How the Federal Reserve`s Quantitative Easing Program Works Under the Monetary Transmission Mechanism

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Kristoffer Rakneberg
Jørgen Stadheim Teigen
Abstract

As the Federal Funds rate had hit the zero lower bound and with the objective to counter the contracting economy following the recent financial crisis, the Federal Reserve introduced unconventional monetary policies in the period from 2008 to 2014. As the zero lower bound had left the Federal Reserve’s conventional tools inoperable, the Federal Reserve sought to ease the overall financial conditions, by infusing credit markets with liquidity. Specific assets were targeted with the aim of reducing their yields thereby reducing borrowing costs for households and businesses. This paper examines how quantitative easing works under monetary policy transmission channels and further analyze the channels relevance in the US economy and their effect on asset prices. In doing so, an extensive report and review of the theoretical foundation that advocates for and against the existence of the transmission mechanisms of quantitative easing is conducted. The existing literature on the subject were assessed and summarized along with a report on the effects of the mechanisms and the response in asset prices. Movement in asset prices was assessed by examining day-to-day price changes and cumulative changes across the relevant time horizons. The review suggest that quantitative easing can successfully influence asset prices, at least under favorable conditions. The results imply that the effect can spread from the assets targeted by the Federal Reserve, to other assets which aids the reduction of real borrowing costs in financial markets. Further, this is consistent with the existence of a portfolio balance channel. We find that portfolio balance effects is likely to represent up to 70 percent of quantitative easing’s effect on Treasury yields. However, MBS purchases in QE1 and QE3 demonstrate that direct targeting of assets related to a specific sector is more effective than targeting US Treasuries. Due to financial stress during the QE programs, the bank-lending channel is found to be ineffective. As for the confidence channel, even in broad, relative terms, it is hard to access whether there has been a direct effect of QE on consumer and business confidence. Measures from investor confidence indicate that quantitative easing can affect stock prices. Our research supports that quantitative easing may provide the Federal Reserve with an effective tool at the zero lower bound.
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1. Introduction

Since the onset of the financial crisis in 2007, different measures have been adopted by central banks around the world to support financial markets in distress. On October 10, 2008, the Federal Reserve’s Federal Open Market Committee (FOMC) saw it necessary to cut the overnight funds rate to a low .79 percent in an attempt to sustenance economic activity. By December 5, 2008, when further responding to the US financial crisis the FOMC lowered the federal funds interest rate to essentially zero (see Graph 1). Generally speaking, targeting the nominal federal funds rate below zero is by many considered to be non-efficient and even hazardous. If a central bank cut the interest rate below zero, savers are faced with negative returns. In such a scenario, it is anticipated that many would stuff their mattress with cash since dollar bills would earn a zero rate of return. This limit in cutting the Fed funds rate is frequently referred to as “the zero lower bound” (ZLB). Since nominal interest rates usually do not go below zero, many analysts believed that the FOMC had run “out of ammunition” to control inflation and unemployment (their dual mandate responsibility). However, in the start of 2009 monetary policy decision makers in the US engaged towards the uncharted waters of “quantitative easing” (QE) programs in an attempt to impact longer-term interest rates. Although quantitative easing programs may mechanically differ from one to another, this kind of unconventional monetary policy involves a central bank purchasing assets in the open market in order to affect long-term interest rates. Thereby, the aim of large-scale asset purchases (LSAP), which is financed by issuing central bank money, is to support economic activity in times when the central bank interest rates cannot be further reduced. Built on theory from monetary transmission mechanism channels, this thesis considers the theoretical implications and examines the effects of large-scale asset purchases – frequently referred to as quantitative easing.

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1 Yates (2002) notes that interest rates could be slightly negative since there are storage costs tied to holding cash, thus potentially reducing a zero rate of return.

2 For more examples as to how negative interest rates may lead to “unhealthy” economic conditions see Anderson and Liu (2013).
Graph 1: The Effective Federal Funds Rate Source: Board of Governors of the Federal Reserve System (2015a)

Long before the start of 2009 however, central bankers have debated if using open market operations (OMO’s) to retain monetary policy when threatened with the zero lower bound can arm policy makers with additional “ammunition”. By conducting such operations, monetary policy may have the ability to construct and control ceilings for yields on longer-term assets. This could include different types of assets such as long-term Treasury securities, agency debt or agency mortgage backed securities (Bernanke, 2002). Given that this type of open market operation is successful, yields on the mentioned securities would fall. This fall in the yield curve would incorporate private debt such as mortgages as well. Furthermore, increased asset prices were pointed out to potentially influence spending (Mishkin, 1996; King, 1999). Not only have the use of OMO’s to control inflation been discussed as an opportunity for central banks. In fact, there has been drawn parallels between events during the financial crisis of 2007-08 and the Great Contraction of 1929-1933. The quantitative easing program we have seen during the recent financial crisis have similar features to the expansionary Treasury gold policy of the 1930’s (Bordo & James, 2009).

For the most part, monetary policy works through financial markets. In doing so, it influences prices and yields of financial instruments and should in turn alter economic decisions and thereby supporting

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3 For related papers referring to discussions of using OMO’s to affect yields on assets see for example, King (1999); Blinder (2000); Eggertsson and Woodford (2003)
the economy (Bernanke & Reinhart, 2004). We therefore find the monetary transmission mechanism to be an important foundation for examining how quantitative easing both function and (potentially) affect the economy. Not only is the transmission mechanism of monetary policy an important mean for explaining how a change in the traditional federal funds rate affects the broad economy, but it can also provide us with important implications as to how this mechanism operate though different channels when unconventional monetary policy is adopted – in this case the Feds quantitative easing programs.

A key implication of the monetary transmission in this thesis is that the model we have implemented “flows” from the start (asset purchases), going on as to how asset price adjustments work (channels of QE), then further examining spending which should support economic activity. In this way, we aim to get the overall picture of QE. In our theoretical review, strong emphasis is placed on the portfolio-balancing channel. The channel is backed by long intellectual history from both Keynesians (Tobin, 1969) and monetarists (Brunner and Meltzer, 1973) and, is perhaps together with alteration of future expectations of policy rates, the most discussed channel in the literature.

1.2 Purpose of the paper

The purpose of this paper is to provide insight to how quantitative easing acts through the transmission mechanism by understanding its aspects. We shed light on the aspects by studying all the different steps in these transmission channels to review and discuss if these channels are of important consideration for monetary policy transmission in the US. We are especially want to shed some light on the relevance of the portfolio balance channel, which is in the center of much of the dispute surrounding the theme today.

Another objective, and also the reasoning of the structure, is to provide a solid grounding for anyone who is new to the theme or wishes to learn more about LSAP in general – and induce a level of critical thinking. We believe that understanding the transmission mechanism of QE is great starting point for anyone studying the theme.

1.3 Topic Delimitations

The real success a quantitative easing program should be judged on its effect on the economy and the performance of economics and aggregate demand. To estimate such effects requires advanced forecasting methods and simulations beyond the capacity of our methodology. These effects will likely take time to fully spread out in the real economy and may have effects in several years ahead. That
limits our ability to consider the full aftermath of these rounds of quantitative easing. Further, the result of this paper is based solely on the US economy. We do not assess this findings adaption or relevance to other economies. Differences in financial markets in terms of size and structures entails that mechanisms that are relevant in one economy may not be effective, or as effective, in other economies. Thus, the result only applied to the United States and the Federal Reserve.

The structure of the paper is outlined as follows: Chapter 1 introduces the topic, the research questions and the limitations of the thesis. In chapter 2, we will start with providing a short background regarding the different QE programs including the size of the purchases and its main intentions. Chapter 3 covers the theory related to quantitative easing. In this chapter, we also aim to provide the reader with a theoretical discussion. QE is definitely a “hot” debate among the media, financial markets, scholars and central bankers. For this reason discussion is commenced to present different points of view on how monetary policy transmission mechanisms work in theory. Further, we outline the theory behind the different transmission mechanisms for monetary policy. In chapter 4, we study these mechanisms and responses in asset prices to quantitative easing. This is carried out by assessing existing studies of relevant channels accompanied by our own analysis. The focus is on US Treasury rates (since this is the common denominator for all QE programs, the focus of the theoretical discussion and, the focus of previous studies). Chapter 5 concludes.

2. The Feds Programs of Quantitative Easing

2.1.1 Q1
The Fed announced its first quantitative easing program on November 25, 2008. The statement revealed that the Fed would initiate a program to purchase the direct obligations of housing-related government-sponsored enterprises (agency-bonds) and mortgage backed securities (MBS) backed by Fannie Mae, Freddie Mac and Ginnie Mae (agency-backed MBS), which are all under the conservatorship of the Federal Reserve. GSE’s are financial service corporations who serve to improve the credit flow to targeted sectors of the economy and make those segments of the capital market more efficient and, also reduce the risk to capital suppliers (investors). The most renowned GSEs – Freddy Mac and Fannie Mae – pools mortgages from the secondary market and sells them as a mortgage-backed security to investors on the open market. The program was aimed to reduce mortgage interest rates and increase credit availability for house purchases, which in turn should support housing markets
and foster improved conditions in financial markets more generally (Federal Reserve, 2008). Targeting the housing and credit markets was sensible as they were particularly shaken by the fall in US real estate prices, sales and construction (Fawley and Neely, 2013).

The announcement stated that purchases of up to $100 billion in GSE direct obligations would be made as well as purchases of up to $500 billion in agency-backed mortgage backed securities (Agency-MBS). The press release further stated that the program was expected to occur over several quarters. As the economy continued its contraction, the program was expanded to $1.25 trillion in MBS and $200 billion GSE debt to provide greater support to mortgage lending and housing markets (Federal Reserve, 2010a). Purchases of $300 billion of medium-term Treasury securities over the next six months was also announced to improve conditions in credit markets. Domestic and foreign economic slack was believed to keep inflation below the rates that would best foster economic growth and price stability in the longer term and thus the Fed would use all means to promote economic recovery and to preserve price stability.

The program expired on March 31, 2010 as the Fed saw improvements in financial markets (Stroebel and Taylor, 2012). In a press release on March 16, 2010 the Fed announced that they would discontinue QE1 that month due to the outlook of economic activity and the labor market. The pace of the economic recovery was still believed to be moderate, yet it was expected a gradual return to higher levels of resource utilization in context of price stability. The federal funds rate would be kept in the 0-0.25 % range (Federal Reserve, 2010b).

2.1.2 Q2

The Fed announced its second round of quantitative easing on November 3, 2010. The FOMC motivation for starting a new program was the elevating unemployment rate and low inflation. Serious financial market disorder had receded by the second half of 2010, but real activity remained sluggish, with a worrisome disinflationary trend in the US (Fawley and Neely, 2013). The aim of QE2 was to promote a stronger pace of economic recovery (lower long-term interest rates) and desirable inflation levels. In addition to keep its current policy of reinvesting principal payments from its security holdings in long term Treasury bonds and maintain a face value of $2.054 trillion (Federal Reserve Bank of New York, 2010; Krishnamurthy and Vissing-Jørgensen, 2012). The FOMC expressed the intention of purchasing $600 billion of long-term Treasury securities by the end of the second quarter of 2011. The
program was set to keep a pace of $75 billion per month, but with regularly review of the pace and the overall size of the program. The committee would maintain the Fed funds rate at the 0-0.25 % level. Although all of the QE programs have been hefty debated, QE2 was certainly controversial among economists. The risk of the program has been criticized of being considerably higher than its benefits. As pointed out by Swanson, Reichlin and Wright (2011) for example, several economists published their opinion in both newspapers and a letter to then Fed Chairman Ben Bernanke expressing their concerns about the program. Specifically these concerns directed towards the inability of the program improving any economic conditions, that the program could lead to risk currency debasement and inflation and, distorted financial markets.

2.1.3 Operation Twist

On September 21, 2011 the Fed announced a maturity extension program that is later to become known as Operation Twist (named after a similar program initiated by the Kennedy Administration in the 1960s). In the aftermath of QE2 the Fed realized that the program had not lead the economy to the intended state, as economic growth still remained slow. Although the Fed expected that the recovery pace would pick up over the next coming quarters, they feared that the unemployment rate would decline too slowly. The inflation level was anticipated to settle at or below the target, but still was considered a concern. Subsequently, the Fed released a statement that it would extend the average maturity of its holdings of securities. The objective of such a program was to lower the long-term interest rates while short-term rates are at the zero bound level, without expanding the central banks` balance sheet (Swanson, Reichlin and Wright, 2011). By expending its balance sheet the Fed runs a risk of adding inflationary pressure. Reducing the supply of long-term Treasuries should reduce long-term interest rates, also the interest rate on financial assets that are considered close substitutes for long-term treasuries (Financial Reserve, 2013). In this operation, the Fed tried to avoid this by selling off short-term treasuries and buying long-term treasuries with the proceeds. The size of the program was reported to comprise of selling $400 billion of short-Treasury securities (treasuries with three year remaining maturities or less) and buy back an equal amount of long-term Treasuries (6-30 years). The size and composition would be regularly reviewed and possibly adjusted. In addition the Fed also announced that I would reinvest principal payments from agency-debt and agency-MBS in agency-MBS. The target rate was kept at 0-0.25 % (Federal Reserve, 2011). The program was due to be discontinued in June 2012, but the Fed decided to extend it through the end of
2012 (Federal Reserve, 2012b). This led to an additional sell off and buying of $267 billion in Treasury securities.

2.1.4 Q3

The third round of quantitative easing was announced on September 13, 2012. The Fed expressed its concern that economic growth would not be strong enough to generate sustained decline in the unemployment rate and that the inflation rate was likely to run at or below its objective of 2%. The program aimed to further support economic growth as well as to ensure the desired level of inflation. The Fed stated that they would start to buy $40 billion worth of agency-backed MBS per month until the unemployment situation had substantially improved. This made QE3 quite different from QE1 and QE2, since the end of the program would be set by a “goal achievement” rather than a given date – thereby the nickname “QE-Infinity”. Together with the still ongoing Operation Twist, the Fed anticipated a monthly $85 billion increase of long-term security holdings throughout 2012. The joint effect was to “put downward pressure on longer-term interest rates, support mortgage markets and help to make broader financial conditions more accommodative”. The Fed funds rate would be kept at the 0-0.25 % level (Federal Reserve, 2012a).

On December 12, 2012, the Fed announced that it would expand their monthly purchases with $45 billion worth long-term treasuries by the start of 2013. The federal funds rate would be kept at the 0-0.25 % level at least for as long as the unemployment rate exceeded 6.5 %, and the one-to-two year outlook for the inflation rate no more than 0.5 percentage point of the 2 % target (Federal Reserve, 2012b).

2.1.5 Tapering of QE3

In a press release on December 18, 2013, the Fed reports that it would start tapering back its asset purchase program in January 2014. They announced that they would cut the total purchases with $10 billion with a $5 billion cut in both agency-backed MBS and long-term Treasury securities, respectively (Federal Reserve 2013).

The Fed argued that the size (and still increasing size) of their long-term securities holdings should continue to keep the long-term interest rates down, support the mortgage markets and promote a stronger economic recovery and ensure that long-term inflation is meeting its target. The Fed saw the “improvement in economic activity and labor market conditions consistent with growing underlying
strength in the broader economy”. Further on the Fed announced that it would taper back its asset purchasing with $10 billion the following month in March, April, June, July and September before they announced its conclusion on October 29, 2014 (Federal Reserve, 2014).

Graph 2: Treasury securities and MBS held by the Federal Reserve Source: Board of Governors of the Federal Reserve System (2015b,c,d)

Graph 2 above gives an overview of the purchases and holdings of assets by the Fed for the whole period of the program. As we see, the purchases started at the same time, but for QE1 MBS exceeded Treasuries. As QE2 started, we observe the opposite – Treasury purchases exceeding MBS. For QE3 the purchases are rather interrelated since purchases were at around the same levels. The level of agency-bonds are relatively small, compared to the other two types of assets.

3. Theoretical Foundation of Quantitative Easing

3.1 Federal Reserve Balance Sheet Expansion

By purchasing financial assets, the Federal Reserve is hoping to push down long-term interest rates in the market. The staring point of explaining the basic principal of QE is by referring to the Federal Reserve’s balance sheet activities. Instead of controlling the traditional Fed funds rate by setting the price of money (conventional monetary policy), QE policy attempts to actively vary the size of the balance sheet by purchasing large quantities of bonds, and therefore it has a closer relationship with the quantity of money. Graph 3 presents the assets and liabilities held by the Fed.
Adopted from Borio and Disyatat (2009) we can distinguish four main forms of balance sheet policies (see Table 1 below). In context of the recent Fed policy, we are mainly concerned with the forms of credit policy and quasi-debt management policy.

<table>
<thead>
<tr>
<th>Market Targeted</th>
<th>Impact on Private sector balance sheets</th>
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<tbody>
<tr>
<td></td>
<td>Change in net FX exposures</td>
</tr>
<tr>
<td>Foreign exchange</td>
<td>A</td>
</tr>
<tr>
<td>Public debt/securities</td>
<td></td>
</tr>
<tr>
<td>Private credit/securities</td>
<td>B</td>
</tr>
<tr>
<td>Bank Reserves</td>
<td></td>
</tr>
</tbody>
</table>

Exchange Rate Policy (A); Quasi-debt management policy B; Credit policy (C)  
Bank Reserves Policy (shaded area)

Table 1: Forms of Balance Sheet Policies Source: Adopted from Borio & Disyatat (2009)

Credit policy involves various types of measures adopted with a goal of targeting specific sectors of private debt and securities. In doing so, the central bank will try to alter the composition of private sector balance sheets for the key purpose of easing the financial conditions for private sector. The
various measures of balance sheet policies central banks adopted during the crisis are presented in Table 2 below, a framework of Borio and Disyatat (2009). As we can observe, the Fed was actively engaged in many of the possible Credit policy actions. The most discussed and relevant actions in the context of QE are the purchases of MBS backed by GSE. The purchases where initiated in order to support the mortgage market directly. Strictly speaking, the acquisitions of MBS should be under quasi-debt management due to the quasi-sovereign nature of the claims. However, the Federal Reserve’s intention of supporting the mortgage market directly through these purchases is the reason that it falls under the category of credit policy. Although backed by the government, the underlying assets that operate in MBS are also related credit policy.

It should further be mentioned that by law, central banks have individual restrictions as to which types of securities they may purchase. In the US, this restriction goes under the Federal Reserve Act. The Act administer (or limit) the Fed to essentially buy Treasuries, MBS and agency bonds. The reason for the Fed facing such limitations for instance relates taking credit risk onto its balance sheet in the form of, e.g. private sector credit risk (Small & Clouse, 2005). As we can observe from Table 2 however, Bank of Japan (BoJ), Bank of Canada (BoC), Bank of England (BoE) and Swiss National Bank (SNB) all engaged in corporate bond funding. It has been suggested that when faced with the zero lower bound, central banks may benefit from such purchases. For example in the context of private sector credit risk, Gagnon (2014) argue that the Swiss National Bank could benefit from purchasing equities. It certainly is important to be aware of the differences in restrictions, but it is not the purpose of this thesis to conduct a cross-country evaluation based on the convenience to buy securities that central banks have in their respective countries. Although such differences may very well have important implications on the economy for each respective central bank, such a comparison would require attention beyond the scope of this thesis.

Quasi-debt management policy involves targeting the financial market for public debt. The central bank is aiming to alter the composition of public debt held by the private sector. Thus, this is related to the purchase of government securities and, as we have seen earlier the Federal Reserve initiated to purchase sizable amounts of government debt with the main intention to affect the yield on the long-termed Treasuries. This type of policy relates the central bank working as an intermediary between the private sector and government. If a close substitutability between the central bank and government
liabilities exists, then the effect of portfolio balancing would be limited⁴. Some research suggest that when adopting Quasi-debt management the central bank would have to purchase very large amounts of Treasuries to experience an effect. For example, Clouse et al. (2003) and Reinhart and Sack (2000) shows that even with changes of large amounts in the composition of the private sectors holdings the effect on the yield curve were rather small. This suggests that if, at all, we should see any effect, there would have the composition of private holdings would have to consist of very large amounts.

<table>
<thead>
<tr>
<th>Type of Balance Sheet Policy</th>
<th>Measures</th>
<th>Fed</th>
<th>ECB</th>
<th>BoE</th>
<th>BoJ</th>
<th>BoC</th>
<th>RB</th>
<th>A</th>
<th>SNB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credit Policy</td>
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<tr>
<td>Influence interbank market conditions:</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Modification of discount window facility</td>
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<tr>
<td>Exceptional long-term operations</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Broadening of eligible collateral</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Broadening of counterparties</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<td>Yes</td>
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<tr>
<td>Inter-central bank FX swap lines</td>
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<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Introduction or easing of conditions for securities lending</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Quasi-Debt Management Policy</td>
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<tr>
<td>Purchase of government bonds</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
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<tr>
<td>Bank Reserves Policy</td>
<td>Target for bank reserves</td>
<td>Yes</td>
<td></td>
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<tr>
<td>Exchange Rate Policy</td>
<td>Purchase foreign currency securities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

Fed = Federal Reserve Bank; ECB = European Central Bank; BoE = Bank of England; BoJ = Bank of Japan; RBA = Reserve Bank of Australia; SNB = Swiss National Bank

Table 2: Measures of balance sheet policies. Source: Adopted from Borio & Disyatat (2009)

We can review how the FOMC and the Board of Governors took action in fighting the recent recession by presenting the Federal Reserve Balance sheet (Table 3). The balance sheet compares the end of the third quarter in 2009, with June 27 2007, which was just before the financial crisis struck. Total assets held by the Fed have increased considerably during this period, going from $869 billions to a whooping

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⁴ See chapter 3.5 in this paper for a more in-depth discussion on the subject of a portfolio balance effect.
$2,144 billion. On the liability side we can observe that the Fed for the most part held Federal Reserve notes and Reserve Balances. Reserve balances are accounts held by depositary institutions such as commercial banks.

