How Does Monetary Policy Affect Shadow Banking Activity? Evidence From Security Repurchase Agreements

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Abstract

We investigate the relationship between instruments of monetary policy and gross financing activity by the primary government securities dealers of the Federal Reserve System. Specifically, we estimate the dynamic effect of money market conditions on repo activity using a recursively identified vector autoregression model at the weekly frequency. We measure shocks to the money market using the effective federal funds rate and open market operations. A positive shock to the federal funds rate significantly affects the level of credit activity. In particular, repo arrangements longer than a day display persistent declines. By comparison, overnight financing increases after a delay. This implies that contractionary monetary policy shocks lead to maturity substitution in the repo market. Our findings show that credit activity in the repo market is more sensitive to monetary policy than previously reported in the literature. Thus, our results indicate that monetary policy can contribute to systemic risk in the shadow banking system. Therefore, the policy actions of central banks should also focus on macroprudential implications in addition to the standard concerns about real activity and price stability.

Keywords: Monetary Policy, Repurchase Agreements, Primary Dealers, Shadow Banking, the Federal Reserve System Open Market Account.

JEL classification: E44, E52, G23.

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"Goldman Sachs seeks to maintain a highly liquid balance sheet. Many of our assets are readily funded in the repurchase agreement and securities lending markets, which have generally proven to be a consistent source of funding, even in periods of market stress..."

– Goldman Sachs Annual Report, 2002

1 Introduction

A repurchase agreement (or 'repo') is a collateralized money market loan used often in the process of intermediation in the shadow banking sector.[1] (Financial Crisis Inquiry Commission, 2011) As described by Geithner (2008), overnight tri-party repos funded approximately $2.5 trillion of assets in early 2007. Prior to the recent financial crisis, along with federal funds, repurchase agreements represented the largest net increase in liabilities of the U.S. financial sector. Moreover, during the crisis, they represented the largest net decrease.[2]

In contrast to standard secured lending arrangements, borrowers in the repo market sell bonds with the agreement to buy them back at a fixed price at a forward date. The difference between the sale and repurchase price is called the repo rate and reflects interest on the loan. The securities sold act as collateral in the cash-loan transaction. During the term of the loan, lenders utilize the securities as their own.[3] In so doing, both parties seek to minimize the cost of default. (Mills and Reed, 2008)

Naturally, securities dealers rely on the repo market to finance intermediation in securities markets. However, relying on repos for short-term liquidity remains problematic.[4] In fact, in 2009 the Task Force on Tri-Party Repo Infrastructure concluded: "repo arrangements were at the center of liquidity pressures faced by securities firms at the height of the financial crisis."[5] Moreover, institutions active in the repo market generally do not have access to the discount window and resort to "fire sales" in order to raise funds quickly.[6] As a result, the absence of a lender of last resort exacerbates problems in the repo market. (Martin et al., 2013)

As stressed by Gorton and Metrick (2012), instabilities in the repo market can cascade into the real economy by shutting off debt market intermediation.[7] As the initial stages of the monetary policy transmission mechanism generally take place through money markets, the actions of the central bank can impact the repo market in systemically important ways.[8] Thus, it is important

[1] According to Bernanke (2010), "*Shadow banks* are financial entities other than regulated depository institutions (commercial banks, thrifts, and credit unions) that serve as intermediaries to channel savings and investment...Leading up to the crisis, the shadow banking system, as well as some of the largest global banks, had become dependent on various forms of short-term wholesale funding. Over the past 50 years or so, a number of forms of such funding have emerged, including, commercial paper, repurchase agreements (repos), ..., and others. In the years immediately before the crisis, some of these forms of funding grew especially rapidly; for example, repo liabilities of U.S. broker dealers increased by 2-1/2 times in the four years before the crisis."

[2] See Woodford (2010) for details.

[3] As outlined in the Bankruptcy Amendments and Federal Judgeship Act of 1984.

[4] Notably, Copeland et al. (2012b) contends that major reforms are necessary to improve stability in the tri-party repo market.

[5] Bernanke (2010) describes how institutions experienced funding disruptions in the repo market during the crisis. Traders call these temporary events "liquidity holes," an outcome akin to a bank run. See Taleb (1997, p. 69) and Morris and Shin (2004).

[6] For further discussion see Begalle et al. (2013).

[7] See also the discussion by the Task Force on Tri-party Repo Infrastructure (2012) about the early morning unwind of all tri-party repo transactions.

[8] Bernanke (2007) points out monetary policy may contribute to risks in the global financial system by operating through the money markets and thereby the nonbank financial institutions who rely on them. For example, in the

to understand the transmission mechanism of monetary policy through the repo market. (Kohn, 2008)

Unfortunately, inadequate data complicates any empirical analysis of repo activity.[9] (Bernanke, 2012) However, the primary dealers of the Federal Reserve file the FR 2004 Reports with the Federal Reserve Bank of New York (FRBNY), as required by law, on an ongoing basis. The FRBNY publishes the FR 2004 Reports weekly and the FR 2004C includes financing transactions classified as repurchase agreements by maturity. Furthermore, the report encompasses dealer financing by security type, maturity length, and financing fails. Therefore, the FR 2004C report is not only a high frequency measure of repo activity, but it also provides contract details nonexistent in other data sets.[10]

As we describe in more detail below, there are two important ways the FR 2004C report measures financing flows in the shadow banking system. First, the data is collected from the primary dealers, an influential group of intermediaries in the shadow banking system.[11] Second, the dealers report financing on a gross basis. As explained by Krishnamurthy et al. (2013), the volume of gross flows contribute to the probability that defaults feed through the shadow banking system across dealers.[12] In this manner, the FR 2004C reflects the level of systemic risk in the shadow banking system. As a result, studying the high frequency response of dealer financing to monetary conditions gives policymakers insight about how their actions affect conditions in the shadow banking system over time.

In addition to regularly reporting repo transactions, primary dealers serve as on-demand counterparties for the FRBNY's trading desk. Consequently, the initial stages in the execution of monetary policy directly transmit to primary dealers. Yet, their role as monetary propagation mechanisms continues to be ignored – even though primary dealers occupy the nexus of money creation and shadow credit facilitation. Hence, the FR 2004 reports provide a distinct view of the monetary transmission mechanism operating through repo market activity.

The objective of this paper is to provide empirical evidence on a transmission mechanism for monetary policy to shadow banking activity which operates through the total volume of repurchase agreements. The number of empirical studies measuring the effect of monetary policy on repo activity is limited though Adrian and Shin (2008) find that changes in the federal funds rate are negatively correlated with the growth of repo financing by dealer banks.[13] In comparison to their single equation analysis, we analyze the response of dealer repo activity through impulse response functions of an estimated vector autoregression (VAR) model. As explained by Stock and Watson (2001), single equation analysis has a number of limitations relative to VARs. Thus, our VAR analysis produces a number of insights that are difficult to determine in single equation analysis such as the dynamic effects of money market conditions which feed through macroeconomic conditions to repo market activity. Consequently, the dynamic effects of monetary shocks can be more precisely estimated as the indirect effects through macroeconomic variables are taken into

four years prior to the summer of 2007, the target rate for federal funds increased by 4.25 percentage points (425 basis points). During the same sample, repo liabilities of US broker dealers increased by 250 percent. (Bernanke 2010)

[9]See Adrian et al. (2013) for a summary of available data sources.

[10]It also avoids measurement error found in the Flow of Funds Accounts. (Krishnamurthy and Nagel, 2013)

[11]See Pozsar et al. (2010) for an overview of the shadow banking system.

[12]FR 2004 data represents market volumes, not origination's. Therefore, multiple transactions in the same security is possible.

[13]Adrian and Shin (2008) also find strong correlations between the growth of repo financing by dealer banks, dealer bank asset growth, and future real macroeconomic activity. In related work, Adrian and Shin (2010) adopt the same estimation strategy but use changes in the target federal funds rate over a one week period in lieu of the effective rate over a thirteen week period.

account. Furthermore, our main identification restriction supports the use of a recursive VAR model which allows us to characterize the monetary transmission mechanism through the repo market.[14] In contrast to Adrian and Shin, we find that the coefficient estimates for the effects of policy are twice as large. Thus, our benchmark results provide further empirical evidence that policymakers need to anticipate financial conditions in the repo market when evaluating monetary transmission mechanisms. In this manner, our findings indicate there are strong connections between the design of monetary policy and macroprudential policy in addition to the standard concerns about real activity and price stability.

In addition to gross repo activity, we consider whether the maturity structure of repo financing responds uniformly to shocks to the federal funds rate. A thorough study of the maturity structure is necessary as many have argued that dealer banks increasingly relied on overnight repo for funding prior to the 2007 crisis. One hypothesis is that the shift towards overnight funding was due to increasing demand for money market instruments.[15] However, our evidence indicates that the monetary tightening between 2004 and 2006 may have played a role – while an increase in the federal funds rate is followed by a reduction in overall repo activity, the decline is concentrated in agreements with maturities longer than a day. In contrast, we find a delayed positive response in overnight repos backed by Treasury securities. Therefore, higher levels of the federal funds rate were partially offset with overnight funding using collateral of the highest quality. As a result, we conclude the "flight to maturity" in the repo market was also due to higher money market interest rates. Consequently, monetary policy likely contributed to systemic risk in the shadow banking system during the run-up to the crisis.

In light of the recent debate on the use of unconventional monetary policy tools, we also study the impact of various components of the Federal Reserve's balance sheet. As communicated by the Federal Reserve, Large Scale Asset Programs (LSAPs) were introduced to ease financial conditions and promote credit activity. Consequently, we study the impact of the size of the Federal Reserve's Treasury portfolio to gain insights into how LSAP programs can affect activity in the repo market. In comparison to the unprecedented size of purchases of Treasuries in recent years, standard open market operations are designed to minimally impact the price of these securities. However, we find that the resulting reduction in the public's Treasury stock does affect repo market activity. Consistent with Bartolini et al. (2011)'s ranking of collateral values by security classes, we find persistent increases in the use of agency securities for overnight financing. For maturities longer than a day, we find evidence of a substitution towards corporate securities. While the motivation for LSAPs is to ease financial conditions, there is some evidence that they may contribute to risk in the repo market. For example, in response to the withdrawal of Treasury bills in standard open market operations, there is an increase in fails of mortgage backed securities (MBS). Thus, one can infer that that the large volumes of purchases of longer-dated securities in a LSAP would have similar but exaggerated effects on repo activity. Furthermore, the intensity of this transmission channel is related to the fraction of Treasury Bills to Treasury securities held by the System Open Market Account (SOMA) and as a result, informative about the effects of the Maturity Extension Program, also known as 'Operation Twist.'[16]

In addition to outright open market operations, the Federal Reserve has increasingly turned to

[14] As argued by Bernanke and Blinder (1992) and Bernanke and Mihov (1998), the identification assumption that monetary policy affects the economy with a lag is more realistic at the weekly frequency.

[15] Brunnermier (2009) is perhaps the most well known to make this argument. By comparison, Gorton et al. (2012) present evidence that the "flight to maturity" actually started in July 2007.

[16] On September 21, 2011 the Federal Reserve announced the Maturity Extension Program and Reinvestment Policy for the purpose of extending the average maturity of Treasury securities in the SOMA portfolio. This program was subsequently continued on June 20, 2012. (Board of Governors of the Federal Reserve System, 2011)

the repo market when accommodating daily variations in the supply of reserves. Fed repos are one type of temporary open market operation used most often to control the level of bank reserves. Under a Fed repo, the open market desk temporarily lends funds to primary dealers and accepts general collateral (GC) in Treasuries, agency, and MBS. By temporarily raising demand for GC, the open market desk promotes the 'collateral rights' of holders of GC securities. In turn, such transactions have a delayed but persistent positive impact on repo activity with maturities longer than a day. Moreover, the withdrawal of Treasury, agency, and MBS leads to a substitution towards overnight arrangements backed by corporate securities. In contrast to outright open market operations, an increase in Fed repos corresponds to a persistent decrease in financing fails. Furthermore, the decrease in financing fails is the largest and most persistent of all fail reactions by policy instrument.[17]

In comparison to Fed repos, Fed reverse-repos have recently attracted attention as the Federal Reserve considers expanding their use in order to improve control over money market rates. Such a tool would seek to "...reassure investors that the Federal Reserve has sufficient tools to manage monetary policy effectively even with a very large balance sheet." (Dudley, 2013) While Fed repos remove the supply of assets that serve as collateral, Fed reverse-repos increase the supply of securities used as collateral. We find that this component of the Federal Reserve's balance sheet also affects activity in the repo market. While Fed repos appear to promote long-term financing, reverse-repos lead to maturity substitution by persistently decreasing term agreements and increasing overnight arrangements. By increasing the supply of assets that are readily accepted as collateral in the repo market, there is a temporary decrease in financing fails for Treasury securities. However, as the relative supply of agency securities is lower after a reverse-repo, there is a persistent increase in financing fails for agency securities. Thus, our results suggest that the Federal Reserve faces a trade-off between temporarily promoting stability in the repo market versus increasing fails via agency securities. We conjecture one reason this trade-off exists is due to the manner each open market operation is conducted. For example, the transmission mechanism for Fed repos operates through a wide array of security classes. In contrast, reverse-repos are regularly backed by Treasury bills.

Our results make important contributions to an emerging literature on shadow banking activity. The closest paper to our work is Bech, Klee, and Stebunovs (2011) who primarily study the instantaneous impact of monetary policy on repo rates. Notably, they identify periods in which the repo rate does not adjust in line with changes to the federal funds rate. This indicates that repo markets may be prone to inefficiency. In contrast to our work, Bech et al. study the overnight Treasury general collateral repo rate at the daily frequency. However, the focus of our research is on the impact of monetary shocks on the level of repo activity rather than rates alone. In this manner, we show that policy shocks affect the amount of credit activity among key participants in the shadow banking system. Moreover, we observe that monetary policy not only affects the maturity structure in repo markets, but also the collateral used.

In comparison to the effects of outside money on repo market activity, Sunderam (2012) argues that short-term liabilities of shadow banking institutions (including repurchase agreements) respond to money demand. That is, Sunderam's work emphasizes that the supply of inside money to the financial system was a response to changes taking place internally within the financial system for high-powered ('inside') money. However, our focus is on the endogenous response of shadow banking institutions to changes in the availability of outside money through the central bank.

Other relevant work addresses the stability of repo markets and its systemic importance. No-

[17] Garbade et al. (2010) discuss the evolution of the recently introduced Treasury Market Practices Group (TMPG) fails charge which was implemented in May 2009 and designed to to encourage timely settlement for Treasury securities.

tably, Gorton and Metrick (2012) study price data on bilateral repos and show evidence supporting the hypothesis that increases in haircuts on private label asset backed securities (ABS) started runs in the system. By comparison, Krishnamurthy et al. (2013) measures the size and composition of loans by the twenty largest lenders in the repo market just prior to, during, and after the crisis. Their data shows that repo financing to the shadow banking system was backed mostly by Treasury, agency, and corporate securities rather than private label ABS. In addition, Krishnamurthy et al. (2013) finds evidence that dealers' balance sheets are a systemically important channel for shadow banking activity operating through the perceived riskiness or illiquidity of the collateral pledged. Tri-party lenders such as money market mutual funds and securities lenders abruptly stop lending after a perceived increase whereas bilateral lenders such as other dealers and hedgefunds demand higher levels of collateralization. Copeland et al. (2012a) measures daily activity in the tri-party repo market during the summer of 2008 through early 2010 and come to a similar conclusion. They find that in contrast to the bilateral repo market, funding and haircuts in the tri-party market were stable with the exception of Lehman Brothers' bankruptcy. Moreover, this change in the willingness to lend to dealers after Lehman's failure was not gradual.

The remainder of the paper is organized as follows. Section 2 proceeds by outlining institutional details linking the transmission of monetary policy, the role of primary dealers, and the repurchase agreement market. Section 3 describes the data and empirical methodology. Section 4 reports the benchmark results. Section 5 discusses the robustness of the benchmark results and extends our analysis to include policy instruments in the System Open Market Account. Section 6 concludes.

2 Institutional Details

Primary dealers inhabit a special place in the U.S. financial system. If monetary policy influences dealer financing activity in the repo market unfavorably, then monetary policy directly contributes to financial instability in the shadow banking system. In the following section we discuss the main institutional features that link the transmission of monetary policy to shadow banking activity.

2.1 Primary Dealers and the Transmission of Monetary Policy to Money Market Activity

Primary dealers denote a key subgroup of securities dealers.[18] Table 1 lists the all of the primary dealers during our sample which includes bank subsidiaries and stand alone broker-dealers. The main role of primary dealers in the Federal Reserve System is to act as the on-demand trading counterparty of the FRBNY in its implementation of monetary policy. There are two ways that this occurs. The first mechanism is through permanent open market operations while the second is "temporary," occurring on a daily basis.

