

An Economic Assessment of Quantitative Easing

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Introduction

With short-term interest rates hitting the zero lower bound in late 2008 to early 2009, major central banks around the world responded by implementing unconventional monetary policies. One of them is the policy of quantitative easing. Under quantitative easing, the Federal Reserve, the Bank of England and few other central banks bought large quantities of assets (mainly long-term bonds) and simultaneously injected huge reserves, also called ‘monetary base’¹ into the system (Benfor et al., 2009, pp. 90-100). Even the Bank of Canada conducted a similar, but brief, quantitative easing program by buying long-term securities (Lavoie and Seccareccia, 2012). The European Central Bank and the Bank of Japan on the other hand expanded the base money in their local currencies, but unlike the Fed and the Bank of England, these central banks lend money to large financial institutions instead of purchasing assets (Fawley & Neely, 2013).

In a monetary economy, the banks and the central bank play a crucial role to effectively make the modern payment system² function. An effective expansionary monetary policy requires commercial banks and other financial institutions to increase lending to businesses and individuals. New money is created and channeled to individuals in need of funds, thereby circulating within the economic system.

Mainstream economists assume that commercial banks and lending institutions are constrained by the amount of reserves they hold and these reserves must initially be deposited at the central banks (Wray, 2007). By this theory therefore, a central bank can simply increase the lending process by injecting reserves in commercial banks and other lending institutions. Heterodox economists, on the other hand, hold the view that banks are not reserve-constrained and, as such, they can increase their lending by directly creating money themselves.

The purpose of quantitative easing has been described to be an attempt to increase the base money in the monetary system to increase overall business lending in the economy. In this paper, we will analyze whether increasing the monetary base via quantitative easing helps increase bank lending in accordance with the mainstream view. If the mainstream view is found to be wrong, we will explain why quantitative easing failed to achieve its desired results. We will examine the

¹ The monetary base (also base money) includes all of commercial banks' reserves that are maintained in accounts with their central bank plus the total currency circulating in the public (Brunner, 1989).

² Payment and settlement systems: National systems for the clearing/settlement of payments within the banking system, in which proper functioning of interbank lending/borrowing increases financial stability through enhanced financial market liquidity, together with a central bank as lender of last resort.

history, motivation, means, and effectiveness of quantitative easing. We will do a critical analysis of quantitative easing. We will analyze particularly the Federal Reserve's conduct of quantitative easing, also known as the Large-Scale Asset Purchases (LSAP) Program, to support our argument for quantitative easing in general. We will discuss what the Federal Reserve was trying to achieve, how it conducted unconventional monetary policy and conclude whether the policy has been successful in achieving its desired results.

Mainstream vs Heterodox view on bank lending

According to mainstream economists, the process of money making is initiated from the deposits of exogenous base money, typically initiated by a process where a central bank deposits the base money in the accounts of the commercial banks (Seccareccia and Lavoie, 2015). This theory holds the idea that the main purpose of a commercial bank is to act as an intermediary where a bank functions to collect deposits and lend them to borrowers who need the money.

For the economy to expand, money creation requires an initial supply of base money. A bank deposit typically starts the money creation process. A portion of this deposit is channelled out to businesses (borrower) by the bank. As businesses invest, a portion of the money is paid out, for instance, as wages and to purchase raw materials. This deposit is again deposited in the banking sector. A portion of this money is further channelled to other businesses. Finally, the income generated by firms return to the banking sector again. By the same process, deposits keep building up and lending gets multiplied. This is called the money multiplier effect and here money is created even before firms start selling their products. This concept entails that the main constraint to such a money multiplier effect is the initial deposits. This entails a strong relationship between money creation and base money. Higher base money will allow banks to lend more, which will create more future deposits and lending than otherwise. According to the mainstream economists, for the economy to expand money expansion requires the supply of base money to increase, which then allows the banking sector to serve its intermediary role to allocate loanable funds to credit-worthy borrowers for the purpose of productive investments. Deposits generate loans and as such banks are constrained to lend businesses by the amount of reserves they hold. (Lavoie & Seccareccia, 2015).

The heterodox economists hold the view that the growth of money or the growth of loans are not constrained by reserves as no “initial base money deposits” are required to start the circulation of money via the multiplier effect as envisaged by mainstream economists. (Lavoie & Seccareccia 2015). In some economies in the developed world, there is no requirement for banks to maintain a reserve ratio to lend out funds to businesses and as such banks are not “reserve-constrained” by any means. Private banks can create money without the requirement of “reserves”. (Lavoie & Seccareccia 2015). According to this theory, money creation requires three key elements: the willingness of banks to take risks and grant loans, the creditworthiness of borrowers, and the willingness of borrowers to go into debt and take a loan.

We will demonstrate the creation of money through the heterodox window, by following Lavoie & Seccareccia (2015) using an example in an economy where we assume only two private banks conducting the banking business. Suppose a person wants to borrow \$20,000 to buy a car and is credit worthy enough to borrow. The lender of these funds (called Bank A) initiates the creation of money by lending him \$20,000. This loan as an asset for the bank and the deposits are treated as its liability. However, as funds are channelled to the bank of the car dealer (Bank B) to pay for the car, in the clearing process Bank A loses the deposits and it is faced with a deficit in its liability side. Bank B on the other hand has extra deposits in its account created by the deposits made by the car dealer, thus creating an excess of assets over its liabilities in its balance sheet. To match the balance sheet on a daily basis, Bank A will seek to borrow from Bank B which has a surplus of deposit in an interbank lending market, called the overnight market in Canada. Thus, new money is created through the loan process without the need of having deposits. This phenomenon can be extended to a more realistic banking system where multiple banks operating in the overnight market will be able to create money when they want to and yet be able to balance their assets with liabilities by the process of borrowing and lending in the interbank lending market. Banks in deficit could potentially always find other banks in surplus who would be willing to lend the deficits in the overnight market. However, for this process to be effective, banks involved in the overnight market must trust each other.

Money can also be destroyed when repayments are made by the borrower (Bank of England, 2014). When the car loan dealer repays back, the bank would simply destroy the amount of deposits from the borrower’s account and at the same time remove the loan that sits on the

liability side. In this way, commercial banks constantly create and destroy money according to business needs. However, as deposits rise with the creation of new money, banks can often require to hold more reserves to meet withdrawal needs from the depositors. The demand for reserves will increase and the central bank should rather supply extra reserves for the commercial banks at the given interest rate only to meet the demand. However, in no way does the central influence new money creation, except through its interest rate policy.

In case a particular bank fails to get lending to correct its deficits in the overnight market, a central bank can always intervene as a lender of last resort through its discount window. The central bank will simply advance funds to the deficit bank that was deemed to be untrustworthy by other commercial banks. This was applied in the aftermath of the financial crisis when banks froze their lending operations in the overnight market due to severe distrust. Nonetheless, the point we are making is that, within this perspective, banks are not “reserve constrained” to lend businesses that need financing. Banks returned to their usual interbank lending process in the aftermath of the financial crisis once central banks provided enough liquidity and banks gained confidence of their counterparties in the interbank market. Banks did not require extra base money to create more money through the lending process.

However, central banks do set the policy interest rate that directly affects rates charged for bank borrowing and paid on bank deposits. The policy rate decided by the central bank can influence the demand for bank loans in the economy. The central bank does not influence lending simply by creating more reserves. The idea of quantitative easing is an example of creating more reserves. Under this scheme, a central bank injects enough reserves to the commercial banks so that these banks can create new money themselves via lending to businesses that want to borrow. Commercial banks will only lend when it can make profits irrespective of extra reserves generated by quantitative easing. Our analysis should conclude whether quantitative easing has been effective in encouraging banks to lend, given the mainstream theory that views banks require “reserves”.