<table>
<thead>
<tr>
<th>Federal Reserve Balance Sheet</th>
<th>(Billions of dollars)</th>
<th>30.09.2009</th>
<th>27.06.2007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Assets</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Short-term lending programs for financial institutions</td>
<td>264</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Targeted lending programs</td>
<td>84</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Securities holding</td>
<td>1593</td>
<td>791</td>
<td></td>
</tr>
<tr>
<td>Treasury securities</td>
<td>769</td>
<td>791</td>
<td></td>
</tr>
<tr>
<td>GSE-related securities</td>
<td>824</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Emergency lending</td>
<td>101</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Other Assets (such as FX, bank premises)</td>
<td>102</td>
<td>78</td>
<td></td>
</tr>
<tr>
<td><strong>Total Liabilities</strong></td>
<td></td>
<td>2093</td>
<td>836</td>
</tr>
<tr>
<td>Federal Reserve notes</td>
<td>874</td>
<td>775</td>
<td></td>
</tr>
<tr>
<td>Reserve balances</td>
<td>848</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Treasury deposits</td>
<td>273</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Other (such as foreign official deposits)</td>
<td>98</td>
<td>41</td>
<td></td>
</tr>
</tbody>
</table>

*Table 3: Federal Reserve Balance Sheet on September 30, 2009 and June 27, 2007. Source: Adopted from Bernanke (2009a)*

On the asset side of the balance sheet, the Federal Reserve intervened to hinder further recession by taking actions such as providing short-term lending programs to depositary institutions and targeted lending programs to nonfinancial borrowers. The assets that are of interest in regards to QE however, are the holdings of marketable securities. Marketable securities consists of Treasury bonds and notes, debt of government sponsored enterprises (agency debt) and, agency-backed MBS. Table 4 provides us with an overview of the purchases of long-term marketable securities by the Fed in three different periods. At the end of the 3rd quarter of 2009 was in total about $1.6 trillion, corresponding to approximately 75 percent of the total assets. That being said, we can also observe that before the crisis, $791 was held. This makes up for about 90 percent of Federal Reserve assets. Although QE certainly was the most well-know intervention by the Fed and took most of the attention, especially in financial markets, other actions as those mentioned above explains why it percentage-wise were hold more marketable securities before the crisis. As noted by Bernanke (2009a) the main goal for the purchases...
at the time was to lower the cost of borrowing and improve availability of credit to households and firms.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Securities holdings</td>
<td>1593</td>
<td>496</td>
<td>791</td>
</tr>
<tr>
<td>Treasury securities</td>
<td>769</td>
<td>476</td>
<td>791</td>
</tr>
<tr>
<td>GSE-related securities</td>
<td>824</td>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>


Source: Adopted from Bernanke (2009a)

3.2 Understanding the Term “Quantitative Easing”

Today quantitative easing is a familiar term to those who follow financial markets, monetary policy or economic news in general. The term however was by no means the standard in a lot of media before 2009. Rather, it was used in “brackets” even when economists such as Ben Bernanke and Vincent Reinhart (2004) explained how monetary policy had the potential to “increase the size of the central bank’s balance sheet beyond the level needed to set the short-term policy rate to zero” when conventional means are no longer plausible. More than often commentators in the media have a tendency to strongly relate QE with a pure quantity expansion of narrow money. The original sense of the term stems from 1994, from Japan. Actually, in the context of a needed change of monetary policy, it was then chief economist of Jardine Fleming Securities (Asia) who expressed the term in presentations to his clients in Tokyo (Lyonnet & Werner, 2012). Although the Bank of Japan (BOJ) mentioned the word “quantitative easing” the year it was introduced, it was a word among others. It was not before 2003 that the BOJ stated that the policy implemented in 2001 was called “quantitative easing”. That being said, the BOJ staff did use the expression, but not always with a positive sense. Indeed, and as bizarre as it is, the term has been used when BOJ staff argued that policy of “quantitative easing” does not work and, therefore the term should not be used at all (Fujiki, Okina & Shiratsuka, 2001).

Quantitative easing programs have been applied in different countries for the last two decades. However, the programs have been mechanically different from one another\(^5\). To explore the interpretation of the term “quantitative easing” one can ask: Is QE very different from what is regarded

\(^5\) For a review as to how QE programs differ we refer to “Four Stories of Quantitative Easing” by Fawley and Neely (2013)
as conventional policy? The purchase of assets is not an unusual part of central bank activities. In such, Bean (2009) argues that the use of open market operations is a return to “textbook” policy. The difference however, is that QE operations are extraordinary (or unconventional) due to the size and outright purchases made by the Fed. In addition, the economic circumstances during the initiation of the programs are, naturally, of a special case. Truly, purchasing government securities and expanding the monetary base is the kind of policy that occurs when a central bank uses open market operations. This is also what Woodford (2012) determines as “pure” quantitative easing. Woodford (2012) uses this term in order to refer to a broader class of possible policies and mechanisms. A key difference from the conventional policy however, is that QE is associated with injecting a specified quantity of broad money, rather than altering the price through changes in the price of base money. In addition there is another important difference, the Federal Reserve went beyond only purchasing short-dated government securities, since they purchased both long-dated government securities and MBS (Bowdler & Radia, 2012). In this thesis, we refer to quantitative easing along the lines of Bernanke (2009b). After all Ben Bernanke – as then chairman of the Fed – was one of the top initiators of the program, and since we explore the QE programs initiated by the Federal Reserve we also try to interpret QE the way Bernanke did. Bernanke (2009b) notes that the program adopted by the US is conceptually distinct from the one BOJ implemented from 2001 to 2006. The QE Policy of the Fed resembles the one of BOJ (therefore QE) since it involves an expansion of the Federal Reserve’s balance sheet. However, according to Bernanke (2009b) the term “Credit easing” is better suited for the type of unconventional policy the Fed introduced in 2009. In the case of pure QE, the central bank policy will focus on the quantity of reserves held – thus it is on the liability side of the balance sheet. On the asset side of the balance sheet, the composition of loans and securities are of a more incidental nature. The policy approach of BOJ from 2001 to 2006 targeted mainly bank reserves. The Fed policy however, also includes the asset side, thus a “credit easing” approach. This by trying to affect the credit conditions of households and businesses by focusing on the mix of loans and securities that it holds. It should be noted that this is not to say that the BOJ policy was of wrong doctrine, whereas the Fed was correct. The differences in the policy approach reflect both economic and financial conditions in their respective times. Specifically, in the US a focus on reducing credit spreads and improving dysfunctional credit markets were the target behind the approach of quantitative easing conducted by the Fed – thereby opting at stimulating aggregate demand.
3.3 Transmission Mechanism of Quantitative Easing
Since Milton Friedman published his paper “A Theoretical Framework for Monetary Analysis” in 1970, substantial experience and changes towards monetary transmission mechanism has occurred. Some important features include a more internationalized framework because of exchange rates being an important part of the transmission mechanism. Rational expectations have lead to an improved quantitative distinction between real interest rates and market interest rates.

Boivin, Kiley and Mishkin (2010) make an important distinction between two basic types of monetary transmission; neoclassical channels contain financial markets to be perfect, and non-neoclassical channels hold financial market imperfections. Neoclassical channels are modeled as traditional channels that depend on investment, consumption and international trade. These three primary channels are further divided in with their respective criteria. Investments include the direct interest rate channel; consumption work within wealth effects and intertemporal substitution effects; and international trade operates through the exchange rate channel. Non-neoclassical channel is also referred to as the credit view since the channels affect credit markets. Market imperfections occur as the market is interfered by governments or by imperfections in private markets due to asymmetric information or market segmentation, leading to ineffective financial markets functioning. The three basic non-neoclassical channels consists of; how credit supply from the government effects credit in markets, bank capital and lending channel and the balance sheet channel (accounts for households and firms). The special case of non-neoclassical channels is their difficulty in assessing empirical results with macroeconomic models and data, possibly since these channels have had limited theoretical guidance. For an overview of the distinctions, we refer to Table 5 below.

<table>
<thead>
<tr>
<th>Channel</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neoclassical channel</td>
<td>Adjustment in short-term policy rates affect the cost of capital for households and firms</td>
</tr>
<tr>
<td>Wealth Effects, Tobin’s Q</td>
<td>Adjusted short-term interest rates affect discounted present values and/or Tobin’s Q for different types of assets. These changes in the market value of assets stimulate changes in consumption</td>
</tr>
<tr>
<td>Intertemporal Substitution</td>
<td>Adjustments in short-term interest rates changes the slope of the consumption profile</td>
</tr>
</tbody>
</table>
**Table 5: Neoclassical and Non-neoclassical Channels of Monetary Policy Transmission**

*Source: Adopted from Boivin, Kiley and Mishkin (2010)*

Horngren (1995) explains how the transmission mechanism acts on two fundamental premises. One is the assumption that the central bank has an *interest rate target* in its monetary policy. As a producer of means of payment, monopoly enables the Fed to control the overnight rate on interbank loans. At first glance this assumption may be acknowledged as conflicting with the fundamental premise. However, it is important to recognize that, even though the Federal Funds Rate is effectively zero, it is still the Fed who has control and who has monopoly over the nominal interest rate. That being said, asset purchases are controversial exactly because the transmission mechanism of QE relies on effects that are different from that of conventional monetary policy (Roche, 2014). The other premise is based on changes in monetary policy being transmitted via *aggregate demand*. If demand outgrows production capacity, inflationary pressure would exist and vice versa. These matters become sophisticated since the process is also affected by *expectations* (Horngren, 1995). Through future monetary shocks, expectations are perceptions households and businesses attain about intertemporal rates of substitution (Cevik & Teksoz, 2013). For example, in a simple Taylor-rule model where long-term rates are determined by the central bank and long-run inflation is aligned with the known target, forward-looking rational agents would base their expectations on the policy rule. If shocks arise, monetary policy makers would adjust the rate according to its rule and rational agents would sit back and wait for inflation to return to its stated value. In the real world complications occur since the target may not be explicit and/or suffer from a credibility problem from the public (Vonnák, 2008).
Figure 1: Transmission Mechanism of Quantitative Easing. Source: The model is based on models that frequently appear in the QE literature in similar forms, for example Joyce et al (2011)

Figure 1 above shows how the transmission mechanism of quantitative easing may work through various channels. After the Fed has purchased assets (engaged in QE), five distinct mechanisms could potentially transmit the effect of the purchases onto various asset prices in the US and abroad. These distinct mechanisms are namely, policy signaling, portfolio rebalancing, market liquidity, bank lending and confidence. The amount of money in the economy is also believed to have a direct effect on bank lending. We are concerned with the theoretical arguments and reasoning as to how QE might affect asset prices through the five channels, as well as previous empirical studies and our own interpretation.

Then we go from asset prices to spending. Here we are interested in the theoretical aspects in which the potential for the mechanisms to propagate real activity and prices. That is, how changes in asset prices might impact nominal spending.

As we also shall discuss, there is a disagreement of both degree and as to which channels that are affected by quantitative easing. The academic literature however, focuses on two specific channels which stand out in a more frequent manner, namely the portfolio balancing channel and the signaling
channel. Researchers often consider these two channels simultaneously, not necessarily because they have features which are similar in theory or practice, but since they complement each other in a logical way. Fratzscher, Lo Duca and Straub (2013) for example, emphasizes that channels of the transmission mechanism are by no means mutually exclusive, but may work simultaneously. Such effects of the LSAP program may, for instance, function through portfolio rebalancing, signaling (by lowering the expected path of future US policy rates) and a confidence channel. Consequently, our empirical review of these two channels is combined. However, it is natural considering the purpose of the monetary transmission mechanism, that all of the channels supplement or supports one another. We recognize that these channels may have a substantial degree of overlap or, in a logical way are connected with each other. For example, portfolio rebalancing and the bank-lending channel may both interact in affecting domestic demand. Although difficult to quantitatively measure, another example is the confidence channel, which perhaps is the result of broader economic effects.

3.4 Two Distinct Views on the Channels Relevance

The channels in which quantitative easing may be effected is subject to a lot of discussion. We find it useful to provide two distinct views on the effect on the channels, which divides economists in the heated debate of quantitative easing. Thereby, this divide represents conceivably the most important factors of debate as to if and how LSAP is an answer for monetary policy when the interest rate reaches the zero lower bound. As the reader will note, these contrasting views are rooted in the theoretical discussion presented.

3.4.1 View 1 – Preferred Habitat Theory

In this “view”, models that include imperfect substitutability between various assets, credit constraints and imperfect markets may alter asset prices by shifting the relative supplies of assets. As the Federal Reserve asset purchases of Treasury bonds and MBS push their price up/decrease their yield, then given that such models are effective investors will have an incentive to rebalance their portfolios by seeking other, more risky assets. The mentioned models (or actually in large; assumptions) are

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6 Several researchers have analyzed these two channels in the related literature of QE. See for example, Ugai (2007), Cecioni, Ferrero, Secchi (2011), Clouse et.al (2003), and Borio and Disyatat (2009).
7 Lim, Mohapatra and Stocker (2014) recognize that the channel overlap and have therefore subsumed channels that may be distant from each other but are likely to be measured in similar fashion, in their study of the effect of quantitative easing on financial flows to developing countries. For this thesis we – apart from the portfolio balance channel and signaling channel – investigate these channels separately for structural and theoretical purposes. In such a way it should be easier for the reader to fully capture the theoretical grounding for quantitative easing on financial markets.
important in the contribution to support the much debated portfolio balance channel. The upcoming of this view stems far back, including the work of Tobin (1965,1969) and Friedman (1974). This view resembles a close connection with the Preferred Habitat Theory presented by Modigliani and Sutch (1966).

3.4.2 View 2 – Irrelevance Proposition
On the opposite, in conventional New Keynesian models, asset purchases by a central bank is argued to operate only in changing agent’s expectations about future policy rates – the most well known reference here being the particular result found in the paper of Eggertsson and Woodford (2003). On its own, purchasing assets will not change the behavior of investors because the assumptions taken into consideration imply the distinction of holding public or private assets to be unimportant. This suggestion is closely related to the theory of the irrelevance proposition presented by Modigliani and Miller (1958). In so, this view would not support any effect on portfolio rebalancing.

3.5 Bond Yields
As we present the theoretical foundation of QE it is important to recognize that the very basic point in the effect of such a policy lies in the bond market. As the reader will note, the yield of bonds are for the most part discussed throughout the rest of the thesis. A lot of the discussion on the point of asset purchases suggests that there should be many similarities between the effect of purchasing long-term assets and the effect of a cut in the federal funds rate – the Fed’s traditional tool. The whole point in cutting the federal funds rate is that longer-term bond yields would also decline and, if you can buy longer term bonds and push up their prices that would be doing the same thing through a different mechanism.

3.5.1 Decomposition of the yield curve
The decomposition of the Treasury yields is built on the idea of the capital asset pricing model. Investors need to be compensated for the time value of the money that they invest (called the risk-free rate of return) and a compensation for taking on additional risk, known as the term premium (The term premium is a measure of the difference in yields that is not explained by the expected path of short-term interest rates). In 3.5 and 3.6, we will discuss how a Central Bank’s unconventional policies affect the two components through the so-called signaling and portfolio balance channels. Primarily monetary policy is expected to affect the risk-neutral rate through the signaling channel and the risk premium through the portfolio balance channel.
This decomposition of the yield curve can be presented in the following simple equation:

\[ y_t^n = YRN_t^n + YTP_t^n \]  

\[ YRN_t^n = Risk\ Neutral\ Component \]

\[ YTP_t^n = Term\ Premium \]

The decomposition of the yield curve into a risk-free rate and a risk premium, and the documented failure of the alternative expectation hypothesis dates back to the 1980s and several studies in later years\(^8\). In the model presented, the term premium can be further decomposed into a maturity specific term premium (reflecting the pricing of interest risk) and an instrument-specific term premium (reflecting supply/demand for that particular security):

\[ YTP_t^n = YTP^n_{risk,t} + YTP^n_{instrument,t} \]  

\[ \text{[Equation 2]} \]

Unlike standard capital asset pricing models, the equation we use accounts for changes in the supply of long-term bonds (Bauer & Rudebusch, 2014). Changes in the bond supply will have direct price effects through the instrument specific premium \( YTP^n_{instrument,t} \) on the particular securities that are bought, while the effect on those securities that is not purchased, through the instrument specific premium, will be modest. Changes in liquidity premiums will also affect the instrument specific premium and thus the term does not just measure portfolio balance effects, but also effects stemming from the liquidity channel (Joyce et. al, 2010b). The maturity specific term premium \( YTP^n_{risk,t} \) may be lowered as the aggregate amount of duration available in the market declines. This present effect may be supported by the existence of investors that prefer a specific amount of duration risk\(^9\). In turn it should also lower the term premium on a range of securities and not just those that are targeted by the Fed (GRRS, Bauer & Rudebusch, 2014).

Estimated term premiums will likely overstate the importance of the portfolio balance channel as signaling effects could influence the term premium effects. This happens as lower future policy rates will decrease interest rate risk (Bauer & Rudebusch, 2014; Woodford, 2012).

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\(^8\) See for example Fama and Bliss (1987); Stambaugh (1988); Cochrane and Piazzesi (2005); Piazzesi and Swanson (2004); Kim and Wright (2005); Cochrane and Piazzesi (2008).

\(^9\) See the discussion of the preferred habitat theory in 3.5.1
3.6 Portfolio Rebalancing Channel
Both in 2010 and 2012, at the annual economic policy symposium hosted by the Federal Reserve Bank of Kansas City, Ben Bernanke presents perhaps one of the main arguments as to how large-scale asset purchases may stimulate economic activity at the zero-bound. He explains that the so-called portfolio-balancing channel holds that purchases of long-term securities from the Federal Reserve affect the economy by changing the mix and structure of investors’ portfolios. In more specific terms, the Fed bases its QE policy on the presumption of imperfect substitutability. That is, financial assets are not perfect substitutes in investor’s portfolios. For example, some investors are bounded by restrictions in which assets they may purchase while others may have certain characteristics in terms of risk that are hard or costly to hedge (Bernanke, 2012). As discussed earlier, the supply of assets may affect the yield on a particular asset. This means that the purchase of Treasuries and agency-MBS should have lowered yields on these securities. By way of this effect, some investors look to invest in other assets with similar duration and credit risk. The hope is that investors adjust their portfolio by, for example, turning away from the agency-MBS they sold to the Fed and towards longer-term corporate bonds, lowering the yields those assets as well (Bernanke, 2010). This eases financial market conditions. The implication for this type of unconventional monetary policy is that imperfect substitution motivates the Federal Reserve to buy assets in order to affect the long-term interest rates for a given short-rate path. Referring to the Equation 1, the portfolio balance effect would thus take effect in the term $YTP_t^n$ since it implies the investors differ in their behavior e.g. their preferred habitat.

The question of a portfolio balance effect has not solely emerged from the recent bond-buying program in the US. In fact, the well-known monetary economist James Tobin explains how the channel may have important means when a central bank faces the zero-bound. During the Great Depression, Tobin (1965) proposes that LSAP may have lowered yields and helped the US economy recover. By presenting illustrative models, Tobin (1969) show that changes in portfolio preferences occur and these preferences depend on factors such as expectations, risk attitudes and risk estimates. Although it is complex to measure the impact of such financial events, Tobin accentuates that as monetary policy can regulate the valuation of physical assets, thereby supporting portfolio preferences – asset demand functions – in respect to public, bank and other sectors. Friedman and Schwartz (1963) points out that as financial assets become more expensive due to open market operations, it creates an incentive for economic agents to invest in nonfinancial assets. As nonfinancial assets become relatively cheaper, investors re-adjust their desired portfolios – acquiring nonfinancial assets. As a result, existing
nonfinancial assets will tend to be expensive relative to new nonfinancial assets. Accompanied with this effect, since the prices of nonfinancial assets has increased due to increased demand, there is a rise in wealth relative to income. This wealth effect should make the direct purchase of current services cheaper, leading to increased demand curves for current productive services. Consequently, the monetary effect of financial markets has transferred to the market for goods and services as well. Other respected monetary economists such as Friedman (1974), Friedman & Schwartz (1982) and Brunner & Meltzer (1993) support the idea that investors’ re-allocation of their portfolios can cause macroeconomic changes in output, the price level or inflation.

Adopted from Joyce, Miles, Scott and Vayanos (2012), Figure 2 provides us with an overview in how the portfolio channel may affect the domestic economy. We are at this point interested in the top part of the figure.

In the case of the Federal Reserve purchasing treasuries from non-banks, most of the proceeds from the sale should show up in bank deposits. Considering money and treasuries being perfect substitutes at the zero lower bound, the conclusion would probably show no indication of investors rebalancing their portfolios – at least for the non-bank private sector. Portfolio rebalancing, however, implies that bank deposits and bonds are not perfect substitutes, at least not at the zero lower bound. Investors who sell treasuries to the Federal Reserve replace a long-dated asset with a short-dated asset (bank deposits). It follows that the investor may simply not believe the change in the portfolio to be a burden. This type of investor however, may be among the minorities. Institutional investors such as pension funds and
insurance firms have long-dated liabilities and would therefore prefer to rebalance their portfolios by evening these liabilities with other types of long-dated assets. As the Federal Reserve purchases long-term Treasuries, they reduce the stock of long-term assets in the private market. This may reduce the term premium for all long-term assets; which causes a rise in prices of long-term corporate bonds and equities. Higher bond and equity prices translates into reduced borrowing costs to access credit in financial markets. In turn, households are perceived to be wealthier due to capital gains of holding some of the assets. If a portion of that gained wealth is consumed by households or if firms invest extra from the funding hoisted on capital markets, demand (GDP) would increase. This mechanism stem from two important theories; the preferred habitat view and duration risk. The latter is occasionally referred to as a “duration channel”.

3.6.1 Term Structure of Interest Rates – The Preferred Habitat View

In studying the term structure of interest rates, Modigliani and Sutch (1966) presented the concept of the Preferred Habitat Theory, which rests on the view that investors differ in their distribution of endowments. The preferred habitat is a reflection of an investor’s preference for bonds with maturity similar to the timing of his endowments – a view of yield curve determination. This theory is thus line with the portfolio balance channel. If the channel is to have an effect on the real economy then different bond investors must prefer one maturity length to another. The required compensation can be interpreted as the risk premium of the term structure. It is the compensation of the risk premium which decides the motivation for an investor to leave the natural, or preferred, habitat. For example, bond investors would demand higher yields on long-term bonds as opposed to short-term bonds due to interest rate risk and maturity risk.

Considering the preferred habitat theory from a historical perspective, institutional investors such as pension funds has had a tendency to “hold to maturity”. Back when the pegging of bond yields ended in the early 1950’s, institutional investors adapted a different attitude to holding bonds as opposed to what banks did. During the 1950’s commercial banks had large holdings of long-term term bonds, however when they faced the need to reduce their bond holdings they were met with significant losses (Nelson, 2013). Due to the major losses, U.S. banks became more risk averse to hold long-term government bonds, thereby falling into a group of investors who perceived long-term bonds as risky (Lindow, 1963). Coming the end of the 1950’s a modernized pattern of investors could be observed. One type of investors would prefer to hold long-term bonds, whereas another group of investors would
rather not to hold such bonds. Milton Friedman, at the Hearings Before the Joint Economic Committee in 1959, supported this interpretation saying: “The people who hold assets, financial institutions, the public at large, and so on, have some preferences about the kind of assets they hold. Some people place a great deal of importance on holding Government-secured obligations that are absolutely certain”. Friedman and Schwartz (1982) further recognize this separation of investment decisions/categorization. They acknowledges that non-bank savings institutions, such as pension funds and insurance companies, are the ones holding most of the long-term bonds, preferably long-term fixed coupon securities. Findings of more recent nature suggest that both changes in the pool of investors over time and the compositions of investors matter to longer maturities. In terms of a changing pool, for example if a portion of preferred habitat investors decreases, short-rate shocks increase the impact on longer maturities. For example, if the composition of preferred habitat investors were constant, US pension funds would purchase more Treasuries compared to foreign banks, resulting in the demand factor would be expected to affect very long maturities. The reason is that pension funds favoring longer maturities than foreign central banks do (Kaminska, Vayanos & Zinna, 2011).

Despite having relevant practice and being suggested many decades ago, the preferred habitat theory is yet to enter the academic mainstream. Nevertheless, Riedel (1999, 2004) studied heterogeneous time preferences and interest rates, and shows the preferred habitat explaining humps in the yield curve, supporting the traditional habitat theory of Modigliani and Sutch (1966). He found that economic agents with a long habitat prefer longer bonds while the more “impatient” investors prefer shorter bonds to long ones. Vayanos and Vila (2009) develop a preferred habitat model of the term structure. It is argued that the model may address quantitative easing policies of central banks since it can capture supply and demand shocks, and short-rate expectations. Although the paper is mainly qualitative, the model itself has the ability to recognize underlying parameters such as risk aversion of arbitrageurs. The preferred habitat term structure is found to cause rich implications in bond risk premiums, demand shocks and short rate shocks expectations, the economic role of carry trade and transmission of monetary policy.

