2014

Quantitative Easing's Effect on Shadow Banking: Have Federal Reserve Purchases Caused a Collateral Shortage in the Repurchase Agreement Market?

Amanda A. Schaible
Scripps College

QUANTITATIVE EASING'S EFFECT ON SHADOW BANKING: HAVE FEDERAL RESERVE PURCHASES CAUSED A COLLATERAL SHORTAGE IN THE REPURCHASE AGREEMENT MARKET?

by

AMANDA ANNE SCHAIBLE

SUBMITTED TO SCRIPPS COLLEGE IN PARTIAL FULFILLMENT OF THE DEGREE OF BACHELOR OF THE ARTS

PROFESSOR FLYNN

PROFESSOR ODELL

APRIL 25, 2014

Abstract

Since the start of the financial crisis in 2008, the Federal Reserve has been engaging in quantitative easing. Quantitative easing is a form of open market operation in which the Federal Reserve buys long-term U.S. government and other securities, versus traditional open market operations that occur through the short-term Treasury bill market. At the same time, the shadow bank system, which is a system of financial intermediaries that perform unregulated credit intermediation outside of traditional banks, has contracted significantly. Some argue that this contraction is due to a collateral crunch induced by quantitative easing in the shadow bank system—a crunch that occurred when the Federal Reserve's quantitative easing program took high-quality collateral off the market. I will focus specifically on repurchase agreements, an instrument within the shadow banking that uses the same types of securities that the Federal Reserve has been buying during quantitative easing as collateral, to determine whether quantitative easing has led to a contraction of the repurchase agreement market. I find that increases in Federal Reserve asset holdings from 2005-2013, and specifically during QE1, are associated with decreases in primary dealer repurchase agreements. This shows that under certain circumstances, Federal Reserve asset purchases lead to contractions in the shadow bank system. This paper aims to increase understanding of how monetary policy affects shadow banking and understanding of the unintended consequences of monetary policy, such as decreased shadow bank lending caused by quantitative easing.

Contents

Acknowledgements

First of all, I would like to thank my readers, Professor Sean Flynn and Professor Kerry Odell, for their valuable guidance and continual support. I would like to further thank Professor Flynn for helping me come up with this topic and for originally convincing me to take an Economics course when I came to Scripps. Next, I would like to thank my parents and brother for their unwavering encouragement and support. I would also like to thank my best friends, the suite life, for always being there. Finally, I would like to thank the various professionals who took time out of their schedule to educate me on shadow banking and repurchase agreements.

Introduction

In an attempt to spur economic growth through credit creation, the Federal Reserve has been engaging in quantitative easing, a form of monetary policy in which the Federal Reserve purchases securities issued by the U.S. Treasury and other agencies. Quantitative easing differs from traditional open market operations because the scale is much larger, longer-term Treasuries and other types of securities are used, and the focus is on adjusting the quantity of reserves, instead of the price of reserves (Dolan 2011). Quantitative easing has taken a large amount of long-term Treasury and mortgage-backed securities off the market, which may be causing a collateral shortage in the repurchase agreement market, because repurchase agreements typically use these very securities. The aim of quantitative easing is to increase bank reserves, which the Federal Reserve hopes will lead to an increase in lending through an increase in the money supply (The Federal Reserve Bank of St. Louis 2011). Even though quantitative easing has resulted in a huge expansion of the Federal Reserve's balance sheet, it has not been effective in stimulating economic recovery. Each subsequent round of quantitative easing has been less effective than the last in stimulating credit creation and economic growth, signifying a diminishing effect of the policy (Rosenberg 2013).

Shadow banks include all entities outside of the regulated banking system that perform credit intermediation; the four aspects of credit intermediation include credit risk transfer, leverage, liquidity transformation, and maturity transformation (Kodres 2013). Shadow banking includes vehicles such as money market funds, hedge funds, structured investment vehicles, repurchase agreements, and other non-bank financial instruments

(Adrian, Ashcraft and Cetorelli 2013). These instruments are often sponsored by or affiliated with banks, investment banks in particular (Kodres 2013). Many shadow banks rely on funding provided by repurchase agreements or asset-backed commercial paper, as opposed to traditional banks which rely on deposits for funding (Adrian and Ashcraft 2012).

Shadow banks behave like banks in that they generate credit by issuing liabilities, but they differ from traditional banks in that they are widely unregulated (Adrian and Ashcraft 2012). They also do not have access to the Federal Deposit Insurance Corporation (FDIC) or the Federal Reserve's Discount Window, making them more fragile than traditional banks (Adrian and Ashcraft 2012).[1] Certain shadow banking instruments, such as repurchase agreements, use U.S. Treasuries, mortgage-backed securities, and agency bonds as collateral, but quantitative easing has taken many of these securities off the market (McCormick and Kruger 2012). Therefore, some argue that the shadow banking system is starved of collateral, which has caused shadow bank lending to decrease (Kessler 2013). In 2008, the shadow bank system contracted significantly, and certain facets of shadow banking have experienced little to no growth since that decline (Kocjan, Ogilvie, Schneider, and Srinivas 2012). Although the purpose of quantitative easing is to increase lending and credit intermediation, if shadow banking has suffered due to quantitative easing, then the program may have counterproductive effects. My goal is to determine and quantify the effect of quantitative easing on shadow banking.

[1] The FDIC is a government entity that insures bank deposits against bank failures. The FDIC aims to maintain confidence and stability within the banking system. The Federal Reserve Discount Window is where banks can borrow from the Federal Reserve.

In order to answer the question of whether quantitative easing has led to a decrease in shadow bank credit intermediation, I will focus on repurchase agreements. A repurchase agreement, also known as a repo, is a money market instrument used to raise capital (BlackRock 2014). It is essentially a collateralized loan. Through a repurchase agreement, the owner of a security sells it to an investor, receiving cash in return, with the agreement to buy the security back at a predetermined price at a later, predetermined date (BlackRock 2014). Repos serve as relatively safe short-term loans for investors and cheap financing for security holders (Carpenter 2014). Uses of repurchase agreements include meeting short-term funding requirements, obtaining cheaper credit than possible through other speculative instruments, financing long positions, and more (Carpenter 2014). Repos allow the seller to receive secured funding and allow the buyer to receive liquidity on a short-term basis. Typically, repurchase agreements are performed on an overnight basis, with the security bought back the next day (Financial Stability Board 2012). I have chosen to focus on repurchase agreements because they inherently require the use of collateral and would presumably be directly affected by any collateral availability fluctuations caused by quantitative easing. Focusing on repurchase agreements, rather than shadow banking as a whole, will make it easier to understand if quantitative easing has caused a collateral shortage. Lastly, repurchase agreements often involve the use of government and agency securities, which are the types of securities that the Federal Reserve has been buying.

I attempt to determine whether quantitative easing has caused a counterproductive consequence of decreased credit intermediation, which, if found to be true, may hold monetary policy implications. I aim to increase understanding of the Federal Reserve's

ability to control or influence the shadow banking system. Such an increase in understanding might be helpful to policymakers.

Literature Review

Quantitative Easing

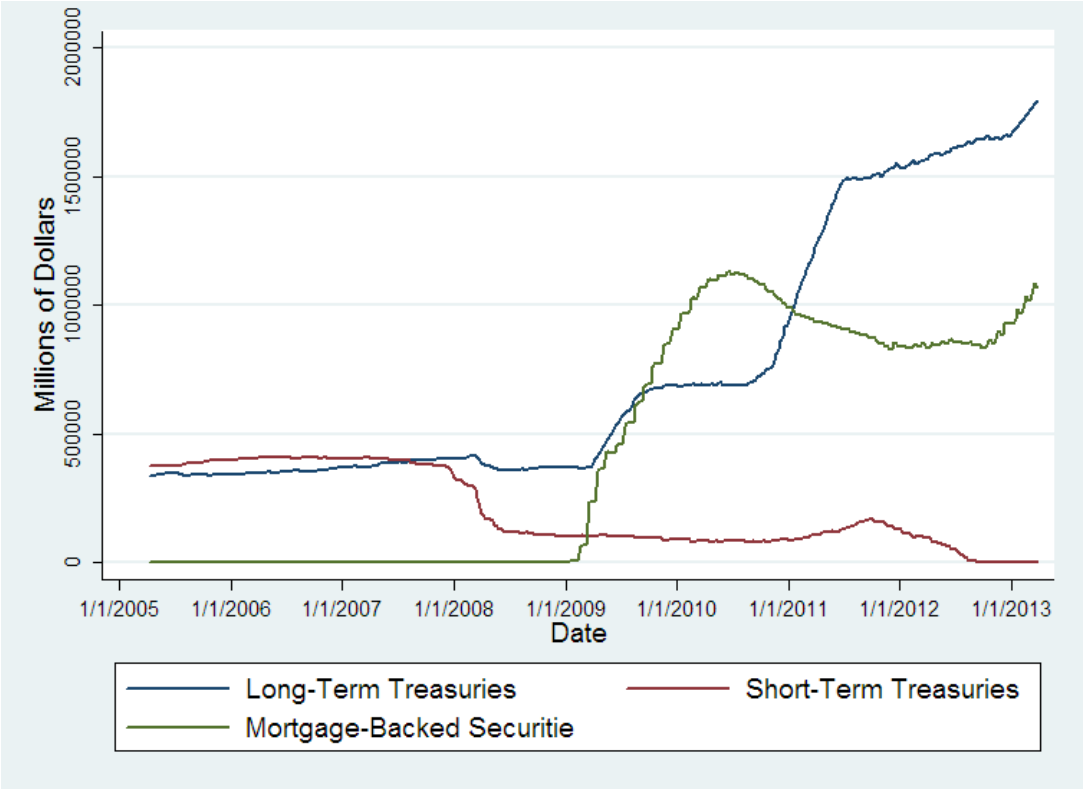
The financial crisis of 2008 and the following recession called for unconventional monetary policy (Williams 2013). With interest rates at the zero bound, the Federal Reserve could not stimulate demand by lowering interest rates any further (Dolan 2011). Therefore, the U.S. central bank responded to the financial crisis through unconventional measures. Open market operations, the buying and selling of bonds, have been a major form of monetary policy for decades. The financial crisis, however, spurred an innovative variety of open market operation. The Federal Reserve started using quantitative easing, a specific open market operation wherein the Federal Reserve buys long-term Treasury and other securities. Quantitative easing differs from traditional open market operations because it operates on a much larger scale, involves the purchase of longer-term securities, and focuses on changing the quantity (not the price) of reserves (Dolan 2011). When the Federal Reserve buys a security, money is given to the bond dealer that previously owned the security, which increases the money supply if the bond dealer deposits and the bank lends out the funds. Because the bond dealers are typically part of large banks such as Goldman Sachs, the Federal Reserve hopes that the bank, which employs the bond dealer, will lend a portion of its increased reserves, thereby expanding the money supply and, hopefully, stimulating economic activity.

Quantitative easing has been pursued on a large scale; the Federal Reserve "doubled its balance sheet in the three months after the climax of the crisis in September 2008" (Hoermann and Schabert 2011). Before the recession, the Federal Reserve held

about $700 billion of Treasuries and partook in open market operations on the scale of tens or hundreds of millions of dollars per week (Federal Reserve Bank of St. Louis). Today the Fed holds over two trillion dollars of U.S. Treasuries and engages in buying tens of billions of U.S. long-term Treasury securities monthly, Federal Reserve holdings from April 2005 to March 2013 are seen on Figure 1 (Federal Reserve Bank of St. Louis). The first round of quantitative easing (QE1) started in November 2008 and lasted for 17 months. It focused primarily on mortgage-backed security purchases, with the Federal Reserve buying $100 billion of securities a month (Harrison 2011). When QE1 ended in 2010, the Federal Reserve was holding $1.25 trillion of mortgage-backed securities, $300 billion of U.S. Treasuries, and $175 billion of agency debt (Federal Reserve Bank of St. Louis). As the values of mortgage-backed securities crashed, the Fed took many mortgage-backed securities onto its balance sheet to prevent further meltdown and to support the functioning of credit markets (Harrison 2011). The second round, quantitative easing two (QE2), started in November 2010 and continued until June 2011 (Harrison 2011). During QE2, the Federal Reserve bought $85 billion of U.S. Treasury securities a month (Harrison 2011). Quantitative easing 3 (QE3), started in September 2012 and is still continuing, but is slowly being phased out. Starting in December 2013, the Federal Reserve decided to begin tapering the program by reducing the quantity of securities bought by $10 billion each month (Shellock 2013). From September 2012 through December 2013, the Federal Reserve was buying $85 billion of bonds a month. The monthly purchase consisted of $45 billion of U.S. Treasury securities and $40 billion of mortgage-backed securities (Kurtz 2013). Currently, the Federal Reserve is phasing out

of QE3 by decreasing the amount of securities bought by $10 billion a month (Financial Times 2013).

Figure 1: Federal Reserve Treasury and MBS Holdings (Millions of Dollars)



Quantitative easing has only been undertaken in troubling economic times when traditional monetary policy would not be effective, given that interest rates are at the zero lower bound (Martin and Milas 2012). When quantitative easing was first introduced after the 2008 financial crisis, the goal was to stabilize a struggling banking system (Putnam 2013). Quantitative easing is a "very effective tool for central banks to use when combating a failing banking system facing systematic solvency and liquidity challenges" (Putnam 2013). Quantitative easing has continued beyond its initial aim during QE1 to provide liquidity in private markets through purchases of mortgage-backed securities, and has become the Federal Reserve's main policy to stimulate economic growth. However,

some believe that once growth is positive and the banking system is liquid and solvent, quantitative easing may have little effect (Bowman, Cai, Davies, and Kamin 2011). Quantitative easing has extended far beyond the initial banking challenges that existed at the beginning of the recession, and its usefulness has come into question.

There are varying hypotheses about why the Federal Reserve's quantitative easing program has not been effective. First, quantitative easing's effectiveness is dependent on banks lending their increased reserves to the public and the public re-depositing those loans. However, banks have instead been holding large quantities of excess reserves without lending, which halts the multiple expansion of deposits (Auerbach 2013). Furthermore, companies have been hoarding cheap money and not spending it in expansionary ways. Also, it is possible that we are in a liquidity trap with low interest rates and reluctance to spend due to pessimistic expectations, which would make monetary policy efforts aimed at increasing lending and consumption ineffective (Free Exchange 2013). Another explanation is that by continuing quantitative easing, the Federal Reserve is signifying that it has a pessimistic outlook for the economy. This, in turn, may encourage caution and discourage people from increasing their lending and spending. Recently, forward guidance by the Federal Reserve has had significant market impact, evidenced by markets pricing in Federal Reserve announcements far before policies are implemented (Femia, Friedman, and Sack 2013). Lastly, the purchase of bonds may have decreased collateral availability, and thus, may have decreased lending in the shadow bank system, diminishing the effect of increased loans from banks (Kessler 2013).

