms that the liquidity trap does not necessarily make it ineffective. Lastly, considering that the recent large increases in the monetary base did not translate into a similar increase in the money supply or into inflationary pressures, it would seem that some of the concerns regarding inflation as a monetary phenomenon in the context of LSAPs did not realize themselves. Some studies explain this disconnect between the monetary base and the money supply by pointing to the accumulation of excess reserves holdings of depository institutions with the Federal Reserve (Edlin and Jaffee, 2009; Mankiw, April 18,2009) (this is discussed in more detail in Chapter 4).

The use by several central banks of their own balance sheets as an alternative monetary policy tool can be justified under both monetarist (Friedman, 1968; Meltzer, 2001) and Keynesian (Brainard and Tobin, 1968; Tobin, 1969) theories. They both build models on the assumption that money and other financial assets are imperfect substitutes (see Chapter 1 for details). On that basis, alternative monetary policy measures designed specifically for the ZLB context have been described in the literature (Bernanke and Reinhart, 2004) but little empirical evidence on their impact exists.

The central banks that are currently using balance sheet policies did not design them in the same way. The differences reflect the different goals of each central bank who responded to a specific economic climate (Shiratsuka, 2010). The literature presents two ways to use the central bank's balance sheet as a monetary policy tool. The first is to change its composition and the second increase its size. These policies do not have to be used together but can often reinforce each other (Bernanke and Reinhart, 2004). Altering the composition can be used to support specific credit markets and improve the

flow of credit in the economy. Changing the size of the balance sheet promotes financial stability by providing a reliable source of liquidity to troubled financial institutions.

Traditionally, most of the assets holdings of the Federal Reserve were in the form of Treasury securities with short maturities. However, this does not have to be the case, as an important participant in the Treasury market, the Federal Reserve is able to influence term premiums and so the overall yield by shifting the composition of its holdings from short term to long term securities (Bernanke and Reinhart, 2004). This means that if investors do not perceive all securities as perfect substitute then if the purchases of the central bank are large enough to significantly alter the demand of a specific type of asset then the purchases can alter the price of not only that asset but also of the assets that investors buy to replace the those the central bank purchased (see Chapter 1 for more detail on the scarcity and duration channels). This reasoning does not only apply to government securities. Indeed, the rebalancing effect that was just described can be triggered using the purchase a wide range of assets, specifically assets that are less liquid and that are blocking the balance sheets of financial institutions.

Consequently, if the central bank wanted to target a specific sector of the economy, it could make targeted asset purchases to alter the prices of the asset holdings in that sector. The sectors that are targeted are often those threatening the stability of the financial system as a whole. By providing them with an emergency source of liquidity, the flow of operations can be restored. The initial purpose of LSAPs was to target the sector blocking credit intermediation. For this reason, using both the size and the composition of the central bank's balance sheet as a tool for monetary policy can promote financial stability and lead to credit easing in specific markets (Bernanke, 2009; King, 2004).

Increasing the size of the central bank's balance sheet can be used in case of liquidity risk. The large increases in the money supply triggered by large-scale purchases of specific types of assets by the Federal Reserve causes investors to rebalance their portfolios in turn reducing the yields and raising the price on a wider range of non-money assets (Bernanke and Reinhart, 2004). If the focus of the central bank is on long-term assets then large-scale purchases of those assets will theoretically reduce their yields and stimulate economic activity. This also reduces liquidity risk if the economy was facing severe credit constraints. There is some evidence that this form of balance sheet policy can boost economic activity even when interest rates are at the zero lower bound (Romer et al., 1990; Chung et al., 2012b). When facing both an economic and financial crisis it is best to use a mix of QE and credit easing in order to give the central bank more flexibility and financial markets more support (Gagnon et al., 2010).

The most notable use of alternative monetary policy resembling LSAPs was in the case of Japan between 1999 and 2006. In 1999, following an episode of deflation, the Bank of Japan (BoJ) introduced the zero interest rate policy (ZIRP). The BoJ committed to keeping the overnight rate at zero until deflationary pressures were under control (Okina and Shiratsuka, 2004). In August 2000, after the year-on-year change in core CPI was above zero the BoJ lifted the ZIRP. However, the slowdown of the world economy and the burst of the dot-com bubble reignited recessionary and deflationary fears. In March 2001, the BoJ announced extraordinary measures that would simultaneously increase its target on bank reserves at the BoJ to 5 trillion yen, while keeping the policy rate at zero and increasing the amount of outright purchases of long-term government bonds (Shiratsuka, 2010). The program ended in 2006 and it is generally accepted that it had much smaller effects than anticipated on macroeconomic variables such as output, inflation and credit (Ugai, 2007). However, QE in Japan did have some benefits. It

stabilized the financial system by alleviating the strains generated by failures of large financial institutions and reversed deflation expectations (Oda and Ueda, 2007).

An early example of using the central bank's balance sheet for monetary policy was Operation Twist conducted in the US in early 1961. The Federal Reserve used the composition of its balance sheet to try and "twist" the yield curve by raising short-term interest rates relative to long-term interest rates. Operation Twist is similar to the Maturity Extension Program that the Federal Reserve started in 2010 (see overarching introduction). It uses open-market operations and Treasury debt management operations to shorten the average maturity of government debt held by the public (Bernanke and Reinhart, 2004). Unfortunately, Operation Twist has been widely described as not having been successful (Modigliani and Sutch, 1966, 1967). The authors note that it was too small to have a significant effect on the maturity of Treasuries. However, other papers (Solow and Tobin, 1987) noted that the Federal Reserve purchases during Operation Twist were small and were quickly offset by increased Treasury issuance of long-term debt (Gagnon et al., 2011).

In 2008, the US economy was experiencing both liquidity issues in the financial system and also a breakdown in credit intermediation. For this reason the Federal Reserve used both the size and the composition of its balance sheet to conduct alternative monetary policy. It provided liquidity to the financial sector (expanding its balance sheet) and also targeted specific markets (the mortgage market), while accepting a wider range of collateral from a wider range of counterparties (changing the composition of its balance sheet). Although the policy designed by the Federal Reserve was an aggressive credit easing policy (Bernanke, 2009) other central banks had different goals. The Bank of England (BoE) proceeded with outright purchases of gilts and corporate bonds to boost the money supply and improve conditions in corporate credit markets; the BoJ

made outright purchases of long-term bonds, asset-backed securities and stocks held by financial institutions in an effort to fight deflation and ensure financial stability (Shiratsuka, 2010). The purpose of the intervention is the main determinant of what policy tool should be used. In the case of the Federal Reserve, lowering long-term interest rates was intended to further ease credit market conditions since the short-term interest rate could no longer be used. In the following section we provide evidence on the success of LSAPs to lower long-term interest rates.

Despite these potential alternatives, many remain skeptical of these unconventional monetary policy measures. The following reasons are often used to justify the lack of confidence. First, even if expansionary monetary policy increases the reserves of the banking system this does not necessarily lead to a multiple expansion of credit. Ultimately, the credit policies adopted by financial institutions determine the availability of credit and not the central bank (Krugman et al., 2007). The central bank can only influence the cost of borrowing and the availability of liquidity. Whether the change in cost is passed on by the bank to its customers and whether the demand for loans actually increases is not in the control of the central bank (Meltzer, Meltzer; Bordo, Bordo). During the recent financial crisis, the monetary base increased sharply however, the money supply (measured by M1, M2 or M3) did not (Gros et al., 2015). The disconnect is explained by banks holding excess reserves with the Federal Reserve. Ultimately, the decision to extend credit remains with banks, the Federal Reserve can only provide incentives.

Secondly, some studies explain that consumption and investment expenditures may not be as sensitive to changes in interest rates as was previously assumed (Meltzer, Meltzer) but instead also depend on changes in net wealth and expectations about future economic activity. Despite the decrease in interest rates, the economic recovery

has been sluggish this does not encourage credit supply or demand. Lastly, some studies have recently re-emphasized the central role played by the financial sector. They explain that the growing role of financial institutions in the monetary transmission channel (see chapter 1 and chapter 2 for a detailed explanation on the role of financial intermediation during the financial crisis) has caused some of the links between monetary policy and real economic indicators to change. When the financial sector is weak, as it was during the recent crisis, it is not difficult to imagine that the mechanisms behind alternative monetary policy actions are weakened or even fail (Hein, 2012; Crotty, 2009; Orhangazi, 2008; Cochrane, Cochrane). In the context of the recent crisis, the rise in financialization since the 1980s and the larger role played by financial institutions in credit intermediation have made the functioning of financial markets increasingly complex. The interlinkages between different financial instruments have come harder to disentangle. This makes predicting the full impact of monetary policy more difficult and increases the probability that the effects of the policy will be weakened beyond their impact on interest rates.

3.2.2 Theoretical Framework

3.2.2.1 The Interest Rate Channel of Monetary Policy during the Financial Crisis

The Federal Reserve's approach to the address the recent crisis seems to rely on the interest rate channel of monetary policy (Gertler and Gilchrist, 1993; Adrian and Shin, 2010b). It can be better described as an interest rate "enhancement mechanism" for traditional interest rate channels of monetary policy. Monetary policy can have an effect on a variety of both short-term and long-term interest rates. For this reason, monetary policy can affect purchases of long-term assets such as housing or production equipment, which respond primarily to long-term interest rates (Bernanke and Gertler, 1995). The interest rate channel argues that the central bank has the ability to both

fine-tune economic outcomes such as output and unemployment and influence business cycles through changes in interest rates (Fontana and Palacio-Vera, 2003; Palley, 1996, 2007). Moreover, the interest rate channel believes that real economic targets such as investment, capacity utilization, growth and output can be influenced using central bank tools such as interest rates (Crotty and Epstein, 2009). The unconventional monetary policy actions by the Federal Reserve align with the interest rate channel. Prior to the start of LSAPs, policymakers explained that the Federal Reserve did intend to alter interest rates in order to stimulate economic activity. It hoped that lower interest rates would ease the credit crunch by encouraging not only borrowing by households and businesses but also lending by banks who had tightened their lending standards considerably compared to previous periods (Hurst and Pugsley, 2011). By facilitating lending, the Federal Reserve hoped to stimulate consumer credit demand for consumption and spending or investment by businesses to expand their activity. The increase in consumption and investment should translate into higher economic growth and in turn boost employment and wages, which would provide another stimulus to aggregate demand.

The interest rate channel relies on several assumptions. First, it assumes that the direct effects of monetary policy on interest rates are amplified because they cause endogenous changes in the external finance premium, which is the difference in cost between funds raised by issuing equity or debt (externally) and funds generated by retained earnings (internally). According to this view, a change in monetary policy that raises or lowers open-market interest rates tends to change the external finance premium in the same direction. Therefore, the traditional impact of monetary policy on the cost of borrowing, and in turn on real spending and real activity, is magnified (Kashyap and Stein, 1994). The interest rate channel also assumes that the actions of the central bank can affect the external finance premium through two channels, the first

is the balance sheet channel, and the second is the bank lending channel. Turning first to the balance sheet channel, this channel explains how changes in monetary policy affect the demand for loans. This channel explains that changes in the interest rate controlled by the central bank leads to changes in borrowers' balance sheets and income statements (including their net worth, cash flow and liquid assets). The second channel or the bank lending channel, on the other hand, focuses on the effects of changes in monetary policy on the supply of loans by depository institutions (Alpanda and Aysun, 2012).[3] A more modern description of the interest rate channel of monetary policy presents the two channels described above as reinforcing one another.

3.2.2.1.1 The Balance Sheet Channel

The balance sheet channel of monetary policy arises because changes in monetary policy not only affect the market interest rates but also the financial positions of borrowers both directly and indirectly (Lettau et al., 2002). For example, tighter monetary policy directly weakens borrowers' balance sheets to the extent that rising interest rates directly increase interest expenses (this is especially true if borrowers have outstanding debt). This increase in interest expenses in turn reduces the borrower's net cash flows and worsens his financial position. Moreover, tight monetary policy and rising interest rates are usually associated with declining asset prices, which directly shrinks the net wealth and collateral value of the borrower causing them to become less creditworthy and therefore making loan acquisitions harder (Igan et al., 2016). The balance sheet channel also describes an indirect link between monetary policy and both net cash flows and collateral values.

[3]Both channels are supported by an extensive literature, including Bernanke (1993), Kashyap and Stein (1994) and Hubbard (1994) amongst others.

The indirect relationship arises because changes in monetary policy cause changes in consumer spending (Gertler and Gilchrist, 1993). Using the same example as above, if monetary policy becomes tighter, this causes interest rates to increase and discourages spending by consumers who now face higher costs of capital and higher interest expenses. This decrease in consumer spending indirectly leads to a decrease in the demand for a firm's goods and services. As a result of this lower consumer demand, the firm's revenues will decline while its various costs of operations do not adjust right away. As the firm's financing gap widens,[4] the firm's net worth and creditworthiness decline overtime. This indirect causality explains why the effects of the balance sheet channel on spending, and more specifically on inventory and investment spending persist for several periods after the initial change in monetary policy. This argument applies to the credit demand side, however, Holmstrom and Tirole (1997) applied the same argument that was described above to the banking sector. The authors found that banks with a lower net worth (as a result of tight monetary policy) supply fewer loans. This finding implies that banks with lower net worth will supply less credit when monetary policy is tightened or economic growth declines. This brings us to the bank lending channel, which focuses on how monetary policy affects credit supply.

3.2.2.1.2 The Bank Lending Channel

The bank lending channel focuses on how changes in monetary policy shift the supply of intermediated credit, particularly loans by banks (Igan et al., 2016). According to this channel, changes in monetary policy cause shifts in banks' loan supply which ultimately leads to changes in investment decisions and other activities of bank-dependent borrowers (Bernanke and Blinder, 1988; Kashyap and Stein, 1994). The mechanisms at

[4]The financing gap is the difference between the funds spent by the firms and the funds coming into the firm (Bernanke and Gertler, 1995).

work begin with the assumption that credit markets are imperfect meaning that banks cannot easily replace lost deposits with other sources of funds (Igan et al., 2016).[5] This assumption implies that contractionary monetary policy, such as open-market sales by the Federal Reserve that decrease banks reserves (and hence deposits) and increase the cost of external funding, has adverse effects on bank lending to the private sector. The decrease in loan supply caused by the increase in the cost of credit will most likely weaken economic activity as the decrease in credit availability leads to a decline in investment and other activities that contribute to growth. Even though borrowers may not be completely shut out from credit markets, they will definitely incur the costs associated with finding a new source of credit. This translates into an increase in the external finance premium, which causes real economic activity to decline.

Moreover, tight monetary policy causes interest rates to increase, which causes bank funding and bank liquidity to decrease and, as a result, banks' willingness to lend also decreases (Berger and Bouwman, 2009; Kiyotaki and Moore, 1997; Iacoviello, 2005). In their seminal paper Bernanke and Blinder (1988) present a model of the bank lending channel in which an increase in the policy rate alters the size and composition of banks' balance sheets; specifically it worsens banks' balance sheets. It is the effects of the interest rate on the balance sheet that explain why contractionary monetary policy limits the supply of bank loans by reducing banks' access to loanable funds. However, in the context of the US economy since the 1980s, the assumption that banks cannot completely offset the decline in liquid funds (induced by tight monetary policy for example) by using other sources of funding has weakened. Indeed, several studies have observed that banks' ability to raise funds on the margin has become less restricted (Romer et al., 1990; Bernanke and Gertler, 1995). This is most likely due to the structural changes

[5]This is because deposits and other sources of funding are imperfect substitutes.

(i.e. deregulation, financialization) that have reformed the US banking sector. The rise of financialization created financial instruments that could be used to raise funds (for example certificates of deposit or new equity issues) and therefore banks can more easily rely on other sources of funding if the external finance premium increases. There is empirical evidence in the case of the US that suggests that small and illiquid banks are more responsive to monetary policy actions and that small banks with low-capital base tend to contract their supply of loans by more than other banks such as "market-based banks,"[6] following the tightening of monetary conditions (Kashyap and Stein, 2000; Kishan and Opiela, 2000; Ashcraft, 2006).

3.2.2.2 How does the Interest Rate Channel of Monetary Policy Theory Relate to the 2007 Financial Crisis?

The interest channel of monetary policy as described above find some applications when it comes to the 2007 financial crisis. The interest rate channel places credit creation as a necessary condition for economic growth. This was true in the context of the 2007 financial crisis, and highlighted the importance of the banking sector and financial intermediaries in the transmission of monetary policy. Indeed, the rise of securitization and the deregulation of the financial market in the last three decades has placed financial intermediaries at the center of the global financial crisis.

Empirical support for the credit view of monetary policy in the context of the financial crisis has highlighted the importance of the balance sheets of financial intermediaries, such as broker dealers and shadow banks, to determine the lending capacity of the banking sector.[7] This is especially true in the US economy where traditional commercial

[6]Market-based banks are funded with managed liabilities and mainly lend to relatively easy-to-evaluate borrowers (Black et al., 2010).

[7]Empirical evidence includes McLeay, Radia and Thomas, 2014; Carpenter and Demiralp, 2010;

banks are no longer the dominant financial intermediaries. Indeed, since the mid-1980s market-based financial intermediaries, such as security broker dealers and ABS issuers, have gained importance in the banking system. According to Adrian and Shin (2010), the importance of broker-dealers in the supply of credit has increased dramatically in recent years with the growth of securitization and the changing nature of the financial system toward one based on the capital market, rather than one based on the traditional role of the bank as intermediating between depositors and borrowers.

The crisis began as a result of a contraction in the balance sheets of several large financial intermediaries. The credit crunch that crippled economic activity began with a few large financial institutions and eventually spread to the rest of the financial sector and to the real economy as these institutions played a crucial role in the functioning of US and international financial markets. During the recent recession, the Federal Reserve expanded its set of counterparties in order to clear the balance sheets of key financial players of illiquid assets. It also accepted a wider range of collateral from its counterparties in order to improve liquidity conditions. In both cases, the measure of the Federal Reserve focused on credit creation to stimulate lending and borrowing.

The Federal Reserve lowered the policy rate to the zero-lower bound partly in order to increase banks' net interest margin,[8] which increases the profitability of bank lending and the present value of bank income. Consequently, the bank's forward-looking measures of bank capital should also rise (through higher value of assets and increases in equity value) allowing banks to expand their balance sheets and therefore the level of credit supply. Note that this increase in credit supply was not feasible under the higher

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Blinder, 2013.

[8]The net interest margin as defined by Adrian and Shin (2010) is the difference between the total interest on the asset side of a banks ' balance sheet and the interest expense on the liabilities side of its balance sheet

policy rate; it is the lower policy rate and the expansion of the bank's balance sheet that allow for greater risk-bearing capacity and therefore increased credit supply (Adrian and Shin, 2010b).

Ultimately, by lowering long-term interest rates, LSAP programs were intended to ease the credit market strains created by the shrinking balance sheets of key financial intermediaries. The Federal Reserve attempted to recapitalize the banking sector by injecting large quantities of assets from its own balance sheet into the balance sheet of private sector financial institutions. The unconventional monetary policy actions used by the Federal Reserve during the recent financial crisis were in line with a version of the interest rate channel of monetary policy that places greater importance on other financial intermediaries, in addition to the banks, than the original theoretical formulation.

3.2.2.3 Empirical Formulation

A growing body of literature exists on the impact of LSAPs on a variety of interest rates. Recent empirical evidence suggests that LSAPs did decrease not only long-term interest rates but also a range of shorter-term interest rates that matter for household and business credit decisions (Gagnon et al., 2010; Joyce et al., 2011; Bauer and Rudebusch, 2013). However, there exist few studies that analyze the wider impacts of LSAPs on the economy. With that in mind, this chapter will examine whether the lower interest rates induced by the unconventional monetary policy actions of the Federal Reserve helped impacted consumer credit, mortgage credit and business credit. Using four different interest rates that should have been influenced by LSAPs, three different measures of credit, different measures of expectations and of economic activity; this chapter will determine if the decrease in the interest rates stimulated any of the credit variables. The results can provide some guidance to policymakers on whether or not LSAPs were the

most efficient form of monetary policy action for credit easing during times of economic and financial turmoil.

3.3 Data

3.3.1 Sources

This paper uses six data sources. The first is the St. Louis Federal Reserve Economic Data (FRED). This database compiles a wide variety of economic and financial series collected from various government agencies such as U.S. Census, the Bureau of Labor Statistics and the Board of Governors of the Federal Reserve System. FRED is an online database consisting of 251,000 economic time series from 79 countries. The series are divided into 9 categories. The categories are academic data, money, banking and finance, national accounts, population, employment and labor markets, production and business activity, prices, international data, US regional data.[9] This source was used to collect data on the various interest rates used in the analysis, the CPI for all items and fixed residential investment as a share of GDP.

The second source of data is the Board of Governors of the Federal Reserve System G-19 Consumer Credit Statistical Release. This database reports outstanding credit extended to individuals for household, family, and other personal expenditures, excluding loans secured by real estate. Total consumer credit comprises two major types: revolving and non-revolving. Revolving credit plans may be unsecured or secured by collateral and allow a consumer to borrow up to a prearranged limit and repay the debt in one or more installments. Credit card loans comprise most of revolving consumer credit measured in the G.19, but other types, such as prearranged overdraft plans, are also

[9]More detail on data description can be found on the FRED website at `http://research.stlouisfed.org/fred2/categories/`

included. Non-revolving credit is closed-end credit extended to consumers that is repaid on a prearranged repayment schedule and may be secured or unsecured. To borrow additional funds, the consumer must enter into an additional contract with the lender. Consumer motor vehicle and education loans comprise the majority of non-revolving credit, but other loan types, such as boat loans, recreational vehicle loans, and personal loans, are also included.[10] These data provide a wealth of information. Changes in total consumer credit outstanding provide an important measure of credit growth. Terms on interest rates, loan size, loan-to-value ratios, and maturity of loans can give economists and borrowers important insights into the ease or difficulty of obtaining credit. This source was used to collect data on consumer credit and household mortgage credit as well as household income.

The third source of data is the Board of Governors of the Federal Reserve System Z-1 Financial Accounts of the United States Statistical Release. This database reports the flow of funds accounts of the United States which are a system of interrelated balance sheets and integrated macroeconomic accounts for the United States. There are two types of balance sheets. The first shows the aggregate assets and liabilities for financial and nonfinancial sectors and the second reports what sectors issue and hold financial assets or instruments of a given type. It measures sources and uses of funds for the economy as a whole and by sector. The flow of funds accounts present both flows and levels of assets and liabilities by sectors and instruments. The sectors included in the flow of funds accounts are households and nonprofit organizations, nonfinancial businesses (corporate and noncorporate), governments (federal, state and local), financial businesses (monetary authority, depositories, insurance and pension funds, investment companies and securitization sectors) and the rest of the world. Some of the instruments

[10]More detail on data description can be found on the Board of Governors of the Federal Reserve System website `http://www.federalreserve.gov/releases/g19/about.htm`

included in the flow of funds accounts are deposits, credit market instruments (open market paper, Treasury and agency securities, municipal securities, corporate bonds, mortgages, consumer credit, and other loans), corporate equities and mutual fund shares, insurance and pension fund reserves, trade credit, security credit and taxes payable.[11] This source was used to collect data on business loans and profit.

The fourth source of data is the Chicago Federal Reserve National Activity Index (CFNAI). The Index is "a weighted average of 85 monthly indicators of national economic activity. The CFNAI provides a single summary measure of a common factor in these national economic data. As such, historical movements in this Chicago Fed index closely track periods of economic expansion and contraction, as well as periods of increasing and decreasing inflationary pressure. The Chicago Federal Reserve's goal in releasing this index monthly is to provide an objective, real-time statistical measure of coincident economic activity derived from a wide range of monthly indicators. Research studies by economists at Harvard University, Princeton University, and the Federal Reserve Bank of Chicago have shown that the CFNAI often provides early indications of business cycle turning points and changes in inflationary pressure." (Chicago Federal Reserve (2013)).[12] The economic indicators used for the CFNAI are in four broad categories: i) production and income, ii) employment, unemployment and hours, iii) personal consumption and housing and iv) sales, orders and inventories. All of the data are adjusted for inflation. Initially, only the aggregate CFNAI was available. However, in 2011 the history of the contributions from each of the four broad categories of indicators became available. The interpretation of the CFNAI is as follows: if the index has a zero value, this indicates that the US economy is expanding at its historical growth rate trend; if it is negative

[11]More detail on data description can be found on the Board of Governors of the Federal Reserve System website at `http://www.federalreserve.gov/releases/z1/about/kennedy-fof-20120628.pdf`

[12]For more detail on the construction of the Index see Background on the Chicago Fed National Activity Index, November 26, 2013.

this indicates below-average growth and positive values indicate above-average growth. This source will be used to collect data on the economic climate that was used to control for economic conditions during the period of analysis.

The fifth source of data is the S&P/Case-Shiller US National Home Price Index. This index is "a composite of single-family home price indices covering 9 US Census divisions. As the broadest national measurement of home prices, the index captures approximately 75% of US residential housing stock by value." (S&P Dow Jones Indices McGraw Hill Financial, 2015). The index is designed to be a consistent benchmark of housing prices in the US. It is based on the work of Robert Shiller and Karl Case and is often considered to be the leading measure of US residential real estate prices. It tracks the changes in the value of residential real estate nationally given a constant level of quality in the homes.[13] This source was used to collect data on residential housing prices in order to estimate the real estate price changes in the home mortgage market.

The last data source is the OECD standardized business and consumer confidence indicators. According to the OECD data, the Business Confidence Index (BCI) is "based on enterprises' assessment of production, orders and stocks, as well as its current position and expectations for the immediate future. Opinions compared to a "normal" state are collected and the difference between positive and negative answers provides a qualitative index on economic conditions."[14] The Consumer Confidence Index (CCI), it is "based on households' plans for major purchases and their economic situation, both currently and their expectations for the immediate future. Opinions compared to a "normal" state are collected and the difference between positive and negative answers provides a qualitative

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[13]For more detail on the construction of the Index see S&P/Case-Shiller US National Home Price Index, Real Estate, 2015

[14]The description can be found on `https://data.oecd.org/leadind/business-confidence-index-bci.htm`

index on economic conditions." [15] This source was used to collect data on business and consumer expectations.

3.3.2 Data Description and Variables

The chapter uses quarterly data from 1980 to 2014, resulting in 138 observations. In order to evaluate the impact of LSAPs on household, mortgage and business credit, separate regressions will be used. One set of regressions will use the 10-year Treasury rate and the other set will include interest rates that are more relevant for the different credit markets. In the case of consumer credit the 24-month loan finance rate on personal loans at commercial banks was used. For mortgage market, the 30-year fixed rate mortgage average was used and the rate on BAA corporate bonds and the AAA corporate bond rate were used for business credit. In order to ensure that these rates were impacted by LSAPs a correlation analysis between the different rates and the 10-year Treasury rate will be conducted. This approach allows us to compare how various credit measures were impacted by different interest rate changes and to determine if some types of credit benefited more from LSAPs than others. Moreover, in order to better understand if the LSAPs had an impact on credit we will run separate regressions on the whole sample from 1980 to 2014 but also on a shorter sample from 1980 to 2006. This allows us to better identify the effects when one adds the LSAP period.

The analysis begins by defining the variables that will serve as measures of the interest rate, credit, and the business cycle.

Following from the theoretical framework, each model must include a variable that serves as a measure of credit and the real long-term interest rate since the tool of the

[15] The description can be found at `https://data.oecd.org/leadind/consumer-confidence-index-cci.htm#indicator-chart`

Federal Reserve was to lower interest rates in order to influence the access to credit of various types. The first measure of credit used in the empirical analysis is the ratio of consumer credit to personal income. This variable is constructed using the FRED series on personal income and the G-19 series on consumer credit. The personal income series is the nominal compensation received by an individual that can be used by households for consumption. The measure used for credit is total nominal consumer credit outstanding in billions of dollars. This variable is an appropriate measure because it includes most short-term and intermediate term credit extended to individuals, excluding loans secured by real estate.[16] Using the ratio allows us to normalize the data so that magnitudes of changes in the variable can be better interpreted and compared across years. The ratio tracks the relationship between consumer credit and personal income, which according to Federal Reserve, is a more adequate measure of consumer credit than a non-normalized credit measure because consumers will not significantly increase their borrowing levels until their personal incomes increase enough to justify the higher debt load. As a result, borrowing may show the largest increase when the economy is already coming out of a recession, rather than during the worst of it.[17] This variable is used by the Conference Board[18] to help assess economic conditions.

Similarly, the second measure of credit is the consumer home mortgage credit normalized by nominal personal income. This variable is constructed using the FRED series on personal income (see above) and the Z-1 series on consumer home mortgages. This series measures the level of home mortgages outstanding held as assets by the govern-

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[16]Definition from The Federal Reserve Board of Governors`http://www.federalreserve.gov/releases/g19/current/g19.pdf`.

[17]See `http://www.investopedia.com/university/releases/consumercreditreport.asp`

[18]The Conference Board is a not-for-profit research organization for businesses that distributes information about management and the marketplace. It is a widely quoted private source of business intelligence.

ment, commercial banks, credit unions, GSEs, ABS issuers and financial companies in billions of dollars. This measure complements the first because it includes loans secured for real estate, which is the main source of debt of most US households. The variable is once again normalized for reasons similar to those provided above.

The last measure of credit is intended to measure the access to credit for nonfinancial corporate businesses. The measure used is the ratio of total nonfinancial corporate business loans to nonfinancial corporate business profits.[19] This credit measure is once again normalized and serves to analyze whether or not nonfinancial businesses were affected differently by the actions of the Federal Reserve than households. Using the three measures described previously provides a more complete picture of the impact of various interest rates on different types of credit available to households and nonfinancial businesses.

Moreover, the model also needs a variable to measure the interest rates since one of the intentions of the LSAPs was to reduce long-term interest rates and it accomplished this goal (see Literature Review for discussion). The interest rate variable is necessary because it links LSAPs and thus monetary policy to credit markets. The long-term interest rate is a central variable in the macroeconomy. It matters to borrowers looking to start a business or purchase a home; to lenders weighing the risks and rewards of extending credit; to savers planning for the future and to policymakers gauging the state of the economy. To conduct the analysis we used five different interest rates: the real 10-year Treasury constant maturity rate, the 24-month finance rate on personal

[19] According to the description provided by the Federal Reserve Board of Governors, the nonfinancial corporate business sector "consists of all private for-profit domestic nonfinancial corporations. S corporations, which have 35 or fewer stockholders and are taxed as if they were partnerships, are included in this sector. Corporate farms are also included. Holding companies and equity real estate investment trusts, or REITs, which are considered financial businesses in the financial accounts, are excluded from this sector." Description of table F.103 in the flow of funds accounts available at `http://www.federalreserve.gov/apps/fof/TableDesc.aspx?t=F.103.`

loans, the 30-year conventional mortgage rate, the AAA bond rate and the BAA bond rate. In order to convert these interest rates into real interest rate we use the CPI. Following from the literature and the Fischer equation, real interest rates are measured by the difference between the nominal rate and the five year unweighted moving average of current and past inflation, measured by the CPI (CBO, 2015).[20] More specifically, we measure the mean CPI for the 5 years preceding and including the actual observation date. This a way to measure inflation expectations that are not observable. Then we subtract this mean from the actual interest rate. This gives us the real interest rate.

Table 3.1. Correlations Between the Interest Rates in First Differences

Variables	Real 10-Year Treas Rate	Real 24-Month Finance Rate	Real 30-year Conventional Mortgage Rate	Real AAA Corp Bond Yield	Real BAA Corp Bond Yield
Real 10-Year Treasury Rate	1				
	—				
Real 24-Month Finance Rate	0.91	1			
	0.00	–			
Real 30-Year Conventional Mortgage Rate	0.99	0.91	1		
	0.00	0.00	–		
Real AAA Corporate Bond Yield	0.99	0.92	0.99	1	
	0.00	0.00	0.00	–	
Real BAA Corporate Bond Yield	0.96	0.88	0.98	0.99	1
	0.00	0.00	0.00	0.00	–

The correlations are between the interest rates in first differences.