Defining quantitative easing

Quantitative easing is typically conducted when policy interest rates are nearing zero. (Bank of Canada, 2009). Many economists at major central banks believe nominal rates cannot theoretically go lower than zero since people can just hold their cash money than save it in a

bank that yields negative interest rates. However, many central banks in Europe are charging private banks for holding reserves. Yet it is widely believed by many economists working at major central banks like the Federal Reserve and the Bank of Canada that interest rates cannot just keep falling (Bank of Canada, 2009). This limitation prompts a central bank to adopt unconventional monetary policies when the economy is still struggling to come out of recession. One particular and popular unconventional monetary policy is to conduct quantitative easing. Officially, quantitative easing is an unconventional form of monetary policy where a central bank creates new money electronically by buying financial assets, like government bonds (Bank of England, 2016). This process aims to directly increase private sector spending in the economy to help the economy recover. Another related term is credit easing. Credit easing is a form of monetary policy where a central bank aims to increase liquidity (ease credit conditions) within a specific market sector of the economy through the purchase of financial assets (Bernanke, 2013). Both mechanisms involve reducing the long-term borrowing rates; however, credit easing typically targets a specific market and may not necessarily require the expansion of the base money.

The Fed's Asset Purchase Program in response to deflation after the great financial crisis has been labelled as quantitative easing by most economists as it involves the injection of base money into the financial system. Going simply by the definition of quantitative easing, it is fair to assume that any kind of expansionary monetary policy that involves asset purchases and base money expansion can be defined as quantitative easing. However, this is by no means as straightforward as it might sound like. The European Central Bank (ECB) and the Bank of Japan (BOJ) recently attempted to increase the monetary base by lending to banks instead of buying assets from the banks. Although the process is different from what has been described by the Bank of England, many people would consider this to be another form of quantitative easing (Fawley & Neely, 2013).

The former and the then Federal Reserve Chairman, Ben Bernanke, described its first Large Scale Asset Purchases Program (LSAP), also called QE1 operations as credit easing because the Fed was trying to improve liquidity in the long-term bond market and the mortgage market (Bernanke, 2013). The Federal Open Market Committee (FOMC), the committee of the Fed that manages asset purchase operations explicitly stated that the intention to pursue the first Large-Scaled Asset Purchases (LSAP) operations was to reduce the borrowing costs and increase the

availability of credit for the purchase of houses, which in turn should support housing markets and foster improved lending conditions in the financial markets. However, in the same speech, the Chairman stated that in a pure quantitative easing regime, the focus of the policy was the quantity of bank reserves, which are the liabilities of the central bank (Fawley & Neely, 2013). We find evidence of the monetary base expanding through the conduct of QE1 and as such, most economists prefer describing QE1 as a quantitative easing operation rather than a credit easing. Fawley and Neely (2013) described credit easing as a particular kind of quantitative easing only when the money supply is increasing.

The European Central Bank (ECB) and the Bank of Japan (BOJ) attempted to increase the monetary base by lending to banks instead of buying assets in the aftermath of the 2007-2008 financial crisis. Some people hold an extreme view that such an expansion can also be described as quantitative easing although they involve no direct asset purchases (Fawley & Neely, 2013). It seems that there is a diversity of views as to what quantitative easing actually is. For the purpose of this research paper, we will assume quantitative easing as described by the Bank of England. As such, we will assume the conduct of QE1 as quantitative easing rather than credit easing although many described it as credit easing that targeted the housing and mortgage markets.

History of the Money Supply Control

The policy termed “quantitative easing” was first used by the Bank of Japan (BOJ) to counter deflation. The policy interest rate used by the BOJ to conduct its usual monetary was close to 0.15% and the BOJ was running out of ammunition to fight deflation. The Bank of Japan experimented with this policy in March 2001 by initially buying excess government bonds to what was required to keep the policy rate close to zero. This resulted in an increase in reserves holdings for Japanese commercial banks at the BOJ from ¥1 trillion to ¥5 trillion. The BOJ continued to hold this policy till March 2006. The reserve holdings reached a peak of ¥35 trillion in 2004. The idea was to flood the commercial banks with reserves so that long-term and medium bond yields would drop. This should reduce cost of borrowing for businesses and hence encourage more borrowing.

Empirical studies conducted later showed that Japan’s first attempt to quantitative easing was not very successful. Bowman, Cai, Davies, and Kamin (2011) found that although injecting

reserves into the financial system helped ease liquidity problems, the impact on bank lending in particular was very insignificant. Ito and Mishkin (2006) concluded that successful unconventional monetary policy implementation required managing market expectations. The BOJ failed to manage expectations and that was the main reason why quantitative easing was not effective. Yet, in the aftermath of the great financial crisis that followed in 2008, major central banks around the world, including the Federal Reserve, the Bank of England, the ECB and even the Bank of Canada opted to put forward a policy that has not been proven to be effective.

Having said this, is it right that the unconventional policy conducted by the BOJ was the first of its kind? The fact is that although the term quantitative easing might have been an invention of the new millennium, similar methods of controlling inflation (conducting monetary policy) by monetary targeting mechanism similar to quantitative easing had already been used by central banks in western countries, including the Bank of Canada, the Federal Reserve and the Bank of England under the umbrella of “Conventional Monetary Policy” (or monetarism) rather than an unconventional one.

After the collapse of the “Gold Exchange Standard” under the Bretton Woods Agreement, global economies around the world experienced periods of very high inflation. Expected inflation was out of control (Mishkin, 2000). To anchor expectations of inflation, the Bank of Canada (BOC) became one of the first countries to introduce monetary targeting as an anchor to control inflation expectations. Inspired by Milton Friedman’s theoretical analysis based on the absence of a tradeoff between unemployment rate and inflation rate as well as the relationship between money growth and inflation, the BOC started targeting M1, the narrow definition of money which is comprised of currencies and demand deposits, as a means to control inflation. The popular belief was that the central bank could control the inflation rate simply by controlling the growth of money supply, in Canada’s case M1. Many other central banks from the developed world started adopting this policy, targeting either M1 or M2, including the Fed. The idea was to gradually reduce the growth of the money supply (through M1 or M2) to reduce inflation. It was believed that this would bring the inflation rate down without permanently hampering real GDP growth and without permanently raising the unemployment rate. Most central banks pulled off from this regime of monetary policy because it failed to achieve its stated goals. In the case of the BOC as well as the Fed, disinflation was achieved but then it moved to a period when

inflation started to increase again. Many major central banks stopped using money supply as its tool in the 1980s. The policy required that central banks be able to know and provide the required money demand in circulation. But money demand turned out to be unstable. Mishkin (2000) finds that one of the reasons this policy failed was because of the unstable relationship between monetary aggregates, like M1 with other economic variables like inflation rate and nominal income. In other countries, the failure of monetary targets was described to be the result of financial innovation as stated by the Bank of England (Mishkin, 2000). Financial innovation changed the relationship between interest rate movements and money demand.

The point we are trying to make here is to show the irony that what used to be the main anchor of monetary policy for major central banks in the late 1970s became a tool for the conduct of unconventional monetary policy in the aftermath of the financial crisis when base money was injected in the financial system to achieve economic growth.

Transmission Mechanism of Monetary Policy

To understand the motivations of the Fed's attempts to conduct unconventional monetary policy, it is important to understand the transmission mechanism that plays its role under a conventional monetary policy. There are two broad channels with which monetary policy is conducted; the asset-price channel and the credit-channel, both of which can be further sub-categorized as we will discuss in this section (Mishkin, 1996).

Asset-Price Channel:

Under the asset-price channel mechanism, monetary policies impact output and the price level by affecting asset prices. Several kinds of assets transmit this policy, but the most common is the interest-rate channel. Inspired from the Keynesian ISLM model, this theory holds that a fall in short-term real interest rates increases investment (or consumption of durable goods like housing) by reducing the cost of borrowing. This pushes the aggregate demand curve up, thus increasing output and the price level (Mishkin, 1996).