As evidenced by the slow recovery, even extremely low interest rates and massive liquidity injections are struggling to stimulate the economy. This suggests that quantitative easing may not be extremely effective at encouraging economic recovery, or that quantitative easing may have other counterproductive consequences. I will focus on the possibility of collateral shortages triggered by quantitative easing, which may decrease collateral-based credit intermediation through shadow banking.

Shadow Banking

Shadow banking is credit intermediation that occurs outside of traditional banks. Shadow bank transactions occur through vehicles such as money market funds, repurchase agreements, collateralized debt obligations, and more. Shadow bank institutions are a network of non-depository financial institutions (Adrian and Ashcraft 2012). They include both investment banks and non-bank financial institutions, such as hedge funds and monoline insurance companies (Adrian, Ashcraft, Boesky, and Pozsar 2012). It is not the institution that defines a transaction as a shadow banking transaction, but rather the type of transaction in general. For example, when the Federal Reserve does a repurchase agreement with Goldman Sachs, that transaction is considered part of the shadow banking system because a repurchase agreement is a shadow bank instrument. Shadow banks perform maturity, liquidity, and credit transformation (Kodres 2013). Instead of using deposits, as do traditional banks, shadow banks "typically fund themselves with securities lending transactions, i.e., use (and re-use) of the collateral they post with banks" (Grung Moe 2012). Shadow banks behave like banks in that they

generate credit by issuing liabilities, but they differ from traditional banks in that they are widely unregulated and lack access to FDIC and the Federal Reserve's Discount Window.

Shadow banking grew substantially in the years leading up to the financial crisis, hitting its peak in 2008 at about $20 trillion (Kocjan, Ogilvie, Schneider, and Srinivas 2012). [2] It peaked prior to the financial crisis partly because banks were able to increase profits by securitizing loans to be sold to mutual funds, hedge funds, and other institutions (Petroff 2010). By working with investment banks to securitize bank assets, banks could boost profits, investors could earn higher returns, and consumers could access cheap credit (Petroff 2010). When things turned sour in 2008, the shadow banking sector collapsed, as dollar volumes of shadow bank transactions plummeted and asset prices dropped substantially. During the following recession, the shadow banking system has been strained and some portions of the system have collapsed (Kocjan, Ogilvie, Schneider, and Srinivas 2012). Some argue that one explanation for the decrease in shadow bank lending is that the shadow banking system is facing a collateral shortage (Kessler 2013). The Federal Reserve's asset purchases through quantitative easing may be leaving the shadow banking system without high-quality collateral. In order to test this hypothesis, I will focus on a specific instrument within shadow banking, the repurchase agreement.

[2] This $20 trillion value is as according to the Deloitte Shadow Banking Index. However, there is contention over measuring the shadow banking sector, which rises from varying definitions about what is included within shadow banking.

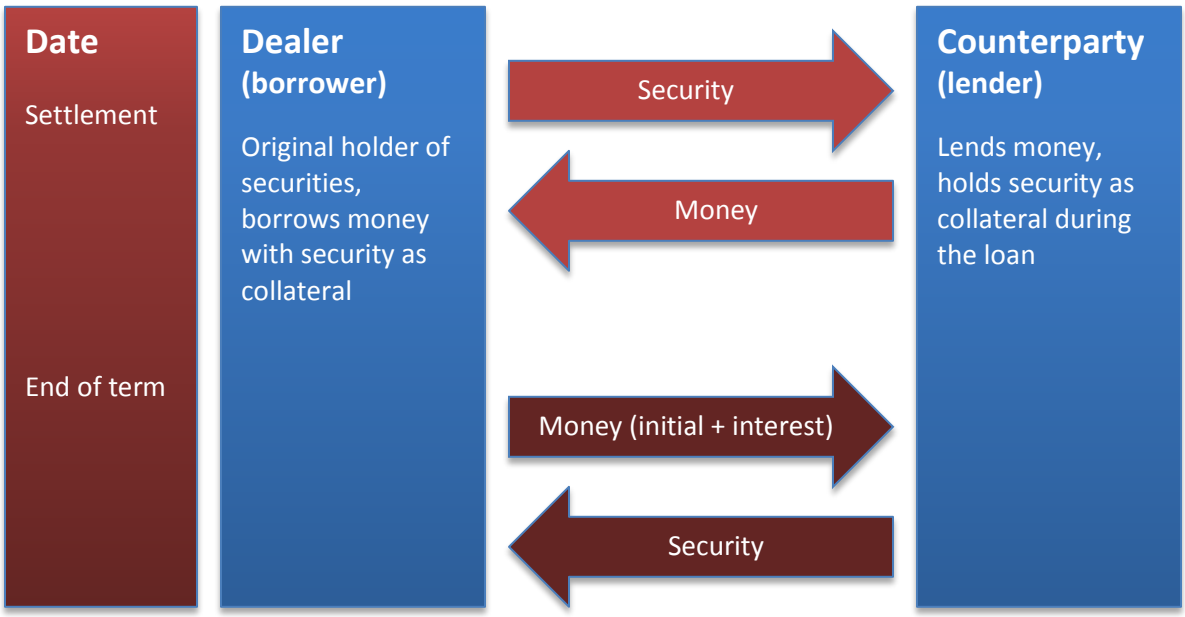
Repurchase Agreements

A repurchase agreement, or repo, is an instrument within the shadow banking system that is inherently tied to collateral, and thus useful in understanding the impact of quantitative easing on shadow banking (Carpenter 2014). A repurchase agreement is the sale of a security with an agreement to buy the security back at a later date; it is essentially a collateralized loan (Fleming and Garbade 2003). The repurchase price is greater than the original sale price and that difference is equivalent to interest. This effectively makes the person selling the security at the start of the transaction a borrower or dealer, while the person initially buying the security is effectively a lender or counterparty (see Figure 2). In the repo market "banks and other big financial investors pawn their assets in exchange for trillions of dollars' worth of short term loans every day" (Alloway and Rodrigues 2013). The repo market is a huge component of our financial system and funds trillions of dollars of transactions daily (Alloway 2013). Repurchase agreements have such a large role in our economy in part due to their ability for rehypothecation, meaning that the repo lender can perform another repo with the security it holds (Kessler 2013).[3] Rehypothecation increases collateral velocity and reduces transaction costs because collateral can be used for more than one transaction at once (Kessler 2013). This means that repos allow for a rapid credit expansion. However, this comes with a similar risk as in traditional banking in that the collateral may not be readily available in the event of a default. If the ability to sell an asset quickly is the essence of

[3] Hypothecation is a financial term that describes the posting of collateral for a loan. Rehypothecation refers to the holder of the collateral asset (the lender) turning around and using that asset on a second loan in which she is the borrower, not the lender. Thus, because the asset gets used as collateral on two loans, it is said to be rehypothecated, that is, hypothecated again.

liquidity, then the rehypothecation of assets implies that there will be many more loans for which only a limited amount of liquefiable collateral is available in case anything goes wrong, a liquidity crunch for example. While an asset can be rehypothecated many times and thus can support the creation of many loans, the asset can only be sold once and thus can only provide liquidity to pay off one of the many loans.

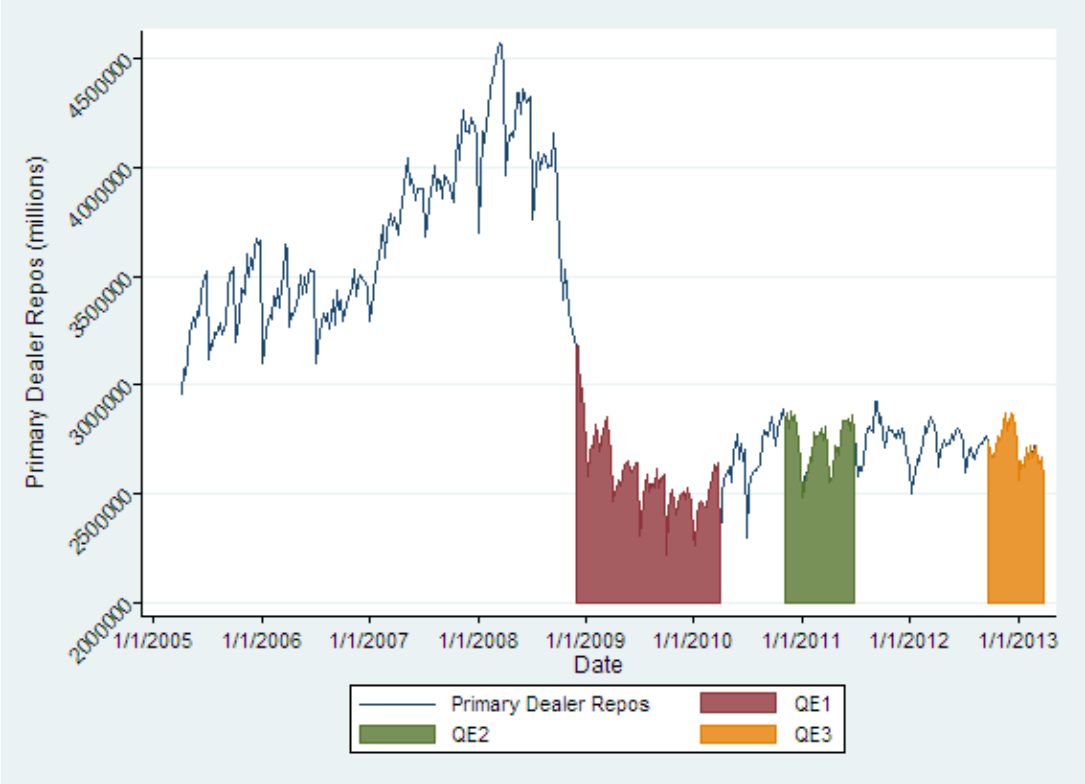
Figure 2: Repurchase Agreement Diagram



The repo market often is regarded as safe because of its use of collateral. The repo market, however, is extremely volatile in times of market anxiety. In 2008, a collateral crunch was a major factor in the financial crisis. Banks were using toxic assets as collateral in repo transactions, and their use "to secure repo funding very suddenly became unacceptable to other banks, causing financial meltdown" (Alloway 2011). Toxic collateral refers to collateral that is overpriced; when the toxic collateral is priced correctly there is a sudden drop in available collateral. Once banks stopped accepting this overpriced collateral, the market faced a shortage of repo-worthy collateral.

Changes in collateral availability can cause large-scale shifts in the repurchase agreement market, as evidenced by repo market's 2011 shock due to the debt ceiling crisis (Garcia 2013). The possibility of default led many to worry about the future of the repo market, because it is extremely reliant on U.S. Treasury securities. Since the financial crisis, the repo market has contracted significantly, and has not experienced much growth since (Federal Reserve Bank of New York). While many other shadow bank instruments have regained volume and have grown substantially after the crisis, dollar volumes of repurchase agreement transactions have stayed at similar levels since 2008 (see Figure 3). Possible explanations for this contraction include regulatory changes such as Basel III and/or a lack of high quality collateral (Kessler 2013).

Figure 3: Primary Dealer Repurchase Agreements (Millions of Dollars)



Collateral Crunch

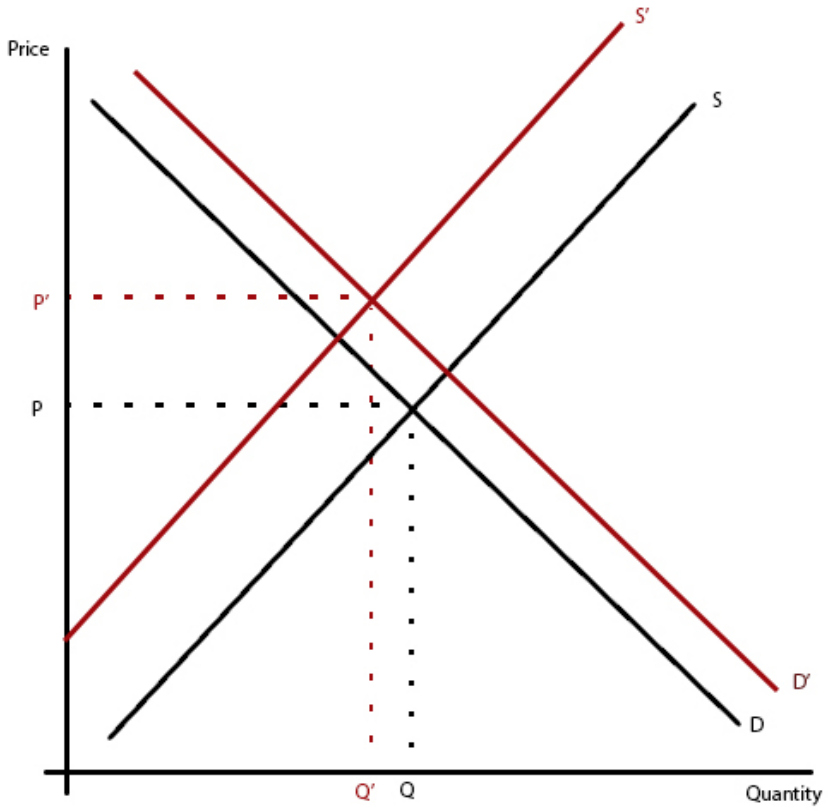
In the aftermath of the financial crisis, demand for collateral based transactions increased. This occurred due to more stringent collateral requirements, including Basel III, which forced banks to maintain large amounts of high-quality liquid assets (Fender and Lewrick 2013). While financial institutions have increased their demand for high-quality securities, they are unable to trade the newly acquired securities, effectively taking the securities used to satisfy Basel III requirements off the market (Coy 2013).

Furthermore, Treasuries have become harder to find because the Federal Reserve has bought huge amounts of Treasury securities through quantitative easing (Kessler 2013). These large-scale purchases have led some to worry about the amount of Treasury and agency securities actually available for purchase. In December 2012, "investors bid for more than four times the amount of two-year notes the Treasury auctioned" (McCormick and Kruger 2012). At the same time, the Federal Reserve was absorbing approximately "90 percent of net new dollar-denominated fixed-income assets" through their monthly QE purchases of $40 billion in mortgage-backed securities and $45 billion of U.S. Treasuries (McCormick and Kruger 2012).

The actual supply of Treasury securities that is available for shadow bank credit intermediation seems to be shrinking as demand is increasing (see Figure 4). The supply of high-quality collateral is independent of demand changes; the supply of U.S. government bonds is driven by the financing needs of the government, not by the amount of Treasury securities demanded in the market. Furthermore, strict capital requirements and Federal Reserve purchases have contracted tradable supply further (Coy 2013). The

securities that allow for shadow bank credit intermediation are becoming harder and harder to find.