[20]This methodology is often used in the literature because inflation expectations are not observable and can also differ between individuals. As a result, measurement of the real interest rate based on nominal rates requires some assumption about "the" expected rate of inflation. See "Long-Term Interest Rates: A Survey, 2015. `https://www.whitehouse.gov/sites/default/files/docs/interest_rate_report_final_v2.pdf`

Even though the effects of LSAPs on long-term interest rates are said to be most visible in the case of the 10-year Treasury rate, the interest rates that consumer face on loans and mortgages as well as the interest rate that influences business decisions closely follow the 10-year Treasury constant maturity rate as we can see from the correlation table presented in Table 3.2. All the correlations are statistically significant and above 0.91. This confirms the findings in the literature regarding the impact of LSAPs on a wide variety of interest rates (not just the 10-year Treasury rate). As was mentioned before, LSAPs' primary purpose was to decrease long-term interest rates. However, the impact on the long-term interest rates was designed to spread to other interest rates including medium-term and shorter-term interest rates, therefore the movements in this long-term interest rate that were induced by LSAPs, will also be reflected in changes in the interest rates on consumer credit.

Lastly, components of the CFNAI, the ratio of the Case-Shiller Home Price Index to the CPI, the business and consumer confidence indices and fixed residential investment to GDP are also included as controls for movements in household, mortgage and business credit markets as well as consumer, homebuyer and business expectations. The model intended to evaluate the reaction of consumer credit to real long-term interest rates includes the consumption and housing component of the CFNAI as it tracks more closely movements in consumer spending (and therefore their need for credit) than the overall CFNAI. The personal consumption and housing component includes personal consumption expenditures, real retail sales and the number of privately-owned new housing units that began construction in the reporting month. The personal consumption and housing component of the CFNAI will serve as a control for the movements in the business cycle. Another control will be the consumer confidence index. This index is added to account for changes in consumer expectations and to track changes in their consumption patterns.

The second model, intended to evaluate how the long-term interest rate impacted consumer mortgage credit, also includes the Case-Shiller home price index over the CPI for all items and fixed residential investment over GDP. Similarly, to the analysis for consumer credit the variables are added to track changes in real estate prices and to control for changes in households' expectations of the residential housing market. Indeed, changes in housing prices influence households' ability to purchase homes for which they need mortgages. In addition, fixed residential investment which consists of "residential structures and of residential equipment that is owned by landlords and pretend to tenants. Residential structures consists of new construction of permanent-site single family and multifamily units, improvements (additions, alterations, and major structural replacements) to housing units, expenditures on manufactured homes, brokers' commissions on the sale of residential property, and net purchases of used structures from government agencies. Residential structures includes some types of equipment that are built into the structure, such as heating and air conditioning equipment."[21] Therefore, fixed residential investment indicates if the housing market is expanding or not, assuming that a higher level of fixed residential investment points to an expanding housing market and vice versa.

The third model, intended to determine how the long-term interest rate impacted business credit, also includes the sales, orders and inventories component of the CFNAI and the business confidence index. This component includes retail trade inventories, real manufacturing and trade sales, new orders of consumer goods and materials, manufacturing and wholesale trade as well as inventory to sales ratio for wholesale and retail trade amongst others. Similarly to the two previous models, these variables are added to control for movements in businesses' expectations regarding production, orders and

[21]The definition is extracted from A Guide to the National Income and Product Accounts of the United States.

stocks now and in the future. They also control for changes in the business cycle that are more suited to the operations of businesses. Indeed, businesses' needs for credit vary with actual and expected changes in the business cycle. They impact the price and the demand of the goods and services businesses provide. If orders and sales are expanding, businesses are more likely to require credit in order to meet the increasing demand, the same can be said if they expect their orders and sales to increase. Moreover, the reverse is also true, if orders and sales are declining.

3.3.3 Summary Statistics

The summary statistics are provided in Table 3.2 The sample is split into pre- and post-LSAP period in order to identify how the variables changed before and after LSAPs. In terms of the credit variables, we can see that in all three cases credit declined, even becoming negative at times in all three cases. In the case of consumer credit to personal income we see that the mean of the change in that variable was 1.19% prior to LSAP and fell by nearly half to 0.5%. This pattern is also seen in the case of mortgage credit to personal income and business loans to profit. In the case of mortgage credit, the change in the ratio was 0.49% to -0.03% and for business loans it went from 100.12% to 49.36%.

Table 3.2: Summary Statistics

Pre-LSAPs

Variable	**Obs**	**Mean**	**Std. Dev**	**Min**	**Max**
Real 30-year Conventional Mortgage Rate	115	8.19	2.59	4.91	15.36
Real 24-month Finance Rate	115	13.19	1.36	10.33	16.84
AAA Bond Yield	115	7.65	2.14	4.50	13.07

Continued on Next Page

Table 3.2: Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
BAA Bond Yield	115	8.73	2.45	5.39	15.09
Real 10-year Treasury Rate	115	6.39	2.39	2.91	12.48
Adjusted Flow of Mortgage Credit	115	0.49	0.234	0.10	1.10
Adjusted Flow of Consumer Credit	115	1.19	0.77	-1.12	3.00
Adjusted Flow of Business Credit	115	100.12	71.66	-35.10	306.48
Adjusted Case-Shiller Home Price Index	115	1.01	0.19	0.82	1.51
Adjusted Fixed Residential Investment	115	0.05	0.01	0.030	0.06
CFNAI-Personal Consumption and Housing	115	0.02	0.09	-0.25	0.2
CFNAI-Sales, Orders and Inventory	115	-0.01	0.14	-0.49	0.33
Consumer Confidence Index	115	100.25	1.42	96.36	102.79
Business Confidence Index	115	99.62	1.24	95.92	102.64

Post-LSAPs

Variable	Obs	Mean	Std. Dev	Min	Max
30-year Conventional Mortgage Rate	23	3.88	0.57	2.87	5.18
24-month Finance Rate	23	10.15	0.41	9.02	10.76
AAA Bond Yield	23	4.17	0.61	3.07	5.16
BAA Bond Yield	23	5.45	1.06	4.18	8.18
10-year Treasury Rate	23	2.16	0.61	1.14	3.10
Adjusted Flow of Mortgage Credit	23	-0.03	0.08	-0.31	0.11

Continued on Next Page

Table 3.2: Summary Statistics

Variable	Obs	Mean	Std. Dev	Min	Max
Adjusted Flow of Consumer Credit	23	0.50	0.88	-1.23	1.63
Adjusted Flow of Business Credit	23	49.36	51.36	-120.57	104.44
Adjusted Case-Shiller Home Price Index	23	1.07	0.06	0.97	1.14
Adjusted Fixed Residential Investment	23	0.03	0.004	0.02	0.04
CFNAI-Personal Consumption and Housing	23	-0.25	0.08	-0.37	-0.12
CFNAI-Sales, Orders and Inventory	23	-0.02	0.18	-0.55	0.13
Consumer Confidence Index	23	98.51	0.79	96.78	99.64
Business Confidence Index	23	100.02	1.11	96.31	101.61

The summary statistics are separated between the pre-LSAP and post-LSAP period. The pre-LSAP period runs from the first quarter of 1980 to the third quarter of 2008. The post-LSAP period runs from the fourth quarter of 2008 to the second quarter of 2014. The variables are expressed in levels. The interest rate variables and credit ratios are mean, the standard deviation, the minimum and the maximum of each variable. Separating the variables allows us to have a better idea of how LSAPs changed expressed in percentages. The summary statistics present the number of observations in each time period, the variables used in the regression analysis.

The large changes are due to the financial crisis that was characterized by a freeze in credit markets especially the mortgage market. The graphs presented in Figure 3.2 reveal that the change in the credit flow in all three cases reached a low in 2008 but we also notice that starting in the second quarter of 2009 credit started to pick up. The graph show that even though the change in credit remained negative for some time after the implementation of LSAP1 it did start to increase and ended up positive in all three cases. The difference between the pre- and post- LSAP period provides preliminary evidence that despite the large liquidity injections and the subsequent fall in the long-term interest, credit was slow to pick up due to the economic downturn. Indeed, the

decrease in all three credit measures started in early 2008. Considering that the largest round of LSAP started in late 2008 and the second round in 2010 we would expect conditions to rebound faster. In addition, the size of the Federal Reserve's liquidity injections were unprecedented, they more than tripled the size of the Federal Reserve's balance sheet. However, the credit variables did not reach their pre-crisis levels until mid-2014. We would have expected to see the a marked increase in credit at least following the first round of LSAP. This is the first hint that the decrease in interest rates induced by LSAPs may have had a weak effect on credit markets. Moreover, the standard deviation of the different credit variables in the pre-LSAP period is lower than in the post-LSAP period. This is most likely because the post-LSAP sample includes the months during which the credit crunch reached its peak as well as the period during which it started to recover, and therefore fluctuated more. However, the standard deviation of the pre-LSAP sample also indicates that there were some fluctuations in the variable. This sample includes multiple recessionary events. It is likely that other variables are important determinants of credit such as economic activity and expectations. For this reason we include such variables in our analysis.

Looking at the real interest rates, the summary statistics confirm that after the first round of LSAP the real interest rates declined. It should be noted that it was already on a downward path before LSAPs. In the case of the 10-year Treasury rate, it went from 6.39% pre-LSAP to 2.16% after the first round of LSAPs. For the 24-month rate on personal loans it did not decrease as much, going from 13.19% to 10.15%. In the case of mortgage credit the rate decline from 8.19% to 3.88%. Lastly, each bond rate did decrease, the AAA-bond rate went from 7.65% to 4.17% and the BAA-bond rate went from 8.73% to 5.45%. In addition, both components the CFNAI variables also declined

after LSAPs as well as the consumer confidence index and fixed residential investment as a percentage of GDP.

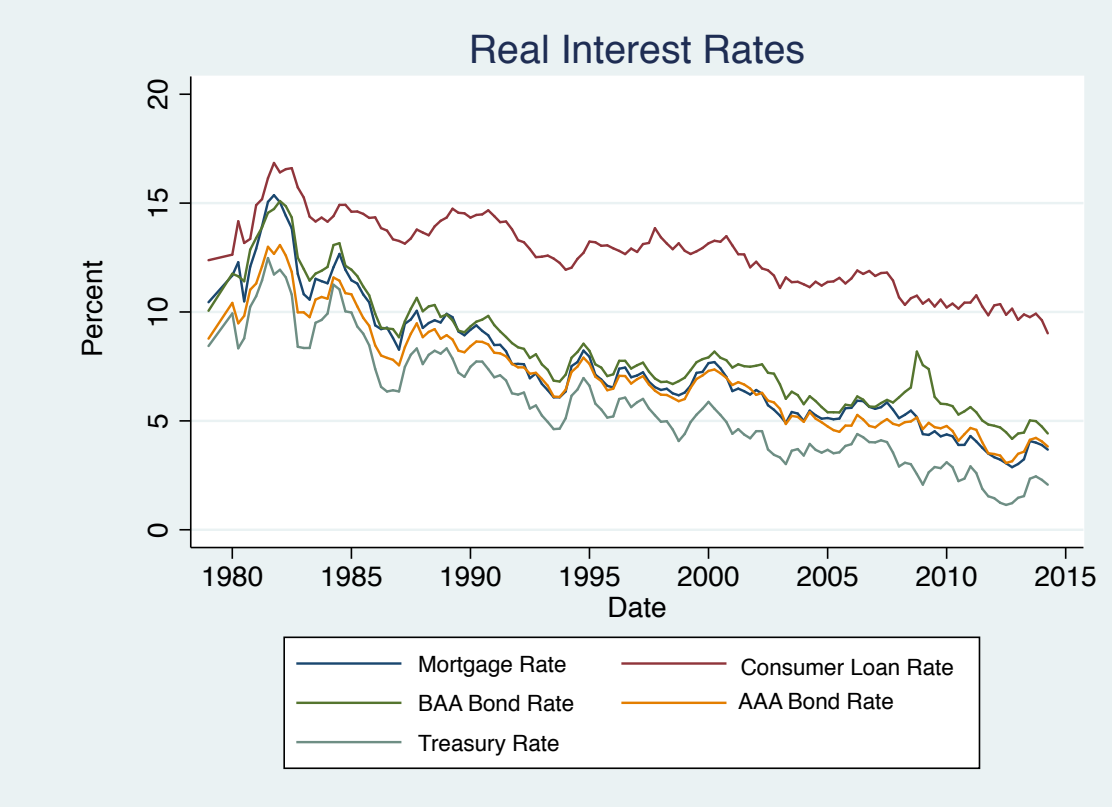

Figure 3.1. Real Long-Term Interest Rates

The Figure displays several real interest rates for the U.S. economy. The real interest rates are measured by the difference between the nominal rate and the five-year unweighted moving average of current and past inflation, measured by the CPI. As we can see all the interest rates have declined since the onset of LSAPs. The data is from the Board of Governors of the Federal Reserve System.

This is probably caused by the financial crisis reaching its lowest point in the second quarter of 2009. The business confidence index increased slightly between the pre- and post-LSAP which is unexpected since the consumer confidence fell and the financial crisis would be expected to impact the expectations of businesses. Lastly, the mean Case-Shiller Home Price Index over the CPI increased between pre- and post LSAPs. However, this can be explained by the size of the samples and the graph of the housing

index. It increased rapidly and reached its peak right before the start of the financial crisis in 2008. As we mentioned before the financial crisis was triggered by the burst of the housing bubble. This means that the index reached its peak prior to 2008 but it remained high and took several years to reach its low in 2011 therefore the index has a higher mean in the LSAP sample. For this reason, the shorter sample after 2008 includes high but declining values of the Case-Shiller home price index.

A visual representation of the variables can also give an idea of who they have evolved over the time period. Graphs of the key variables are provided in Figures 3.1-3.3. From Figure 3.1, the real interest rates have been declining since the mid-1980s. However, the fall appears to be more pronounced in the period following LSAP. The large liquidity injections were bound to have a more significant effect on interest than during the time where the Federal Reserve was still relying on the federal funds rate. The BAA and the AAA corporate bond yields have been evolving in a similar way and have been quite close to one another.

Next, looking at the graphs of the credit variables, we can see that the flow of consumer credit has varied much more than the flow of mortgage credit. The flow of consumer credit shows some peaks prior to LSAPs but also some lows. However, it reaches its lowest point in the first quarter of 2009 before starting on an upward trajectory. Even though the flow of consumer credit never reaches its pre-recession level it does start to pick up after the implementation of LSAPs.

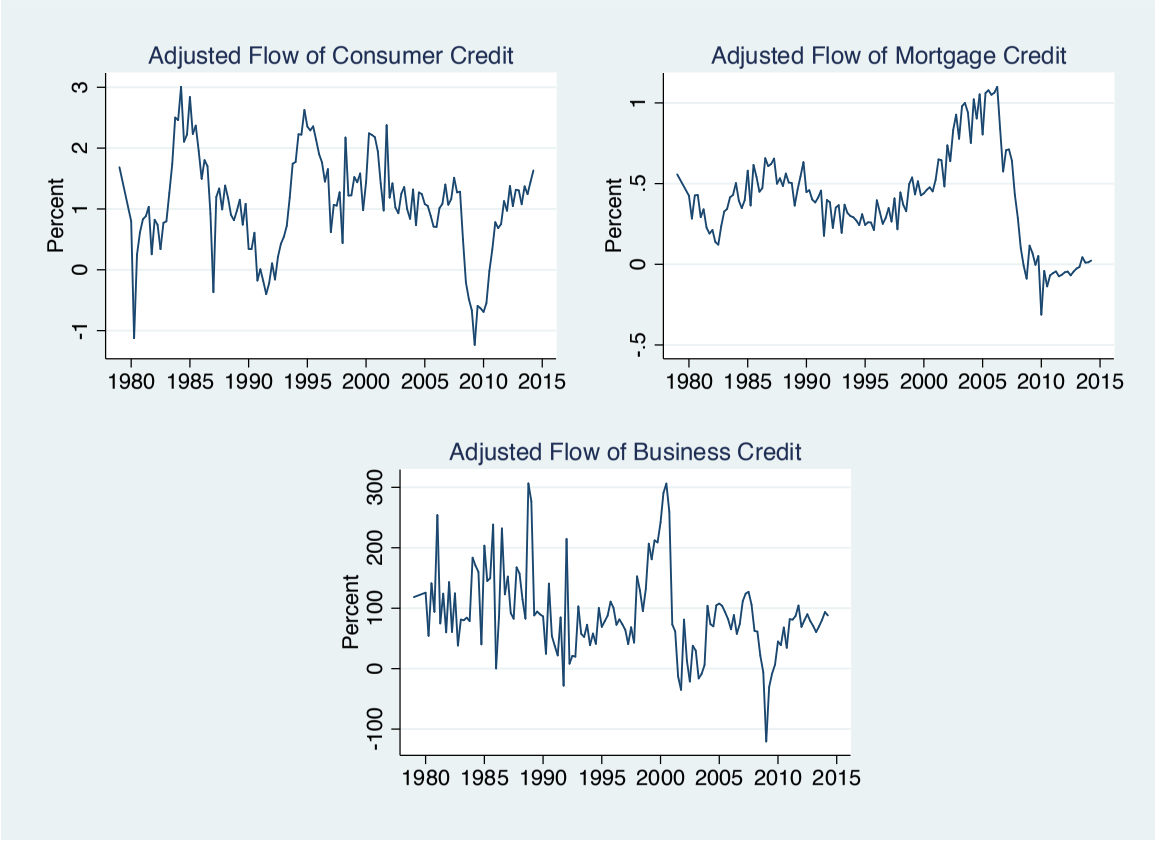

Figure 3.2. Adjusted Credit Variables

This Figure shows the adjusted flow of consumer credit. This variable is measured as the ratio of consumer credit to nominal personal income. The variable is expressed in real terms as both the flow of consumer credit and personal income are in nominal terms. The ratio shows a serious fall in 2009. However, it does start to pick up as LSAP started. Figure 3.3 also shows the adjusted flow of mortgage credit. This variable is measured as the ratio of mortgage credit to nominal personal income. The variable is expressed in real terms as both the flow of mortgage credit and personal income are in nominal terms. The ratio fell considerably during the subprime mortgage market crisis. However it has slowly started to pick up since the implementation of LSAPs. Lastly, Figure 3.2 shows the adjusted flow of nonfinancial corporate business credit. This variable is measured as the ratio of nonfinancial corporate business loans to total nonfinancial corporate profits. The variable is expressed in real terms as both business loans and total profits are in nominal terms. Similarly to the other credit variables the 2008 financial crisis was marked by a large fall in business loans to profits. It has picked up since as longer interest rates were lowered. All three graphs seem to indicate that LSAPs helped ease the credit conditions in various markets although the rebound has been weak considering the size of the liquidity injections. The data on consumer credit is from the G.19 series of the Federal Reserve Board, the data on mortgage credit is from the Z.1. series of the Federal Reserve Board, the data on business credit is from the Flow of Funds accounts, data on nominal personal income is from the U.S. Bureau of Economic Analysis.

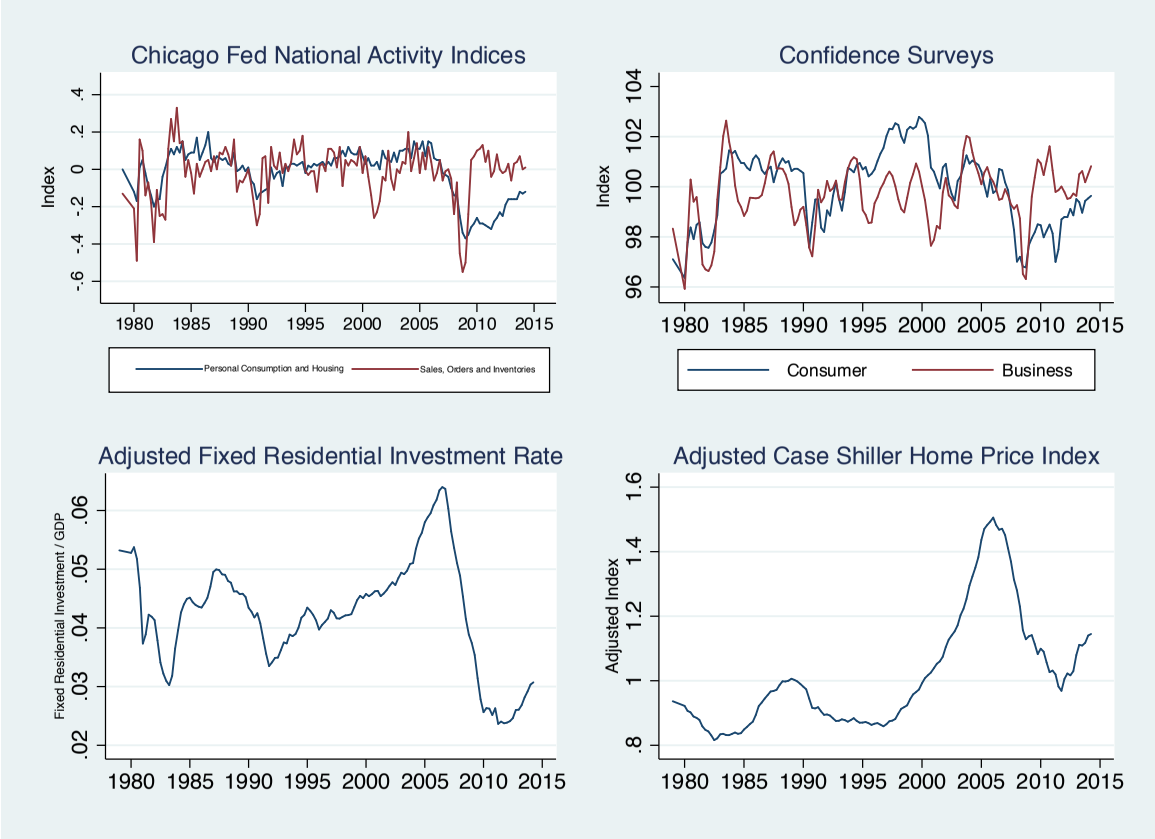

Figure 3.3. Control Variables

Figure 3.3 shows the control variables in the ARDL model. The Chicago Fed National Activity Index (CFNAI) is an index designed to gauge overall economic activity. It is constructed to have an average value of zero and a standard deviation of one. Since economic activity tends toward trend growth rate over time, a positive index reading corresponds to growth above trend and a negative index reading corresponds to growth below trend. Data for the CFNAI comes from the Federal Reserve Bank of Chicago. This Figure also shows the Consumer Confidence Index (CCI) and the Business Confidence Index (BCI). The CCI is designed to measure the degree of optimism on the state of the economy that consumers are expressing through their activities of savings and spending. The BCI is based on enterprises' assessment of production, orders and stocks, as well as its current position and expectations for the immediate future. Both have a long-term average of 100 so values above 100 represent optimism while values below 100 represent depressed expectations. Data on the CCI and BCI are from the OECD. This Figure shows adjusted fixed residential investment. This variable is measured as the ratio of fixed residential investment to GDP. It is intended to reflect the activity in the housing market. The variable is expressed in real terms as fixed residential investment is normalized by GDP. Data for fixed residential investment and GDP comes from the U.S. Bureau of Economic Analysis. Lastly, this Figure shows the adjusted Case-Shiller Home Price index. This variable is measured as the ratio of the Case-Shiller Home Price Index to the CPI for all items. The variables is expressed in real terms as the Case-Shiller home price index is adjusted using the CPI for all items. Data for the Case Shiller Home price index is from the S&P Dow Jones Indices LLC. and data on the CPI is from the OECD.

This could be the first indication that LSAPs helped ease consumer credit conditions. The flow of mortgage credit has been flatter. It peaked in mid-2006 before starting on a downward trajectory. It did start to pick up after the implementation of LSAPs but much more slowly than in the case of consumer credit. This is another indication that LSAPs and the purchases of MBS helped restore mortgage credit. The flow of business loans to business profits evolved in a way similar to consumer credit meaning it shows a lot of variation.

However it clearly fell to one of its lowest levels during the latest financial crisis. Similarly to the other credit variables it starts to pick up after the implementation of LSAPs. Following from the graphs of the credit variables it seems that in all three cases the implementation of LSAPs coincides with the variables starting to recover from the crisis. This could be an indication that LSAP and the decrease interest rates they triggered helped ease the credit crunch.

In addition, both components of the CFNAI show fluctuations that are in line with the US business cycle since 1980. For example, the recessions of 1981 and 2001 are reflected by a dip, followed by an upward trend. The financial crisis is clearly reflected by a larger dip in the graph. However, it does seem to improve after the worst of the crisis had passed. Moreover, fixed residential investment as a percentage of GDP plunges as a result of the financial crisis after rising sharply between 2001 and 2007. It does start to pick up in mid-2011. The ratio of the Case-Shiller home price index to the CPI shows little fluctuations before 1997. After that it starts to increase, reaching its peak at the beginning of 2006. After that time it starts to decline reaching its low in mid-2011. After 2011 it starts to pick up again as the housing market was recovering. Lastly, the confidence indices seem to track each other closely, falling during economic downturns and rising in times of economic expansion. This pattern is expected since both

consumers and businesses alter their expectations as a result of changes in the economic climate. It is worth noting that the business confidence index reacts more strongly than the consumer confidence index, consistently peaking and dropping to lower levels.

3.3.4 Methodology

3.3.4.1 Empirical Framework

In order to determine if the interest rate channel of monetary policy was triggered by LSAPs, we evaluate if the decrease in various longer-term interest rates, induced by LSAPs, was successful in boosting credit availability for consumption, mortgages and businesses. This chapter will use time series data to conduct an autoregressive distributed lag (ARDL) model and a bounds testing procedure. The use of this model is strongly supported in the literature as ARDLs play a central role in empirical macroeconomics (Pesaran et al., 2001; Gujarati and Porter, 2004). The bounds testing procedure is a powerful econometric tool in the estimation of level relationships when the underlying time series data is entirely I(0), entirely I(1) or a mix of I(0) and I(1) variables (Dees et al., 2014). Autoregressive distributed lag models are an extension of pure vector autoregression (VAR) models. The ARDL model combines the regression model and the vector error correction model (VECM). Their general form can be expressed as follows:

$$\Delta y_t = v + \beta_1 \Delta y_{t-1} + ... + \beta_s \Delta y_{t-s} + \gamma_1 \Delta x_t + ... + \gamma_s \Delta x_{t-s} + \lambda_1 y_{t-1} + \lambda_2 x_{t-1} + \epsilon_t \quad (3.2)$$

where y_t is the variable of interest, x_t is an independent variable assumed to impact y, β and γ are short-run coefficients, λ are the long run coefficients and ϵ_t is an error term assumed to be white noise. the short run coefficients can be estimated using ordinary least square (OLS) methods and the number of lags can be determined with the AIC or BIC criteria discussed later.

The ARDL model to conduct a bounds testing procedure is often used to determine whether there exists a short-run and/or a long-run relationship between the variables in the model. As discussed by Pesaran et al. (2001), they advocate the use of the ARDL model for the analysis of level relationships because once the order of the variables has been established; the model can be estimated using OLS. Moreover, the bounds test allows for a mixture of I(1) and I(0) variables as regressors meaning that this methodology does not require a specific identification of the order of the underlying data. Lastly, this methodology can be used for small and finite samples (Pesaran et al., 2001). Bound testing as an extension of the ARDL model uses F and t-statistics to test the significance of lagged levels of the variables in a univariate error correction model when the underlying variables are of mixed order. Other techniques to test cointegration between non-stationary time series have been used (Engle and Granger, 1987; Johansen, 1988) but bound testing is preferred to the other methods because of its relatively better performance when the sample size is small and the variables included in the models are both stationary and non-stationary (Omoniyi and Olawale, 2015).

Since we are analyzing how the long-term interest rate impacted three measures of credit (discussed above), the ARDL models in this chapter takes the following forms:

$$\Delta(\frac{Cons.Credit}{Perso.Income})_t = \alpha_0 + \alpha_{11}\sum_{j=1}^{n}\Delta(\frac{Cons.Credit}{Perso.Income})_{t-j} + \alpha_{21}\sum_{j=1}^{n}\Delta(LTIR)_{t-j} + \alpha_{31}\sum_{j=1}^{n}\Delta(CFNAI)_{t-j} + \alpha_{41}\sum_{j=1}^{n}\Delta(CCI)_{t-j} + \beta_{11}\frac{Cons.Credit}{Perso.Income}_{t-1} + \beta_{21}LTIR_{t-1} + \beta_{31}CFNAI_{t-1} + \beta_{41}CCI_{t-1} + \epsilon_{1t} \quad (3.3)$$

$$\Delta(\frac{HH.MortgageCredit}{Perso.Income})_t = \alpha_0+\alpha_{12}\sum_{j=1}^{n}\Delta(\frac{HH.MortgageCredit}{Perso.Income})_{t-j}+\alpha_{22}\sum_{j=1}^{n}\Delta(LTIR)_{t-j}$$
$$+\alpha_{32}\sum_{j=1}^{n}\Delta(\frac{CSPriceIndex}{CPI})_{t-j}+\alpha_{42}\sum_{j=1}^{n}\Delta(\frac{fixedresidentialinvestment}{GDP})_{t-j}+$$
$$\beta_{12}(\frac{HH.MortgageCredit}{Perso.Income})_{t-1}+\beta_{22}(LTIR)_{t-1}+\beta_{32}(\frac{CSPriceIndex}{CPI})_{t-1}+$$
$$\beta_{42}(\frac{fixedresidentialinvestment}{GDP})_{t-1}+\epsilon_{2t} \quad (3.4)$$

$$\Delta(\frac{BusinessCredit}{Perso.Income})_t = \alpha_0+\alpha_{13}\sum_{j=1}^{n}\Delta(\frac{BusinessCredit}{Perso.Income})_{t-j}+\alpha_{23}\sum_{j=1}^{n}\Delta(LTIR)_{t-j}+$$
$$\alpha_{33}\sum_{j=1}^{n}\Delta(CFNAI)_{t-j}+\alpha_{43}\sum_{j=1}^{n}\Delta(BCI)_{t-j}+\beta_{13}(\frac{BusinessCredit}{Perso.Income})_{t-1}+$$
$$\beta_{23}(LTIR)_{t-1}+\beta_{33}CFNAI_{t-1}+\beta_{43}BCI_{t-1}+\epsilon_{3t} \quad (3.5)$$

where all the variables are as previously described, Δ denotes the first difference, ϵ_t are the error terms, α_{ki} where k=1,2,3,4 and i=1,2,3 represents short-run coefficients or the short-term effects of the independent variable on the dependent variable and β_{ki} reflects the long run cointegration coefficients.

The first step of a bounds testing procedure for cointegration is to estimate the three credit equations above by OLS in order to establish the short run relationship between the variables. The statistical significance denoted by the p-values of each coefficient will determine if there exists a statistically significant short-run relationship between the variables. The second step tests for the existence of a long-run relationship between the variables by conducting an F-test for the joint significance of the coefficients of the lagged levels of the variables (Belloumi, 2009):

$$H_0 : \beta_{i1} = \beta_{i2} = \beta_{i3} = \beta_{i4} = 0 \text{ vs. } H_1 : \beta_{i1} \neq \beta_{i2} \neq \beta_{i3} \neq \beta_{i4} \neq 0$$

for i=1,2,3.

According to Pesaran et al. (2001), two sets of critical values for a given significance level can be determined. The first is calculated assuming that all the variables included in the model are I(0) and the other assuming that all the variables are I(1).

It is also assumed that lower bound critical values can be used for I(0) variables while upper bound critical values can be used for I(1) variables. The null hypothesis of no cointegration is rejected when the value of the F-statistic is greater than the upper critical bounds value, and it is accepted if the F-statistic is lower than the lower bounds value, if the F-statistic falls between the upper and lower bound values then the test is inconclusive (Belloumi, 2009). This step provides us with the first sign that a long-run relationship exists. The third step involves formulating the long run cointegration form of the model in order to determine which long-run relationships (if any) are statistically significant. This formulation is estimated using a vector error correction model, where the p-values of the long run coefficients determines which long-run relationships are statistically significant.

Before estimating the above models, several tests will have to be conducted to determine whether the variables have unit roots, the rank of the system (meaning the number of cointegrating equations) and the optimal number of lags to include. The unit root tests are especially important for ARDL models because there needs to be a mix of variables integrated of order 0 and 1. Moreover, the unit root test allows us to ensure that the variables are not I(2) and therefore to avoid spurious regression results. If some of the variables are integrated of order 2 then we cannot interpret the values of the F-statistics provided by Pesaran et al. (2001).

3.3.5 Preliminary Tests

3.3.5.1 Optimal Lag Selection

The first preliminary test is the optimal lag selection test. Most statistical softwares now provide appropriate statistics to determine the optimal lag selection based on various information criteria. Choosing the optimal lag length can prove to be a difficult task since we have to balance the costs and benefits of adding lags. If we include too few lags we run the risk of omitting potentially significant information but if we add too many lags we estimate more coefficients than needed.