The traditional interpretation of open market operations – the method of implementing changes in monetary policy – occurs through *permanent* open market operations. If the Fed wants to lower the target federal funds rate, it purchases Treasury securities from the primary dealers which increases the supply of reserves to the financial system. Purchases are generally held to maturity. By comparison, it sells securities to increase the target. These transactions affect the amount of assets held outright in the SOMA domestic portfolio. Such transactions take place via the open market desk at the FRBNY following instructions by the Federal Open Market Committee

[18] In the third quarter of 2012, primary dealers underwrote 79, 70, and 49 percent of all US, US agency, and corporate bonds. (Bloomberg Global Fixed Income League Tables, 2012)

(FOMC). The top left panel of Figure 1 plots the total amount of SOMA securities bought outright from December 18, 2002 to January 31, 2007. On average, 100% of the securities purchased are Treasuries with close to 60% of the portfolio invested in notes and bonds. Over time, the portfolio holdings steadily grow, consistent with permanent operations being used predominantly to offset increases in circulating currency. The maturity distribution of the portfolio is plotted in the top right panel. Securities with maturities ranging from 16 days to 5 years represent, on average, about 60% of investments. Interestingly, outright holdings seem to be balanced between short and medium term maturities. While the largest average holdings mature between one and five years, Treasury bills average about 40% of the portfolio.

In addition to permanent changes in reserve balances, the supply and demand for reserves in the federal funds market fluctuates daily.[19] Changes in demand take place for a number of reasons. Notably, Hamilton (1997) describes how the amount of Treasury deposits at Federal Reserve banks varies on a daily basis depending on fiscal receipts and expenditures.[20] To offset these fluctuations, the Federal Reserve also conducts "temporary" open market operations through repurchase agreements and reverse repurchase agreements.[21] In a temporary open market operation that adds liquidity to the banking system, the desk at the FRBNY lends funds to a primary dealer in exchange for collateral. As illustrated in Figure 2, delivery of collateral to the lender is settled as "tri-party" through the custodial account of the FRBNY's clearing bank. By comparison, Figure 3 depicts how reverse repos take place as bilateral transactions, settle delivery versus payment, and may also take place through institutions other than primary dealers.[22]

The bottom panel of Figure 1 plots SOMA holdings of repo and reverse repo. Temporary open market operations represent on average less than 7% of the SOMA portfolio and are dominated by transactions with maturities of 13 days or less. Consistent with their daily policy function, Fed repos show more weekly variation than reverse repos. Finally, excluding the negligible fraction of repos maturing in over 13 days, temporary open market operations generally occur no later than 9:30 am Eastern time each morning. Permanent open market operations, on the other hand, occur anytime after the morning auction. (Federal Reserve Bank of New York, 2002)

In addition to trading with the open market desk, primary dealers are expected to regularly participate in all U.S. government debt auctions. Bids submitted by the primary dealers are competitive and as such determine the yield and price paid by filled competitive and noncompetitive bids for each Treasury issue.[23] Dealers then hold or trade any securities awarded. Thus, "primary dealer" is short for primary dealer in U.S. government securities.

[19]This is by design. The Federal Reserve System operates at a 'structural deficiency' meaning reserves added permanently are less than the amount needed. This enhances the Desk's ability to control liquidity slack in the system.

[20]Reserves can also fluctuate because of float and currency held by the public.

[21]The Master Repurchase Agreement published by the Securities Industry and Financial Market Association is the base form documenting the legal terms and conditions under which the FRBNY and counterparties may undertake repo market transactions. Federal Reserve Banks have engaged in repurchase agreements since 1916 and switched from matched sale purchase to reverse repurchase agreements on December 13, 2002. (Simmons, 1954)

[22]Prior to the recent extension of counterparties for reverse-repos, such transactions took place as bilateral arrangements rather than tri-party as the Federal Reserve was not considered to be a dealer in clearing banks' systems. Consequently, reverse repos with the primary dealers were bilateral transactions. We thank Antoine Martin for clarifying these details with us. In addition to the primary dealers, there were also reverse-repos conducted through foreign official and international accounts. As of August 18, 2010 the Fed has expanded its list of eligible participants to include Money Market Mutual Funds (MMF), Government-Sponsored Enterprises (GSE), and banks.

[23]Except for the 10 year note, auctions for specific issue Treasury bills and bonds occur on weekly and monthly schedules respectively.

The Weekly Report of Dealer Financing and Fails

As primary dealers are significant intermediaries in money markets, their activity provides important information to the Federal Reserve for federal funds targeting. Consequently, primary dealers are required to file form FR 2004 on an ongoing basis. It is collected, consolidated, and released publicly every week by the FRBNY. The FOMC uses the report to monitor the condition of the U.S. Treasury securities market which allows it to carry out more informed open market operations and actions as fiscal agent of the U. S. Treasury. The forms include the Weekly Report of Dealer Positions, the Weekly Report of Cumulative Dealer Transactions, the Weekly Report of Dealer Financing and Fails, the Weekly Report of Specific Issues, the Daily Report of Specific Issues, and the Daily Report of Dealer Activity in Treasury Financing.[24]

The weekly releases show market data reported by the legal entity that functions as the primary dealer on outright positions, cumulative transactions, gross financing, and cumulative fails in U.S. Treasury, government agency, agency MBS, and corporate debt securities. These four security classes represent the four largest classes of collateral in the tri-party repo market.[25] (Copeland et al. 2012a) Reporting is as of the close of business each Wednesday and the FRBNY releases summary data each Thursday after market hours. The FRBNY staff reviews data submitted on the FR 2004 reports and, as needed, may ask for explanations or revisions. However, other than monitoring their participation in these requirements, the FRBNY has no regulatory power over the primary dealers. Thus, the FRBNY expects the dealers to submit accurate data but does not audit it.

The Weekly Report of Dealer Financing and Fails, or FR 2004C, collects outstanding financing arrangements and fails for the calendar week. Fails are reported on a cumulative basis for the reporting period for both lending and borrowing arrangements. The amount reported is the transaction's principal value on the day the failed trade was to be settled. Financing data is reported on a gross basis of actual funds paid or received. It is disaggregated by security class and maturity length. Repo activity is identified as a subset of aggregate financing activity and disaggregated only by maturity. Overnight and continuing contracts (OC) mature after one business day and can be renewed daily unless terminated by either party. Term agreements (TERM) have a specified length of more than one day.

Previous work has emphasized the importance of repo market activity by primary dealers in the extension of credit to the real economy. For example, Gorton and Metrick (2012) stress that repo financing plays a significant role in "securitized banking" in which dealers use repo to purchase large volumes of loan obligations and make markets in the repackaged tranches of asset-backed securities. In particular, King (2008) points out that in the financial quarter prior to Bear Stearns' failure, five 'pure' investment banks funded between 28 and 55 percent of the financial instruments on their balance sheets through repurchase agreements.[26] In addition, at its peak, the largest dealer position in the tri-party repo market totaled over $400 billion dollars. (Federal Reserve Bank of New York, 2010) Furthermore, repos can be collateralized with assets dealers do not hold outright. For example, collateral held by the dealer when executing the first leg of a reverse repo is often reused for additional repo funding, a process also known as "re-hypothecation."[27]

[24] Reporting guidelines for preparing the FR 2004 primary government securities dealers reports can be found at: `http://www.federalreserve.gov/reportforms.`

[25] The data collected by Krishnamurthy et al. (2013) does not distinguish between agency and agency MBS.

[26] At the time, the five investment banks of Bear Stearns, Goldman Sachs, Lehman Brothers, Merrill Lynch, and Morgan Stanley all had primary dealer status.

[27] Re-hypothecation occurs when a dealer secures financing using collateral posted by a client. (Duffy, 2010) For example, Krishnamurthy et al. (2013) finds that gross repo activity from the fourth quarter of 2006 to the first quarter of 2010 was on average, 4 times as large as the amount lent by MMF's and SL's.

Figure 4 plots our three main repo variables and their financing analogs: gross repo, gross overnight and continuing repo, and gross term repo. As Krishnamurthy et al. (2013) explains, the inclusion of inter-dealer repo in the FR 2004C eliminates gross repo as a useful measure of unique repo flows into the shadow banking system. However, for our purposes, gross repo is an advantageous quantity to use for a few key reasons. First, because one security is often needed by dealers to satisfy more than one short position, gross repo measures the velocity of repo collateral which is analogous to a money multiplier. (Gorton and Metrick, 2012) Second, gross repo is overwhelmingly composed of inter-dealer repo. Although inter-dealer repo is not an original funding source for the shadow banking system, it does measure the reallocation of original funding into illiquid and risky securities. (Krishnamurthy et al., 2013) Third, if the federal funds rate is cointegrated with the GC repo rate and this spread is a strong determinant in the quality of collateral composition then it is important to understand how monetary policy transmits not only to original funding but also its reallocation. (Bech et al., 2011; Bartolini et al., 2010) Lastly, during a run, repo lenders are unwilling to lend against illiquid and or risky collateral. (Copeland et al., 2012a; Krishnamurthy et al., 2013) Furthermore, lenders have no incentive to return high quality collateral to institutions experiencing runs. Therefore, if the amount of short interest exceeds the total quantity of the security issued during a run, it can be too burdensome for borrowers to acquire the specific collateral needed to avoid distress. Combined with evidence by Krishnamurthy et al. (2013) that dealers continue lending against illiquid and risky collateral even during tumultuous money market conditions, gross repo can proxy for the risk of systemic contagion in the shadow banking system. As a result, Adrian and Shin (2009) among others, have argued gross repo may be a better measure of the financial system's health than traditional monetary aggregates.

2.2 Net Repo Activity by the Primary Dealers

In order to better understand the primary dealers' economic use of repo over time, we graph two simple measures of dealer borrowing: net financing and net repo financing. Net repo financing is a measure of the net amount of borrowing by primary dealers using repurchase agreements. It is calculated by subtracting the difference between gross repo (out) and reverse repo (in) thereby netting out the effects of re-hypothecation. However, net repo financing does not account for collateralized securities lending which is economically identical to repos but under generally accepted accounting principles not always treated as such.[28] We therefore include net financing, the net amount of funds borrowed by primary dealers in all reported financing transactions. Net financing is calculated as the difference between securities delivered (out) minus securities received (in). The bottom left panel of Figure 5 plots the level of net repo and net repo financing by maturity during our sample period. The top and bottom lines in the figure represent net overnight and term repo borrowing respectively. Moving clockwise by panel shows time-series plots for each of our three measures of net repo financing with its net financing analog.

There are a number of observations that one can make from looking at Figure 5. First, and consistent with previous findings, throughout our sample, primary dealers are net borrowers in repo markets. Furthermore, borrowing occurs through overnight arrangements. However, the dealers are net lenders in term activity. Consequently, like traditional intermediaries, primary dealers engage in maturity mismatch in that most of the borrowing takes place overnight but lending is for longer periods.

Over time, the level of net borrowing activity varies. During the second half of the sample, net repo financing grew at a faster pace than in the first half. Gorton and Metrick (2012) observe

[28] This is one source of the measurement error found by Krishnamurthy and Nagel (2013) in the Flow of Funds Accounts.

that dealers' reliance on the repo market is positively related to growth in the securitized banking system. However, the acceleration in repo borrowing by primary dealers appears to also coincide with a monetary tightening cycle beginning June 30, 2004. As stressed by Woodford (2010), the increase in net repo could be the by-product of the compression in term spreads that began prior to but continued during the FOMC's 2004 to 2006 tightening cycle. Further evidence from bank loan performance and mortgage growth to subprime ZIP codes is strongly supportive of this hypothesis. (see Federal Reserve Bank of New York (2013) and Mian and Sufi (2009).) On the other hand, term lending shows no such evidence of demand effects. Term lending is stable prior to the summer of 2004, but increases abruptly in November of that year, and eventually bottoms out around one year later.

When we compare primary dealers' net repo borrowing with net financing, a slightly different picture emerges. Dealers are still net borrowers engaged in maturity mismatch. However, the top left panel of Figure 5 shows that dealers' wholesale funding needs did not change over the sample. Furthermore, as plotted in the two right panels, the intensity of overnight borrowing and term lending is different for the two measures. Net repo dominates overnight agreements and net financing dominates term.

One possible explanation for the discrepancy is measurement error. As shown by Krishnamurthy and Nagel (2013), the Flow of Funds overstates the amount of net repo borrowing of commercial banks because it does not include repo positions of securities lenders. A comparison of the time series properties of securities out, securities in, and gross reverse repos reveals what could be a similar overstatement in the FR 2004C. The bottom left panel of Figure 4 shows securities out and securities in are highly correlated but securities in and gross reverse repos are not. Consequently, it seems that net repo borrowing overstates net financing by the primary dealers. However, another possible explanation is regulatory arbitrage. Varying degrees of balance sheet 'window dressing' can be beneficial for non-bank intermediaries and their hedge fund clients. Upon inspection of the weeks surrounding the end of financial quarters, Figure 4 is suggestive of dealers engaging in this behavior. In particular, with term agreements more than overnight. One well known example of dealer window dressing is Lehman Brothers' use of repo 105. Once recognized as a true sale under GAAP, repo 105 removed assets from Lehman's balance sheet thereby lowering the amount of leverage disclosed to the public. (Valukas, 2010) On the other hand, if a client wishes to avoid recording assets on their balance sheet, a dealer will instead engage in a collateralized loan.

2.3 The Composition of Net Financing Activity

As argued by Gorton and Metrick (2012) and documented extensively by Krishnamurthy et al. (2013) and Copeland et al. (2012a), repo markets appeared to breakdown during the crisis because money market funds and securities lenders became unwilling to lend against private label MBS. In more general market conditions, one can extrapolate that institutions would be less willing to hold more credit-sensitive and illiquid assets as money markets tighten, particularly agency MBS and non-fed eligible collateral such as corporate bonds. For example Bartolini et al. (2010) find that classes of securities can be ranked by their collateral values in the general collateral market. As a way of generating insights into these issues, we look at primary dealer net financing by security class.

The top left panel of Figure 6 plots net borrowing among dealers by the type of collateral used. Consistent with Copeland et al. (2012a)'s tri-party data, the dominant form of collateral is agency MBS. Notably, its importance slowly grows over the sample period. In this manner, our data are consistent with Krishnamurthy et al. (2013) who modify the arguments of Gorton and Metrick (2012) to recognize that private label MBS was not the dominant form of repo collateral in the securitized banking model. Over most of our sample, both agency and corporate securities oscillate between second place. However, in 2005 net borrowing in corporate and agency securities diverge and corporates take over. On the other hand, net lending by dealers is dominated by Treasuries.

The aggregate data provides important insights, lending further support to Woodford (2010)'s arguments about demand effects. However, the aggregate time-series properties of collateral used may vary by maturity. The top right panel of Figure 6 looks at net collateral used in overnight agreements. By comparison, the bottom right panel of Figure 6 plots the securities used as collateral in term arrangements. When looking at net financing by collateral and maturity the only evidence for an increase in demand is the steady increase in net overnight borrowing in MBS over our sample. Net overnight borrowing using corporates increases steadily beginning in 2004 whereas overnight borrowing in the other two security classes do not show much variation. Furthermore, we do not find evidence that lenders distinguish collateral in a predictable manner by collateral type when the FOMC tightens. In contrast, we do find evidence of collateral rankings in term financing. Net term financing shows strong variation in lending and strong declines after the 2004 policy tightening. Only Treasuries show a consistent increase in net term lending over our whole sample. The other three classes show gradual increases starting with corporates in 2003, MBS in 2004, and agency in 2006.

Liquidity Disruptions

While repurchase agreements are specified to be settled at a particular time and date, occasionally, liquidity problems emerge. For example, sometimes a participating party may fail to deliver or receive a security on time. The bottom left panel of Figure 6 is a time-series graph of cumulative fails by security class. There are some notable observations to take from the data. First, there are several episodes of major dislocations that occur. In fact, there are fails in every week. The biggest failures occur in Treasuries, followed by MBS, and agency securities. Moreover, failures appear to be persistent events. Consequently, fail persistence is likely to increase counterparty risk and reduce market liquidity if a number of market participants are relying on receipt of the same class of securities throughout the same trading period.

Fleming and Garbade (2005) detail how such persistence is likely to emerge in the form of a "daisy chain" or "round robin." A fail can be the result of operational disruptions such as the September 11 attacks, but is mostly determined by the incentive embedded in the cost of failing. In deciding whether to reverse repo in the collateral necessary to avoid failing, a market participant must weigh the cost of borrowing the security with the cost of failing to settle. In practice, the borrowing cost (or reverse repo rate) can exceed the cost of failing to deliver. These events are most often associated with strong demand due to short positions or limited security supply. Furthermore, although the likelihood of failing to settle does not appear to be correlated with changes in monetary policy, there is strong evidence it is related to the general level of interest rates. For example, in contrast to the weeks after September 11th, in 2003 when the FOMC lowered the federal funds rate to 1 percent, we can see in Figure 6 a corresponding increase in settlement fails for all securities. Such findings are consistent with the arguments of Fleming and Garbade (2002) who stress that the incentives to avert a fail are low when interest rates are low. Interestingly, however, we shown that the timing pattern of fails by security is different. Liquidity pressures appear first in MBS, then Treasury, and lastly agency.

2.4 Adding the Monetary Authority to the Securitized Banking Model

The transmission of monetary policy from repo activity to securitized banking is outlined by the stylized flow diagram in Figure 7. The starting point in the figure is a group of obligors, individuals seeking access to funds. Mortgage borrowers, entrepreneurs, and consumers seeking loans are all examples. Originators can be traditional banks or mortgage brokers. Upon granting credit to obligors, originators sell the loan obligations to a bankruptcy remote special purpose vehicle (SPV). The "true sale" of the obligations to a SPV provides originators with funds to extend additional credit. (Gorton and Souleles, 2007) SPVs pool the loan obligations and package them into securities which are bought by a dealer. Dealers can acquire funds to make markets in these securities via repos with money market mutual funds and securities lenders. Dealers then sell some of the securities they hold to other market participants such as hedge funds, commercial banks, and other dealers. In addition, dealers also extend credit to finance these purchases to other market participants through reverse repos. Proceeds from outright sales in addition to offsetting reverse repo agreements provide the dealers with the necessary income to settle their originating repo obligations thereby keeping the securitized banking model running efficiently.