In relation to the development of Vayanos and Vila’s model there exists a so-called “duration channel”. Described by Bowdler and Radia (2012), this channel may have the potential in affecting asset prices by adjusting aggregate demand of interest risk in the bond market. The term duration stems from interest risk and can be linked to the extent of movements in the interest rate affecting the value of
bonds with fixed income. As a central bank purchases long-duration assets (such as medium to long-term government bonds) it reduces duration risk. Given the extent of reduced duration risk a natural maneuver for investors – assuming the preferred habitat theory – would be to seek other investments since the compensation for holding government bonds has now been relatively reduced compared to other types of assets.

Investors re-invest the proceeds from their sale of Treasuries into long-dated assets such as corporate bonds, in order to restore the duration in their portfolios. This could influence agents to invest in slightly more risky assets such as high quality bonds.

Other researchers who contributes to duration channel discussion includes Greenwood and Vayanos (2010) who present evidence based on U.S. data that the supply of bonds affects yields. Results that are broadly consistent, in regards to term structure models of U.S. data, can be found in other papers as well (e.g. Li & Wei, 2012; Krishnamurthy & Vissing-Jorgensen, 2012).

**3.6.2 The Irrelevance Proposition**

So far we have explained how imperfect substitutability is a key assumption for what we presented in the theoretical introduction as “View 1 – preferred habitat theory” – the portfolio balance effect. Now we shall shift over to the theoretical aspects of “View 2” which rests on the intuition of the irrelevance proposition.

Standard textbook theory building on frictionless markets and the absence of arbitrage absence suggest that central bank asset purchases should not affect asset prices or the broader economy, with all else held constant (Williams, 2014). Eggertsson and Woodford (2003) also discuss this argument by providing theoretical doubt as to how LSAP may stimulate economic activity at the zero bound. They demonstrate that quantitative easing would not have any effect in a world with limited financial frictions and where it is maintained a clear separation between monetary and fiscal policy, aside from that an effect is perhaps existent in that extra money creation can signal the central banks intentions in directing future values of the short-term interest rate.

As part of the theoretical discussion, it is useful to review the literature on Wallace Neutrality, also known as Wallace Irrelevance Proposition. Wallace Neutrality says that such effects of portfolio preferences would not occur. Wallace Neutrality rests upon a no arbitrage argument related to that of Modigliani and Miller (1958). It states that whenever a central bank aims to expand its balance sheet by
purchasing assets at the zero bound, it has no general equilibrium effect on interest rates, prices and non-financial economic activity (Wallace 1981). By using a property of economic models, Wallace (1981) suggests that the equilibrium of household consumption level and equilibrium price level stay unchanged.

### 3.6.3 Theoretical Arguments For and Against – a Matter of Assumptions?

New-Keynesian New Classical model provide an important theoretical grounding for the Federal Reserve and many other central banks when studying monetary policy. As emphasized by for example Walsh (2003) and Mankiw (2006), the class of these models is appealing because they are relatively simple and manageable, providing a clear and precise path in directing monetary policy. Indeed, such New-Keynesian models are a subject when the Fed analyzes monetary policy at the zero lower bound.

In such a model, influencing expectations should be the *single tool* in which policy makers may gain traction (Eggertsson & Woodford, 2003). The main argument for this result is due to the economy behaving as if there are only two assets at presence, modeled as money and bonds. Considering nominal interest rates being close or at zero, the marginal benefit and marginal cost are effectively zero. This implies that money and bonds become perfect substitutes. As such, economic agents view it as no different to hold bonds versus holding money.

In 2012, Michael Woodford published a non-technical discussion paper that raised eyebrows within the monetary economy discipline. In addition to supporting nominal level GDP targeting, Woodford (2012) goes far in questioning the effect of quantitative easing, including the effect of a possible portfolio balance channel. Woodford argues that one must only fulfill two assumptions in order for Wallace Neutrality to be present. The first assumption (I) is that assets are valued only for their pecuniary returns. That is, assets may be imperfect substitutes for an investor, but that is due to different risk characteristics the assets possess, *not for any other reason*. Assumption (II) holds that all investors may purchase arbitrary quantities of similar assets at similar market prices where there are no constraints as to the position an investor can take, other than his spending limit. If these two assumptions hold then, as Woodford indicates, the irrelevance of open-market operations is as noted by Wallace, a Modigliani-Miller result.

As argued by Eggertsson and Woodford (2003) in the context of a representative-household model, we can in more illustrative terms try to explain the argument for the portfolio balance channel’s lack of
presence. Consider the Fed purchasing some risky assets, such as MBS. When the Fed has made its asset purchase, the direct risk has indeed gone away from the investor selling the asset. However, it has simply switched hands, not vanished from the economy. It is now in the central bank’s earnings and, since the balance sheet of the central bank simply is a part of the total government balance sheet, it is the government’s income which is being reduced. To alter the reduced income, government must increase taxes on the private sector. The function of these increased taxes imply that the investor is just as reliant on his assets payoff as before the investor sold the asset, that is, the investor will seek to hedge the additional amount of taxes that comes along with a change in the central bank’s portfolio. Furthermore, the investor would prioritize his consumption stream – what he can afford depending on income. If assumption (II) above holds, then the investor will seek to purchase assets, which combined with payment streams will keep the consumption profile unchanged. The result of asset purchases by the central bank is thus ineffective due to an immediate offset by investors’ adjustments of portfolios.

3.6.4 Wallace Neutrality – Theoretical Status of Today

The irrelevance proposition suggested by Wallace (1981) has been criticized for being limited to a simple environment, which raises questions about the adoptability for a broader class of environments in which the proposition holds. Earlier analysis performed have often been considered to be of little practical relevance, since results of Wallace Neutrality is invalid due to government-issued currency being widely observed to be dominated in return. Various dimensions of the proposition have been explored by Peled (1985) and, Chamley and Polemarchakis (1984), however their results has been in an environment were money is not dominated as the rate of return in equilibrium. Sargent and Smith (1987) study how the irrelevance proposition functions in a context were currency can be dominated in the rate of return. The authors show that an irrelevance – to that of Wallace’s – of open market operations does exist. Also, as recognized by Eggertsson and Woodford (2004a), in the matter of unconventional monetary policy conducted at the zero bound, Wallace Neutrality is appropriate considering liquidity services presented by money balances at the margin have fallen to zero.

Ricardian Neutrality (used interchangeable with Ricardian Equivalence) is an economic theory characterized as a situation were an increase in government debt spending is accompanied with the public saving excess money to pay for a future tax increase due to a future tax raise. Since the public predicts future taxes by cause of government spending, aggregate demand will not be affected. No matter which way of government spending (debt or tax financing) is implemented the outcome will
stay unaffected. The theory originates from David Ricardo, but Robert Barro would later implement a more nuanced view and extensions of the basic proposition (e.g. Barro, 1988, 1996). Ricardian Neutrality is not crucial for this theoretical discussion. However, from a theoretical standpoint, the proposition may help us shed light on the discussion of Wallace neutrality and explain why such models are of importance. We can compare Ricardian Neutrality from a philosophy of science perspective to Wallace Neutrality’s philosophy of science perspective.

All studies rest on a theoretical framework, which are propositions/hypothesis that are intended for testing. As Kimball and DeLong (2012) specify, both Ricardian neutrality and Wallace neutrality can be categorized as “optimizing models”. Optimizing models include intelligent agents who seek to maximize best value. As such, optimizing models are argued to possess the ability to be the starting point for thinking how the world works. The authors believe that Wallace Neutrality has the same presence of baseline modeling status as Ricardian Neutrality. Suggesting that a model has baseline status is suggesting that a model should be a starting point in terms of how the real world works. One could therefore debate on how the real world differs from that of a theoretical standpoint. From an economic, historical perspective, when Robert Barro first reestablished the Ricardian neutrality as a model there was an immediate skepticism towards the proposition being an applicable description of actuality. Those in disbelief had great success in finding cogent reasons for why Ricardian neutrality might not hold in a more realistic model of the world – for example, it diverge from more popular theories provided by Keynesian economists. Until this day, however, there is indeed a minority of economists who consider the proposition to represent an accurate description of the real world.

In terms of theoretical status, the two theories differ since we are currently in the progress of putting together models that aim to show how the world deviates from Wallace Neutrality. 25 years ago, studying explanations for why Ricardian Neutrality might not obey were frontier research, presenting theoretical reasons for why Wallace Neutrality might not obey is frontier research now (Kimball, 2012).

Curdia and Woodford (2011) analyze the impact of LSAP on what they separate as credit easing (purchases of privately held issues) and quantitative easing (purchases of government bonds). They found that, under the assumption that central bank money and government bonds are perfect substitutes, credit easing had a welfare improvement in the perspective of financial market disturbances, but quantitative easing did not have an effect what so ever. Because of the assumption of
perfect substitutes however, either of them has by definition an effect on asset prices and yields. However, the paper analyses the bond purchase program by the BOJ, which is argued by Bernanke (2009b) to be mechanically different from the one of the Fed.

Models constructed by those of Curdia and Woodford (2011) or Gertler and Karadi (2011, 2013) consider asset purchases by the central bank which for many investors are difficult to purchase directly. The reason is that only some specialized intermediaries have the knowledge required to evaluate them. The model formulated by Araújo, Schommer and Woodford (2015) involves all traders being able to invest in the same set of assets, and can therefore be argued as more efficient for financial markets. Studying how collateral constraints matter for both conventional and unconventional monetary policy is, as argued, interesting since the recent financial crisis was accompanied with sharp increases in collateral requirements. The authors impose collateral constraints under two assumptions. (1) Financial markets are not frictionless, which is argued to have important consequences for unconventional policy. (2) Similar to Geanakoplos (1997) and, Araújo, Páscoa, and Torres-Martínez (2002) it is assumed that all privately issued financial claims must be collateralized. Further, the constraints are dependent on the amount of collateral agents must maintain to back privately issued assets. It is found that the allowance of collateral constraints is critical to the outcome of changes in the central banks’ balance sheet. The effect is determined by the degree in which way and how the collateral constraints bind in equilibrium. In the case of constraints being non-binding (abundant for no households), asset purchases are found to be irrelevant for financial assets, prices of goods and services nor the allocation of resources. Consequently, a form of Wallace neutrality can be observed. In the case of binding collateral constraints, the outcome is dependent upon the particular way in which they bind – depending on the investors’ situation. For example, under some circumstances, the central banks’ purchase of risky assets backed by collateral, such as agency MBS, it will relax private borrowers constraints. Yet, it can generally be observed that when the central bank purchases a large fraction of the total supply of the collateral good it tightens the constraint.

Bernanke, Reinhart and Sack (2004) argue that the assumptions of frictionless financial markets and difference in fiscal and monetary policy are quite strong/unrealistic. If these assumptions do not hold, quantitative easing may have some basis in being effective. For the portfolio balance channel to have an effect, the assumptions discussed by Woodford (2012) must be modified. As discussed in the previous section, earlier work from (Tobin, 1961, 1963, 1969; Brunner and Meltzer, 1973, 1993),
emphasizes that a central bank may alter the demand of debt securities’ yield indirectly through purchasing them. If this effect is to take place, credit restrictions and heterogeneity across investors must be in force, thus contradicting to the assumptions of Woodford (2012). In response to the skepticism from Woodford, Gagnon (2012) notes that the debate on the portfolio balance channel matters because it provides the Fed with a tool when the interest rates are fall close to zero. It is argued that requirements regarding fully informed, forward-looking and rational agents should be a third factor given Woodfords (two) assumptions; a requirement which are clearly violated in the real world. In terms of assumption (II) – all investors can purchase arbitrary quantities of similar assets at similar market prices where there are no constraints as to the position an investor can take, other than his spending limit – Gagnon is contend that a violation exits. Since the assumption requires an unlimited ability for private investors to take short positions in the market were the Fed is buying assets, private agents seeking to take such positions are argued to face considerable collateral requirements and pay substantial higher interest rates than the Treasury. Further, Woodford has recognized that some of the empirical evidence supporting a portfolio balance effect shows that economic agents are fully informed and rational. Gagnon on the other hand, argues that having the capability to respond to the Fed announcing LSAP is far more straightforward than being able to anticipate the purchases implications for the investor’s taxes and transfers in the distant future. Yet the case against a portfolio balance effect requires economic agents to attain that exact knowledge (Gagnon, 2012).

3.7 Signaling channel
Expectations about future monetary policy is affecting the shape of the yield curve. FOMC statements, for example, may signal to investors that the Fed has changed its view on present and prospective economic conditions. They may also give information about adjustments in monetary policy reaction functions or policy objectives, such as the target inflation. Such statements would alter the yields by lowering or rising the average expected short-rate component of the long-term interest rates and affecting the so-called risk-neutral component of interest rates. QE announcements would lower expectations component of long-term yields (Bauer & Rudebusch, 2014). Other news releases, such as job reports, that gives indications of where the economic outlook and the likely path of upcoming FOMC policy decisions may also very well have an effect on the yield curve.
For central banks, signaling is an available tool used during times of both conventional and unconventional monetary policy. The two main alternatives for signaling used by the Fed at the zero lower bound are forward guidance and balance sheet policies.

3.7.1 Forward Guidance

Forward guidance are explicit statements about the future economic outlook and future policy, in addition to what policy action that the central bank will be implementing in the present time. Woodford (2012), Eggertsson and Woodford (2003) and Krugman (1998) among others, argue that the most effective form for forward guidance, at the zero lower bound, involves advance commitment to definite criteria for the future policy decisions. At the zero bound, the central bank obviously cannot lower the policy rate any further, but they can communicate how the policy rate is likely to be set in the future. Hence, it is crucial that the central bank make their intentions clear and provide explicit guidance when they want to change investor’s expectations about future policies, especially when conducting unconventional monetary policy (Bernanke, Reinhart & Sack 2004; Eggertsson & Woodford 2003; Woodford, 2012; Bernanke 2010a). In cases where the central bank want investors’ expectations to depart from what have happened in the past, the central bank must convince the investor’s that the current policy will behave differently than it previously has done. This entails a promise to overshoot the inflation target in the future in order to dodge a greater undershooting of the inflation target today (Woodford 2012, Krugman 1998). Also providing forward guidance facilitates commitment. The future policy that the central bank wants the investors to expect is of a nature that the central bank will not have a motive to implement later if the central bank were to make its decision then in a purely forward looking way, based on the central banks’ objectives, such as the Feds dual mandate (Krugman 1998; Eggertsson & Woodford 2003; Woodford 2012). This can be achieved in practice by publicly stating the commitment in such a manner that it becomes embarrassing for the central bank to ignore the commitment at a later point in time. Previously it has been tempting for central banks to provide forecasts of implementing a likely future policy with the intention to affect financial conditions without really making any commitments to any future policy. For example, the Fed releases anonymous forecasts from its board members four times a year. However, it is assumed that such tools hold little credibility amongst investors and consequently has little effect in interest rates (Woodford, 2012). The real potential of forward guidance is grounded in the credibility that the central bank holds amongst the
public. Thus, central banks are arguably anchored to their commitments as departing from former expectations could possibly ruin their credibility and in turn forward guidance as a policy tool.

The Fed and other central banks has shown a higher willingness to provide forward guidance in their statements at the zero lower bound than during conventional times, where statements have been far less transparent. QE1 statements (March 2009 – June 2011) for example, described the economic conditions as “likely to warrant exceptionally low levels of the federal funds rate for an extended period” and the FOMC made the guidance even more explicit in August 2011 when the statement stated that the federal funds rate would remain exceptionally low "at least through mid-2013" (Bernanke, 2012). Such phrasing may have been a strong signal about the extensiveness of the economic downturn and that the QE policy would take place for a longer period.

### 3.7.2 Signaling of Balance Sheet Policies

Balance-sheet policies, which is a reference to altering the size or composition of the central bank`s balance sheet. Altering the size refers to purchasing assets with new money. Altering the average maturity of its balance sheet is done by selling of bonds short-term bond and purchasing long-term bonds with the proceeds. Asset purchases, in the light of signaling effects, are proposed as measures that can usefully support a central bank’s forward guidance, by allowing it to take concrete actions that may be viewed as underlining its intentions with regard to future interest-rate policy – instead of relying purely upon speech.

Woodford (2012), who is not by any means an advocate of portfolio-balance effects, is opposed to the idea that balance sheet policies can be used as a substitute for forward guidance. He argues that if it is to have any effect it must be as a reinforcement to the central banks view on the economic state and to future policy commitment (Woodford 2012; Eggertsson & Woodford 2003).

Although asset purchases could potentially offer an additional dimension of policy to forward guidance, Woodford (2012) addresses some concerns towards the extent of its use. In an interview discussing his 2012 paper with the vice president in the Research division at the Reserve Bank of St. Louis, David Andolfatto, Woodford states that although outright asset purchases may have some positive effects, that does not mean that purchasing even more assets can only necessarily be better. In his 2010 Jackson Hole speech, Bernanke discusses potential costs of QE where he, inter alia, discusses the case where additional asset purchases could reduce investors` confidence in the Feds ability to exit
smoothly from QE at the appropriate time”. A confidence loss in the expectations about the future could increase the risk of costly decreases in inflation expectations and a following increase in financial and economic instability.

### 3.8 Liquidity Channel

Liquidity can be defined as how a security performs in a “bad market” (Acharya and Pedersen, 2005). Investors will demand a liquidity premium on assets that cannot easily be converted into cash. In times of financial market stress, investors may demand a higher liquidity premium on securities as compensation for taking on the risk due to the potential absence of buyers at a given time. Quantitative easing increase the liquidity in the bond market and thus should lower the liquidity premium on bond prices. In turn, this should lead to higher yields on liquid assets, relative to less liquid assets. However, the effect is only likely to be present during the purchasing period. In addition, the Treasury markets are in general considered to be vastly liquid so the effects are expected to be minor in QE (Joyce et al, 2011, Bowdler & Amar, 2012). Due to its temporary nature and the liquidity of government bond markets, the liquidity channel is assumed not to be a significant driving force for the Feds motive with QE, nor has it received a lot of attention in the QE research available to this date. Spillover effects to untargeted security markets could also arguably be absent as the markets know that these markets will not be targeted by the Fed. Yet, it is plausible that there should be some spillover if investors rebalance their portfolios; however, researchers have failed to significantly quantify such effects (Christensen & Gillan, 2014).

The liquidity channel is expected to be more efficient when purchasing private assets (which the Fed is not allowed to purchase). BOE, for example, authorized purchases up to £50 billion in private sectors assets, corporate bonds and commercial paper in January 2009. Purchases were funded through expanding the BOE balance sheet, when used as a monetary policy tool (Bank of England, 2015). The purpose of the Funds operations was to improve liquidity in the dysfunctional credit market. Joyce et al (2010) suggest that the liquidity premium for corporate bonds fell following the introduction of the APF corporate bond purchases. Following the announcement of the purchases, bond spread was nearly cut in half over the subsequent year (Fisher, 2010). It is off course hard to untangle the reduction in the liquidity premium from other factors such as improvements in the global financial markets, but it is widely recognized that the bond market was suffering from a substantial liquidity premium. This
argument was further strengthened through reduced bid-offer spreads and a contraction in the CDS-bond basis. The latter can directly be interpreted as a measure of liquidity premium (Fisher, 2010).

3.9 Confidence Channel
Besides the channels that we have described, quantitative easing may also influence inflation and economic growth through confidence channels, which again, may be topic of a widespread or “spillover” effect towards other channels discussed. There certainly is a broad belief amongst economists, policy makers and influential news members that confidence of agents in the economy play an essential role in the transmission of monetary policy\textsuperscript{10}. In its essence, the confidence channel of quantitative easing should aim to aspire confidence and keep inflation expectations from falling further. Agents’ confidence is subject through the Fed’s operations and announcements that may deliver the earlier discussed signaling effect. An improved economic outlook may increase consumer and business confidence, thereby encouraging spending and investments directly. Additionally, the confidence channel may reduce asset prices by reducing risk premium (Hausken & Ncube, 2013).

3.9.1 Confidence in Markets
The strong correlation between the confidence of agents and domestic demand is widely supported by data. Further, the confidence channel is considered to be closely linked with macroeconomic cycles (e.g. Fei, 2011). Considering LSAP announcements however, the difficulty monetary policy agent’s encounter in the channel is known to be a challenge. For example, what distinguishes the confidence channel from the signaling channel? Fratzscher et al. (2013) points out that signaling refers to the future path of interest rates whereas confidence provides information regarding the state of the economy. Confidence of economic agents may effect portfolio decisions and asset prices by shifting the risk perception of investors. Essentially, information from the confidence channel may very well be fundamentally different from the one of signaling. Agents and markets may interpret LSAP announcements by the Federal Reserve as an indicator that economic conditions are worse than what was previously expected. The result would drive down all asset prices and make agents prey for a safe haven (Neely, 2011). On the other hand, the result of an LSAP announcement may be perceived positively in the market, leading to net inflows into all US assets due to markets anticipating an improved state of the US economy\textsuperscript{11}. These two opposite market interpretations exemplifies the

\textsuperscript{10} Bachmann and Sims (2011) provide a range of sampling quotes from economists and policy-makers to illustrate this case.

\textsuperscript{11} See Joyce et al. (2010) and Wright (2011) for a discussion in LSAP announcement leading to such positive effects.
challenge in deriving a clear consensus as to how this channel should be implied for assets and portfolio decisions.

If there is a mutual understanding between economic agents and a central bank, then confidence exists. When discussing monetary policy at the zero lower bound, Blinder (1999) sums up credibility of monetary policy by noting: “A central bank is credible if people believe it will do what is says”. According to Montes (2009), credibility may be associated with the degree of confidence the general public hold towards a central bank’s capability and determination to keep up on announced goals and achieve them. Although both creditability and reputation may increase agents’ expectations in a positive way, they should be regarded as more distant concepts since reputation is linked to the public’s acceptance of the policymaker and anticipations formed by the public concerning actions monetary authorities will take. Applicable to the interaction between LSAP, the Federal Reserve and market confidence is the framework of the confidence strategy. The simplified chain CCC consists of: Communication-Common Understanding-Confidence. Figure 3 represents the confidence strategy in New Keynesian economics. The CCC framework is not simply entrenched within the economic discipline, but also features political aspects such as the dual mandate role of the Federal Reserve.

![Figure 3: The Confidence Strategy. Source: Wray and Forstater (2006)](image)

It should be noted that it is not the intention of this thesis to per say analyze the part of “elected representatives” in the figure, for example. Rather, the CCC illustrates all the different factors and challenges that should be taken into account when assessing the confidence channel. What is of higher
importance however, is interactional learning and common understanding. Thus, we are mainly interested in the lower part of the triangle in figure 3.

Opinions matter because they are shared. Shared information may build or decrease confidence levels. Quantitative easing – being regarded as a rather new monetary policy tool – is often associated with a lot of skepticism and uncertainty and (see Appendix for a range of quotes), has therefore the potential to suffer from communication barriers such as complexity (of QE operations), obscure assumptions or even semantic barriers. In such a case, many would argue that transparency and openness of central banks is key. In discussing communication and monetary policy efficiency, Wray and Forstater (2006) note that in “monetarist central banking”, bank efficiency place confidence in constructive ambiguity; never explain, never excuse. Although it can be argued that ambiguity or “vagueness” has not entirely departed, openness is today regarded as a requisite for monetary policy. Indeed, the Fed has over the last decades demonstrated more openness. For example, in a speech before the American Economic Association, Bernanke (2004) refers to “Fedspeak” as a way of communicating clearly and extensively about Fed actions to the general public. In addition, referring to the complexity of QE, common understanding – mutual comprehension of the economic environment – between agents and policy should not be neglected.