Figure 4: Supply and Demand for High Quality Collateral



Notes:

- D and S represent initial supply and demand
- D' represents increased demand for high quality collateral due to more stringent collateral requirements
- S' represents decreased supply due to QE

Data

To determine the effect of Federal Reserve holdings, specifically changes due to quantitative easing, on repurchase agreement flows, I construct a time-series data set using weekly data from April 2005 to March 2013. I focus on repurchase agreements because they are an instrument within shadow banking that implicitly requires the use of collateral, and would be most affected by changes in collateral availability.

The following subsections detail each of the data series that I construct and which will be used below in regressions to determine the effect of quantitative easing on the repo market. The first subsection discusses the dependent variable. The next discusses the various independent variables.

Dependent Variable

Change in Primary Dealer Repurchase Agreements (Millions of Dollars)

In the regressions below, the left-hand side variable is the weekly change in repurchase agreements by primary dealers. This is calculated as a difference; repurchase agreements at time 0 minus repurchase agreements at time t-1. It is the first difference of weekly repurchase agreements. I used the flow of primary dealer repurchase agreements because level values are non-stationary.[4] The Federal Reserve Bank of New York

[4] Stationarity is commonly assumed in time series regressions. Stationarity means that the mean, variance, and autocorrelation do not change over time. Stationarity makes it easier to predict values using regressions.

publishes the data needed to calculate these first differences weekly. This data series is the most comprehensive repurchase agreement series available.

Primary dealers serve as trading counterparties to the Federal Reserve Bank of New York, and participate as counterparties in New York Federal Reserve trades. The minimum capital threshold to become a primary dealer is $150 million (Federal Reserve Bank of New York 2010). Primary dealers report weekly to the Federal Reserve Bank of New York on their trading activities, financing positions, and cash positions. The data represents the aggregate amount of overnight/continuing and term agreement repurchase agreements by primary dealers. While other smaller institutions not classified as primary dealers can perform repos, the "primary dealer data include all repos that use open market operations (OMO)-eligible and corporate collateral…Primary dealers do not comprise the entire universe of securities dealers active in the repo market, but [Copeland, Davis, LeSueur and Margin argue] that the vast majority of repo activity is conducted by these dealers" (Copeland, Davis, LeSueur, and Martin 2012). Thus, primary dealer repos provide a strong estimate for movements across the total repurchase agreement. Primary dealers are the most likely dealers to be affected by Federal Reserve policy because the Federal Reserve trades directly with them.

Independent Variables

Change in Short-Term Treasury Securities Held by the Fed (Millions of Dollars)

Change in short-term Treasury securities held by the Fed is the weekly change in U.S. Treasury securities maturing within one year held by the Federal Reserve. The unit is millions of dollars. The calculation for this series is: short-term Treasuries held by the

Fed at time 0 minus short-term Treasuries held by the Fed at time t-1; it is the first difference of short-term securities held by the Federal Reserve. The data is published weekly on the St. Louis Federal Reserve FRED database. I used the flow of short-term Treasuries because level values are non-stationary. This sums the FRED data series "U.S. Treasury securities held by the Federal Reserve: Maturing" within 15 days, 16-90 days, and 91 days to 1 year (Federal Reserve Bank of St. Louis).

Change in Long-Term Treasury Securities Held by the Fed (Millions of Dollars)

Change in long-term Treasury securities held by the Fed is the weekly change in U.S. Treasury securities maturing in over one year held by the Federal Reserve. The unit is millions of dollars. This is calculated as: long-term Treasuries held by the Fed at time 0 minus long-term Treasuries held by the Fed at time t-1; it is the first difference of long-term securities held by the Federal Reserve. The data is published weekly on the St. Louis Federal Reserve FRED database. I use the flow of long-term Treasuries because level values are non-stationary. This sums FRED data series "U.S. Treasury securities held by the Federal Reserve: Maturing in" 1-5 years, 5-10 years, and over 10 years (Federal Reserve Bank of St. Louis).

Change in Mortgage-Backed Securities Held by the Fed (Millions of Dollars)

Change in mortgage-backed securities held by the Fed is the weekly change in the dollar value mortgage-backed securities held by the Federal Reserve, in millions of dollars. The calculation is: mortgaged-backed securities held by the Fed at time 0 minus mortgage-backed securities held by the Fed at time t-1; it is the first difference of mortgage-backed securities held by the Federal Reserve. The data is published weekly on

the St. Louis Federal Reserve FRED database under the title “Mortgage-backed securities held by the Federal Reserve: All Maturities.” I use the flow of mortgage-backed securities held by the fed, because the levels are non-stationary.

Change in Federal Debt Held by the Public (Millions of Dollars)

This is the weekly change in U.S. federal debt held by the public. Debt held by the public consists of all federal debt held by individuals, corporations, state governments, local governments, foreign governments, and other entities (TreasuryDirect). It does not include the Federal Financing Bank or the Federal Reserve. It includes, but is not limited to, securities such as Treasury bills, Treasury notes, Treasury bonds, U.S. savings bonds, state and local government securities, and Treasury inflation-protected securities. The United States Treasury publishes level values daily. I use the weekly flow of federal debt held by the public, because the levels are non-stationary.

Change in Federal Debt Held by the Government (Millions of Dollars)

This is the weekly change in intragovernmental holdings of U.S. Federal Debt. Intragovernmental holdings consist of Government Account Series securities held by government trust funds, special funds, and revolving funds. Intragovernmental holdings are incurred when the government borrows from federal trust funds to fund government operations. These holdings consist primarily of the Social Security Trust Fund, the Medicare Trust Fund, and Federal Financing Bank securities (Treasury Direct). The

United States Treasury publishes level values daily. I use the weekly flow of intragovernmental holdings, because the levels are non-stationary.[5]

Treasury Fails/Treasury Transactions (Percentage Points)

This series consists of the dollar value of primary dealer "fails to deliver" on U.S. government securities divided by the dollar value of primary dealer outright and financing transactions of U.S. government securities (Federal Reserve Bank of New York). The fails data includes fails for both outright and financing transactions (Federal Reserve Bank of New York). U.S. government fails occur when transactions using Treasury securities fail to settle on the agreed upon date (Fleming and Garbade 2005). Failures to deliver occur when a primary dealer does not deliver a security for a transaction on the agreed upon date.

The Federal Reserve Bank of New York also publishes failure to receive data. Because the failure to deliver and failure receive data series have a correlation coefficient of 0.99, I choose to use only failures to deliver. Fails are reported weekly on a cumulative basis. Fails continue to be counted until the transaction is settled (Fleming and Garbade 2005). For example, if a dealer fails to deliver $10 million of Treasury securities on a Monday, but delivers the securities that Tuesday, then the dealer reports $10 million in fails to deliver. If that $10 million delivery does not occur until Friday, four days after the scheduled date, then the dealer reports $40 million in fails to deliver.

[5] Note that neither the change in federal debt held by the public nor the change in federal debt held by the government includes debt held by the Federal Reserve. Change in federal debt held by the Federal Reserve is reflected in change in short-term and long-term Treasuries held by the Federal Reserve.

Fails are believed to affect market liquidity, particularly when they occur at high levels (Fleming and Garbade 2005). Fails and transaction data series are published weekly by the Federal Reserve Bank of New York. The quotient Treasury Fails/Treasury Transactions represents the proportion of primary dealer Treasury securities failures to deliver divided by primary dealer outright and financing transactions using Treasury securities. The Treasury transactions value includes T-bills, Treasury coupons, and Treasury inflation-indexed securities for both outright and financing transactions. It does not include repurchase agreements, because the primary dealer survey does not specify the type of security used in repurchase agreements. Therefore, the Treasury security transactions value likely leaves out some transactions that use Treasury securities, repos in particular.

Mortgage-Backed Security Fails/Mortgage-Backed Security Transactions (Percentage Points)

Mortgage-backed security fails/mortgage-backed security transactions is the dollar value of primary dealer fails to deliver mortgage-backed securities divided by the dollar value of primary dealer outright and financing transactions of mortgage-backed securities. Fails data includes fails for both outright and financing transactions. Mortgage-backed fails occur when transactions using mortgage-backed securities fail to settle on the agreed upon date. Failures to deliver occur when a primary dealer does not deliver a security for a transaction on the agreed upon date. Fails and transaction data series are published weekly by the Federal Reserve Bank of New York. Mortgage-backed security fails/mortgage-backed security transactions represents the proportion of mortgage-backed securities failures to deliver by primary dealers divided by the outright

and financing transactions using mortgage-backed securities by primary dealers. The denominator likely leaves out some transactions because I only use primary dealer data that specifies when mortgage-backed securities are being used.

Dummy Variables

In the regressions below, I also used a number of binary (zero or one) dummy variables:

2005- Dummy variable for the year 2005

2006-Dummy variable for the year 2006

2007-Dummy variable for the year 2007

2008-Dummy variable for the year 2008

2009-Dummy variable for the year 2009

2010-Dummy variable for the year 2010

2011-Dummy variable for the year 2011

2012-Dummy variable for the year 2012

Basel III- Dummy variable for the after the Basel III capital, liquidity, and leverage requirements changes were agreed upon on 12/16/2010. Basel III raises banks' required amounts of capital, introduces a minimum leverage ratio, and introduces required liquidity ratios

Crisis- Dummy variable for after Lehman Brothers collapse on 9/15/2008

QE1- Dummy variable for the first round of quantitative easing from 11/25/2008-3/31/2010

QE2-Dummy variable for the second round of quantitative easing from 3/3/2010-6/30/2011

QE3-Dummy variable for the third round of quantitative easing from 9/13/2012-the end of the dataset (3/27/2013)

Table 1 contains summary statistics for the aforementioned variables.

Table 1: Summary Statistics

Variable		Mean	Standard Deviation	Min	Max
Repo	Repo flow, millions of dollars	-651.5	107,947.9	-564,857	256,845
Fed ST Treasuries	Flow of Fed holdings of short-term Treasuries, millions of dollars	-909.17	4,493.03	-38,266	12,335
Fed LT Treasuries	Flow of Fed holdings of long-term Treasuries, millions of dollars	3,504.62	7,760.02	-19,710	39,682
Fed MBS	Flow of Fed holdings of mortgage-backed securities, millions of dollars	2,580.56	15,768.47	-17,390	167,531
Debt Held by Public	Flow of debt held by the public, millions of dollars	14,988.61	36,911.35	-73,987.3	236,328
Debt Held by Government	Flow of debt held by the government, millions of dollars	4,023.32	21,125.66	-63,068.6	105,527.8
Treasury Tightness	Treasury fails/Treasury transactions, percentage points	2.27	6.11	0.15	57.23
MBS Tightness	MBS fails/MBS transactions, percentage points	13.34	16.16	0.15	84.14

Methods

I test the effect of quantitative easing on repurchase agreements using ordinary least squares regressions.

I apply the Dickey-Fuller unit-root tests on all continuous variables to ensure their stationarity. The null hypothesis of the Dickey-Fuller test is that the variable being tested contains a unit root; the alternative hypothesis is that the variable is stationary. The null hypothesis was rejected for all variables, ensuring that all continuous variables are stationary. Next, I determine the optimal lag length by finding the autoregressive process that minimizes the Bayesian information criterion (BIC). I use heteroskedasticity robust standard errors for all regressions.

With those preliminaries completed, I estimate the following regression model, which explores the relationship between the dependent variable, weekly change in primary dealer repurchase agreements, and the independent variables: change in short-term Treasury securities held by the Fed, change in long-term Treasury securities held by the Fed, change in mortgage-backed securities held by the Fed, change in federal debt held by the public, change in federal debt held by the government, Treasury fails/Treasury transactions, mortgage-backed security fails/mortgage-backed security transactions, and dummy variables for years 2005-2010, Basel III, the financial crisis, and rounds one to three of quantitative easing.

Expressed algebraically, the model looks like:

$$RepoFlow = \beta_0 + \beta_1 FedShortTermTreasuryFlow + \beta_2 FedLongTermTreasuryFlow + \beta_3 FedMBSFlow + \beta_4 DebtPublicFlow + \beta_5 DebtGovFlow + \beta_6 TreasuryTightness + \beta_7 MBSTightness + \beta_8 2005 + \beta_9 2006 + \beta_{10} 2007 + \beta_{11} 2008 + \beta_{12} 2009 + \beta_{13} 2010 + \beta_{14} 2011 + \beta_{15} 2012 + \beta_{16} Basel + \beta_{17} Crisis + \beta_{18} QE1 + \beta_{19} QE2 + \beta_{20} QE3 + \varepsilon$$

I then run a similar regression, using BIC determined optimal lags.

$$RepoFlow = \beta_0 + \beta_1 l(1/3).RepoFlow\ \beta_2 FedShortTermTreasuryFlow + \beta_3 FedLongTermTreasuryFlow + \beta_4 l(0/2).FedMBSFlow + \beta_5 DebtPublicFlow + \beta_6 l(0/3).DebtGovFlow + \beta_7 l(0/1).TreasuryTightness + \beta_8 l(0/3).MBSTightness + \beta_9 2005 + \beta_{10} 2006 + \beta_{11} 2007 + \beta_{12} 2008 + \beta_{13} 2009 + \beta_{14} 2010 + \beta_{15} 2011 + \beta_{16} 2012 + \beta_{17} Basel + \beta_{18} Crisis + \beta_{19} QE1 + \beta_{20} QE2 + \beta_{21} QE3 + \varepsilon$$

Next, I run specific regressions during each period of quantitative easing to see if the effect on repurchase agreement flows varies across the three rounds. I also run these regressions with a variety of lags.

$$RepoFlow = \beta_0 + \beta_1 FedShortTermTreasuryFlow + \beta_2 FedLongTermTreasuryFlow + \beta_3 FedMBSFlow + \beta_4 DebtPublicFlow + \beta_5 DebtGovFlow + \beta_6 TreasuryTightness + \beta_7 MBSTightness + \beta_8 2009 + \beta_9 2010 + \varepsilon \; if \; QE1 > 0$$

$$RepoFlow = \beta_0 + \beta_1 FedShortTermTreasuryFlow + \beta_2 FedLongTermTreasuryFlow + \beta_3 FedMBSFlow + \beta_4 DebtPublicFlow + \beta_5 DebtGovFlow + \beta_6 TreasuryTightness + \beta_7 MBSTightness + \beta_8 2010 + \beta_9 Basel + \varepsilon \; if \; QE2 > 0$$

$$RepoFlow = \beta_0 + \beta_1 FedShortTermTreasuryFlow + \beta_2 FedLongTermTreasuryFlow + \beta_3 FedMBSFlow + \beta_4 DebtPublicFlow + \beta_5 DebtGovFlow + \beta_6 TreasuryTightness + \beta_7 MBSTightness + \beta_8 2012 + \varepsilon \; if \; QE3 > 0$$

These regressions attempt to isolate the effects of Federal Reserve purchases on the flows of repurchase agreements. Two limitations are that these regressions assume that changes in primary dealer repurchase agreements are indicative of repo flows across the entire repo market and there may be omitted variable bias.