The most common measures are the SIC and the AIC. These two measures rely on different assumptions; the SIC will select a more parsimonious model than the AIC meaning that it has the fewest number of parameters to estimate. In most cases the more parsimonious model is preferred and the AIC does not always suggest the most parsimonious model because the AIC function is largely based on the log likelihood function. Moreover, since we have a small sample it is best not to lose information by including more lags. Therefore, our analysis will rely on the SIC to determine the optimal lag number. According to Table 3.3 to Table 3.5, we can see that for each autoregressive distributed lag model the optimal number of lags for each variable varies. The statistical software used is able to determine how many lags of each variable need to be included in the ARDL model.

3.3.5.2 Unit Root Test

Before we begin the analysis we have to determine the order of each variable. In order to determine this we use stationarity tests. The results are presented in Table A.1. In order to determine if the series is stationary the popular Augmented Dickey

Fuller (ADF) test is used. The null hypothesis of the test is that the series contains a unit, if the null hypothesis cannot be rejected then the series is not stationary. The next step would be to run an ADF test on the first difference of each variable that was not stationary in our first test, if the we can reject the null hypothesis then the variable is said to be I(1) or integrated of order 1. In order to confirm the results of the ADF test, a DF-GLS test is used as a robustness check to ensure that the variables are indeed I(0) or I(1) (Elliot et al., 1996). The null hypothesis is that the series is a random walk possibly with drift. This test is often used to confirm the results of the ADF test.

The results are presented in Table A.1. In all three models we have a mix of I(0) and I(1) variables. This means that an ARDL is an appropriate model to estimate the relationship between LSAPs and consumer credit, household mortgage credit and business credit. The results of the ADF test are confirmed by the DF-GLS test.

3.3.6 Robustness Checks

3.3.6.1 Lagrange Multiplier Test (LM test)

The first robustness check is a Lagrange Multiplier (LM) test. It is an alternative to the Q-statistics for testing serial correlation in the residuals. The null hypothesis of this test is that there is no autocorrelation at the lag order specified. Evidence of autocorrelation would indicate that the model is not properly specified. However, if we cannot reject the null of no autocorrelation this is an indication that the model is correctly specified. The results from the Lagrange-Multiplier tests presented Tables 3.3, 3.4 and 3.5 suggest that at all lags we cannot reject the null hypothesis of no autocorrelation in the residuals. So far the tests do not suggest that there is a model misspecification.

3.3.6.2 Autoregressive conditional Heteroskedasticity Test

The second robustness check is the heteroskedasticity test in the residuals from a least square regression. The coefficients estimated using OLS are consistent in the presence of heteroskedasticity but the standard errors are no longer valid. The null hypothesis of the test is that there is no heteroskedasticity and the alternative hypothesis is that some general form of heteroskedasticity exists (Engle, 1982). The heteroskedasticity test is an important test for model specification given that the null hypothesis assumes that the residuals are heteroskedastic and independent of the other regressors and that the linear specification of the model is correct. If the F-statistic reported by the test is statistically significant then one of these assumptions is violated. As we can see from Tables 3.3, 3.4 and 3.5 in all three cases the heteroskedasticity test indicates that the models are correctly specified.

3.3.6.3 Ramsey RESET Test

The last robustness check is the Ramsey's Regression Specification Test (Ramsey, 1969). This test serves to identify the following types of specification errors: omitted variables meaning that relevant explanatory variables have been omitted, incorrect functional form meaning that some of the variables could be transformed in some way by for example taking the log and lastly correlation between the dependent variable and the error term caused by measurement error in one or more of the explanatory variables. If any of these errors exists than the estimators will be biased and inconsistent. This means that the residuals will have a non-zero mean (Ramsey, 1969), therefore the null hypothesis of the Ramsey RESET test is the the residuals have a $N(0, \sigma^2 I)$ distribution and the null is that the residuals have a $N(\mu, \sigma^2 I)$ distribution. From Tables 3.3, 3.4 and 3.5, there does not seem to be a misspecification in the models that we have estimated.

3.3.7 Limitations

The methodology is subject to some limitations. Since most aggregate economic time series are highly correlated with their own previous values and with present and past values of other time series, multicollinearity can become a serious problem as more and more series and lagged values of series are added to the model. As the system expands, it can become very difficult to separate the effects of the explanatory variables, and the parameter estimates can become highly sensitive to the combination of variables used in the model (Schlegel, 1985). Also, a high degree of multicollinearity will make it difficult to determine which explanatory variables are significant because the standard errors of the coefficient estimates will tend to be large. Moreover, as mentioned previously, as the number of variables included in the ARDL increases, there will be more parameters to estimate. This will cause random events of the past as well as systematic relationships to be increasingly reflected in the coefficients, this makes forecasting less accurate (Schlegel, 1985).

Moreover, selecting the variables to include in the full ARDL can be challenging. Indeed, given the above discussion on multicollinearity and the problems associated with adding too many variables to the model, it can be difficult to determine and choose which variables are important for the model. Unfortunately, this can be problematic because all the effects of omitted variables will be in the residuals. When analyzing the effects of monetary policy, a measure of monetary policy is required but depending on the research question, the set of additional variables to include needs to be carefully considered and should be based on theoretical causality. The rank, the optimal lag order and the stationarity of the variables needs to be identified and these statistics are very sensitive to the data itself.

3.4 Results

Consumer Credit:

In Table 3.3, the regression results using the 24-month consumer rate from the shorter sample and the longer sample are presented in reg 1 and reg 2. Reg 3 and reg 4 use the 10-year long-term Treasury rate. Using these four regressions we can compare how the different interest rates impacted consumer credit during the shorter sample from 1980 to 2006 and the longer sample that runs until 2014. In the case of the 24-month finance rate on personal loans from reg 1, we can see that in the short run the interest rate does not have a significant impact on credit and neither does the consumer confidence index. However, the indicator for real economic activity is statistically significant at the 1% level. This tells us that in the short run an increase in the CFNAI of 0.1 causes the ratio of consumer credit to personal income to increase by 1.33 percentage points. Following from the speed of adjustment and the bounds test presented in Table 3.3 that are statistically significant at the 1% level, there is evidence of a long-term relationship between the dependent variable and the independent variables in reg 1. Looking at the long run coefficients in the shorter sample, only the CFNAI has an impact on consumer credit. In the long run the impact is again statistically significant at the 1% level but more pronounced as an increase of 0.1 in the CFNAI leads to a 5.2 percentage point increase in the ratio of consumer credit to personal income. Once again neither the interest rate nor the consumer confidence index affects the credit ratio. The results from this regression indicate that, prior to the LSAPs economic activity was the main driver of consumer credit. This finding has been documented in the literature (Miles and Wilcox, 1991). The authors explain that because of information asymmetries, interest rates do not clear credit markets and quantities of credit may move without a change in its price.

Looking at the results from reg 2 in Table 3.3, we see that including the period with LSAPs leads to different results. In this regression, the 24-month finance rate on personal loans does have an impact on the ratio of consumer credit. The results are statistically significant at the 1% level and indicate that a 1 percentage point decrease in the interest rate leads to an increase in the ratio of consumer credit to personal income of 0.25 percentage points. The consumer confidence index is once again statistically significant at the 1% level but the results are smaller than in the shorter sample. An increase of 0.1 in the CFNAI causes the ratio of consumer credit to personal income to increase by 1.01 percentage points. However, the consumer confidence index is not statistically significant. Once again the bounds test and the speed of adjustment are statistically significant at the 1% level and therefore the results presented in Table 3.3 for reg 2 indicate that there is a long-run relationship so we can interpret the long run coefficients. From Table 3.3 we can see that in the long run the interest rate also has an impact on consumer credit the results are statistically significant at the 5% level. A one percentage point decrease in the interest rate causes an 0.12 percentage point increase in the ratio of consumer credit to personal income. Similarly to the short run coefficients, the consumer confidence index is not statistically significant, but the CFNAI is at the 1% level and it tells us that an increase of 0.1 in the CFNAI increases the ratio of consumer credit by 6.30 percentage points.

These results can be compared to the impact of the 10-year Treasury rate on the ratio of consumer credit to personal income presented in reg 3 and reg 4. Even though this interest rate was said to be most impacted by LSAPs, from the correlations presented in Table 3.1 we can see that it has a 0.91 correlation with the 24-month finance rate in first difference. This means that the two interest rates have evolved in a similar way. However, from Table 3.3 we can see that the effects on consumer credit are different. In both the short run and long run the 10-year interest rate did not have an impact

on consumer credit. However, in both reg 3 and reg 4 the CFNAI and the consumer confidence index are statistically significant at the 1% level (except for the consumer confidence index in the short run in the shorter sample). In the case of the CFNAI, in the short run, an increase of 0.1 increases the ratio of consumer credit to personal income by 1.40 percentage points.

Table 3.3: Consumer Credit

Dependent Variable: Adjusted Flow of Consumer Credit				
Lags	Reg 1 (1,1,0,0)	Reg 2 (1,1,1,0)	Reg 3 (1,0,0,0)	Reg 4 (1,0,0,0)
Sample Size	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2
Short Run Coefficients				
24 Month rate	-0.19 (0.15)	-0.25 (0.02)		
10 Year Treas. rate			0.01 (0.49)	0.02 (0.39)
CFNAI HH & Cons	1.33 (0.00)	1.01 (0.0)	1.40 (0.00)	1.41 (0.00)
Consumer Confidence	0.00 (0.91)	0.00 (0.75)	0.02 (0.12)	0.00 (0.04)
Speed of Adjustment	-0.26 (0.00)	-0.24 (0.00)	-0.27 (0.00)	-0.23 (0.00)
Long Run Coefficients				
24 Month rate	-0.007 (0.62)	-0.12 (0.05)		
10 Year Treas. rate			0.05 (0.50)	0.06 (0.38)
CFNAI HH & Cons	5.20 (0.01)	6.30 (0.00)	5.30 (0.00)	5.90 (0.00)
Consumer Confidence	0.00 (0.90)	0.00 (0.75)	0.08 (0.08)	0.08 (0.03)
Diagnostics				
Breush-Godfrey (n=2)	0.16	0.64	0.16	0.52
ARCH	0.34	0.51	0.33	0.61
RESET	0.32	0.97	0.15	0.84
Adjusted R^2	0.61	0.71	0.60	0.70
Bounds F-statistic	3.88**	5.14***	3.92**	3.83**

1) Reg 1 uses the 24-month interest rate for the shorter sample, reg 2 uses the 24-month interest rate for the longer sample , reg 3 uses the 10-Treasury rate for the shorter sample and reg 4 uses the 10-year Treasury rate for the longer sample. All variables are expressed in first difference.

2) Number in parentheses are p-values for the coefficients.

3) Diagnostics: The table shows the p-value for the null hypothesis of no serial correlation of 2nd order (Breusch-Godfrey), no ARCH errors (one lag), and no mis-specification error (RESET, using the squared fitted values).

4) Bounds test: Rejects the null of long-run relationship at the *** 1%, ** 5%, * 10% significance level. The F test uses the critical values from Pesaran et al. (2001) The tests were performed on the initial ARDL equation, which included the number of lags indicated in the Table in each first-differenced variable, for the different sample sizes.

In the long run, an increase of 0.1 in the CFNAI causes the ratio of consumer credit to personal income to increase by 5.30 percentage points in the shorter sample.

For the longer sample that includes the LSAP period, in the short run the CFNAI causes the credit ratio to increase by 1.41 percentage points and 5.90 percentage points in the long run. The consumer confidence index has a milder effect. In the short run it has no impact in the shorter sample. However, in the long run it is statistically significant at the 5% level. This tells us that a one point increase in the consumer confidence index increases the ratio of consumer credit to personal income by 0.08 percentage points and the effect is statistically significant at the 5% level. In the longer sample the consumer confidence index is statistically significant at the 1% level; however after rounding the coefficient is 0. In the long run the effect is again statistically significant at the 1% level and the coefficient tells us that a one point increase in the consumer confidence index increases the consumer credit ratio by 0.08 percentage points. The different impact of the interest rates tells us that, despite a correlation of 0.91, the interest rate that is more relevant for consumer credit has more of an impact than the 10-year Treasury rate. This is probably because households' spending decisions are more responsive to changes in that interest rate rather than the longer-term 10-year Treasury rate. These results from reg 2 are in line with economic theory. If the interest rate decreases then it becomes cheaper for households to borrow, so they will increase their level of consumption spending and their demand for credit. Using the 24-month consumer rate, the results from the longer sample that includes LSAPs indicate that adding the LSAP period causes the impact of the interest rate on the ratio of consumer credit to change.

Even though the changes in the interest rate did have an impact on consumer credit, the effects were small. Moreover, the other variables included in the regression had much larger effects (when they are statistically significant). Thus, even if reducing

interest rates is helpful for promoting credit, it is important for economic conditions and expectations to improve. The lackluster performance of credit is well documented (Brown et al., 2013) and it seems that the losses experienced by banks and households as a result of the crisis may have outweighed the potential benefits of low short-run and long-run interest rates. Indeed, the rapid rise in the unemployment rate is positively correlated with the decline in consumer debt (Brown et al., 2013). As households expect poor economic activity, they increase their precautionary saving to protect themselves against job loss. This means that despite lower interest rates, households are not looking to increase their demand for credit as much as they normally would. This idea is supported by the results regarding the CFNAI and to a lesser extent the consumer confidence index. These variables also have an impact on consumer credit. The CFNAI is statistically significant in all the regressions, which tells us that economic activity is an important determinant of credit conditions. Moreover, it is also possible that the supply of credit from banks did not bounce back despite lower interest rates. If banks hold pessimistic expectations regarding future economic activity it causes them to be reluctant to extend credit, as lending is perceived as risky. Moreover, the pool of creditworthy borrowers probably became smaller as households were negatively affected by the financial crisis.

Mortgage and Housing Credit:

In the case of household mortgage credit, the results are different than in the consumer credit model. The results are presented in Table 3.4. Reg 5 presents the results using the 30-year mortgage rate for the shorter sample. In the short run, the 30-year conventional mortgage rate had a small but significant impact on the ratio of mortgage credit to nominal personal income. A 1% decrease in the interest rate causes the ratio of mortgage credit to personal income to increase by 0.02 percentage points and the result is statistically significant at the 1% level. The Case-Shiller home price index also has a statistically significant impact. A one point increase in the ratio of the Case-Shiller

home price index to CPI causes mortgage credit to personal income ratio to increase by 7.57 percentage points, that result is statistically significant at the 1% level. Fixed residential investment does not have a statistically significant impact.

Table 3.4: Mortgage Credit

Dependent Variable: Adjusted Flow of Mortgage Credit				
Lags	Reg 5 (1,0,1,0)	Reg 6 (1,0,1,0)	Reg 7 (1,1,1,0)	Reg 8 (1,0,1,0)
Sample Size	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2
Short Run Coefficients				
30 Year Mortgage	-0.02 (0.02)	-0.03 (0.04)		
10 Year Treasury			-0.04 (0.41)	-0.02 (0.06)
Case-Shiller Index	7.57 (0.00)	5.91 (0.03)	7.74 (0.00)	5.90 (0.00)
Residential Investment	3.54 (0.69)	28.06 (0.00)	3.30 (0.71)	26.82 (0.00)
Speed of Adjustment	-0.56 (0.00)	-0.35 (0.00)	-0.59 (0.00)	-0.33 (0.00)
Long Run Coefficients				
30 Year Mortgage	-0.05 (0.01)	-0.07 (0.01)		
10 Year Treasury			-0.06 (0.01)	-0.07 (0.03)
Case-Shiller Index	1.33 (0.04)	-1.94 (0.13)	1.34 (0.03)	-2.02 (0.12)
Residential Investment	6.30 (0.69)	81.23 (0.01)	6.31 (0.70)	80.47 (0.00)
Diagnostics				
Breush-Godfrey (n=2)	0.80	0.54	0.70	0.52
ARCH	0.74	0.67	0.77	0.64
RESET	0.62	0.44	0.67	0.43
Adjusted R^2	0.72	0.83	0.72	0.83
Bounds F-statistic	10.88***	7.32***	11.30***	7.03***

1) Reg 5 uses the 30-year mortgage rate for the shorter sample, reg 6 uses the 30-year mortgage rate for the longer sample , reg 7 uses the 10-Treasury rate for the shorter sample and reg 8 uses the 10-year Treasury rate for the longer sample. All variables are expressed in first difference.

2) Number in parentheses are p-values for the coefficients.

3) For a description of the diagnostics and bounds test, see notes from Table 3.3.

The results for mortgage credit are similar in the long run. The speed of adjustment and bounds test presented in Table 3.4 indicates that there is a long-run relationship and it is significant at the 1% level. The real 30-year conventional mortgage rate did have an impact on mortgage credit. For each 1% decrease in the 30-year conventional mortgage

rate, the ratio of mortgage credit to personal income increases by 0.05 percentage points again the effect is statistically significant at the 1% level. The Case-Shiller index is statistically significant at the 1% level but had a weaker impact, as a one point increase causes a rise of 1.33 percentage points in the ratio of mortgage credit to personal income. Fixed residential investment does not have a statistically significant impact. Turning to the longer sample in reg 6, which includes the LSAP period, the results tell a similar story, although the statistically significant variables have a greater impact. In the short run, the 30-year mortgage interest rate has a slightly larger impact than in the short sample. A 1 percentage point decrease in the mortgage rate causes an increase in the ratio of mortgage credit to personal income of 0.03 percentage points and the result is statistically significant at the 1% level. Moreover, both Case-Shiller index and fixed residential investment are statistically significant at the 1% level. A one point increase in the Case-Shiller housing price index causes an increase in the ratio of mortgage credit to personal income of 5.91 percentage points, while a one percentage point increase in fixed residential investment increases the dependent variable by 28.06 percentage points. We also find evidence of a long-run relationship through the speed of adjustment and the bounds test, which are both statistically significant at the 1% level, so the long run coefficients can also be interpreted. In the long run, the interest rate does have an impact on mortgage credit. A one percentage point decrease in the 30-year conventional mortgage rate causes the ratio of mortgage credit to personal income to increase by 0.07 percentage points, a result that is significant at the 1% level. In addition, fixed residential investment is also statistically significant at the 1% level: a 1 percentage point increase in the ratio of fixed residential investment to GDP causes an increase in mortgage credit to personal income ratio of 81.23 percentage points. The adjusted Case-Shiller home price index does not have a statistically significant impact on mortgage credit in the sample that includes LSAPs in reg 6. Even though the interest rate did have an impact

on mortgage credit and the sign on the coefficient is negative as expected, once again it seems the effects are relatively small in both the short and long sample. This is especially apparent when we compare the shorter sample to the longer sample. The coefficient increases slightly from 0.02 percentage points to 0.03 percentage points in the short run and from 0.05 percentage points to 0.07 percentage points in the long run.

The estimates using the 10-year Treasury rate are also presented in Table 3.4. Reg 7 presents the results from the shorter sample and reg 8 from the longer sample that includes the LSAP period. The correlation between the 10-year Treasury rate and the 30-year conventional mortgage rate is 0.99, so we expect the results to be similar. However, they do differ in their statistical significance. Indeed, in the short run, the real interest rate does not have a statistically significant impact on mortgage credit and neither does fixed residential investment in reg 7. The adjusted Case-Shiller price index is statistically significant at the 1% level and a one point increase leads to a 7.74 percentage points increase in mortgage credit to personal income. There is evidence of a long-run relationship from the speed of adjustment and the bounds test is statistically significant at the 1% level, so the long-run coefficients can be interpreted. They are nearly identical to the ones presented in reg 5: in the long run, a decrease in the 10-year Treasury rate increases mortgage credit by 0.06 percentage points and the results are statistically significant at the 1% level. Moreover, a one point increase in the Case-Shiller home price index causes an increase of 1.34 percentage points and the result is statistically significant at the 1% level. Fixed residential investment is not statistically significant. Turning to reg 8, we see that the results are nearly identical to reg 6 for the longer sample. A 1 percentage point decrease in the 10-year Treasury rate increases mortgage credit to personal income by 0.02 percentage points, and it is statistically significant at the 5% level, and is slightly less than the effect of the 30-year mortgage rate. The Case-Shiller index and fixed residential investment have positive effects on mortgage credit and both

are statistically significant at the 1% level. A one point increase in the Case-Shiller price index causes a 5.90 percentage point increase in the ratio of mortgage credit to personal income and a one percentage point increase in fixed residential investment causes a 26.82 percentage point increase in the ratio of mortgage credit to personal income. In the long run, both the mortgage rate and residential investment have an impact on the ratio of mortgage credit to personal income, and the coefficients are statistically significant at the 1% level. A 1 percentage point decrease in the mortgage rate causes an increase in mortgage credit to personal income of 0.07 percentage points and an a one percentage point increase in residential investment as a percentage of GDP causes a 80.47 percentage point increase in mortgage credit to personal income. Once again, the adjusted Case-Shiller home price index is not statistically significant in the long run. This result could be due to the Case-Shiller price index being on a downward trajectory throughout the implementation of LSAPs despite the adjusted mortgage credit variable showing some signs of recovery.

Similarly to the results for consumer credit, the changes in the 30-year conventional mortgage rate did have a statistically significant impact on the mortgage credit market in both short and long samples, but in both cases this impact is small. The effects in the mortgage market were even smaller than in the case of consumer credit. This indicates that the changes in interest rates that occurred during the time of LSAPs had more impact on mortgage and consumer credit than prior to LSAPs. However, the already weak effects in the case of consumer credit were even weaker for mortgage credit. Considering that the Federal Reserve purchased MBS to target that sector (where the crisis began) and alleviate the liquidity crunch that affected it, one might expect that this sector would have benefited more from the lower interest rates than consumer credit, but our results do not support that expectation.

Moreover, the changes in home prices reflected in the Case-Shiller home price index and residential investment seem to be more important determinants of the changes in the ratio of mortgage credit to personal income, especially in reg 6 which uses the longer sample and the 30-year mortgage rate. As we expected for reg 6, an increase in home prices reflect a more robust mortgage market and thus stimulates that market. The importance of mortgage interest rates and home prices for the mortgage market has been documented in the literature (Himmelberg et al., 2005; Mayer and Sinai, 2007). The weak effects of LSAPs may be due to the weak recovery of the housing market, which was at the heart of the financial crisis and therefore took longer to start to rebound. As a result, despite the Federal Reserve's efforts, other factors such as economic activity and overall conditions in that market were more influential than the interest rate.

It should be noted that although the relationship between consumer and mortgage credit and the interest rates became more pronounced, it still remains small. As was described previously, the Federal Reserve nearly tripled the size of its balance sheet as a result of LSAPs. These were unprecedentedly large liquidity injections, intended to ease credit conditions for households. Yet, the results found in this chapter point to lower interest rates boosting consumer and mortgage credit but not by very large percentages but not in proportion to the interest rate reductions. Such findings are in line with some of the predictions made in the literature on the interest rate channel of monetary policy (Thornton, 2012; Federal Reserve Board, 1993; Bernanke and Gertler, 1995).

Business Credit:

To measure the effects of the interest rate on business credit, we use the AAA and the BAA corporate yields. The BAA incorporates a risk premium and therefore especially indicates when there is stress in business borrowing. The results for business credit are presented in Table 3.5. From the shorter sample that uses the AAA bond rate in reg 9,

Table 3.5: Business Credit

Dependent Variable: Adjusted Flow of Business Credit						
Lags	Reg 9 (1,0,0,1)	Reg 10 (1,1,1,0)	Reg 11 (1,1,0,1)	Reg 12 (1,1,1,1)	Reg 13 (1,0,0,1)	Reg 14 (1,0,0,1)
Sample Size	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2
Short Run Coefficients						
AAA	2.74 (0.21)	12.08 (0.12)				
BAA			9.59 (0.24)	8.93 (0.14)		
10 Year Treasury					2.61 (0.12)	2.14 (0.12)
CFNAI	47.58 (0.01)	27.22 (0.09)	47.26 (0.00)	42.56 (0.01)	46.14 (0.01)	49.92 (0.06)
BCI	-7.99 (0.01)	-0.09 (0.14)	-6.53 (0.06)	-4.46 (0.16)	-7.65 (0.02)	-7.44 (0.00)
Speed of Adjustment	-0.49 (0.00)	-0.38 (0.00)	-0.48 (0.00)	-0.41 (0.00)	-0.49 (0.00)	0.41 (0.00)
Long Run Coefficients						
AAA	5.57 (0.14)	5.72 (0.11)				
BAA			4.64 (0.15)	4.99 (0.27)		
10 Year Treasury					5.23 (0.21)	5.18 (0.19)
CFNAI	17.69 (0.01)	16.50 (0.00)	18.13 (0.01)	16.65 (0.00)	17.62 (0.02)	12.11 (0.60)
BCI	-0.22 (0.18)	-0.23 (0.12)	-0.21 (0.24)	-0.24 (0.12)	-0.15 (0.28)	-0.14 (0.20)
Diagnostics						
Breush-Godfrey (n=2)	0.59	0.53	0.61	0.63	0.55	0.68
ARCH	0.35	0.36	0.38	0.41	0.39	0.45
RESET	0.48	0.42	0.50	0.55	0.43	0.65
Adjusted R^2	0.43	0.57	0.44	0.56	0.44	0.56
Bounds F-statistic	9.95***	12.08***	9.92***	13.69***	10.84***	13.28***

1) Reg 9 uses the AAA bond rate for the shorter sample, reg 10 uses the AAA bond rate for the longer sample, reg 11 uses the BAA bond rate for the shorter sample and reg 12 uses the BAA bond rate for the longer sample. Reg 13 uses the 10-Treasury rate for the shorter sample and reg 14 uses the 10-Treasury rate for the longer sample. All variables are expressed in first difference. Number in parentheses are p-values for the coefficients. For a description of the diagnostics and bounds test, see notes from Table 3.3.

we see that only the short run coefficient for the CFNAI and the business confidence index are statistically significant at the 1% level. However, the business confidence index has the wrong sign,[22] indicating that there is a negative relationship between the business confidence index and the ratio of business credit to profits. We would expect this effect to be positive. There is evidence of a long-run relationship for reg 9 as indicated by the speed of adjustment and the bounds test of Table 3.5, both of which are statistically significant at the 1% level. The AAA bond rate is not statistically significant. Only the CFNAI is statistically significant in the long run. The long-run coefficient indicates that a 0.1 increase in the CFNAI increases the ratio of business credit to profits by 17.69 percentage points.

Turning to the longer sample that includes the LSAP period (reg 10), the AAA bond rate is not statistically significant in either the short run or the long run. However, once again the CFNAI is positive and statistically significant at the 5% level. In the short run a 0.1 rise increases business credit to profit by 27.22 percentage points and in the long run it increases it by 16.50 percentage points. Once again, the business confidence index is not statistically significant. The results using the BAA bond rate presented in reg 11 and reg 12 are very similar. This is not surprising given that the correlation between the AAA bond rate and the BAA bond rate is 0.99. Once again, in both the short run and the long run the BAA bond rate does not have a statistically significant impact on the ratio of business credit to profit. Similar to the regressions using the AAA bond rate, the CFNAI is the most important variable. It increases business credit by 47.26 percentage points in the short run and 18.13 percentage points in the long run. For the longer sample, it increases the dependent variable by 42.56 percentage points in the short run

[22]We tested whether the problem could be coming from multicollinearity by determining if the coefficients changed after we remove the CFNAI. The results are presented in the Appendix of Chapter 3. There does not appear to be a issue of multicollinearity as the coefficients do not change much. The issue could stem from endogeneity issues between the regressors but this is something for future research.

and 16.25 percentage points in the long run, and these results are statistically significant at the 1% level. The business confidence index is only statistically significant at the 5% level in reg 11 but again the sign is anomalously negative. This is not in line with what we would expect. It is possible that LSAPs were not able to boost credit because other factors (especially business activity as reflected in the CFNAI) were influencing business credit decisions more than interest rates. Even if credit is cheaper it does not mean that profitable and creditworthy opportunities are available and therefore credit would not increase.

The results from the regressions that use the 10-year Treasury rate (reg 13 and reg 14 in Table 3.5) indicate that this interest rate does not have a statistically significant relationship effect on the business credit to profit ratio. It should be noted that separately the BAA and the AAA corporate bond yields have a 0.96 and 0.98 correlation with the Treasury rate so it is to be expected that the latter would not be statistically significant since the first two are not. In the shorter sample, in the short run, both the CFNAI and the business confidence index are statically significant at the 1% level, but only the CFNAI has the expected positive sign. An increase in the CFNAI increases business credit to profit by 46.14 percentage points. In the long run, the CFNAI increases business credit to profit by 17.62 percentage points in the long run (both the speed of adjustment and the bounds test are statistically significant at the 1% level). Anomalously, an increase in the business confidence index appears to decrease the ratio of business credit to profit in the short run, but this effect is not statistically significant in the long run. In the longer sample, an increase in the CFNAI increases the business credit to profit ratio by 49.92 percentage points and the result is statistically significant at the 5% level. It is not statistically significant in the long run. The business confidence index is statistically significant in the short run at the 1% level but again the sign is negative. It is not statistically significant in the long run. The results that include the 10-year interest

rate indicate that other factors, mainly economic activity, influence business credit more than interest rates do. If businesses do not believe that economic activity was going to improve they would be reluctant to increase their level of debt. Moreover, if household balance sheets have not rebounded, businesses are unlikely to face a strong demand and therefore they will not need to take on more debt.

Taken together, these results clearly point to LSAPs being at best only partially successful. On the one hand given that the Federal Reserve could not lower the federal funds rate any further, it seems to have managed to use longer-term interest rates as substitutes for its traditional monetary policy instrument. Our findings suggest that the decrease in long-run interest rates spurred consumer credit and mortgage credit to some extent, exactly as the Federal Reserve intended. However, these increases in credit were small relative to the interest rate reductions which themselves were modest as discussed earlier. Considering the LSAP mechanisms described previously, one might have expected such liquidity injections to provide greater stimulus to credit. From the results presented in this chapter, it seems that even if LSAPs did increase lending or stimulate some credit markets, the effects may not have been large enough to give a boost to economic growth (Mora, 2014). Moreover, lower long-run interest rates did not significantly boost business credit. Given the pre-crisis consumer debt levels, even if lending was stabilized, LSAPs may not have been enough to restore economic activity to its pre-crisis level. Studies on quantitative easing in Japan report that even if financial and credit markets are stabilized, supplying credit is relatively ineffective or has a weak impact on economic growth (Spiegel, 2006; Bowman et al., 2015). Despite the unconventional and unprecedented reaction of the Federal Reserve, it seems that economic recovery has been sluggish compared to previous US recoveries. However, without an accurate counterfactual it is difficult to establish the usefulness of LSAPs. Indeed, although the effects may have been milder than anticipated, it is not to say that the actions of the Federal

Reserve did not serve to avoid a total collapse of the financial system that would have proved much costlier in the long run than the Great Recession alone (Wu, 2014).

Moreover, the reason why the effects were weak, despite the theoretical relationship between interest rates and loan demand and supply, could be due to the new regulations that emerged as a result of the financial crisis such as the Dodd-Frank Act, which imposes more stringent mortgage underwriting standards and increased regulatory scrutiny by the Consumer Financial Protection Bureau which made it more difficult for banks to extend credit (Mora, 2014). Another possible explanation for why the impact of a decrease in long-term interest rates on consumer credit is weaker than expected is that the financial sector was greatly consolidated during and after the Great Recession. Indeed, some financial institutions such as Merrill Lynch and Bear Stearns were absorbed by other large banks, like Bank of America, making them even larger (i.e. Too Big to Fail) and increasing market concentration. As a result, such banks, which also happen to be lenders, may have gained pricing power and therefore did not transmit the effects of monetary policy to commercial banks (Dudley, 2012; Fuster et al., 2013). Also, as was mentioned earlier, it is possible that consumer credit has not rebounded as was expected because investors and banks still maintain a poor expected economic outlook. As a result, they perceive both borrowers and lenders as carrying higher risk than before the crisis and may be looking to rebuild their balance sheets, therefore retaining the liquid funds, instead of lending out the funds. From this chapter it seems that although LSAPs were often presented as a credit policy (Bernanke, 2012), they may have been more effective at fulfilling their goal of stabilizing the financial system. We found in chapter 2 that primary dealers and to a lesser extent other financial sectors experienced larger abnormal returns than nonfinancial sectors. This is an indication that the Federal Reserve was concerned with restoring confidence in the financial system to avoid the

collapse of the big banks (especially after the failure of Lehman Brothers, a primary dealer, in September 2008).