Using a standard VAR analysis, Debes, Garies, Mayer and Ruth (2014) finds that a confidence channel exists in the transmission of monetary policy of monetary shocks. It is found that during times of monetary tightening the confidence of household’s drops significantly. The findings suggest that the quantitative importance of the confidence channel is triggered by a change in the Federal funds rate. Also, the direction of monetary policy is found to make up for a relevant part of variances in consumer confidence. Likewise, Beaudry, Dupaigne and Portier (2008) applies VAR models to show that news shocks regarding better productivity has a positive effect on not only the US domestic economy, but also for their neighboring country Canada. Jannsen, Potjagailo and Wolters (2014) study the effects of monetary policy by comparing episodes of non-crisis nature to those of financial crisis. In studying the transmission mechanism, the authors find evidence to support the importance of the confidence channel. Market confidence has a higher response to monetary shocks during the recession stage of a financial crisis than both expansionary policy during a financial crisis and expansionary policy during non-crisis.
3.10 Bank Lending Channel

In turbulent economic conditions the bank-lending channel may be weak as banks are concerned with refinancing themselves, which decreases their ability and likelihood to grant loans. Nevertheless, we find it useful to consider this channel since banks play a central role in the transmission mechanism by supplying available funds for borrowers in the financial market. As borrowers get access to available funding, credit conditions in financial markets may ease during times of financial distress. Indeed, it is widely recognized that financial intermediaries play an important role in both monetary policy transmission and liquidity policies (see, e.g. Adrian & Shin, 2008, 2009; Mishkin, 2009). As noted by Berger, Molyneux and Wilson (2015), the transmission mechanism of bank lending operate through the balance sheets of banks, namely shifts in liabilities and assets. In the case of contractionary monetary policies, banks may experience a reduction in available bank reserves. Since banks are forced to create fewer reservable deposits, they would typically find themselves in a situation were they either replace the lost reservable deposits with non-reservable liabilities or they would reduce their assets. This would be in the form of, for example, loans and securities to maintain total amount of assets at the level of the reduced amount of liabilities. A combination of these responses is usually observed. The outcome is, given that banks are unable or unwilling to wholly insulate their loan portfolio, a fall in the accessibility of loans, which would slow down aggregate demand.

Over the years, various forms of the bank-lending channel have been presented. As first expressed by Bernanke and Blinder (1988), the direct impact from monetary policy on how bank deposits act under the transmission channel is a fundamental proposition in central bank research. By deposits we refer to the degree of supply of loanable funds in the market, driven by the force of bank lending. When considering this deposit perspective, contractionary monetary policy will lead to a drop in deposits and banks will cut back on their lending – given they experience frictions in issuing uninsured liabilities to substitute the shortage of deposits. Kashyap and Stein (1995) make the same argument. They find empirical results supporting the view that lending behavior from banks changes as monetary policy tightens. Disyatat (2010) however, finds this form of the bank-lending channel misplaced. Rather, loans are argued to drive deposits – suggesting that the process works in reverse. The alternative mechanism in which bank lending works is based on the underlying premise that variances in health of financial intermediaries’ leverage and quality of assets and, perception of risk is more important as the cause of monetary shocks. The level of deposits is de-emphasized since the focal point rests on frictions that address financial intermediaries themselves. Another alternative presentation of the bank lending view
is a study by Peek and Rosengren (1995) who points out that capital constraints determines how a bank reacts to monetary policy induced expansion of deposits. A bank experiencing capital constraint will offset a higher quantity of deposits in order for the size of the balance sheet not to increase and not violate the maximum leverage ratio; having no effect on lending supply. In a situation where monetary policy is loosened; a bank which is unconstrained will allow total deposits to rise. This enlargement of the balance sheet results in increased loan supply. In the discussion of central bank asset purchases, Gertler and Karadi (2013) focus on balance sheet constraints of financial intermediaries as one of the key justifications for unconventional policy. Central bank asset purchases can be understood as a specific type of financial intermediation, which may improve the private sectors access to credit during times of financial distress when private balance sheet constraints tightens. In such a case, central banks have the ability to obtain funding more elastically than private banks. This ability can lead to reduced costs of credit and prevent aggregate demand from degrading.

In a simplified setting were money, government bonds and bank loans are the only considered assets, three conditions for the bank-lending channel must be effective if the transmission mechanism is to hold. The first condition is that money must not be neutral in the short run. That is, a change in money supply must not result in an instant change in prices. Second, open market operations must influence the supply of bank loans. Third, as a source of credit, money and bonds cannot be perfect substitutes at least for some borrowers – also discussed as a requirement for a portfolio rebalancing effect. It should be noted that the set of assets can be expanded and include privately issued bonds and non-bank intermediated loans as well.

Bank lending – related to the credit channel – is often connected within the theory of non-neoclassical channels. And, as in non-neoclassical channels, imperfect markets are assumed. It follows that asymmetric information and credit market frictions is critical as to how individual banks react to their liability side of the balance sheet. If monetary policy tightens, banks usually use uninsured non-reserve liabilities as their marginal source of funding. The ease of raising uninsured non-reserve liabilities, such as large time deposits, differs from bank to bank. It is thus expected that larger, relatively healthier bank with higher degree of transparency has an easier task of raising external, uninsured funds, and would therefore use a higher proportion of external finance to cover their liabilities, resulting in a smaller shrinkage of their assets. This is supported by Holod and Peek (2007), who separated the loan portfolios of publicly traded banks and non-publicly traded banks to determine if there was a difference.
in banks’ ability to raise external funds. It was found that the loan portfolios of public traded banks shrink less than non-publicly traded banks in times of contractionary monetary policy.

Imperfect markets also determine the role in which firms perceive bonds and non-bank intermediary loans to be perfect substitutes for bank loans. Given a tight monetary policy and, in a case when non-bank sources is considered perfect substitutes for bank loans, borrowers will tend to substitute non-bank credit sources for bank loans. As a result, one would see no effect on aggregate demand arising from the reduction in bank credit. However, there may not be such perfect substitutes for bank loans from some borrowers. One example would be insurance companies who are operating in the commercial real estate market and are important suppliers in term financing that permits them to better balance the maturities of their assets and liabilities (Berger et. al, 2015).

3.10.1 Bank Lending in a QE perspective

Considering the bottom part of figure 2 (page 28), we can observe how the portfolio rebalancing channel and bank lending channel interact. Due to asset purchasing by the Federal Reserve broadly replacing long-term assets with liquid money, the commercial banks’ potential for refinancing and thus its ability to offer credit is improved. This channel tends to be more efficient under two circumstances: (1) As an economy faces a crisis, when banks face a shortage of liquidity and money markets are performing in a poor manner. (2) In the situation of large-scale asset purchases, there is a longer debt maturity structure in which banks receive from the Fed. That is, the bank has been financed with more long term than short-term debt; otherwise, there would be a likelihood of banks to hoard liquidity rather than extending new loans – the reason being to guard against sudden withdrawals of short-term funds (König, Bernoth & Raab, 2015). Described by Joyce et al (2012a), the channel might improve the availability of credit, however, considering the second circumstance discussed above, banks who are concerned in regards to their ability to refinance themselves are less likely to issue loans. The channel could be weak when funding from central banks asset purchases come to banks as very short-term wholesale deposits. In such a scenario, banks may seek to increase its liquid holdings in reserve balances at the central bank. Banks would act in such a way to insure against risk of these deposits being withdrawn in a relatively short period. On the other hand, if the money that flows in to the bank – by cause of asset purchases – are of longer-term funds (such as bonds) it could give rise to an increased, or at least avoided contraction of bank lending in the market.
If we describe the bank-lending channel along the lines to that of Kashyap and Stein (1995), a key factor for such a type of bank lending follows that market funding is undesirable compared to deposits. Deposits are regarded as a cheaper source of funding whereas market funding for banks is assumed to become more expensive as more is issued. According to Butt, Churm & McMahon (2015) in order to understand how the bank lending channel might be affected in the case of quantitative easing, the common myth that QE involves merely injecting reserves directly into banks should be dispelled. The reality however, should involve a central bank opting to buy assets from non-banks in order for the channel to be an effective part of the transmission mechanism. Central banks should aim purchase medium to long-term assets from non-banks, also known as Other Financial Corporations (OFC) such as pension funds and insurance companies, however the transaction should take place via banks that are eligible to transact in the Federal Reserve’s quantitative easing operations. Figure 4 represents a balance sheet of a buyer of assets (Federal Reserve), the conduit of the transaction (banks) and seller of the assets (OFC’s). As OFC’s sell their bonds, the deposits grow on the bank they transact though. On the liability side of the balance sheet, the central bank creates reserves which are used to acquire bonds from the commercial bank and credit their account with reserves. As QE increase the amount of deposits, commercial banks and other financial intermediaries may consider this source of funding (deposits) as more suitable than other sources.

Figure 4. Source: Adopted from Butt, Churm & McMahon (2015)
As noted by for example Joyce et al. (2011) and Bowdler and Radia (2012) however, when the Federal Reserve engaged in QE the American economy was in a state far from normal. The strains in the financial system at the time had seen brighter times, resulting in banks facing pressure in reducing their balance sheets. Subsequently, the Fed turned their attention towards the next subject, namely ways in which the costs of borrowing and cost of capital may be reduced besides the one of the banking sector.

3.11 From Asset Prices to Nominal Spending

3.11.1 Cost of Borrowing

Although we up until this point have presented an important grounding for LSAP by looking at how asset purchases may lower asset prices, implications on whether the purchases have lowered various borrowing rates is a natural aspect of the effectiveness. Ultimately, private borrowing rates are the most relevant interest rates for transmission monetary policy (Bauer & Rudebusch, 2014). Cost of borrowing and wealth effects generated by LSAP can potentially boost the spending of businesses and households, achieve desired inflation target, stimulate economic growth and reduce the unemployment rate (Hausken & Ncube, 2013).

Assuming the transmission channels previously presented in figure 1 effectively have adjusted asset prices, it will have implications for interest rates (Bernanke & Reinhart, 2004). The interest rate is the cost of borrowing. Cheaper borrowing should make it more attractive for the public to borrow and spend and, businesses would increase their investments. Savings will be less attractive because of their low return, thus increasing the likelihood of spending. As the Fed buy assets, we know they are trying to influence the supply and demand for these assets in financial markets. By purchasing a particular asset like a MBS, the Fed creates demand, which ultimately raises the price of the MBS. Since the Fed has acquired the MBS’, it has also reduced supply of the asset available to the public, which raises the price and ultimately decline their yields. Mortgage rates and corporate bond yields decrease as investors take the proceeds made from the sale of the MBS to the Fed and look elsewhere for more lucrative investments, hence portfolio rebalancing and expectations. In such a way, quantitative easing has pushed down a broad range of borrowing rates in the economy (Williams, 2012).

If the cost of borrowing is lowered; are the effects efficiently distributed across the board? In the case of portfolio balancing effects, reduced borrowing costs through corporate bonds would be directed towards larger businesses with access to capital markets. Thus, we can expect smaller businesses and households not to be directly affected through the portfolio rebalance channel, since such markets are
not subject to smaller firms and households. Smaller firms however could be exposed to so-called supply-chain effects. Smaller companies who do frequent business within the supply chain of larger companies will profit by increased demand or improved trade credit. Perhaps the most obvious inference in the case of decreased bond yields belong to the government, who will experience lower cost of borrowing. This would also be the case in conventional monetary policy, where a lowering short-term interest rate reduces the cost at which the government can borrow. As opposed to businesses and households, who in theory would increase their spending, governments act differently by taking a long-term view. Therefore, the spending should be unaffected by cyclical changes in interest rates (Bowdler & Radia, 2012).

3.11.2 Wealth effects

In explaining the basic accounting reasoning of QE we emphasized that asset purchases changes the composition of assets held by the private sector going from bonds to bank deposits or bank reserves. We can consider the purchases as an asset swap that will adjust the composition of private held assets, not add to any net financial assets. Leaving the perception aspect of wealth aside, the transfer from bonds to bank deposits by itself would in theory not make an economic agent “wealthier”, it would simply mean that the agent now holds more liquid “money”. As a result there is no net worth increase within the private sector. If such is the case why should there potentially be any wealth effects?

Asset purchases by the Fed reduces the relative supply of bonds in the market, which may reduce interest rates via increasing the demand for other types of bonds. By way of this, prices can increase and a wealth effect may occur. In turn, this should lead to increased spending and nominal demand since higher asset prices have increased the wealth of asset holders. Roche (2014) notes however, that even though asset purchases can drive up prices, it does not necessarily drive up fundamentals. We explain this in the light of a corporation buying its own stock, which is not very different. Although the stock price will immediately increase, it will not alter an effect for the underlying corporation. Any wealth effect resulting from quantitative easing is driven by other confirming effects that must be in place for the price to increase. For this reason one could say that, the wealth effect “puts the chart before the horse”. When a company buys its own stock it effectively reduces the supply of outstanding stocks, but that does not imply higher future stock prices. For the stock price to increase in the future the company must prove itself a worthy stock by influencing investor expectations via development of business operations. Hence, wealth effects are depended on more than simply the supply of assets.
In all conventional monetary policy, a shift in the Federal Funds rate leads to differences in some part of the public gain and some loose. The monetary policy of QE does not have different implications to savers and spenders. That is, differences in the distribution of wealth effects due to asset purchases will, like unconventional policy, be unequal to a given degree.

4. Analysis of the strength of the Feds quantitative easing

4.1 Bank Lending: Discussing QE, expansion of the monetary base and the bank lending channel

Earlier we noted that in the wake of a crisis, the bank-lending channel is likely to be ineffective due to the financial distress in the system. As we can see from Graph A, there is more or less a relationship between the deposits and loans and leases from commercial banks in the U.S. before QE was introduced. However, as QE1 was adopted, loans decreased while deposits still increased, signifying a vibrant divide in the relationship between the two.

Graph A: Deposits and, Loans and Leases of All Commercial Banks Source: Board of Governors of the Federal Reserve System

Graph B below further illustrates the rather odd divergence of the relationship as QE1 began, by providing us with the loan-to-deposit ratio of the two parameters. Clearly, since the onset of the financial crisis the total bank lending from commercial banks has decreased.
Graph B: Loan-to-Deposit Ratio of U.S commercial banks Source: Board of Governors of the Federal Reserve System

The relationship provided in graph A and B is by no means any secret as to quantitative easing having virtually no effect on the bank-lending channel. In explaining this phenomenon, describing a simple economy may help us see why such bank lending effects would not occur. A market with a restricted amount of agents with access to one marketplace (or auction house) should illustrate a rather simple economy. The marketplace is responsible for trading/bartering commodities for commodities, with price being determined by supply and demand. Let us assume that due to a change in trade barriers agents now had access to massive amounts of oil. Because of the decreased barriers to trade, prices of other commodities increased considerably relative to trading oil. The trading of tea, which was traded for about 1 million oil barrels previous to the episode, has gone up to 5 million. Although simplified, such an illustration can exemplify how liberal printing of money to finance deficit can lead to hyperinflation\(^{12}\). The effects of increasing the monetary base can be referenced back to monetarisms foundations, specifically Irving Fishers principles of money and prices (Fisher & Brown, 1914). As one of America’s greatest mathematical economists of all time, Fisher presented the quantity theory of money. The theory offers a powerful tool in reviewing how we think about an economy. For this reason Fisher’s equation shall be our basis when discussing the myth in relating QE to the expansion of the monetary base and the bank-lending channel. The equation of exchange can be identified as follows:

\[ \text{Money supply} \times \text{velocity of money} = \text{total expenditure} \]

\(^{12}\) Zimbabwe is an example of a country that has suffered from hyperinflation in recent times. As QE 1 was launched, critics feared hyperinflation in the US as well. After hyperinflation occurred as the government decided to print money to pay of its debts in 2008, Zimbabwe is now in the struggle of fighting deflation (Bloomberg, 2015).
\[ MV = PQ \]  

**Where:**

- \( M \) = the total nominal money supply in circulation
- \( V \) = velocity of money, the frequency of money circulating in the economy
- \( P \) = the average price level
- \( Q \) = an index of real expenditure of newly produced goods and services

Therefore, the amount of money in the economy multiplied by the velocity of circulation should be equal to the level of nominal expenditure (PQ) in an economy. By holding \( V \) (velocity of money) and \( Q \) (quantity of goods and services produced) constant, an increase in \( M \) (money supply) will lead to a proportionally increase in \( P \) (price level). If banks are ineffective due to liquidity constraints under a financial crisis then the Fed can purchase assets from banks which would flood them with liquidity. In the light of this matter, we can ask: If the Federal Reserve is in the process of printing money to increase holdings of securities, should we then see a rise in inflation? Keeping in mind the quantity theory of money, we should see an increase in the monetary base proportionate to the increase in the price level. Graph 4 however, shows no such relationship. The Consumer Price Index (CPI) has been held at the same level since the onset of the crisis whereas the monetary base has increased considerably since the QE programs started. The relationship between CPI and the monetary base is however more clear in the years before the initiation of QE 1 (Graph 5)

![Graph 4: CPI and Monetary Base relationship from Jan 2007 to Sept 2015 Source: Board of Governors of the Federal Reserve System (2015d,e)](image-url)
The occurrence of the relationship/non-relationship in graph 4 and 5 above does not necessarily mean that Fisher’s equation of exchange is validated. QE is certainly an unconventional type of policy with different features than that of conventional policy, but Fisher’s equation is of the nature that it holds in all situations, meaning that assumptions should be adjusted accordingly. One of the most respected economists of the century and believer in monetarism, John Maynard Keynes, challenged the assumption that velocity of money stay constant. In questioning how economic agents allocate their money, he argued that not only is money used as a trade for goods and services, but also used as store of value. If the agent use money as a store of value or not, is dependent upon the interest rate. As such, opportunity costs arise since money can be invested in assets. Higher interest may be found in assets (dependent upon the interest rate) than in holding cash – known as the liquidity preference theory. Due to the zero lower bound, the window of opportunity cost naturally decreases. The connection between the liquidity preference theory and QE is that commercial banks and other depository institutions are bound to hold money as a store of value. After selling bonds to the Fed, banks primarily stuff their cash reserves and the proceeds they make never enter the economy. In the new Fisher equation below, $M_1V_1$ demonstrates the new money created by QE.
MV + M₁V₁=PQ  

[Equation 4]

Thus, given that the new money sits in the bank, M₁V₁=0, meaning that the velocity is zero. Thereby there should be no change in PQ. This is also evident, as banks do not lend out their reserves to the public. Further, banks are in the business of making profits; hence risk is a natural component. Lending is also a function of creditworthy borrowers. Therefore, increased supply of loanable funds does not automatically mean that more loans will be granted.

To further explain this occurrence we must separate between M0 and M2. It should be noted that that even though the monetary base spiked during the whole QE period the system hinders hyperinflation due to the fractional reserve banking system. More than the amount of coins, paper money and bank deposits affects money supply. Through the fractional reserve banking system, banks and other depository institutions act as financial intermediaries between borrowers and savers. Banks are thus in the business of generating loans from their existing deposits – known as the money multiplier effect. While M0 consists of highly liquid money that can easily be converted into currency and is often the type of money supply that most think of, M2 represents a more interesting feature since it includes fractional reserve banking and credit. In Graph 6 we observe that M2 money supply was rather stable during the period of QE.

Graph 6: M2 Money Stock. Source: Board of Governors of the Federal Reserve System (2015e)
If the M0 (see Graph 7) spike was not a result of the money multiplier through the credit system, it must have gone somewhere. The difference between M0 and M2 further supports the hording of money banks and depository institutions undertook in order to fill up their own balance sheets.

Graph 7: Money stock M0. Source: Federal Reserve Bank of St. Louis (2015f)

The bottom line is that while we saw a sudden increase in M0 because of QE, the financial sector has essentially retained this spike, as M2 remained quite stable. This is not a very surprising outcome considering that banks still had bad loans and toxic assets on their balance sheets both under and after the crisis

4.2 US Treasury bonds
To measure the individual transmission channels effect on yields is not an easy task. Most of the acclaimed studies that estimate the term premium component including Bauer and Rudebusch (2014), Krishnamurthy and Vissing-Jorgensen (2011), Gagnon, Raskin, Remache and Sack (2011) and, Campbell et al. (2012) are using a dynamic term structure model. The model divides the yield on long-term interest rates into the term premium component and the expected future short rates component.

These models have been proven difficult to estimate. They often suffer from sample size biases, large statistical uncertainty, which in turn make their estimates of risk neutral rates (signaling effects) and term premiums (portfolio balance effects) unreliable (Bauer & Rudebusch, 2014). There are several challenges for researchers when investigating these effects. Central bank statements and announcements that include information about unconventional policies also tend to include information
that is not unconventional. This makes it difficult to estimate the effect of the unconventional policy, as
the conventional announcement information also will affect yields. The most common way to examine
the effects of monetary policy is through use of event studies that measures the effect of monetary
announcements by looking at the changes in the suspected rates within a tight window of time after the
announcement is released. The studies are relying on either one or two-day window since they are
assumed to be small enough so monetary announcement is the only news that has affected the
suspected rate(s) during that time frame. At the same time it should be big enough to capture the entire
effect of the news. The windows sizes are appropriate and in line with Farma`s (1970) efficient market
hypothesis.

If news about unconventional policies are leaked or anticipated by the market prior to the official
announcements, researchers will underestimate the full effect of the policy. The premise of the event
study methodology for monetary policy is based on the assumption that the markets are effective and
will adjust to news about purchases right away. They will not wait until the actual purchases are carried
out. QE2, for example, was highly anticipated among investors prior the official announcement in
November 2010, particularly through a Reuters poll on October 5, 2010. QE3 was anticipated by a bad
job report in September, amped by statements from Goldman and Sachs13. Thus, event studies will not
be able to capture the full effect, especially of the consecutive programs, due to the narrow windows
that they have to examine. The observed window, while it has to be big enough for the effect of the
announcement to have its impact, also has to be tight enough so that one can be fairly certain that there
is no other news within that window that would affect the observed interest rates. Markets are also
sufficiently efficient, so that effects on yields will occur as investors change their expectations and not
when actual purchases take place (Gagnon et al. 2012; Bauer & Rudebusch 2014). Anticipation of the
policies prior to their announcements are very likely to be that cause of the diminishing effects of
unconventional policies, observed over QE1 – QE3. Although this reduces the power of the tests, it
does not lead to any biases in the measures.

Because of second round effects, separating signaling effects from portfolio balance effects are more
complicated than splitting the yield changes into expectations about future short-term interest rates and
risk premium components. Risk-neutral rates are likely the lower bound for the signaling channels
contribution to interest rates changes. News about easier monetary policy in the future and

demonstrations of central banks willingness to act will lead to a reduction in the risk premium on financial assets, meaning that signaling would also affect the term premium and not just the risk-neutral rates. Fed data from 2001-2003 backs up this connection. During the descending Fed Funds Rate target from 2001 to 2003, the 10-year yield was reduced with 56 basis points in sum over the announcement days. Of this, -35 bps can be accredited reduced risk-neutral rates, while -21 bps can be accredited reduced term premiums, demonstrating a big signaling effect on the term premium (Bauer & Rudebusch, 2014). However, most studies ascribe the effects on the term premium to the portfolio balance channel, while they credit effects on the risk-neutral rates to the signaling channel.

4.2.1 Comparative studies evaluating QE’s effect on US Treasuries
Eventually, a wide range of studies have been conducted in regards to QE’s effect on Treasury yields and the importance of signaling and portfolio balance channel effects. Some are more frequently referred to than others, such as Bauer and Rudebusch (2014), D’Amico et al. (2011) and Krishnamurthy and Vissing-Jørgensen (2011). The studies are either event studies or time-series regressions or panel regressions.