$i \downarrow \rightarrow I \uparrow \rightarrow Y \uparrow \text{ and } P \uparrow$

Asset-price mechanisms can also be of other forms. Under the exchange-rate mechanism, a fall in short-term rates causes the local currency to depreciate as deposits in local currency become

less attractive relative to deposits in foreign currencies. A depreciation in local currency leads to an increase in net exports as domestic goods become more competitive (Mishkin, 1996).

The equity-price mechanism focuses on Tobin's q theory (Mishkin, 1996). Tobin's q is defined as the ratio of the total market value of a firm to its cost of capital. This mechanism states that if q is high, it implies that equity price per every unit cost of capital is relatively high compared to that when q is low. This means that for every dollar cost of capital, firms get relatively higher price for shares that are newly issued when the firm's Tobin's q is relatively high. This makes public offerings of shares more attractive, which directly encourages more business spending. Cost of capital is directly affected by long-term interest rates as firms substitute between equity and debt when it comes to financing. Another way to encourage a higher Tobin's q is by increasing the money supply. As money supply increases, some people substitute the extra money with equity holdings, thus driving up equity prices. As such, lowering short-term interest rates which translates into lower cost of borrowing for more equity value makes issuance of new shares more attractive. More issuance of shares increases investments by corporations. An alternative channel that uses the same asset mechanism is through wealth effects. As expansionary monetary policy helps increase equity prices, people start spending more in the economy as they feel richer. This makes issuance of new shares more attractive by prompting more investments from corporations.

Credit channel:

The credit channel theory focuses on asymmetric information in the credit markets (Mishkin, 1996). Monetary policy affects the amount of total credit supply available, which in turn affects total investments in the economy. Factors that affect credit supply available arise from information discrepancies. There are two basic channels through which monetary policy impacts the credit markets: the bank lending channel and the balance-sheet channel.

Under the bank lending channel, it is assumed that banks lend money to credible borrowers for business spending and acts as the primary intermediary that solves the problem of asymmetric information in the credit markets (Mishkin, 1996). Under this theory, the central bank's attempt to increase the money supply leads to private banks holding extra money. With more money available, banks will increase their business lending. Through the multiplier effect in particular,

more investments via more lending will increase the total output and inflation. Contrary to the interest-rate channel, this theory takes no account of the impact caused by the changes in the cost of borrowing due to changes in interest rates.

Money supply $\uparrow \rightarrow$ bank reserves $\uparrow \rightarrow$ bank loans $\uparrow \rightarrow$ output \uparrow and $P \uparrow$

The mechanism is strong when banks play a major role in the credit market and when their loan making decisions are more correlated with their deposits. With the advent of deregulation and growth of financial innovation, many researchers believe this mechanism plays a weaker role in the monetary policy transmission than what it used to be. Banks are simply not constrained by reserves. We will expand on this theory later in our paper.

Many researchers tend to emphasize the role of balance-sheet channel. Under this theory, the external financing premium is indirectly related to a firm's net worth (Mishkin, 1996). This mechanism relies on the presence of asymmetric information. Lenders are constrained in their lending due to the presence of adverse selection and moral hazard. When a borrower's net worth is lower, it means that the collateral in the form of lender's claims in the face of liquidation is much lower. Risks associated with adverse selection is much higher with low net worth. At the same time, moral hazards are high when net worth is low as troubled firms with lower net worth are more likely to apply for risky loans to fund their investments. A higher net worth increases the lender's claims to the borrower's assets in the face of liquidation. Lenders feel secure as the impact of asymmetric information is reduced. Banks and financial institutions are more likely to lend when faced with lower asymmetric information.

Nominal $i \downarrow \rightarrow$ Equity Prices $\uparrow \rightarrow$ Adverse Selection $\downarrow \rightarrow$ Lending $\uparrow \rightarrow$ Investment $\uparrow \rightarrow$ Output and Price Level \uparrow

A drop in nominal interest rates also help increase a firm's net cash flow as lower cash is used to pay interest expenses which again reduces adverse selection.

Nominal $i \downarrow \rightarrow$ Net Cash Flows $\uparrow \rightarrow$ Adverse Selection $\downarrow \rightarrow$ Lending $\uparrow \rightarrow$ Investment $\uparrow \rightarrow$ Output and Price Level \uparrow

One difference between this mechanism and that of the interest-rate channel is that this mechanism focuses on changes in nominal interest rates rather than on changes in real interest

rates. Another effect of the balance-sheet channel is through the price level. An expansionary monetary policy that leads to a rise in price level reduces liabilities in real terms but typically inflates asset values. This is because debt obligations for repayment are fixed even in an inflationary period whereas asset values typically rise with an increase in the price level. As such firms that borrowed from banks and other financial institutions have higher net worth in real terms. Banks face less problems of adverse selection and moral hazards as higher net worth in real terms provides higher collateral in real terms, thus encouraging more lending.

Nominal $i \downarrow \rightarrow$ Price level $\uparrow \rightarrow$ Real Net Worth $\uparrow \rightarrow$ Lending $\uparrow \rightarrow$ Investment $\uparrow \rightarrow$ Output and Price Level \uparrow

The balance-sheet channel mechanism works through the rise of an initial price level that later further increases the price level through this phenomenon. This demonstrates a lagged impact of monetary policy. It might be hard to determine the duration of the lagged impact on the lending to occur.

Whether it was the credit or asset-price channels that the Fed was aiming at, that argument is open to discussion. However, most will agree that the Fed was injecting base money into the balance sheets of commercial banks and that can be easily attributed to the credit channel monetary policy mechanism. On the other hand, lowering long-term yields was another aspect that the quantitative easing promised and this can be attributed to the interest-rate channel. Before we get into further analysis, it is important to explain quantitative easing as viewed by the mainstream economists.

Quantitative easing mechanism through the interest rate channel:

Credit easing typically involves the lowering of long-term rates or yields of the assets the central bank targets. If this activity is combined with large-scale unsterilized asset purchases, it can be termed as quantitative easing. A quantitative easing can thus involve a reduction in long-term yields. A long-term bond's yield reflects its risk. It has an inverse relationship with its price since expensive bonds should have lower risk. To explain long-term bond yields we will decompose a typical bond yield into several components given by the equation:

$$y_t(\tau) = 1/\tau \int_t^{t+\tau} E_t^P [rs] ds + T P_t(\tau),$$

The $y_t(\tau)$ represents a typical yield on a US Federal government bond. The $1/\tau \int_t^{t+\tau} E_t^P [rs] ds$ captures the risk-neutral aspect of the yield which is identical of all bonds of varying maturities issued by the same entity. This says that the long-term yield is the total sum of expectations of future short-term rates given by $E_t^P [rs]$, inspired from the Expectations Hypothesis Theory (Gourieroux & Jasiak 2001, p. 164). The $T P_t(\tau)$ represents the term premium that is not reflected in the yield on a typical treasury bill of the shortest maturity. This premium is affected by monetary policy and captures bond risk that is unrelated to the structure of the yield curve. This $T P_t(\tau)$ reflects risk factors related to uncertainty of certain macro factors like GDP growth, changes in risk aversion of investors, changes inflation, credit risk of the issuer, liquidity risk and finally a premium for the possibility of market imperfections of the bond caused by a mismatch of demand and supply in the market.

To understand the quantitative easing effects on bond yields, we will explain the widely accepted quantitative easing transmission channels. The signaling channel states that quantitative easing works by changing expectations of future rates (Krogstrup & Christensen, 2016). When the Fed buys assets, it sends a strong signal that the future short-term rates will remain low for a long-time. This in turn should drag down yields on long-term bonds as we know that long-term yields are affected by future spot rates according to the Expectation Theory Hypothesis. The component $1/\tau \int_t^{t+\tau} E_t^P [rs] ds$ as well as $E_t \pi_t(\tau)$ can both be attributed to the signaling theory if expectations can be anchored by monetary policy. This says that the long-term yield is the total sum of expectations of future short-term rates.