The final agent in Figure 7 is the monetary authority. For our purposes, we are principally interested in the trades that occur between the monetary authority (the open market desk) and the primary dealers. As described previously, these could be either permanent or temporary open market operations. As an example, in a temporary open market operation, the open market desk may lend funds to a dealer. That is, the interaction between a dealer and the open market desk can be the same as a repo between a dealer and a money market mutual fund. In turn, this affects the amount of activity that a dealer can undertake with other market participants, including activities with the SPV. As a result, monetary policy transmits to repo and securitized banking activity.

3 Empirical Methodology

In the following section we outline the empirical model we use to identify the transmission of monetary policy to repo market activity. We begin by defining and summarizing simple descriptive statistics of the variables used in our study. We then present preliminary evidence suggesting a link between traditional monetary policy tools and repo market activity. Lastly, we define our empirical model of the transmission mechanism including the assumptions necessary for identification.

3.1 Data Description

Detailed descriptions of our data and its sources are listed in the appendix. Our interest is in the response of repo market behavior with respect to changes in monetary policy instruments including traditional cost of credit measures and System Open Market Account holdings. The SOMA holdings, effective federal funds rate, and federal funds target rate are each collected from the Board of Governors H.4.1, H.15, and press releases respectively. Our repo data is published by the FRBNY and collected from the FR 2004C report. All of the repo data we use is based upon the report's July 2001 revision. As a result, our sample begins July 4, 2001 and ends January 31, 2007, a week before the first bank was placed into FDIC receivership.[29]

It is common in the monetary transmission literature to include a real activity measure and a measure of overall prices. These are included to control for possible endogeneity due to economic

[29]The last bank to be placed in FDIC receivership was on June 24, 2005. In addition, Gorton et al. (2013) presents empirical evidence of a structural break beginning one week before our sample end date in the price of subprime credit risk.

activity, however, most studies are conducted at lower frequencies than ours.[30] Notably, energy prices have been shown in a number of papers to be an important real activity measure.[31] We follow the literature by using the spot price of West Texas Intermediate (WTI) Crude Oil (Cushing, Oklahoma) as a measure of energy prices. The price of WTI crude oil is released by the U.S. Department of Energy in the Energy Information Administration Petroleum Status Report. We calculate a weekly measure of oil prices by taking an un-weighted average of the daily closing spot price over the specified time period.

In addition, we include the four week average of initial jobless claims published in the U.S. Department of Labor Unemployment Insurance Weekly Claims Report as a measure of labor market conditions. It is published Thursday for the week ending Saturday before the release and is revised. New unemployment claims are compiled weekly and show the number of individuals filing for unemployment insurance for the first time.[32]

Table 2 presents descriptive statistics of our variables over our sample. Except for interest rates and the SOMA fraction of Treasury bills to Treasury securities, we transformed all of our variables into natural logs. The last column lists the coefficient from a regression, in levels, of the row variable on its one period lag. Other than SOMA repos and deviations in the federal funds rate from the target rate, our variables display high levels of persistence. As a result we take first differences and transform our log variables into growth rates.

3.2 Preliminary Evidence

In this section we present results from univariate regressions and an augmented distributed lag (ADL) model which shows a strong relationship between traditional cost of credit policy instruments and shadow banking activity. The results introduced here motivate the use of a VAR model for representation of the monetary transmission mechanism to gross repo activity.

Net Borrowing by Dealers and Interest Rate Indicators of Monetary Policy

Though our ultimate aim is to study the transmission of monetary policy to repo markets using a VAR, we begin with a simple single equation analysis. Notably, if monetary policy transmits to shadow banking activity then we should see a strong correlation between FOMC-controlled measures of the cost of credit and repo market activity. We begin by looking at the relationship between the cost of credit in the money market and net repo flows. Table 3 presents a set of simple univariate OLS regressions corresponding to the following levels-on-levels specification:

$$\mathrm{y}_w = \alpha + \beta \mathrm{x}_w + \mathrm{u}_w \tag{1}$$

where y_w is our net repo and x_w is the our cost of credit measure. The coefficient β measures the correlation between the cost of credit and net repo flows. As previously mentioned, we find strong persistence in our variables so we report Newey-West (1987) standard errors which are robust to serial correlation up to 13 lags. Furthermore, because the repo data is not seasonally adjusted we report results from regressions that include weekly fixed effects.

[30] Early work by Geweke and Runkle (1995) finds that time aggregation does not have a significant impact on inference in studying the effects of monetary policy in standard VAR's. More recently, Ghysels et al. (2012) and Chiu et al. (2012) have begun developing VAR methodologies that use daily interest rates and monthly measures of real activity.

[31] For example see Leduc and Sill 2004, Hamilton and Herrera 2004, and Hamilton 2009.

[32] The literature on real-time forecasts of economic activity finds marginal information in the weekly jobless claims report to be statistically significant in quarterly forecasts of real GDP. For measures observed daily however, the informational gains are limited (see Gavin and Kliesen (2002), Giannone et al. (2008), and Aruoba et al. (2009)).

We find robust correlations between our traditional cost of credit measures and net repo activity. Results for both the target federal funds rate and the effective rate indicate that higher levels of the interest rate are positively related to net repo activity. Thus, higher costs of credit in the interbank market are positively related to the level of repo borrowing among the dealers.

It is also instructive to look at the relationship between indicators of monetary policy and activity across the maturity structure. First, there is a strong positive relationship for net repo flows and net overnight and continuing repo funding. Net term flows, while highly significant, have a negative correlation. In addition to different qualitative responses to the federal funds rate, there are also significant quantitative differences by maturity. In particular, the response of net overnight and continuing repo is ten times higher in absolute terms than term activity. Consistent with this pattern, as observed by the different R-squared numbers across regressions, monetary policy appears to be a much more significant factor in overnight and continuing repo activity than term.

These results describe a richer relationship between shadow banking activity and monetary policy than previously identified in the literature. Not only is the level of the federal funds rate highly correlated with the amount of net repo financing conducted by primary dealers, the correlation extends to the maturity structure. However, when thinking about monetary transmission mechanisms, the interest rate channel suggests we should find a negative correlation between interest rate policy measures and net repo. On the other hand, Woodford (2010) observes that the rate for federal funds may not fully capture conditions in the money market. As a result, we also look at the correlation between deviations of the funds rate from the target rate and net repo behavior. Towards that end, we define the variable '*MISS*' as the weekly average target rate subtracted from the weekly average effective rate in the funds market. For example, if the *MISS* is positive, this implies that the federal funds market is trading more tightly than desired by the FOMC. Notably, we find that such imbalances are significant and negatively related to net repo and net overnight and continuing repo activity. As such, the coefficient on the *MISS* suggests that while the level of reserves is not related to large amounts of net funding in the repo market, net repo funding is responsive to the interest rate channel.

In terms of net financing, the coefficient is still positive and significant. However, as we would expect from Figure 5, the relationship is muted. Again, we find the qualitative response of net overnight and continuing and net term financing varies. Nevertheless, the magnitudes are much closer than the estimates for net repo. Interestingly, the *MISS* is not a significant predictor of either net financing flows or net overnight financing. We do find a marginally significant negative relationship with respect to net term activity.

Gross Flows

In the previous section we presented regressions that showed net flows into the repo market are highly correlated with the federal funds rate and reserve imbalances. However, while the level of interest rates is informative, it is unable to indicate how repo activity responds to changes in monetary policy. Furthermore, fragility in the shadow banking system can emerge as a particular piece of collateral is used to finance multiple arrangements with multiple counterparties. As a result, we now turn to studying how changes in the cost of credit affect gross repo activity. In particular, the gross repo flows in Figure 5 suggest the series have non-stationary time series properties. Consequently, a simple static specification such as (1) from the previous section is inappropriate. Instead, we model gross repo activity through an ADL(13,13) model as follows:[33]

[33] Following Adrian and Shin (2010) we choose a lag length of 13 weeks.

$$\Delta y_w = \alpha + \beta \Delta x_w + \Sigma_{i=1}^{13} \gamma_i \Delta x_{w-i} + \Sigma_{i=1}^{13} \theta_i \Delta y_{w-i} + u_w \tag{2}$$

In equation (2), we look at how current and past changes in monetary policy affect gross repo growth. Table 5 presents the results for the impact multipliers associated with different policy indicators. In contrast to the results for net flows, the effective federal funds rate is significantly related to gross activity but not the target. However, the difference is likely to be due to the increase in the number of parameters to estimate in the ADL specification in (**??**). The *MISS* is also significant. As in the case of the net flows, there is evidence of maturity substitution from term to overnight contracting arrangements. However, the magnitude for the multiplier is larger in absolute terms for term activity than overnight activity. As this indicates that higher rates drive gross flows down, the results aggregated across maturities are consistent with the lower volume of gross activity.

3.3 Modeling the Open Market Desk

The preceding single-equation analysis provides a number of motivating issues. For example, there is an array of evidence that seems to indicate that policy-tightening is associated with both changes in levels of activity and the maturity structure of repo arrangements. However, there is one major concern that limits our insights from Section 3.2. That is, it is hard to argue there is a clear causal mechanism from policy to repo activity. One well known solution is to estimate a VAR model with a limited set of variables. In conjunction with a suitable identification scheme, a VAR model allows one to isolate the endogenous response of the central bank from purely exogenous variation. However, because we are using weekly observations, any unexplained variation in our chosen indicator of the stance of Federal Reserve policy likely reflects the actions of the open market desk designed to promote federal funds rate targeting. We therefore modify the standard estimation procedure slightly in keeping with institutional realities. Specifically we identify a monetary policy shock with the residuals from the following regression equation:

$$p_w = \Psi\left(\Omega_w^{\text{DESK}}\right) + \lambda^{p} \varepsilon_w^{p} \tag{3}$$

In other words, the chosen policy instrument (p_w) is equal to a linear combination of the current economic state observed by the open market desk when setting the policy instrument $\left(\Omega_w^{DESK}\right)$ each week and a positive serially uncorrelated shock $(\lambda^{p} \varepsilon_w^{p})$ orthogonal to the desk's observed state of the economy as a result of information lags. Using the model's reduced form representation, we measure the dynamic responses of repo market activity to our monetary policy shock by estimating the following VAR:

$$\Psi_w = A(L)\Psi_{w-1} + u_w \tag{4}$$

where $A(L) \equiv I - A_1 L$ is defined as the auto-regressive lag polynomial of order one, and u_w is a vector of reduced form residuals.[34] After rearranging the VAR, we equate u_w to the structural economic shocks ε_w as:

$$u_w = \Lambda \varepsilon_w \tag{5}$$

Identification of the underlying structural monetary policy shock, ε_w^{p}, requires a set of restrictions to be imposed upon Λ. We elaborate on our identification scheme in the following sub-section.

[34] For simplicity, we generalize by considering a first order VAR and excluding deterministic regressors.

3.4 Identification

Our aim is to present evidence on the transmission of monetary policy to repo market activity. However, in addition to including a measure of policy and repo activity in Ψ_w, our identification assumptions also require the inclusion of a limited number of variables which adequately capture the state of the real economy. For obvious reasons we would like to use real GDP and the GDP deflator to measure macroeconomic productivity and the general price level respectively. However, we are forced to use new indicators of broad macroeconomic conditions because the measures found in the literature are unavailable week to week.[35] We therefore use the four week moving average of initial jobless claims and the spot price of oil as our measures of economic activity and energy prices respectively. Figure 8 provides supporting evidence in that these two high frequency measures closely approximate their low frequency analogues. In addition, we begin our analysis by assuming the effective federal funds rate is the relevant monetary instrument and gross repo activity by the primary dealers is a measure of shadow banking activity. To summarize, our VAR includes the following four variables:

$$\Psi_w^{\mathrm{T}} = [\mathrm{DL\_CLAIMS}_w,\ \mathrm{D\_FF}_w,\ \mathrm{DL\_OIL}_w,\ \mathrm{DL\_R}_w] \tag{6}$$

As a result, the relationship between our reduced form residuals and structural disturbances defined by equation (5) can now be expressed as:

$$\begin{bmatrix} u_{1w} \\ u_{2w} \\ u_{3w} \\ u_{4w} \end{bmatrix} = \begin{bmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_w^{\mathrm{DL\_CLAIMS}} \\ \varepsilon_w^{\mathrm{D\_FF}} \\ \varepsilon_w^{\mathrm{DL\_OIL}} \\ \varepsilon_w^{\mathrm{DL\_R}} \end{bmatrix} \tag{7}$$

As denoted in the previous section, each structural disturbance is serially uncorrelated and has a covariance matrix equal to the identity matrix. If we replace $E\left[u_w u_w^T\right] = \Sigma_u$ by its sample analogue, Σ_u has $\frac{n(n+1)}{2} = 10$ free parameters and the Λ matrix contains 16 elements. Therefore, $\frac{n(n-1)}{2} = 6$ additional restrictions are necessary and sufficient to estimate an exactly identified system.

Our main identification assumption, proposed by Bernanke and Blinder (1992), is that real activity responds to changes in monetary policy with a lag. However, we argue that repo volumes and oil prices respond contemporaneously to monetary shocks. We therefore impose a Choleski decomposition such that $b_{1,2} = b_{1,3} = b_{1,4} = b_{2,3} = b_{2,4} = b_{3,4} = 0$ with the following recursive structure:

$$\begin{bmatrix} u_{1w} \\ u_{2w} \\ u_{3w} \\ u_{4w} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_w^{\mathrm{DL\_CLAIMS}} \\ \varepsilon_w^{\mathrm{D\_FF}} \\ \varepsilon_w^{\mathrm{DL\_OIL}} \\ \varepsilon_w^{\mathrm{DL\_R}} \end{bmatrix} \tag{8}$$

In other words, consistent with our identification assumptions, the restricted Λ matrix is equivalent to monetary policy affecting financial market activity contemporaneously and real activity with a lag.

[35] Bernanke and Mihov (1998) construct a bi-weekly measure of industrial production and the CPI using interpolation.

The Information Content of Interest Rate Indicators of Fed Policy

A key issue in using VAR-based models of policy is whether the shocks for policy that are constructed are purely exogenous. Standard analysis in the monetary policy literature uses observations at low frequencies such as the monthly or quarterly basis. One solution in the literature is to use daily observations of policy actions. As a result of these concerns, it is also questionable whether the effective rate indicates changes in policy rather than changes in demand at the weekly frequency. One simple way to investigate this issue is to look at the reduced-form relationships at the daily level. Table 6 presents forecast regressions between changes in the effective federal funds rate, changes in the target rate, and the *MISS* variable. Regressions of the target on lagged changes in the effective rate indicate the effective rate has limited information content about the target. In contrast to the regression of the target on the effective rate, the target is an important forecasting variable for the effective rate. As the effective rate is largely influenced by changes in the target but the target does not appear to respond to the effective rate, this indicates that the effective rate is an important indicator of Federal Reserve policy even at the daily frequency.

Figure 9 provides implicit graphical evidence of the relationship between the *MISS*, the target rate, and the effective rate. The tightening and easing cycle during our sample shows an apparent systematic relationship between the *MISS* and the target. Table 6 provides statistical evidence that there is significant information content in the *MISS*. These results are consistent with arguments by Demiralp and Jorda (2002) that the *MISS* is an important measure of expected changes in Fed policy.

The Weekly Supply and Demand for Bank Reserves

In this sub-section, we pursue an alternative approach to defend our measure of monetary policy shocks based upon a strategy proposed by Bernanke and Blinder (1992). In order to claim that the effective federal funds rate is an indicator of monetary policy at the weekly frequency, Bernanke and Blinder begin by setting up a simple 3-variable VAR with the federal funds rate, nonborrowed reserves, and required reserves. They then run a regression of the innovations of the funds rate on innovations to nonborrowed reserves. Their null hypothesis is that if the federal funds rate is unresponsive to nonborrowed reserves, then the innovations are representative of supply shocks in the money market rather than demand shocks. However, their sample period is different than ours.

Therefore, we find it necessary to run the same scheme during our sample. We begin by presenting a simple partial-correlation matrix among the three variables found in Table 7. The results are supportive of an interest rate targeting regime. As the federal funds rate is uncorrelated with the innovations to money demand, the innovations to the funds rate are measures of supply shocks. Moreover, required reserves are correlated with nonborrowed reserves but not the federal funds innovations. Thus, required reserves can be an instrument for nonborrowed reserves. In addition to the lack of correlation of the federal funds rate with the two measures of money demand in the correlation matrix, the t-stat in the regression of funds innovations on nonborrowed reserves in Table 9 is small (0.009) along with its economic significance.

The Open Market Desk's Reaction Function

While we have already shown evidence that innovations to the funds rate are not correlated with transactions demand for money, there may still be questions about our identification methodology at the weekly frequency. For example, there may be questions about the recursive ordering. In particular, we assume that financial variables can react contemporaneously to the funds rate but real activity does not. Hence, our measures of shocks would be inaccurate due to misspecification of the identification assumptions.