The results from this chapter indicate that the potency of monetary policy is limited at the ZLB but unconventional monetary policy can still have some impact. In the case of consumer credit, adding the LSAP period made the 24-month finance rate statistically significant (it is not in the shorter sample). In the case of mortgage credit, the impact of the 30-year mortgage rate on credit becomes marginally stronger after the LSAP period is included. However, the recent unconventional monetary policy actions more than tripled the size of the Federal Reserve's balance sheet. It was a large and unprecedented monetary policy intervention, but the impact of interest rates on credit was not as strong as the impact of economic activity. This could be taken as evidence that even with unconventional monetary policy being used there is also room for fiscal policy to boost aggregate demand and influence expectations. Indeed, from the results it seems that expectations and economic activity are also important determinants of credit and should not be neglected while designing a policy response.

Estimation Exercise to assess the quantitative impact of LSAP-induced reductions in interest rates on the various types of credit:

We also conducted an estimation exercise to gauge the economic significance of the estimated impact of lower interest rates on two of the types of credit we studied that had statistically significant coefficients for those rates. Using the estimates of the impact of LSAPs on the 10-year Treasury rate from the literature, the correlations between the interest rates from Table 3.1 and the coefficients on the interest rate variables (from reg 2 and reg 6), we estimate the impact of interest rate reductions on each type of credit. We use the estimates of the impact of LSAPs on interest rates from Krishnamurthy and Vissing-Jorgensen (2012) and Gagnon, Raskin, Remache and Sack (2011). Gagnon

et al. (2011) conduct an event study to estimate the impact of LSAPs on 10-year Treasury yields. They find that LSAPs lowered the longer-term interest rate by 30 basis points. Krishnamurthy and Vissing-Jorgensen (2012) also use an event study and find that LSAPs reduced long-term Treasury rates by 15 basis points. Using this range of estimates as an upper bound and a lower bound, we will estimate by how much LSAPs changed each credit variable used in the analysis. Since the interest rates used in the two papers are not the same as the ones we use (in the case of the regressions that use interest rates that are more specific to the credit markets), we use the correlations between the interest rates shown in Table 3.1. The correlations between the real 10-year Treasury rate and the real 24-month finance rate on personal loans is 0.91 and the correlation with the real 30-year conventional mortgage rate is 0.99, with all rates measured in first differences. Using the estimates from the literature for the change in the 10-year rate, the correlations and our coefficients we use the following formula for each type of credit:

Change in 10-year Treasury rate due to LSAPs * correlation * credit market coefficient = Impact of interest rates on the credit market

The estimates obtained from the above equation are presented in Table 3.6 for both consumer and mortgage credit in both the short run and the long run. In the short run, a decrease in the interest rate between 15 and 30 basis point due to LSAPs increased the ratio of consumer credit to personal income between 0.034 percentage points and 0.068 percentage points. In the long run, the lower interest rate stimulated consumer credit between 0.016 and 0.031 percentage points. For mortgage credit, we find that a

reduction in the interest rate induced by LSAPs caused the share of mortgage credit to personal income to increase by a range of 0.005 to 0.009 percentage points. In the long run, mortgage credit increased by 0.011 to 0.021 percentage points. In all cases, the results are based on estimated coefficients that were statistically significant at the 1% level. Similar estimates are not shown in Table 3.6 for business credit, because the coefficients on interest rates were not statistically significant.

These results support our earlier conclusions. The lower long-term interest rates induced by LSAPs did provide some support to the consumer and mortgage credit markets, but LSAPs may have been more successful at achieving their goal of enhancing financial stability. Indeed, given the decrease in consumer and mortgage credit from 2007 to 2009, the increase in credit attributed to the interest rate effects of LSAPs was modest. The ratio of consumer credit to personal income fell by 2.04 percentage points and the ratio of mortgage credit to personal income fell by 1.8 percentage points, but the lower long-term interest increased the ratio of consumer credit to personal income by 0.068 percentage points in the short run and 0.031 percentage points in the long run while the ratio of mortgage credit to personal income increased by 0.009 percentage points in the short run and 0.021 percentage points in the long run.

We mentioned earlier that LSAPs had several goals. Those included stabilizing financial markets as well as stimulating credit. From the results in this chapter, it seems that LSAPs fulfilled their purpose of stimulating credit through lower long-term interest rates, but only to a very limited extent and only for households. We already saw in Chapter 2 that they bolstered the stock prices of the financial sector and especially primary dealers. This could have served to restore confidence in a fragile financial system. Restoring confidence was important in 2008 especially when we consider how expectations and economic activity impact credit markets. By avoiding a collapse of more

systemically important financial institutions, the Federal Reserve most likely prevented a more severe downturn as the health of the banking sector eventually reaches the broader economy as we saw during 2008. Nevertheless, the direct impact of the reductions in interest rates attributed to the LSAPs on household demand for credit were relatively small, while the impact on business demand for credit was statistically insignificant.

Table 3.6. Estimated Impact of LSAPs on Credit Markets via the Interest Rate Channel

	Change in Cons. Credit	Change in Mort. Credit	Cons.	Mortgage
SR Impact - Lower Bound	-2.04	-1.80	0.034***	0.005***
SR Impact - Upper Bound	-2.04	-1.80	0.068***	0.009***
LR Impact - Lower Bound	-2.04	-1.80	0.016***	0.011***
LR Impact - Upper Bound	-2.04	-1.80	0.031***	0.021***

Table 3.6 presents the estimated impact of LSAP on the ratios of consumer and mortgage credit in percentage points. Both the short-run and the long run estimates are presented. In order to measure the impact, we use the coefficients of reg 2 and reg 6. We also use the correlations presented in Table 3.1 and lastly the estimates provided in the literature on the impact of LSAPs on the 10-year Treasury rate. The statistical significance is indicated with *** 1%, ** 5% and * 10%. Columns 1 and 2 present the change in the ratios of consumer and mortgage credit from 2007 and 2009 in percentage points (using the 2007 average and the 2009 average). This helps to evaluate how large the effects of lower long-term interest rates were.

3.5 Conclusion

This chapter examined whether the interest rate reductions induced by LSAPs contributed to stimulating consumer, household mortgage and business credit after the recent financial crisis. The correlations presented in Table 3.1 suggest that movements in the 10-year Treasury rate strongly influenced movements in other interest rates, including the rates that matter to households such as the rates on consumer loans and mortgages as well as corporate bond yields. The question addressed in this chapter is to what extent the decreases in these interest rates were successful in boosting certain key types of private sector credit. According to our findings, the reduction in the inter-

est rates did help to stimulate consumer and mortgage credit, but the effects (although statistically significant) were economically modest, and there were no statistically significant effects of the interest rate reductions on business credit.

Considering the other results we find, it seems, that interest rates were not always the most important determinant of credit. The other variables such as expectations, housing prices and especially economic activity had a larger impact on credit. From our findings, it seems that structural factors could be responsible for the disappointing effects of LSAPs. The financial crisis was characterized by a credit crunch that brought almost the entire economy to a halt, which had a marked impact on expectations and economic activity. The Federal Reserve's response, in providing liquidity to banks to stimulate credit was in theory an appropriate reaction. However, the Federal Reserve had no way of predicting how the unprecedented economic climate that followed the financial crisis would affect credit above and beyond the decrease in long-term interest rates, and it seems that the impact of these other variables outweighed the small effects of the long-term interest rate reductions.

Chapter 4

HOW EFFECTIVE WAS THE FEDERAL RESERVE'S LARGE SCALE ASSET PURCHASE PROGRAM? A VIEW FROM BANKS' BALANCE SHEETS

4.1 Introduction

The effects of unconventional monetary policy have been fiercely debated in recent years, and the Federal Reserve's Large Scale Asset Purchase Program (LSAP) was no exception (Gagnon et al., 2011; Krishnamurthy and Vissing-Jorgensen, 2011; Joyce et al., 2011; D'Amico et al., 2012). Previous studies have focused on measuring the LSAP program's net effect on longer-term interest rates (Bauer and Rudebusch, 2013; D'Amico et al., 2012; Hancock and Passmore, 2011; Christensen and Rudebusch, 2012). We take a different tack in this paper, taking a view from the banking system to see how effective this large increase in the monetary base could have been, given banks' recent preferences to hold large balance of cash and reserves in excess of their legal requirements. Some studies have documented the rise of excess reserves since the onset of the crisis but their focus was on their potential inflationary effects and the unwinding of LSAPs (Martin et al., 2013; Keister and McAndrews, 2009; Ricketts and Waller, 2014; Kliesen, 2013).

This paper is different because we analyze the changes in both the Federal Reserve's balance sheet and banks' balance sheets. Using Call Report data we analyze how the balance sheets in the financial system and of the largest banks have changed as a result of LSAP and what are the implications for the effectiveness of such unprecedented and unconventional monetary policy. We do not provide a precise quantitative estimate of the effectiveness of the LSAP program, but instead provide an upper bound.

The goal of open market operations is to expand credit availability, to expand the money supply, and to lower interest rates. However, if banks simply swap assets for cash or other liquid assets or excess reserves in response to an asset purchase by the central bank, then credit availability, the money supply, and interest rates will all remain unchanged.[1] This possibility can be referred to as a liquidity trap, where traditional monetary policy loses its effectiveness, as money demand is infinitely elastic in this case and all new money created by the central bank becomes an idle hoard with no effect on economic activity. During the recent monetary policy response to the financial crisis, the decline of market interest rates on the back of monetary expansion has contributed to market conditions that are typical of a liquidity trap (van den End, 2014). Krugman (1998) finds that in the context of a liquidity trap, an expansion of the monetary base might even lead to a decline in bank deposits and bank credit. He explains that is due to the fact that the public would prefer to hold currency rather than deposits and that banks reduce credit to increase their reserve holdings. Martin et al. (2013) provides further evidence by explaining that excess reserves could crowd out lending because of the reduced cost of holding excess reserves. In this case, bank lending will be reduced to equalize the marginal return on lending to the marginal cost of holding

[1]It is possible for the increase in the amount of cash relative to other assets on banks' balance sheets to reduce their debt load and improve the health of their balance sheets. We are not able to address this channel and so only provide an estimate of the effect of LSAPs working through traditional monetary policy channels.

on to excess reserves. Generally, these situations tend to occur in the wake of large recessions when nominal interest rates are low, as was the case in the United States in the late 2010s. Not only was the opportunity cost of holding cash low due to low nominal rates, but the Federal Reserve coincidentally started paying interest on both required and excess reserves in 2008, which further reduced the opportunity cost of holding additional reserves by banks. It is of course possible that monetary policy retains its effectiveness even after a deep recession or when interest rates are low, and thus quantitative easing and credit easing programs which massively expands the monetary base would increase nominal income growth significantly and result in high inflation or hyperinflation (Meltzer, May 3, 2009; Feldstein, 2009). The reality is between these two positions, and this paper endeavors to put an upper bound on the importance of the liquidity trap theory in terms of banks' holding of excess reserves.

Firstly, we look at aggregate quantities, and examine changes in cash or close substitutes like reserves, relative to changes in the overall monetary base stemming from the LSAP program. The larger the ratio of the change in cash or cash substitutes relative to the change in the overall monetary base, the less effective quantitative easing could potentially be, as this simply swaps one asset for another (cash or reserves). We also focus on the exact transmission mechanism of open market operations. The Federal Reserve Bank of New York, which conducts open market operations on behalf of the Board of Governors, transacts with a select number of large, important banks called primary dealers. Under the traditional monetary mechanism, an asset purchase by the Federal Reserve would result in additional reserves at a primary dealer, who then would lend out these reserves to another entity like a corporation or a bank. When these funds were deposited, this would generate a requirement for the depositing bank to hold a portion of the deposit as required reserves, with the remaining excess reserves free to be lent out again. Notice however that if in the first transaction the primary dealer instead keeps

the newly created monetary base as excess reserves and does not lend it out, then no new credit is created and there is no reason for interest rates to change, and no reason for output or prices to change. We will thus first see what fraction of new money being created is held as excess reserves or cash by the broker-dealers. Then, of the remaining new money creation, we will see how much is kept as cash or excess reserves by outside banks, who may have kept some of the new lending done by broker dealers as cash or as excess reserves. This yields an upper bound on the amount of new net lending done by the banking system and some insight into the effectiveness of LSAPs through bank balance sheets. This chapter is organized as follows: Section 4.2 reviews the evidence regarding the Federal Reserve's balance sheet and the liquidity trap, Section 4.3 presents the effects of LSAPs on the Federal Reserve's balance sheet and how it can be used to conduct monetary policy, Section 4.4 presents the data used for the analysis, Section 4.5 presents the results and Section 4.6 concludes.

4.2 Literature Review of Monetary Policy at the Zero Lower Bound

4.2.1 Traditional open market operations and the money multiplier

The Federal Reserve can use three tools to achieve its monetary policy goals: the discount rate, reserve requirements and open market operations (Brunner and Meltzer, 1968). All three affect the amount of funds in the banking system.

- Interest Rates: The Federal Reserve can change its target for the federal funds rate. When the Federal Reserve lowers this target interest rate other interest rate tend to decrease such as the discount rate (Keister and McAndrews, 2009). The discount rate is the interest rate Reserve Banks charge commercial banks for short-term loans. Federal Reserve lending at the discount rate complements open market operations in achieving

the target federal funds rate and serves as a backup source of liquidity for commercial banks (Federal Reserve Board, 2016b).

- Reserve requirements: are the portions of deposits that banks must hold in cash, either in their vaults or on deposit at a Reserve Bank (Federal Reserve Board, 2016b).

- Open Market Operations (OMO): the sale or purchase of government securities through security dealers in the bond market. The Federal Reserve sets its target for the federal funds rate and uses OMOs to reach it.

If the financial system becomes strained, such as the recent "credit freeze" and inter-bank lending is disrupted the Federal Reserve can decide to use the above conventional monetary policy tools. If conditions in credit markets are tight, the Federal Reserve can decide to lower the short-term interest rate in order to increase credit and stimulate economic activity. This should facilitate lending by banks. However, depending on the nature of the crisis, it might be more effective to use OMOs (Keister and McAndrews, 2009). This conventional monetary policy tool allows the Federal Reserve to use its balance sheet to expand or contract the monetary base. As we will discuss in detail later, the monetary base is comprised of reserves held by banks and currency in circulation. From this it follows that in order to change the monetary base, the Federal Reserve can either change reserves or currency in circulation. More commonly, conventional monetary policy usually relies on altering reserves. Broadly, open market operations consist of providing or absorbing liquidity from the banking sector. Indeed, in the case of expansionary monetary policy, the Federal Reserve purchases assets on the bond market from banks and credits their accounts. As a result, the holdings of total reserves in the banking system and the monetary base increase one-for-one (Mishkin, 2014). Since the opportunity cost of holding on to excess reserves is higher than lending them, banks use their increased reserves to expand credit. Given the nature of the recent financial cri-

sis, and the mechanisms behind monetary policy, a combination of lowering short-term interest rates and open market operations should have eased credit market conditions.

The conventional monetary policy channels described above rely on the assumption that banks would prefer to lend rather than hoard excess reserves. Traditionally, bank reserves did not earn any interest. This meant that banks did not have any incentive to hold on to reserves beyond the amounts held in required reserves. Therefore they chose to lend out excess reserves or use them to purchase other short-term assets. This in turn lowers the short-term market interest rate (Keister and McAndrews, 2009). In order to eliminate some of the pressure this poses for its target interest rate, the Federal Reserve can pay interest on reserves. By paying interest on reserves, banks' incentives change. They are no longer inclined to lend out excess reserves at an interest rate that is lower than the rate paid by the Federal Reserve. This allows the Federal Reserve to have some control over the market interest rate and guide it towards its target level (Goodfriend, 2002). This is exactly what the Federal Reserve started to do in October 2008. According to the Federal Reserve Board, this was done to "give the Federal Reserve greater scope to use its lending program to address conditions in credit markets while also maintaining the federal funds rate close to the target established by the Federal Open Market Committee" (Federal Reserve Board, 2008). These new incentives encouraged banks to hold large quantities of excess reserves not only because the Federal Reserve was paying interest on reserves but also because profitable credit opportunities were scarce.

Banks choosing to hold on to excess reserves conflicts with the textbook description of the money multiplier. Traditionally, an increase in bank reserves (through open market purchases) translate into an increase in excess reserves. Before 2008, when reserves rise, any level above the required amount would be lent out. This is because banks could

make a profit by lending out the excess reserves and this was more profitable than having them sit idly in the excess reserve account earning no interest (Cecchetti, 2007). For this reason, banks usually choose to lend out these excess reserves and keep the bare minimum required by the Federal Reserve. This means that the bank reserves are "multiplied" into a larger increase in the broad money supply and credit via the financial sector as banks expand their deposits and lending activities (using the new reserves created by the open market purchases of the Federal Reserve) (Annunziata, 2011). If the Federal Reserve increases reserve requirements then the multiplicative effects of open market purchases will be diminished as banks cannot create as many deposits (they instead must hold on to additional reserves that cannot be lent out). This multiplicative effect is referred to as the money multiplier. The relationship between the monetary base, the broad money supply, the reserve ratio and the money multiplier can be presented using the following formulas:

$$\text{Money Supply} = \text{Monetary Base*Money Multiplier} \tag{4.1}$$

where the money multiplier can be expressed as follows:

$$\text{Money Multiplier} = \frac{1}{\text{Reserve Ratio}} \tag{4.2}$$

Another way to think of the money multiplier is by using the money supply and the monetary base:

$$\text{Money Multiplier} = \frac{\text{Money Supply}}{\text{Monetary Base}} \tag{4.3}$$

The equation above tells us that the money multiplier is the number of dollars of money supply that can be created for every dollar of monetary base. To better illustrate

the money multiplier in normal times, we use an example. In this example we assume that banks do not hold on to excess reserves, that the reserve requirement is 10%, and that when the level of checking account deposits and loans changes, the quantity of currency held by the nonbank public does not. First we start with an open market purchase of $100,000 by the Federal Reserve from Bank A. The purchase doesn't change the level of assets but it shifts $100,000 out of securities and into reserves, increasing reserves by the amount of open market operations. The change in the composition of Bank A assets means that Bank A received noninterest bearing reserves in exchange for its interest bearing securities. This means that Bank A must find something profitable to do with the reserves in order to avoid a fall in revenue. Since liabilities are unchanged as a result of the open market operations there is no change in required reserves but there is an increase in excess reserves. Bank A will choose to lend out the additional excess reserves. Bank A receives a loan application from Company A. After Bank A approves the loan, it credits Company A's checking account. The next step is Company A uses the loan to make a payment to Company B. Company B deposits the $100,00 with Bank B. As a result, Bank B's account at the Federal Reserve is credited with $100,000. The increase in Company B's checking account is expensive to service for Bank B so it will make a loan with the deposit. Since the reserve requirement is 10%, Bank B must hold $10,000 in reserves but can loan out $90,000. If the $90,000 is deposited in another bank by the borrower then this third bank will have to hold 10% or $9000 in reserves and once again loan out $81,000. From this chain of events we see that an initial open market purchase by the Federal Reserve creates $271,000 in new loans and $191,000 in new checking account deposits. This process could repeat itself for additional rounds. This example shows how open market operations can be multiplied into the money supply.

By definition the money supply is the stock of money held by the public and the monetary base, as we mentioned before, it is sum of currency in circulation and reserves.

They can therefore can be expressed as follows:

$$\mathrm{M} = \mathrm{C} + \mathrm{D} \tag{4.4}$$

$$\mathrm{B} = \mathrm{C} + \mathrm{R} \tag{4.5}$$

where M is the money supply, C is currency, D is deposits, B is the monetary base, R is reserves. If we rearrange the expressions above we have:

$$\frac{M}{B} = \frac{C+D}{C+R} = \frac{C+D}{C+R} * \frac{D/(CR)}{D/(CR)} \tag{4.6}$$

$$M = B * \frac{C+D}{C+R} * \frac{D/(CR)}{D/(CR)} \tag{4.7}$$

$$M = B * \frac{\frac{D}{R}(1+\frac{D}{C})}{\frac{D}{R}+\frac{D}{C}} \tag{4.8}$$

The money multiplier is $\frac{\frac{D}{R}(1+\frac{D}{C})}{\frac{D}{R}+\frac{D}{C}}$. This means that currency and reserves affect the multiplicative effect of the monetary base into money supply. Specifically, the choice of reserve holdings by banks and currency holdings by the public determine the multiplier and in turn the money supply. Often the discussion of the money multiplier ignores the possibility of banks holding on to excess reserves (this was the case in the example above). However, this has become an important consideration since the latest financial crisis. Indeed, prior to the crisis , the reserve ratio was determined by required reserves as banks did not hold excess reserves. This meant that reserves were relatively stable as banks would only hold on to the minimum amount required by the Federal Reserve. However,

since 2008, banks have been choosing to increase their holdings of excess reserves. If banks choose to hold excess reserves in addition to required reserves and if account holders withdraw more cash, the deposit expansion mechanism (or the money multiplier) described above will be smaller as fewer newly created reserves (through open market purchases) will be multiplied into loans and deposits (Cecchetti, 2007). Indeed, from equation 4.8 increased excess reserves or currency would cause the ratio of deposits to reserve and the ratio of deposits to currency to decrease and therefore would reduce the money multiplier. In this context the money multiplier is determined not only by required reserves but also by excess reserves and cash holdings. In order to better illustrate how the money multiplier can break down with excess reserves and currency holdings we provide another example. In this example we relax the assumption that banks do not hold on to excess reserves and instead we assume that banks hold on to 5% of checking accounts in excess reserves. Moreover, we assume that the holders of checking accounts withdraw 5% of a deposit in cash. We maintain the reserve requirement at 10%.

To illustrate why these changes matter we use the same premise as the previous example. After Company B deposits the $100,000 with Bank B, because Bank B wishes to hold excess reserves and Company B wishes to hold currency, Bank B cannot make a loan of $90,000. Indeed, if Company B holds on to 5% then that leaves $95,000 in Bank B's reserve account. Then Bank B holds on to 15% in reserves (required and excess reserves) this increases the reserve account by $14,250 and leaves $80,750 in loans. We see that in the previous example Bank B had $90,000 available to make loans but now it has $80,750. As the process goes on each account holder and each bank will hold on to 5% in currency and 15% in reserves leaving fewer funds available to create new loans and deposits. This implies that the multiplier is weaker then when banks did not hold on to excess reserves and the nonbank public did not hold on to currency.

This has important implications for monetary policy. The money multiplier determines the amount of money supply created from a given amount of monetary base. This means that while the Federal Reserve can control the monetary base it cannot control the money supply. As long as banks maintain a low level of excess reserves (as was the case before the crisis) then there is a direct relationship between the monetary base and the money supply. However, if banks hold on to excess reserves then the Federal Reserve cannot force the money supply to grow as that process is determined by banks' decisions to lend. From this discussion, the monetary policy tools described above and the money multiplier formula, it is clear how the Federal Reserve can control the monetary base directly. However, it cannot directly control the money supply and credit availability. Both the money supply and credit are controlled by the money multiplier and therefore by banks' lending decisions and their customers' decisions on how to allocate their wealth (Mishkin, 2014).

In normal times the money multiplier tends to be relatively stable. Following the traditional view of the money multiplier, the large increase in reserves due to LSAPs should have led to uncontrollable inflation (Cecchetti et al., 2006). However, this was not the case during the recent crisis. The banking system was greatly impaired and therefore reserve increases did not translate into money creation instead banks chose to increase their excess reserves. This also implies that the liquidity injections did not leave the banking system and therefore did not reach the broader economy. The textbook presentation of the money multiplier failed during the financial crisis because it assumes that the central bank does not pay interest on reserves and that banks do not hold on to excess reserves.

The equations above show that the broad money supply does not necessarily grow proportionally to the monetary base. The broad money supply can be restrained if banks

choose to hold on to their excess reserves instead of lending them out. Prior to 2008, banks did not earn any interest on reserves and therefore they immediately looked to loan out excess reserves to earn interest. This creates additional deposits in the banking sector as a whole and leads to a small increase in required reserves but to a large increase in the supply of excess reserves. These are in turn used to make additional loans and the process repeats itself (Keister and McAndrews, 2009). The money multiplier process can be disrupted if the short-term interest rate reaches the zero lower bound. In this case, the banks' incentives change as they no longer face an opportunity cost of holding reserves and therefore do not lend out their excess reserves. Following from the monetary base equation, this means that the money multiplier stops (Annunziata, 2011). The process stops even sooner if the central bank pays interest on reserves. Instead of continuing until the market rate hits zero it will continue until the market rate is equal to the rate paid on reserves. In such a scenario the money multiplier breaks down and changes in the monetary base, induced by the Federal Reserve, will not lead to money or credit creation. When expansionary monetary policy becomes powerless, the economy is in a liquidity trap (Blanchard, 2009). The failure of the money multiplier described above applies in the context of the recent financial crisis.

4.2.2 The Importance of Sweeps

In the 1990s, when the Federal Reserve could not pay interest on reserves, sweep accounts became a popular tool used by depository institutions to avoid having funds sitting idly in their reserve requirement account at the Federal Reserve earning no interest. This banking practice in which depository institutions shift funds out of their customer accounts subject to reserve requirements into interest earning accounts has reduced the required balances held by banks in their accounts at the Federal Reserve (Anderson and Rasche, 2001). Indeed, the use of sweeps increased rapidly in 1995 and

their impact on total required reserves has been considerable. Bennett and Hilton (1997) estimate that by February 1997, the values of all transactions balances subject sweep arrangements had accumulated to about $184 billion. They find that this reduced total required reserves by about $18 billion since the end of 1993. Moreover, the authors also find that sweeps since 1997 have continued to rise and therefore that the trend toward lower required reserve balances is likely to continue.

When sweeps first emerged there was a concern that they would lead to greater volatility in the federal funds rate as banks try to manage their accounts with very low balances. Given that the Federal Reserve traditionally conducts monetary policy through the federal funds rate, and that rate is highly correlated with other interest rates, an increase in its volatility could have some implications for the broader economy (Bennett and Peristiani, 2002; Wrase, 1998). Moreover, sweep programs are a costly and inefficient way to avoid reserve regulations. Therefore, the popularity of these programs highlighted the need for reform. For this reason in 2006, Congress approved the Financial Services Regulatory Relief Act (FRSSA) a bill that would allow the Federal Reserve to pay interest that depository institutions hold on at Federal banks beginning in 2008. FRSSA also permits the Federal Reserve to lower reserve ratios on transaction accounts, with the possibility of even ending reserve requirements (Dutkowsky and VanHoose, 2011). The Federal Reserve wanted to have better control over interest rates and more leverage to battle the 2008 credit crunch.

The result of such legislation was to contribute to the reduction in sweeps. There is some evidence that by paying interest on reserves, the Federal Reserve can alter banks' incentive to encourage a reduction in sweeps. According to Dutkowsky and VanHoose (2008), the interest rate on reserves that the Federal Reserve would have to pay depends on the rate of required reserve. The sweep eliminating interest rate on reserves being

higher if the reserve requirement remains unchanged and lower if it is lowered. In any case the authors do find that by paying interest on reserves the Federal Reserve is able to reduce sweeps.

4.2.3 The Liquidity Trap:

In the case of the financial crisis, the Federal Reserve was paying interest on reserve starting in October 2008 and by December 2009, the short-term interest rate had hit the ZLB. This meant that the Federal Reserve could no longer use the short-term interest rate to conduct monetary policy, as it cannot be negative. It also meant that open market operations would not trigger the money multiplier as the opportunity cost of holding money had become zero and therefore banks would prefer to hoard excess reserves. Such a scenario is called a liquidity trap.

Since conventional monetary policy becomes ineffective in a liquidity trap other policy measures have been suggested. These policies can be grouped in three classes: 1) Signaling to shape policy expectations, 2) changing the size of the central bank's balance sheet, and 3) changing the composition of the central bank's balance sheet; (Bernanke and Reinhart, 2004) (Bernanke et al., 2004). According to the signaling channel, using announcements, the central bank can provide signals to the rest of the economy regarding its objectives and future monetary policy actions (Williams, 2014).This type of monetary policy does not necessarily affect financial markets directly but rather indirectly by altering the public's expectations of future monetary policy actions. The importance of expectations for the conduct of monetary policy in normal times and when the policy rate is near or at the ZLB has been stressed in many papers (Eggertsson and Woodford, 2003) (Eggertsson, 2003) (Bernanke et al., 2004). Through increased transparency and communication with the public, the Federal Reserve can guide monetary policy even at

the ZLB. Indeed, evidence from Japan suggest that when the zero interest rate policy (ZIRP) was reinstated in March 2001 and the Bank of Japan (BOJ) announced that it would target bank reserves it was successful in affecting policy expectations through its announcements (Fujiki and Shiratsuka, 2002; Takeda and Yajima, 2002; Okina and Shiratsuka, 2003).

The second policy involved increasing the size of the central bank's balance sheet. As we noted earlier, when the interest rate is at the ZLB, the central bank can no longer use it as a monetary policy tool however, this does not prevent the central bank from adding liquidity to the system beyond what is needed to reach the ZLB, such a policy is called quantitative easing (Bernanke et al., 2004). This policy assumes that financial markets are not frictionless and that they are segmented (Williams, 2014). Using these assumptions there are two channels through which quantitative easing may be effective. The first is the portfolio-rebalancing channel. This channel is associated with both monetarist arguments presented by Meltzer (1999) and Keynesian arguments presented by Brainard and Tobin (1968) and Tobin (1969), builds from the assumption that money and financial assets are imperfect substitutes. According to this theory increases in the monetary base through large liquidity injections will induce households and firms to rebalance their portfolios by trading money for financial assets (that are relatively scarcer). This increases the demand for financial assets and therefore tends to raise their price and decrease their yield and this stimulates economic activity (Andrés et al., 2004). More recently, in the context of large-scale asset purchases by the Federal Reserve this has been called the scarcity effect.

The third policy is closely related to the second as it also involves using the central bank's balance sheet, but this time through its composition. Similarly to the second channel, the central bank can make large asset purchases but in this case it does not

restrict its purchases to short-term Treasury securities. Instead it purchases Treasuries with a wider range of maturities and/or non-Treasury assets such as Mortgage Backed Securities as was the case during the recent financial crisis. By buying or selling a wider range of securities the Federal Reserve could influence the relative supply of these securities (Bernanke et al., 2004). This channel, like the second channel, relies on the assumption that financial markets are not frictionless and that investors have strong restrictions on where they put their money, or preferred habitats (Vayanos and Vila, 2009). According to this channel, if the Federal Reserve alters the composition of its balance sheet by purchasing a variety of assets, it also alters the portfolio composition of investors. Because investors wish to recreate their original portfolio (with similar characteristics) they will purchase new assets that are similar to those purchased by the Federal Reserve. This alters the demand for the assets purchased by the Federal Reserve and for a wider range of non-purchased assets (Williams, 2014). As we described above, the change in demand will cause the price and yields of the assets to change (Joyce et al., 2011; Gagnon et al., 2011). This channel relies on the scarcity and the duration channels in the recent LSAP literature (these have been discussed in Chapter 2).

The effectiveness of alternative monetary policy has become an important consideration as several central banks including the Bank of England, the European Central Bank and the Federal Reserve have used unconventional monetary policy actions in response to the financial crisis and the ZLB environment. Before the crisis, most of the evidence regarding liquidity injections or large-scale asset purchases came from the Japanese lost decade and a few episodes in the United States such as Operation Twist in the 1960s (Modigliani and Sutch, 1966, 1967) and changes in the demand or supply of Treasury securities (Bernanke et al., 2004). More recent evidence is now available, as several central banks have used large-scale asset purchase programs.

4.2.4 Other LSAP Literature:

There exists an increasing number of studies looking into the effects of LSAPs. Most of them focus on the impact of LSAPs on yields on long-term securities. The findings differ in terms of magnitude but the results all point to LSAPs having sizable effects on long-term yields. Most of the studies use event studies or various time series methodologies and find that these types of asset purchases lowered the long-term Treasury yield by around 15 to 30 basis point (Krishnamurthy and Vissing-Jorgensen, 2011, 2012; Gagnon et al., 2011; Hancock and Passmore, 2011; D'Amico et al., 2012; Neely, 2015; Hamilton and Wu, 2012).