The portfolio balance channel states that yields for long-term bonds drop as bond prices rise due to a reduction in the supply of these assets in the overall market created by the large-scale asset purchases (Krogstrup & Christensen, 2016).

Former Federal Reserve's Chairman Ben Bernanke, however points to another channel, called the "reserve channel" which is similar and yet is in sharp contrast to the portfolio balance channel (Krogstrup & Christensen, 2016). This channel is of special interest to us as it does seem to point out as to why the Fed was conducting quantitative easing. Under the reserves channel, the increases in the supply of bank reserves puts upward pressure on the bond prices as extra demand is created from the availability of extra reserves. Krogstrup and Christensen (2016)

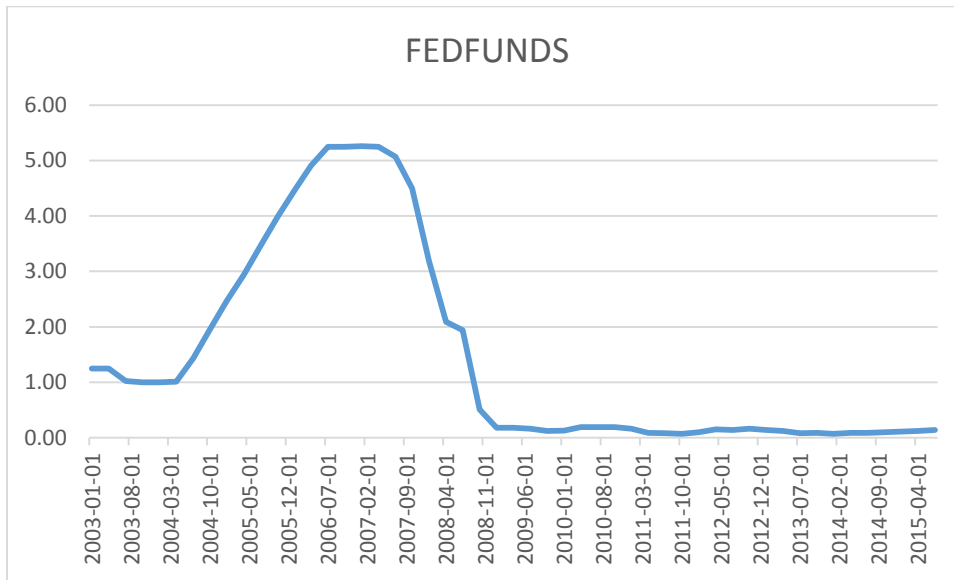
argue that there is enough evidence of this channel. They found that the Swiss central bank, called the Swiss National Bank, injected huge reserves into the domestic banking system without much altering the supply of long-term bonds simply by conducting lots of short-term repos. They found out that long-term rates dropped indicating a reserve-induced quantitative easing which is independent of changes in the supply of long-term bonds in the market. In the case of the Fed's Large-Scale Asset purchases, it is hard to assess the impact of the reserve-induced quantitative easing mechanism as bond supply was affected by the asset purchase program. The component $T P_t(\tau)$ demonstrates both portfolio balance and the reserves channel effects on the long-term bond yield. Other things remaining constant, a shortage in the supply of long-term bonds will reduce the risk factor associated with the $T P_t(\tau)$ as some of the risks have been transferred to the books of the central bank that purchased those securities. This reflects the portfolio balance effect. With more reserves and less number of bonds available in the market, investors faced with more cash will demand less premium associated with the risk of holding long-term bonds. Thus there will be a drop in the $T P_t(\tau)$ component, reflecting the reserve channel effect.

Motivations behind quantitative easing

A central bank commits to a zero interest-rate policy environment where it slashes policy interest rates to near zero and often promises to keep it near zero for a long period of time to change future expectations of short-term rates and also change the long-term yield by reducing the $1/\tau \int_t^{t+\tau} E_t^P [rs] ds$ component of a typical yield through the signaling channel. By late 2008, the US went through one of the worst financial crisis ever as financial markets stopped functioning, the economy went into a recession and the federal funds rate was brought down close to zero and could not be lowered any further. The Fed first adopted a forward guidance policy under this zero lower bound (ZLB) situation in which it promised to keep the federal funds rate close to zero until the monetary objectives were reached. The objectives were to bring the unemployment rate down to 6.5 percent and achieve a mid-term inflation rate of 2.5 percent, thereby anchoring the inflation (Engen et al. 2015). The Fed eventually continued to keep its policy rate near zero till mid-2015. However, such a signaling channel is inconsistent according to Eggertsson (2006) as people perceive that the central bank will eventually revert to its conventional monetary policy once economic conditions improve and, as such, market expectations are not completely

anchored by the central bank. This creates a drag in anchoring market expectations. This problem is called time inconsistency.

Figure 1: Federal Funds rate



Source: Federal Reserve Bank of St. Louis

Probably to counter the problem of time inconsistency it is believed that central banks, like the Fed, adopted the quantitative easing scheme to reduce long-term yields by conducting large scale asset purchases. Investors were expected to demand less yield as the risks of holding such bonds have been transferred to the Fed. More money is available to investors for less risk and the Fed’s purchase itself sends signals to the entire market about its motivation to lower the term premium on long-term yield. Thus, signaling, portfolio balance and reserve channeling were all expected to play a role to reduce the term premium and help stimulate the economy by encouraging borrowing and investment through the multiplier effect under the credit and asset-price channels.

The financial crisis of 2007-2008 followed after a collapse of the US housing market in 2006 (Covitz et al., 2009). Mainstream economists point out that the financial crisis arose due to the financial system’s association with complex packaged securities, mortgage backed securities and asset backed securities which were exposed to risky subprime mortgages that failed in the aftermath of the housing market collapse (Covitz et al., 2009). What followed was a “credit crunch” which is basically the curtailment of credit in the entire credit market. The default of many subprime mortgages caused credit rating agencies to significantly downgrade the credit

ratings of many of the complex packaged securities (Mizen, 2008). Large institutional investors, typically investment banks had already bought these highly profitable securitized assets through their managed Conduits and Securitized Investment Vehicles (SIV) and funded their purchases by issuing Asset Backed Commercial Paper (ABCP). The market for ABCP, therefore, was correlated with the value of the assets that the Conduits and SIVs held. As the news about the uncertainty of the mortgage backed securities and asset backed securities exposed to subprime mortgages spread, the market for ABCP froze. Major banks were initially forced to provide liquidity for the ABCP market and this finally took a toll on commercial bank lending when the entire banking system was exposed to the commercial paper market.