Results

A. Regressions for Entire Time Period

The first set of regressions regress primary dealer repurchase agreement weekly changes on the dependent variables from April 6th, 2005 to March 27th, 2013. The units of the dependent variable are millions of dollars. This timeframe contains 415 weekly observations. The first regression uses no lags. The second regression uses the lags determined by prior BIC tests. The regression results are presented in columns of (1) and (2), respectively of Table 2.

Regression 1

In Regression 1, with no lags, the following variables were statistically significant: change in short-term Treasuries held by the Fed, change in federal debt held by the public, change in federal debt held by the government, 2005, 2006, 2007, 2008, 2009, 2010, and Basel III.

The results indicate that a 1 million dollar increase in change of short-term Treasuries held by the Fed is associated with a 2.64 million dollar increase in change in primary dealer repurchase agreements, on average. The results also indicate that a 1 million dollar increase in federal debt held by the public leads to a -0.63 million dollar decrease in weekly repo flows. Further, a 1 million dollar increase in federal debt held by the government is associated with a -2.09 million dollar decrease in weekly repo flows. The negative coefficient on Basel III indicates that weekly repurchase agreement flows

dropped significantly after Basel III was passed. This model explains 24.91% of the variation in change of primary dealer repurchase agreements.

Regression 2

In Regression 2, using BIC optimal lags, the following variables were statistically significant: one to three week lags of weekly repurchase agreement flows, a two-week lag of mortgage-backed securities held by the Federal Reserve, change in federal debt held by the public, change in federal debt held by the government, a three week lag of change in federal debt by the government, Treasury fails/Treasury transactions (Treasury market tightness), a one-week lag of Treasury market tightness, a two-week lag of MBS fails/MBS transactions (mortgage-backed security market tightness), 2005, 2006, 2007, 2008, 2009, 2010, Basel III, and QE3.

The negative coefficients on all three lags of weekly repurchase agreement changes indicate that a one million dollar increase in repo flows is associated with a decrease of 0.22 million dollars one week later, a decrease of 0.12 million dollars two weeks later, and a decrease of 0.11 million dollars three weeks later, on average. A one million dollar increase in change in mortgage-backed securities held by the Federal Reserve is associated with a 1.23 million decrease in weekly change in primary dealer repurchase agreements. A one million dollar increase in federal debt held by the public leads to a 0.33 million dollar decrease in repurchase agreement flows, on average. A one million increase in federal debt held by the government is associated with to a 2.14 million dollar decrease in weekly repo flows, while a three-week lagged million dollar increase in federal debt held by the government is associated with a 0.31 million dollar increase in weekly repurchase agreement flows. A one percentage point increase in

Treasury fails/Treasury transactions, which represents Treasury market tightness, is associated with a 4,513.48 million dollar decrease, and a one-week lag of Treasury market tightness is associated with a 3,244.95 million dollar decrease in repo flows, on average. A one percentage point increase in mortgage-backed security market tightness is associated with a 1,722.33 million dollar decrease in change in primary dealer repurchase agreements, on average. Furthermore, my regression results indicate that Basel III led to a decrease in weekly flows in repurchase agreements. Lastly, the third round of quantitative easing is associated with an increase in weekly repo flows. This model explains 39.41% of the variation in change of primary dealer repurchase agreements.

Table 2: Repurchase Agreement Flows (2005-2013)
Section A: Regressions 1 and 2

	(1)	(2)
Constant	218104.8	814666.70
	(62255.50)	(192948.20)
L1.Repo flow		-0.22**
		(0.05)
L2.Repo flow		-0.12**
		(0.05)
L3.Repo flow		-0.11**
		(0.04)
Change in short-term Treasuries held by the Fed	2.64*	2.26
	(1.58)	(1.53)
Chang in long-term Treasuries held by the Fed	0.13	0.34
	(0.87)	(0.73)
Change in mortgage-backed securities held by Fed	0.5	-0.16
	(0.33)	(0.28)
L1.Fed MBS flow		-0.20
		(0.27)
L2.Fed MBS flow		-1.23**
		(0.36)
Change in federal debt held by the public	-0.63**	-0.33*
	(0.19)	(0.19)
L1.Federal debt public flow		0.25
		(0.19)
Change in federal debt held by the government	-2.09**	-2.14**
	(0.45)	(0.43)

L1.Federal debt government flow		-0.04
		(0.18)
L2.Federal debt government flow		0.30
		(0.19)
L3. Federal debt government flow		0.31*
		(0.17)
Treasury Fails/Transactions	727.74	-4,513.48**
	(1977.54)	(2169.28)
L1.Treasury tightness		-3,244.95**
		(1438.86)
MBS Fails/Transactions	-137.22	-59.05
	(488.43)	(493.06)
L1.MBS tightness		767.05
		(555.35)
L2.MBS tightness		-1,722.33**
		(604.21)
L3.MBS tightness		693.55
		(603.05)
2005	-190443.6**	-498,440.50**
	(67749.81)	(113805.80)
2006	-208001.1**	-514,131.70**
	(65616.20)	(111340.40)
2007	-187354.6**	-475,037.60**
	(36675.36)	(105590.10)
2008	-183161.6**	-446,481.70**
	(63375.36)	(98789.69)
2009	-96538.09**	-257,742.40**
	(49393.15)	(63422.54)
2010	-86403.9**	-198,091.10**
	(42776.19)	(51359.34)
2011	9861.22	-66,497.67
	(33873.81)	(40397.61)
2012	14218.39	1796.86
	(25763.01)	(25035.13)
Basel III	-117121.5**	-129,248.10**
	(24648.53)	(27409.43)
Crisis	-83434.21	583.32
	(51316.69)	(59298.14)
QE1	-27338.8	-49,916.70
	(33449.82)	(32815.94)
QE2	-30679.27	-21,900.48
	(23788.17)	(23917.14)
QE3	-19042	39,755.51*
	(19370.80)	(22464.69)

n	415	412
R2	0.2491	0.3941
F	5.5	7.43
Standard errors in parentheses *p<0.10, **p<0.05		

B. Regressions During Quantitative Easing 1 (QE 1)

The first round of quantitative easing (QE1) lasted from November 25, 2008 to March 31, 2010. During QE1, the Federal Reserve bought $1.25 trillion of mortgage-backed securities, $300 billion of U.S. Treasuries, and $175 billion of agency securities.

This section reports on the same two regression models described above, but estimated only on data from the QE1 period. The units of the dependent variable are millions of dollars. The QE1 timeframe contains 70 weekly observations. The first regression uses no lags. The second regression incudes the same variables as Regression 1, with the addition of one- and two-week lags of the change in mortgage-backed securities held by the Federal Reserve, as indicated using BICs.

Regression 1

Table 3 reveals that in a regression using all continuous variables and dummy variables for the years 2009 and 2010, the following independent variables are statistically significant: change in short-term Treasuries held by the Fed, change in long-term Treasuries held by the Fed, change in federal debt held by the public, and MBS fails/MBS transactions (mortgage-backed security market tightness), 2009, and 2010. The estimated slope coefficients demonstrate that a 1 million dollar increase in the change in short-term Treasuries held by the Fed leads to a 14.72 million dollar decrease of the change in primary dealer repurchase agreements, on average. A one million dollar

increase in long-term Treasuries held by the Federal Reserve is associated with a 3.99 million dollar decrease in weekly repo flows. A one million dollar increase in federal debt held by the public leads to a 1.15 unit decrease in weekly repurchase agreements, on average. A one percentage point increase in mortgage-backed security market tightness is associated with a 2,537.49 million dollar decrease in weekly repurchase agreement flows. This model explains 30.87% of the variation in change in primary dealer repurchase agreements during QE1.

Regression 2

The second regression incudes all continuous variables, plus the addition of one- and two-week lags of the change in primary dealer repurchase agreements and the change in mortgage-backed securities held by the Federal Reserve. The results reported in Table 3 indicate that the following independent variables are statistically significant: one-week lag of repurchase agreement flow, change in short-term Treasuries held by the Fed, change in long-term Treasuries held by the Fed, a two-week lag of change in mortgage-backed securities held by the Fed, change in federal debt held by the public, change in federal debt held by the government, MBS market tightness, 2009, and 2010. A one million dollar increase in last week's repo change is associated with a 0.23 million dollar decrease in repo flows. A one million dollar increase in short-term Treasuries held by the Fed is associated with a 12.75 million dollar decrease in repo flows, and a one million dollar increase in long-term securities held by the Fed is associated with a 3.29 million dollar decrease in repo flows. An increase in mortgage-backed securities held by the Federal Reserve leads to a 1.20 million decrease in repurchase agreement change, on average. Increases in federal debt held by the public and by the government are

associated with repo flow decreases of 0.99 and 1.48 million respectively. A one percentage point increase in mortgage-backed security market tightness is associated with a 2,131.59 million dollar decrease in weekly repurchase agreement flows. This model explains 44.86% of the variation in change of primary dealer repurchase agreements during QE1.

Table 3: Regressions During QE1
Section B: Regressions 1 and 2

	(1)	(2)
Constant	-160396.7	-131820.90
	(100467.70)	(101276.90)
L1.Repo flow		-0.23*
		(0.13)
L2.Repo flow		-0.08
		(0.12)
Change in short-term Treasuries held by the Fed	-14.72**	-12.75**
	(4.38)	(4.56)
Change in long-term Treasuries held by the Fed	-3.99**	-3.29*
	(2.02)	(1.66)
Change in mortgage-backed securities held by Fed	0.6	0.18
	(0.49)	(0.51)
L1.Fed MBS flow		-0.15
		(0.39)
L2.Fed MBS flow		-1.20**
		(0.31)
Change in federal debt held by the public	-1.15**	-0.99**
	(0.34)	(0.32)
Change in federal debt held by the government	-1.28	-1.48*
	(0.92)	(0.86)
Treasury Fails/Transactions	8152.65	2,522.42
	(7113.57)	(7769.44)
MBS Fails/Transactions	-2537.49**	-2,131.59*
	(1123.00)	(1085.07)
2009	212444.5**	211,932.80**
	(80392.67)	(92027.90)
2010	273170.4**	256,832.60**
	(87913.67)	(96573.59)
n	70	70

R2	0.3087	0.4486
F	2.4	2.93

Standard errors in parentheses

*p<0.10, **p<0.05

C. Regressions During Quantitative Easing Two (QE2)

The second round of quantitative easing, QE2, lasted from November 3, 2010 to June 30, 2011. During QE2, the Federal Reserve concentrated on long-term U.S. Treasury securities. The Fed bought $75 billion of U.S. Treasuries per month. There are 35 weekly observations during QE2. This is important to note because the small sample size of only 35 weeks raises questions about the validity of the regression results for the two regressions. The first regression uses no lags. The second regression uses the same variables as in regression one plus a one-week lag of repurchase agreement flows.

Regression 1

In this regression, I use all continuous variables and dummy variables for 2010 and Basel III. As shown in Table 4, the following independent variables are statistically significant: change in short-term Treasuries held by the Fed, change in federal debt held by the public, change in federal debt held by the government, Treasury fails/Treasury transactions (Treasury market tightness), 2010, and Basel III. The results indicate that repo flows increase by 8.68 million per every one million increase in short-term Treasuries held by the Fed. A one million dollar increase in federal debt held by the public is associated with a 1.05 million dollar decrease in change in repurchase agreements. A one million dollar increase in change in federal debt held by the government is associated with a 0.71 million dollar decrease in repo flows. As Treasury market tightness increases by one percentage point, primary dealer repurchase agreement

change decreases by 28,432.39 million, on average. This model explains 56.3% of the variation in change in primary dealer repurchase agreement flows.

Regression 2

Regression 2 uses the same variables as in Regression 1, but also includes a one-week lag of repo flows. The results do not vary significantly as a similar set of independent variables are found to be statistically significant: one-week lag of repo flows, change in short-term Treasuries held by the Fed, change in federal debt held by the public, change in federal debt held by the government agencies, Treasury fails/Treasury transactions (Treasury market tightness), 2010, and Basel III. Compared to the first regression, the coefficient for change in short-term Treasuries held by the Fed falls to 8.16, the coefficient for change in federal debt held by the public falls to -1.03, the coefficient for change in federal debt held by the public falls to -1.31, and the coefficient for Treasury fails/Treasury transactions falls to -38,054.62. 62.15% of the variation in change in primary dealer repurchase agreement flows is explained by this model.

Table 4: Regressions During QE2
Section C: Regressions 1 and 2

	(1)	(2)
Intercept	86122.11	108975.10
	(49744.58)	(35725.90)
L1.Repo flow		-0.38**
		(0.19)
Change in short-term Treasuries held by the Fed	8.68**	8.16**
	(3.40)	(3.65)
Change in long-term Treasuries held by the Fed	1.56	0.98
	(1.10)	(1.01)
Change in mortgage-backed securities held by Fed	1.21	-1.03
	(2.12)	(1.50)
Change in federal debt held by the public	-1.05**	-1.03**
	(0.35)	(0.36)
Change in federal debt held by the government	-0.71*	-1.31**
	(0.38)	(0.44)

Treasury Fails/Treasury Transactions	-28432.39*	-38,054.62*
	(15166.39)	(19425.70)
MBS Fails/MBS Transactions	123.89	775.54
	(823.07)	(1043.47)
2010	-100250.6**	-152,283.60**
	(33088.14)	(33,484.48)
Basel III	-120,731.00**	-151,555.90**
	(34432.13)	(29024.28)
n	35	35
R2	0.563	0.6215
F	6.87	13.5

Standard errors in parentheses
*p<0.10, **p<0.05

D. Regressions During Quantitative Easing Three (QE3)

The third round of quantitative easing, QE3, started on September 13, 2012 and continued beyond the end of the dataset in March 2013. Currently, as of April 2014, QE3 is in the process of tapering. QE3 was still ongoing at its original, non-tapered rate as of the last date included in my data set. During QE3, the Federal Reserve bought both mortgage-backed securities and U.S. long-term Treasuries. The Fed was buying $40 billion of mortgage-backed securities and $45 billion of long-term U.S. Treasuries a month. My dataset contains 28 weekly observations during QE3. The small sample size raises questions about the validity of the regression results, especially considering the large number of variables. My QE3 regression uses no lags because the BICs did not suggest using any lags.