As a way of establishing the validity of our results, we begin by studying the reaction of the federal funds rate in response to unemployment shocks (through shocks to the four-week moving average of claims) and price level shocks (through the spot price of West Texas intermediate crude). That is, we are attempting to establish that the results from our exercise are consistent with plausible desk reaction functions.

First, we identify shocks to the labor market. Figure 10 shows a shock to claims is positive, significant and peaks in about week 3. In turn, the federal funds rate declines and is statistically significant for up to three weeks after the shock to claims. Thus, it appears that the desk reacts in a reasonable way to adverse labor market shocks. Second, shocks to energy prices push the federal funds rate in the opposite direction. Thus, our estimates for the desk reaction function behave the same way as those found by Bernanke and Blinder (1992).

4 Results

The first section focuses on the response of the effective federal funds rate, jobless claims, and the spot price of oil after a shock to the federal funds rate. The second section focuses on the behavior of primary dealers' repo activity after a shock to the federal funds rate and compares this behavior with the responses of dealer repo activity by contract maturity.

4.1 Benchmark Response – An Increase in the Cost of Credit

The benchmark specifications for the VARs include one quarter of lagged variables, a constant, and weekly fixed effects since the FR 2004 report is not adjusted for seasonality. We begin by studying the impulse responses for the recursive VAR ordered: DL_CLAIMS, D_FF, DL_OIL, DL_R. We report 90% probability intervals for impulse responses. (Sims and Zha, 1999)

The Federal Funds Rate and Real Activity

The response of the federal funds rate to its own shock is plotted in Figure 12. The federal funds rate responds by increasing contemporaneously approximately 6 basis points and is significantly different from zero after one year. However, looking at Figure 13, neither initial jobless claims or the spot price of oil react much to federal funds rate shocks. There are a number of reasons why this is viable in our sample. First, it might be due to the high frequency nature of our data. Second, it could also be due to the sample period that we study. In particular, many observers have pointed out that monetary policy was not particularly effective around the time of the recession in 2001 and the latter jobless recovery. Notably, the FOMC continued to lower the federal funds rate to the historically low 1% rate in June 2003 where it remained for one year. Third, it could also be the result of modest policy adjustments implemented during the "Great Moderation." For example, Angrist et al. (2013) find it takes around 18 months for industrial production and employment to respond to policy shocks in studying the U.S. economy from 1989 - 2010. Moreover, there is no inflation response out to two years.[36]

[36]Caplin and Leahy (1996) argue that modest changes in policy are likely to be ineffective in stimulating macroeconomic activity.

The Level and Maturity Structure of Repo Financing

We begin by studying the impact of the cost of credit shocks on the total amount of repo activity presented in Figure 14. The contemporaneous response of total repurchase agreements is negative and statistically significant. The point estimate indicates that the contemporaneous 6 basis point increase in the effective federal funds rate is associated with a decline in the level of total repo financing by nearly 0.4%. By comparison, the single equation analysis of Adrian and Shin (2009) found that an increase in the federal funds rate of 1% (or 100 basis points) would be associated with about a 4% decline in repo activity. Instead, our empirical model suggests that the same increase in the effective rate would be associated with nearly an 8% decline. Thus, our results indicate that policy shocks would have a larger impact on repo volumes than previously found. We view that our VAR analysis with additional controls for endogeneity is more suggestive of an exogenous policy shock. Consequently, the impact of policy appears to be stronger.

The advantage of our VAR approach is the ability to study the cumulative effects of shocks over a period of time. In particular, we find that the peak (negative) response occurs around the fifth week after a shock to the effective rate. While the federal funds rate is virtually the same as the level following the initial shock, the impact on total repo volumes is even lower at around a 7% decline. Again, this highlights that our evidence indicates that the effect of monetary policy on repo markets is greater than previous work. Though the point estimate is not statistically significant, it continues to be negative one year after the shock.

In contrast to the impact on total repo activity, how do cost of credit shocks affect the maturity structure of repo financing? Notably, many observations from the crisis suggest that adverse money market conditions contributed towards a shift towards short-term financing. For example, many have suggested that the failure of Lehman Brothers severely affected repo markets to the point where only overnight financing was available.

Moreover, policymakers still debate the concerns that they have about rollover risk among institutions with significant maturity mismatch. Notably, Figure 5 demonstrates that primary dealers' net borrowings are short-term while they engage in relatively long-term lending in the repo market. As another example of maturity mismatch, Adrian and Fleming (2005) cite the delay that dealers have in placing their inventories of mortgage-backed securities. In particular, they observe that beginning in 2001 net financing among primary dealers was significantly larger than their net positions in mortgage backed securities. One possible explanation is that the gap increased as dealers were holding larger inventories of mortgage obligations that would settle long-term but were financed on a daily basis. (Please refer to Figure 7 for additional discussion – one of the final steps in the intermediation chain of securitized banking takes place when dealers eventually place securities through sales to other intermediaries such as hedge funds and commercial banks.)

Figure 14 also plots the impulse response of maturities of repos in response to the cost of credit shocks. In response to the shock to the target rate, term volumes are negative and statistically significant beginning in week 1. The point estimate for the decline is about 1% lower in response to about a 5 basis point shock. As the standard policy change is 25 basis points, our estimates imply that a standard rate hike would correspond to a 5% decline in term repo volumes. There is weak evidence of maturity substitution – as the point estimate for term activity is negative and significant, the point estimate for open activity is positive but generally insignificant.

5 Discussion

5.1 Alternate Interest Rate Measures of Monetary Policy

In addition to shocks to the effective rate, we study impulse response functions from shocks to the main policy tool - the target for the federal funds rate. The point estimate for the contemporaneous response is negative and shows significance from the first week after the shock for a total of three months. Moreover, the elasticity of total repo activity in response to shocks to the target is the same as shocks to the effective rate.

As the behavior of repos following shocks to the target so closely mirrors shocks to the effective rate, we argue that shocks to the effective rate represent supply shocks to money markets in the same manner as shocks to the target. Though the differences are minor, the impulse response functions for the target are somewhat more smooth than shocks to the effective rate. This potentially reflects that information in the target incorporates lower frequency broad macroeconomic conditions in comparison to weekly movements in unemployment claims and oil prices.

Our final type of cost of credit shock is the deviation of the effective rate from the target rate, the *MISS*. As discussed by Demiralp and Jorda (2002), the deviation of the funds rate serves as an indicator of reserve imbalances in the money market. In comparison to shocks to the effective rate and the target, an initial shock does not signal the beginning of a cycle over time. Thus, one could interpret that such shocks are not long-lasting. We find that these deviations are associated with lower volumes of repo activity. However, such losses are concentrated in overnight repos. Moreover, overnight repos secured by MBS contract the most. (See the third row and column of Figure 17.) This likely reflects that distortions in reserves have the greatest impact on activity in the most interest-sensitive sectors of the economy.

5.2 The Response of Aggregate Financing

As previously discussed, repurchase agreements are a subset of the overall collateralized borrowing the primary dealers report. In this section we compare the responses of gross financing arrangements with gross repo. Figure 15 plots the responses of our three financing measures to our three cost of credit shocks. The first, second, and third columns plot responses to a shock in the effective federal funds rate, target, and MISS respectively. Qualitatively, all of the responses we find are very similar to the ones found for repo activity. Changes in the level of the federal funds rate lead to declines in gross financing and financing with longer maturities. However, overnight financing activity increases with a delay. An increase in reserve imbalances leads to a delayed decline in gross financing and financing overnight.

However, there are a few subtle differences. Looking at the first row, we see the decline in financing activity in response to an increase in the federal funds rate has a similar magnitude to the response of gross repo but in contrast, greater persistence. In particular, the response of gross financing is significant for over 6 months in contrast to a month for repo activity. In addition, we find the response of overnight financing activity to shocks in the federal funds rate and the target both show similar point estimates but weaker significance.

5.3 The Response of Financing Fails

In addition to affecting the level of repo activity, one obvious question involves understanding whether unanticipated monetary policy actions contribute to instability in the repo market. One sign of instability would be if there is a change in the level of fails in the system in response to monetary policy shocks, indicating that agreements do not settle promptly. The first row of Figure

16 plots the responses of financing fails to our cost of credit shocks. There does not appear to be a direct relationship between monetary policy and fails in repos. However, reserve imbalances (as indicated by the *MISS*) affect the level of fails.

5.4 The Response of Security Asset Classes

We are also interested in the securities that are used for collateral across repurchase agreements. Figures 6 plots net financing by security class and by maturity. As previously discussed, dealers activity engage in maturity mismatch where they borrow short-term and lend long-term. Figure 5 demonstrates that the majority of net repo activity occurring overnight takes place through pledging MBS as collateral. By comparison, Figure 6 shows the types of collateral accepted in return for lending funds.

We begin by looking at securities that are pledged in financing transactions by the dealers. Financing transactions can take place in two forms: (a) securities pledged for cash and (b) securities pledged in order to borrow other types of securities. Standard repo transactions (in which securities are pledged for cash) represent the majority of transactions in which securities are pledged. Consistent with our finding that cost of credit shocks drive down total repo activity, we observe in Figure 17 a decrease in the use all of types of securities as a form of collateral.

Yet, we view that our results tell interesting story about a "collateral cycle" in financing behavior after a shock to the effective rate. First, the initial stages of a shock to the effective rate generally are associated with a tightening cycle in which rates continue to rise over time. In the initial stages of the cycle, rates do not rise by much. Consequently, the first column of Figure 18 shows there is some substitution of collateral towards agency and corporates in overnight and continuing agreements. Over time, however, rates increase further such that interest rate sectors of the economy are under pressure. After about twelve weeks, less transactions take place through agency and corporates while treasuries are positive and statistically significant. The effects for MBS are insignificant as there may be two conflicting factors. First, there is weak evidence of maturity substitution from term financing to overnight – the bulk of overnight net financing occurs through MBS. However, the housing sector is very interest-sensitive which would lead to substitution out of MBS as a form of collateral.

One might conclude there is indirect evidence of policy affecting the stability of the repo market through liquidity disruptions. Shocks from deviations of the effective rate are associated with a temporary increase in the number of fails involving treasuries (see Figure 20). That is, in response to imbalances in money markets, there is a substitution towards the highest quality of collateral. As a result, there is an increase in demand for treasuries. One interpretation is that money markets would be moving ahead of the central bank whenever deviations occur. The deviations are eventually followed by a response from the FOMC. However, in such cases, the central bank is simply following a tightening cycle initiated in money markets.

5.5 Repo Activity and the System Open Market Account

The FOMC influences the money market not only through the cost of credit but also through changes in the level of bank reserves. The level of reserves is changed through open market operations which can be temporary and or permanent. In the following subsection we explore the response of dealer repo activity after a change in the composition of the SOMA. Temporary operations are conducted through repurchase and reverse repurchase agreements while permanent operations occur through treasury securities.

Temporary Liquidity Injections

The impulse responses for the recursive VAR ordered DL_CLAIMS, L_FEDR, DL_OIL, DL_R after a one standard deviation increase in L_FEDR are plotted in Figure 21. As described previously, temporary repos initiated by the desk are tri-party with the dealers as counterparties. Figure 17 illustrates the transmission mechanism from the actions of the desk. A shock to repos conducted by the desk is positive, significant, peaks in week 20 and remains significant after one year. It takes some time before L_FEDR shocks to affect repo activity. Following the peak in L_FEDR, term repo activity is positive and significant. As the data for L_FEDR are in log levels, the contemporaneous shock represents a shock to repos initiated by the desk of around $200 million. Cumulatively, the increase peaks around $630 million. In response to the peak increase, term repo activity increases by around 1.5%. At the beginning of the sample, term repos by the dealers were equal to about $860 billion. Thus, the $630 million shock from the desk would have translated into an increase of term repos by nearly $13 billion.[37]

There are interesting findings from looking at how repo arrangements are collateralized. In this respect, there are two competing factors. First, an injection of liquidity promotes repo activity. It does so in two ways. First, injections may lead to longer-term credit arrangements. Second, they can also affect the types of securities that are used as collateral. In this manner, the effects L_FEDR shocks are hard to pin down a priori. We therefore need to turn to the impulse response functions to determine the net impact.

As a first step, we begin by focusing on collateralization. That is, the first column of Figure 22 looks at the response of aggregate financing activity according to how the arrangements are collateralized. At first, there is a substitution away from safe securities such as Treasuries and Agency securities. During the first six weeks after the injection, point estimates are negative and statistically significant. Thereafter, there is a movement towards securities in the credit-sensitive sectors of the economy. Point estimates for corporates are positive and significant after the eighth week. The point estimate for MBS as collateral behaves in a similar way, but it takes longer to reach significance. Presumably, this reflects that the housing sector is the sector in the economy which is more sensitive to liquidity.

We proceed by dis-aggregating further by studying the maturity structure along with collateralization. Impulse response functions plotted in Figure 24 indicate that the short-term response is a movement away from Treasuries as collateral for term arrangements. At the same time, Figure 23 shows an increase in short-term arrangements that are collateralized with corporate securities. Presumably, this indicates that there is a movements towards sectors that are credit sensitive after an injection of liquidity. After a quarter of time, there is a movement towards term funding and an increase in the use of each form of collateral. A shock to L_FEDR appears to be linked to stability in the repo market. After the shock, fails decline. In particular, Figure 25 shows a decline in arrangements secured by MBS.

Temporary Liquidity Withdrawals

In contrast to repos initiated by the desk, reverse repos are bilateral, delivery vs. payment transactions with money market mutual funds. Instead of temporarily injecting liquidity to money markets, reverse repos temporarily remove liquidity. The significance of money market funds as counterparties is that these institutions lend heavily to the dealers. Thus, reverse repos would pull funds away from private institutions. Contemporaneously, the shock to reserve repos (Figure 12)

[37]A similar exercise by Hamilton (1997) studies the impact of sustained shocks to nonborrowerd reserves on the federal funds rate. In particular, he finds that a $30 million shock is associated with an increase of 10 basis points.

increases by about 6% but later declines to 4%. This may suggest that the initial implementation of monetary tightening occurs through temporary open market operations and then is substituted by permanent open market operations. After the initial response, there is a sustained loss of term repo activity of nearly 2%. There is strong evidence of maturity substitution after the shock. During the same time frame of the contraction in term repo activity, open volumes increase by around 3/4 of a percent.

Impulse response functions for securities out mirror the response for term repurchase agreements and we therefore do not p them. The impact on treasuries used as collateral is particularly strong. In fact, Figure X shows maturity substitution from term to overnight explains the increase in overnight and continuing agreements secured by Treasuries. The second column of Figure 25 shows a short-term negative impact on fails in treasuries which seems to be driven by the increased supply of collateral from reverse repos conducted with the desk.

Securities Held Outright

The FOMC can also permanently change the level of reserves by selling and buying Treasury securities in the open market. The first and second columns for Figures 26 plot the response of our variables of interest to an unexpected increase in the System Open Market Account holdings of Treasury securities and Treasury bills respectively. Overall these results show little significance although the responses of dealer repo activity to a shock to the System Open Market Account holding of Treasury bills shows a significant negative contemporaneous response and dealer repo activity is negative but insignificant.

Recent monetary actions through the Fed's balance sheet policies have been geared towards impacting financial market conditions. Consequently, the composition of the System Open Market Account could have an impact on dealer repo activity. We investigate this claim by constructing the ratio of Treasury bills to Treasury securities in the SOMA as an indicator of the SOMA's composition. Figure 26 column 3 shows the effect of an unexpected 1 percentage point increase in dealer repo, overnight, and term activity. While overnight and continuing activity is negative and significant contemporaneously, only the level of repo activity seems to show a significant persistent decline. Of all the response functions showing securities used as collateral in Figures 27 to 29, the effect on agency securities is positive and highly significant presumably due the fact that there is a lower supply of Treasuries. Consequently, there is a movements towards the use of Treasuries as there is an increase in Treasuries held on the Fed's balance sheet.

In comparison to the effects of permanent open market operations through Treasury securities, we find more evidence of significant activity. Presumably, this reflects that bills have a central role in money market activity than other securities. Due to the lower volume of term repo activity in response to the SOMA's holding of Treasury bills, there is a contemporanous decline in agency securities used as collateral in overnight arraingements. As a result of the maturity substitution towards overnight arrangements, there is also an increase in the use of agency securities for overnight funding. The withdrawal of collateral from repo markets as a result of the purchases leads to an increase in fails. The majority of fails are concentrated in MBS.

Our final look is to study the effects of an increase in the proportion of treasury bills relative to total treasuries (bills + securities) held in SOMA. Such shocks would represent the inverse of the Federal Reserve's recent Maturity Extension Program, also known as "Operation Twist." In this manner, one might interpret as results as providing insight into a "Maturity Reduction Program." First, note that a shock to the proportion of bills held is associated with a lower amount of repo activity over time. Consistent with this observation, we find there is a short-term decrease in the use of each type of asset as collateral. The results are somewhat stronger for term agreements than total repo activity.

Interestingly, we find that shifting the maturity of the SOMA portfolio towards short-term securities leads to a significant increase in fails. Thus, our results suggest that the recent MEP likely promoted stability in repo markets. An increase in fails is observed in virtually every category of security.