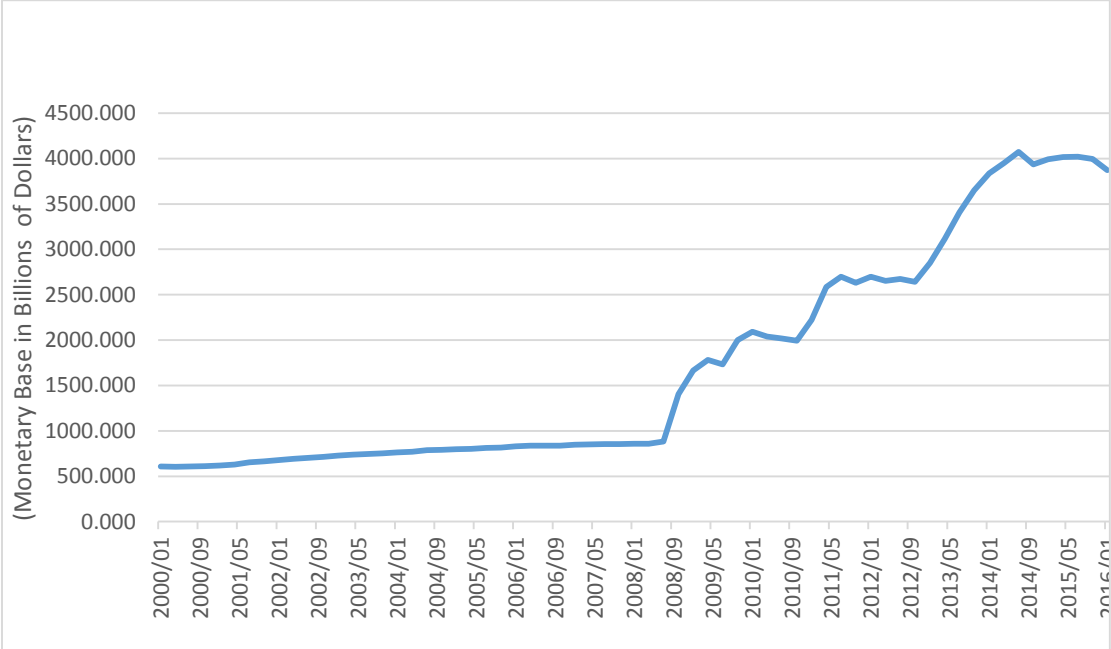
At the end of 2007, banks stopped lending among each other as banks became skeptical about each other's exposure to risk, thus prompting the credit crunch (Covitz et al., 2009). The Fed and other major central banks rushed in to provide liquidity to financial firms. The Fed opened its Discount Window Lending facilities to serve its role as a lender of last resort. These short term debts were sterilized by the equivalent purchases of treasury bills in order to keep the Fed's fund rate unchanged. After the collapse of the investment bank, Lehman Brothers, the demand for funds at the discount window soared and the Fed was forced to provide lending without any sterilization (Thornton 2012). This took place around September 2008, which was followed by a collapse of the federal funds rate to near zero. (Mizen, 2008, p. 545). This unsterilized lending facility just predated the purchase of securities under the first quantitative easing scheme called QE1. Yet, this was the first time the monetary base was allowed to increase as the Fed was motivated to provide liquidity to the financial markets. Although, no assets were purchased at this point, we might infer from this increase in the size of the monetary base that perhaps quantitative easing's secondary objective might have been to provide extra cash to the troubled banks in addition to help boost the economy.

The Fed's Large Scale Asset Purchase Program:

At the end of November, the Federal Reserve announced its plans to purchase \$100 billion in Government-Sponsored Enterprise (GSE) debt and \$500 billion in mortgage backed securities (MBS) issued by the same GSE (Fawley & Neely, 2013). On March 2009, the Fed announced to purchase an addition of \$100 billion in GSE debt, \$750 billion in MBS, and \$300 billion in long-term Treasury securities. The Federal Reserve purchased these assets from the financial sector,

thus directly increasing its balance sheet size. The purchases of these assets were met with increases in bank reserves at the Federal Reserve. These purchases are commonly referred to as QE1. It was the Fed’s first attempt to undertake quantitative easing by popular definition, although the Fed had already started increasing its monetary base from mid-2008 by conducting unsterilized lending through its discount window. Figure 2 below reveals that these purchases increased the monetary base/money reserves substantially.

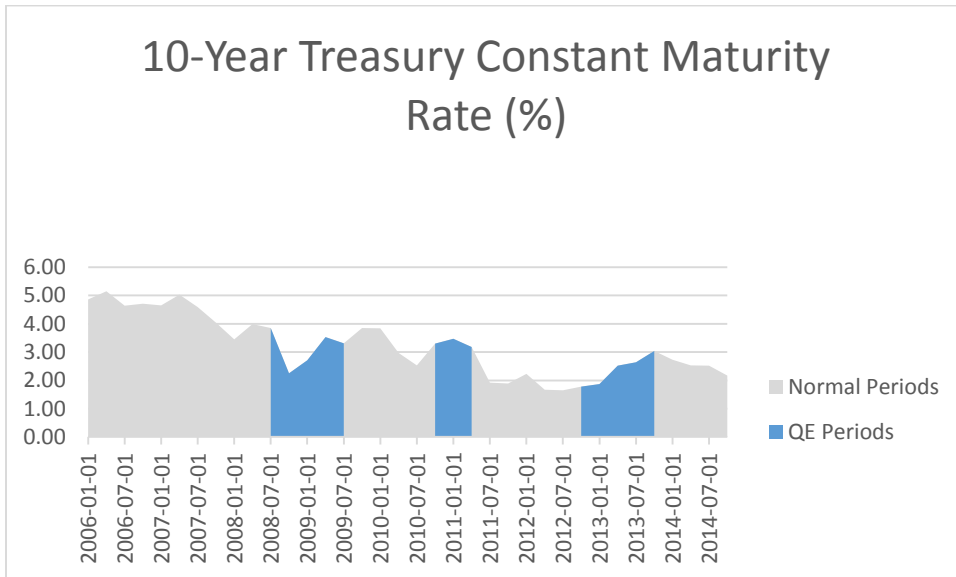
Figure 2: Value of Monetary Base over time



Source: Federal Reserve Bank of St. Louis

Although these asset purchases were designed to support the entire economy, the Fed was focusing particularly on the housing market, as indicated by its purchase of MBS and mortgage bonds. The idea was to reduce housing borrowing costs and provide liquidity in the MBS as well as the mortgage market so as to spur growth in the housing market and support the overall financial system. As described earlier, this operation was also termed as credit easing by the then Chairman of the Fed. However, if we look at Figure 2, it is evident that the monetary base kept on increasing throughout the period of QE1 which lasted until the first quarter of 2010. That is why this asset purchase scheme has been described as quantitative easing as well as credit easing. QE1 was very effective in bringing down long-term yields sharply right at the time of QE1 as shown by Figure 3.

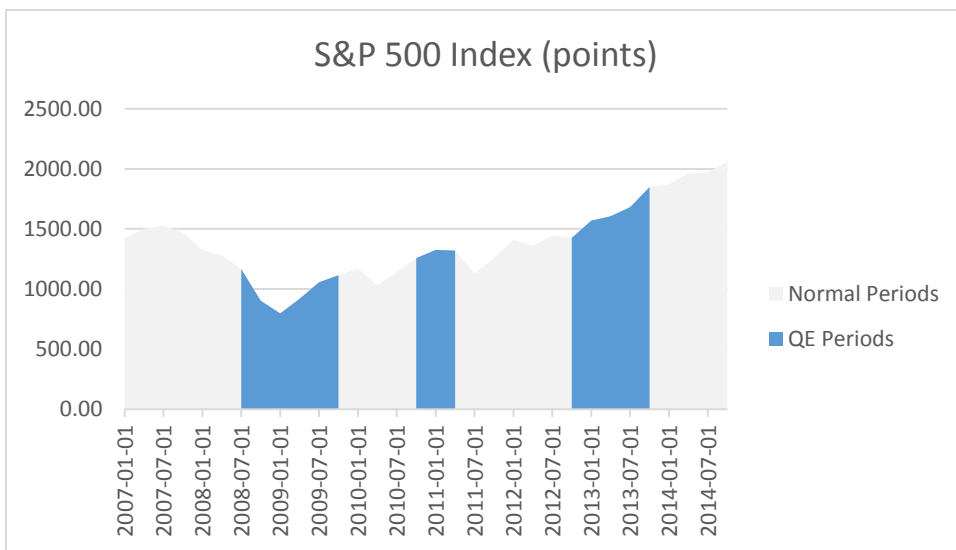
Figure 3: Yield of 10-Year Government Bond over time



Source: Federal Reserve Bank of St. Louis

Lower long-term interest rates indicate the partial success of quantitative easing in bringing down yields through the signaling, portfolio balance and reserves channel. If the traditional theory holds, a drop in interest rates, in particular, should help the Fed achieve its goals through various asset price channels, particularly the interest-rate channel by directly lowering the cost of borrowing.