Bauer and Rudebusch (2014) examined the effect of QE1 on Treasury bond yields, focusing on the strength of the portfolio balance channel and the signaling channel. Their event study showed that 1 month and 6 month yields was reduced by 20-40 balance points over a series of QE1 announcement. Based on an assumption that such short-term rates carry almost no duration risk, these results indicate that the risk-neutral rate has been lowered by about 20-40 balance points. They further confirm the attribution to policy expectations through the decomposition of the yield in their model. By using a dynamic term structure model they break down the 10- and 5-year Treasury yield. On the 10-year Treasury the cumulative effect of all the LSAP announcements included in QE1 lowered the yields by 90-102 basis points, depending on different model specifications. The risk neutral rate is accredited -31-46 basis points in different model specifications. For the 5-year Treasuries the risk neutral rate is accredited 30-48 basis points of total 93-97 basis points decline, while the term premium is accredited a drop of 44-62 basis points. The authors estimate that the contribution of policy expectations to lowering long-term yields to be 40-50 %.

In contrast Gagnon et. al. (2011) only attributes 22 % of the effect on the 10-year Treasury yield to the signaling channel as reduction in the term premium is accredited -71 basis points of their models total -91 basis points change. Bauer and Rudebusch (2014) argue that the different estimations of the
reductions in the risk-neutral rate stems from a fitting error in the applied Kim-Wright model. In Gagnon et al. (2010), the -71 basis points reduction in the term premium component is divided by the actual observed reduction of the 10 year yield on the event days (-91 basis points) and not the -102 basis points estimated in the Kim-Wright model. So based on the actual model fitted results the contribution of the risk-neutral component should be 30% (Bauer & Rudebusch, 2014).

D’Amico and King (2010) studied the change in yields of different maturities during the Fed’s purchase of $300 billion in long-term securities between March and October of 2009. They concluded that these purchases lowered the yield on 10-year Treasuries by about 50 basis points. It was found that the local supply channel persistently put a 30 basis point downward pressure on the yields over the course of the purchases. Meaning and Zhu (2011) used the same method to estimate the effect of QE2. They found that QE2 lowered the yield curve by 21 basis points on average.

D’Amico et al. (2011) find that both the scarcity and duration channels (The duration channel seems to be identical to the portfolio balance channel) are statistically significant. They found that the portfolio balance channel during QE1 reduced long-term yields by 18 basis points. For QE2, they estimated the effect to be about 36 basis points. They find no evidence of an important signaling channel.

Krishnamurthy and Vissing-Jørgensen (2011) found that QE1 had strong effects on Treasury yields and reduced the 30-year, 10-year, 5-year, 3-year and 1-year Treasury yields by 73, 107, 74 39 and 25 basis points, respectively. Further, the signaling effects on 5- to 10-year Treasury bonds accounted for 20-40% of the reductions in these yields. For QE2 they were not able to obtain as strong effects. Reductions in the 10-year yields ranged from 18-30 basis points and in the 5-year yield from 17-20 basis points (depending on window size).

For QE2 the effects on real borrowing rates were smaller in total than in QE1 and Krishnamurthy and Vissing-Jørgensen`s (2011) analysis suggest that all movements in real borrowing rates during QE2 stems from signaling effects. The drop off in QE`s effect on real borrowing rates can be understood from one of the main conclusions from their study, that effects on particular assets depend critically on which assets are purchased. The MBS purchases in QE1 were decisive for putting a downward spiral on MBS yields as well as corporate credit risk and thus corporate yields. Swanson, Reichlin and Wright (2011)
Cahill, D’Amico, Li and Sears (2013) quantify the average impact for the term premium on Treasury yields, by further decomposition into duration risk and local supply channel. They find that the two channels are of similar importance to the transmission of LSAP purchases to the term structure. The analysis suggests that reductions in duration risk and local supply channel accounts for about 50% of the decline in yields on announcement days. Looking at the 10-year Treasury yields, the results suggest that (when controlled for pre-announcement market expectations) duration risk effect is about -5 basis points on average per $100 billion of LSAP purchases, while the similar average effect of the local supply channel is -4 basis points per $100 billion LSAP purchases. However, the method has been criticized for having limited data availability (in terms of both sample period and questions asked) and are not necessarily perfect measures of investors’ beliefs (Rogers, Scotti & Wright, 2014).

Li and Wei (2012) found that QE1 reduced the 10-year yield by 99 basis points and the 5-year yield by 65 basis points. They ascribe around 40% of the reduction in the 10-year yield to the signaling channel and 20% to the 5-year yield. They further assess QE2 and find that yields were reduced for the 10-year and 5-year Treasuries by 50 and 30 basis points respectively. Swanson, Reichlin and Wright (2011) examined QE2 and Operation Twist and found that it only reduced long-term interest rates by 15 basis points. Most studies find that QE1 had an effect, but some claim that these are short lived. For example Wright (2011) concludes that the effects has died off within two months. Thornton (2012) is skeptical of the significance of the portfolio balance channel and argues that the assumptions in Vayanos and Vila (2009), which is commonly referred to in empirical research, are "extreme". Further his research yields no significant support for the portfolio balance channel after correcting for the common trends in the term premium and measures of the maturity structure of public debt (such as long-term Treasury yields). Thornton claims that there is no support for any decline in the Term Structure in the various event-studies is due to portfolio balance effects. The reduction in yields recorded in event studies seems to be a consequence of the signaling channel. However Thornton fail to provide an explanation for why a fixed time trend is an appropriate variable for that regression (Gagnon & Hinterschweiger, 2013). Guo (2015) notes that Thornton focuses on long-term effects of QE, and therefore, he relies on less frequent monthly data.

Our empirical review suggests that QE1 did have a solid effect on the interest rates of Treasuries among all maturities. The studies we examined found significant proof that the Feds purchases reduced yields across all maturities and that the strongest reaction occurred on the long-end of the yield curve.
On average studies find that the 10-year Treasury decreased with 96 basis points and that the five-year Treasury decreased with 89 basis points. On the other hand 2-3 year decreased with 35-60 basis points (Table 6). This supports the objective of the purchases, to reduce the long-end of the yield curve. In addition it demonstrates that the Fed succeeded in reducing the yields on those assets they targeted (long-term maturities), but also that the effect rubbed off on assets that was not included in the purchases (short-term maturities). On average, the studies ascribe 43 % of the effect to the signaling channel and 50 % of the effect to the portfolio balance channel for 10-year Treasuries (Table 7).

Studies of QE2 and operation twist found smaller effects of the purchases than what was unveiled in the assessment of QE1. On average QE2 were found to lower the 10-year Treasuries with 31 basis points and the 5-year Treasury yield with 25 basis points. In the short end of the yield curve the effects ranged from (-)2-8 basis points (Table 6). Some of the studies that found significant effects for QE1 were not able to replicate this for QE2 or QE3. Also, we found very few studies of QE2 and QE3 compared to QE1. We recognize two reasons for this: Primarily, many of the most acclaimed studies were released before QE2 was completed and thus were obviously not able to consider the consecutive programs. Secondly, most of the methodology used for event studies loose a lot of ground due to market anticipation. Thus, the applied assumption, that the windows are big enough to capture all of the effect is false for QE2 and QE3 (also for the tapering announcements that we include in our own assessment). For this reason, the focus for trying to understand the mechanisms of QE has been QE1 and some researchers claim that the consecutive programs are not eligible for assessment through these methods (Bauer and Rudebusch, 2014; Neely, 2010). Thus, studies cannot claim to account for all events that affected the market and, the numbers conducted in the studies cannot really be used to conclude that QE1 was more effective than QE2 or QE3.

<table>
<thead>
<tr>
<th>Author:</th>
<th>Treasuries yields QE1</th>
<th>Treasuries yields QE2</th>
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<tbody>
<tr>
<td></td>
<td>10 year</td>
<td>5 year</td>
</tr>
<tr>
<td>Kim-Wright</td>
<td></td>
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</table>
Table 6: Reported effect of QE1 and QE2 on Treasury yields.

<table>
<thead>
<tr>
<th>10 year yield</th>
<th>Risk-neutral rate</th>
<th>Term Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bauer and Rudebusch (2014)</td>
<td>-31</td>
<td>-71</td>
</tr>
<tr>
<td>Kim-Wright</td>
<td>-33</td>
<td>-60</td>
</tr>
<tr>
<td>OLS</td>
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<tr>
<td>Krishnamurthy and Vissing-Jørgensen (2011)</td>
<td>(-)20-40</td>
<td>(-)67-80</td>
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<td>Lei and Wei (2012)</td>
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<td>Rudebusch and Christensen (2012)</td>
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<td>D’Amico et al. (2011)</td>
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<tr>
<td>Average</td>
<td>-41</td>
<td>-48</td>
</tr>
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</table>

Table 7: Reported effect on term premiums and risk-neutral rates.

4.2.2 Evidence of the liquidity channel in the US

As mentioned, the liquidity channel has not been given too much attention in the empirical research that analyze the effect of the Feds QE programs. This is likely do to the expected minor effects on the purchased securities and challenges in measuring it. Referring to the Treasury yield equation, the
liquidity channel affects the instrument specific term premium which also is affected by the portfolio balance channel. For this reason it is hard to separate the two channels significance. However there are a few studies that try to measure these effects.

The spread between Treasury yields and Agency bond yields isolates a liquidity premium as they have similar default risk, especially after Freddie Mac and Fannie Mae was placed under the conservatorship of the US government. As Agency bonds are considered the less liquid security, Treasury yields should be expected to fall much less than Agency bond yields Krishnamurthy and. Krishnamurthy and Vissing-Jørgensen (2011) found evidence for a liquidity channel across all maturities (3, 5, 10 and 30 years) in their event study for QE1. The 10 year Agency-Treasury spread fell by 93 basis points. For QE2 however, they found no evidence of a liquidity channel, as there was apparently almost no spread between Agency bond yields and Treasury yields. The change in liquidity premium between QE1 and QE2 can be explained by the fact that the market was way more liquid during QE1 than QE2. Reserve balances were nearly 4.5 times as high and the government increased the Treasury supply by roughly 16 percent (Krishnamurthy & Vissing-Jørgensen, 2011).

Christensen and Gillan (2014) however found evidence of a liquidity channel effect also under QE2, by looking at the less liquid TIPS (Treasury inflation-protected securities) rates. They found that liquidity premiums were 12-14 basis points below its expected levels during the program. They interpret their findings as that QE successfully improves the market conditions for the targeted securities. To assess the effect on securities that were not included in the program they also analyze short-term spreads of AAA-rated corporate bonds, which yielded no significant results. Admitting that they only considered one asset class, this is still interpreted as evidence that the liquidity channel is limited to the targeted security classes.

4.2.3 Analysis of QE`s effect on US Treasuries
We take a look at the events for QE dates to see if we can observe any possible patterns. It is important to note that we do not do any testing of significance level of the results and thus we do not draw any strong conclusions based on our reports. We anticipate to finds similar results as our review of the empirical evidence looking at the same events. Also, our data includes QE3 and the tapering period, which to our knowledge has not received a lot of attention in the existing literature. This makes sense as most of the literature on QE was released prior to these periods. We expect to see stronger
movement on event dates during QE3 than our empirical review could provide for QE2. We expect to see tendencies of the opposite effects of tapering announcement dates compared to other QE dates.

In order to distinguish the term premium and the risk-neutral rate we use secondary data from the Kim-Wright Model. We adopt the term premium estimates obtained from the Kim and Wright’s (2005) dynamic term structure model. Based on previous literature we interpret the term premium as portfolio balance effects, although some of it should stem from the liquidity channel. Our method does however not allow us to distinguish between the two and the liquidity effect in Treasuries are reportedly very small. The data from the Kim-Wright model gives us the daily changes in Treasury yields across several maturities, broken down into the term premium and the risk-neutral rate, which as mentioned earlier, are commonly used to determine the effect of the portfolio balance channel and the signaling channel.

4.2.3.1 Changes on QE event dates

As discussed earlier, the main challenge in isolating the effect of QE is to determine the size of the observed window so that it will capture all of the effect of QE while not including effect stemming from other events. In the previous literature, this window size has been determined to be one or two days and thus we chose to look at changes for both these windows (Bauer and Rudebusch 2014; Gagnon et. al. 2012; Daines, Joyce, Tung 2012). The one and two day windows are recognized as adequate to capture most of the effects of the announcements in QE1 and to not include any other news. However, for QE2, operation twist, QE3 and tapering announcements the size of the windows are arguably not large enough to capture the whole effect of the events because the events was greatly anticipated leading to a wider spread of the effect. For example, a Bloomberg study revealed that almost two thirds of economists foresaw QE3 and the only uncertainty at the program launch was the length and size of the program. Introducing a bigger window would solve this problem, but would unfortunately it would likely include effects stemming from other events. Thus this is not an option and we have to accept that it’s not possible to isolate the total effect of the consecutive rounds of QE using event studies. As mentioned earlier this entails that one cannot say that QE1 was more effective than the other programs based on this data. In order to shed light over this issue, we also assess the cumulative movements in the yields across the program spans.
4.2.3.2 QE1

Table 8 display the one and two-day change in the 10-year Treasury yield on the entire event dates of QE1. The one-day window changes are in line with the observations used in Bauer and Rudebusch (2014) and Gagnon et al (2011). Our inclusion of the two-day window as well indicates that the effect of QE could have had even stronger effects than what a lot of research suggest. The data show a total 102 basis points reduction in the 10-year Treasury rate and over the one-day window and a total 133 basis points reduction over the two-day window. Most of the events in QE1 show the expected sign (a negative effect), which supports the claimed effect of the purchases. On January 28 2009, however the announcement caused a big increase in the yields. It has been suggested that investors were displeased by “the lack of concrete language regarding the possibility and timing of purchases of longer-dated Treasury securities” (Bauer and Rudebusch, 2014).

| 10 Year US Treasury Yield: | | |
|---|---|---|---|---|---|---|---|
| QE1 | One day change | Two day change | | | |
| | Yield Change | Term Premium | Risk Neutral Rate | Yield Change | Term Premium | Risk Neutral Rate | |
| 25.11.08 | FOMC Statement | -24 | -17 | -7 | -34 | -23 | -10 |
| 01.12.08 | Bernanke Speech | -24 | -17 | -7 | -29 | -20 | -8 |
| 16.12.08 | FOMC Statement | -18 | -12 | -7 | -36 | -24 | -12 |
| 28.01.09 | FOMC Statement | 12 | 9 | 3 | 28 | 20 | 8 |
| 18.03.09 | FOMC Statement | -56 | -40 | -16 | -52 | -36 | -12 |
| 12.08.09 | FOMC Statement | 4 | 3 | 1 | 9 | 7 | 2 |
| 23.09.09 | FOMC Statement | -2 | -1 | -1 | -7 | -5 | -2 |
| 04.11.09 | FOMC Statement | 7 | 5 | 2 | 5 | 3 | 2 |
| **Total** | **-102** | **-71** | **-31** | **-133** | **-92** | **-37** |

| Five Year US Treasury Yield: | | | | | |
|---|---|---|---|---|---|---|---|
| QE1 | One day change | Two day change | | | |
| | Yield Change | Term Premium | Risk Neutral Rate | Yield Change | Term Premium | Risk Neutral Rate | |
| 25.11.08 | FOMC Statement | -22 | -15 | -7 | -29 | -20 | -9 |
| 01.12.08 | Bernanke Speech | -21 | -15 | -6 | -24 | -17 | -7 |
| 16.12.08 | FOMC Statement | -16 | -10 | -6 | -21 | -15 | -6 |
| 28.01.09 | FOMC Statement | 9 | 7 | 3 | 24 | 17 | 7 |
| 18.03.09 | FOMC Statement | -47 | -34 | -13 | -41 | -28 | -8 |
| 12.08.09 | FOMC Statement | 2 | 2 | 0 | -10 | -7 | -3 |
| 23.09.09 | FOMC Statement | -3 | -2 | -1 | -8 | -5 | -3 |
| 04.11.09 | FOMC Statement | 4 | 3 | 1 | 1 | 1 | 0 |
| **Total** | **-94** | **-64** | **-30** | **-108** | **-74** | **-29** |

Table 8: QE1 Events. Source: Term premium estimates are adopted from the Kim Wright (2011) DTSM
The Kim-Wright model ascribes around 70% of the total movements in the 10-year yields for both the one-day and the two-day changes to changes in the Term Premium. For the 5-year Treasury yields, the total changes were in total -94 (one-day) and -108 basis points (two-days). Also here, the data ascribes just shy of 70% of the effect to the alterations in the Term Premium.

The data accumulated through the Kim-Wright Model also show that the yields for shorter maturity Treasuries (1 year, 2 year and 3 year) also was reduced on QE announcement dates with a diminishing effect ranging from the 10 year yield to the 1 year yield. This effect is graphically presented in graph 8, which demonstrates the movements listed in table 9 below. This supports the idea behind quantitative easing; to reduce the long end of the yield curve.

**Graph 8: Yield curve change CE1. Source: Kim Wright**
One day change Treasury yield | Two day change Treasury yield
---|---
Yield Change | Term Premium | Risk Neutral Rate | Yield Change | Term Premium | Risk Neutral Rate
---|---|---|---|---|---
10Y US TREASURY YIELD | -102 | -71 | -31 | -133 | -92 | -37
5Y US TREASURY YIELD | -94 | -64 | -30 | -108 | -74 | -29
3Y US TREASURY YIELD | -79 | -53 | -26 | -80 | -53 | -29
2Y US TREASURY YIELD | -65 | -45 | -20 | -56 | -45 | -5
1Y US TREASURY YIELD | -41 | -31 | -11 | -30 | -30 | 4

Table 9: QE1 events effect across all maturities. Source: Term premium estimates are adopted from the Kim Wright (2011) DTSM

4.2.3.3 Cumulative changes QE1

One of the main arguments from critics of QE is that the change in yields observed on and around announcement days are destined to be short lived. Graph 9 to 11 indicate the cumulative changes in the Yield Curve over the course of QE1. Graph 9 shows the yield curve on 24.11.2008 (the day before the first QE1 announcement) and on 06.11.2009 (two days after the last QE1 announcement). Graph 10 and 11 shows the Term Premium and the Risk-neutral rate on the same dates. The data shows that the 10-year Treasury yield is marginally 1 basis point higher than it was on the day before the first announcement, while we see that there is a bit of a downward shift that increases as the maturity drops. On the short end you find the 1 year treasury yield that has been reduced by 31,24 basis points. Further, graph 10 and 11 shows that the difference in yields on the long side of the curve stems from a reduction in the term premium, while the risk-neutral rate is actually higher than before the program, especially for the 10-year maturities. In addition, it is worth noting that the market did not react as anticipated on the announcement on 04.11.2009. The announcement contained information that QE1 would close in on $25 billion less than the previously announced maximum (Federal Reserve, 2009). This could very likely have led to the positive shift in the interest rates. Also, as some skeptics of QE have pointed out, the interest rates were showing a downward trend before the first QE announcement. As this fact is usually used to argument against the seemingly effect of the first QE1 announcement, this also means that the yield curve was lower than what one would usually expect on the day before the first announcement. Had yield levels been higher at that point, the first QE announcement could arguably have caused a bigger impact on the Treasury yield.
As the observed changes across the QE1 period are not within the commonly window estimations we should not draw any conclusions on these observations or imply that the changes can solely or at all be attributed to quantitative easing.

**Graph 9: Cumulative change in the yield curve during QE1**

**Graph 10: Cumulative change in the yield curve’s term premium during QE1**
Opponents of QE has often argued that the effect are temporary, saying that it often relied on the fact that interest rates have moved a lot within the period of the purchases. As we can observe in graph 12 below, the 10-year interest rate moves around during the period and is indeed higher than it was prior to the first announcement for a vast part of the QE period. We would argue that, for the same reason that you cannot attribute negative changes in interest rates outside of the one or two day window to QE, you also cannot attribute the positive changes to QE. The yield increase that we see in the first two quarters of 2009 could have been caused by issuance of new Treasuries, higher expected growth and the return of investors’ appetite for risk (Meyer and Bomfim (2009)).
4.2.3.4 QE2 and Operation Twist

As mentioned in last section, the consecutive rounds of quantitative easing were highly anticipated by the market and thus it is harder to capture the effect using event studies and narrow windows. This is evident by the figures derived on event days.

Table 10 displays the one and two day changes on the event dates during QE2 and Operation Twist for the 10 Year US Treasury and the 5 Year US Treasury. As opposed to what we would expect, the total sum of change to the yield for both maturities are positive in the one day-window. A substantial part of the effect stems from Bernanke`s Jackson Hole speech on August 27 2010, where he hinted about the forthcoming extension, which caused a 16 basis points hike in the 10 year yield and 13 basis points hike in the 5 year yield. It is worth noting that the speech followed several negative economic reports and that the yield was already following a downward trajectory and was at a pretty low level (2.48 %) at the time (Graph 13).

![Graph 13: 10 Year US Treasury yield 06.11.2009-27.08.2010](image)

The two-day window showed more of the signs that we would expect from QE events. The total change across all event dates was -61 basis points and -39 basis points for the 10 and 5 year US Treasuries respectively. The Kim-Wright model ascribes 72 % of the change to the term premium in the 10-year yield and 79 % in the 5-year yield.
### 10 Year US Treasury Yield

<table>
<thead>
<tr>
<th>QE2 and OT</th>
<th><strong>One day change</strong></th>
<th><strong>Two day change</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>27.08.10 Bernanke Speech</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>21.09.10 FOMC Statement</td>
<td>-12</td>
<td>-9</td>
</tr>
<tr>
<td>12.10.10 FOMC Min Released</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>15.10.10 Bernanke Speech</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>03.11.10 FOMC Statement</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>22.06.11 FOMC Statement</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>21.09.11 FOMC Statement</td>
<td>-6</td>
<td>-4</td>
</tr>
<tr>
<td>20.06.12 FOMC Statement</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>10</strong></td>
<td><strong>8</strong></td>
</tr>
</tbody>
</table>

### 5 Year US Treasury Yield

<table>
<thead>
<tr>
<th>QE2 and OT</th>
<th><strong>One day change</strong></th>
<th><strong>Two day change</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>27.08.10 Bernanke Speech</td>
<td>13</td>
<td>10</td>
</tr>
<tr>
<td>21.09.10 FOMC Statement</td>
<td>-9</td>
<td>-7</td>
</tr>
<tr>
<td>12.10.10 FOMC Min Released</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>15.10.10 Bernanke Speech</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>03.11.10 FOMC Statement</td>
<td>-2</td>
<td>-1</td>
</tr>
<tr>
<td>22.06.11 FOMC Statement</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>21.09.11 FOMC Statement</td>
<td>0</td>
<td>-1</td>
</tr>
<tr>
<td>20.06.12 FOMC Statement</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>12</strong></td>
<td><strong>9</strong></td>
</tr>
</tbody>
</table>

Table 10: QE2 events: Source: Term premium estimates are adopted from the Kim Wright (2011) DTSM

Unlike what we saw in QE1, the graph below shows that yields across all maturities increased on QE2 and Operation Twist event dates. The picture looks a bit more promising when taking the two-day window into considerations. Here we see a substantial shift in the long-end of the yield curve, while there is a marginal increase in the short-end (Graph 14 and 15). This may support Christensen and Rudebusch (2014)’s argument that the one-day window may be too short to capture the full effect of the announcements.
4.2.3.5 Cumulative changes QE2 and Operation Twist

Graph 16 to 18 looks at the cumulative changes in the Yield Curve over the course of QE2 and Operation Twist. Graph 16 shows the yield curve on 26.08.2010 (the day before the first QE2 announcement) and on 22.06.2012 (two days after the last Operation Twist announcement). Graph 17 and 18 shows the Term Premium and the Risk-Neutral Rate of Return on the same dates. The data shows stronger signs of a reduction at the far end of the yield curve, than the corresponding graph did
for QE1. The 10-Year Treasury yield had dropped by 95 basis points between the two dates while the 5-year Treasury yield had dropped by 64 basis points. The reduction in the Term Premium was by 65 and 45 basis points for the 10 and 5 Year Treasury respectively. Graph 19 below shows the 10-year yield during the QE2 and OT period. Similarly, to QE1, we find variations during the purchasing period. However, in the case of QE2 and OT we did experience that the yield was at a lower point by the end of the program than when it first was announced.