5.6 Choosing the Right Policy Instrument: Evidence from Forecast Error Variance Decompositions

We conclude our statistical analysis with variance decompositions that show the overall influence of various policy instruments available to the open market desk on each aspect of repo activity. Interestingly, Federal Reserve reverse-repos have the largest impact of any instrument on total repo activity. (See Panel A of Table 10) However, for most time horizons, the target for the federal funds rate has the largest impact on short-term repo activity. In contrast, term activity is dominated by reverse-repos.

It is important to note that other methods of intervention by the Desk and money market indicators also play a role. For example, reserve imbalances as captured by the *MISS*, are an important factor in total repo activity. The second largest contributor to overnight repos is the amount of Fed repos. For term activity, it depends on the horizon. At short horizons, the *MISS* is the second largest factor while at longer horizons the target dominates. The relationships are more clear in looking at the determinants of financing.

In terms of thinking about stability of the repo market, we look at the most important factors in explaining the level of financing fails. At short horizons, fails are dominated by the effective federal funds rate. The second most important factor is the amount of reverse-repos. At longer horizons, the relationships change. The amount of reverse-repos is the most important factor followed by the *MISS.* In this manner, our results echo the warnings of Bernanke and Blinder (1988) who argue that different tools have different impacts.

6 Conclusion

The monetary transmission mechanism of the Federal Reserve System is linked through the aggregate balance sheets of three counterparties: depository institutions, Federal Reserve Banks, and the primary dealers. Traditionally, macroeconomists have focused on the first two and ignored the last. However, the financial crisis put more emphasis on understanding the systemic importance of market based intermediaries such as the primary dealers.

The purpose of our work is to identify whether monetary policy transmits to the shadow banking system via primary dealers' gross repo activity. Using a vector autoregression model, we characterize the monetary transmission mechanism at the weekly frequency and measure its' impact on repo market volumes. We find evidence that this is the case. When the open market desk conducts monetary policy, the structure of the transmission mechanism influences credit activity in the repo market through the FRBNY's counterparty relationships. Furthermore, it has been argued that the class of security in repos can trigger runs. As instability spirals through the shadow banking system, the commercial banking system is also at risk. Our results show that FOMC decisions can influence supply and demand for money substitutes such as repurchase agreements and may lead to unintended consequences. Moreover, the FRBNY's relationship with the primary dealers, is that of counterparty, not regulator. The limited degree of oversight suggests that macroprudential policy should be an important concern for monetary authorities.

REFERENCES

Adrian, Tobias, Brian Begalle, Adam Copeland, and Antoine Martin. 2013. Repo and securities lending. In *Quantifying Systemic Risk Measurement: NBER Research Conference Report Series*, ed. J.G.Haubrich, A.W. Lo. University of Chicago Press. Forthcoming.

Adrian, Tobias, Michael J. Fleming. 2005. What financing data reveal about dealer leverage. *Current Issues in Economics and Finance*, 11(3): 1-7.

Adrian, Tobias, and Hyun Song Shin. 2010. Financial intermediaries and monetary economics. In *Handbook of Monetary Economics*, ed. Benjamin M. Friedman and Michael Woodford, 1(3), Chapter 12: 601-650, Elsevier.

——-. 2009. Money, liquidity, and monetary policy. *American Economic Review Papers & Proceedings*, 99(2): 600-605.

——-. 2008. Financial intermediaries, financial stability, and monetary policy. *Federal Reserve Bank of New York Staff Reports*, no. 346.

Andreou, Elena, Eric Ghysels, and Andros Kourtellos. Should macroeconomic forecasters use daily financial data and how? *Forthcoming Journal of Business & Economic Statistics.*

Angrist, Joshua D., Òscar Jordà, and Guido Kuersteiner. 2013. Semiparametric estimates of monetary policy effects: string theory revisited. *NBER Working Paper*, No. 19355.

Arouba, S. Borağ and, Francis X. Deibold, and Chiara Scotti. 2009. Real-time measurement of business conditions. *Journal of Business & Economic Statistics*, 27(4): 417-427.

Bech, Morten, Elizabeth Klee, and Victor Stebunovs. 2011. Arbitrage, liquidity and exit: the repo and federal funds markets before, during, and emerging from the financial crisis. *Board of Governors Finance and Economics Discussion Series*, 2012-21: 1-54.

Begalle, Brian, Antoine Martin, James McAndrews, and Susan McLaughlin. 2013. The risk of fire sales in the tri-party repo market. *Federal Reserve Bank of New York Staff Reports*, No. 616: 1-38.

Bartolini, Leonardo, Spence Hilton, Suresh Sundaresan, Christopher Tonetti. 2010. Collateral values by asset class: evidence from primary securities dealers. *The Review of Financial Studies*, 24(1): 248-278.

Bernanke, Ben S.. 2012. Fostering financial stability. 9 April.

——-. 2010. Statement before the financial crisis inquiry commission. 2 September

——-. 2007. The financial accelerator and the credit channel. Speech at The Credit Channel of Monetary Policy in the Twenty-first Century Conference. 15 June.

Bernanke, Ben S., and Alan S. Blinder. 1992. The federal funds rate and the channels of monetary transmission. *American Economic Review*, 82(4) (Sep.): 901-921.

——-. 1988. Credit, money, and aggregate demand. *American Economic Review.* 78(2) (May): 435-439.

Bernanke, Ben S., and Ilian Mihov. 1998. Measuring monetary policy. *Quarterly Journal of Economics*, 113(3): 869-902.

Board of Governors of the Federal Reserve System. 2011. Federal Reserve issues FOMC statement. *Press Release*, 20 June.

Brunnermeier, Markus K.. 2009. Deciphering the liquidity and credit crunch 2007-2009. *Journal of Economic Perspectives*, 23(1) (Winter): 77-100.

Caplin, A. and J. Leahy. 1996. Monetary Policy as a Process of Search. *American Economic Review*, 86(4): 689-702.

Chiu, Ching Wai, Bjørn Eraker, Andrew T. Foerster, Tae Bong Kim, and Hernan D. Seoane. 2012. Estimating VAR's sampled at mixed or irregular spaced frequencies: a Bayesian approach. *Federal Reserve Bank of Kansas City Research Working Paper*, RWP 11-11.

Copeland, Adam, Antoine Martin, and Michael Walker. 2012a. Repo runs: evidence from the tri-party repo market. *Federal Reserve Bank of New York Staff Reports*, No. 506.

Copeland, Adam, Darrell Duffie, Antoine Martin, and Susan McLaughlin. 2012b. Policy issues in the design of tri-party repo markets. *Unpublished manuscript*, federal Reserve Bank of New York.

Demiralp, Selva, and Òscar Jordà. 2002. The announcement effect: evidence from open market desk data. *FRBNY Economic Policy Review*, (May): 29-48.

Dudley, William C.. 2013. Reflections on the economic outlook and implications for monetary policy. 23 September.

Duffie, Darrell. 2010. The failure mechanics of dealer banks. *Journal of Economic Perspectives* 23(1) (Winter): 51-72.

Federal Reserve Bank of New York. 2013. Quarterly trends for consolidated U.S. banking organizations. *Federal Reserve Bank of New York Research and Statistics Group*, Second Quarter 2013.

——-. 2010. Tri-party repo infrastructure reform white paper. *Federal Reserve Bank of New York Markets Group*, May.

——-. 2002. Domestic open market operations during 2001. *Federal Reserve Bank of New York Markets Group*, February.

Financial Crisis Inquiry Commission. 2011. The financial crisis inquiry report. New York: Public Affairs.

Fleming, Michael J., and Kenneth D. Garbade. 2005. Explaining settlement fails. *Current Issues in Economics and Finance*, 11(9).

Garbade, Kenneth D., F.M. Keane, L. Logan, A. Stokes and J. Wolgemuth. 2010. The Introduction of the TMPG Fails Charge for U.S. Treasury Securities. *Federal Reserve Bank of New York Economic Policy Review*, (October): 45-71.

Gavin, William T., and Kevin L. Kliesen. 2002. Unemployment insurance claims and economic activity. *Federal Reserve Bank of St. Louis Review*, (May): 15-28.

Geithner, Timothy F.. 2008. Reducing system risk in a dynamic financial system. Speech before the Economic Club of New York, 9 June.

Geweke, John F., and David E. Runkle. 1995. A fine time for monetary policy? *Federal Reserve Bank of Minneapolis Quarterly Review*, (Winter): 18-31.

Giannone, Domenico, Laucrezia Reichlin, and David Small. 2008. Nowcasting: the real-time informational content of macroeconomic data. *Journal of Monetary Economics*, 55(4): 665-676.

Gorton, Gary, and Andrew Metrick. 2012. Securitized banking and the run on repo. *Journal of Financial Economics*, 104(3): 425-451.

Gorton, Gary, Andrew Metrick, and Lei Xie. 2012. The flight from maturity. *Yale School of Management Working Paper.*

Gorton, Gary, and Nicholas S. Souleles. 2007. Special purpose vehicles and securitization. In *The Risks of Financial Institutions*, University of Chicago Press.

Hamilton, James D.. 2009. Causes and consequences of the oil shock of 2007. *National Bureau of Economic Research Working Paper Series*, No. 15002.

——-. 1997. Measuring the liquidity effect. *American Economic Review*, 87(1): 87-97.

Hamilton, James D., and Ana Maria Herrera. 2004. Oil Shocks and aggregate macroeconomic behavior: the role of monetary policy: comment. *Journal of Money, Credit and Banking*, 36(2): 265-286.

King, Matt. 2008. Are the brokers broken? *Citi European Quantitative Credit Strategy and Analysis*, 5 September.

Kohn, Donald L., 2008. Monetary policy and asset prices revisited. 19 November.

Krishnamurthy, Arvind, Stefan Nagel, and Dmitry Orlov. 2014. Sizing up repo. *Forthcoming Journal of Finance.*

Krishnamurthy, Arvind, and Stefan Nagel. 2013. Interpreting repo statistics in the flow of funds accounts. *NBER Working Paper Series*, No. 19389.

Leduc, Sylvain, and Keith Sill. 2004. A quantitative analysis of oil-price shocks, systematic monetary policy, and economic downturns. *Journal of Monetary Economics*, 51(4): 781-808.

Martin, Antoine, David Skeie, and Ernst-Ludwig von Thadden. 2013. Repo runs. *Forthcoming, Review of Financial Studies*

Mian, Atif and Amir Sufi. 2009. The consequences of mortgage credit expansion: evidence from the u.s. mortgage default crisis. *Quarterly Journal of Economics*, 124(4): 1449-1496.

Mills, David C. Jr., and Robert R. Reed. 2008. Default risk and collateral in the absence of commitment. *Working Paper*.

Morris, Stephen, and Hyun Song Shin. 2004. Liquidity black holes. *Review of Finance*, 8(1): 1-18.

Newey, Whitney K., and Kenneth D. West. 1987. A simple, positive and semi-definate, heteroskedasticty and autocorrelation consistent covariance matrix. *Econometrica*, 55(3): 703-708. *Review of Finance* 8(1): 1-18.

Pozsar, Zoltan, Tobias Adrian, Adam Ashcraft, and Haley Boesky. 2010. Shadow banking. *Federal Reserve Bank of New York Staff Reports*, No. 485.

Sims, Christopher A., and Tao Zha. 1999. Error bands for impulse responses. *Econometrica*, 67(5): 1113-1156.

Stock, James H., and Mark W. Watson. 2001. Vector autoregressions. *Journal of Economic Perspectives*, 15(4): 101-115.

Stock, James H., and Motohiro Yogo. 2005. Testing for weak instruments in linear IV regressions. In *Identification and Inference for Econometric Models: Essays in Honor of Thomas Rothenberg*, Donald W.K. Andrews and James H. Stock, 80-108. Cambridge University Press.

Sunderam, Adi. 2012. Money creation and the shadow banking system. *Mimeo*.

Taleb, Nassim. 1997. Dynamic hedging: managing vanilla and exotic options. New York: John Wiley & Sons.

Task Force on Tri-party Repo Infrastructure Payments Risk Committee. 2012. Final report. 15 February.

——-. 2009. Progress report. 22 December.

Velukas, Anton R. 2010. Lehman brothers holdings inc. chapter 11 proceedings examiners report. *United States Bankruptcy Court Southern District of New York*, Vol. 3.

Woodford, Michael. 2010. Financial intermediation and macroeconomic analysis. *Journal of Economic Perspectives*, 24(4): 21-44.

DATA APPENDIX

This section provides documentation of the data we use in our empirical analysis. Weekly financing data is reported on Wednesday by the primary dealers in the FR 2004C Weekly Report of Dealer Financing and Fails. The report is published by the Federal Reserve Bank of New York and collects gross outstanding collateralized borrowing and lending including repo and reverse repurchase agreements in millions of dollars on a gross basis. Security financing is not seasonally adjusted and include U.S. Treasuries, Federal Agency and GSE excluding MBS, Federal Agency and GSE MBS, and corporate securities disaggregated by maturity. Detailed descriptions of the securities that make up these broad categories can be found in the Reporting Guidelines published by the Board of Governors. The value reported by dealers is the actual funds paid or received excluding transactions conducted on behalf of prime brokerage customers. Settlement fails are disaggregated by by security on a cumulative basis for the reporting period. The number reported is the principle value that was to be paid of received from cash and financing transaction on theday the trade settled.

Our interest rate variables are collected from two different sources. The weekly effective federal funds rate is from the Board of Governors H.15 release. It is constructed as the 7 day average of the daily weighted average rate on brokered trades. The daily target federal funds rate is published by the Federal Reserve Bank of New York. Average weekly deviations from the target rate are constructed as the 7 calendar day average of daily federal funds minus the 7 calendar day average of the target rate.

Weekly holdings of the System Open Market Account is published in the Board of Governors H.4.1 release. On December 13, 2002 the Federal Reserve switched from using Matched Sale Purchases to Reverse Repurchase Agreements. The two week daily average of nonborrowed and required weekly reserves of depository institutions is from the Board of Governors H.3 release. The U.S. Energy Information Administration publishes daily spot prices of WTI Crude Oil in the weekly Petroleum Status Report. The four week moving average of initial jobless claims is from the U.S. Department of Labor's Unemployment Insurance Weekly Claims Report.

Table 1: The Primary Government Securities Dealers

Dealers at Beginning of Sample	**Commercial Banking**	**Public**	**Added**	**Withdrawn**	**Name Change**	**Merger**
ABN AMRO Inc.	Yes	Yes	9/29/1998		12/8/2002	
BMO Nesbitt Burns Corp.	No	No	2/15/2000	4/1/2002		
BNP Paribas Securities Corp.	Yes	Yes	9/15/2000			
Banc of America Securities LLC	Yes	Yes	5/17/1999			
Banc One Capital Markets, Inc.	Yes	Yes	4/1/1999	8/2/2004		8/2/2004
Barclays Capital Inc.	Yes	Yes	4/1/1998			
Bear, Stearns & Co., Inc.	No	Yes	6/10/1981			
CIBC World Markets Corp.	Yes	Yes	5/3/1999			
Credit Suisse First Boston Corporation	No	Yes	12/16/1996		1/16/2003	
–			1/17/2003		1/16/2006	
Daiwa Securities America Inc.	No	Yes	12/11/1986			
Deutsche Banc Alex Brown Inc.	Yes	Yes	1/12/2001		3/30/2002	
Dresdner Kleinwort Wasserstein Securities LLC	No	No	4/30/2001		9/18/2006	
Fuji Securities Inc.	Yes	Yes	12/28/1989		4/1/2002	
Goldman, Sachs & Co.	No	Yes	12/4/1974			
Greenwich Capital Markets, Inc.	Yes	Yes	7/31/1984			
HSBC Securities, Inc.	Yes	Yes	6/1/1999	1/17/2006		
J.P. Morgan Securities Inc.	Yes	Yes	5/1/2001			8/2/2004
Lehman Brothers Inc.	No	Yes	8/31/1995			
Merrill Lynch Government Securities Inc.	No	Yes	5/19/1960			
Morgan Stanley & Co. Inc.	No	Yes	2/1/1978			
Nomura Securities International, Inc.	No	Yes	12/11/1986			
Solomon Smith Barney Inc.	Yes	Yes	9/1/1998		4/7/2003	
SG Cowen Securities Corporation	Yes	Yes	7/1/1999	10/31/2001		
UBS Warburg LLC.	Yes	Yes	5/1/2000	6/12/2003		
Zions First National Bank	Yes	Yes	8/11/1993	3/31/2002		
Dealers Added During Sample						
Countrywide Securities Corporation	Yes	Yes	1/15/2004			
Cantor Fitzgerald & Co.	No	No	8/1/2006			

Source: Federal Reserve Bank of New York and the Securities Exchange Commission.

Note: The table lists all primary dealers from July 4, 2001 to January 31, 2007. The table includes the name of the dealer, whether it is a commercial banking affiliate, whether it is publicly traded, and the following primary dealer effective event dates: added, withdrawn, name change, or merger.