Figure 4: S & P 500 Index



Source: Federal Reserve Bank of St. Louis

QE1 was also followed by a subsequent rise in global stock prices, as evident by the rise in the returns of the S&P 500 index. Although QE1 commenced at the third quarter of 2008, the significant rise in S&P 500 Index started from the middle of 2009. However, such a boom in equity prices can be caused by many other factors apart from quantitative easing. Research suggests that quantitative easing was one of the driving factors that caused the stock market returns to improve although it was not the most important factor (Villanueva, 2015). Given such evidence, the equity price channel theory under the asset-price channel and balance-sheet channel under the credit channel theory should help drive the economy following quantitative easing. There was also evidence of quantitative easing being one of the factors that led to the depreciation of the US dollar against major currencies (Martin Feldstein, 2010). According to the exchange-rate channel, the depreciation should help increase exports by making US export prices more competitive. As Figure 2 shows, the period of QE1 saw a huge build-up of the monetary base. This occurrence is testimony of the Fed wanting to increase the monetary base. With more money pumped into the financial system, according to the bank lending channel theory, more reserves should propel banks to lend out more money for investments. Although the Fed seems to have been successful in its objective of bringing down long-term borrowing rates, deducting whether business profited from such an action is trickier. We will form our analysis using empirical data to see whether monetary policy objectives were met with QE1.

Following a worrisome period of threats of disinflation throughout the year 2010, the Fed started buying treasury assets. But since these asset purchases were neutralized, the Fed's balance sheet and the monetary base remained fairly constant. However, that was not enough to dissolve the threats of disinflation. On November 2010, the Fed announced another round of asset purchase program popularly known as QE2 by deciding to buy 600-million-dollar worth of US Treasuries, which are long-term bonds. The idea was again to increase the monetary base in the system. That is why these purchases were not neutralized in the Fed's balance sheet.

The bond markets were already expecting a second round of quantitative easing as indicated by various polls that were conducted prior to the QE2 announcement. Figure 3 shows that the yield of the 10-year Treasury started falling from August 2010 and slightly rose after the QE2 announcement. This anticipation meant that asset prices had already adjusted prior to the announcement (Fawley & Neely, 2013). The yield on 10-year Treasury notes started falling from

April 2011. The program stopped in June 2011. Figure 2 confirms this. The monetary base time series became flat rather than increase at this point. Although, the slump in interest rates were lower than the previous asset purchases, the program received positive results as equity prices improved and the US Dollar depreciated.

Long-term yields on 10-year Treasuries continued to fall as shown in Figure 3. The end of QE2 (around June 2011) was followed by a credit easing process that involved a further purchase of long-term bonds of varying maturities by the Fed but neutralized by an equivalent sale of treasury bills and short term bonds to the financial markets (Fawley & Neely, 2013). This would be reflected by a flat monetary base line but a falling 10-year bond yield rate, as indicated in Figure 2 and Figure 3 right after June 2011. The Fed conducted this program for a total of \$267 billion dollar. For our research purpose in this paper, we will not identify this action with quantitative easing and we will not include this event in our empirical analysis of QE2.

Despite these efforts, the labor market remained sluggish and the Fed had to come up with another scheme. On September 2012, the Fed announced a third round of quantitative easing, called the QE3. This time, however, the Fed gave no information about the total amount it planned to buy. Instead it announced to purchase mortgage backed securities (MBS) at a rate of \$40 billion/month. Later in December of the same year, it announced purchases of \$45 billion/month worth of long-term Treasury bonds under the QE3 scheme. None of these purchases were sterilized and in Figure 2 monetary base shows its expansion from the fourth quarter of 2012 till the end of 2014 when the program was curtailed. The yield on 10-year treasury note, in Figure 3, shows an initial jump right at the commencement of the QE3 program (fourth quarter of 2012), which is rather contrary to what the intended objective of conducting a quantitative easing might be. However, it started to gradually fall from the 4th quarter of 2009. But the most interesting aspect from these quantitative easing operations is the rise in the monetary base to more than 4 trillion dollars at the end of QE3 period. This is phenomenal, given the fact that the monetary base was less than 1 trillion even before the commencement of the first quantitative easing process. It is quite evident from these developments that the Fed was targeting to splash the financial system with reserves so that these extra funds could be lent out.

Our objective is to find out whether quantitative easing conducted by the Fed was pivotal in helping the economy grow again in accordance with monetarism. Our primary interest is that of

quantitative easing at its purest form and as such we are specifically interested in the build-up of monetary reserves. We want to find whether the extra monetary injections prompted banks to start lending to businesses. Our main focus is the increase in the monetary base. According to theory, this idea can be attributed to the bank lending credit channel already discussed. Although the interest-rate asset channel or other channels can also help quantitative easing achieve its expansionary monetary goals, our hypothesis is that large monetary base injections should induce banks to lend more.

Model:

We want to find out whether bank lending was impacted which can serve as a proxy to our claims that improvements in bank lending should lead to an economic recovery through the various monetary policy channels already discussed. We test our hypothesis using a regression model given below:

$$(LogCIL_t - LogCIL_{t-1}) = \alpha + \beta_1 (LogCIL_t - LogCIL_{t-2}) + \beta_2 (LogOUTPUTGAP_t - LogOUTPUTGAP_{t-1}) + \beta_3 R.PRIME_t + \beta_4 CAPRATE_t + D_1 QE + \varepsilon_t$$

The Variables

The variable CIL_t is total Commercial and Industrial Loans at time t . $(LogCIL_t - LogCIL_{t-1})$ is the log differences in CIL_t from period $t-1$ to period t . This is our dependable variable as it indicates how much banks are changing their lending to businesses. The Commercial and Industrial Loans, CIL_t consist of all bank credit made to businesses for a wide array of purposes, but primarily for financing inventory and for investment in new equipment (Federal Reserve Bank of San Francisco, 2016). As of 2004, this segment is comprised of the second biggest asset classes at 18.5 % of total bank credit in the US. Commercial and Industrial loans, which are a major source of revenue and reflects US business lending performance from banking source. These loans exclude loans secured by residential assets, loans to other financial institutions, loans for agricultural production and loans to individuals. Therefore, this serves our purpose of reflecting a dependent variable that exclusively measures “loans for commercial purpose”. Commercial and Industrial loans are increasing over time. The variable CIL_t was first tested for stationarity using Dickey Fuller unit-root test. The time series data was not stationary. We expect that by taking the log differences the data can be made stationary.

We add a lag variable of the dependent variable denoted by $(\text{LogCIL}_{t-1} - \text{LogCIL}_{t-2})$.

$(\text{LogOUTPUTGAP}_t - \text{LogOUTPUTGAP}_{t-1})$ represents log differences between output gap from t-1 to output gap at period t and forms our most important explanatory variable. We choose log differences in output because the data for OUTPUTGAP_t is expected to be non-stationary. At the same time, the model needs to be consistent with economic behavior. Commercial and Industrial loans are assumed to be impacted by the output gap. To be consistent with the model, changes in output gap should reflect a stronger effect on changes in Commercial and Industrial loans than the simple output gap. The output gap is calculated as the difference between the actual GDP and the potential GDP. The output gap represents the cyclical nature of business lending. It is representative of the impact of the aggregate demand's impact on changes in business lending. Lending is expected to be positively related to the business cycle. In other words, we should expect a positive and significant coefficient for this variable. According to the modern business cycle theory, it is the changes in the business cycle that impacts business lending rather than the other way round although this theory is by no means in short of controversy. (Calverley et al., 2011). When the economy is doing well, gross domestic product (GDP) growth rises, unemployment falls, and therefore business confidence is also very high. This causes a higher demand for business loans from the side of the investors. Supply of business loans also rises during an economic expansionary period because default risks fall and lender underwriting standards loosen, thereby leading to an easier availability of credit. When the economy is doing poorly, GDP growth falls, unemployment rises, default risks rise and lender underwriting standards tighten. The demand for and supply of loans both increase during expansionary periods and vice versa. This results from the cyclical nature of business lending.