**Graph 16: Cumulative change in the UST yield curve during QE2 and OT**

**Graph 17: Cumulative changes in the UST yield curve’s term premium during QE2 and OT**
Graph 18: Cumulative changes in the UST Yield Curve’s Risk-Neutral rate during QE2 and OT

Graph 19: 10 year yield during QE2 and OT

4.2.3.6 QE3

Table 11 display the one and two day changes on the event dates during QE3 for the 10-Year US Treasury and the 5-Year US Treasury. QE3 announcements caused a 34 basis points drop in the 10-year Treasury yield and a 26 basis points drop in the 5-year Treasury yield. Of the total downward effect, 73% on the 10-year yield and 76% of the effect on the 5-year yield are allocated to the term premium. The effect is stronger than the one that we saw in QE2. This is likely because the Fed used less transparent communication in the case of QE3. Prior to the official announcement of QE3 there
were a larger degree of uncertainty regarding when the program would be officially introduced. Another possible factor is related to the total amount not being released before the tapering announcement, adding to the level of uncertainty. Unlike QE2, QE3 included both purchases of US Treasuries and MBS’s so this result could also add substance to Krishnamurthy and Vissing-Jørgensen (2011)’s conclusion, that the effect will depend on the kind of assets being purchased. We also note that the effect observed over the two-day window is smaller than the effects observed in the one-day window. This is unexpected and not in conjunction with what we have seen in QE1 and QE2. As we can read from graph 20 below, movements in the yield curve exhibit the expected form, with a decreasing effect starting at the long end of the curve.

<table>
<thead>
<tr>
<th>10 Year US Treasury Yield</th>
<th>One day change</th>
<th>Two day change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>QE3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.08.12 FOMC Min Released</td>
<td>-11</td>
<td>-8</td>
</tr>
<tr>
<td>13.09.12 FOMC Statement</td>
<td>-5</td>
<td>-4</td>
</tr>
<tr>
<td>12.12.12 FOMC Statement</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>18.09.13 FOMC Statement</td>
<td>-23</td>
<td>-17</td>
</tr>
<tr>
<td>Total</td>
<td>-34</td>
<td>-25</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5 Year US Treasury Yield</th>
<th>One day change</th>
<th>Two day change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>QE3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.08.12 FOMC Min Released</td>
<td>-8</td>
<td>-6</td>
</tr>
<tr>
<td>13.09.12 FOMC Statement</td>
<td>-3</td>
<td>-3</td>
</tr>
<tr>
<td>12.12.12 FOMC Statement</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>18.09.13 FOMC Statement</td>
<td>-17</td>
<td>-13</td>
</tr>
<tr>
<td>Total</td>
<td>-26</td>
<td>-19</td>
</tr>
</tbody>
</table>

Table 11: QE3 events. Source: Term premium estimates are adopted from the Kim Wright (2011) DTSM
4.2.3.7 Cumulative effect QE3

Graph 21 to 23 looks at the cumulative changes in the yield curve over the course of QE3. Graph 21 shows the yield curve on the day before the first QE3 announcement and on the last day of the QE program. The graphs show that interest rates are higher than they were before the program. The 10-year yield is 118 basis points higher on the last day of the program compared to the day before the first announcement. The biggest difference in the yield seems to be due to a shift in term premium, as the difference in the risk-neutral rate is relatively modest.

Graph 20: Yield curve pre and post QE3
Graph 22: Cumulative change in the UST yield curve’s term premium during QE3

Graph 23: Cumulative change in the UST yield curve’s risk neutral rate during QE3

Graph 24 below shows the 10-year yield during QE3. As it shows, the 10-year yield started to incline substantially in the middle of the program span, after having consistently kept stable between 1.5 and 2 percent. This evidence do suggest that QE3 did not succeed to hold long-term interest rates down in an cumulative aspect, but of course, there could be several other factors that affected the yield hike. For
example, the first hint of tapering came on 22.05.2013, which is around the time when the yield really started to increase.

Graph 24: 10 year yield during QE3

4.2.3.8 Tapering

Considering the tapering events, we want to see the opposite of what we were looking for in the other QE events – strong positive shifts. To our knowledge, there has not been any studies of the effect of the Fed’s tapering announcements on the Treasury yield. Most of the recognized studies have focused on the tapering events effect on credit flows to emerging markets. We have adopted the recognized events used in these studies (Rai and Suchanek, 2014, among others).

Table 12 shows the movement in the yields on the three event dates during the tapering period. The total change in the 10-year US Treasury yield amounted to a 36 basis points increase in the one-day window and a 49 basis point increase in the two-day widow. For the 5-year Treasury yield the corresponding increase was 24 and 37 basis points. Out of the total movement, around 70 % of the increase in the 10-year yield are ascribed to change in the Term Premium. Term Premium movements explains 80 % of the movement in the 5-year yield. As we can read from table 13 and graph 25 below, the movements in the yields on tapering event days are as we would expect, with a stronger increase across the longer maturities.
<table>
<thead>
<tr>
<th>TAPERING</th>
<th>One day change</th>
<th>Two day change</th>
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<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>10 Year US Treasury Yield</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.05.13 Bernanke Q&amp;A FOMC Statement</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>19.06.13 FOMC Statement</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>18.12.13 FOMC Statement</td>
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<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>26</td>
</tr>
<tr>
<td>5 Year US Treasury Yield</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.05.13 Bernanke Q&amp;A FOMC Statement</td>
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<td>6</td>
</tr>
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<td>19.06.13 FOMC Statement</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>18.12.13 FOMC Statement</td>
<td>3</td>
<td>3</td>
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<tr>
<td>Total</td>
<td>24</td>
<td>19</td>
</tr>
</tbody>
</table>

*Table 12: Tapering events. Source: Term premium estimates are adopted from the Kim Wright (2011)*

**DTSM**

**Graph 25: Total change tapering**
<table>
<thead>
<tr>
<th>Total Changes Tapering</th>
<th>One day change 2 year Treasury yield</th>
<th>Two day change 2 year Treasury yield</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yield Change</td>
<td>Term Premium</td>
</tr>
<tr>
<td>1Y US TREASURY YIELD</td>
<td>-3</td>
<td>7</td>
</tr>
<tr>
<td>2Y US TREASURY YIELD</td>
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<td>11</td>
</tr>
<tr>
<td>3Y US TREASURY YIELD</td>
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<td>14</td>
</tr>
<tr>
<td>5Y US TREASURY YIELD</td>
<td>24</td>
<td>19</td>
</tr>
<tr>
<td>10Y US TREASURY YIELD</td>
<td>36</td>
<td>26</td>
</tr>
</tbody>
</table>

Table 13: Changes on tapering events across maturities. Term premium estimates are adopted from the Kim Wright (2011) DTSM

4.2.3.9 Cumulative effect Tapering

Graph 26 takes a look at the cumulative changes in the yield curve during the tapering period. Graph 27 looks at the yield curve on the day before the first tapering event and on the day after the last event. Looking at Graph 26 it seems reasonable to argue that the yield curve shifted upwards and stabilized itself for a period around 3%. The picture presented in the graph certainly suggest that the tapering events has had the expected effect on the yields. Also, graph 23 support this, as it shows that the yield curve was at an adequately higher level on the post-event date than the pre-even date.

Graph 26: 10 year yield during tapering
4.2.3.10 Summary of US Treasury bonds

The average 10-year interest rate between the event dates was 3.63%, 2.66% and 2.06% for QE1, QE2 and OT and QE3 respectively. In contrast the average 10-year interest rate from 2003-2007, which are considered to be normal times, were 4.58%. As the Fed funds rate dropped from 4.24% in December 2007 to 0.39% in November 2008, still the average 10-year interest rate was 4.10% (Board of Governors of the Federal Reserve, a). Based on the previous research that we have reviewed and on our own observations, we are leaning towards those that claim that quantitative easing indeed is effective in lowering interest rates, especially long-term interest rates. However, as purchases becomes more predictable, the total effect seems to be harder to measure. Thus, we believe that we are not able to report on the full picture with the current methods.

Our examination of the decomposition of the yield curve point toward a strong effect of changes in the term premium across all maturities and window sizes. Roughly 70% of the yield movement on event dates seems to be due to a change in the term premium. As we have discussed, the term premium is likely to over-estimate the effect of the portfolio balance effect. However, the average portion of the Treasury yields movements accountable to the term premium in the above mentioned normal-time period is only 13%. This suggests that the portfolio balance channel do indeed play a big role in transmitting policy decisions to interest rates. The roughly 30% share of the movement awarded to the changes in the risk-neutral rate is also of considerable importance and indicates that both the portfolio

Graph 27: cumulative change in the UST yield curve during tapering
balance channel and the signaling channel are important transmission channels for effects stemming from quantitative easing.

The movements in the short end of the yield curve that we also have observed point towards the conclusion that quantitative easing possibly led to changes in in untargeted bonds as well. This suggest that QE had widespread effects on other assets than those that were purchased by the Fed, consistent with findings by Bauer and Rudebusch (2014), Gagnon et al. (2011) and Krishnamurthy and Vissing-Jørgensen (2011).

4.3 Agency-MBS and Agency bonds
The financial crisis started in the housing market and lead to a collapse in the sector. Thus, naturally one of the main objectives of QE1 was to provide direct support to the housing market sector. The program aimed to reduce mortgage interest rates and increase credit availability for house purchases, which in turn should support housing markets and foster improved conditions in financial markets more generally.

4.3.1 Comparative studies evaluating QE’s effect on Agency-MBS and Agency-Bonds
Hancock and Passmore (2011) used pricing models measure deviations from normal market rates in MBS yields and mortgage rates during QE1. The initial announcement alone led to an 85 basis points reduction between November 25 2008 and December 31 2008 (prior to the actual purchases). As the purchases started, the risk premiums that embedded in mortgage rates declined by 50 basis points. However, observed mortgage rates declined only slightly. The author ties this to the general increase in interest rates that we saw in this period. As the interest rates declined in May 2009, the mortgage rates in the study held level similar to the norm prior to the financial crisis and by the end of the QE1 program; mortgage rates were significantly lower than they were prior to the program launch. They attribute the effect to reduced risk premiums and note that if the portfolio balance effect had any effects it had to be after the conclusion of the QE1, while the Fed still held a substantial portion of the outstanding stock of MBS.

Hancock and Passmore (2014) looks at QE1 and QE2 and finds that an increase in the Feds share of Treasury bonds and MBS seems to put downward pressure on MBS yields. This is consistent with the portfolio balancing channel. Because the Feds holdings of MBS was falling during QE2, the effects of increasing Treasury holdings was offset by the reductions in the MBS holdings. Further, their analysis
suggest that putting more money into the banking system puts upward pressure on MBS yields. In their calculations, a $100 billion increase in MBS holdings would result in a 5.6 basis points decline in MBS yields and a 5 basis points decline in mortgage rates. When comparing QE1 and QE2 it seems as changes in the Feds MBS holdings does not have the same effects during all period. During QE1, they see bigger effect, likely because the market was in a state of distress, while during QE1 they were approximately at normal levels. In such an environment substantially larger purchases has to be applied in order to generate effects. Moreover, it seems like Treasury purchases and MBS purchases have dramatically different effect. This is in line with one of the main conclusions in Krishnamurthy and Vissing-Jørgensen (2011) that “effects on particular assets depend critically on which assets are purchased.” They found that mortgage backed securities purchases in QE1 were crucial for lowering mortgage-backed security yields. During QE1, the 30-year Agency-MBS declined by 107 basis points. 15-year Agency-MBS declined by 88 basis points. QE1 also affected Agency-bond yields with declines ranging from 144 basis points (30-year Agency-bonds) to 123 basis points (3-year Agency-bonds). Smaller effects were found for QE2. The 30-year and 15 year Agency-MBS yields declined by 9 and 12 basis points, respectively. Reductions in Agency-bond yields ranged from 9 (30-years) to 10 (3-years). However, unlike Hancock and Passmore, the portfolio balance channel was found to be the main driver behind the movements in Agency-bonds and MBS during QE1. For QE2 these movements are believed to be solely due to signaling effects. Further, they note that due to its nature, QE3 should work both through signaling and portfolio balance effects, but the effects should be smaller than QE1, because the market conditions were less stressed than during QE1 and because the MBS purchases of QE3 will be smaller than for QE1. This conclusion fits the model and assumptions of Hancock and Passmore (2012). Hancock and Passmore (2014) extend their model to QE3 and confirm the conclusion from their 2012 study. MBS yields were, on average, lower during QE1 and QE3. In contrast they were lower during Operation Twist and QE2. They also find a significant link between the Feds market shares of MBS and Treasuries and the MBS yields after accounting for expectations. Thus, they provide evidence for the portfolio balance channel and liquidity channel. MBS yields were about 55 basis points lower when the Feds held 24 percent of the available MBS.

Krishnamurthy and Vissing-Jørgensen (2013) provides an event study covering QE1, QE2, QE3 and Tapering events. Decreases in 15 and 30-year Agency MBS-yields were found to be 88 and 107 basis points for QE1, 9 and 12 basis points for QE2, 7 and 23 basis points for Operation Twist and 16 and 17 basis points for QE3. On Tapering events, the yield on Agency-MBS increased with 26 and 30 basis
points. Their main finding is that QE purchases work primarily through distinct channels – each having effects primarily on the asset purchased. This is in line with the main take away from Krishnamurthy and Vissing-Jørgensen (2011), that the effect of QE vary with the types of assets purchased. Secondly, they find that MBS purchases seems to be more beneficial for the economy than Treasury purchases.

Gagnon et al. (2011) found that QE1 reduced 30-year Agency-MBS yields by 123 basis points on event dates and a 140 basis points reduction in the 10-year Agency-bond yield. According to Gichrist, Lopez-Salido and Zakrajsek (2014) an unconventional policy easing that leads to a 10 basis points reduction in the short-end of the yield curve for US Treasuries would reduce 30-year MBS yields by about 12 basis points. A similar reduction in the long-end of the Treasury yields, would reduce the 30-year MBS yield by 10 basis points. Popescu (2015) discovered evidence of a positive effect of QE on the housing market, by examining the effect of QE on permits for building new houses and the number of new private house building starts. Gabriel and Lutz (2014) found that QE raised equity market returns for homebuilders and real estate investment trusts and increases housing sentiment. A 25 basis points reduction in the 10-year Treasury yield were found to reduce the Fannie Mae MBS yield by 36 basis points. However, the effect seemed to be short-lived and disappear after less than 60 days. Fuster and Willen (2010) measures the effect of QE1 on the primary mortgage rates by examining a menu of rates offered to borrowers. The data revealed a wide dispersions in the rate offered to borrowers, some seeing immidate reductions up to 40 basis points while other borrowers saw rate increases. Further, QE1 had led to a market boost in form of increases in searches, applications and originations for refinance mortgages, but not purchase mortgages. The improved credit availability was found to be more likely to benefit more creditworthy borrowers.

4.3.2 Analysis of QE’s effect on Agency-MBS

We use the 15-year and 30-year Freddie Mac MBS rates to analyze QE’s effect on MBS rates. As our data consist of weekly observations we cannot compute yield movements on the event dates and thus, we only consider the cumulative movements across the programs span. Graph 28 below plots the movements in the 30-year and 15-year Agency-MBS yield from 01.01.2007 to 01.05.2015. Both rates demonstrates a strong downward spiral throughout all three LSAP periods. Also we can see a upward shift related to Tapering events. Because of the turbulent state of the mortgage market prior to QE1, the strong downward trend was expected. Overall, we note that both the 30-year and the 15-year Agency
MBS moves in the same direction at all times, but it seems like the 15-year Agency-MBS reacted somewhat stronger than the 30-year Agency-MBS.

Graph 28: Agency-MBS yields 2007-2015 Source: Datastream

The articles in our empirical review generally agreed, that QE1 had a great impact on mortgage rates. Graph 29 support this as it demonstrates how the Agency-MBS yields were held at a lower point than it had prior to the announcement of the purchases. When we compare November 24 2008 with August 10 2010 (the day prior to and the last day of QE1), the 30-year Agency-MBS yield had decreased by 165 basis points and the 15-year Agency-MBS yield was down 186 basis points.

Graph 28: Agency-MBS yields during QE1. Source Datastream
QE2 did not include purchases of new Agency-MBS and thus were not expected to bring the same level of easing to the mortgage market. This anticipation if strengthened by the fact that most of the disruptions in the mortgage market sector had bypassed. Graph 29 shows a downward spiral at the start of the program. Hancock and Passmore (2011) noted that this is were likely due to portfolio balance effects from QE1, as the Fed still held a large portion of MBS. This theory can find some support in Graph 29. Where the Feds MBS shares also are plotted. We can see that the number of MBS on the Feds balance sheet peaks at the start of the program and that the MBS rates starts to increase as the Fed starts to sell of their MBS more rapidly. Also, Graph 28 above shows that the downward spiral at the start of QE2 is connected to a trajectory form QE1. Comparing the Pre-QE2 date to the end of QE2-date we see a -73 basis points difference in the 30-year Agency-MBS and a -94 basis points difference in the 15-year Agency-MBS.

QE3 did, like QE1, include purchases of Agency-MBS and thus were expected to cause downward pressure of MBS yields. Graph 30 show that the initial response in Agency-MBS rates were of the opposite sign of what we would predict, but following the short hike, the movements were of the expected sign. However, the difference in the MBS rates prior to and post-program was only 25 basis points for the 30-year Agency-MBS yield and 17 basis points for the 15-year Agency MBS yield.
The response to tapering announcements are in line with our predictions as we see an increase in yields for both maturities in our sample. Graph 31 show that the yields have kept higher than the pre-tapering level, but we note that the yields have been approaching the same level as before the tapering announcements in the spring of 2015. However, there could be several reasons for this and the Fed does still hold a large amount of MBS on their balance sheet.
4.4 Corporate bonds

4.4.1 Comparative studies evaluating QE`s effect on Corporate Bonds

Bauer and Rudebusch (2014) looked at corporate bond yield across several maturities during QE1. They find that corporate bond yields generally declined, but by less than Treasury yields. In 10-year maturities, AA-bonds declined by 89 basis points, BBB-bonds declined by 80 basis points and BB-bonds declined by 43 basis points. QE had diminishing effects across maturities for all bond rating – lower maturity bonds saw lower declines in yields. Part of the diminishing effect were likely due to increased credit spreads following bad news about the economy on announcement days. The increasing credit spread had a stronger effect on lower quality bonds (BBB and BB) and shorter maturities. Wright (2011) examines event dates during QE1 and the beginning of QE2 and finds significant evidence of monetary policy shocks effects on corporate bonds and lowers them by about 12,5 basis points. The effect did however decline rapidly over the subsequent months, limiting, but not eliminating their potential to provide support for the economy. Gagnon et al. (2011) found that QE1 reduced BAA yields by 67 or 74 basis points, depending on event dates included. Further they note that the yield on BAA bonds declined by 482 basis points between the start and end of QE1. Big cumulative movements in the BAA yield relative to other assets such as MBS and Agency-bonds, in combination with a rising Treasury yield, suggest that the “extreme financial strains and flight-to-quality that characterized the early part of 2009” dwindled over time. In Krishnamurthy and Vissing-Jørgensen (2011) there was observed a 77 basis points drop in AAA bonds and a 81 basis points decrease in BAA bonds on QE1 events. On QE2 events the corresponding bonds decreased by 23 and 18 basis points (two-day window). Neely (2010) finds a 35 basis points reduction in BAA yields on QE1 dates.

4.4.2 Analysis of QE`s effect on Corporate Bonds

We examine QE`s effect on corporate bonds by analyzing movements in the Moody`s Seasoned BAA and AAA corporate bond rates. AAA bonds carry the highest investment grade and are considered virtually risk free. BAA bonds carry the lowest investment grade and are considered as safe investments as well. We look at the yield changes on QE event dates as well as the cumulative change across the QE periods. The changes on event dates are summarized in table 14 below.

On QE1 event dates the BAA middle rate was reduced by a total of 35 basis points while the AAA middle rate was reduced by 48 basis points. This is seemingly a large reduction in the bond yields and supports the claim that QE had an effect on assets beyond those that were purchased in the program. As
we see from graph 32, yields on both Moody`s AAA and BAA was reduced substantially during QE1 and, unlike the Treasury Bond Yields, which stayed down after the event dates. When comparing the AAA and BAA bonds to the 10-year US Treasury yield for the same period, we can see that the AAA and 10-year US Treasury yield have been following somewhat the same pattern, while the BAA yield has experienced bigger downward movement over the course of QE1.

**Graph 32: Corporate bond yields during QE1. Source Datastream**

As for the Treasury rates, AAA and BAA bonds increases across QE2 and OT event days as well. BAA bond prices increased with 18 basis points on event dates in total, while AAA bond prices increased with 37 basis points. As discussed earlier, it is likely that these results stems from QE2 being widely anticipated and thus the market had adjusted to news before they were introduced. For QE2 and OT however AAA, BAA and 10-year Treasury yields all decline over the period, cumulatively. Especially in the middle of QE2 and OT, around the end of July 2011, all three yields started a downward trend. Unlike what we saw in QE1, it seems like AAA and BAA bonds are moving in more or less the same pace, while the 10-year Treasury yield experienced a bit more aggressive drop. The pattern is similar across all of the three assets.
On QE3 event dates the BAA middle rate was reduced by a total of 13 basis points while the AAA middle rate was reduced by 9 basis points. These small alterations contributed to keeping both BAA and AAA yields at relatively low levels throughout the whole period. The BAA does however move slightly different than the AAA, which goes in the same direction as the 10-year Treasury yield (minor increase). The BAA on the other hand is at a lower level at the end of QE3, as a result of a downward cumulative trend (graph 34). These movements are quite similar to those that we witnessed in QE1. The overall image is also in line with what we would expect.

On the Tapering event dates BAA bonds increased with a total 18 basis points. AAA bonds increased with 13 basis points. Although arguably not very strong effects the changes on the dates went in the expected direction. BAA and AAA bonds are moving in the same fashion, both shows a less aggressive trend than the 10-year Treasury yield (graph 35).

From what we can see in our analysis of BAA and AAA corporate bonds during the different rounds of QE is that there seems to be a connection between the Fed`s asset purchases and corporate bond yields. Our observation of the BAA and AAA bonds is strongly related to our observations of Treasury yields. Where we observed a strong effect of the asset purchases of Treasury rates we also observed bigger alterations in corporate bond yields and were we did not find strong a strong connection between purchases and Treasury yields we could not find a connection between the purchases and corporate

*Graph 33: Corporate Bond yields during QE2. Source: Datastream*
bond yields either. The corporate bond yields have been following the same path as the 10-year Treasury yield, which strengthen our conception that there do exist a portfolio balance effect.