Table 2: Descriptive Statistics: July 4, 2001 to January 31, 2007

	Obs.	Max	Min	μ	σ	ρ
Panel A: Net Collateralized Borrowing						
Net Repo (NETREPO)	292	1304.24	450.10	805.54	230.67	0.994
Net Overnight and Continuing Repo (NETREPO_OC)	292	1456.44	558.35	927.13	252.21	0.990
Net Term Repo (NETREPO_TERM)	292	8.26	-232.43	-121.59	39.54	0.788
Net Financing (NETFINANCING)	292	369.31	106.81	223.96	49.16	0.832
Net Overnight and Continuing Financing(NET_OC)	292	864.46	310.80	532.44	125.82	0.962
Net Term Financing (NET_TERM)	292	-101.83	-562.05	-308.48	99.72	0.964
Panel B: Repurchase Agreements						
Repo (DL_R)	291	6.72	-25.29	0.25	4.12	0.978
Overnight and Continuing Repo (DL_OC_R)	291	21.31	-20.17	0.32	4.40	0.986
Term Repo (DL_TERM_R)	291	19.43	-57.88	0.15	10.15	0.845
Panel C: Securities Out						
Securities Out (DLALL_OUT)	291	6.66	-22.40	0.25	3.75	0.982
Overnight and Continuing Securities Out (DLALL_OUT_OC)	291	21.04	-19.76	0.34	3.97	0.986
Term Securities Out (DLALL_OUT_TERM)	291	18.79	-56.81	0.14	9.80	0.867
US Securities Out (DLALL_OUT_US)	291	7.63	-27.89	0.23	5.15	0.975
Agency Securities Out (DLALL_OUT_AGENCY)	291	13.65	-22.25	0.13	3.98	0.899
MBS Securities Out (DLALL_OUT_MBS)	291	14.33	-12.62	0.31	4.67	0.978
Corporate Securities Out (DLALL_OUT_CORP)	291	18.70	-26.47	0.50	3.80	0.992
Overnight and Continuing US Securities Out (DLOUT_OC_US)	291	21.82	-27.33	0.35	5.47	0.984
Overnight and Continuing Agency Securities Out (DLOUT_OC_AGENCY)	291	39.57	-42.34	0.19	5.64	0.885
Overnight and Continuing Agency MBS Securities Out (DLOUT_OC_MBS)	291	26.37	-25.85	0.35	6.37	0.967
Overnight and Continuing Corporate Securities Out (DLOUT_OC_CORP)	291	26.09	-30.65	0.49	4.55	0.988
Term US Securities Out (DLOUT_TERM_US)	291	18.03	-63.65	0.12	11.97	0.852
Term Agency Securities Out (DLOUT_TERM_AGENCY)	291	31.08	-59.18	0.03	8.85	0.868
Term Agency MBS Securities Out (DLOUT_TERM_MBS)	291	38.71	-37.95	0.24	7.98	0.948
Term Corporate Securities Out (DLOUT_TERM_CORP)	291	66.97	-50.71	0.56	9.61	0.986
Panel C: Settlement Financing Fails						
All Fails (DLALL_FAIL)	291	238.46	-174.34	-0.17	54.59	0.748
US Fails (DL_FAIL_US)	291	342.11	-253.60	-0.49	74.16	0.777
Agency Fails (DL_FAIL_AGENCY)	291	279.38	-186.10	-0.36	50.87	0.819
MBS Fails (DL_FAIL_MBS)	291	265.74	-117.81	-0.04	93.37	0.546
Corporate Fails (DL_FAIL_CORP)	291	76.13	-82.89	0.17	25.67	0.491
Panel D: Cost of Credit						
Effective Federal Funds Rate (D_FF)	291	52.00	-102.00	0.47	10.41	1.002
Federal Funds Target Rate (D_TRGT)	291	25.00	-50.00	0.52	8.79	1.003
Average Weekly Deviation From The Target (MISS)	291	45.00	-53.00	-0.10	6.73	0.042
Panel E: System Open Market Account						
SOMA Repos (L_FEDR)	292	4.11	1.95	3.27	0.29	0.338
SOMA Reverse Repos (DL_FEDRR)	215	26.08	-26.98	0.18	6.45	0.934
SOMA All Treasuries (DL_FEDTALL)	291	3.30	-2.23	0.13	0.32	0.996
SOMA Treasury Bills (DL_FEDBILL)	291	9.45	-7.20	0.15	0.89	0.993
SOMA Fraction of Bills to Treasuries (DFEDALPHA)	291	0.02	-0.02	0.00	0.00	0.980
Panel F: Real Activity and Energy Prices						
West Texas Intermediate Crude Oil (DL_OIL)	291	8.70	-19.23	0.26	4.02	0.995
Four Week Moving Average of Continuing Claims (DL_CLAIMS)	291	7.75	-5.03	-0.08	1.70	0.992

Source: Authors' calculations based on data from the Board of Governors H.15 release, Board of Governors press releases, the Federal Reserve Bank of New York FR 2004C report, the U.S. Department of Labor Unemployment Insurance Weekly Claims Report, and the U.S. Department of Energy Petroleum Status Report.

Note: The table reports univariate descriptive statistics of extreme values, central tendency (μ), dispersion (σ), and persistence (ρ) defined as the coefficient of a first-order autoregressive equation (in levels) for each column variable.

Table 3: Net Repo Borrowing and the Cost of Credit: July 4, 2001 to January 31, 2007

Panel A: NETREPO

	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	123.84***	125.54***				
	(15.31)	(14.22)				
FF			123.88***	125.66***		
			(15.51)	(14.37)		
MISS					-3.51**	-4.32**
					(1.69)	(2.07)
Constant	489.61***		489.58***		804.11***	
	(48.08)		(48.38)		(48.36)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.63	0.66	0.63	0.65	0.01	0.03
F-test		12.35***		11.55***		3875.03***

Panel B: NETREPO_OC

	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	137.35***	138.90***				
	(14.97)	(13.87)				
FF			137.42***	139.05***		
			(15.18)	(14.02)		
MISS					-3.77**	-4.59**
					(1.77)	(2.20)
Constant	576.80***		576.70***		925.61***	
	(47.78)		(48.01)		(53.07)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.65	0.67	0.65	0.67	0.01	0.03
F-test		18.18***		17.65***		4221.74***

Panel C: NETREPO_TERM

	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	-13.51***	-13.35***				
	(3.21)	(2.95)				
FF			-13.54***	-13.39***		
			(3.22)	(2.95)		
MISS					0.24	0.27
					(0.001)	(0.34)
Constant	-87.19***		-87.12***		-121.50***	
	(6.79)		(6.76)		(6.89)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.25	0.36	0.26	0.36	0.001	0.11
F-test		29.33***		28.27***		5795.53***

Obs. = 292

Note: The table reports OLS regressions of net repo borrowing by primary dealers on the cost of credit in the U.S. financial system. The dependent variable is alternatively net repo, net overnight and continuing repo, or net term repo. The cost of credit is defined as either the effective federal funds rate, the federal funds target, or the average weekly deviation from the target. Newey-West (1987) standard errors allowing for 13 weeks of lags are in parenthesis. The F-test is of the joint significance of weekly fixed effects. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 4: Net Financing and the Cost of Credit: July 4, 2001 to January 31, 2007

			Panel A: NETFINANCING			
	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	13.01**	13.22***				
	(5.85)	(5.13)				
FF			13.04**	13.30***		
			(5.86)	(5.11)		
MISS					-0.18	-0.04
					(0.39)	(0.51)
Constant	190.66***		190.55***		233.70***	
	(16.92)		(16.91)		(8.64)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.15	0.31	0.15	0.31	0.0006	0.15
F-test		24.45***		24.32***		3837.61***
			Panel B: NET_OC			
	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	65.32***	65.86***				
	(9.49)	(8.02)				
FF			65.46***	66.06***		
			(9.5)	(7.99)		
MISS					-1.28	-1.41
					(0.82)	(1.08)
Constant	365.66***		365.34***		531.57***	
	(25.02)		(24.92)		(25.66)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.59	0.64	0.59	0.64	0.004	0.05
F-test		11.61***		11.73***		4152.04***
			Panel C: NET_TERM			
	(1)	(2)	(1)	(2)	(1)	(2)
TRGT	-52.31***	-52.64***				
	(6.14)	(5.38)				
FF			-52.41***	-52.76***		
			(6.19)	(5.42)		
MISS					1.10*	1.37*
					(0.63)	(0.80)
Constant	-175.00***		-174.79***		-307.87.57***	
	(16.92)		(16.94)		(20.41)	
Fixed Effects	N	Y	N	Y	N	Y
R^2	0.60	0.63	0.60	0.63	0.005	0.04
F-test		11.61***		9.20***		3276.50***
			Obs. = 292			

Note: The table reports OLS regressions of net collateralized borrowing by primary dealers on the cost of credit in the U.S. financial system. The dependent variable is alternatively net financing, net overnight and continuing financing, or net term financing. The cost of credit is defined as either the effective federal funds rate, the federal funds target, or the average weekly deviation from the target. Newey-West (1987) standard errors allowing for 13 weeks of lags are in parenthesis. The F-test is of the joint significance of weekly fixed effects. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 5: Gross Financing and Changes in the Cost of Credit: July 4, 2001 to January 31, 2007

	D_FF		D_TRGT		MISS	
	(1)	(2)	(1)	(2)	(1)	(2)
DL_R	-0.017	-0.080***	-0.021	-0.009	0.014	-0.072***
DL_OC_R	0.072***	0.072***	-0.000	0.002	-0.042	-0.020
DL_TERM_R	-0.132***	-0.200***	-0.006	0.009	0.109	-0.109**
DLALL_OUT	-0.021	-0.076***	-0.023	-0.010	0.010	-0.068***
DLALL_OUT_OC	0.054***	0.051***	-0.004	-0.004	-0.043	-0.021
DLALL_OUT_TERM	-0.120**	-0.194***	-0.003	0.013	0.100	-0.110**
Fixed Effects	N	Y	N	Y	N	Y
Obs. = 278						

Note: The table reports impact multipliers for a 13 week autoregressive distributed lag model of the growth rate of gross collateralized borrowing on the cost of credit in the U.S. financial system. The dependent variable is alternatively repo, overnight and continuing repo, term repo, securities out, overnight and continuing securities out, or term securities out. The cost of credit is defined as either the effective federal funds rate, the federal funds target, or the average weekly deviation from the target. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 6: Daily Forecast Regressions of Federal Funds Target Rate Changes: July 4, 2001-January 31, 2007

	D_FF		MISS		D_TRGT	
	(1)	(2)	(1)	(2)	(1)	(2)
1. Lag on D_TRGT:						
Intercept	0.001	0.001	0.001	0.001		
	(0.001)	(0.001)	(0.70)	(0.001)		
β	0.003	0.003	0.063***	0.052***		
	(0.015)	(0.015)	(0.024)	(0.019)		
R^2	0.00	0.00	0.03	0.02		
2. Lag on D_FF:						
Intercept					0.001	0.001
					(0.002)	(0.002)
β					0.363**	0.188***
					(0.163)	(0.042)
R^2					0.07	0.01
3. Lag on MISS:						
Intercept					0.003	0.004**
					(0.002)	(0.002)
β					0.392	0.002
					(0.360)	(0.072)
R^2					0.02	0.00
Obs.	2036	2035	2036	2035	2036	2035

Note: The table reports the results from OLS regressions of the column (dependent) on the row (independent) variable and a constant. The second column of each regression excludes the September 17, 2001 change. Parenthesis contain standard errors. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 7: Innovations in The Reserve Market: July 4, 2001-January 31, 2007

	ε^{FF}	ε^{RR}	ε^{NBR}
ε^{FF}	1.00	-0.07	-0.05
ε^{RR}		1.00	0.94
ε^{NBR}			1.00

Note: The table reports correlation coefficients between residuals obtained from a vector autoregression model with 12 lags. The VAR includes the following three variables (in levels): required reserves (RR), nonborrowed reserves (NBR), and the federal funds rate (FF).

Table 8: First-Stage Results: ε^{NBR} Regressed on Instruments: July 4, 2001-January 31, 2007

	(1)	(2)
ε^{RR}	1.0767***	
	(0.0235)	
$\varepsilon^{\text{DL\_CLAIMS}}$		-0.116*
		(0.061)
Constant	-0.000	-0.000002
	(0.0195)	(0.063)
R^2	0.883	0.013
Instrument F-test (statistic)	2107**	3.59
Obs. = 280		

Note: The table reports first stage results from OLS regressions using residuals from a vector autoregression model with 12 lags. The VAR includes: required reserves (RR) or the four week moving average of initial jobless claims (DL_CLAIMS), nonborrowed reserves (NBR), and the federal funds rate (FF). Standard errors in parenthesis. Significance of the F-test statistic is based on Stock and Yugo (2005) 5% critical values for the test of weak instrument bias in a linear IV regression. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 9: Estimated Slope of the Supply Function for Nonborrowed Reserves: July 4, 2001-January 31, 2007

	OLS	IV	OLS	IV
	(3)	(4)	(5)	(6)
ε^{NBR}	-0.003	0.0059		
	(0.003)	(0.0091)		
$\varepsilon^{\text{DL\_CLAIMS}}$			0.0004	-0.000004
			(0.003)	(0.003)
Constant	-0.000	-0.000	-0.000	-0.000
	(0.003)	(0.003)	(0.003)	(0.003)
R^2	0.003	0.000	0.000	0.000
Instrument F-test (statistic)		2107**		3.59
Obs.	280	280	280	280

Note: The table reports second stage and raw results from OLS regressions using residuals from a vector autoregression model with 12 lags. The VAR includes: required reserves (RR) or the four week moving average of initial jobless claims (DL_CLAIMS), nonborrowed reserves (NBR), and the federal funds rate (FF). Standard errors in parenthesis. F-test statistic significance from the first stage regression is based on Stock and Yugo (2005) 5% critical values for the test of weak instrument bias in a linear IV regression. *Statistically significant at the 10 percent level. **Statistically significant at the 5 percent level. ***Statistically significant at the 1 percent level.

Table 10: Variance Decompositions of Gross Repo: July 4, 2001-January 31, 2007

Horizon	D_FF	D_TRGT	MISS	L_FEDR	DL_FEDRR	DL_FEDTALL	DL_FEDBILL	DFEDALPHA
					I. DL_R			
13 Weeks	1.8	1.6	3.4	1.4	**11.5**	2.1	2.3	2.0
	[0.6,6.2]	[0.6,12.3]	[0.6,12.3]	[0.2,6.8]	**[3.2,29.1]**	[0.6,7.8]	[0.8,7.4]	[0.7,7.2]
26 Weeks	2.1	2.2	4.1	2.9	**12.8**	2.7	2.9	2.6
	[0.4,9.7]	[0.4,10.9]	[0.8,16.8]	[0.3,12.9]	**[3.6,35.1]**	[0.6,12.1]	[0.8,11.8]	[0.7,7.2]
39 Weeks	2.4	2.5	4.3	3.6	**13.7**	3.0	3.1	2.8
	[0.3,12.5]	[0.3,13.8]	[0.7,18.5]	[0.3,16.2]	**[3.5,37.7]**	[0.5,14.7]	[0.6,14.1]	[0.6,12.7]
52 Weeks	2.7	2.8	4.4	3.9	**14.6**	3.1	3.2	2.9
	[0.3,14.0]	[0.3,15.6]	[0.6,19.7]	[0.3,17.4]	**[3.4,39.7]**	[0.4,16.4]	[0.6,15.2]	[0.5,13.7]
					II. DL_OC_R			
13 Weeks	2.7	6.6	2.0	**8.3**	7.9	4.8	4.1	3.0
	[0.8,8.8]	[1.2,18.9]	[0.6,7.1]	**[1.3,21.3]**	[3.6,16.4]	[1.0,15.2]	[1.1,13.6]	[0.8,10.7]
26 Weeks	3.5	**9.9**	2.4	9.7	7.4	7.9	5.4	3.5
	[1.0,10.8]	**[1.4,28.7]**	[0.6,9.7]	[1.2,27.9]	[3.0,17.9]	[1.1,24.2]	[1.0,20.4]	[0.7,15.1]
39 Weeks	3.6	**11.6**	2.4	10.1	7.3	8.6	5.7	3.6
	[0.9,11.7]	**[1.4,32.3]**	[0.5,10.8]	[1.1,30.2]	[2.4,19.1]	[1.1,26.6]	[0.9,22.6]	[0.6,16.6]
52 Weeks	3.4	**12.5**	2.4	10.2	7.1	9.0	5.8	3.6
	[0.8,12.0]	**[1.5,34.1]**	[0.4,11.0]	[1.0,31.1]	[2.2,20.6]	[1.0,27.9]	[0.7,23.7]	[0.5,17.3]
					III. DL_TERM_R			
13 Weeks	2.4	2.0	3.9	1.0	**12.3**	2.0	2.1	2.0
	[0.6,9.5]	[0.5,8.8]	[0.7,13.4]	[0.2,4.7]	**[4.6,29.6]**	[0.6,7.4]	[0.7,7.6]	[0.7,6.8]
26 Weeks	3.7	3.7	4.3	1.6	**12.9**	2.8	2.8	2.6
	[0.4,16.6]	[0.4,16.5]	[0.8,17.8]	[0.2,8.1]	**[4.2,35.6]**	[0.6,7.4]	[0.7,13.0]	[0.6,10.3]
39 Weeks	4.4	4.7	4.2	1.9	**13.9**	3.2	3.1	2.7
	[0.4,20.6]	[0.4,21.2]	[0.7,19.7]	[0.2,10.2]	**[4.0,38.9]**	[0.6,15.8]	[0.6,15.6]	[0.5,11.9]
52 Weeks	4.9	5.2	4.2	2.0	**14.6**	3.3	3.1	2.7
	[0.3,23.1]	[0.4,24.1]	[0.6,20.8]	[0.2,11.3]	**[3.8,40.5]**	[0.5,17.4]	[0.5,17.0]	[0.5,12.7]

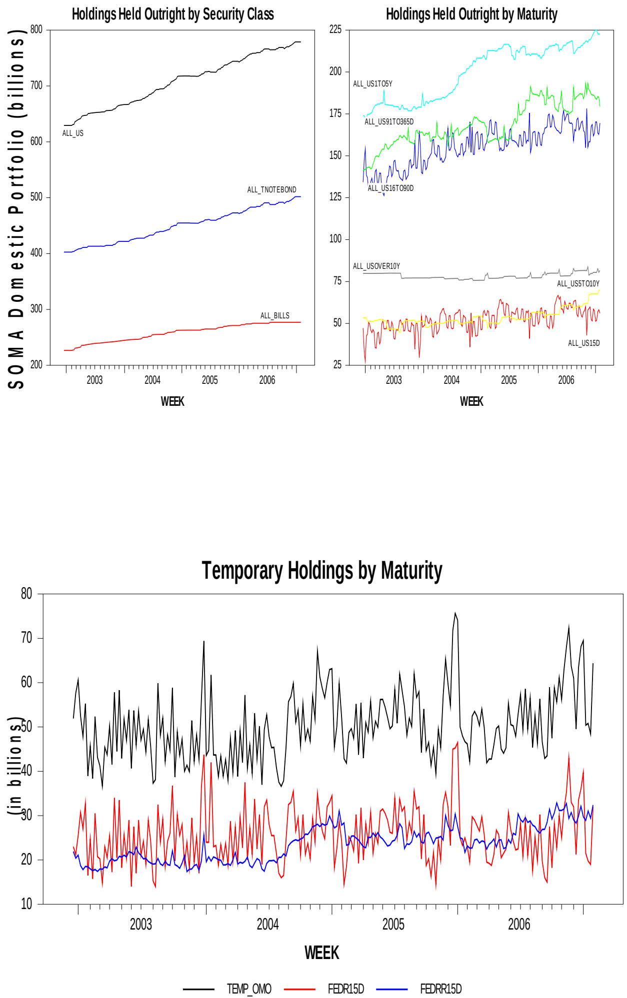
Note: The table records the percentages of the variance of the forecasted variable accounted for by variation in the column variable at 13 week horizons. Point estimates are based on a vector autoregressions with 13 weekly lags of each variable included in the VAR. The ordering of the variables in the variance decomposition is based on the benchmark identification: DL_CLAIMS, the column variable, DL_OIL, and the panels repo variable listed in the heading. Numbers in brackets represent 90 percent confidence intervals. Numbers in bold are the largest percentage variance for each row.