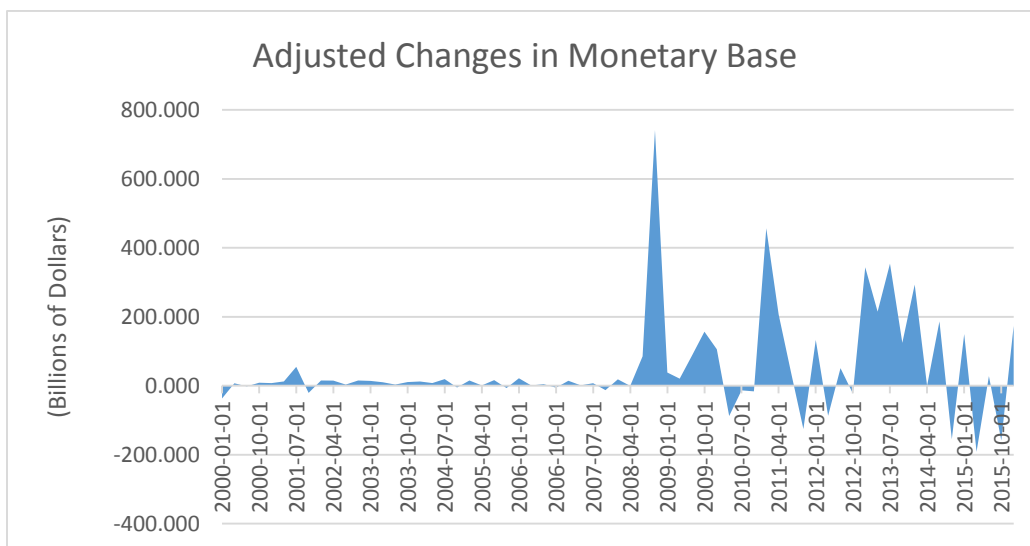
The $R.PRIME_t$ represents real prime interest rates. Prime interest rate is a short-term rate on which lenders are willing to accept to lend funds to the highest credit quality borrowers. Most Commercial and Industrial Loans are based on prime interest rates. Real prime interest rate is calculated by deducting the rate of inflation from the nominal interest rate to account for changes in the price level. Given that banks are actually not supply constrained, typically, a lower real prime rate should encourage more investments as the cost of borrowing becomes cheaper, keeping other things constant. Although banks are not assumed to be supply constrained in this regression model, policy interest rates affect the real prime rate which in turn determines the

demand for bank loans irrespective of the business cycle situation. We should expect to see a negative relationship with our dependent variable (Federal Reserve Bank of San Francisco, 2005).

The $CAPRATE_t$ is the bank capitalization rate. It is defined as the total FDIC insured bank equity / total FDIC bank total assets in our context. Berrospide and Edge’s analysis (2010) based on panel data finds modest effects of (Bank Holding Companies) capital-to-asset ratios on BHC lending. Using macroeconomic time series and aggregated commercial banks’ balance sheet data they found that there are modest effects of capital ratio shocks on loan growth. Highly capitalized banks tend to lend more money. Although most banks are assumed not to be reserve constrained, few banks are still constrained to lend due to regulation in the banking system. Banks take more risk with more lending. Regulation in the banking system restricts banks from over-lapping a certain risk threshold. As such, banks are required to have enough capital before they can increase their lending. The findings by Berrospide and Edge (2010) might be capturing the impact of regulation on business lending.

Our proxy for quantitative easing is a dummy variable QE which have values of 1 during periods of QE1, QE2 and QE3 and when the monetary base starts expanding on the third quarter of 2008. Figure 5 explains it.

Figure 5: Changes in Monetary Base over time



Source: Federal Reserve Bank of St. Louis

We choose the third quarter of 2008 as our starting point for assigning our dummy variable with '1'. The dummy variable is assigned 1 only during the periods that showed sharp changes in monetary base after 2008 and these changes correspond to the three quantitative easing periods that we have already explained. QE1 ended on the last quarter of 2009 shown by the highest steep of the curve. QE2 ran a small span of period from the fourth quarter of 2010 till the second quarter of 2011. QE3 is assigned from the fourth quarter of 2012 till the fourth quarter of 2013. The Fed pumped huge reserves during these periods and we are trying to find whether this variable serves as a proxy to quantitative easing and whether the dummy variable had any effect on the changes in business loans. We choose a dummy variable instead of actual changes in the monetary base because changes in the monetary base have occurred throughout our sample period. Figure 5 shows that there have been small occasional positive monetary base changes from the start of 2000 as the monetary base is an upward sloping curve as shown in Figure 2 earlier. This makes it hard to separate the impact of the unusual increases in the monetary base due to unconventional monetary policy activities from normal changes in the monetary base resulting from normal economic activity. We are only concerned whether the injection of huge reserves through the Large Scale Asset Purchases had any impact on the total business lending. As such, instead of taking actual numbers of reserves a dummy variable was deployed to indicate whether on average those quantitative easing periods are associated with changes in business lending keeping other things constant.

Data and Estimation:

The data used are all US quarterly data from 1985 Q1 till 2015 Q3. All the data were downloaded from the databases of Haver Analytics. For calculating real prime rates, we first calculated inflation rate by using quarterly Consumer Price Index (CPI) from Haver Analytics. Nominal prime rates were also downloaded from Haver Analytics. The data that was required to calculate bank capitalization was found on the website of the Federal Deposit Insurance Corporation. To ensure stationary data, we conducted Dickey Fuller unit-root tests on all the variables. Only prime rate and capitalization rates were both found to be non-stationary. As such we took the first differences of the data representing the two variables and ran the Dickey Fuller tests. After taking the first differences, the data was tested to be stationary. Then we conducted a Multicollinearity test. The results from the multicollinearity tests show no major detection of multicollinearity as shown in the table below.

Table 1: Multicollinearity tests, Collinearity Matrix:

	<i>LOG DIFFERECES IN OUTPUT GAP</i>	<i>R. Prime</i>	<i>CAPRATE</i>	<i>QE</i>
<i>LOG DIFFERECES IN OUTPUT GAP</i>	1			
<i>R. Prime</i>	-0.0711	1		
<i>CAPRATE</i>	0.0559	0.0405	1	
<i>QE</i>	-0.1893	-0.0089	0.3922	1

Then we added several lags to the model and tested for the optimal number of lags using the Akaike Information-Criterion. We found that the appropriate number of lags were 1 for all the explanatory variables apart from the quantitative easing dummy variable, which required 2 lags. We then tested this model for serial correlation test using the Breusch–Godfrey serial correlation tests and found that the model had no serial correlation at 5% significance level.

We tested the results of the regression using a robust standard error to account for heteroscedasticity. The results of the regression are shown in Table 2.

Table 2: Regression Results

Variable	Coefficient	p-values
Lagged Changes in CIL	0.799521	0.000 ***
Changes in Output Gap	0.156372	0.069 **
Lag of Changes in Output Gap	0.190747	0.034 ***
Prime Rate	0.001249	0.104
Lag Changes in Prime Rate	0.006920	0.434 **
Capitalization Rate	-0.505599	0.286
Lag of Capitalization Rate	0.540747	0.249
quantitative easing	0.002857	0.167
1 st lag of quantitative easing	0.002444	0.382
2 nd lag of quantitative easing	-0.002924	0.203
Constant	-0.001349	0.529

* Indicates Significance at 90% **95% ***99%

Conclusion derived from the Model

T tests were performed and the results determined from the p-values are posted in Table 2 above. The estimators are unbiased and efficient since the model has accounted for non-stationarity, and heteroscedasticity. At the 5% significance level, the first lag of our dependent variable and the first lag of changes in output gap are significant. At the 10% significant level, only the changes in output gap is significant. Real prime rate and its lagged variable are both found to be statistically insignificant possibly because our total number of observations is too low, given that we are using quarterly data. Capitalization rate and its lagged variable are also found to be insignificant.