Regression 1

In Regression 1, I use all continuous variables and a dummy variable for 2012. None of the independent variables are statistically significant in this regression. Furthermore, minimizing BICs does not suggest using a lag for any of the continuous

variables. My model explains 25% of the variation in change in primary dealer repurchase agreements during QE3. The F-statistic equals 0.84, which is not statistically significant and suggests a 58.27% probability of receiving an F-statistic as extreme as mine if the null hypothesis that the coefficients are 0 is true.

Table 5: Regressions During QE3
Section D: Regression 1

	(1)
Constant	-56346.86
	(67260.32)
Change in short-term Treasuries held by the Fed	-38.74
	(66.93)
Change in long-term Treasuries held by the Fed	1.86
	(3.46)
Change in mortgage-backed securities held by Fed	0.58
	(0.69)
Change in federal debt held by the public	-0.23
	(0.43)
Change in federal debt held by the government	-1.25
	(0.74)
Treasury Fails/Transactions	21611.38
	(34512.32)
MBS Fails/Transactions	413.05
	(2595.41)
2012	32622.78
	(36469.40)
n	28
R2	0.25
F	0.84

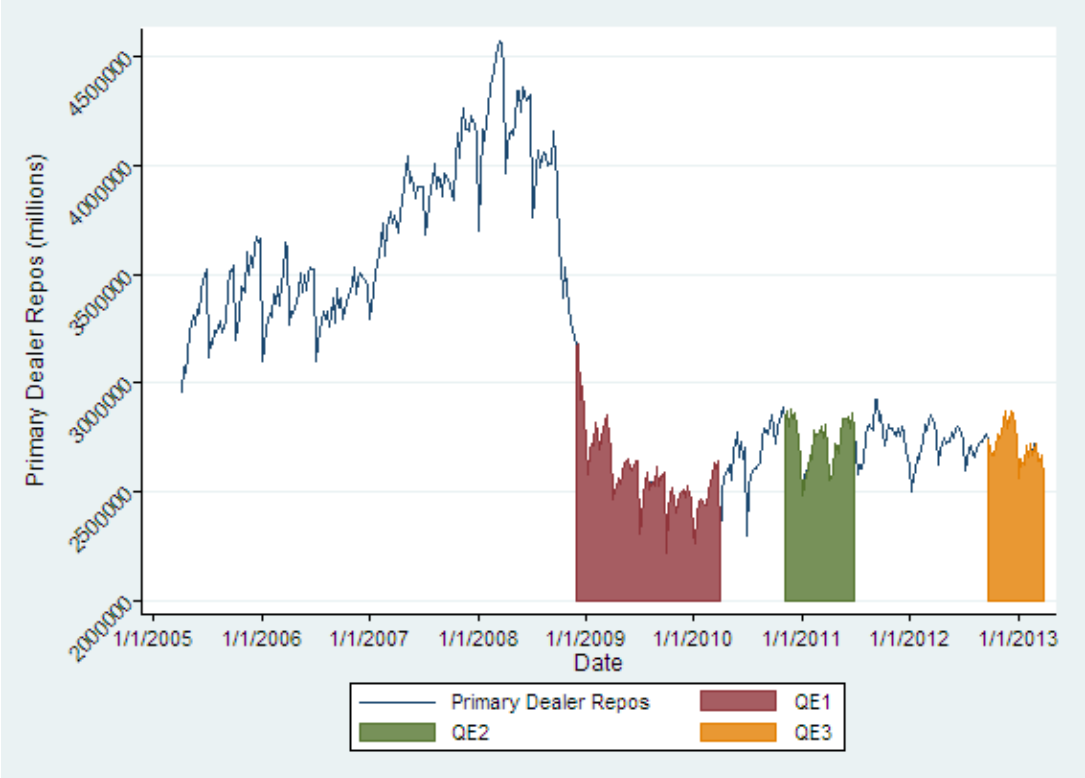
Standard errors in parentheses
*p<0.10, **p<0.05

Discussion of Results

A. Regressions for Entire Time Period

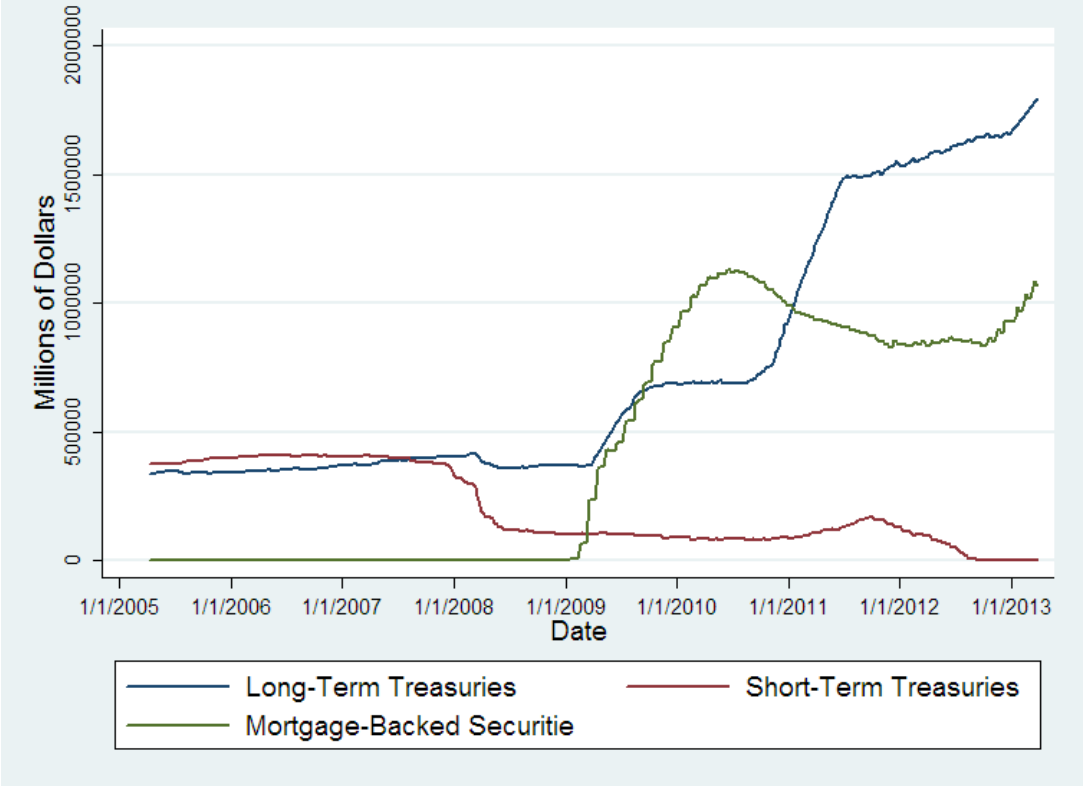
The first set of regressions that are reported in Table 2 includes regressions across the entire time period from 2005 to 2013. During this time period, the aggregate amount of repurchase agreements traded weekly by primary dealers rose until reaching a peak of $4,567,192 million in 2008. As the recession started in late 2008, the aggregate amount of repurchase agreements dropped substantially and has continued to stagnate since (see Figure 5).

Figure 5: Aggregate Amount of Primary Dealer Repurchase Agreements (Millions of Dollars)



The Federal Reserve started the first round of quantitative easing on November 25, 2008. At the start of QE1, the Federal Reserve held $648,589 million of long-term U.S. Treasury securities, $96,290 million of short-term U.S. Treasury securities, and $622,864 million of mortgage-backed securities. At the end of my data set, March 27, 2013, the Federal Reserve held $1,794,146 million of long-term U.S. Treasury securities, $314 million of short-term U.S. Treasury securities, and $1,070,932 of mortgage-backed securities (see Figure 6).

Figure 6: Federal Reserve Holdings of U.S. Treasuries and Mortgage-Backed Securities (Millions of Dollars)



Regression 1 uses no lagged variables, while Regression 2 uses optimal lags as determined by the BIC. I believe the second model with some BIC selected lags is the most accurate, as changes in repurchase agreements are likely to be dependent on earlier happenings. I am primarily testing for the effects of Federal Reserve purchases on the

repurchase agreement market, and the effects of these changes may not occur immediately.

Regression 2, which uses some lags, found negative correlations between one-week, two-week, and three-week lags of primary dealer repurchase agreement flows. These negative correlations suggest the volatile nature of repurchase agreement flows across this time period. While the general trend across 2008 was a decline in repo flows, repo flows stagnated and fluctuated both positively and negatively from 2009 onwards.

The non-lagged regression, Regression 1, found that change in short-term Treasuries held by the Federal Reserve had a positive correlation with the change in primary dealer repurchase agreements. The Federal Reserve decreased their holdings of short-term Treasuries, signifying that the change in Federal Reserve holdings of short-term Treasuries was negative for most of the period. This result suggests that as the Federal Reserve decreased its holdings of short-term Treasury securities, the quantity of repurchase agreements by primary dealers also fell. Both the change in Federal Reserve holdings of short-term Treasuries and the change in primary dealer repurchase agreements dropped significantly during 2008, which is likely to be the cause of this positive relationship. Furthermore, in Figure 6, it is clear that the volume of short-term Treasuries sold by the Fed is much smaller than the volume of long-term Treasuries and mortgage-backed securities bought by the Fed. The regression with some lags failed to find a significant relationship. Therefore, I believe the non-lagged results may represent a spurious relationship that occurred from the negative trend in both series.

While change in long-term Treasuries held by the Federal Reserve has no statistically significant impact on repurchase agreement flows, a two-week lag of change

in mortgage-backed securities held by the Federal Reserve is statistically significant. This negative coefficient suggests that repurchase agreement flows fall two weeks after the Fed acquires additional mortgage-backed securities. This could be evidence in favor of my hypothesis that an increase in Federal Reserve purchases causes declines in repurchase agreement lending.

Change in federal debt held by the public had statistically significant negative coefficients in both regressions. Federal debt held by the public includes individuals, corporations, state and local governments, and other entities. The negative correlation suggests that most of the entities included in this data series do not make their holdings of Treasury securities available for repurchase agreements. Large investment banks and other financial institutions, which make up only a portion of this category, are likely to trade Treasury securities, but the other groups may refrain from doing so. The small magnitude suggests that a $1 million increase in federal debt held by the public leads to only a $0.33 million decrease in repurchase agreement flows. This confirms my hypothesis that some of the Treasury securities under this bucket are traded, while others are taken off the market. It is the securities taken off the market that lead to the negative coefficient.

Change in federal debt held by government agencies had statistically significant negative coefficients in both regressions. These coefficients were -2.09 and -2.14 in the non-lagged and lagged regressions respectively. Federal debt held by the government includes securities held by government trust funds, such as the Social Security Trust Fund. Securities are typically not traded after being included in these funds, which explains the negative coefficient. An additional one million dollars of debt held by the government

leads to a $2.1 million decrease in repurchase agreements. This falls in line with the rehypothecation of repurchase agreements. Securities can be lent multiple times; therefore, taking a single repurchase agreement off the market has a multiplied effect. The negative coefficients suggest that holdings of U.S. Treasuries in government agencies are not available for further repos.

It appears that primary dealer repurchase agreements fall as federal debt held by any group increases. This is counterintuitive because it seems that an increase in the federal debt, and thus U.S. Treasuries, would lead to an increase in repurchase agreements. The coefficients of federal debt held by the public and federal debt held by government agencies of -0.33 and -2.09 respectively, suggest that Treasuries held by the public have a greater likelihood of being traded.

The lagged regression reports large significant coefficients on Treasury fails/Treasury transactions, which represents Treasury market tightness. This suggests that as the Treasury market becomes tighter, fewer repurchase agreements happen. This supports my hypothesis that collateral scarcity has the potential to cause drastic changes in repurchase agreement market transactions. The coefficients for no lag and a one-week lag equal -4,513.48 and -3,244.95 respectively.

Similarly, the lagged regression, Regression 2, finds a statistically significant two-week lag of mortgage-backed security market tightness with a negative correlation. This suggests that as mortgage-backed securities become scarcer, primary dealer repurchase agreements fall two weeks later. This indicates that it may take some time for the full effect of the market tightness to reach the repurchase agreement market. It is interesting to note that both MBS market tightness and MBS held by the Fed are

statistically significant with a two-week lag. This is a potential indication that effects in the repurchase agreement market due to mortgage-backed security changes do not happen immediately.

Finally, the dummy variable for Basel III is statistically significant for both regressions; the coefficients are -117,121.5 in Regression 1 and -129,248.10 in Regression 2. This implies that the collateral requirements introduced by Basel III caused the volume of repurchase agreements to fall drastically. This suggests that as banks prepared for more stringent capital rules, securities that could be used in repos were taken off the repo market, causing change in primary dealer repurchase agreements to fall.

Regression 1 explains 24.91% of the variation in primary dealer repurchase agreement flows. Regression 2 explains 39.41% of the variation in primary dealer repurchase agreement flows. These results suggest that under certain circumstances, increases in Federal Reserve holdings of repo-worthy assets lead do decreases of repurchase agreement flows.

B. Regressions During Quantitative Easing 1 (QE1)

QE1 lasted from November 25, 2008 to March 31, 2010. During this timeframe, the Federal Reserve focused on buying mortgage-backed securities, buying $1.25 trillion of mortgage-backed securities, $300 billion of U.S. Treasuries, and $175 billion of agency securities. I perform two regressions using data from QE1: Regression 1 with no lags and Regression 2 with BIC determined lags. These regression results are located in Table 3.

Repo levels fell significantly at the end of 2008. The amount of primary dealer repurchase agreements fluctuated, but continued to trend downward from the beginning of 2009 to the end of QE1 in March 2010 (see Figure 7). During this time period, the Federal Reserve was buying mortgage-backed securities and some long-term Treasury securities, taking large amounts of these securities off the market. The Federal Reserve also sold a small amount of short-term Treasury securities, which added to the supply of assets that could be used in repos. However, the magnitude of long-term Treasuries and mortgage-backed securities bought by the Fed dwarfs the amount of short-term Treasuries sold by the Fed during QE1. Figure 8 shows Federal Reserve holdings during the first round of quantitative easing.