Graph 34: Corporate bond yields during QE3. Source: Datastream

Graph 35: Corporate bond yields during Tapering. Source: Datastream
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*Table: 14. Source: Datastream*
4.5 Investor Confidence and stock markets
Theory and empirical works suggest that changes in monetary policy will transmit through the stock market via changes in the values of private portfolios (the "wealth effect"). This also goes for changes in the cost of capital, and by other mechanisms as well (Bernanke and Kuttner, 2005). Actually, when writing an article for the Washington Post, Bernanke (2010c) wrote, “higher stock prices will boost consumer wealth and help increase confidence, which can also spur spending”. All else being equal, downward pressure on long-term interest rates could increase equity prices through the different mechanisms. Firstly by lowering the discount rate applied by investors it could increase the present value of future cash flows and increase the valuation of the stock market. Secondly, portfolio balance effects will be relevant as equities could offer higher interest rates to investors in a situation with diminishing yields on bonds (Rajan, 2013). Thirdly, equity prices could be affected by increased corporate profits through lower borrowing costs and through stronger economic growth (realized and expected) (Dobbs, Lunds, Koller & Shwayder, 2013). In times of conventional monetary policy, Bernanke and Kuttner (2005) analyze the impact of changes in monetary policy on equity prices, and document that, on average, a hypothetical unanticipated 25 basis points cut in the Federal funds rate target is associated with about a 1% increase in excess stock returns.

4.5.1 Confidence channel: Consumer and Business Confidence
Sources of information when determining the confidence channel include indexes of business and consumer confidence. There are evidence that these measures are lagging indicators of stock market performance. It should be noted however, that separating QE from other factors affecting confidence proves a difficult task. Among others, Leduc (2010) reminds us that the relationship between business cycle fluctuations and changes in business and consumer confidence is controversial. As the government tries to impact economic activity, monetary policy is not the only tool to consider. In the recovery of the recent financial crisis in the US, fiscal policy instruments are found to have implications for confidence and economic recovery (Romer, 2009). If we consider confidence effects from the monetary policy side, the Federal Reserve is (as part of its dual mandate) in the position to control unemployment and inflation given that the transmission mechanism of changes in the federal funds rate is effective. Although QE is probably the most well-know and controversial measurement taken to substance economic activity, the Fed engaged in helping financial markets by influencing
interbank market conditions\textsuperscript{14}. Such factors are not accounted for in this thesis, but may very-well be an important contributor in addition to broader economic effects. For levels of consumer and business confidence, we refer to graph 36 and 37 below. Based on opinion surveys, the overall picture demonstrates that during all QE programs an increase in both business and consumer confidence has occurred, with business confidence increasing from a negative net percent to a positive. For consumer confidence, after the Fed introduced the first round, it increased relatively quickly. Surely, a crucial aspect of success for any monetary policy action would depend on consumers being confident, as they are the ones delivering the vitality for growth. If these levels would decrease however, critics would likely point at QE being ineffective. Supporters on the other hand would probably say that other factors should be taken in to account, such as the US economy still suffering from the economic downturn. We are now faced with the opposite situation. Critics appoint the increased confidence to be a factor of upsides possibly other than that of QE. Then who is correct? The fact is that whether estimated consumer confidence levels have decreased or increased during a given time, changes in macroeconomic policy are extremely difficult to evaluate. In contrast to for example the science of chemistry, the effects of macroeconomic policy does not offer controlled experiments. In addition to the high possibility of omitted variable bias, lags in the economy complicate models even further. The choice of metrics to use also has considerable potential for bias. Thus, even in broad, relative terms, it is hard to access whether there has been a direct effect of QE on consumer and business confidence.

\textbf{Graph 36: Consumer Opinion Surveys}\hfill\textbf{Source: Organization for Economic Co-operation and Development (2015a)}

\textsuperscript{14}See Table 2 “Measures of balance sheet policies” provided in this thesis for the overview of measures taken by the Federal Reserve under the recent financial crisis
4.5.2 Comparative studies evaluating QE`s effect on the stock market

Moessner (2013) found that explicit FOMC policy announcements about expansionary monetary policies, increased equity prices, for the S&P 500 index. Hattori, Schrimpf and Sushko (2013) found that the Feds QE program drove investors towards more risky assets. In Hausken and Ncube (2013) that the Feds QE program managed to support the stock market. By simulation, the expected path of the S&P 500 index without QE they found that the index would be lower over the period from the end of 2008 and onwards if the Fed had not implemented QE. According to Rosa (2011) FOMC news had a significant impact on stock prices. Neely (2010) found that the S&P 500 increased by 5.25 % on QE1 events. Gabriel and Lutz (2014) and, Lutz (2014) uses a time series regression to estimate that an unconventional monetary shock that lowers the 10-year Treasury yield with 25 basis points lead to an 11.2 % increase in the S&P 500 index and 12.7 % increase in the Dow Jones Industrial Average. Kiley (2014) found that a policy-induced 100 basis points decline in 10-year Treasury yields was associated with a 6-9 % increase in equity prices prior to the zero lower bound period, while the effect is weakened in the zero lower bound period with only 1.5-3 % increases in equity prices in response to QE news. However, the weakening may have been caused by the binding zero lower bound and the importance of short-term and long-term interest rates in determining the impact on equity prices of monetary statements, rather than the relationship between equity prices and long-term Treasury yields.
4.5.3 Analysis of QE’s effect on the stock market

In order to make an opinion of QE’s effect on the stock market we analyze the impact on the S&P 500 index. The index is applicable as it is designed to reflect the US stock market as a whole.

Across QE1 events the S&P 500 increased with 11.48% (Table: 15). However, our data is missing for 01.12.2008. Neely (2010) notes that for this event the S&P 500 index actually decreased by close to 5%, so our data would show a much smaller effect if the dataset were complete. However, the downfall of the index on this day was likely due to other news that occurred and not actually related to the Bernanke’s speech. On December 1, the UK government promised to back retail deposits at London Scottish Bank. US construction spending and the ISM index was released on this date and both were weaker than expected. In addition, the US was officially declared to be in a recession by the NBER dating committee (Neely, 2010). Thus, it arguably makes sense for us to leave this date out of our evaluation. Graph 38 show that, as with the other asset prices we have analyzed, there was a decline in the price in the spring of 2009, but after that the market picked up and exceeded the Pre-QE1 level quite a bit.

![Graph 38: S&P500 during QE1. Source: S&P Dow Jones Indices LLC, S&P 500©](image)

Our QE2 and OT data does not reveal any particular movement. In total, the index fell by 1.4% on the event dates, which is the opposite of what one generally would expect. However, as graph 39 describes, the index remained above the Pre-QE2 level throughout the program span.
On the QE3 events, we saw an almost 3% increase in the S&P 500 index. However, for major parts of the program, the index stayed below the Pre-QE3 level, which could suggest that the event shocks did not have lasting effects (Graph 40).

On tapering events we observe very weak effects across the announcements, with a total of 0.67% increase in the S&P 500 index. Graph 41 shows that the index stayed close to the pre-tapering level for most part of the period, but started to move away from it again around mid-October 2013.
Before the Fed launched their asset purchase program, the S&P 500 had seen a descending trend following the financial crisis of 2007 and 2008. Graph 42 below shows that the index has been slowly increasing since the before mentioned dip in the spring of 2009 and is slowly approaching to the same path as before the turbulence caused by the financial crisis. Our data for QE1 and QE3 shows the same level as Neely (2010) and Kiley (2014), varying around 1.5-3 % change per news shock. However, our estimates are far lower than the estimates from Gabriel and Lutz (2014) and Lutz (2014).
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Table 15. Source: S&P Dow Jones Indices LLC, S&P 500©

4.6 International bond rates

The Feds QE purchases are expected to influence international asset prices “because risk-arbitrage ties expected international returns closely together in a world of capital mobility.” All else equal, downward pressure on US Treasury yields should cause investors to swap their Treasury holdings for foreign bonds (Neely, 2010). Whether or not foreign asset prices are affected by the Feds quantitative easing would depend on how investors considers these assets. In a flight-to-safety scenario, foreign bonds has to be considered as safe by US investors in order for them to substitute these foreign bonds in favor of US bonds (Fratzscher, Lo Duca & Straub, 2013).
4.6.1 Comparative studies evaluating QE’s effect on international bond rates
Fratzscher et al. (2013) found that QE1 effectively lowered yields on government bonds globally across 65 markets. Further, they find that actual Fed operations had a larger effect than Fed announcement, which is the focus of most studies. According to Neely (2010) QE1 announcements had strong negative effects on international long-term bond yields, reducing yields on the 10-year Government bonds of Australia (-78 bps), Canada (-54 bps), Germany (-50 bps), Japan (-19 bps), the UK (-65 bps). He states that the weaker effect on the Japanese government bond was likely due to the fact the yields on these bonds were at a very low level (between 1-2 %). In Bauer and Neely (2013) the effect of the signaling and portfolio balance channel on international and US bond yields during QE1, QE2 and QE3 are investigated. Bonds with high degree of substitutability with US Treasuries (such as Australian and German government bonds) seems to be more affected by the portfolio balance channel, while the signaling channel are more significant towards countries that have similar interest dynamics as the US during normal times, such as Canada. Lutz (2014) found that quantitative easing in the US affected government bond yields in the UK and Germany. The study indicates that a -25 basis points shock in the 10-year US Treasury would lower the 10-year German and UK bonds by 17 and 50 basis points, respectively. The effect seemed to have worn off after approximately 750 days. Wright (2012) found the Canadian 10-year government bond yield likely to be reduced by 5,6 basis points on response to QE announcements. German and UK government bonds were reduced by 4,3 and 3,6 basis points respectively.

For the QE3 period, as discussed previously, German long rates and expected short rates actually rose around the key announcements, likely due to news about ECB bond buying that reduced spreads with peripheral countries. Thus, one cannot estimate a signaling or portfolio balance effect for these episodes, due to the presence of euro area news (Bauer & Neely, 2013).

4.6.2 Analysis of QE’s effect on international bond rates
We examine the different programs effect by looking at movements in a selection of foreign 10-year government bonds on event dates, using a one-day window. Table 16 summarizes the results. We do not consider cumulative changes as we did for the domestic bonds. The rationale for this is that the ECB and BOE were simultaneously conducting LSAP purchases of their own for most of the period and thus it would be hard to argue that the observed cumulative movement was due to the Feds purchases and not the two central banks in Europe’s own operations. This could arguably also have led to smaller effects on international bond yields compared to what we possibly could have observed in a
situation where the Fed was the only central bank conducting unconventional monetary policy. A similar argument was made in Neely (2010) who argues that the small reaction in Japanese long-term yields were likely due to the fact that these interest rates were already at a low point.

Our data suggest that QE1 did make an impact on our selected bonds. The Fed’s purchases seem to have had the largest effect on Canadian and Australian government bond yields, reducing the yields on the respective 10-year bonds with 50 and 30.5 basis points. The UK government bonds saw a 20.5 basis points reduction across QE1 event dates, while Dutch, German and French government bonds was reduced by 25, 20 and 16.7 basis points, respectively.

For QE2 and OT we generally do not observe any particular movements in most of the yields. Based on the results in our examination of the US Treasuries, this was widely expected. The exception from this is the Australian government bond which increased by 26.5 basis points on event dates. The movements do however carry the opposite sign of what would be expected as the effect of quantitative easing. As Australian government bonds are documented to be affected by US monetary policy (Craine & Martin, 2008; Hausman & Wongswan, 2011), we would have expected the result to be otherwise. Bauer and Neely (2013) predicts that the portfolio balance effect should have a particular strong effect on Australian bonds. However, our one-day window examination of QE2’s effect on US Treasuries also showed a positive effect, while we observed a negative effect in our two-day window. Bauer and Neely (2013) finds a negative effect on Australian yields with a two day-window, so a connection may be observed.

Also on QE3 dates, we see a positive effect on Australian bonds. However, unlike QE2, this does not fall in line with our observations of Treasury yields, except for the response in the announcement on 12.12.2012. Consequently, it is worth noting that most of the positive response in the Australian yields stems from this date. The Canadian government bond decreased by 14 basis points on QE3 dates, which is in line with expectations, as these bonds are maybe those most affected by US monetary policy in other studies. In the Eurozone, we see a small decrease in the total bond yields across event dates. However much of this stems from movement on 13.09.2012. On this date these movements cannot be ascribed effects from the US, but rather news about ECB purchases of Eurozone debt (European Central Bank, 2012).
On Tapering events we see that the yield on Canadian Government Bonds increases by 19 basis points and that the Australian yield increases by 4.5 basis points. We find poor and negative effects on the Eurozone bonds, while there was a small positive effect (2.6 basis points) on UK yields.

<table>
<thead>
<tr>
<th>Date</th>
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<th>CANADA 10Y GOV BOND</th>
<th>GERMANY 10Y GOV BOND</th>
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**QE2 and OT**

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**QE3**

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*Table 16. Source: Datastream*

Our analysis shows that 10-year government yields responded in the expected manner on announcements during QE1, but was all over harder to assess for QE2, QE3 and Tapering. As
mentioned before, this has a lot to do with the market adjusting to the news before they are released, but we also uncover some other implications. Implications include the size of the event windows and simultaneously ran QE programs by other central banks. Other studies (Bauer and Neely, 2013 and Neely, 2013) has found bigger effects by applying two-day windows rather than the one-day window applied in this study. The biggest effects are seen in the yields of Canadian bonds, which is in line with previous research (Craine and Martin, 2008 and Hausman and Wongswan, 2011 among others). Canadian bonds are regarded as very substitutable for US Treasuries. In addition, the Canadian financial market was experiencing less disturbance from its own central bank during this period. All in all the total picture that we are left with is quite similar to what we have seen in our assessment of the US Treasuries, where the movements in QE1 is in line with our expectations while the observations across the other programs are harder to interpret in a straightforward, sensible way.

4.7 Exchange rates
Another asset class that might be influenced by LSAP is the exchange rate. The intuition is not per say different from that of conventional policy. If a central bank buys assets and, can effectively adjust a variety of prices, it could include an alteration in the exchange rate. Regardless of monetary policy being directed towards the lower zero bound or not, if the goal of monetary policy is to lower the interest rate, then in theory, a lowering of the rate would lead to a depreciation of the exchange rate (Dornbusch, 1976). Demand for the US dollar would decrease, causing a fall in its value, which would lead to increased US competitiveness. Aggregate demand should then rise.

In conventional monetary policy, changes of the federal funds rate are found to have implications in the jump of depreciations of the US dollar. Conclusions that link such exchange rate dynamics to fundamentals can be found in papers of Andersen, Bollerslev, Diebold and Vega (2003) and Faust, Rogers, Wang and Wright (2007). Implications on jumps in depreciation are not only found in monetary policy actions, but also for the financial market impact of central bank communication. Rosa (2011a, 2011b) studies the effects of FOMC statements on the level of volatility of stock prices and exchange rates. Central bank policy decisions and communication are found to have significant effects on stock prices and exchange rates. In examining the impact of the Federal Reserve’s on bonds, stocks and exchange rates, Rosa (2012) finds the news of LSAP announcements to effect asset prices, including the exchange rate. This further shows consistency in the efficient market hypothesis, as asset prices alone respond to new information.
Yellen (2011) observe that a depreciation of the US dollar relative to other countries might have taken place during QE. Thus, falling domestic interest rates because QE may have exchange rate implications just like conventional policy has. We have earlier pointed out that although larger companies with access to capital markets are those who benefit by portfolio rebalancing, smaller businesses may benefit from supply chain effects. In addition, smaller companies who operate in the export sector may gain on QE. As a result of domestic currency depreciation these companies may experience increased competitiveness. Although currency depreciation serves well for exporting businesses it may also have its caveat due to case of economic conditions a country is experiencing. When discussing the real exchange rate channel Broadbent (2011) notes that while a depreciation of the exchange rate relative to a trading partner may boost the competitiveness smaller firms, they may have issues in getting access to credit under harsh economic periods. As opposed to larger firms who have access to credit through to capital markets, smaller firms may not have the ability to expand their operations and respond to the relative competitiveness.

4.7.1 Comparative studies evaluating QE’s effect on exchange rates
Labonte (2014) points out that many developed countries have employed stimulative monetary policies during the period of QE in the US and that this could potentially reduce the effects on the USD’s exchange rate. Yet he notes that the real value of the USD has declined from March 2009 to July 2011. Neely (2010) found that USD declined by 3,6 to almost 10,8 percent (depending on currency) over QE1 event dates. The study showed that the USD depreciated most against the Yen (10,78 %) and the Euro (8,13 %). The declines on the observed event dates were very large compared with the typical dollar movements. On average across the currencies the dollar depreciated 6,56 %. Further, Neely points out that the relative small depreciation of the dollar relative to the decrease in Treasury yields could plausibly stem from that investors interpreted QE announcements as bad news for the world economy, “provoking flights to safety that further depressed U.S. yields compared with international substitutes and reduced the required return to dollar assets” (Neely, 2013, p. 28). Glick and Leduc (2012) studied intraday rates between the USD and the British pound, Canadian dollar, Euro, Japanese yen and the trade-weighted dollar (the Broad Index). They found that the average intraday depreciation of the USD on event days were between 42 and 69 basis points for the different currencies on QE1 event dates and 13 to 27 basis points on QE2 dates. For QE3 event dates the effects ranged from five basis points appreciation to 18 basis points depreciations. Chen et al. (2015) found that the USD depreciated by 3,72 percent against Asian emerging markets currencies on QE1 event dates and
appreciated by 0.04 percent on QE2 event dates. Morgan (2011) found that QE1 announcements cumulatively increased the relative value of the Korean WON against the USD with 10%, that the Singapore dollar appreciated by 3.3% and the Indian Rupee appreciated by 2.1%. Further, he notes that the large effect on the won could reflect the openness and size of the Korean financial markets, while he expect that the lack of effect on other Asian currencies should stem from a combination of the effects of foreign exchange intervention and capital inflow restrictions. The latter reasoning is supported by Eichengreen and Gupta (2014), who examines the effect of tapering on emerging markets. Further, they found that emerging markets currencies depreciated against the dollar over the period of April-July 2013 with the strongest effect on the Brazilian real which saw a 12.52% depreciation over the period and the Indian rupee that depreciated by 9.98% against the USD. Aizeman, Binici and Hutchinson (2014) found significant evidence that 26 emerging markets currencies appreciated following the QE announcements and in turn depreciated following the tapering announcements. They study showed that emerging markets with robust fundamentals (current account surpluses, high international reserves and low external debt) saw a bigger currency depreciation following tapering news than currencies in less robust emerging markets. The findings support the reasoning in Morgan (2011) and Eichengreen and Gupta (2014); that countries with more open and bigger financial markets are more volatile as they should expect forthcoming balance sheet adjustments.

Our review of empirical studies suggest that QE had a strong effect on the exchange rates towards emerging markets, but failed to make an impact on exchange rates between the USD and developed markets in Europe and on the US’s biggest trading partners.

4.7.2 Analysis of QE’s effect on exchange rates
To follow up on the empirical literature on the subject of QE’s effect on exchange rates, we examined the dollar value against a sample of emerging market currencies, a sample of advanced market economies and, the US trade-weighted index. We examine the effect by looking at the movements in the exchange rates on QE event dates. Also, we consider the cumulative movements in the exchange rates over the period of the program span, but as we have discussed earlier, we cannot estimate how much of these movements that are a consequence of quantitative easing. However, because these movements are expected to be spread, it makes sense to include this in our analysis. As discussed earlier, we expect the analysis of the events in QE1 to yield the most legitimate results, as the other announcements were widely anticipated and thus in line with the efficient market hypothesis.
4.7.2.1 The USD and Emerging Markets

Our emerging market sample includes Brazilian real (BRL), the Indian rupee (INR), the Chinese Yuan (CNY), the Korean Won (KRW) and the Singaporean dollar (SGD). Table 17 below shows the movement in the exchange rates on the event dates, as well as the total effect\(^{15}\).

First, we notice that QE seems to have had little effect on the USD/CNY throughout all programs, including tapering face. This was expected as China is constantly intervening in the currency market to manipulate the USD/CNY. Graph 43 Show how the USD/CNY has seen very little movement and a flat trend over the last 10 years.


On QE1 events, the biggest changes are in the USD/BRL, where the USD depreciates with total 4.41 % and the USD/KRW, where the USD depreciates with 2.53 %. Strong movements in these currencies was expected and in line with the argument that more bigger and more open financial markets should experience a bigger effect Morgan (2011) and Eichengreen and Gupta (2014). Graph 44 shows that the USD depreciated against both currencies throughout the QE1 period. The USD did appreciate quite a bit against the KWD for a period between December 2008 and February 2009, but fell rapidly afterwards and returned to the same downward trend as USD/BRL. By the end of QE1, the USD had depreciated by 24.12 % against the BRL and 19.72 % against the KRW, relative to the pre-QE1 date (24.11.2008).

\[^{15}\text{Table 17 displays the percent change in the value of the U.S. dollar against the other currencies. Each rate is expressed in units of foreign currency per USD. Thus, a negative number corresponds to a depreciation in the value of the USD against the specified foreign currency.}\]
We do not see any particular movement in the USD/INR or the USD/SGD on the QE1 dates. The USD depreciated with -0.32% against the INR and appreciated with 0.047% against the SGD. These movements are not particularly large and comparable to normal fluctuations. Considering Graph 44, the USD did not depreciate as adequately against the INR and SGD as the BRL and KRW. Still the USD depreciated quite a bit against both over the course of the first round of quantitative easing from the Fed. Comparing the start and end date of QE1 the USD depreciated with 9.86% against the INR and 7.28% against the SGD.

On QE2 dates, movements in the USD are not found against any of our selected emerging market currencies. The strongest effect is observed in the USD/INR and the USD/BRL. The USD appreciated with a total 2.43% against the INR and 1.81% against the BRL. These effects are of the opposite sign than what we would have expected, but are nonetheless not particularly strong. In addition, our sample is missing the data for both currencies on December 10, 2010. Against the KRW and the SGD, the USD depreciated around 0.3-0.5 percent.

Over the period, all of the currencies held weakened against the USD for the first 13 months, but at the end of QE2 the USD had appreciated by 15.44% against the BRL and depreciated with 2.74% against the KRW (Graph 45). The USD depreciated against the SGD over the course of the program. The USD was 5.78% weaker than the SGD at the end of QE2 compared to the start of QE2. Against the INR, the

Graph 44: USD/EM currencies during QE1. Source: Board of Governors of the Federal Reserve System (2015h, i, j, k, l)
USD faced an upward spiral over the course of the program and had appreciated by 20.22% by the conclusion of QE2 (Graph 45).

**Graph 45: USD/EM currencies during QE2. Source: Board of Governors of the Federal Reserve System (2015h, i, j, k, l)**

On QE3 event dates we observe no significant movements in any of the currencies. The total movement on all dates ranges from -0.042% to 0.73%. Over the program span the USD depreciated against the KRW with 5.07% and appreciated with 3.04% against the BRL (Graph 46). The USD depreciated with 2.3% against both the INR and SGD over the course of the announcements (Graph 42).

**Graph 46. Source: Board of Governors of the Federal Reserve System (2015h, i, j, k, l)**
On tapering event dates, the USD appreciated against the BRL and KRW with 1.28% and 1.38% respectively. The changes do hold the expected sign, but are not as strong as we would expect.

Assessing the movement over the course of the tapering announcements, the USD had appreciated with 51% against the BRL by 24.06.2015, relative to 20.05.2013. However it had depreciated with 5.78% against the KRW (Graph 47). Against the INR and SGD, the USD appreciated with a mere 0.450% and 0.596% on the tapering announcement days. Against the INR the USD appreciated with 14.65% by 24.06.2015, while it appreciated with 6.77% against the SGD.