Table 11: Variance Decompositions of Securities Out and Settlement Fails: July 4, 2001-January 31, 2007

Horizon	D_FF	D_TRGT	MISS	L_FEDR	DL_FEDRR	DL_FEDTALL	DL_FEDBILL	DFEDALPHA
				I. DLALL_OUT				
13 Weeks	1.7	1.7	3.5	1.4	**10.8**	2.0	2.4	2.1
	[0.6,6.4]	[0.5,6.5]	[0.6,12.8]	[0.2,7.5]	**[3.2,27.7]**	[0.6,6.9]	[0.8,7.4]	[0.7,6.9]
26 Weeks	2.2	2.3	4.2	2.8	**12.3**	2.5	2.9	2.8
	[0.4,10.1]	[0.5,11.1]	[0.8,17.4]	[0.3,13.9]	**[3.8,34.5]**	[0.5,11.5]	[0.7,12.5]	[0.7,11.5]
39 Weeks	2.6	2.8	4.6	3.5	**13.4**	2.7	3.2	3.1
	[0.3,12.8]	[0.4,14.2]	[0.8,19.3]	[0.3,17.9]	**[3.7,38.6]**	[0.5,14.0]	[0.6,15.5]	[0.6,13.7]
52 Weeks	2.8	3.1	4.6	3.9	**13.8**	2.9	3.2	3.2
	[0.3,14.4]	[0.3,16.0]	[0.7,20.7]	[0.3,19.5]	**[3.6,40.3]**	[0.4,15.9]	[0.6,17.3]	[0.5,14.9]
				II. DLALL_OUT_OC				
13 Weeks	5.7	**7.3**	2.0	6.9	7.1	3.6	3.2	2.5
	[1.1,16.1]	**[1.3,19.8]**	[0.6,8.1]	[0.9,19.4]	[3.1,15.5]	[0.8,12.4]	[0.9,10.7]	[0.8,8.5]
26 Weeks	8.2	**11.3**	6.2	4.2	7.2	5.6	4.0	2.8
	[1.0,23.3]	**[1.4,29.5]**	[1.9,17.6]	[1.4,12.4]	[2.7,17.4]	[0.8,19.8]	[0.8,16.1]	[0.6,11.8]
39 Weeks	9.0	**12.5**	6.0	4.1	7.0	6.1	4.2	2.8
	[1.0,26.4]	**[1.5,33.4]**	[1.6,18.8]	[1.3,13.6]	[2.3,19.0]	[0.7,21.4]	[0.7,17.8]	[0.5,13.0]
52 Weeks	9.5	**13.2**	5.9	3.9	7.1	6.1	4.2	2.8
	[1.0,27.9]	**[1.5,35.6]**	[1.4,19.5]	[1.1,14.2]	[2.2,20.1]	[0.6,22.3]	[0.6,18.4]	[0.4,13.4]
				III. DLALL_OUT_TERM				
13 Weeks	2.2	1.7	4.3	0.9	**13.3**	1.9	2.1	2.1
	[0.6,8.9]	[0.5,7.5]	[0.7,14.2]	[0.2,4.6]	**[5.1,30.7]**	[0.6,6.9]	[0.7,7.4]	[0.7,6.8]
26 Weeks	3.2	3.0	4.4	1.6	**14.3**	2.8	2.9	2.5
	[0.4,15.6]	[0.4,15.5]	[0.9,18.0]	[0.2,8.4]	**[4.6,37.1]**	[0.7,11.8]	[0.8,12.7]	[0.6,10.1]
39 Weeks	3.9	3.8	4.4	2.0	**15.1**	3.1	3.1	2.5
	[0.4,19.1]	[0.4,19.7]	[0.8,19.8]	[0.2,10.7]	**[4.1,41.3]**	[0.6,14.7]	[0.6,14.9]	[0.5,11.8]
52 Weeks	4.2	4.3	4.3	2.2	**15.9**	3.3	3.2	2.5
	[0.3,21.1]	[0.3,22.1]	[0.7,20.5]	[0.2,11.5]	**[3.8,42.4]**	[0.5,16.3]	[0.5,16.2]	[0.5,12.8]
				IV. DLALL_FAIL				
13 Weeks	**6.4**	2.4	3.4	1.7	5.4	2.0	3.1	3.5
	[1.5,16.6]	[0.7,9.8]	[0.8,11.0]	[0.3,7.0]	[2.1,14.9]	[0.7,7.0]	[1.1,8.5]	[1.2,9.1]
26 Weeks	5.3	2.5	6.2	4.1	**7.2**	2.2	3.0	3.6
	[0.9,18.4]	[0.4,12.1]	[1.0,19.5]	[0.4,15.9]	**[2.3,22.8]**	[0.5,9.7]	[0.8,11.5]	[0.9,12.7]
39 Weeks	4.9	2.7	6.8	5.2	**7.6**	2.3	3.1	3.9
	[0.6,19.9]	[0.3,13.5]	[0.9,22.1]	[0.4,20.2]	**[2.2,24.9]**	[0.4,11.3]	[0.6,13.8]	[0.7,14.9]
52 Weeks	4.7	2.7	7.1	5.7	**8.0**	2.3	3.1	4.0
	[0.5,20.4]	[0.3,14.4]	[0.8,23.0]	[0.4,22.1]	**[2.1,26.3]**	[0.4,12.4]	[0.5,14.8]	[0.6,16.2]

Note: The table records the percentages of the variance of the forecasted variable accounted for by variation in the column variable at 13 week horizons. Point estimates are based on a vector autoregressions with 13 weekly lags of each variable included in the VAR. The ordering of the variables in the variance decomposition is based on the benchmark identification: DL_CLAIMS, the column variable, DL_OIL, and the panels financing measure listed in the heading. Numbers in brackets represent 90 percent confidence intervals. Numbers in bold are the largest percentage variance for each row.

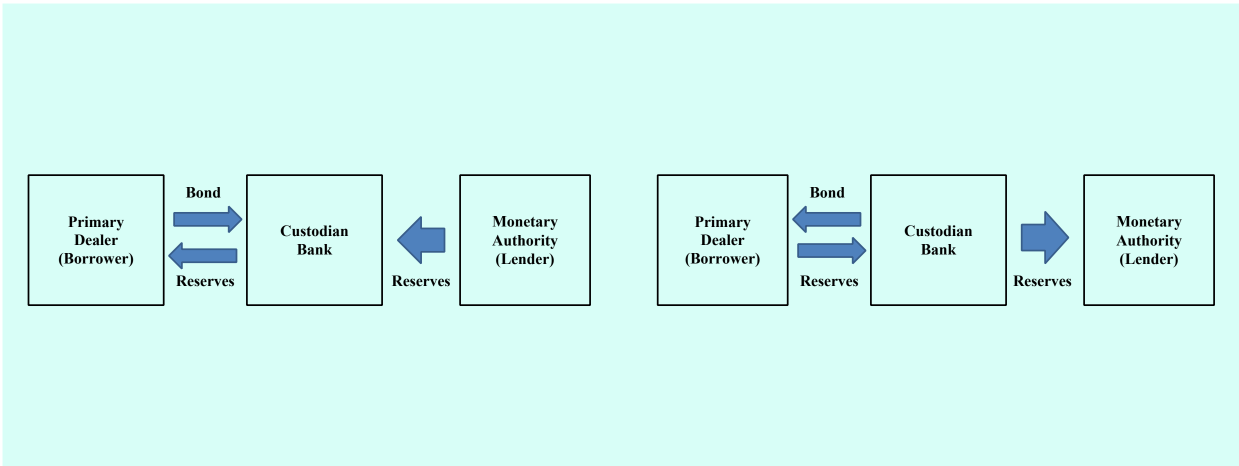
Figure 1: System Open Market Account Holdings: December 18, 2002-January 31, 2007



Source: Authors' calculations based on data from the Board of Governors H.4.1 release.

Note: The figure plots outright and temporary holding of the System Open Market Account (in billions) by: Security class (top left), security class by maturity (top right), and temporary holdings (bottom).

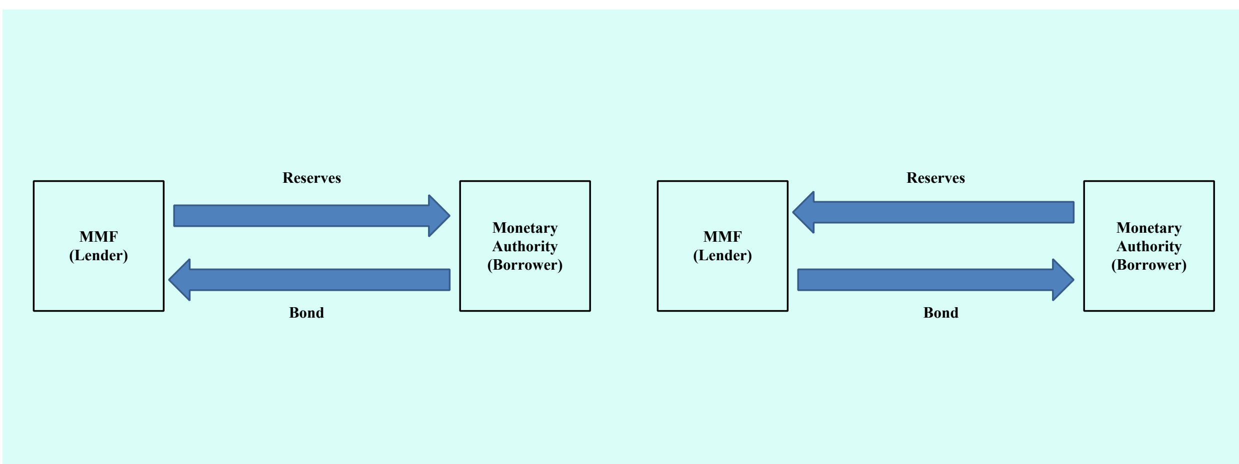
Figure 2: Temporary Open Market Operation - Tri-party Repo



T = 0 T = 1

Note: A Fed repo is an open market operation which temporarily adds reserves to the banking system. It is conducted via auction at the initiative of the open market trading desk of the FRBNY. At T = 0, through FedTrade each dealer is requested to present the rates they are willing to pay to borrow money against Treasury, agency, and mortgage backed collateral. Winning bids are selected on a competitive basis. The dealer delivers collateral to the Fed's custodial account at the dealers tri-party agent, also known as the clearing bank. The Fed makes payment by crediting the reserve account of the clearing bank. When the repo matures at T = 1, the dealer returns the loan plus interest (repurchase price) and the tri-party agent returns the collateral.

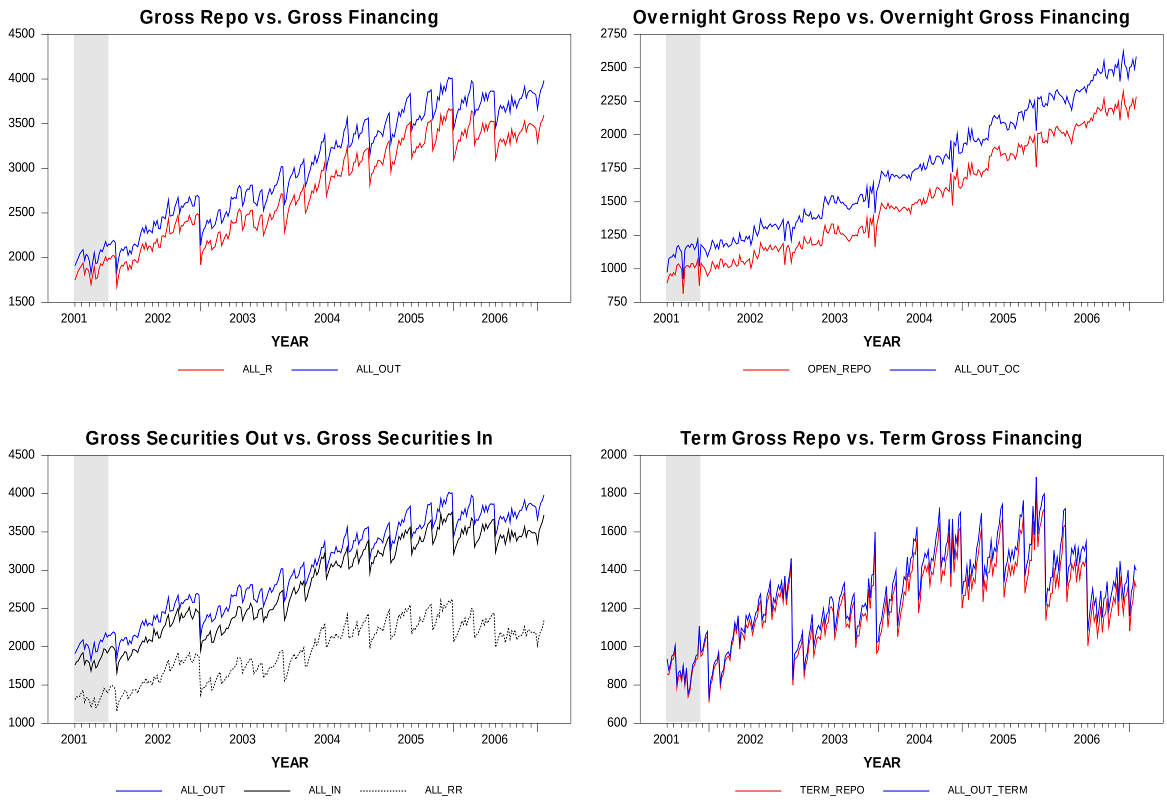
Figure 4: Temporary Open Market Operation - Bilateral Reverse Repo



T = 0 T = 1

Note: A Fed reverse repo is an open market operation which temporarily drains reserves from the banking system. It is conducted via auction at the initiative of the open market trading desk of the FRBNY. At T = 0, through FedTrade each participant is requested to offer the rates they are willing to lend money to the Fed versus Treasury collateral. Winning offers are selected on a competitive basis. Settlement is delivery versus payment so the delivery of collateral and reserves is simultaneous. When the deal matures at T = 1, the lender and the Fed return the collateral and the loan plus interest (repurchase price) respectively.