Despite a growing literature that provides information on the effects on LSAPs, there still exists a lot of uncertainty regarding the magnitude of these effects and their impact on the greater economy (Williams, 2013). In addition, it is still unclear through which transmission channel these effects impact the real economy. Most of the studies on LSAPs focus on their impact on financial markets rather than macroeconomic variables such as economic growth or unemployment. It is difficult to evaluate the effects of lower long-term interest rates when they are being progressively lowered over several months (or longer time horizons) and when policy measures, other than monetary policy, are also in place (Williams, 2014). One study that does attempt to evaluate how LSAPs impacted the general economy is Chung et al. (2012). They find that LSAP II lowered unemployment by a quarter percentage point. Another study by Chen, Curdia and Ferrero (2012) finds smaller effects. However, both papers agree that LSAPs are more effective when they also work through the signaling channel, making sure that economic agents expect sustained expansionary monetary policy (Williams, 2014).

Moreover, studies on the impact of LSAPs are unclear regarding the underlying transmission channel. Indeed, despite some evidence on the magnitude of the effects of LSAPs, evidence regarding the channels that are at work is unclear. It is difficult to distinguish between the signaling channel and the preferred habitat channels described in the previous section. Krishnamurthy and Vissing-Jorgensen (2011, 2012) find incomplete pass-through from LSAPs to prices of other securities. Since the signaling channel implies that the effect of LSAPs should be reflected across a wide range of securities, this provides evidence in favor of the preferred habitat channels or the portfolio rebalance channel that view assets as imperfect substitutes. Another study by Bauer and Rudebusch (2014) concludes even though it is very difficult to disentangle the effects from the three channels, in the United States all the channels play some part in the transmission mechanisms of LSAPs. On the other hand, evidence from asset purchases in the United Kingdom suggests that the preferred habitat channels are more significant (Christensen and Rudebusch, 2012).

This paper differs from already existing studies because it analyzes the effects of LSAPs through the balance sheet of the Federal Reserve and the balance sheet of banks. If the Federal Reserve injects liquidity into the balance sheets of banks, the effects will depend on how banks use the liquidity. If they use the liquidity to conduct normal business activities, such as extending credit, then the effects on the rest of the economy could be significant. However, if they keep most of the liquidity on hand then the effects of LSAPs will most likely be more modest. In both cases, LSAPs could still be beneficial, if banks use the liquidity it should help the overall economy and if banks "hoard" the liquidity it may also be helpful but in this case for financial stability. Given the context of the financial crisis, rebuilding the balance sheets of systemically important financial institutions and other banks is important to avoid similar future crisis and to encourage these institutions to resume their business activities.

4.3 Large-Scale Asset Purchase Program

4.3.1 Description of Large Scale Asset Purchases

Between 2008 and 2012, in an effort to restore the liquidity of the banking sector and to promote lending by banks, the Federal Reserve used three rounds of LSAPs to decrease long-term interest rates. The first round of LSAPs began in November 2008, when the Federal Reserve announced its intention to purchase $100 billion in GSE debt[2] and $500 billion in agency MBS. Later in December 2008, the Federal Reserve chairman Ben Bernanke suggested in a speech, that the Federal Reserve intended to extend LSAPs to Treasuries. In January 2009, the Federal Reserve bought Treasury Bills and in March, the Federal Reserve purchased $300 billion in long-term securities and an additional $750 and $100 billion in MBS and GSE debt. By November LSAPs had been downsized as agency debt purchases finished at $175 billion. In August 2010, the Federal Reserve announced that it would maintain its balance sheet and reinvest principal payments from LSAPs in Treasuries. This marked the end of LSAP I. Ultimately LSAP I reached $1.7 trillion.

Unfortunately, by the second half of 2010, the financial market faced turmoil once again and the economy remained lethargic (Fawley and Neely, 2013). This prompted the second round of LSAPs that began in August 2010 and ended in June 2011. In November 2010, a statement by the FOMC announced the Federal Reserve's intention to purchase an additional $600 billion in Treasury Bills. The goal of LSAP II was to lower the long-term interest rate and to maintain the level of inflation consistent with the

[2]GSEs are privately held corporations with public purposes created by the US Congress to reduce the cost of capital for certain borrowing sectors of the economy. Members of these sectors include students, farmers and homeowners. GSEs carry the implicit backing of the U.S. Government, but they are not direct obligations of the U.S. Government. For this reason, these securities will offer a yield premium over Treasuries. Examples of GSEs include: Freddie Mac, Fannie Mae and Ginnie Mae.(Investopedia, `http://www.investopedia.com/terms/g/gse.asp`

Federal Reserve's mandate. During this round of LSAPs, the Federal Reserve continued to reinvest principal payments in order to avoid increasing the size of its balance sheet and therefore the monetary base.

Despite this monetary easing, recessionary fears and weaknesses in the financial market re-emerged; this resulted in the Federal Reserve undertaking the Maturity Extension Program and Reinvestment Policy or "Operation Twist" in August 2011. Using a combination of sales and purchases of assets with different maturities, this program was intended to "twist" the yield curve, by reducing long-term interest rates relative to short-term interest rates, and not to increase the monetary base (Fawley and Neely, 2013). The Federal Reserve first used "Operation Twist" in 1961. The economy had been in recession for several months, so policymakers decided to lower long-term interest rates while keeping short-term interest rates unchanged. The goal was to influence business investment and housing demand that were primarily determined by longer-term interest rates (Alon and Swanson, 2011). The effectiveness of Operation Twist in the 1960s was found to be at best moderately successful (Modigliani and Sutch, 1966), probably because the purchases were too small and offset by Treasury issuance (Blinder, 2000). In the case of the recent financial crisis, following Operation Twist, the labor market remained sluggish, which led to speculation regarding the Federal Reserve's next move. In August 2012, Bernanke acknowledged that "the stagnation of the labor market in particular is a grave concern" and that "the Federal Reserve will provide additional policy accommodation as needed." (Bernanke, 2012). This marked the beginning of LSAP III.

In August 2012, the third round of LSAPs was officially announced and consisted of additional monthly purchases of $40 billion of MBS as long as the labor market remained weak. The Federal Reserve announced the expansion of LSAP III and its intention to

purchase $45 billion of long-term Treasury Bills per month in December 2012. This time however, the purchases were no longer going to be sterilized so the monetary base was going to expand as a result of this round of LSAP. The last round of LSAPs was open-ended with the rate and length of purchases dependent on the state of the economy (Ricketts and Waller, 2014). Ultimately LSAP III reached $1.485 trillion. This gave the Federal Reserve some flexibility while conducting monetary policy. The impact of LSAPs on the balance sheet of the Federal Reserve can be seen in Figure 1.8 and Figure 1.9. Each round of LSAPs is reflected in the step-like increase in the holding of Treasury securities and mortgage-backed securities (see Figure 1.8). Furthermore, prior to LSAP I, the Federal Reserve did not hold any agency debt securities or mortgage-backed securities. The purchase of a broader range of assets was intended to alleviate the stress on banks' balance sheets and facilitate the flow of liquidity in the financial system. Both Figure 1.8 and Figure 1.9 show that the Federal Reserve used its balance sheet to conduct monetary policy.

4.3.2 The Federal Reserve's Balance Sheet and Monetary Policy

During the most recent downturn, the Federal Reserve faced two constraints on monetary policy. First, as a result of the crisis, the normal flows of credit and financing were inhibited. This meant that the effects of expansionary monetary policy through the federal funds rate were weakened. Second, since December 2007, the federal funds rate was close to the zero lower bound rendering the traditional monetary policy tool ineffective to boost economic activity (Doh, 2010). To overcome these constraints, the Federal Reserve initiated a series of new lending programs (Bernanke, 2009) and large-scale asset purchases. The goal of LSAPs was to increase the monetary base and decrease the long-term interest rate by purchasing a wider range of assets with longer maturity. In order to implement these new policies, the Federal Reserve relied on changing the

size and composition of its balance sheet, which is directly linked to the monetary base. Data on the assets and liabilities of the Federal Reserve as well as on the monetary base published by the St Louis Federal Reserve clearly reflects the use of these new tools. Both the balance sheet and the monetary base have drastically increased since the onset of the 2007 financial crisis.

Traditionally, the Federal Reserve's assets comprised mainly Treasury securities and its largest liability item was Federal Reserve notes or currency.[3] In addition, before 2007 the Federal Reserve's balance sheet grew steadily at a moderate pace with the purchase of additional Treasury securities closely tracking the expansion of currency. This means that the monetary base was also relatively stable. However, the unconventional monetary policy actions of the Federal Reserve have drastically changed the size and composition of its balance sheet (Carpenter et al., 2013). The Federal Reserve did not only purchase large amounts of Treasuries therefore increasing the quantity of bank reserves, it also purchased other types of assets including riskier assets (such as MBS) therefore changing the composition of the balance sheet. Ultimately, the large increase in the balance sheet caused the monetary base to nearly triple (Collignon et al., 2012).

At the start of the crisis, the Federal Reserve's balance sheet began to expand rapidly because of an increase in lending through the various liquidity and credit facilities that were created (Carpenter et al., 2013). By the time these liquidity facilities closed in mid-2010, the Federal Reserve had already started large-scale asset purchases in late 2008. As a result, the Federal Reserve's holding of securities in its System Open Market Account (SOMA) portfolio more than tripled (Chung et al., 2012a). These operations expanded the asset side of the balance sheet and the matching increase on the liability

[3]The Federal Reserve publishes its balance sheet weekly in the H.4.1 statistical release available at `http://www.federalreserve.gov/releases/h41/`

side was mostly reflected in reserve balances. These changes in the Federal Reserve's balance sheet are especially important because through its control of the monetary base it can influence interest rates (Anderson et al., 2010). In order to better understand how LSAPs impacted the monetary base and therefore the broader economy, we begin by reviewing the key components of the balance sheet that relate to the monetary base and how they changed.

Similarly to other banks, the Federal Reserve lists its assets, liabilities and capital on its balance sheet. Moreover, like all balance sheets, the asset side has to equal the sum of the liabilities and capital accounts. We examine the categories included in both assets and liabilities because they are an important tools for the Federal Reserve to manipulate the money supply. Indeed, holding everything else constant, increases in the monetary base will lead to multiple increases in the money supply (Blanchard, 2009). For this reason, the monetary base is also called high-powered money (Mishkin, 2014). In order to better understand how the Federal Reserve can use its balance sheet to conduct monetary policy and affect the monetary base, we begin by expressing the monetary base as the sum of the demand for currency and the demand for reserves by banks (Blanchard, 2009). It can be expressed as follows:

$$Monetary\ Base = Currency\ in\ Circulation + Reserves \tag{4.9}$$

Using the balance sheet, currency in circulation can be expressed as follows:

$$Currency\ in\ Circulation = Federal\ Reserve\ Notes + Treasury\ Currency - Coin \tag{4.10}$$

If we replace the currency in circulation component of the monetary base we get:

$$Monetary\ Base = (Federal\ Reserve\ Notes + Treasury\ Currency\ \text{-}\ Coin) + Reserves \tag{4.11}$$

Where, Federal Reserve notes is the amount of paper currency in the hands of the public. Historically, Federal Reserve notes have been the largest liability on the Federal Reserve's balance sheet. When a U.S. depository institution needs more currency to meet its customers' needs, it relies on the Federal Reserve Bank to send it more Federal Reserve notes. Specifically, the Federal Reserve Bank transfers the currency to the institution and debits the institution's Federal Reserve account by the amount transferred.[4] The second term, Treasury currency, is equal to Treasury currency outstanding minus Treasury cash holdings (more details to follow). The term, coin, consists of Treasury currency held by the Federal Reserve. Lastly reserves are the amount of balances institutions hold in accounts at Federal Reserve Banks that are available to satisfy reserve requirements.[5] Unfortunately, equation 4.3 does not tell us what factors determine the monetary base. Meaning that we cannot precisely track the items that cause the base to change. However, using the "assets equal the sum of liabilities and capital account" property of the balance sheet (Mishkin, 2014), it is possible to relate the items in equation 4.3 to items of the Federal Reserve's balance sheet. Historically, the size of the balance sheet reflected growth in Federal Reserve notes and reserves (Carpenter et al., 2013). Both items are classified as liabilities on the Federal Reserve's balance sheet. Specifically, since Federal Reserve notes and reserves are both liabilities, their sum will

[4]The definition is from: The Board of Governors of the Federal Reserve system: `https://www.federalreserve.gov/monetarypolicy/bst_frliabilities.htm`

[5]The definition can be found on the Federal Reserve's website at `https://www.federalreserve.gov/releases/h3/h3_technical_qa.htm`

equal the sum of all assets minus all the other Federal Reserve liabilities and capital accounts. Using a generalized version of the Federal Reserve's balance sheet we have:

$$\begin{aligned} &Federal\ Reserves\ Notes + Reserves = Securities, unamortized\ premiums \\ &and\ discounts, repurchase\ agreements + loans + gold\ and\ SDRs + coin + \\ &Net\ portfolio\ holding\ of\ Maiden\ Lane\ LLC + cash\ items\ in\ process\ of\ collection + \\ &bank\ premises + Central\ bank\ liquidity\ swaps + foreign\ currency \\ &denominated\ assets + other\ Federal\ Reserve\ assets - Deposits \\ &(= Term\ deposits - Treasury\ deposits - foreign\ and\ other\ deposits) - \\ &deferred\ availability\ cash\ items - other\ Federal\ Reserve\ liabilities\ and \\ &capital\ accounts \end{aligned} \quad (4.12)$$

We can rewrite equation 4.6 using the following accounting definitions: the items "cash items in process of collection" and "deferred availability cash items" can be combined into one item called float by subtracting "deferred availability cash items" from "cash items in process of collection" (Mishkin, 2014). Moreover, it follows from equation 4.3 that to reconstruct the monetary base using equation 4.6 we add Treasury currency and subtract coin (see equation 4.5) in order to write the monetary base equation as follows:

$$\begin{aligned} Monetary\ Base &= Federal\ Reserves\ notes + Treasury\ currency - coin + reserves \\ &= Securities, unamortized\ premiums\ and\ discounts, repurchase\ agreements + \\ &loans + gold\ and\ SDRs + float + Net\ portfolio\ holding\ of\ Maiden\ Lane\ LLC + \\ &bank\ premises + Central\ bank\ liquidity\ swaps + foreign\ currency\ denominated\ assets + \\ &other\ Federal\ Reserve\ assets + Treasury\ currency (= Treasury\ currency\ outstanding - \\ &Treasury\ cash\ holdings) - Deposits (= Term\ deposits - Treasury\ Deposits - \\ &foreign\ and\ other\ deposits) - other\ Federal\ Reserve\ liabilities \\ &and\ capital \end{aligned} \quad (4.13)$$

Each item in Equations 4.6 and 4.7 is defined in the Appendix, but to understand how the Federal Reserve's unconventional monetary policy changed the composition and size of its balance sheet which led to an increase in the monetary base we discuss the evolution of certain items. In the context of LSAPs, which are reflected in the SOMA portfolio, reserve balances were the driving force behind changes in the monetary base. These reserve balances with Federal Reserve banks (or reserves) are equal to the difference between "Total factors supplying reserve funds" and "Total factors, other than reserve balances, absorbing reserve funds."[6] More specifically, reserves consist of the deposits at the Federal Reserve and vault cash (currency that is physically held by banks). Moreover, as we mentioned before, total reserves can be divided between

[6]The equations and definitions provided in the following section are from the Federal Reserve statistical release "H.4.1 Factors Affecting Reserve Balances of Depository Institutions and Condition Statement of Federal Reserve Banks" and the accompanying interactive guide that provides detailed information on the items of the Federal Reserve balance sheet (`https://www.federalreserve.gov/monetarypolicy/bst_fedsbalancesheet.htm`).

required reserves or the reserves that banks are required to hold and excess reserves or any additional reserves that banks choose to hold (Blanchard, 2009).

$$\begin{aligned} &Reserve\ Balances\ with\ Federal\ Reserve\ Banks\ (or\ reserves) \\ &= Total\ factors\ supplying\ reserve\ funds - Total\ factors\ other\ than\ reserve\ balances \\ &\qquad absorbing\ reserve\ funds \end{aligned} \quad (4.14)$$

From Table 1 presented in the weekly statistical release of the Federal Reserve, we can write equation 4.8 in the following generalized form:

$$\begin{aligned} &Reserve\ Balances\ with\ Federal\ Reserve\ Banks\ (\text{orreserves}) \\ &= (Reserve\ Bank\ credit + Foreign\ currency\ denominated\ assets + \\ &gold\ stock + SDRs + Treasury\ currency\ outstanding) - (Currency\ in\ circulation + \\ &Reverse\ repurchase\ agreements + Treasury\ cash\ holdings + \\ &Deposits\ with\ Federal\ Reserve\ Banks + Other\ liabilities\ and\ capital) \end{aligned} \quad (4.15)$$

Reserve Bank credit usually includes securities held outright, unamortized premiums on securities held outright, unamortized discounts on securities held outright, repurchase agreements, other loans, net portfolio holdings of Maiden Lane LLC, float, central bank liquidity swaps, and other Federal Reserve assets. However, as a result of the recent monetary policy actions, Net Portfolio Holdings of Commercial Paper Funding Facility, Net portfolio holdings of LLCs funded through the money market investor funding facility

and term auction credit are also part of reserve bank credit. We can therefore express Reserve Bank credit as:

$$\begin{aligned} Reserve\ Bank\ Credit = {} & securities\ held\ outright + \\ & unamortized\ premiums\ on\ securities\ held\ outright + unamortized\ discounts \\ & on\ securities\ held\ outright + repurchase\ agreements + other\ \text{loans} + \\ & net\ portfolio\ holdings\ of\ Maiden\ Lane\ LLC + float + central\ bank\ liquidity\ swaps + \\ & other\ Federal\ Reserve\ assets + Preferred\ interest\ in\ AIA\ Aurora\ LLC \\ & and\ ALICO\ Holdings\ LLC + Net\ portfolio\ holdings\ of\ commercial\ paper\ funding\ facility + \\ & term\ auction\ credit \end{aligned} \quad (4.16)$$

The most important item of Equation 4.10 in the context of the Federal Reserve's unconventional monetary policy is securities held outright. This balance sheet item is the cumulative result of permanent open market operations: outright purchases or sales of securities, conducted by the Federal Reserve. Traditionally, securities held outright were made up of U.S. Treasury securities or high quality and low risk securities. Treasury securities are used to lend to financial institutions, therefore increasing the money supply through the money multiplier. However, since late 2008, the composition of the securities held by the Federal Reserve has changed and now includes mortgage backed securities and federal agency debt securities. The purchase of these new low quality securities was intended to ease the credit crunch that triggered the subprime financial crisis. Between 2009 and 2011, the Federal Reserve purchased more than $1 trillion of agency mortgage-backed securities and $170 billion of agency debt and other government-sponsored enterprises (GSEs) (Mishkin, 2011a). The Federal Reserve also

purchased $1.6 trillion in US Treasury securities. By March 2012, the sum of the purchases was more than $2.6 trillion, or three times the pre-crisis level of securities held outright. The other items of Equation 4.10 are defined in the Appendix.

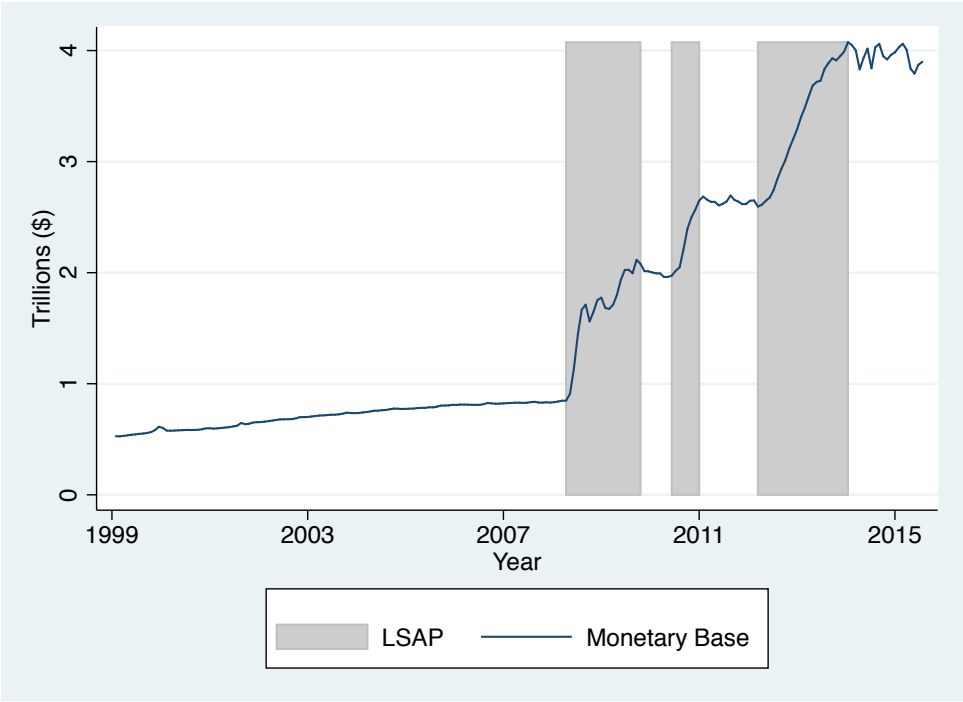

Figure 4.1. Monetary Base

Figure 4.1. plots the total monetary base. The variable is millions of dollars. We notice that it was relatively flat prior to the crisis but it started to increase dramatically as monetary easing started and in particular LSAPs. The start of each round is easily noticed on the graph as the monetary base experiences a large increase. The data is from the H.3. series of the Federal Reserve.

As we mentioned previously, reserves are the most influential component of the monetary base. This is reflected in the fact that many of the items they include are also included in the assets and liabilities of the balance sheet that makeup the monetary base according to equation 4.9. As we can see using accounting logic we were able to reconstruct the monetary base using the items included in the Federal Reserve's balance sheet. This exercise is particularly useful because it allows us to identify the factors affecting the monetary base or the "source of the monetary base (Mishkin, 2014). From equation 4.10 we see that certain items increase the monetary base such as securities,

unamortized premiums and discounts, repurchase agreements, loans, gold and SDRs, float, net portfolio holding of Maiden Lane LLC, bank premises, central bank liquidity swaps, foreign currency denominated assets, other Federal Reserve assets and Treasury currency, while others decrease the monetary base such as deposits and other Federal Reserve liabilities and capital.

The impact of LSAPs on the monetary base can easily be detected. As we see in Figure 4.1, the monetary base has increased in line with the large asset purchases. This increase was mostly caused by the amount of securities held by the Federal Reserves who purchased a wider range of assets than the traditional Treasury securities in order to facilitate the functioning of credit markets. However, while the monetary base has increased the money supply has not followed as the money multiplier would dictate and excess reserves have drastically increased. Moreover, inflation has remained in line with the mandate of the Federal Reserve. This means that the liquidity injections have not reached the broader economy and therefore could not have had a significant impact on credit and other macroeconomic indicators. This also means that the liquidity injections remained in the financial system that had been greatly weakened by the crisis. The decision by banks to hold on to their excess reserves can be explained in part by the Federal Reserve's decision to pay interest on reserves.

4.3.3 Earning Interest on Reserves and the Incentive to Hold Reserves

As was mentioned previously, the FSRRA authorized the Federal Reserve to begin paying interest on reserve balances held by or on behalf of depository institutions at Reserve Banks (IOR), with implementation accelerated to 2008 .[7]

[7]The description comes from the Board of Governors of the Federal Reserve System, 2016. Details on the Financial Services Regulatory Relief Act of 2006 can be found at `https://www.congress.gov/109/plaws/publ351/PLAW-109publ351.pdf`

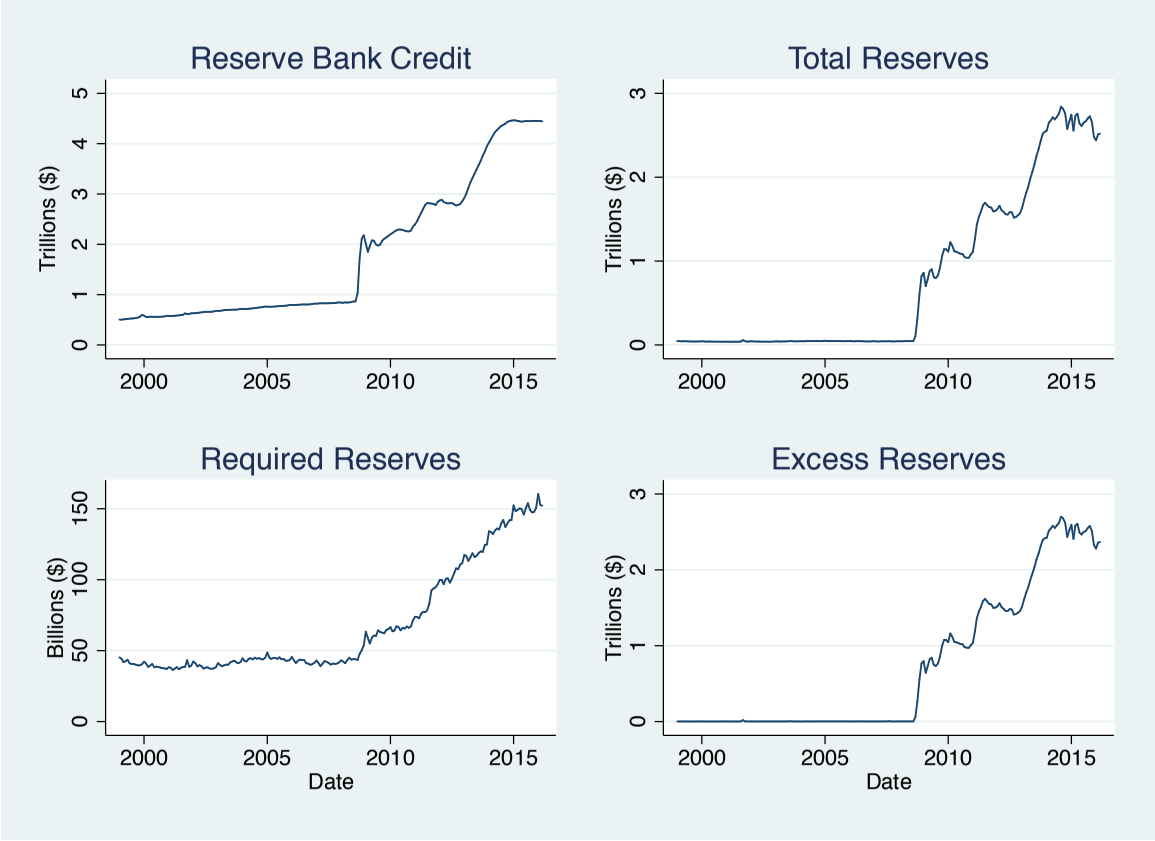

Figure 4.2. The Components of the Monetary Base

Figures 4.2 plots reserve bank credit. Federal Reserve Bank credit refers to the process of the Federal Reserve lending funds to member banks in order to meet their liquidity and reserve needs. By lending money to member banks, the Federal Reserve helps to maintain the steady flow of funds between consumers and banking institutions. This plot follows the monetary base as it was stable before the start of LSAPs and then it increased dramatically. Similarly to the monetary base, the start of each round of LSAPs can be noticed by a large increase in reserve bank credit. Figure 4.2 also plots total reserves and its components, required reserves and excess reserves. In the case of total reserves, the series used to be very flat and near zero. However, since the financial crisis, total reserves have increased dramatically and have kept increasing with every round of LSAP. For required reserves, they are the reserves that banks have to hold with the Federal Reserve to meet some of their obligations. It is one of the components of total reserves and has historically been relatively low. However, since LSAPs required reserves have increased steadily. Lastly, excess reserves are the reserves held by banks at the Federal Reserve above the amount that they are required to hold. This image clearly explains the evolution of total reserves. Excess reserves were usually close to zero (as it was not profitable to hold on to excess reserves before the Federal Reserve started to pay interest on reserves) but since the crisis and since the Federal Reserve has started paying interest on reserves we see that excess reserves have increased rapidly and can explain the evolution of total reserves. The data on reserve bank credit comes from the H.4.1 series of the Federal Reserves while the other series are from the H.3. series of the Federal Reserve.

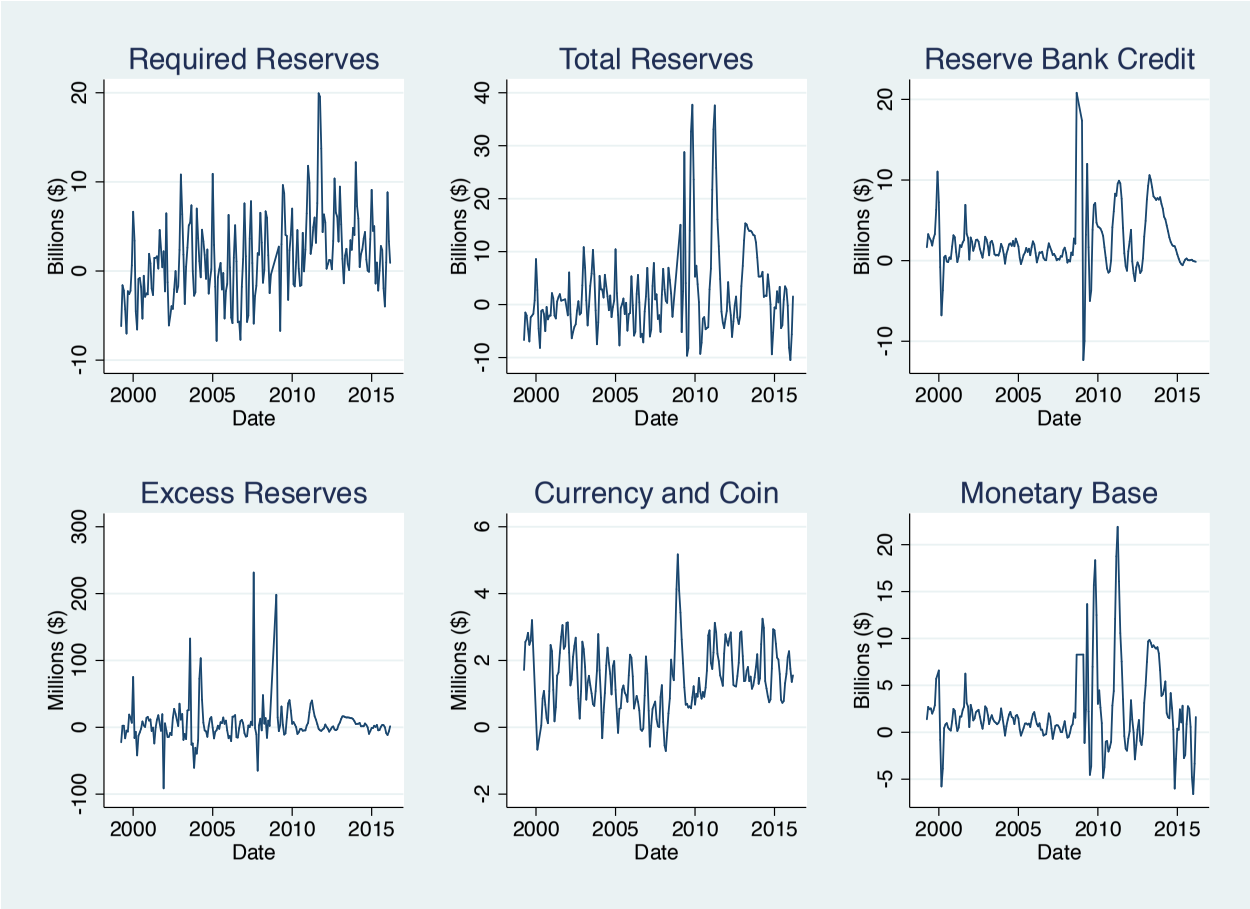

Figure 4.3. Quarterly Change of the Monetary Base and Its Components

Figure 4.3 plots the quarterly change in the monetary base and its components. The greatest spikes in all six series occur at the start of LSAPs. The quarterly change also tells us that LSAP1 caused the largest change in each series. Following LSAP1 there are some larger fluctuations than before the start of LSAPs. We also notice that in the case of the monetary base, excess reserves and total reserves, LSAP2 is also marked by a spike. This is probably because LSAP1 was the largest round and it occurred in a short period of time, and while LSAP2 was smaller it also occurred in a short period of time. LSAP3 was more open-ended and consisted of smaller liquidity injections. The data come from the Federal Reserve H.3. and H.4.1. series.