However, we are concerned with the coefficients attached to the dummy variables and although we stated that we expect to see a positive relation with the dummy variables and the dependent variable, it is not surprising that the results indicate no relationship between quantitative easing and changes in Commercial and Industrial Loans. It is always possible to yield different results with an alternative regression model. However, the results are consistent

with what others have found regarding quantitative easing. Krishnamurthy and Vissing-Jorgensen (2013) uncovered evidence that the Fed's LSAP program had little "portfolio balance" impact on other interest rates and that quantitative easing was not a macro-stimulus.

Conclusion

According to our regression analysis, quantitative easing failed to make any significant impact on business lending. Our evidence shows that increasing more base money had no impact on money multiplication. Perhaps, the reason for quantitative easing failing to impact business lending can be related to the theory envisaged by the heterodox economists. If banks are not constrained by reserves, the injection of trillions of dollars serves no purpose in prompting banks to lend to businesses. In the case of the USA, interbank lending markets were working actively when quantitative easing was conducted. Banks were normally borrowing and lending between themselves. Banks could increase their business lending without the need of extra reserves that was created through the conduct of quantitative easing.

The heterodox viewpoint is right in explaining how money is actually created in a realistic banking practise. A study by the Bank of England (2014) also acknowledges this view.

In reality, reserves can only be used to make inter-bank payments but they cannot be directly channelled out to businesses and consumers since consumers and businesses hold no "Reserves account" (Bank of England, 2014). If bank lending is not affected by extra reserves and if those reserves cannot be directly channelled for business lending, then the reserves simply serve no purpose in increasing bank lending. This is why we conclude that quantitative easing has failed to live up to its promises.

The "bank lending channel" that holds the idea that banks lend when faced with more money supply is not an accurate channel that describes the monetary transmission mechanism. As for other channels described in the literature review, our results show no positive outcome from the conduct of quantitative easing. We have already discussed the interest-rate channel and the balance-sheet channel. Evidence has shown that long-term interest rates have fallen due to the Fed's LSAP operations and, as such, lower long term interest rates should have impacted business lending. Although we have not created any variable or a model that captures the impact of long-term rates, we do have a quantitative easing dummy variable that can vaguely be used to

proxy the impact of long-term yields. Given our findings that long-term yields did fall after quantitative easing, it seems that those channels have failed to live up to their expectations as well. However, we cannot claim that the interest-rate channel has failed to yield results based on this result because we do not have sufficient information about our dependent variable.

Our dependent variable, Commercial and Industrial Lending, is possibly comprised of mostly short to medium term loans that are used to finance mostly inventory. It is more likely for large corporations in US to finance long-term investments through the securities market. A drop in long-term yields was targeted with the vision of bringing down the cost of borrowing for long-term investments. If long-term business loans are insignificant as a proportion of the Commercial and Industrial Lending variable, the impact of quantitative easing, if any, via the interest-rate channel would not be reflected through this regression analysis.

As pointed out earlier, the equity-pricing channel and the exchange-rate channel should have helped business lending given that equity prices have risen and that the US dollar depreciated following quantitative easing. We have not conducted testing whether changes in the S&P stock market index or the US Dollar has had any impact on business lending. Therefore, we cannot directly claim that we can assure that quantitative easing has failed to deliver using the results through other channel mechanisms. We are merely claiming using our results that quantitative easing probably failed to make a serious impact through other monetary transmission channels.

Quantitative easing's ability to drive the economy through the money multiplier effect has failed to live up to its promises. So far, no economic research has come forward into stating that quantitative easing had indeed helped a central bank achieve its economic objectives.

So has there been any benefit to these asset purchases? Buying mortgage backed securities in large quantities have transferred toxic assets, particularly subprime mortgages and other securitized assets that were exposed to subprime mortgages, from the balance sheets of banks and other participants in the financial markets to the balance sheet of the Federal Reserve. Trust in the financial system has been recovered. This can be attributed to any other quantitative easing policy that involves central banks removing unwanted risky assets from the financial markets. On top of that, these asset purchases improved the liquidity in the financial system, thereby stabilizing a banking system that almost crumbled during the financial crisis. Perhaps, the

Federal Reserves, the Bank of England, the Bank of Canada and many other central banks can brag about their contribution to save the global financial system from crumbling all together.

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Appendix A: Stata Output: Model (lags) Selection, Regression Statistics & Robustness for 1985Q1 – 2015 Q3

Lag selection criteria for our regression model:

Model 11: 1 lags

Model 12: 2 lags

Model 13: 3 lags only for changes in Commercial and Industrial Loan, 2 lags for other variables

Model 14: 4 lags

Model 15: 5 lags

Model 16: 7 lags

Model 17: 8 lags

```

. *Selecting the best lags:
.
. estimates stats model11 model12 model13 model14 model15 model16 model17

Akaike's information criterion and Bayesian information criterion

```

Model	Obs	ll (null)	ll (model)	df	AIC	BIC
model11	121	389.4317	484.807	11	-947.6141	-916.8604
model12	120	385.79	487.5694	15	-945.1388	-903.3264
model13	119	382.0777	484.7317	16	-937.4633	-892.9974
model14	118	378.3691	485.4108	23	-924.8216	-861.0959
model15	117	374.6694	482.4984	27	-910.9968	-836.4181
model16	115	367.3907	476.4264	34	-884.8529	-791.5252
model17	114	364.4641	477.8359	37	-881.6718	-780.4324

Note: N=Obs used in calculating BIC; see [R] BIC note

```

.
. **Select Model 1
.
.

```

Serial correlation test results :

```
. estat bgodfrey, lags(1)
```

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	2.395	1	0.1217

H0: no serial correlation

```
.
```

```
. estat bgodfrey, lags(2)
```

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
2	2.505	2	0.2857

H0: no serial correlation

```
.
```

```
. estat bgodfrey, lags(3)
```

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
3	3.741	3	0.2909

H0: no serial correlation

```
.
```

```
.
```

```
. estat bgodfrey, lags(4)
```

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
4	3.932	4	0.4153

H0: no serial correlation

```
.
```

Regression test results:

```

. regress dif1_LN_DCIL L1.dif1_LN_DCIL dif1_LN_DOUTPUTGAP L1.dif1_LN_DOUTPUTGAP dif1_PRIME L1.dif1_PRIME CAPRATE L1.CAPRATE QEDUM L1.QEDUM L1.QEDUM
> L2.QEDUM, r
note: L.QEDUM omitted because of collinearity

Linear regression                               Number of obs =    121
                                                F( 10,   110) =   42.63
                                                Prob > F      =  0.0000
                                                R-squared     =  0.7933
                                                Root MSE     =  .00462

```

	Coef.	Robust Std. Err.	t	P> t	[95% Conf. Interval]	
dif1_LN_DCIL						
L1.	.7995211	.0626548	12.76	0.000	.6753539	.9236883
dif1_LN_DOUTPUTGAP						
--.	.1563719	.0850671	1.84	0.069	-.0122111	.3249549
L1.	.1907474	.0890115	2.14	0.034	.0143475	.3671474
dif1_PRIME						
--.	.0012488	.0007623	1.64	0.104	-.0002619	.0027596
L1.	-.0006919	.0008807	-0.79	0.434	-.0024373	.0010534
CAPRATE						
--.	-.5055993	.4712164	-1.07	0.286	-1.43944	.4282409
L1.	.5407466	.4664862	1.16	0.249	-.3837195	1.465213
QEDUM						
--.	-.0028574	.0020544	-1.39	0.167	-.0069288	.001214
L1.	.0024442	.0027822	0.88	0.382	-.0030695	.0079578
L1.	0	(omitted)				
L2.	-.0029243	.0022834	-1.28	0.203	-.0074494	.0016008
_cons	-.001349	.0021339	-0.63	0.529	-.0055779	.00288