Figure 7: Primary Dealer Repurchase Agreements During QE1 (Millions of Dollars)

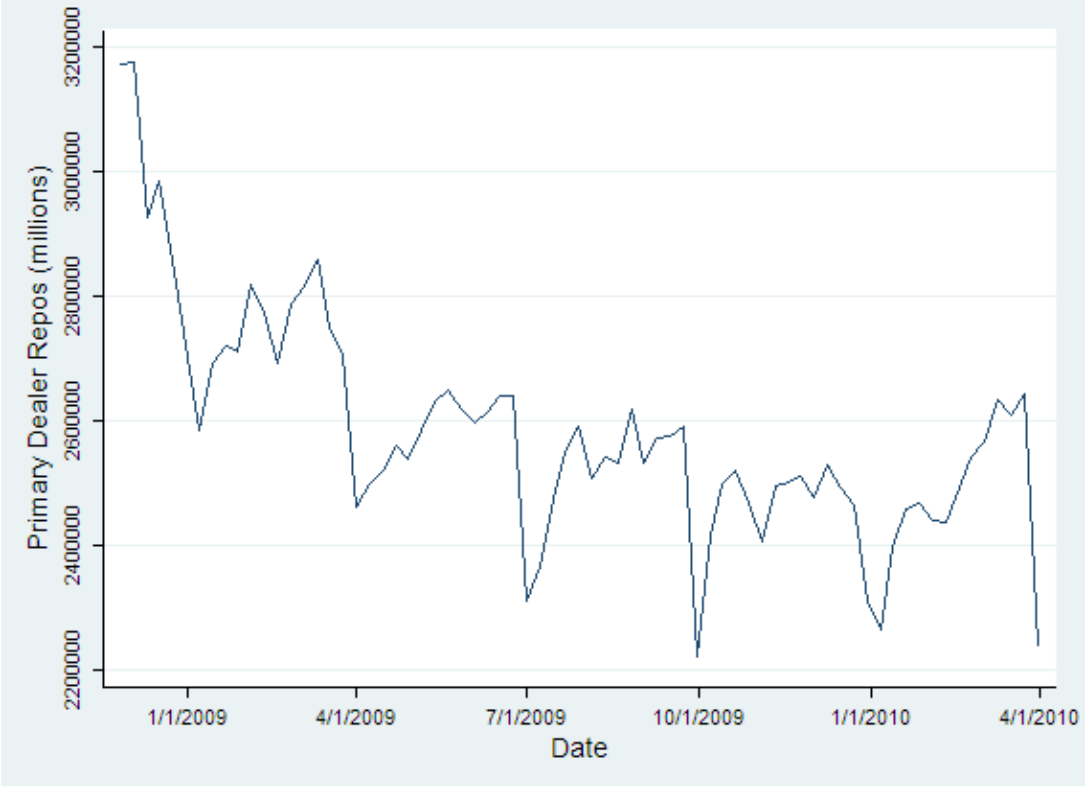
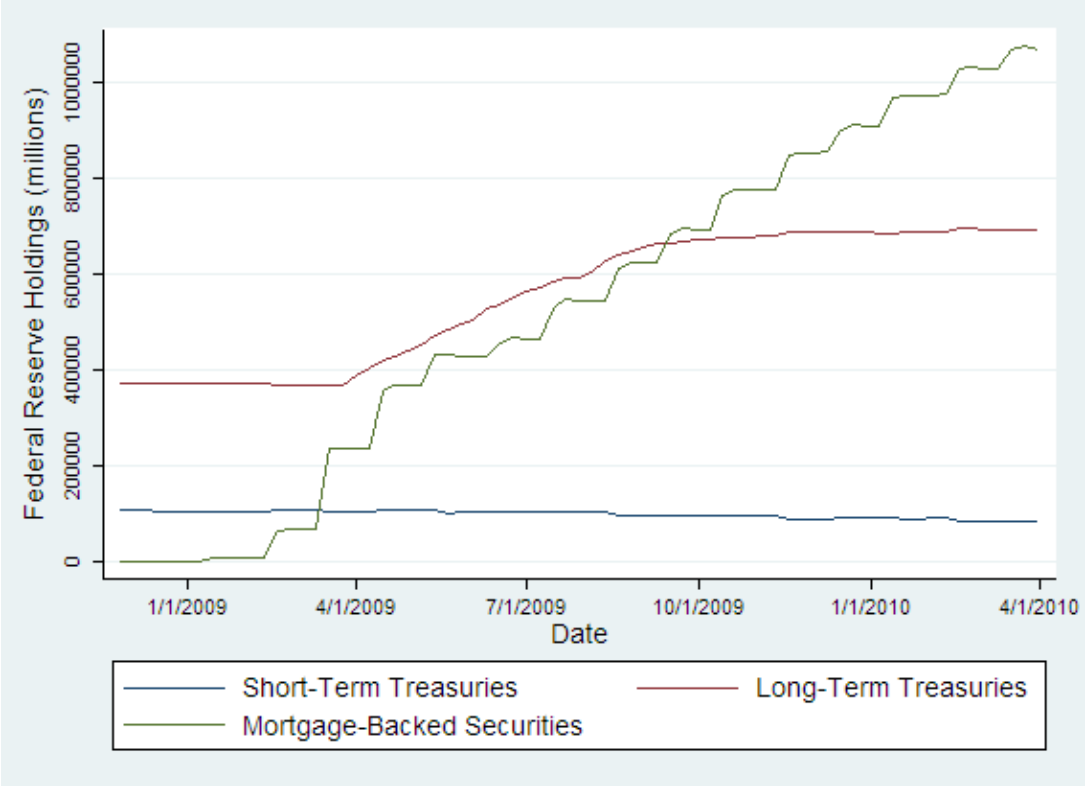


Figure 8: Federal Reserve Holdings During QE1 (Millions of Dollars)



The lagged regression finds a one-week lag of change in primary dealer repurchase statistically significant with a coefficient of -0.23. This is consistent with my findings across the entire timeframe and confirms the repurchase agreement market's volatility. While the dollar amount of repurchase agreements had a generally decreasing trend during QE1, weekly repurchase flows varied significantly. Large drops in primary dealer repurchase agreements were often followed by a few smaller increases before another significant decrease (see Figure 7).

Change in short-term Treasuries held by the Fed was statistically significant in both regressions, with coefficients of -14.72 and -12.75 in the non-lagged and lagged regressions respectively. This suggests that as the Fed sold short-term Treasury securities the quantity of repurchase agreements increased. While the volume of short-term

Treasuries sold during QE1 was not particularly large, this suggests that the increase in short-term Treasuries available for trade in the market is associated with increased repurchase agreement transactions. This supports my hypothesis that that decreases in Federal Reserve holdings of securities that could be used for repos results in increases of repurchase agreements.

Both regressions had statistically significant negative coefficients for change in long-term Treasuries held by the Fed. The Federal Reserve bought long-term U.S. Treasuries during QE1. Repurchase agreement flows decreased by 3.6 times the equivalent increase of long-term Treasuries held by the Federal Reserve. This supports my hypothesis that increased Federal Reserve purchases caused decreased repurchase agreement flows.

The lagged regression found that an increase in mortgage-backed securities held by the Fed leads to a decrease in change in repurchase agreements two weeks later. I am not sure why the change in mortgage-backed securities has an effect on repurchase agreements two weeks later, versus Treasury effects occurring the week of. For some reason, the effect of mortgage-backed securities being taken off the market by the Federal Reserve is not felt until two weeks after the transaction. However, my initial regressions over the entire time period find the same two-week lag for mortgage-backed security changes to be associated with repurchase agreement changes. This could potentially be due to a delay in the delivery of mortgage-backed securities. The negative coefficients support my hypothesis that increases in mortgage-backed securities held by the Federal Reserve lead to decreases in primary dealer repurchase agreements.

Change in federal debt held by the public has negative and statistically significant coefficients in both regressions. This aligns with the findings during the entire dataset time period. This could be due to the fact that some of the securities held by the public are taken off the market after purchase. While financial businesses, which are included in this data series, are likely to continue trading Treasuries, the other entities may instead take these securities off the market, causing a total decrease in repurchase agreements.

Change in federal debt held by the government is statistically significant in the lagged regression. This confirms my hypothesis that Treasury securities held by government agencies go into funds where they are not traded. The magnitude of this coefficient, -1.48, is greater than for federal debt held by the public, -0.99, which suggests that government holdings of federal debt have a more contractionary effect on repurchase agreements than do public holdings of federal debt. This makes intuitive sense because the entities included in the public, such as companies and individuals, are more likely to trade Treasury securities than is the Social Security fund, for example.

Mortgage-backed security fails/mortgage-backed security transactions attempts to represent the tightness in the MBS market. This works because fails to deliver are thought to happen due to inability to secure the collateral necessary for the transaction. Both regressions find negative and statistically significant coefficients for MBS fails/MBS transactions. The coefficients for the non-lagged and lagged regressions equal -2,537.49 and -2,131.59, respectively. This suggests that as the mortgage-backed security market gets tighter, fewer repurchase agreements happen. Furthermore, in Figure 9 we see that mortgage-backed security fails increase as Federal Reserve holdings of mortgage-backed securities increase during QE1. Figure 10 shows the relationship across

the entire time period. I am able to use the dollar value for mortgage-backed security fails in this graph because mortgage-backed security fails and mortgage-backed security tightness have a 0.9867 correlation. Furthermore, MBS fails and Federal Reserve holdings of mortgage-backed securities have correlation coefficient of 0.75. This supports my hypothesis that increased Federal Reserve holdings of mortgage-backed securities is associated with greater MBS market tightness, which leads to fewer repurchase agreement flows.

Figure 9: MBS Fails and Federal Reserve Holdings of MBS During QE1 (Millions of Dollars)

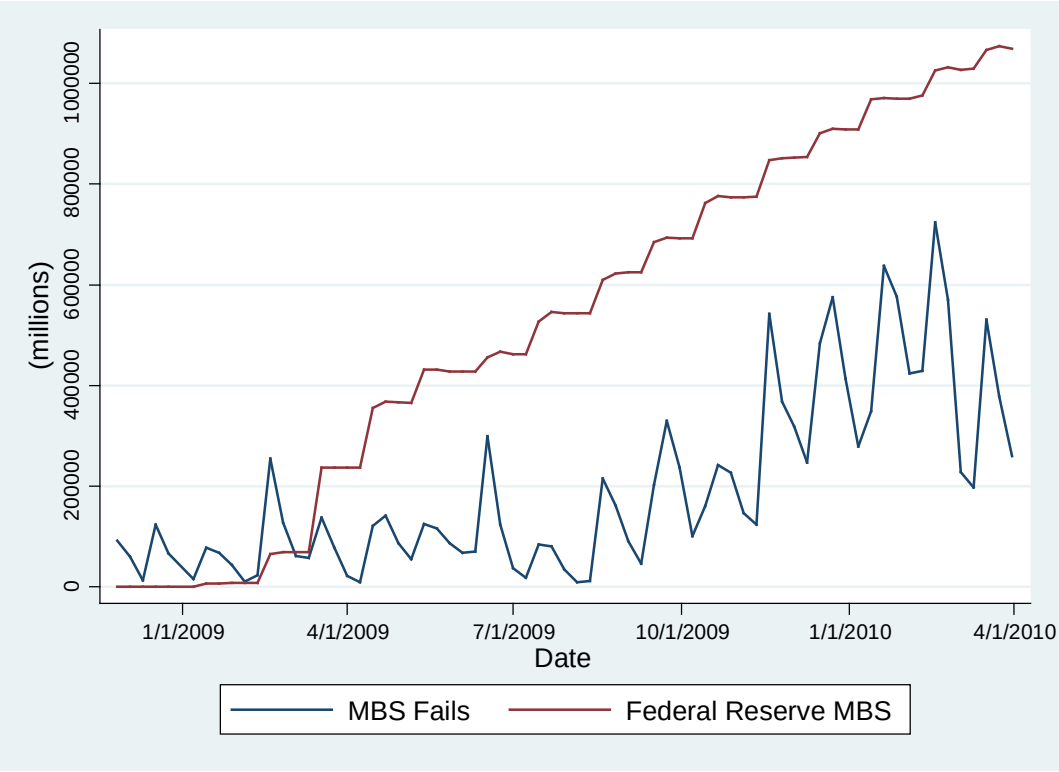
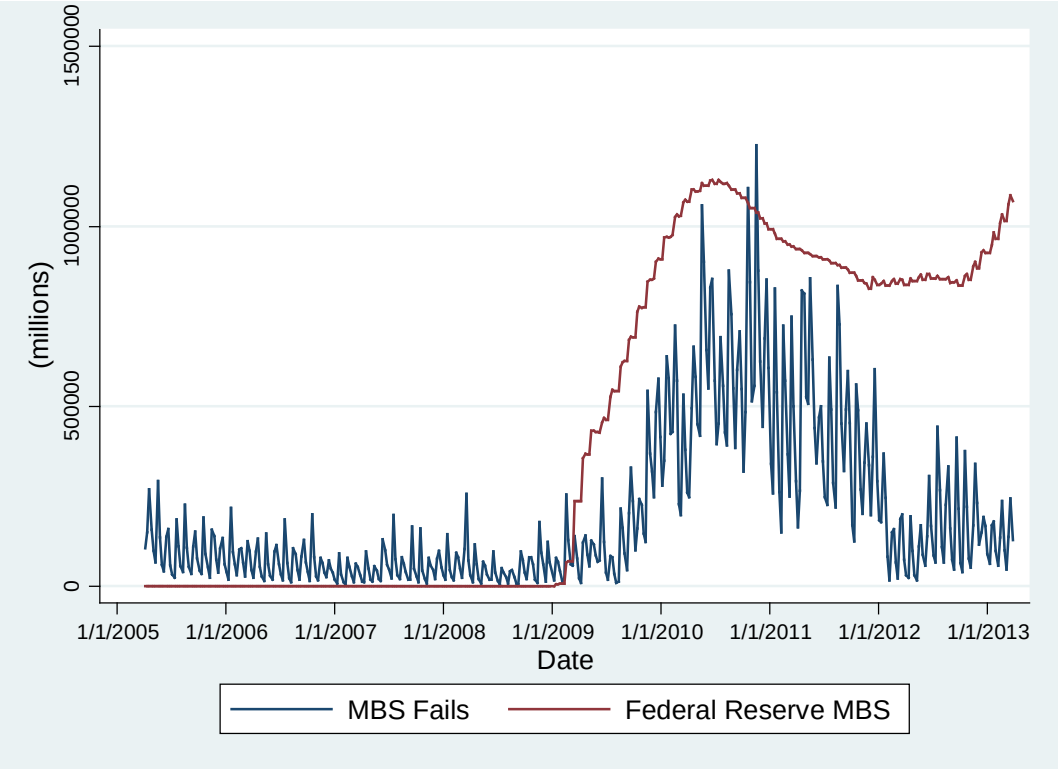


Figure 10: MBS Fails and Federal Reserve Holdings from 2005-2013 (Millions of Dollars)



These models explain 31.87% and 44.86% of the variation in primary dealer repurchase agreement changes during QE1 for the non-lagged and lagged regressions, respectively. These observations support my hypothesis that Federal Reserve purchases of securities that can be used in repurchase agreements lead to decreased amounts of primary dealer repurchase agreements. This shows that quantitative easing may have had the counter-productive tendency to decrease lending in the repurchase agreement market. By extension, it may have also decreased lending in the other parts of the shadow banking system, and not just in the repo market which is a subset of the overall shadow banking system.