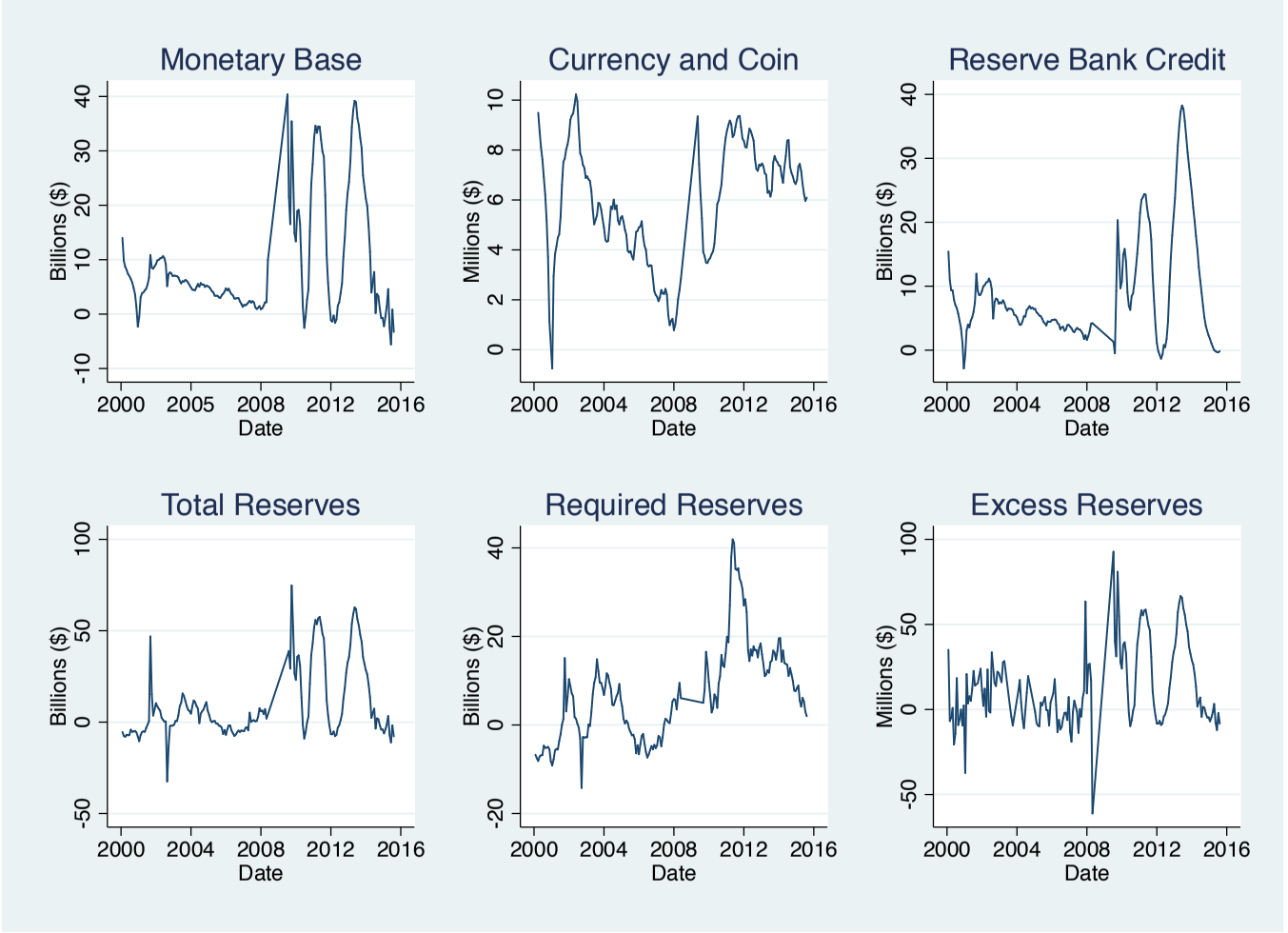

Figure 4.4. Annual Change of the Monetary Base and Its Components

Figure 4.4 plots the annual change in the monetary base and its components. The changes caused by each round of LSAP are noticeable in the case of the monetary base, reserve bank credit, total reserves and excess reserves. The implementation of LSAPs caused large fluctuations in the Federal Reserve's balance sheet and each round caused an increase in the monetary base. From these graphs it is apparent that the change in the monetary base was greatly influenced by excess reserves. This means that banks were not lending out the liquidity injections but rather hoarding them on their balance sheets. The data come from the Federal Reserve H.3. and H.4.1. series.

The Emergency Economic Stabilization Act of 2008 accelerated the implementation date to October 1, 2008 instead of 2011.[8] This Act granted the Federal Reserve the authority to amend its Regulation D (Reserve Requirements of Depository Institutions) to mandate that Federal Reserve Banks pay interest on both required and excess reserves help by depository institutions (Walter and Courtois, 2009). The implementation of such an IOR regime has found support in the literature. For more than 40 years, Milton Friedman advocated the idea and many central banks today employ some form of IOR.

The practice of paying interest on reserves is intended to impact banks' incentives to hold both required and excess reserves. Paying interest on required reserves eliminates the implicit tax that reserve requirements impose on depository institutions, which is equal to the income banks could have earned by using those funds for profit-generating loans and investments. It should eliminate the opportunity cost of holding required reserves and promote efficiency in the banking sector. The idea was to increase banks' efficiency by reducing the opportunity cost they incurred in being required to hold reserves that bore no interest. Eliminating a distortionary tax was not the only motivation. The practice of paying interest on excess reserves gives the Federal Reserve an additional tool for the conduct of monetary policy. It allows the Federal Reserve to expand its balance sheet as needed, to provide the necessary liquidity to support financial stability while implementing the monetary policy that is appropriate given the objectives of price stability and full employment of the Federal Reserve (Monetary Policy Releases, 2008).[9] Specifically, the Open Market Trading Desk (Desk) at the Federal Reserve Bank of New York (FRBNY) uses its authority to pay interest on reserves as a way to prevent the federal funds rate from falling to very low levels. The payment of interest on excess bal-

[8]This section is from the Board of Governors of the Federal Reserve System `https://www.federalreserve.gov/monetarypolicy/reqresbalances.htm`

[9]Monetary Policy Releases, 2008 can be found at `https://www.federalreserve.gov/monetarypolicy/20081006a.htm`

ances gives market participants little incentives "for arranging federal funds transactions at rates below the rate paid on excess reserves" (Federal Reserve Bank of New York, 2008). It essentially sets a floor on market rates and enhances the Desk's ability to keep the federal funds rate around the target for the federal funds rate (Bernanke, 2008). To better understand why IOR helps the Federal Reserve achieve its interest rate target, a review of the mechanism for monetary policy implementation is helpful.

The Federal Reserve conducts monetary policy through daily interventions in the market for bank reserves (Ennis and Keister, 2008). In particular, it aims to change the supply of reserves available to banks so that it equals demand at exactly the target rate of interest. In order to achieve its target, the Federal Reserve must estimate banks' demand for reserve and adjust the supply accordingly. In the absence of IOR, banks demand for reserves is set based on the reserve requirements set by the Federal Reserve[10], their payment obligations to other financial institutions and the cost associated with falling below the required amount[11]

Prior to October 2008, banks did not receive interest on reserves and as a result they minimized their holdings of excess reserves, which earn no income (Walter and Courtois, 2009). Through IOR, the Federal Reserve changed the incentives of banks to make them more willing to hold excess reserves. During the recent financial crisis the ability to pay interest on reserves was important for the conduct of monetary policy. As Chairman Bernanke explained at the time:

> *our liquidity provision had begun to run ahead of our ability to absorb excess reserves held by the banking system, leading the effective funds rate, on many days, to fall below the target set by the Federal Open Market Committee. ... Paying interest on*

[10]The reserve requirements are usually set to zero to 10% of deposits (Board of Governors of the Federal Reserve, 2016 `https://www.federalreserve.gov/monetarypolicy/reservereq.htm`

[11]For more on the cost of falling below the required amount, see Ennis, H. M., & Weinberg, J. A. (2007). Interest on reserves and daylight credit. FRB Richmond Economic Quarterly, 93(2), 111-142.

> *reserves should allow us to better control the federal funds rate, as banks are unlikely to lend overnight balances at a rate lower than they can receive from the Fed; thus, the payment of interest on reserves should set a floor for the funds rate over the day. With this step, our lending facilities may be more easily expanded as necessary.*[12]

The expansion of the Federal Reserve's various liquidity facilities caused a large increase in excess balances. This placed strong downward pressure on the overnight federal funds rate. At the time the Federal Reserve was not yet facing the ZLB on interest rates that it faces today. Therefore, Federal Reserve officials became concerned that they were pushing the target interest rate below its target. When it first started using liquidity facilities, the Federal Reserve prevented the expansion of excess balances by reducing the other assets it held on its balance sheet, notably holdings of US Treasury securities. It was essentially sterilizing the effects of the liquidity injections (Walter and Courtois, 2009).

However, after the failure of Lehman Brothers and the rescue of AIG in September 2008, the credit market freeze intensified and lending through the Federal Reserve's discount window skyrocketed. As a result the Federal Reserve could no longer offset the lending with the sale of its assets. Consequently, the Federal Reserve had to rely on paying interest on reserves as it allowed it to achieve its operating target for the federal funds rate, regardless of how much emergency lending it did (Bernanke, 2015).

By paying interest on reserves, banks would be more willing to hold on to excess reserves instead of trying to purge them from their balance sheets using loans or transfers into other holdings, such as bonds. The implementation of IOR allowed the Federal Reserve to keep the federal funds rate close to the FOMC's target even as it provided liquidity to support financial stability, resulting in higher levels of excess balances. The

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[12] `http://www.federalreserve.gov/newsevents/speech/bernanke20081007a.htm`

change in banks' incentives is reflected in the disconnect between the monetary base and the money supply during the financial crisis. Indeed, when the Federal Reserve no longer sterilized its lending through discount windows, the monetary base increased considerably. As we explained in the previous section, the monetary base is comprised of total reserves in the banking system plus currency in circulation, from July 2007 to December 2008, the Federal Reserve added $770 billion to reserves (Carpenter and Demiralp, 2012).

However, this increase did not lead to a proportional increase in any measure of the money supply. The increase in M2 of $538 billion was less than the additional reserves. This means that instead of the normal multiplier mechanism described previously, a fractional expansion of deposits existed (Cecchetti et al., 2006). This disconnect can most likely be explained by weakened credit market. The lack of attractive lending opportunities meant that banks preferred to hold excess reserves with the Federal Reserve earning the IOR rate at no risk.

4.4 Empirical Framework

4.4.1 Data

This paper uses data from three sources. The first is quarterly Call Reports data, and the other two are the H.4.1 series and the H.3 series from the Federal Reserve Board of Governors. As a result of an act of Congress, all regulated national and commercial banks are required to file with their federal supervisory agency a full statement of condition every quarter. These statements are called Call Reports; they provide a comprehensive balance sheet and income statement for each bank. Banks use standardized forms provided by the Federal Financial Institutions Examination Council (FFIEC) to

submit their data and each Call Report is audited by an FDIC analyst for errors and audit flags. These reports are publicly available on the FDIC website or the Chicago Federal Reserve website.[13] The Call Reports provide data on banks' balance sheet and income statements. Specifically, they provide detailed information about the assets, liabilities and income of insured financial institutions. The information can be used to assess and monitor the financial condition of Bank Holding Companies (BHC) and individual banks. These reports are the primary analytical tool used to monitor financial institutions between on-site inspections (Board of Governors of the Federal Reserve System, 2016 [14]

This chapter uses data on cash and due from banks from the Call Reports. As was discussed previously, financial institutions are required to maintain cash on hand to comply with statutory reserve requirements and to meet customer demands. Cash items are made up of checks or other items in process of collection payable in cash upon presentation. Cash items not in the process of collection are carried in a noncash account and reported as other assets. Due from banks are made up of accounts that "enable the transfer of funds between banks. The accounts are used to facilitate the collection of cash items and cash letters,[15] the transfer and settlement of security transactions, the transfer of participation-loan funds, the purchase or sale of Federal funds, and for many other purposes" (FDIC, 2012). The balances due from institutions cover all interest-bearing and noninterest-bearing balances whether in the form of demand, savings or

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[13]The data description of Call Reports is available at `http://www.investopedia.com/terms/c/callreport.asp`

[14]Description by the Federal Reserve can be found at `http://www.federalreserve.gov/apps/reportforms/reportdetail.aspx?sOoYJ+5BzDal8cbqnRxZRg==`

[15]A cash letter is A cash letter is a group of negotiable items, usually checks, accompanied by a specific set of instructions for each of the items. Cash letters are normally sent to a clearing house or the Federal Reserve check collection system. The definition can be found at `https://www.reference.com/business-finance/cash-letter-7e29b29aa8882d87`

time balances, but exclude certificates of deposit held for trading.[16] Cash and balances due from other banks represent an institution's primary liquidity reserves. Considering that they generate little or no income, banks do not usually hold excessive levels of cash and due from banks. However, as this paper shows this was not the case after the start of LSAPs. Tracking the cash in the financial system allows us to follow the LSAP liquidity injections and determine whether these injections were hoarded in the form of cash by recipient banks and other large financial institutions or if they were used to impact the greater economy. If the cash is hoarded, clearly LSAP cannot have the effects described by the theory since there will be no multiplier effect or rebalancing effect.

The second source of data is the H.4.1 statistical release, "Factors Affecting Reserve Balances of Depository Institutions and Condition Statement of Federal Reserve Banks." According to the description provided by the Federal Reserve Statistical Release, the release presents a balance sheet for each Federal Reserve Bank, a consolidated balance sheet for all 12 Reserve Banks, an associated statement that lists the factors affecting reserve balances of depository institutions, and several other tables presenting information on the assets, liabilities, and commitments of the Federal Reserve Banks.[17] For the purpose of this paper, this data needs to be analyzed with the third data source, the H.3 statistical release, "Aggregate Reserves of Depository Institutions and the Monetary Base." The Federal Reserve provides a description of the release, the H.3 release provides data on aggregate reserves of depository institutions, including required reserves, total reserves, reserve balances maintained, interest paid on reserve balances maintained, non-borrowed reserves, and borrowings by depository institutions from the Federal Reserve's

[16]The description can be found on the FDIC's website at `https://www.fdic.gov/regulations/safety/manual/section3-4.pdf`

[17]The description can be found at `http://www.federalreserve.gov/releases/h41/about.htm`

discount window. The release also provides data on the monetary base, which includes currency in circulation and total balances maintained.[18]

For our purposes, the two statistical releases are better interpreted together because some of the aggregated series in the H.3 series are decomposed into subcomponents in the H.4.1 series. This means that the components of the monetary base and reserves can be traced to specific items on the Federal Reserve's balance sheet. For example, "total reserve balances maintained at the Federal Reserve" in table 2 of the H.3 statistical release, which is the largest component of the monetary base (see the description of the Federal Reserve balance sheet and how it relates to the monetary base presented above), is equivalent to "other deposits held by depository institutions" published in the H.4.1 statistical release, which is equal to the difference between "Total factors supplying reserve funds" and "Total factors absorbing reserve funds." Since each item that makes up "Total factors supplying reserve funds" and "Total factors absorbing reserve funds" is presented in the H.4.1 series we can trace these items to the monetary base. In the case of LSAPs, Treasury securities, mortgage-backed securities and Federal agency debt securities (all assets purchased in the context of LSAPs) are presented in the H.4.1 series, they can be traced to the reserve held at the Federal Reserve and in turn the monetary base presented in the H.3 series. Putting together this Federal Reserve balance sheet data with cash data from banks allows us to trace how much of LSAPs are still in banks' balance sheet.

4.4.2 The Bank Balance Sheet Channel of Large-Scale Asset Purchases:

The traditional channels of monetary policy and the mechanisms behind unconventional monetary policy such as LSAPs were described previously. In contrast to other

[18]The description can be found at `http://www.federalreserve.gov/releases/h3/about.htm`

studies in the literature that test either the effectiveness of traditional monetary policy through the money multiplier or the effectiveness of LSAPs through the portfolio rebalancing and signaling channels, this paper tests the effectiveness of LSAP using banks and the Federal Reserve balance sheets. As we mentioned before, LSAPs have drastically changed the composition and the size of the Federal Reserve's balance sheet. In particular and as we will detail in the following section, the level of excess reserves has reached a historical high. Since September 2008, the quantity of reserves in the US banking system has grown dramatically. Before the financial crisis, required reserves that averaged $40 billion were much larger than excess reserves that averaged $1.5 billion (Keister and McAndrews, 2009). After the collapse of Lehman Brothers, reserves began to grow rapidly. The increase was almost entirely driven by excess reserves, indeed required reserves grew to approximately $60 billion and excess reserves grew to over $800 billion by mid-2009.

This unprecedented rise in excess reserves seems problematic for the implementation of unconventional monetary policy that relies on liquidity injections because the level of excess reserves sets the upper bound on the effects of LSAPs on the broader economy. Rather than promoting the flow of credit to firms and households, the money lent to banks is simply sitting idle in banks' reserve account (Martin et al., 2013; Edlin and Jaffee, 2009). If banks are hoarding the cash from the liquidity injections in excess reserves or cash on their balance sheet then the transmission mechanisms described in both the case of the money multiplier theory and the case of the portfolio rebalancing theory break down and the effectiveness of monetary policy is limited. This chapter attempts to trace the liquidity injections from LSAPs to determine whether or not banks were hoarding cash, therefore limiting the ability of monetary policy to strengthen the broader economy. If we find that the increase in the monetary base was not reflected in

the broad money supply because cash and excess reserves increased then this can explain why the impact of LSAPs has been, as other studies found, only mild.

Although LSAPs may not work as strongly as the theory describes, it may still support the broader economy by strengthening the banking system in general. As we discussed previously, the current banking system in the United States no longer resembles the traditional textbook model of fractional reserve banking. Historically, through the money multiplier, the quantity of reserves supplied by a central bank determined the amount of bank loans (Martin et al., 2013). Through the money multiplier banks expand loans to equal the amount of reserves divided by the reserve requirement (Martin et al., 2013). However, the money multiplier seems to have "broken down" since the financial crisis and specifically since interest rates have reached the zero-lower bound. This situation reflects the liquidity trap environment. As we mentioned, in a liquidity trap, an increase in base money will be hoarded as central bank reserve are not lent out. Krugman (1998) goes as far as to say that in a liquidity trap an expansion of base money might even lead to a decline in bank deposits and bank credit regardless of the health of the banking system. If the liquidity injections were hoarded on banks' balance sheet it is possible that LSAPs affect the economy by strengthening bank balance sheets rather than by promoting credit.

The increase in excess reserves is not only noticeable on the side of the Federal Reserve's balance sheet, it can also be seen in the large increase of banks' cash holdings (cash holdings include currency, coin, cash items in process of collection and balances due from domestic and foreign banks and central banks) (Craig et al., 2014). While many studies argue that increased cash holdings reflect the ineffectiveness of the Federal Reserve's unconventional monetary policy (Ashcraft et al., 2011; van den End, 2014; Krugman et al., 1998), it is possible that LSAPs were successful in alleviating balance

sheet fragility. The recent financial crisis was characterized by a credit crunch due to weak financial sector balance sheets that carried illiquid assets. By injecting liquidity into the balance sheets of systemically important financial institutions, like the primary dealers that interact with the Federal Reserve, the financial system has become more resilient. Indeed, by holding large amounts of cash, banks are more resilient in the face of unexpected shocks or losses (Yellen, 2014), thereby minimizing the risk that losses experienced by these primary dealers will reverberate throughout the financial system. Adrian and Shin (2008b) explain that the balance sheets of broker-dealers hold information on underlying financial conditions and financing constraints of the financial system. Therefore, the high cash holdings may reflect a lack of credit but they also mean that the risk of default from large financial institutions is greatly reduced. This is an important benefit given that one of the causes of the financial crisis was an illiquid financial system (Adrian and Shin, 2009). Moreover, according to a Federal Reserve press release (2015),[19] recent stress tests conducted by U.S. bank regulators have revealed that many of the systemically important financial institutions, including the broker-dealers that deal with the Federal Reserve, are better able to withstand adverse developments. Even though LSAPs did not increase credit the way the theory describes, they did contribute to improving the resilience of systemically important financial institutions that play an important role for financial intermediation (Adrian and Shin, 2008a). A well-functioning financial system, where institutions have a low probability of default will help prevent another financial crisis.

[19]For the full press release see `http://www.federalreserve.gov/newsevents/press/bcreg/20150305a.htm`

4.5 Results

4.5.1 A View from the Federal Reserve Balance Sheet

The graphs of the monetary base, its components and total reserves and its components clearly reveal that LSAPs had a considerable impact on the Federal Reserve's balance sheet. Figures 4.1 and 4.2 show a marked increase starting in the third quarter of 2008 when the first round of LSAPs started. Moreover, each subsequent round is also marked by a more pronounced increase in excess reserves, total reserves, Federal Reserve Bank credit and the monetary base. These four graphs have a "stair-like" shape starting in the last quarter of 2008 where each additional step represents a new round of LSAPs.

Moreover, when looking at excess, required and total reserves in Figure 4.2 it is apparent that excess reserves contributed most to the increase in total reserves. The graphs look very similar, while the graph for required reserves only shows an upward trend. Considering that total reserves are made up of excess and required reserves and given the shape of each series we can conclude that the increase in reserves is caused by excess reserves. If we adopt a similar approach when looking at the monetary base, we can say that the increase in the monetary base can be largely attributed to total reserves rather than currency in circulation. As we discussed in the previous section, describing the accounting of the Federal Reserve's balance sheet, the monetary base is made-up of total reserves and currency in circulation. We can see from the graphs that the monetary base and total reserves have a very similar evolution while currency in circulation is simply increasing after LSAPs at a faster rate than before LSAPs. This tells us that the change and evolution in the monetary base can be attributed to changes in total reserves.

In addition, Federal Reserve Bank credit presented in Figures 4.2 which is made up of the various kinds of credit extended by the Federal Reserve to different institutions, including securities that the Federal Reserve purchases for the conduct of monetary policy follows a pattern similar to the total reserves and the monetary base. Once again this tells us what is the main driver behind the change in the monetary base. As we discussed, Federal Reserve Bank credit is one of the items that contributes to total reserves and given that the evolution of the two series is similar we can trace the increase in total reserve to the increase in the Federal Reserve Bank credit. Following from this discussion, we have the first indication that the increase in the monetary base is due to an increase in total reserves (rather than currency in circulation) which is driven by an increase in excess reserves rather an increase in reserve requirements which can attribute its rise to Federal Reserve Bank credit which increased because of the unconventional monetary policy actions of the Federal Reserve.

The accounting chain that we described is supported by the evolution in quarterly and annual changes of the monetary base, required reserves, excess reserves, total reserves, currency in circulation and Federal Reserve Bank credit. As we can see in Figure 4.3 and Figure 4.4, according to both the quarterly and the annual percent change there has been little change in total reserves and required reserves since late 2008. However, excess reserves have fluctuated a lot more. The interest on reserves that financial institutions received seems to have given them the incentive to hold-on to liquidity injections in the form of excess reserves. Before October 2008, the cost and benefits of holding reserves were such that banks chose to hold low levels of excess reserves. However, once banks started to receive interest on reserves, the trade-off they faced when deciding their level of excess reserves to hold favored holding higher levels of excess reserves. In terms of the change in the monetary base, the change in currency in circulation has been small

since 2000 as we saw from the previous figure, the changes are driven by changes in total reserves.

4.5.2 A View from Banks' Balance Sheets

Looking at the balance sheets of insured and noninsured banks as well as Bank Holding Companies (BHCs), we notice that the top asset holders for the first quarter of 2016 are either primary dealers (in the case of Bank Holding Companies) or in the case of insured banks they are affiliated with the primary dealers that trade directly with the Federal Reserve. Specifically in the first quarter of 2016, eleven out of the top 40 largest Bank Holding Companies, as measured by their assets, were primary dealers. In addition, eleven of the top 40 largest banks were subsidiaries of primary dealers. Taking a closer look at the numbers provided in Table B.1., allows us to notice that the level of assets of these primary dealers (especially the top four) are considerably larger than the other 40. This again applies in the case of insured banks that are subsidiaries of BHC that act as direct counterparties to the Federal Reserve. These results are a first indication that trading with the Federal Reserve presents an advantage for BHCs and their subsidiaries. Moreover, it seems that the liquidity injections received by primary dealers helped to increase their level of assets. Depending on the type of assets that experienced increased levels this could be an indication of a stronger balance sheet that is more resilient to negative liquidity shocks like the one experienced during the crisis.

Next we analyze how the composition of primary dealers and insured and non-insured banks' balance sheet has changed as a result of LSAPs. We pay particular attention to the most liquid assets on the banks' balance sheet, those are cash and due from depository institutions, securities and Federal funds sold and securities purchased under agreements to resell. We begin by analyzing the banking sector. As we can see

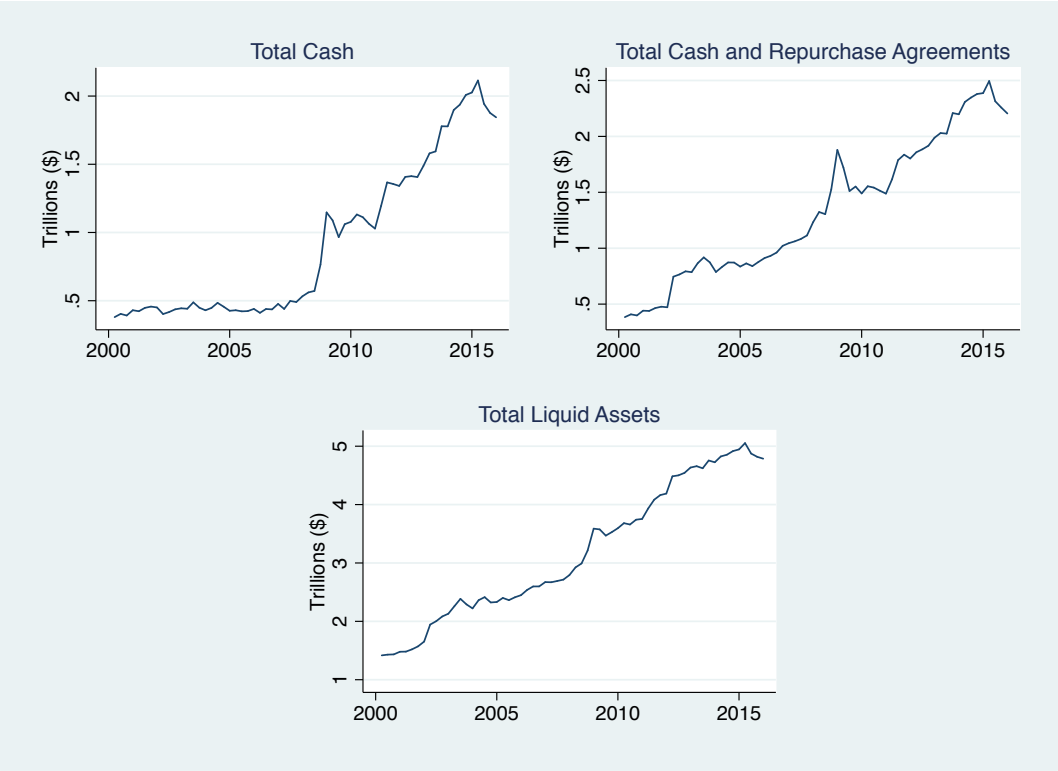

Figure 4.5. Banks' Holdings of Short-Term Liquid Assets

Figure 4.5 plots the evolution of cash held by insure and noninsured banks. Prior to the financial crisis cash which is a very liquid asset was stable and low. However, since the start of LSAPs it has increased and has been on an upward trend since. This tells us the composition of banks' balance sheets has changed as a result of LSAPs and specifically it seems banks are holding on to this very liquid asset. Figure 4.5 also plots the evolution of cash and repurchase agreements held by insured and noninsured banks. The graph shows that together these liquid assets have been increasing since 2000. However, since LSAP it seems that they have increased faster and that the increase may be caused by the increase in cash that we noticed in the plot of cash. Lastly Figure 4.5 plots the evolution of liquid assets held by insured and noninsured banks. Liquid assets are made up of cash, repurchase agreements and securities. Similarly to graph cash and repurchase agreements, the liquid assets have been on an upward trend and the start of LSAPs seems to have led to a sharper increase starting in 2008. This tells us that LSAPs definitely contributed to the change in the composition of banks' balance sheets. Banks have been holding on to these liquid assets maybe in an attempt to rebuild and strengthen their balance sheets. This could be an unattended consequence of LSAPs that would benefit the financial sector as a whole. The data was collected from banks' 10-Q and 10-K fillings of insured and noninsured banks.

from Figure 4.5, the level of cash has increased since the beginning of LSAPs. In the case of cash, from 2000 until the start of LSAPs the level remains the same with only small fluctuations. The level has drastically increased since the start of the Federal Reserve liquidity injections. This is especially true in the case of LSAP I, we can notice that after the first round the level of cash spikes and comes down slightly during the next two periods. It does keep increasing after that. In the case of cash and securities, the level was also flat before LSAPs but it started to increase in early 2009 and has remained on

its upward path. In general, liquid assets for insured and noninsured banks has been increasing since the beginning of 2000 but at an increasing pace since the first quarter of 2009. Moreover, from Figure 4.6 the share of cash held with depository institutions out of the monetary base was relatively stable from 2000 to mid 2008 and even tended to be decreasing. However, in late 2008 the share of cash spiked to 90% before coming back down to 66%. The share remained higher than its pre-LSAP level until late 2012, after that it hovered around its pre-LSAP level. The same trend can be seen in the case of cash and repurchase agreements (Figure 4.7) except the level spikes to a much higher level of 375% before returning to its pre-LSAP level slowly.

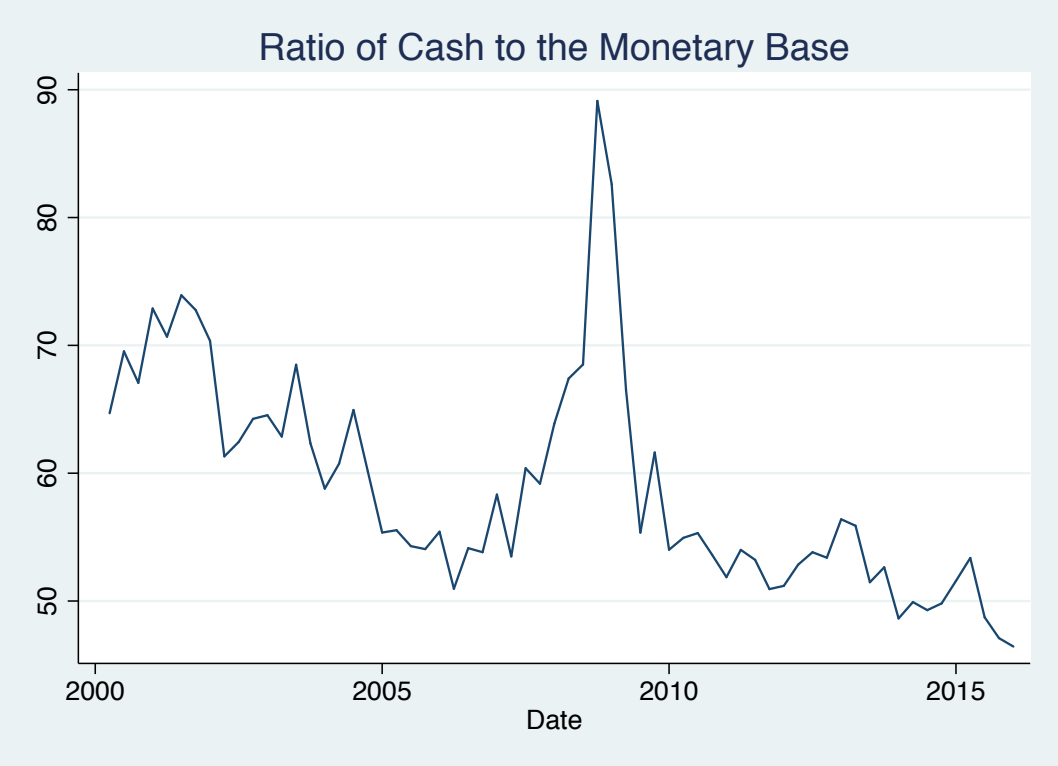

Figure 4.6. Ratio of Cash to the Monetary Base

Figure 4.6 shows the ratio of cash held by insured and noninsured banks to the monetary base. The most noteworthy aspect of the graph is the large spike in the case of LSAP1. This was during the time when banks were experiencing the most liquidity problems and therefore they most likely held on to the liquidity injections. After LSAP1 the ratio falls indicating that the monetary base grew faster than the level of cash that banks were holding onto. The data was collected from banks' 10-Q and 10-K fillings of insured and noninsured banks.