Graph 47: USD/EM Currencies during Tapering. Source: Board of Governors of the Federal Reserve System (2015h, i, j, k, l)
Our sample of developed markets includes Canadian dollar (CAD), Euro (EUR), Japanese Yen (YEN) and the Great British Pounds (GBP). Table 18 below shows the movement in the exchange rates on the event dates, as well as the total effect\(^\text{16}\).

Our data suggest that QE1 had biggest impact on the USD/EUR and the USD/CAD on event dates. The USD depreciated overall by 4.08 % against the EUR and 3.72 % against the CAD on the QE1 announcement days. Graph 48 shows the movements in the exchange rates during QE1 (24.11.2008 = 100). It shows that all of the currencies did indeed depreciate substantially for periods during QE1 relative to the pre-QE1 date. However, for a big part of the period, the rate levels contradict the theoretical expectations. Despite the biggest depreciations on the event days, the USD had only depreciated by 1.97 % against the EUR, when comparing the start and the end of QE1. On the other hand, the USD had depreciated with 15.6 % against the CAD. Against the YEN, the USD depreciated by 10.94 % and appreciated by 0.26 % against the GBP. Over the course of QE1 the USD depreciated with 10.16 % against the YEN and 4.11 % against the GBP.

\(^{16}\) Table 18 displays the percent change in the value of the U.S. dollar against the other currencies. Each rate is expressed in units of foreign currency per USD. Thus, a negative number corresponds to a depreciation in the value of the USD against the specified foreign currency.
On QE2 dates USD appreciated by within the range of 0,3-2,4 % against all of the developed market currencies on our sample. By the end of the program the USD/YEN had seen the biggest change, as the USD had depreciated by 6,23 %. The USD also depreciated by 3,16 % against the CAD and 1,01 % against the GBP, all relative to the pre-QE2 date (24.11.2008). Although weaker movements on the event dates, we notice that the USD kept weaker relative to the pre announcement date for a bigger proportion of the program span (Graph 49).

**Graph 48: USD/DM currencies during QE1. Source: Datastream**

**Graph 49: USD/DM currencies during QE2. Source: Datastream**
QE3 did not yield any strong movements on the exchange rates between the USD and our developed markets sample. The combined effect of all event days range from -0.71-0.77%. Comparing the start and the end of the program USD/EUR was down 3.98%, USD/GBP 1.98%, USD/CAD almost unchanged at 0.13%, while USD/YEN had appreciated by 3.82%. Further, Graph 50 shows that the EUR and the GBP remained below the Pre-QE3 level throughout the whole announcement period, while the YEN and the CAD stayed above the line for a great part of the era.

Graph 50: USD/DM currencies during QE3. Source: Datastream

As for QE3, we did not see any strong movements in the exchange rates on the tapering event days with effects varying from -1.02% to 0.92%. Considering the exchange rates we see that the USD has appreciated extensively against CAD, EUR and YEN, compared to the rates before the tapering announcements. However, the USD seems to have started appreciating long after the first events. The CAD started to move in a positive direction at an earlier point than the other rates. By 24.05.2015, the USD had appreciated against the YEN by 21.25%, against the CAD by 20.36% and the EUR by 15%.
4.7.2.3 Trade-Weighted Index

The Trade-Weighted U.S. Dollar index: Broad index refers to a weighted average of the foreign exchange value of the USD against several major trading partners; the Euro area, Canada, Mexico, and China. The trade-weighted index is composed such that it should reflect the developments in the US`s trading patterns (Loretan, 2005). Canada, Mexico and China alone accounted for over 41 % of the US exports in 2014. Thus, the index largely reflects the competitive patterns of the US.

From table 18 we can read that the Trade-Weighted index of the USD depreciated by 2.19 % on QE1 dates. However, across the other programs there is little record of large changes on the event dates with measured effects ranging from 0.012-0.6 % (appreciation). During QE1 we see that the USD stayed consistently depreciated, relative to the Pre-QE1 level, from the spring of 2009 and throughout the QE1 period. By the end of QE1, the Trade-Weighted USD had depreciated by 7.65 % since 24.11.2008 (Graph 52). During QE2, the Trade-Weighted USD stayed depreciated relative to the Pre-QE2 level throughout the whole program, but appreciated towards the end of the program, holding a low level (-6-8 %) for most part of 2011 (Graph 53). During QE3 we saw little movement. The Trade-Weighted USD stayed depreciated by 0-2 % throughout the whole period (Graph 54). The little movement on tapering event dates is also reflected by paltry movements during the tapering announcement period.

First around mid-2014, the USD started to appreciate and the Trade Weighted index had appreciated by 19 % by 27.11.2015.

Graph 51: USD/DM currencies during Tapering. Source: Datastream
Graph: 52. Trade-Weighted USD during QE1: Board of Governors of the Federal Reserve System (US) (2015l)

Graph 53: Trade-Weighted USD during QE2. Source: Board of Governors of the Federal Reserve System (US) (2015l)

Graph 55: Trade-Weighted USD during Tapering. Source: Board of Governors of the Federal Reserve System (US) (2015l)
<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>USD/CAD</th>
<th>EUR/USD</th>
<th>YEN/USD</th>
<th>GBP/USD</th>
<th>Trade-Weighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>25.11.08</td>
<td>FOMC Statement</td>
<td>-0.268 %</td>
<td>-1.244 %</td>
<td>-0.871 %</td>
<td>-1.353 %</td>
<td>-0.643 %</td>
</tr>
<tr>
<td>01.12.08</td>
<td>Bernanke Speech</td>
<td>0.371 %</td>
<td>0.710 %</td>
<td>-1.512 %</td>
<td>3.410 %</td>
<td>0.467 %</td>
</tr>
<tr>
<td>16.12.08</td>
<td>FOMC Statement</td>
<td>-0.737 %</td>
<td>-0.643 %</td>
<td>-0.442 %</td>
<td>0.464 %</td>
<td>-0.570 %</td>
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<tr>
<td>28.01.09</td>
<td>FOMC Statement</td>
<td>-1.539 %</td>
<td>-0.382 %</td>
<td>0.934 %</td>
<td>-0.930 %</td>
<td>-0.544 %</td>
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<tr>
<td>18.03.09</td>
<td>FOMC Statement</td>
<td>-0.024 %</td>
<td>-1.051 %</td>
<td>-0.779 %</td>
<td>0.329 %</td>
<td>-0.195 %</td>
</tr>
<tr>
<td>12.08.09</td>
<td>FOMC Statement</td>
<td>-1.117 %</td>
<td>-0.495 %</td>
<td>0.355 %</td>
<td>-0.224 %</td>
<td>-0.293 %</td>
</tr>
<tr>
<td>23.09.09</td>
<td>FOMC Statement</td>
<td>0.327 %</td>
<td>0.089 %</td>
<td>0.263 %</td>
<td>-0.292 %</td>
<td>0.098 %</td>
</tr>
<tr>
<td>04.11.09</td>
<td>FOMC Statement</td>
<td>-0.739 %</td>
<td>-1.071 %</td>
<td>0.520 %</td>
<td>-1.140 %</td>
<td>-0.513 %</td>
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<td><strong>Total</strong></td>
<td></td>
<td>-3.726 %</td>
<td>-4.087 %</td>
<td>-1.532 %</td>
<td>0.265 %</td>
<td>-2.193 %</td>
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<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>USD/CAD</th>
<th>EUR/USD</th>
<th>YEN/USD</th>
<th>GBP/USD</th>
<th>Trade-Weighted</th>
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<tr>
<td>27.08.10</td>
<td>Bernanke Speech</td>
<td>0.693 %</td>
<td>0.140 %</td>
<td>0.402 %</td>
<td>0.698 %</td>
<td>-0.002 %</td>
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<tr>
<td>21.09.10</td>
<td>FOMC Statement</td>
<td>0.126 %</td>
<td>-0.366 %</td>
<td>-0.466 %</td>
<td>0.219 %</td>
<td>-0.098 %</td>
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<tr>
<td>12.10.10</td>
<td>FOMC Min Released</td>
<td>-0.256 %</td>
<td>0.445 %</td>
<td>-0.329 %</td>
<td>0.779 %</td>
<td>Data missing</td>
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<tr>
<td>15.10.10</td>
<td>Bernanke Speech</td>
<td>0.738 %</td>
<td>0.521 %</td>
<td>-0.025 %</td>
<td>0.025 %</td>
<td>0.137 %</td>
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<tr>
<td>03.11.10</td>
<td>FOMC Statement</td>
<td>-0.089 %</td>
<td>0.084 %</td>
<td>0.755 %</td>
<td>-0.442 %</td>
<td>0.030 %</td>
</tr>
<tr>
<td>22.06.11</td>
<td>FOMC Statement</td>
<td>-0.031 %</td>
<td>-0.431 %</td>
<td>-0.100 %</td>
<td>0.508 %</td>
<td>-0.067 %</td>
</tr>
<tr>
<td>21.09.11</td>
<td>FOMC Statement</td>
<td>0.685 %</td>
<td>0.151 %</td>
<td>-0.039 %</td>
<td>0.763 %</td>
<td>0.490 %</td>
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<tr>
<td>20.06.12</td>
<td>FOMC Statement</td>
<td>0.216 %</td>
<td>-0.203 %</td>
<td>0.430 %</td>
<td>-0.191 %</td>
<td>0.116 %</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>2.082 %</td>
<td>0.340 %</td>
<td>0.628 %</td>
<td>2.360 %</td>
<td>0.606 %</td>
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<th>EUR/USD</th>
<th>YEN/USD</th>
<th>GBP/USD</th>
<th>Trade-Weighted</th>
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<tbody>
<tr>
<td>22.08.12</td>
<td>FOMC Min Released</td>
<td>0.761 %</td>
<td>0.112 %</td>
<td>-0.139 %</td>
<td>-0.120 %</td>
<td>0.120 %</td>
</tr>
<tr>
<td>13.09.12</td>
<td>FOMC Statement</td>
<td>-0.082 %</td>
<td>-0.142 %</td>
<td>-0.565 %</td>
<td>-0.093 %</td>
<td>-0.088 %</td>
</tr>
<tr>
<td>12.12.12</td>
<td>FOMC Statement</td>
<td>-0.162 %</td>
<td>-0.325 %</td>
<td>0.668 %</td>
<td>-0.081 %</td>
<td>-0.058 %</td>
</tr>
<tr>
<td>18.09.13</td>
<td>FOMC Statement</td>
<td>0.262 %</td>
<td>0.000 %</td>
<td>-0.413 %</td>
<td>-0.420 %</td>
<td>0.038 %</td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.779 %</td>
<td>-0.354 %</td>
<td>-0.449 %</td>
<td>-0.714 %</td>
<td>0.012 %</td>
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<th>GBP/USD</th>
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<tr>
<td>22.05.13</td>
<td>FOMC Statement</td>
<td>0.320 %</td>
<td>-0.039 %</td>
<td>0.936 %</td>
<td>0.638 %</td>
<td>0.321 %</td>
</tr>
<tr>
<td>19.06.13</td>
<td>FOMC Min Released</td>
<td>-0.225 %</td>
<td>-0.094 %</td>
<td>-0.617 %</td>
<td>-0.332 %</td>
<td>-0.064 %</td>
</tr>
<tr>
<td>18.09.13</td>
<td>FOMC Statement</td>
<td>0.262 %</td>
<td>0.000 %</td>
<td>-0.413 %</td>
<td>-0.420 %</td>
<td>0.038 %</td>
</tr>
<tr>
<td>18.12.13</td>
<td>FOMC Statement</td>
<td>0.566 %</td>
<td>-0.233 %</td>
<td>0.487 %</td>
<td>-0.915 %</td>
<td>0.132 %</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.923 %</td>
<td>-0.366 %</td>
<td>0.393 %</td>
<td>-1.029 %</td>
<td>0.427 %</td>
</tr>
</tbody>
</table>

Table 18. Source: Datastream and Board of Governors of the Federal Reserve System (US) (2015l)

The event data did not provide strong basis for claiming that the Feds QE programs had a big effect on exchange rates. The results came widely out as anticipated; where the only worthy returns stemmed from QE1 events. Albeit the returns were not strong, we did see some movements especially in currencies belonging to the US` major trading partners, such as Canada and the Eurozone. This claim...
may support the observed movements in the Trade-Weighted Index for the dollar, which to the largest extent stayed depreciated across the purchase periods. The tapering announcements did not seem to influence any of the exchange rates noteworthy during the one-day windows, nor did we see any particular movements during that time. It was first in the summer of 2014 that a larger incline in the Trade Weighted Index is observed and the USD against our developed market sample. On average the emerging markets currencies did not respond during the observed window and has yet to depreciate against the dollar (Graph 56). However we do note that the Brazilian Real did move in a stronger direction than the other currencies in our sample and rather followed a pattern similar to the average DM and the TW during over the tapering announcement period (graph 45). We note that the USD appreciated against all of our samples between QE3 and the Tapering announcements and as we know that the cutbacks were expected it is reasonable to assume that some of the strengthening in the USD over this period were followed an early market adaption.

We expected to see a stronger depreciation in the BRA and the KRW over the course all of the QE programs compared to the INR and SGD. For the latter we can say that this was the case, as the USD depreciated against the KRW to a larger extent than the other EM currencies in our sample, but the BRA did not act as we expected except for QE1. We did expect the TW to move down the lines of an IS-LM model, as this index should reflect trade and competitiveness by the US. These expectations were met to some degree, as the TW index certainly moved along the lines of the theoretical predictions.

4.8 Summary: Strength of the Feds quantitative easing

The limited effect of the bank-lending channel correspond with banks not responding in loans and leases of credit despite an increase in deposits. The relationship between deposits and loans of US commercial banks and the loan-to-deposits ratio gives us a rather clear picture of the situation during the QE programs. We then discussed this phenomenon by applying the theory of Fisher’s equation and note that banks are in the business of making profits, thus, risk neutral component matters – as the number of creditworthy borrowers may be limited during a financial crisis. We find further support for banks holding on to their deposits in the discussion of the M2 and M0 money stock.

Based on the empirical evidence and our own analysis, QE1 seems to have had a big impact on the housing market, especially early on in the purchase period. As the housing market improved, it seems as the effect of the purchases diminished. The Feds holdings of MBS also seems to influence the yields. During QE1 the MBS yield were lower than the pre-QE1 level in the period from March 18 2009 – Mid-June 2009. This suggests that MBS yields were affected primarily through the Feds holdings during this period. Both findings are reinforced by the examinations of QE2 and QE3. The effects on MBS yields seems to have passed through to mortgage rates, but some studies find that it mostly just benefit creditworthy borrowers.

QE1 seems to have had a great impact on corporate bond yields as well. The BAA yield decreases across the whole QE1 period, even when the Treasury yield were increasing, which may suggest that investors are more risk willing than they were in the beginning of QE1. QE2 event dates did not display any sensible movements in the yields, but the overall trajectory for both AAA and BAA pointed downwards, in line with the Treasury rate. On QE3 we saw small negative impacts on event dates that seemed to hold the BAA and AAA at low levels over the period, but the AAA moves more in the same direction as the 10-year Treasury, while BAA experience a slight increase over the period. Our observation of the BAA and AAA bonds is strongly related to our observations of Treasury yields. The corporate bond yields have been following the same path as the 10-year Treasury yield, which strengthen our conception that there do exist a portfolio balance effect.

Also when analyzing the effect on the stock market, we find a strong response to QE1 announcements accompanied by a cumulative increase across the period. QE2 events shows weak effects, but across the period, we see a strong growth in the index. By the end of OT, the S&P 500 is up 30 % compared to the start of QE2. For QE3, we see effects within what we would expect on event dates, but weak
movement across the period. In between QE3 and tapering and during tapering, the S&P 500 index continues to grow (Graph 38). These movements seems to lead the S&P 500 index back to the path it was on before the financial crisis. QE1 and QE3 event data shows movements between 1.5-3 percent for each event, which is the same level as some of the studies in our empirical review.

Although the indexes of both consumer and business confidence are generally positive is difficult to claim how much of the increase to be assigned the asset purchase program. Other factors such as fiscal policy during the period may also have contributed. This is most likely the channel which is affected by the highest number of macroeconomic variables, making any conclusions hard to draw.

Our data suggest that QE1 did make an impact on our selected foreign government bonds. The Fed’s purchases seem to have had the largest effect on Canadian and Australian government bond yields. We cannot say the same for QE2, where there is little response in bond yields on event days. On QE3 event days, we again see a strong reaction in the Canadian government bond, but modest response in the other bonds. Movements in Euro bonds during QE3 is likely due to announcements from ECB. Tapering events also show a strong response in Canadian bonds. Other studies has also found that Canadian bonds particularly reacts to US monetary news, so this was expected.

Our review of empirical studies on exchange rate movements, suggest that QE had a strong effect on the exchange rates towards emerging markets, but failed to make an impact on exchange rates between the USD and developed markets in Europe and on the US’s biggest trading partners. In our assessment of selected currencies in emerging markets, developed markets and the trade-weighted index, we did mostly not find any strong basis for claiming any connection between QE and the exchange rate. The results came widely out as anticipated; where the only worthy returns stemmed from QE1 events. The strongest movements were seen in US trading partners such as Canada and the Eurozone and we also saw similar trends in the trade-weighted index for the dollar

5. Conclusion
We have stressed the challenges and complications in measuring the impact of quantitative easing. Particularly, the fact that many of the policy events were greatly anticipated makes it an impossible task for event studies to capture all of the effect. Consequently, we doubt that it is possible to achieve any consensus on the subject, especially considering the subsequent programs. However, our work do
make ground for some consistent conclusions and strong believes for how the transmission mechanisms in quantitative easing behaves.

QE1 can be deemed successful in lowering interest rates on Treasuries and MBS and across all other assets. A strong response in MBS rates and corporate borrowing rates suggest that the program did successfully lower real borrowing costs. Some research does challenge the longevity of the effects, but in general, the results are in favor of QE1. In addition, QE1 had particular strong effects on Agency-MBS yields, which proves that direct effects on targeted assets are stronger than purchasing just Treasuries. It is consistent with the portfolio balance channel. For Treasuries, we found that the portfolio balance channel account for up to 70% of the movements in Treasury rates. However, we discuss how these estimates probably overstates the importance of portfolio balancing. In addition, we note that estimating the portfolio balance channel is difficult since it is ultimately the outcome of a proxy - the Kim Wright model. Although, any scientific of the preferred habitat theory may not be concluded, we find this theory more consistent than that of the irrelevance proposition due to the movements in Treasury yields. The combined evidence exhibited in this thesis shows that the Fed certainly can alter long-term interest rates through, inter alia, portfolio balance effects.

Event studies of QE2 does not yield any positive result, but rather the opposite. However, some former research has been able to find some effect of the expected sign by use of other methods. The exclusion of MBS purchases in QE2 especially led to disappointing effect on the mortgage market, compared to QE1. That being said, when we compare pre and post-QE2 levels, Treasury rates, corporate bond rates and exchange rates have decreased, while equity prices have risen. Over the course of the period, asset prices did move as we expected and although it is not possible to dismantle QE’s share of this effect it is reasonable to assume that it played a role. Similar results were found for QE3 as well. Here we also find movements on event dates that are in line with our expectations, however weaker than for QE1. Although QE3 also was anticipated, there were bigger uncertainties around the nature of the program in terms of the size, duration and composition of the purchases. This preserved some of the Feds surprise component and made market reluctant to fully adjust prior to the news. On tapering announcement days generally see that the prices are increasing, but the effects are varying from assets. Common for all is that asset prices increase over the tapering period, however we are in doubt how much, if any at all, of this effect can be credited tapering strategy. The Fed still holds most of the assets that it purchased during QE.
Besides anticipation, some other important factors likely aided QE1 in being more successful than QE2 and QE3. Maybe the most important argument is that the financial market distress and turmoil that we were experiencing at the beginning of QE1 were bypassed by the time of the other programs. Thus, the conditions surrounding QE1 arguably facilitated better circumstances for quantitative easing to enter in force. In addition, the 10-year Treasury interest rates were high when QE1 was launched (above 3 percent), but at a low level at the introduction of QE2 and QE3 (under 3 percent). Arguably, as policy decision makers are faced with low long-term interest rates, the amount of asset purchases necessary to efficiently produce downward pressure would need to be higher.

Since nominal interest rates usually do not go below zero, many analysts believed that the FOMC had run “out of ammunition” to control inflation and unemployment (their dual mandate responsibility). Based on what we have found, we would argue that the Federal Reserve retain an effective tool at the zero lower bound, but it seems as the powerfulness of their “ammunition” is dependent on the circumstances in which it is deployed. Specifically, the expectations towards QE may be very different from that of the period(s) examined.
Recommendations for further research:
The next time that it will be reasonable for the Federal Reserve to turn to quantitative easing there will likely be anticipations among investors prior to the launch. Thus, we believe that alternative methods to event studies should be further developed and improved in order to better measure the effect and further enhance our understanding of this policy. Our study argue that the response in asset prices following policy announcements are likely to vary based on the current level of long-term interest rates and the current financial market conditions. We therefore suggest that future research on the subject of quantitative easing develop methods to account for such factors.
References


Board of Governors of the Federal Reserve System (US) (2015e)
Monetary Base; Total [BOGMBASE]
retrieved from FRED, Federal Reserve Bank of St. Louis

Board of Governors of the Federal Reserve System (US) (2015f)
M2 Money Stock [M2],
retrieved from FRED, Federal Reserve Bank of St. Louis

Board of Governors of the Federal Reserve System (US) (2015g)
China / U.S. Foreign Exchange Rate [DEXCHUS],
retrieved from FRED, Federal Reserve Bank of St. Louis

Board of Governors of the Federal Reserve System (US) (2015h)
Brazil / U.S. Foreign Exchange Rate [DEXBZUS],
retrieved from FRED, Federal Reserve Bank of St. Louis

Board of Governors of the Federal Reserve System (US) (2015i)
India / U.S. Foreign Exchange Rate [DEXINUS], retrieved from FRED, Federal Reserve Bank of St.

Board of Governors of the Federal Reserve System (US) (2015j)
South Korea / U.S. Foreign Exchange Rate [DEXKOUS]
retrieved from FRED, Federal Reserve Bank of St. Louis

Board of Governors of the Federal Reserve System (US) (2015k)
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Appendix

Quotes signifying the uncertainty and skepticism of QE:

“We are effectively conducting the greatest monetary policy experiment in history and no one – no one in this room and no one outside this room – really knows how it's going to end.”

- David Zervos, 2014, Financial Markets Conference

"The recent global financial crisis has led central banks to rely heavily on “unconventional” monetary policies. This alternative approach to policy has generated much discussion and a heated and at times confusing debate. The debate has been complicated by the use of different definitions and conflicting views of the mechanisms at work.”

- Borio and Disyatat (2009)

"Note that the expectational and fiscal channels of quantitative easing, though not the portfolio substitution channel, require the central bank to make a credible commitment not to reverse its open-market operations, at least until certain conditions are met. Thus this approach also poses communication challenges.”

- Bernanke & Reinhart, 2004

"There is a considerable diversity of views within the FOMC, and among economists more generally, about the use of LSAPs and other nonconventional policy tools.”


“With $3.5 trillion in excess reserves sitting in the banking system, what good can the Fed do by adding to it that the banks couldn’t do on their own? The answer is nothing. Whatever has happened in the economy isn’t being caused by quantitative easing.”

- Alan Meltzer, Carnegie Mellon economist, in a comment to Fortune.com, 2014

“Quantitative easing (QE) has become a highly controversial policy, particularly in the USA, where the Federal Reserve has been criticized by politicians, investors and academics up to and including the charge of treason”.

- Simon Taylor, “The controversy over quantitative easing”, 2012