C. Regressions During Quantitative Easing 2 (QE2)

The Federal Reserve engaged in QE2 from November 3, 2010 to June 20, 2011. This round of quantitative easing focused on buying long-term U.S. Treasury securities. QE2 lasted for 35 weeks; therefore, the data include 35 weekly observations. This low sample size raises questions about the validity of the results, which is particularly important considering that 10 different variables are included in the regression. Given the small sample size, I believe my results for the entire time period and during quantitative easing one are more accurate. Still, the results from QE2 have some interesting features. These regression results are located in Table 4.

During QE2, the weekly volume of repurchase agreements varied significantly (see Figure 11). The quantity of primary dealer repurchase agreements dropped significantly twice, but primary dealer repurchase agreements started and ended QE2 at similar values. During QE2, the Federal Reserve bought long-term Treasuries, sold some mortgage-backed securities, and bought small quantities of U.S. short-term Treasuries (see Figure 12).

Figure 11: Primary Dealer Repurchase Agreement Levels during QE2 (Millions of Dollars)

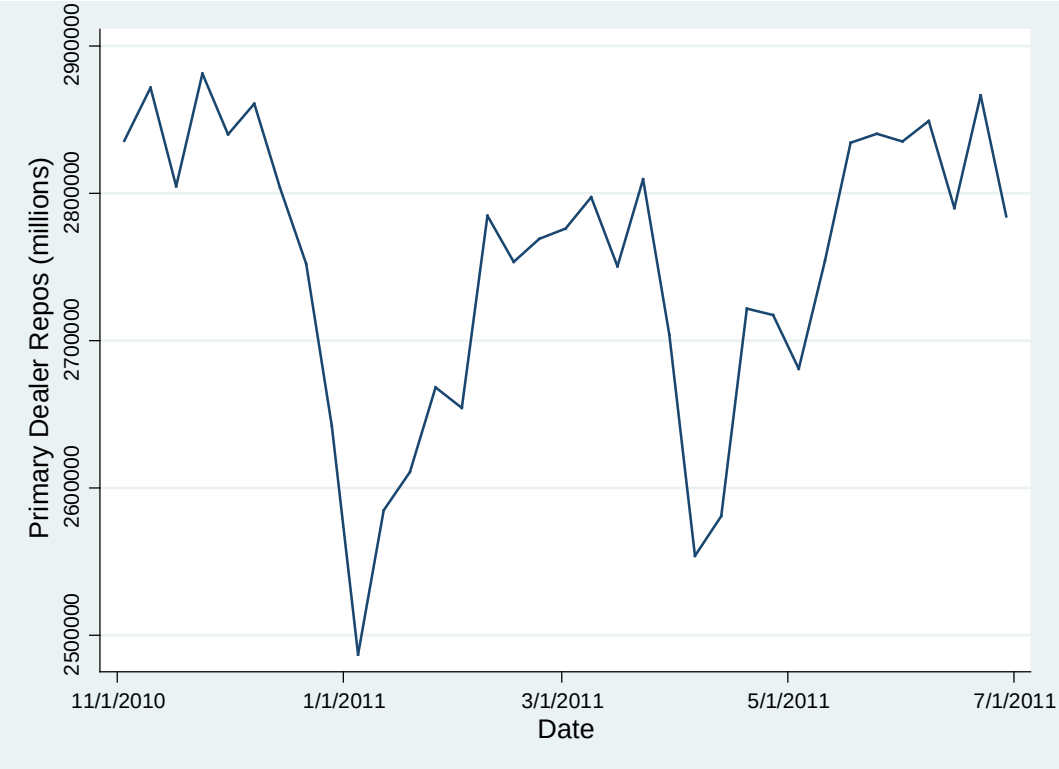
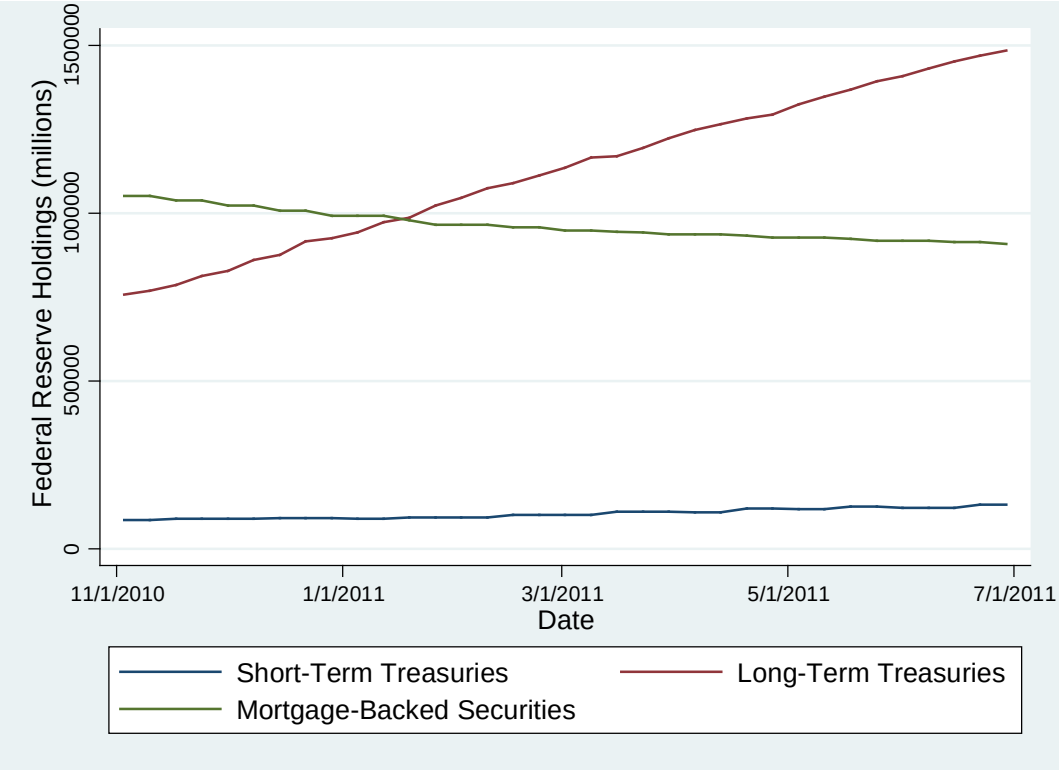


Figure 12: Federal Reserve Holdings during QE2 (Millions of Dollars)



Regression 2, which includes a one-week lag of repurchase agreement flows, found that a one-week lag of repo flows has a statistically significant negative coefficient of -0.38. This further emphasizes repurchase agreements' volatile behavior. Even if a general trend is present, the weekly change of primary dealer repurchase agreements varies.

Change in short-term Treasuries held by the Fed had statistically significant positive coefficients of 8.68 in Regression 1 and 8.16 in Regression 2, which includes a one-week lag of repo flows. This result is surprising and refutes my hypothesis that increases in holdings by the Fed leads to decreases in repurchase agreements flows. It does not seem that the Federal Reserve made any attempts to reverse their squeeze on the

collateral market during QE2. Therefore, the Federal Reserve attempting to reverse any collateral shortages is not a potential explanation for the positive coefficient.

The positive change in short-term Treasuries coefficient could indicate that primary dealers had gotten over the scare caused in 2008, and were less concerned about counterparty risk and more willing to repo during QE2 than during QE1. Also, this could be a spurious relationship simply due to the low sample size. Third, this may occur because the flows of Fed holdings of short-term Treasuries remain relatively close to zero while repurchase agreement flows fluctuate both positively and negatively throughout the time period. The correlation coefficient between change in short-term Treasuries held by the Fed and primary dealer repurchase agreement flows equals 0.0977, suggesting minimal correlation between the two variables. Neither of the other variables for securities held by the Federal Reserve have statistical significance in this model, which shows that Federal Reserve holdings did not have a contractionary effect on repurchase agreements during QE2.

Change in federal debt held by the public has a negative coefficient of -1.05 and -1.03 in the non-lagged regression and regression with lag of repo flows, respectively. This suggests about a one-to-one relationship between an increase in Treasuries held by the public and a decrease in repurchase agreement flows. As discussed earlier, this could be due to the fact that many of the groups included in "the public" do not allow for their Treasury securities to be used for repurchase agreements, effectively taking them off the repo market.

Change in federal debt held by the government also has a negative coefficient; this coefficient equals -1.31 for the regression including a lag of change in primary dealer

repurchase agreements. This is consistent with my previous findings and confirms that increases in Treasuries held by government lead to decreases in repurchase agreements.

Treasury fails divided by Treasury transactions, which represents tightness in the Treasury market, is statistically significant with a negative coefficient. The coefficient for the Regression 2 equals -38,054.62. This suggests that fewer repurchase agreements happen when the market for U.S. Treasury securities gets tighter. Fails to deliver can be caused by a lack of collateral availability. Mortgage-backed security market tightness was significant during QE1 when the Fed was buying mortgage-backed securities, and Treasury market tightness was significant during QE2 when the Fed was buying Treasury securities. This may indicate that repurchase agreements become more susceptible to changes in MBS or Treasury market tightness when the Federal Reserve is buying that specific type of security.

A dummy variable for Basel III is statistically significant with a negative coefficient in both regressions. This suggests that the passage of Basel III, which increased capital requirements for banks, led to a decrease in repurchase agreement flows. Given that many of the financial institutions Basel III is targeted at are the same primary dealers included in the repurchase agreement data, it is not surprising that Basel III has a large effect. As these banks are forced to keep more capital, thus, they cannot perform repurchase agreements with those securities.

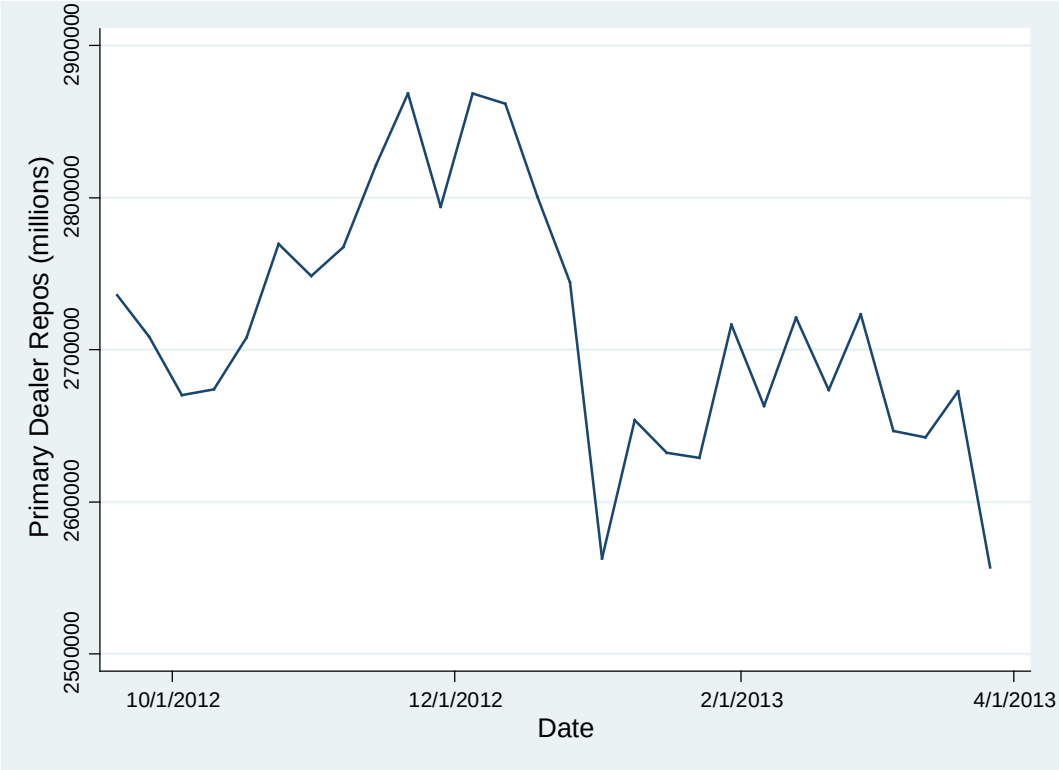
My model explains 57.3% of the variation in the original regression and 62.15% of the variation in the model with a one-week lag of repo flows.

D. Regressions During Quantitative Easing 3 (QE3)

QE3 started in September 13, 2012 and continued through the end of the dataset in March 2013. This round of quantitative easing involved the Federal Reserve purchasing both mortgage-backed securities and long-term U.S. Treasuries. The Fed bought $45 billion of long-term U.S. Treasuries and $40 billion of mortgage-backed securities each month. My dataset contains 28 observations during quantitative easing three. This small sample size is problematic and may indicate a lack of validity of my results. These regression results are located in Table 5.

During the portion of QE3 that I have data for, the amount of primary dealer repurchase agreements fell, but did so with various fluctuations along the way (see Figure 13). The Federal Reserve increased holdings of long-term U.S. Treasuries and mortgage-backed securities during this time.

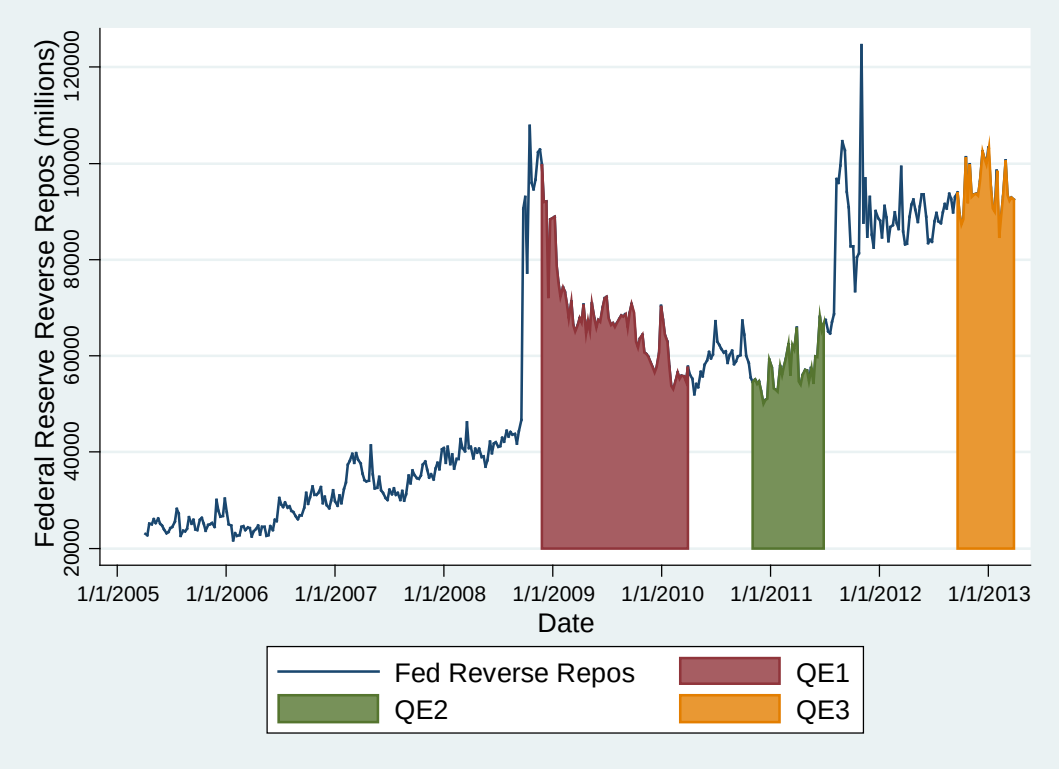
Figure 13: Primary Dealer Repurchase Agreements during QE3 (Millions of Dollars)



My regression of change in primary dealer repurchase agreements on my continuous variables and a dummy variable for year 2012 did not produce any statistically significant coefficients. This suggests that changes in Treasury holdings, changes in federal debt, and Treasury and mortgage-backed security market tightness did not have statistically significant relationships with repurchase agreement flows. One explanation for the lack of relationship between Federal Reserve asset purchases and repo flows is that the Federal Reserve increased their reverse repurchase agreement transactions before QE3, which may be an effort to reverse their squeeze on collateral availability (see Figure 14). By performing reverse repos, the Fed borrows money and uses securities as collateral, inserting collateral into the market. The primary dealers on the other side of the transaction can use these securities in other transactions, which

would help mitigate the effects of a collateral shortage. This may explain the lack of a relationship between Federal Reserve purchases and repurchase agreement flows during QE3. Also, the small sample size could contribute to the lack of significant relationships.