Overall, it doesn't seem like the liquidity injections changed the share of cash out of the monetary base that banks held. Despite the intention of LSAPs to increase the availability of liquidity in the banking sector it seems that insured and noninsured banks did not use the injections to increase lending. It appears they kept the cash and other liquid assets on their balance sheets and simply increased their holding of those types of assets. The balance sheets of primary dealers has also changed as a result of LSAPs. The Federal Reserve's primary dealers are BHCs and they were the direct counterparties during the time when the Federal Reserve undertook unconventional monetary policy actions.

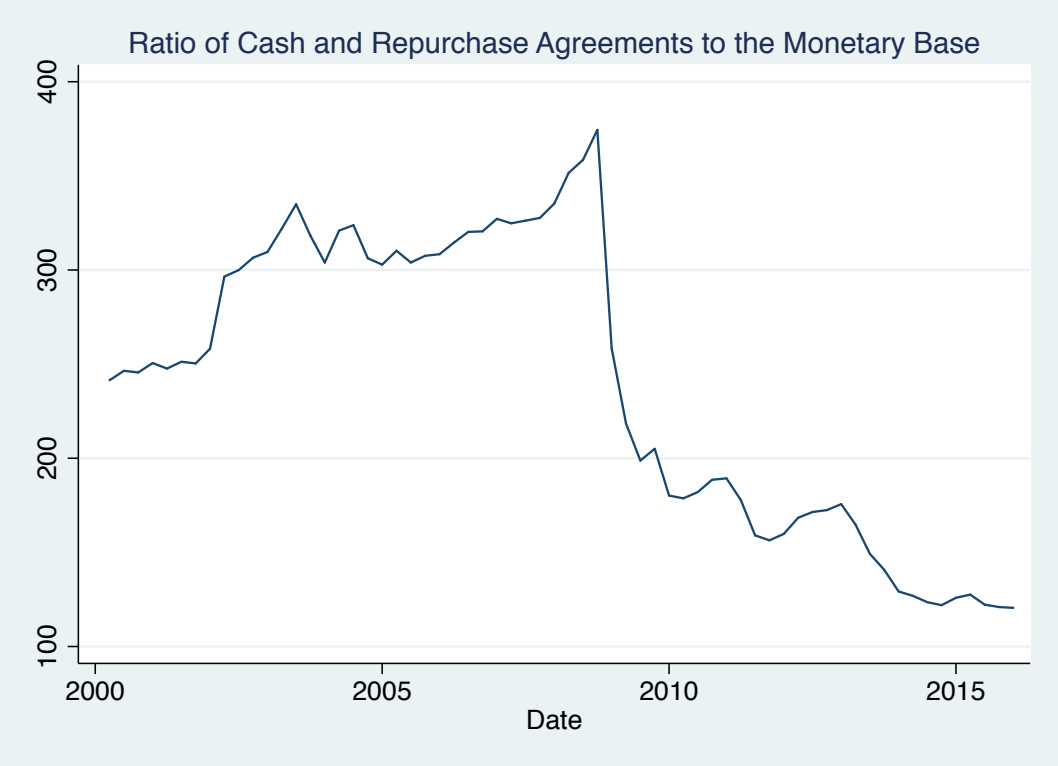

Figure 4.7. Ratio of Cash and Repurchase Agreements to the Monetary Base

Figure 4.7 plots the ratio of cash and repurchase agreements to the monetary base. Similarly to Figure 4.6 LSAP1 caused a spike in the ratio which then fell sharply and remained on a downward trend. Once again this can be explained by the large increase in the monetary base. These liquid assets represented a large share of the monetary base when banks were experiencing the worst of the liquidity crisis. After the first round of LSAP the monetary base increased more rapidly than the liquid assets were holding onto. The data was collected from banks' 10-Q and 10-K fillings of insured and noninsured banks.

They received the liquidity injections in exchange for securities first and were supposed to resume normal business activities including providing liquidity to the rest of the banking sector. Looking at the evolution of liquid assets from Figure 4.8, we notice that total liquid assets were flatter prior to LSAPs. They have been increasing but faster after LSAP I, in fact we can see that liquid assets increased fast at the beginning of 2009 before coming back down the next period and then trending upwards. A closer look at

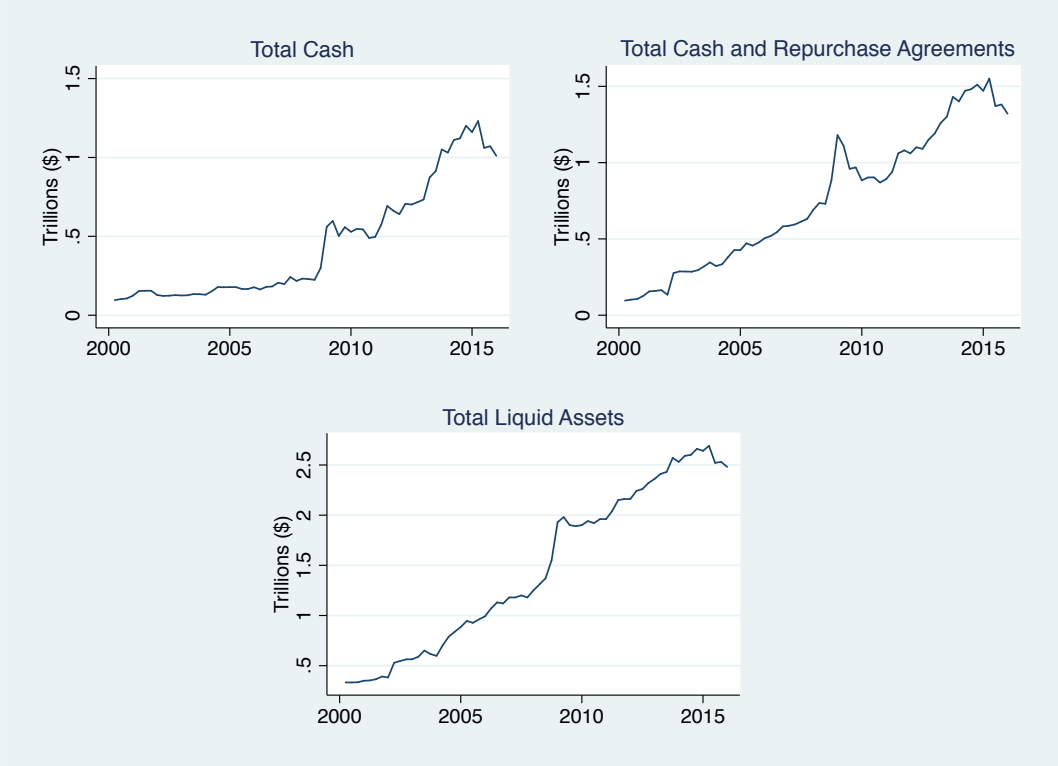

Figure 4.8. Primary Dealer Holdings of Short-Term Liquid Assets

Figure 4.8 plots total cash held by primary dealers. Similarly to insured and noninsured banks cash used to be stable and low. However, since the start of LSAPs it has greatly increased and the evolution seems to follow each round of LSAPs even more closely than for banks. We see that following each round there is a larger increase in the cash held by primary dealers. They also altered the composition of their balance sheet to hold on to more liquid assets. Figure 4.8 also plots the evolution of cash and repurchase agreements held by primary dealer banks. The graph shows that together these liquid assets have been increasing since 2000. However, since LSAP it seems that they have increased faster especially during LSAP1 where we notice a spike. The trend returned to a more normal path after the first round. Lastly, Figure 4.8 plots the evolution of cash, repurchase agreements and securities held by primary dealers. Similarly to Figure 4.5 these liquid assets have been on an upward trend since 2000. However, we notice that at the start of LSAPs there was a jump in the total liquid assets held by primary dealers. After LSAP1 they came down but continued on their upward trend. LSAP1 is more noticeable graphically than the other rounds, most likely because it was the largest round and because that round at a time when primary dealers were focused on rebuilding their balance sheets. Primary dealers holding on to liquid assets also indicate that they were not lending the funds. It is possible that in early 2009, with the economy in a recession not many safe lending opportunities existed. The data was collected from primary dealers 10-Q and 10-K fillings.

cash reveals that the level of cash was relatively flat prior to LSAPs but increased a lot since the start of LSAPs. Despite some fluctuations, overall cash has been increasing. The same can be said of cash and repurchase agreements. In all three graphs the start of LSAP is easily noticeable and although the level has started to decrease since the last quarter of 2015, during the whole LSAP periods, liquid assets on primary dealers' balance sheets increased. Although for both banks and primary dealers the level of liquid assets has gone up, we see in Figures 4.6 and Figures 4.9 that the share of cash in each case is different.

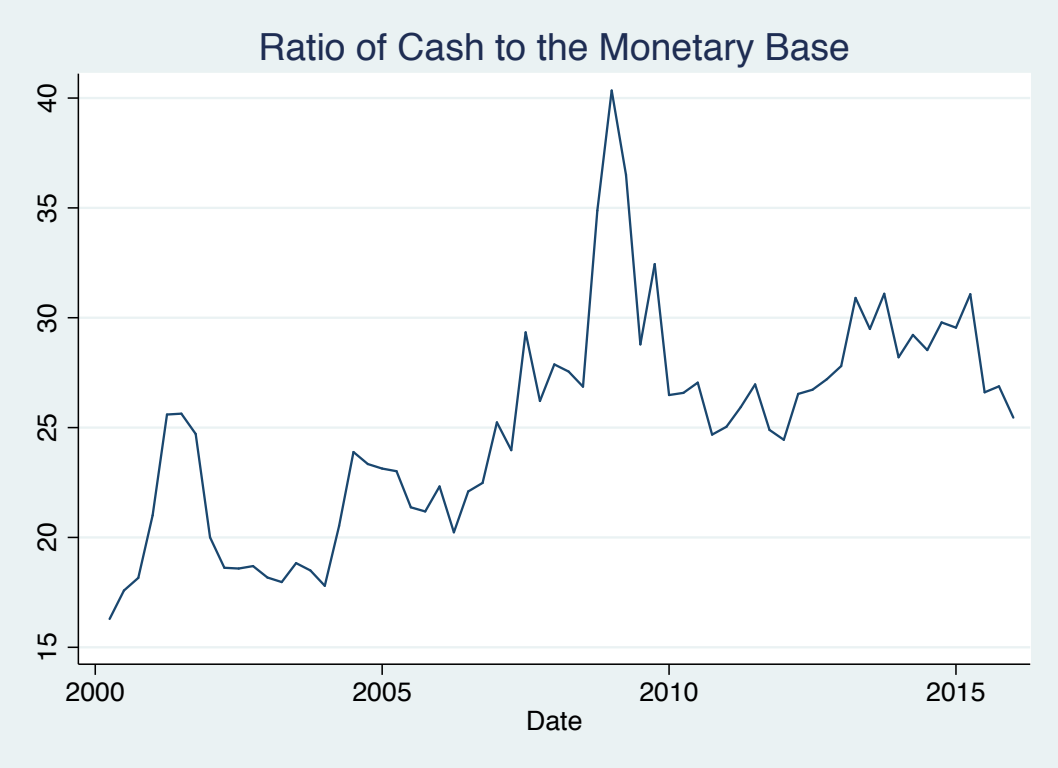

Figure 4.9. Ratio of Cash Held by Primary Dealers to the Monetary Base

Figure 4.9 plots the ratio of cash held by primary dealers to the monetary base. Similarly to Figure 4.6 there is a spike in the case of LSAP1. However, unlike in the case of insured and noninsured banks the ratio remains stable after the decrease following LSAP1. It also starts to increase again after LSAP3. This shows that primary dealers changed the composition of their balance sheet as a result of LSAP but their cash holding were much larger as they could keep up with the increase in the monetary base. Primary dealers are made up of the largest banks, they are very influential in the financial system in 2008 another primary dealer, Lehman Brothers, failed and therefore it could explain why other primary dealers were being cautious and building a significant cushion of liquid assets. The data was collected from primary dealers 10-Q and 10-K fillings.

The share of liquid assets out of the monetary base (From Figure 4.5 and 4.8) has increased since the start of LSAPs. In the case of share of cash for primary dealers (Figure 4.9), while it was at 16% at the beginning of 2000, it reached nearly 40% and then hovered around 30%. Unlike in the case of banks (Figure 4.7) the level is still higher compared to before the implementation of LSAPs. This is also true in the case of the share of cash and repurchase agreements for primary dealers. In early 2000 the share of cash and repurchase agreements was at 16%, it peaked at 102% and then decreased to 40% by the first quarter of 2015.

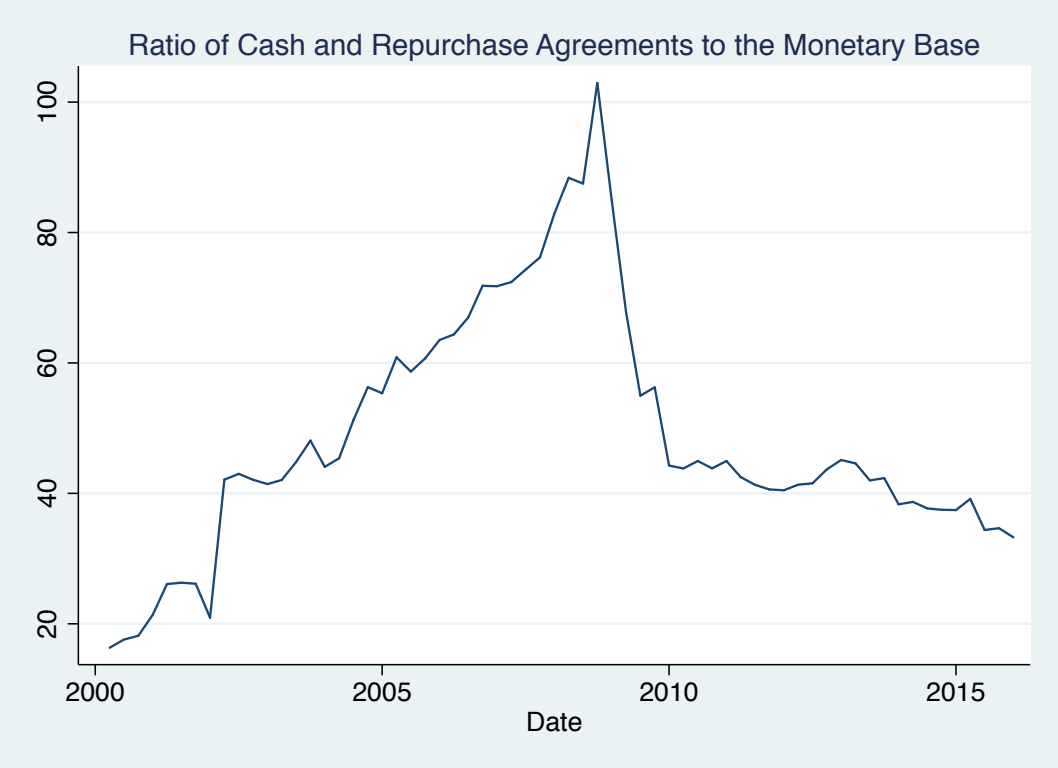

Figure 4.10. Ratio of Cash and Repurchase Agreements Held by Primary Dealers to the Monetary Base

Figure 4.10 plots the ratio of cash and repurchase agreements held by primary dealers to the monetary base. Similarly to Figure 4.9 there is a spike in the case of LSAP1 followed by a sharp decrease. The ratio continues on a downward trend even though it is less pronounced than in the case of insured and noninsured banks. After LSAP1 liquid assets grew at a slower rate than the monetary base. Given the important place of primary dealers in the financial system, it is beneficial to have stronger financial institutions that are often labelled as "too big to fail.? Similarly to the banks, stabilizing the financial system is a positive consequence of LSAPs. It may help avoid another crisis. The data was collected from primary dealers 10-Q and 10-K fillings.

4.5.3 The Implications for the Effectiveness of Large-Scale Asset Purchases

Figure 4.11 as well as the discussion above tells us that excess reserves have become a large share of the monetary base since the start of LSAPs. This rise in excess reserves explains the concurrent rise in total reserves. This change in the composition in the Federal Reserve's balance sheet has been documented in the literature (Keister and McAndrews, 2009), (Carpenter et al., 2013). Prior to unconventional monetary policy actions, excess reserves were a small share of the monetary base and Federal Reserve bank credit but in November 2008, the ratio spiked drastically and remained high overall despite occasional dips. This can be explained by the fact that banks' incentives changed when the Federal Reserve started paying interest on reserves in 2008, it seems to have encouraged banks to hoard excess reserves.

Looking at Figure 4.11, it confirms that the monetary base has grown due to an increase in excess reserves. In addition, if we look at Figure 4.12 we notice that excess reserves are also behind the rise in reserve bank credit. As we mentioned earlier, reserve bank credit is the most important component of reserves. It is made up of securities, swaps and repurchase agreements (amongst others) and therefore was greatly influenced by LSAPs. Figure 4.12 clearly indicates that most of reserve bank credit is due to excess reserves. Another important point to note regarding Figures 4.11 and 4.12 is the spikes. The spike occur at the same time on both graphs (due to the accounting identities mentioned before relating the monetary base to reserve bank credit) and we notice that they clearly follow the timeline of LSAPs. The first spike is marked by a sharp increase in excess and total reserves that occurred at the same time as LSAP I. This indicates that from the beginning of LSAPs banks had changed their behavior and were holding on to excess reserves.

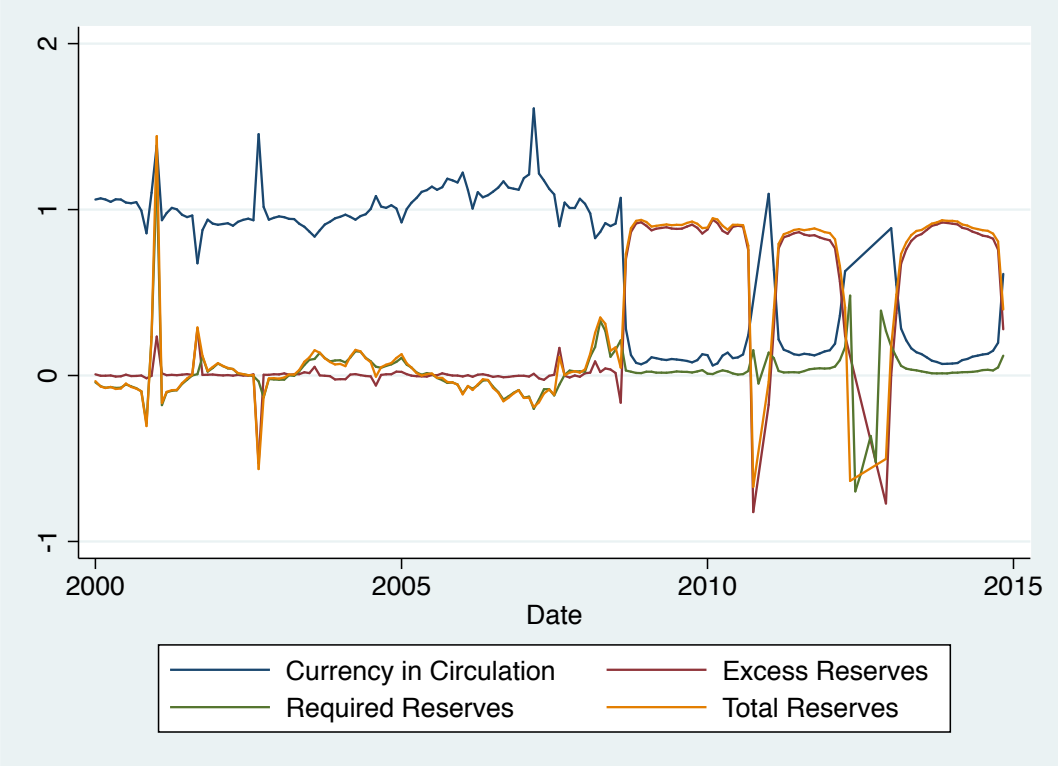

Figure 4.11. Ratio to the Monetary Base

Figure 4.11 plots the ratio of the yearly change in currency in circulation, total reserves, required reserves and excess reserves to the yearly change in the monetary base. This graph allows us to see how each component has evolved relative to the monetary base as a result of LSAP that included using its balance sheet to conduct unconventional monetary policy. We notice that while the ratios were relatively stable prior to LSAPs. Since LSAPs excess reserves (and therefore total reserves) have represented a much larger share of the monetary base while the ratio of required reserves has fallen. This tells us that since the start of LSAPs, there has been a reversal in terms of the components that guide the monetary base. This reversal also indicates that the decisions of financial institutions have changed since the implementation of LSAPs. While prior to LSAPs banks kept low levels of excess reserves they are now holding on to the liquidity injections and therefore excess reserves have greatly increased (See Figure 4.2). Each round of LSAPs is marked by an increase in the ratio of excess (and total) reserves followed by a sharp decline. These changes are noticeable through the spikes in the series.The data was collected from the H.3. series published by the Federal Reserve.

This is the start of the break down of the money multiplier as they no longer held the bare minimum amount of excess reserves. Excess reserves fell by late 2010 during the time that the Federal Reserve was gearing up to start LSAP II. The sharp decrease in excess reserves is matched by an increase in currency in circulation (from the fact that the monetary base is equal to the sum of currency in circulation and reserves). Once the actual LSAP II purchases began we see that excess reserves and total reserves spike again. This round was shorter and therefore the increase is not as long lasting. During

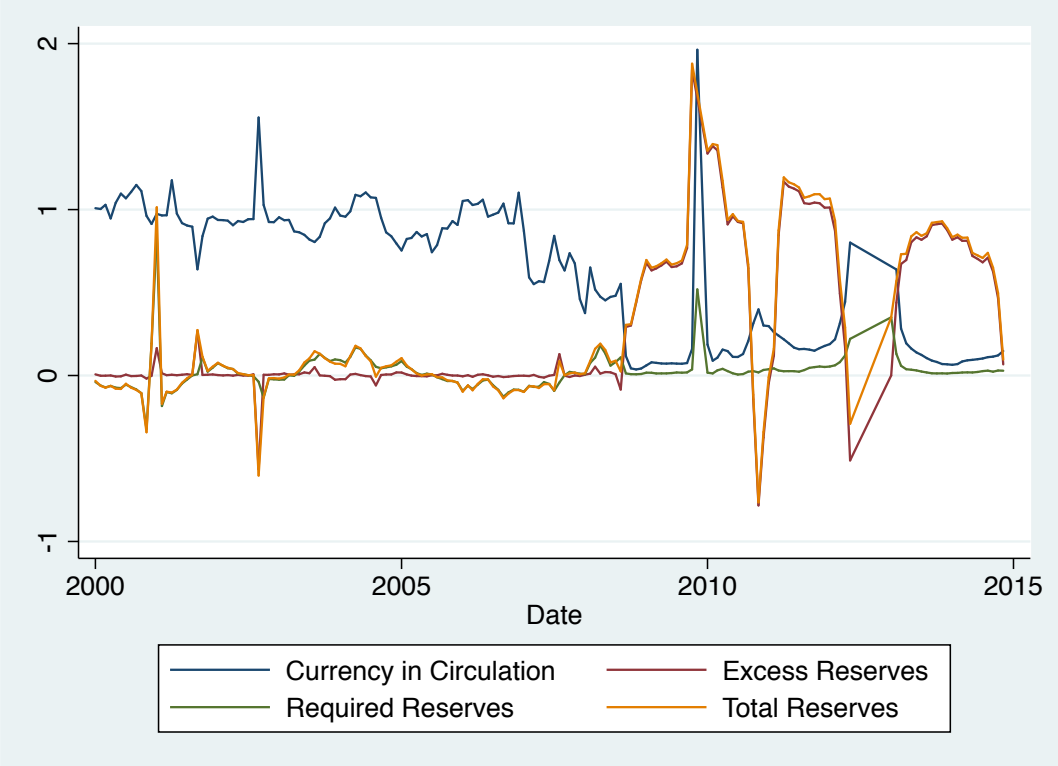

Figure 4.12. Ratio to the Reserve Bank Credit

Figure 4.12 plots the ratio of the quarterly change in currency in circulation, total reserves, required reserves and excess reserves to the quarterly change in Federal Reserve bank credit. This graph shows a very similar evolution to Figure 4.11 it is clear that total reserves has become a much more important component but this is due to the large increase in excess reserves that was discussed in Figure 4.2. We notice that LSAP1 is the most notable spike in the ratio of excess reserves followed by LSAP2 and then LSAP3. Currency in circulation also spiked during LSAP1. These changes caused by the implementation of LSAPs confirm that the liquidity injections were not use mainly to boost credit availability but rather to rebuilt the balance sheets of banks that were experiencing serious liquidity problems as a result of the financial crisis. The data was collected from the H.3. series published by the Federal Reserve.

the MEP there seems to be a decrease in excess reserves (matched by a spike in currency in circulation). This means that the increase in the monetary base at this point was not driven by excess reserves but rather by currency in circulation. The rise in currency also indicates that the multiplier effect during LSAP was not working as it had prior to the crisis. The last spike we notice occurred in 2012 when LSAP III started. Once again, this tells us that the change in excess reserves was driving most of the change in the monetary base. As we mentioned in our discussion of the money multiplier, is banks hold on to excess reserves then the monetary base cannot be multiplied into the

money supply or credit. The implications are that expansionary monetary policy like the one that occurred during LSAPs does not necessarily guarantee an increase in credit. Ultimately, the decision to expand credit remains with financial institutions. During the crisis, banks were struggling and having trouble accessing liquidity in addition it is likely that they were not finding many profitable lending opportunities as both businesses and households had taken a hit. For these reasons, it is unlikely that LSAPs were able to stimulate credit as the Federal Reserve intended as most of the liquidity remained on the balance sheets of financial institutions.

If we consider the change in the monetary base as a result of each round of LSAP we can decompose it into excess reserves, currency in circulation and required reserves. We mentioned before that each round of LSAPs increased the monetary base but with Table 4.1, we are able to identify the source of the increase.

Table 4.1: Share of Monetary Base Components:

LSAP Round	**Change in Monetary Base**	**Change in Excess Reserves**	**Change in Currency in Circulation**	**Change in Required Reserves**
LSAP 1	248405	188270	60497	1964
LSAP 2	703415	640139	60465	2614
LSAP 3	1431378	1242666	170300	18412
Share of Monetary Base LSAP 1	100	75.79	24.35	0.79
Share of Monetary Base LSAP 2	100	91.00	8.60	0.37
Share of Monetary Base LSAP 3	100	86.82	11.90	1.29

Table 4.1 presents the share of currency in circulation, required reserves and excess reserves from the monetary base. We measure the change in the each of the component and the monetary base from the start to end of each round of LSAP. We then take the ratio of the change in each component to the change in the monetary base. We see that most of the change in the monetary base can be attributed to growth in excess reserves. This means that the liquidity injections could have only weakly impacted the broader economy.

Using the increase in excess reserve, currency in circulation and required reserve during each round of LSAP we can identify what share of the monetary base each of these components was (the monetary base is made up of currency in circulation and reserves). We can see that required reserves, were 0.79% for LSAP1, 0.37% during LSAP2, and 1.28% during LSAP3. In the case of currency in circulation they were 24.3% during LSAP1, 8.6% during LSAP2 and 11.9% during LSAP3. Considering the evolution of currency in circulation and required reserves and the accounting identity that links monetary base to its components, the decrease in currency in circulation and required reserves had to be matched by an increase in excess reserves. Excess reserves represented the greatest share, with 75.79% of the monetary base during LSAP1, 91% during LSAP2 and 86.81% during LSAP3. Given that excess reserves were the main source for the increase in the monetary base it is unlikely that LSAP could have stimulated economic activity given that most of the liquidity injections were hoarded by financial institutions in the form of excess reserves.

The opposite can be said of currency in circulation. Before the financial crisis the change in currency in circulation was the largest share of both the monetary base and Federal Reserve Bank credit but since the start of LSAPs their share has fallen and has tended to remain low despite some spikes (this was also noted in Table 4.1). Ultimately the changes in the components of the monetary base indicate that LSAPs are reflected in excess reserves. Since they have been increasing rapidly along with the monetary base this is a first indication that LSAP could only have had a small effect on the broader economy, including credit, since banks are choosing to hold on to excess reserve rather than use them for normal operations (Berrospide, 2012). This result is in line with the studies that find that banks are holding on to excess reserves because they offer a much less risky return (van den End, 2014; Martin et al., 2013). Their incentives have

changed as a result of the Federal Reserve paying interest on reserves and the disruptions in financial markets caused by the crisis.

Another way to establish how effective LSAPs were to stimulate economic activity is to analyze how the liquidity injections affected checkable deposits compared to excess reserves. Checkable deposits are the funds held at banks and other financial institutions as a means for customers to access their accounts by writing checks or drafts. These accounts include checking, savings and money market accounts.[20] In order to relate checkable deposits to the monetary base we have to consider that during LSAPs the reserve requirement for checkable deposits was 10%. This means that 10% of new deposits originated from the monetary base. By subtracting 10% of new deposits from the change in the monetary base we can determine what share of the monetary base was attributed to checkable deposits compared to excess reserves. If deposits make up a small share of the monetary base then only a small share of LSAPs allowed for new lending and new deposit creation. This means that LSAPs did not stimulate credit as they were intended to.

Table 4.2 shows the share of LSAPs that went to new deposits compared to excess reserves. In order to determine the share of LSAPs that led to new deposits we need to take 10% of the change in deposits from the beginning to the end of each round of LSAPs and subtract it from the monetary base. The difference between the change in the monetary base and 10% of the change in new deposits gives us the share that remained as excess reserves. From Table 4.2, we see that for LSAP1, 98.48% of the liquidity injections remained as excess reserves while 1.51% generated new lending. In the case of LSAP2, 99.58% of the change in the monetary base stayed as excess reserves while

[20]The definition of checkable deposits is from the business dictionary `http://www.businessdictionary.com/definition/checkable-deposits.html`.

0.41% generated new lending. Lastly, in the case of LSAP3, 98.69% of the monetary base went to excess reserves compared to 1.30% to checkable deposit. These findings are another indication that the effects of LSAPs were small, most of the liquidity injections remained as excess reserves and therefore on the balance sheet of financial institutions instead of stimulating credit markets and economic activity.

Table 4.2. Creation of Checkable Deposits vs. Excess Reserves:

LSAP Round	**Change In Checkable Deposits**	**Checkable Deposits Originating from Monetary Base**	**Monetary Base that Remained as Excess Reserves**	**Percent of Monetary Base in Excess Reserves**	**Percent in Checkable Deposits**
LSAP 1	37700	3770	244635	98.48	1.52
LSAP 2	28900	2890	700525	99.59	0.41
LSAP 3	187300	18730	1412648	98.69	1.31

Table 4.2 measures how much of the monetary base created checkable deposits as opposed to excess reserves. The rate of required reserves was 10% during LSAP meaning that 10% of the change in checkable deposit originated from the monetary base according to the money multiplier. Subtracting the 10% of deposit from the change in the monetary base tells us what percentage went to excess reserves as opposed to checkable deposits. We see that there was not a lot on new lending compared to excess reserves.

From the perspective of bank's balance sheets, it seems that the recipients of LSAP injections, the primary dealers, kept the funds on their balance sheets in the form of liquid assets. Specifically, we saw that the Federal Reserve's counterparties are amongst the largest financial institutions (according to their level of assets). Moreover, since the start of LSAPs they have steadily increased the level of cash, securities and overall liquid assets that they hold on their balance sheets. This reflects their tendency to keep excess reserves and liquidity in general rather than extending credit to other banks. In Chapter 2, we found that the primary dealers experienced the largest abnormal returns when compared to the other financial and nonfinancial sectors. This points to an insider effects where the liquidity injections do not ripple out to the broader economy because

they remain on the balance sheets of the Federal Reserve's counterparties. Moreover, the findings of Chapter 2 and the fact that the Federal Reserve expanded its set of counterparties at the start of LSAPs seems to indicate that, at least, at first the main concern of LSAPs was to keep banks solvent. Other papers find that the changes in the composition of primary dealers' balance sheet indicate that these large banks are holding on to excess reserves (Craig et al., 2014). The changes in balance sheet composition can also be noticed in the case of insured and noninsured bank balance sheets but to a lesser extent. Indeed, primary dealers are holding on to cash but they are not the only banks that are "hoarding cash" on their balance sheets. As we discussed the share of cash to the monetary base was relatively flat prior to LSAP but once LSAPs started the share started to rise. Even when it started to decrease after LSAP1, it remained at its pre-LSAP level meaning that despite the increased liquidity banks were still choosing to hold more cash on their balance sheets. This is another indication that the effects of LSAPs on the broader economy were limited. Much of the liquidity injections that were intended to ease liquidity and credit conditions in the financial market were kept on banks' balance sheets, especially primary dealers who are also the first step in the unconventional monetary policy transmission mechanism.

The evidence that Large-Scale Asset Purchases served to bolster banks' balance sheet and keep banks solvent rather than improve credit conditions means that the Federal Reserve was more successful in fulfilling one of the goals of LSAPs. We saw in Chapter 3 that credit markets did not rebound as much as financial markets. Indeed, only consumer and mortgage markets experienced a small increase in credit as a result of lower interest rates. This tells us that the interest rate channel of LSAPs may have been undermined by other factors. However, there are also some advantages to strengthening financial market conditions through the balance sheets of large and systemically important financial institutions. The evidence from this paper indicates that LSAPs may

have been an effective countercyclical balance sheet policy. Prior to the financial crisis US financial markets were frozen as liquidity was not flowing and confidence was low. However, LSAPs have enabled the most influential banks to rebuilt their balance sheets and accumulate higher levels of liquid and higher quality assets. The role of monetary policy in promoting financial stability has long been debated and has mostly focused on the reaction to asset price bubbles (Blanchard, 2000; Mishkin, 2008). However, only recently have studied started to focus on the role played by the largest financial institutions for financial stability (Adrian and Shin, 2008). This paper focuses on primary dealers and finds that they now hold much more liquid assets and therefore have a lower risk of default.

Moreover, the evidence from stress tests conducted by banking regulators reveals that these banks are much stronger. According to a release by the Board of Governors of the Federal Reserve, the largest bank holding companies continue to build their capital levels and improve their credit quality, strengthening their ability to lend to households and businesses (Federal Reserve Board, 2016a). In addition, the accumulation of capital is important to banking institutions, the financial system and the economy because it provides a cushion to absorb losses and it helps ensure that losses are incurred by shareholders. The accumulation of excess reserves (and cash) means that the liquidity problems that prevented the financial system from functioning correctly have been greatly alleviated by LSAPs.

4.5.4 Counterfactual Exercise

In order to estimate how large LSAPs should have been to promote full economic recovery we will conduct a counterfactual exercise. This counterfactual exercise assumes that there is a linear relationship between the money multiplier, reserves and economic

activity. To start we will estimate the gap between actual nominal GDP and potential nominal GDP. The absolute value of the difference between these measures will tell us by how much output fell short during the period of LSAPs. The measure also tells us how much income needed to be created to promote full recovery and how many deposits needed to be created by the money multiplier. Using the the ratio of the actual change in deposits (as measured previously) during each LSAP period to the gap in nominal GDP we compute the factor of how much bigger LSAPs should have been to lead to a full recovery of deposits (and therefore income). The last step in the counterfactual exercise is to multiply the scale factor for each round of LSAP by the actual size of each LSAP program. As we discussed previously, the first round of LSAP was $1.7 trillion, the second round was $600 billion and the last and longest round was $1.48 trillion. By multiplying each scale factor by the size of the rounds we can determine how large LSAPs should have been to promote full recovery. Table 4.3 presents each estimate of this counterfactual exercise. It also shows that the first round of LSAPs should have been $28 trillion larger, LSAP2 should have been $13 trillion larger and LSAP3 should have been $2 trillion larger. This means that LSAPs overall should $43 trillion larger. Although each subsequent round needed to be smaller these results have some policy implications. We also compute the ratio of the required LSAPs to total private wealth and separately to GDP. Once again we see that LSAPs should have been much larger, they are about half of total wealth and a little less than twice GDP for LSAP1. Even though the shares get smaller with each following round eventually reaching 3.83% of total wealth and 11.59% of GDP they still needed to be much bigger for a full recovery. Given the skepticism that surrounded LSAPs it is unlikely that the liquidity injections would have been so large.

The counterfactual exercise tells us that LSAPs were relatively modest compared to the large output gap that existed during the financial crisis (assuming a linear relation-

ship between the money multiplier, reserves and economic activity). Despite having been the largest unconventional monetary policy action undertaken by the Federal Reserve, it appears that LSAPs were not large enough to truly promote economic recovery. This result is in line with the findings from the previous chapters, we found that despite some effect on consumer and mortgage credit, LSAPs did not promote a strong recovery in credit markets. There effect was small. The same is true of financial markets. Despite boosting some stock prices the effects were small relative the unprecedented size of each round. We saw that only primary dealers, or the direct counterparties of the Federal Reserve experienced large abnormal returns while those in other financial sectors were more modest. Many of the nonfinancial sectors did not experience any abnormal returns.

Table 4.3: Counterfactual Exercise:

LSAP Round	**GDP Gap**	**Change in Deposits**	**Change in Deposits to GDP Gap**	**Actual Size of LSAPs**	**Size of LSAP**	**Ratio to Private Wealth**	**Ratio to Nominal GDP**
LSAP1	641000	37700	0.059	1700000	28.90	54.95	193.15
LSAP2	628600	28900	0.046	600000	13.05	24.81	84.10
LSAP3	254200	187300	0.737	1485000	2.01	3.83	11.59

Table 4.3 presents a counterfactual exercise to evaluate how large LSAPs should have been to bridge the gap between nominal GDP and potential nominal GDP. We measure the absolute value of the change in the difference between potential nominal GDP and nominal GDP as well as the change in deposits. Using these measures we compute the ratio of the change in deposits to the change in the difference in nominal GDP. Next, we multiply this factor by the actual size of LSAPs which allows to determine how much larger LSAPs should have been to promote full recovery. The values in columns1,2 and 4 are in millions of dollars. The size of LSAPs is in trillions of dollars

Moreover, this counterfactual exercise also tells us that given how large LSAPs should have been, they do not seem to be feasible to implement in practice in a way that generates complete recovery. Unconventional monetary policy actions such as LSAPs seem to work to prevent a catastrophic collapse of financial markets. They may be necessary to avoid deeper recessions but they are not as effective to promote economic

recovery. Without a counterfactual we cannot know how much worst the recession would have been without the intervention from the Federal Reserve. However, it is likely that the bankruptcy of several financial institutions, including primary dealers, was avoided through the actions of the Federal Reserve, and therefore economic recovery may have been facilitated.

4.6 Conclusion

This paper focused on the impact of LSAPs from the perspective of the Federal Reserve and the banking sector's balance sheets. This paper finds that the effects of LSAPs on the broader economy were dwarfed by the changes in the composition of the Federal Reserve and primary dealer balance sheets. As we mentioned before, the Federal Reserve injected liquidity into the balance sheets of its primary dealers in order to alleviate the liquidity strains experienced by the banking sector and credit markets. According to the theory behind unconventional monetary policy, banks should use the liquidity to resume normal business operations such as extending credit. Unfortunately, credit has not increased as was expected but banks' balance sheets have rebounded and become more stable. For this reason we explored how effective LSAPs were, in the ZLB environment, from the perspective of banks' balance sheets.

The results presented in this chapter tell us that LSAPs were too small to promote economic recovery. They should have been much larger to bridge the output gap. The tendency of financial institutions to store the liquidity injections as excess reserves most likely contributed to the weak effects of LSAPs as they never reached the broader economy. Despite the poor performance of LSAPs to stimulate credit it did have other benefits that should not be overlooked. The multiple rounds were successful in restoring the health of banks' balance sheets that had been greatly damaged since the crisis and

prevented the smooth functioning of financial markets. This indicates that even though LSAP may not be a credit policy, it is an effective countercyclical balance sheet policy. It may not have had the intended effects in terms of credit but it greatly alleviated the liquidity problems that troubled the financial system. Hopefully this will also have some beneficial long-term effects on the broader economy as normal activities resume and confidence returns.

Appendix A

CHAPTER 3 APPENDIX

A.1 Figures

Table A.1: Stationarity Tests

Augmented Dickey Fuller Test

Variables	**In Level**	**First Difference**
Adjusted Case-Shiller Home Price Index	0.40	0.00
Adjusted Fixed Residential Investment	0.20	0.00
Adjusted Flow of Consumer Credit	0.09	0.00
Adjusted Flow of Mortgage Credit	0.45	0.00
Adjusted Flow of Business Credit	0.08	0.00
Consumer Confidence Index	0.18	0.00
Business Confidence Index	0.13	0.00
CFNAI-Sales, Orders and Inventory	0.01	0.00
CFNAI-Perso.Consumption and Housing	0.35	0.00
Real 10-year Treasury Rate	0.50	0.01
Real 24-month Finance Rate	0.90	0.02
Real 30-year Conventional Mortgage Rate	0.79	0.01
Real AAA Corp. Bond Yield	0.63	0.01
Real BAA Corp. Bond Yield	0.85	0.01

Continued on the next page.

Table A.1: Stationarity Tests

DF-GLS Test

Variables	**In Level**	**First Difference**
Adjusted Case-Shiller Home Price Index	0.12	0.00
Adjusted Fixed Residential Investment	0.09	0.00
Adjusted Flow of Consumer Credit	0.10	0.00
Adjusted Flow of Mortgage Credit	0.24	0.00
Adjusted Flow of Business Credit	0.15	0.00
Consumer Confidence Index	0.30	0.00
Business Confidence Index	0.22	0.00
CFNAI-Sales, Orders and Inventory	0.00	0.00
CFNAI-Perso.Consumption and Housing	0.12	0.00
Real 10-year Treasury Rate	0.50	0.01
Real 24-month Finance Rate	0.56	0.01
Real 30-year Conventional Mortgage Rate	0.93	0.01
Real AAA Corp. Bond Yield	0.30	0.00
Real BAA Corp. Bond Yield	0.35	0.00

The Augmented Dickey Fuller Test and the DF-GLS Test are used to test whether the variables are stationary. The null hypothesis of the ADF test is that the variable contains a unit root, and the alternative is that the variable was generated by a stationary process. We confirm the order of the variables using the DF-GLS test. This test has a better overall performance in terms of small sample size and power. We notice that the tests confirm one another and there is a mix of I(0) and I(1) variables.

Table A.2: Business Credit

Dependent Variable: Adjusted Flow of Business Credit						
Lags	Reg 15 (1,1,1)	Reg 16 (1,1,1)	Reg 17 (1,1,0)	Reg 18 (1,0,1)	Reg 19 (1,1,1)	Reg 20 (1,0,1)
Sample Size	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2	1980Q1-2006Q4	1980Q1-2014Q2
Short Run Coefficients						
AAA	2.24 (0.17)	12.24 (0.15)				
BAA			10.08 (0.16)	8.64 (0.11)		
10 Year Treasury					1.97 (0.16)	1.86 (0.15)
BCI	-6.87 (0.08)	-0.12 (0.07)	-5.93 (0.05)	-5.37 (0.37)	-6.56 (0.06)	-6.56 (0.04)
Speed of Adjustment	-0.46 (0.00)	-0.38 (0.00)	-0.47 (0.00)	-0.39 (0.00)	-0.47 (0.00)	0.38 (0.00)
Long Run Coefficients						
AAA	4.73 (0.13)	5.97 (0.10)				
BAA			5.25 (0.12)	4.17 (0.13)		
10 Year Treasury					4.57 (0.27)	4.43 (0.18)
BCI	-0.25 (0.29)	-0.27 (0.37)	-0.27 (0.68)	-0.29 (0.42)	-0.18 (0.25)	-0.16 (0.39)
Diagnostics						
Breush-Godfrey (n=2)	0.37	0.39	0.42	0.45	0.41	0.51
ARCH	0.23	0.28	0.25	0.31	0.29	0.35
RESET	0.36	0.32	0.39	0.37	0.33	0.45
Adjusted R^2	0.39	0.50	0.41	0.50	0.40	0.51
Bounds F-statistic	11.25***	13.23***	10.17***	14.15***	10.84***	14.01***

1) Reg 15 uses the AAA bond rate for the shorter sample, reg 16 uses the AAA bond rate for the longer sample, reg 17 uses the BAA bond rate for the shorter sample and reg 18 uses the BAA bond rate for the longer sample. Reg 19 uses the 10-Treasury rate for the shorter sample and reg 20 uses the 10-Treasury rate for the longer sample. All variables are expressed in first difference. Number in parentheses are p-values for the coefficients. For a description of the diagnostics and bounds test, see notes from Table 3.3.

Appendix B

CHAPTER 4 APPENDIX

Table B.1: Largest Commercial Banks by Asset Size

Bank ID	**Institution Name**	**Assets (in billions of USD)**	**Primary Dealer LSAP Status**
1039502	J.P. Morgan Chase & Co.	242.4	Yes
1073757	Bank Of America Corporation	218.9	Yes
1120754	Wells Fargo & Company	184.9	Yes
1951350	Citigroup Inc.	180.1	Yes
2380443	Goldman Sachs Group, Inc.	87.8	Yes
2162966	Morgan Stanley	80.7	Yes
1562176	American International Group	50.2	
1119794	U.S. Bancorp	42.8	
3587146	Bank Of New York Mellon Corp	37.2	
1069778	PNC Financial Services Group	36.1	
2277860	Capital One Financial Corp	33.1	
3232316	HSBC North America Holdings	28.9	Yes
4932239	GE Capital Global Holdings	28.7	
3606542	TD Group Us Holdings Llc	27.4	Yes
1111435	State Street Corporation	24.4	
1074156	BB&T Corporation	21.2	
1131787	Suntrust Banks, Inc.	19.4	
1026632	Charles Schwab Corporation,	19.1	
1275216	American Express Company	15.8	
1562859	Ally Financial Inc.	15.6	
1070345	Fifth Third Bancorp	14.2	
1447376	United Services Automobile A	14.2	

Continued on the Next Page

Table B.1: Largest Commercial Banks by Asset Size

Bank ID	Institution Name	Assets (in billions of USD)	Primary Dealer LSAP Status
1132449	Citizens Financial Group, In	14	
3226762	RBC USA Holding Corporation	13.9	Yes
3981856	Santander Holdings Usa, Inc.	13.1	
1245415	BMO Financial Corp.	12.5	Yes
3242838	Regions Financial Corporatio	12.5	
1037003	M&T Bank Corporation	12.4	
1378434	MUFG Americas Holdings Corp	12.1	
1199611	Northern Trust Corporation	11.7	
1068025	Keycorp	9.8	
1025608	Bancwest Corporation	9.6	
1078529	BBVA Compass Bancshares, Inc	9.2	
3846375	Discover Financial Services	8.8	
4504654	Synchrony Financial	8.2	
1068191	Huntington Bancshares Incorp	7.3	
1199844	Comerica Incorporated	6.9	
1036967	Cit Group Inc.	6.7	
1027004	Zions Bancorporation	5.9	
1032473	Deutsche Bank Trust Corp.	5.3	Yes

Table D.1. shows the list of the largest commercial banks by asset size. As we can see the top 6 banks are branches of primary dealers banks. The bank ID is a unique identifier assigned to institutions by the Federal Reserve.

Table B.2: Largest Bank Holding Companies by Asset Size

Bank ID	Institution Name	Assets (in billions of USD)	Primary Dealer LSAP Status
852218	JP Morgan Chase Bank	2016	Yes
451965	Wells Fargo Bank	1668	Yes
480228	Bank of America	1654	Yes
476810	Citibank National	1343	Yes
504713	US Bank National	423.2	
817824	PNC Bank National	350.6	
541101	Bank of New York Mellon	299.8	
112837	Capital One National	271.2	
497404	TD Bank National	253.7	Yes

Continued on the Next Page

Table B.2: Largest Bank Holding Companies by Asset Size

Bank ID	**Institution Name**	**Assets (in billions of USD)**	**Primary Dealer LSAP Status**
35301	State Street Bank &Trust Co.	239.3	
852320	Branch Banking & Trust Co.	206.9	
413208	HSBC Bank USA National	198.8	Yes
675332	Suntrust Bank	189.9	
3150447	Charles Schwab Bank	147.0	
2182786	Goldman Sachs Bank	143.4	Yes
489913	Chase Bank USA National	142.9	
723112	Fifth Third Bank	140.0	
1456501	Morgan Stanley Bank	137.0	Yes
233031	Regions Bank	124.6	
501105	Manufacturers & Traders Co.	124.0	
212465	MUFG Union Bank	120.0	
210434	Northern Trust Co	117.4	
3284070	Ally Bank	110.7	
3303298	Citizens Bank National	109.3	
75633	BMO Harris Bank	104.4	Yes
2253891	Capital One Bank USA	99.55	
280110	Keybank National	96.38	
722777	Santander Bank	92.29	
697633	Compass Bank	87.62	
30810	Discover Bank	86.81	
804963	Bank Of The West	77.05	
619877	USA Federal Savings Bank	75.05	
12311	Huntington National Bank	72.46	
60143	Comerica Bank	69.00	
4114567	First Republic Bank	62.10	
1216022	Synchrony Bank	62.04	
276579	ZB National	58.26	
3212149	UBS Bank USA	55.48	Yes
2966306	American Express Bank	51.90	
214807	Deutsche Bank	51.67	Yes

Table D.2. shows the list of the largest BHCs. Primary Dealers banks are the top four largest banks. This reveals how systemically important these institutions are. The bank ID is a unique identifier assigned to institutions by the Federal Reserve.

Federal Reserve Balance Sheet Items:

The items of reserve bank credit are:[1]

• Unamortized premiums on securities held outright: This release reports Federal Reserve holdings of securities at face value, not necessarily at market value. If the Federal Reserve pays more than the face value for securities it purchases, the premiums over the face value are amortized over time. For U.S. Treasury and Federal agency debt securities, amortization is on a straight-line basis, which results in a constant amount of amortization in each period. For mortgage-backed securities, amortization is on an effective-interest basis, which results in a constant effective yield in each period, and the amortization is accelerated when principal payments are received. As the unamortized premiums on securities are reduced, a simultaneous balancing reduction is made in the capital account. Securities purchased at a premium over face value are accounted for in this way because, at maturity, the Federal Reserve Banks receive only the face amount of the securities, not the amount actually paid. The premiums paid on securities bought under repurchase agreements, though, are not amortized. These premiums are, in effect, returned to the Federal Reserve Banks when the securities are repurchased by the dealer, since the negotiated price in the original transaction reflects the premiums.

• Unamortized discounts on securities held outright: This release reports Federal Reserve holdings of securities at face value, not necessarily at market value. If the Federal Reserve pays less than the face value for securities it purchases, the discounts over the face value are amortized over time. For U.S. Treasury and Federal agency debt securities, amortization is on a straight-line basis, which results in a constant amount

[1]The description of the items included in the Federal Reserve's balance sheet can be found on the interactive guide provided by the Board of Governors of the Federal Reserve at: `https://www.federalreserve.gov/monetarypolicy/reservebalances_p.htm`

of amortization in each period. For mortgage-backed securities, amortization is on an effective-interest basis, which results in a constant effective yield in each period, and the amortization is accelerated when principal payments are received. Securities purchased at a discount under face value are accounted for in this way because, at maturity, the Federal Reserve Banks receive only the face amount of the securities, not the amount actually paid. While discounts are typically reported as a liability, this release is presenting them with the corresponding securities held outright, which is in the assets section. The discounts paid on securities bought under repurchase agreements, though, are not amortized. These discounts are, in effect, returned to the Federal Reserve Banks when the securities are repurchased by the dealer, since the negotiated price in the original transaction reflects the discounts.

- Repurchase agreements (repos): Repurchase agreements reflect some of the Federal Reserve's temporary open market operations. Repurchase agreements are transactions in which securities are purchased from a primary dealer under an agreement to sell them back to the dealer on a specified date in the future. The difference between the purchase price and the repurchase price reflects an interest payment. The Federal Reserve may enter into repurchase agreements for up to 65 business days, but the typical maturity is between one and 14 days. Federal Reserve repurchase agreements supply reserve balances to the banking system for the length of the agreement. The Federal Reserve employs a naming convention for these transactions based on the perspective of the primary dealers: the dealers receive cash while the Federal Reserve receives the collateral. Repos are the main tool used by the Federal Reserve to keep interbank lending rates and thus other interest rates in the economy close to their target. Repos serve to sell securities to financial institutions and temporarily removing liquidity from the market. The FRBNY repurchases the securities at a later date in order to maintain the stability and liquidity of the financial system (Adrian and Shin, 2010c).

• Other loans: Loans is traditionally the sum of "Primary credit," "Secondary credit," "Seasonal credit," and "Other credit extensions."[2] As a results of the recent unconventional monetary policy actions they also include "Primary dealer and other broker-dealer credit," "Asset-backed commercial paper money market mutual fund liquidity facility" and "Term Asset-Backed Securities Loan Facility" The amount of Federal Reserve loans is affected by the discount rate or the interest rate that it charges for primary credit loans.[3] Prior to the financial crisis borrowing from the Federal Reserve tended to be less than a couple hundred million dollars per day. During the crisis, loans increased dramatically reaching over one trillion dollar per day (Carpenter et al., 2013). The "Primary dealer and other broker-dealer credit" facility allowed a wider range of primary dealers (many of which are investment banks) to borrow on similar terms than depository institutions using the traditional discount window. The "Asset-backed commercial paper money market mutual fund liquidity facility" allowed the Federal Reserve to lend to primary dealers so that they could purchase asset-backed commercial paper from money mutual funds. The "Term Asset-Backed Securities Loan Facility" was used by the Federal Reserve to commit to lend up to $1 trillion to holders of high-rated newly issued ABS, backed by the ABS as collateral (Mishkin, 2011b).

• Net portfolio holdings of Maiden Lane LLC: The three Maiden Lane entities were launched to facilitate the acquisition of the Bear Stearns Companies, Inc. by JPMorgan Chase & Co., and prevent the contagion affects of Bear Stearns' disorderly collapse to

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[2]Primary credit is the discount lending that plays the most important role in monetary policy because it allows healthy banks to borrow all they want at very short (usually overnight) maturities. Secondary credit is usually extended to troubled banks that are experiencing liquidity problems. Seasonal credit is used to meet the needs of a limited number of small banks in vacation and agricultural areas that have a seasonal pattern of deposits (Mishkin, 2011b)

[3]The discount rate is the interest rate charged on primary credit. It is higher than the federal funds rate (usually by 100 basis point) but lower than the interest rate on secondary and seasonal credit. The interest rate on secondary credit is usually 50 basis point higher than the discount rate (Mishkin, 2009) tools of monetary policy in money banking and financial markets)

the broader economy. The Federal Reserve Bank of New York (FRBNY) created and extended credit to Maiden Lane LLC. Maiden Lane LLC is a limited liability company formed to acquire certain assets of Bear Stearns and to manage those assets through time to maximize the repayment of credit extended to it and to minimize disruption to financial markets. Maiden Lane I holds the largest part of the illiquid Bear and Stearns assets. Maiden Lane II was created to purchase residential MBS from AIG subsidiaries. Maiden Lane III was created to purchase multi-sector collateralized debt obligations (CDO) on which AIG had writtencredit default swapand similar contracts in return for the cancellation of those contracts (Board of Governors of the Federal Reserve, 2016).[4] On June 14, 2012, the remaining outstanding balance of the senior loan from FRBNY to Maiden Lane LLC was repaid in full, with interest. This line reports the fair value of the assets held by the LLC. Because the FRBNY is the primary beneficiary of the LLC, the assets and liabilities of the LLC are consolidated onto the books of the FRBNY.

- Float: Reserve balances can be affected by mismatches in check-clearing operations. When a check is received by a Reserve Bank, the depositing institution's account is credited according to a fixed schedule, regardless of when the check is presented to the bank on which it is drawn. When there are delays in the presentment of checks to the paying institution, the receiving institution's account is credited before the account of the paying depository institution is charged, elevating reserve balances. Conversely, if the paying institution's account is debited faster than the schedule for crediting the receiving institution's account, reserve balances are reduced. These increases or decreases in reserve balances that result from mismatches in the timing of check clearing are known as float.

- Central Bank Liquidity Swaps: The FOMC has authorized temporary reciprocal

[4]The descriptions of Maiden Lane I, II, III can be found at: `https://www.federalreserve.gov/newsevents/reform_aig.htm`

currency arrangements (central bank liquidity swaps) with certain foreign central banks to help provide liquidity in U.S. dollars to overseas markets. These swaps involve two transactions. First, when the foreign central bank draws on the swap line, it sells a specified amount of its currency to the Federal Reserve in exchange for dollars at the prevailing market exchange rate. The foreign currency that the Federal Reserve acquires is placed in an account for the Federal Reserve at the foreign central bank. This line in the statistical release reports the dollar value of the foreign currency held under these swaps. Second, the dollars that the Federal Reserve provides are deposited in an account for the foreign central bank at the Federal Reserve Bank of New York. At the same time as the draw on the swap line, the Federal Reserve and the foreign central bank enter into a binding agreement for a second transaction in which the foreign central bank is obligated to repurchase the foreign currency at a specified future date at the same exchange rate. At the conclusion of the second transaction, the foreign central bank pays a market-based rate of interest to the Federal Reserve. Central bank liquidity swaps are of various maturities, ranging from overnight to three months.

- Other Federal Reserve assets: These include deposits and bonds denominated in foreign currencies, accrued interest and other accounts receivables and physical goods (such as buildings and equipment) owed by the Federal Reserve.

- Preferred interest in AIA Aurora LLC and ALICO Holdings LLC: "On December 1, 2009, the FRBNY received preferred interest in two special purpose vehicles, AIA Aurora LLC and ALICO Holdings LLC, that were formed to hold the outstanding common stock of AIG's largest foreign insurance subsidiaries, American International Assurance Company Ltd. (AIA) and American Life Insurance Company (ALICO). In exchange, the outstanding balance of, and the amount of credit available excluding capitalized interest and fees, under the revolving credit facility was reduced. By establishing the

AIA and ALICO SPVs as separate legal entities, these transaction positioned AIA and ALICO for future IPOs or sales" (Board of Governors of the Federal Reserve, 2016).

• Net portfolio holdings of commercial paper funding facility: This facility was created in October 2008 to promote the smooth functioning of the commercial paper market that was experiencing some difficulties. Using this facility the Federal Reserve could purchase commercial paper directly from issuers at a rate that is 100 basis point over the expected fed funds rate over the term of the commercial paper.

• Term auction credit: The TAF was announced in December 2007. It allowed the Federal Reserve to make discount loans at a rate determined through competitive auctions. The TAF enabled the Federal Reserve to provide term funds to a broader range of counterparties and against a broader range of collateral than it could throughopen market operations.As a result, the TAF helped promote the distribution of liquidity when unsecured bank funding markets were under stress. It also provided access to term credit without the stigma that had been associated with use of the discount window.[5]

The other components of reserve balances held at Federal Reserve banks presented in equation 5 and equation 7 include:

• Foreign currency denominated assets: Foreign currencies are revalued daily to reflect movements in market exchange rates each day. If the dollar depreciates relative to a foreign currency, the dollar value of the respective foreign currency denominated asset increases. On the other side of the balance sheet, the increase in value of the foreign currency denominated asset is reflected as an increase within the capital account. The capital account then declines in value while the Treasury's general account increases by

[5]For more details on TAF see `https://www.federalreserve.gov/newsevents/reform_taf.htm`

the same amount, as the earnings are remitted to the U.S. Treasury by the Reserve Banks.

- Gold stock and Special Drawing Rights (SDRs): The gold stock of the United States is held by the Treasury and consists of gold that has been monetized: the Treasury has issued certificates reflecting the value of the gold to the Federal Reserve in return for a credit for the same dollar value to the Treasury's accounts. The gold stock also includes unmonetized gold, against which certificates have not been issued by the Treasury (although virtually all the Treasury's gold has been monetized since 1974). Reserve Banks hold special drawing rights certificates (SDRs), an international monetary reserve asset created by the International Monetary Fund in 1969. Under the law providing for the United States' participation in the SDR system, the Secretary of the Treasury is authorized to issue SDR certificates, somewhat similar to gold certificates, to the Reserve Banks, which are required to purchase the SDRs for the purpose of financing SDR acquisitions or exchange stabilization operations. The value of the SDRs is established monthly, based on the exchange rates of a number of the underlying currencies.

- Treasury currency outstanding: Coin and paper currency (excluding Federal Reserve notes) held by the public, financial institutions, Reserve Banks, and the Treasury are liabilities of the U.S. Treasury. This item consists primarily of coin, but includes about a small amount of U.S. notes–that is, liabilities of the U.S. Treasury–that have been outstanding since the late 1970s. U.S. notes are no longer issued.

- Currency in circulation: Currency in circulation includes paper currency and coin held both by the public and in the vaults of depository institutions. The total includes Treasury estimates of coins outstanding and Treasury paper currency outstanding.

- Reverse repurchase agreement: Reverse repurchase agreements are transactions in which securities are sold to a set of counterparties under an agreement to buy them

back from the same party on a specified date at the same price plus interest. Reverse repurchase agreements may be conducted with foreign official and international accounts as a service to the holders of these accounts. All other reverse repurchase agreements, including transactions with primary dealers and other counterparties who have been established specifically to transact in reverse repurchase agreements, are open market operations intended to manage the supply of reserve balances; reverse repurchase agreements absorb reserve balances from the banking system for the length of the agreement. As with repurchase agreements, the naming convention used here reflects the transaction from the counterparties' perspective; the Federal Reserve receives cash in a reverse repurchase agreement and provides collateral to the counterparties.

• Treasury Cash Holdings: Treasury cash holdings include paper currency and coin held in Treasury vaults, including silver bullion, silver dollars, coinage metal, and unmonetized gold.

• Deposits with Federal Reserve Banks, other than reserve balances:[6] This item is the sum of "Term deposits held by depository institutions," "U.S. Treasury, General Account," "U.S. Treasury, Supplementary Financing Account," "Foreign official accounts," and "Other deposits." In the following paragraphs we describe each item.

Term deposits are deposits with specified maturity dates that are held by institutions that are eligible to receive interest on their balances at Reserve Banks. Term deposits are separate and distinct from balances maintained in an institution's master account at a Federal Reserve Bank as well as from those maintained in an excess balance account. Term deposits are intended to facilitate the conduct of monetary policy by providing a tool for managing the aggregate quantity of reserve balances. U.S. Treasury, General Account is the primary operational account of the U.S. Treasury at the Federal Reserve.

[6]The definition of the items described in this section is from: `https://www.federalreserve.gov/monetarypolicy/consolidated_statement_cpa.htm`

Virtually all U.S. government disbursements are made from this account. Some tax receipts, primarily individual and other tax payments made directly to the Treasury, are deposited in this account, and it is also used to collect funds from sales of Treasury debt.

The second item is U.S. Treasury, Supplementary Financing Account. This item was created because of the dramatic expansion of the Federal Reserve's liquidity facilities, the Treasury agreed to establish the Supplementary Financing Program with the Federal Reserve. Under the Supplementary Financing Program, the Treasury issues debt and places the proceeds in the Supplementary Financing Account. The effect of the account is to drain balances from the deposits of depository institutions, helping to offset, somewhat, the rapid rise in balances that resulted from the various Federal Reserve liquidity facilities.

The third item is foreign official deposits are balances of foreign central banks and monetary authorities, foreign governments, and other foreign official institutions with accounts at FRBNY. These balances usually are relatively small because the accounts do not bear interest. While transactions in these accounts are handled by FRBNY for balance sheet purposes, the deposits are allocated across all of the Reserve Banks based on each Reserve Bank's capital and surplus.

The last item is other deposits at Federal Reserve Banks. They include balances of international and multilateral organizations with accounts at FRBNY, such as the International Monetary Fund, United Nations, International Bank for Reconstruction and Development (World Bank); the special checking account of the Exchange Stabilization Fund (ESF) (where deposits from monetizing SDRs would be placed); and balances of a few U.S. government agencies and government-sponsored enterprises, such as Fannie Mae and Freddie Mac. Also includes balances of financial market utilities that are designated as systemically important by the Financial Stability Oversight Council under Title VIII of the Dodd-Frank Wall Street Reform and Consumer Protection Act. It also

includes certain deposit accounts other than the U.S. Treasury, General Account, for services provided by the Reserve Banks as fiscal agents of the United States.

• Other liabilities and capital accounts: This item includes the liabilities to entities other than the Federal Reserve of the LLCs that have been consolidated on the books of the Federal Reserve as well as the liability for earnings remittances due to the U.S. Treasury.[7]

[7]More detail on this item can be found in Table 9 of the H.4.1 Statistical Releases of the Federal Reserve

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