Figure 14: Federal Reserve Reverse Repos (Millions of Dollars)



Conclusion

This paper analyzes the effect of Federal Reserve asset purchases, quantitative easing in particular, on the repurchase agreement market. Under certain circumstances, increases in Federal Reserve asset purchases lead to decreased flows of repurchase agreements. From 2005 to 2013, a two-week lag of increases in mortgage-backed securities held by the Fed is associated with a decrease in primary dealer repurchase agreements. This effect is most robust during QE1, during which the Federal Reserve increased its holdings of mortgage-backed securities and long-term U.S. Treasury securities. During QE1, I found that increases in Federal Reserve holdings of Treasury securities and mortgage-backed securities were associated with declines in primary dealer repurchase agreements.

This demonstrates that Federal Reserve purchases have the ability to affect the shadow banking system, even though the shadow banking system falls outside of the Fed's regulatory remit and beyond the traditional purview of Fed policy. The existence of the negative relationship between Federal Reserve purchases and primary dealer repurchase agreements under certain circumstances supports my hypothesis that quantitative easing led to decreased lending in the repurchase agreement market. The decrease in repurchase agreements is counterproductive to the goal of quantitative easing, which is to increase lending.

The results do not find this relationship under all circumstances. During QE2 and QE3, increases in Federal Reserve security purchases are not associated with decreases in

repurchase agreement flows. Therefore, assertions of an overwhelming collateral shortage caused by quantitative easing are not supported. The lack of effect could be due to the small sample sizes or to the Federal Reserve taking actions to reverse the collateral crunch, which is evidenced by their increases in reverse repurchase agreements during QE3. Another possibility is that decreases in repurchase agreements during QE1 occurred in part due to market pessimism, and not entirely due to a lack of collateral availability.

This study shows that the monetary policy has the potential to affect the shadow-banking system, even if those effects are unintentional. While quantitative easing is aimed at traditional banking, unintended and counterproductive consequences may occur in the shadow bank system. The shadow banking system has become a huge part of our economy, warranting greater consideration by monetary policy makers.

Works Cited

Adrian, Tobias, and Adam Ashcraft. "Shadow Banking Regulation." Federal Reserve Bank of New York. N.p., Apr. 2012. Web. 21 Apr. 2014. <http://www.newyorkfed.org/research/staff_reports/sr559.pdf>.

Adrian, Tobias, Adam Ashcraft, and Nicola Cetorelli. "Shadow Bank Monitoring." Federal Reserve Bank of New York. N.p., Sept. 2013. Web. 21 Apr. 2014 (http://www.newyorkfed.org/research/staff_reports/sr638.pdf)

Adrian, Tobias, Adam Ashcraft, Hayley Boesky, and Zoltan Pozsar. "Shadow Banking." Federal Reserve Bank of New York. N.p., July 2012. Web. 21 Apr. 2014. < http://www.newyorkfed.org/research/staff_reports/sr458.pdf>.

Alloway, T and Rodrigues V, "Pullback in US repo financing could affect other assets," *Financial Times,* August 20, 2013 (http://www.ft.com/intl/cms/s/0/e15bf36a-093a-11e3-ad07-00144feabdc0.html?siteedition=intl#axzz2kS4hZDR9)

Alloway, T, "Market with a weakness for withdrawals," *Financial Times,* March 4, 2013. (http://www.ft.com/intl/cms/s/0/5de43e40-7b80-11e2-8eb3-00144feabdc0.html?siteedition=intl#axzz2l6yJ9BCk)

Alloway, T, "The collateral crunch," *Financial Times,* June 13, 2011. (http://ftalphaville.ft.com/2011/06/13/592161/the-collateral-crunch/)

Auerbach, Robert. "Massive Misconceptions About Where the Bernanke Fed's Money

Explosion Went." The Huffington Post. N.p., 25 June 2013. Web. 21 Apr. 2014. <http://www.huffingtonpost.com/robert-auerbach/massive-misconceptions-ab_b_3490373.html>

Bernanke, B, Reinhart, V, and Sack, B. “Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment,” *Divisions of Research & Statistics and Monetary Affairs: Federal Reserve Board, Washington D.C.,* 2004

Bowman, David, Fang Cai, Sally Davies, and Steven Kamin. "Quantitative Easing and Bank Lending: Evidence from Japan." International Finance Discussion Papers (2011). Board of Governors of the Federal Reserve System. Web. 21 Apr. 2014. <http://www.federalreserve.gov/pubs/ifdp/2011/1018/ifdp1018.htm>.

Carpenter, Jennifer. "The Repo Market." NYU Stern, 2014. Microsoft Powerpoint file. <http://people.stern.nyu.edu/jcarpen0/courses/b403333/08repo.pdf>.

Carvalho de Rezende, F (Summer 2011). “The Structure and the Evolution of the U.S. Financial System, 1945-1986: A Minskian Approach Explaining the Emergence of Shadow Banking” *International Journal of Political Economy,* vol. 40, no. 2, Summer 2011, pp. 21-44.

Copeland, Adam, Isaac Davis, Eric LeSueur, and Antoine Martin. "Mapping and Sizing the U.S. Repo Market." Web log post. *Liberty Street Economics*. Federal Reserve Bank of New York, 25 June 2012. Web. 22 Apr. 2014. <http://libertystreeteconomics.newyorkfed.org/2012/06/mapping-and-sizing-the-us-repo-market.html#.U1bnsVUkLzh>.

Coy, Peter. "A Treasury Shortage Squeezes the Heart of the Market." *Bloomberg*

Businessweek. N.p., 29 Aug. 2013. Web. 22 Apr. 2014. <http://www.businessweek.com/articles/2013-08-29/a-treasury-shortage-squeezes-the-heart-of-the-market>.

FRED, Federal Reserve Economic Data, Federal Reserve Bank of St. Louis: *U.S. Treasury securities held by the Federal Reserve: All Maturities*; U.S. Department of Labor: Bureau of Labor Statistics; 22 Apr. 2014. <http://research.stlouisfed.org/fred2/series/TREASt>.

FRED, Federal Reserve Economic Data, Federal Reserve Bank of St. Louis: *Mortgage-backed securities held by the Federal Reserve: All Maturities*; U.S. Department of Labor: Bureau of Labor Statistics; 22 Apr. 2014. <http://research.stlouisfed.org/fred2/series/MBST>.

Dolan, Ed. "Quantitative Easing: Your Ultimate Cheat Sheet to the Monetary Policy." *Wall St. Cheat Sheet*. N.p., 1 June 2011. Web. 21 Apr. 2014.

Femia, Katherine, Steven Friedman, and Brian Sack. "The Effects of Policy Guidance on Perceptions of the Fed's Reaction Function." Federal Reserve Bank of New York, Nov. 2013. Web. 21 Apr. 2014. <http://www.newyorkfed.org/research/staff_reports/sr652.pdf>.

Fender, I, and Lewrick, U. "Mind the gap? Sources and implications of supply-side imbalances in collateral asset markets," *BIS Quarterly Review* (September 2013): 67-81.

Fleming, Michael, and Kenneth Garbade. "Explaining Settlement Fails." *Current Issues in Economics and Finance: Federal Reserve Bank of New York* 11.9 (2005): n. pag. Web. 21 Apr. 2014.

Fleming, Michael, and Kenneth Garbade. "The Repurchase Agreement Refined: GCF Repo." *Current Issues in Economics and Finance: Federal Reserve Bank of New York* 9.6 (2003): n. pag. Web. 21 Apr. 2014.

Garcia, Cardiff. "Meet the New Idiots, Same as The… Actually These Idiots Might Be Worse." Web log post. *Alphaville*. Financial Times, 26 Sept. 2013. Web. 21 Apr. 2014. <http://ftalphaville.ft.com/2013/09/26/1647792/meet-the-new-idiots-same-as-the-actually-these-idiots-might-be-worse/>.

Golay, E, Friedman, S, and McMorrow, M, "Understanding the New York Fed's Survey of Primary Dealers," *Federal Reserve Bank of New York*, 2013 (http://www.newyorkfed.org/research/current_issues/ci19-6.pdf)

Harrison, Edward. "What Are the Differences between QE1, QE2 and QE3?" Web log post. Credit Writedowns. N.p., 20 June 2011. Web. 21 Apr. 2014. <https://www.creditwritedowns.com/2011/06/qe1-versus-qe2-versus-q3.html>.

Hoermann M, Schabert A. When is Quantitative Easing effective?. [serial online]. 2011;Available from: EconLit, Ipswich, MA. Accessed October 23, 2013.

Joyce, M., Miles, D., Scott, A. and Vayanos, D. (2012), Quantitative Easing and Unconventional Monetary Policy – an Introduction. The Economic Journal, 122: F271–F288.

Kocjan, John, Don Ogilvie, Adam Schneider, and Val Srinivas. "The Deloitte Shadow Banking Index." Deloitte, 2012. Web. 21 Apr. 2014. <http://www.deloitte.com/assets/Dcom-

UnitedStates/Local%20Assets/Documents/CFO_Center_FT/US_FSI_The_Deloitte_Shadow_Banking_052912.pdf>.

Kodres, Laura E. "What Is Shadow Banking?" International Monetary Fund, June 2013. Web. 21 Apr. 2014 (http://www.imf.org/external/pubs/ft/fandd/2013/06/basics.htm)

Kessler, A, "The Fed Squeezes the Shadow-Banking System," *Wall Street Journal*, May 22, 2013, (http://online.wsj.com/news/articles/SB10001424127887323628004578456991962372414)

Kurtz, Annalyn. "This Could Be the Largest Fed Stimulus Yet." CNN Money [New York] 28 Oct. 2013.

Martin C, Milas C. Quantitative Easing: A Sceptical Survey. *Oxford Review Of Economic Policy* [serial online]. Winter 2012;28(4):750-764. Available from: EconLit, Ipswich, MA. Accessed October 23, 2013.

McCormick, L and Kruger, D, "Treasury Scarcity to Grow as Fed Buys 90% of New Bonds," *Bloomberg*, December 3, 2012 <http://www.bloomberg.com/news/2012-12-03/treasury-scarcity-to-grow-as-fed-buys-90-of-new-bonds.html>

Moe, Thorvald Grung (01/01/2012). "Shadow Banking and the Limits of Central Bank Liquidity Support: How to Achieve a Better Balance between Global and Official Liquidity".

"New York Fed Publishes Revised Policy for Administration of Primary Dealer

Relationships." Federal Reserve Bank of New York, 11 Jan. 2010. Web. 22 Apr. 2014. <http://www.newyorkfed.org/newsevents/news/markets/2010/ma100111.html>.

Petroff, Eric. "The Rise And Fall Of The Shadow Banking System." Investopedia, 11 Oct. 2011. Web. 21 Apr. 2014. <http://www.investopedia.com/articles/economics/10/shadow-banking-system.asp>.

Primary Dealer Statistics: *Repurchase Agreements, Fails*; The Federal Reserve Bank of New York; 22 Apr. 2014. <http://www.newyorkfed.org/markets/gsds/search.html>.

Putnam, Bluford H. (01/01/2013). "Essential Concepts Necessary to Consider When Evaluating the Efficacy of Quantitative Easing". *Review of financial economics (1058-3300)*,22 (1), p. 1.

"Quantitative Easing Explained." Liber8: Economic Information Newsletter. Federal Reserve Bank of St. Louis, Apr. 2011. Web. 21 Apr. 2014.

Rosenberg, David. "5 Signs of QE's Diminishing Returns." Gluskin Sheff (3 July 2013).

"Securities Lending and Repos: Market Overview and Financial Stability Issues." Interim Report of the FSB Workstream on Securities Lending and Repos. Financial Stability Board, 27 Apr. 2012. Web. <http://www.financialstabilityboard.org/publications/r_120427.pdf>.

Shellock, Dave. "S&P 500 Hits Record after Fed Taper Move." *Financial Times*. N.p., 18 Dec. 2013. Web. 22 Apr. 2014. <http://www.ft.com/intl/cms/s/0/5738fb68-6792-11e3-a5f9-00144feabdc0.html#axzz2zaoU7ouW>.

"Tapering Talk Turns to Action." Financial Times 19 Dec. 2013. Web. <http://www.ft.com/intl/cms/s/0/4a756eac-6819-11e3-8ada-00144feabdc0.html?siteedition=intl#axzz2zaoU7ouW>.

TreasuryDirect, *The Debt to the Penny and Who Holds It*; 22 Apr. 2014. <http://www.treasurydirect.gov/NP/debt/current>.

"Understanding Repurchase Agreements." BlackRock, 2014. Web. 21 Apr. 2014. <https://www.blackrock.com/cash/literature/whitepaper/understanding-repurchase-agreements.pdf>.

"Why is the Liquidity Trap?" Web log post. Free Exchange. The Economist, 21 Oct. 2013. Web. 21 Apr. 2014. <http://www.economist.com/blogs/freeexchange/2013/10/monetary-policy-2>.

Williams, John. "Lessons from the Financial Crisis for Unconventional Monetary Policy." Panel Discussion at the NBER Conference. Massachusetts, Boston. 18 Oct. 2013. Speech.