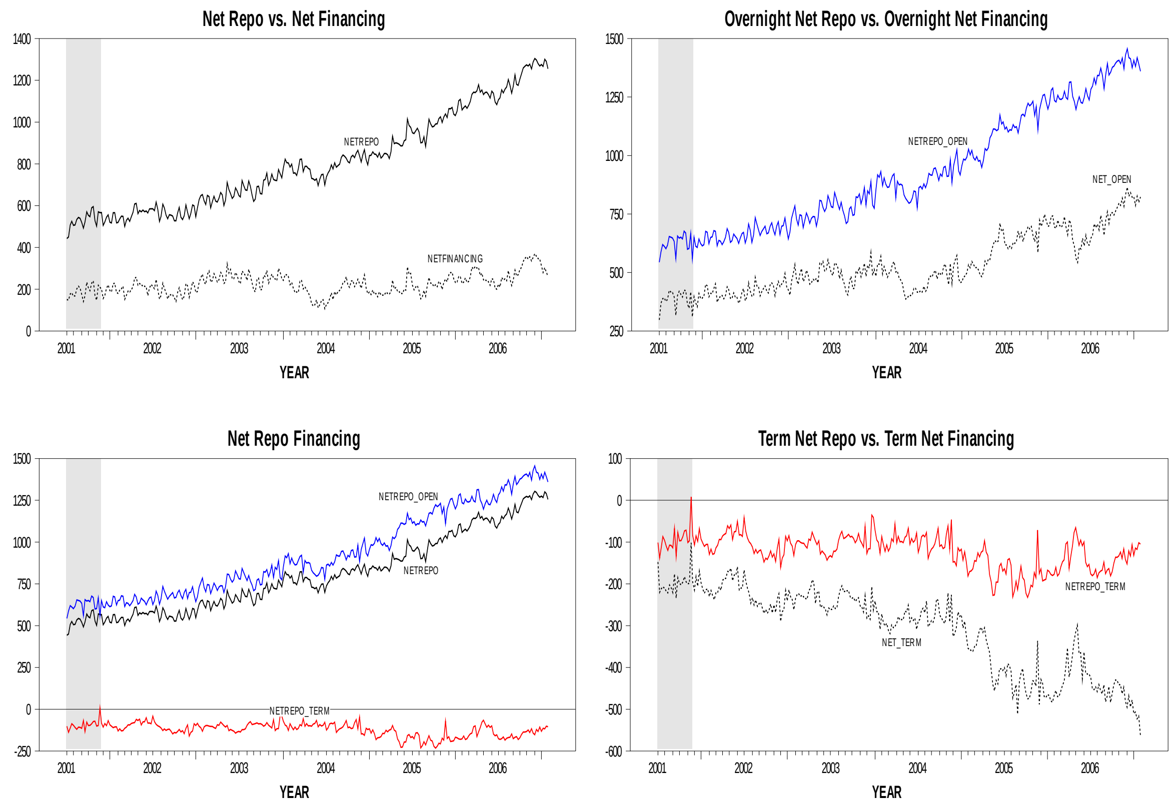
Figure 6: Gross Repo Activity: July 4, 2001-January 31, 2007



Source: Authors' calculations based on data from the Federal Reserve's FR 2004C Report.

Note: The figure plots weekly gross repo and gross financing (in billions of dollars) by maturity. The bottom left panel plots gross financing for securities out, securities in, and gross reverse repo financing reported by the primary dealers. The shading reflects NBER business cycle dates.

Figure 7: Primary Dealers Net Financing By Maturity: July 4, 2001-January 31, 2007



Source: Authors' calculations based on data from the Federal Reserve's FR 2004C Report.

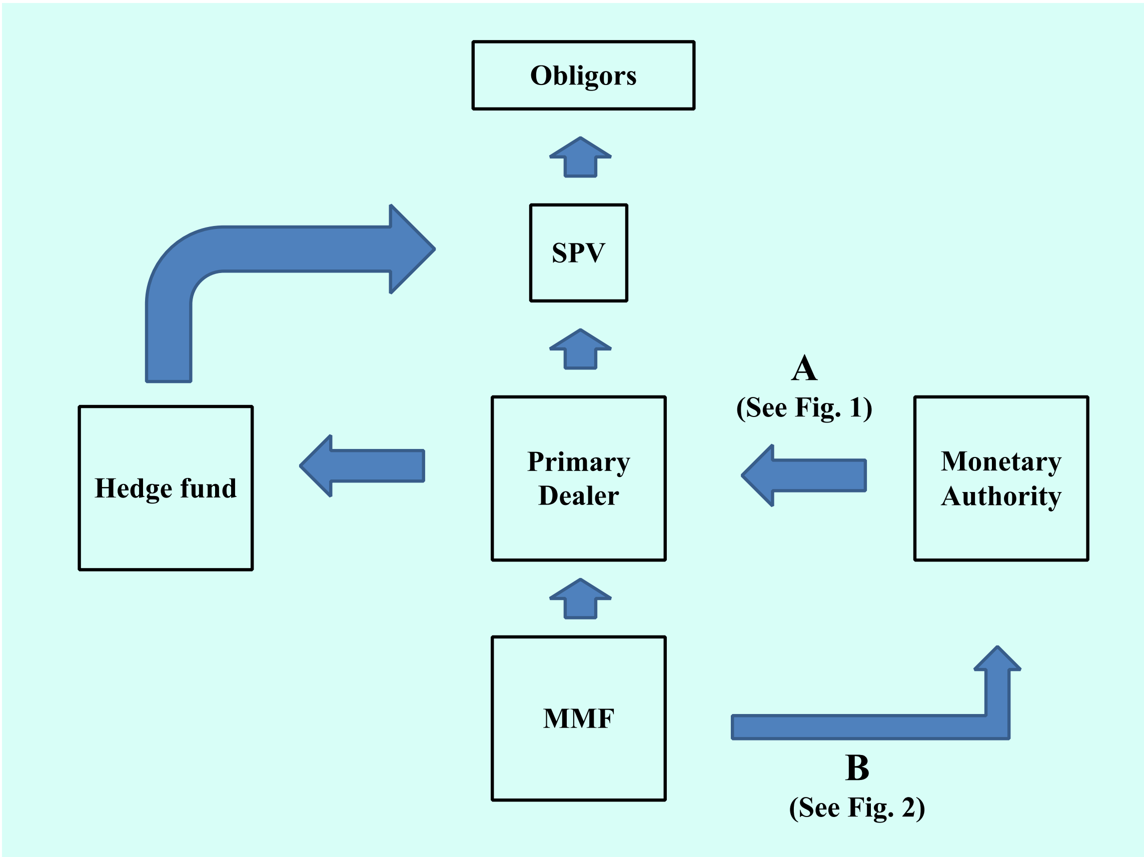
Note: The figure plots weekly net financing and net repo financing (in billions of dollars) by maturity. Net financing by dealers is calculated as securities delivered (out) minus securities received (in). Net repo financing by dealers is calculated as repo minus reverse repo. The shading reflects NBER business cycle dates.

Figure 8: Primary Dealers Net Financing and Fails By Security Class: July 4, 2001-January 31, 2007

Source: Authors' calculations based on data from the Federal Reserve's FR 2004C Report.

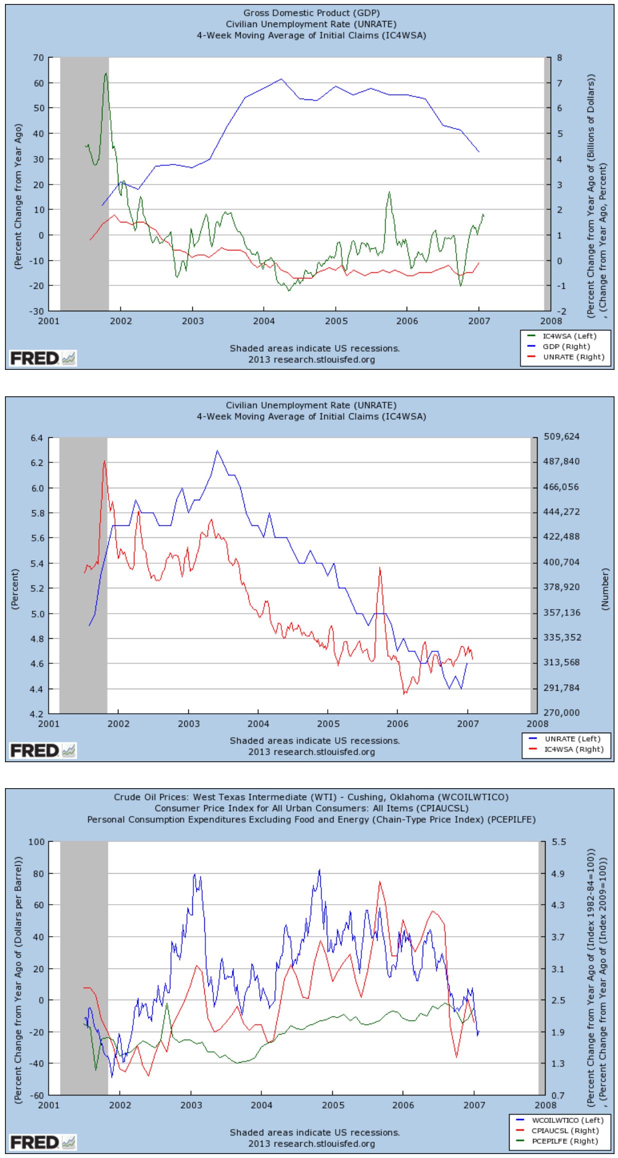
Note: The figure plots weekly cumulative fails and net financing by security class (in billions of dollars). Net financing by dealers is securities delivered (out) minus securities received (in). The shading marks NBER business cycle dates.

Figure 9: Monetary Policy and Securitized Banking



Note: The figure maps short term funding flows from the monetary authority to activity in the shadow banking system. The monetary authority conducts open market operations with primary dealers and money market mutual funds which directly impacts the extension of credit in the shadow banking system.

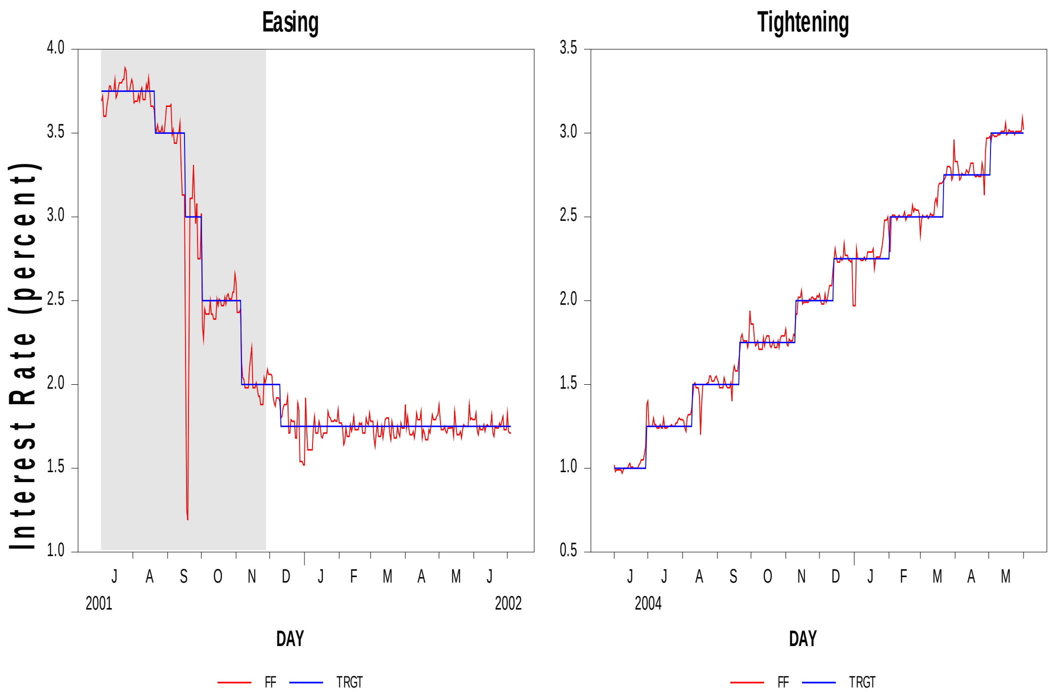
Figure 10: Measures of Real Activity: July 4, 2001-January 31, 2007



Source: Authors' calculations based on Federal Reserve Economic Data (FRED).

Note: The figure plots the four week moving average of initial jobless claims (top and middle) and the WTI crude oil spot price (bottom) with alternate monthly and quarterly economic indicators.

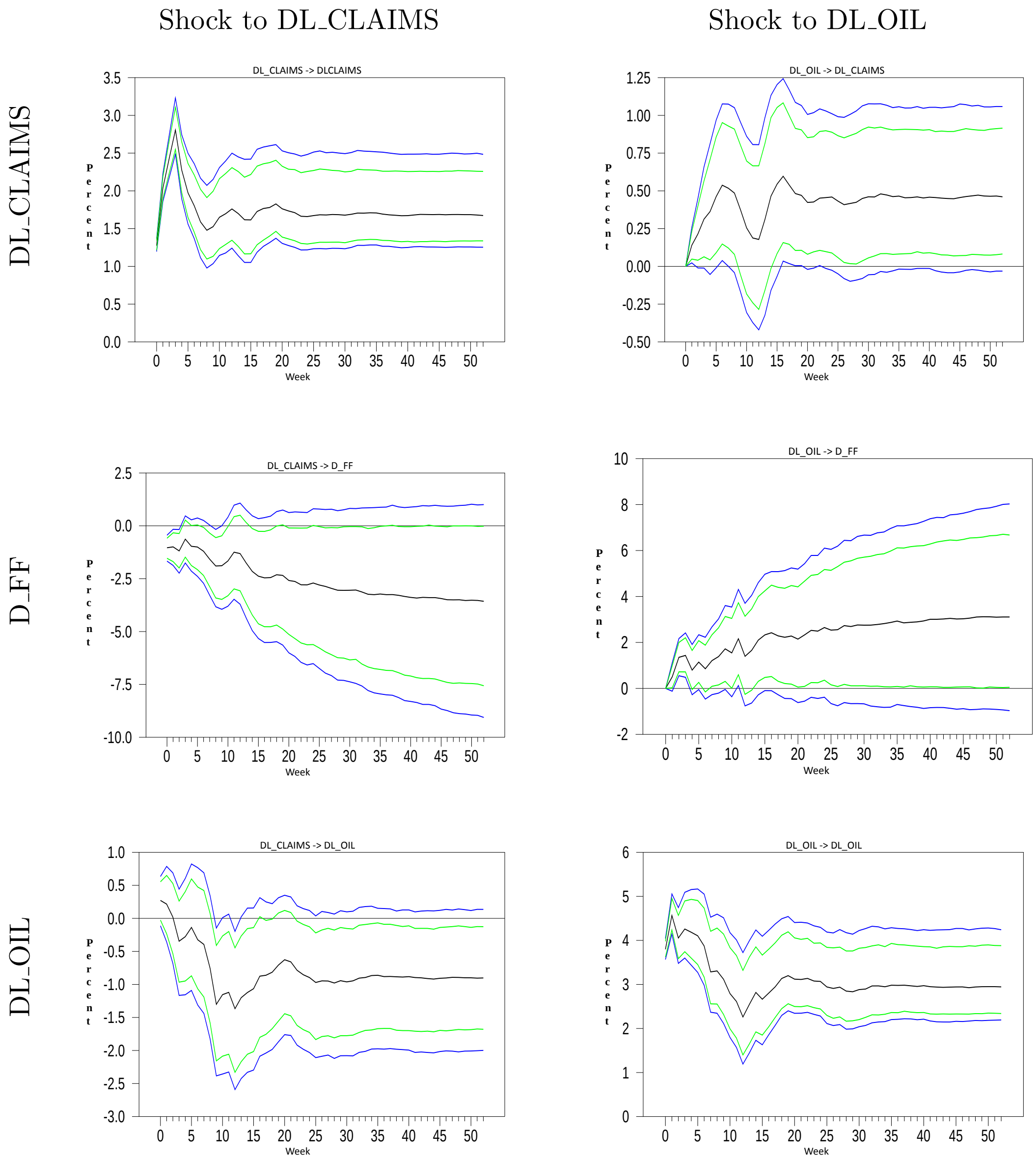
Figure 11: The Federal Funds Rate and Federal Funds Target in 2001 and 2004



Source: Authors' calculations based on data from the Board of Govenors H.15 release.

Note: The figure plots the daily effective federal funds rate and target rate for one year during a monetary easing (July 4, 2001-July 4, 2002) and tightening (June 1, 2004-June 1, 2004) cycle. The shading reflects NBER business cycle dates.

Figure 12: Response of The Federal Funds Rate to Energy and Employment Shocks



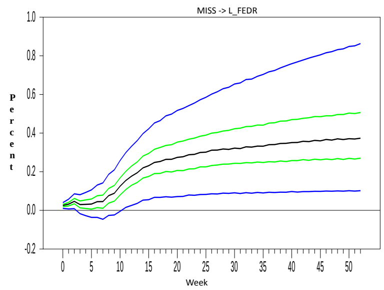
Note: The figure plots impulse responses of the federal funds rate to energy and employment shocks from a recursive VAR model based on the benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 13: The Response of Open Market Operations to Reserve Imbalance Shocks

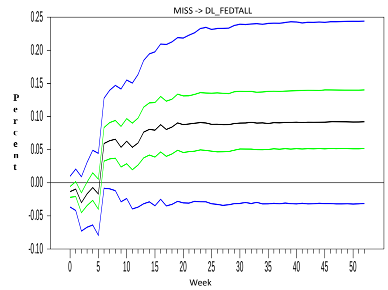
Shock to MISS

Temporary

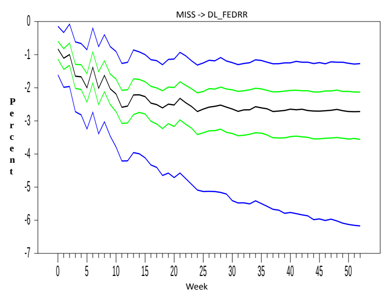
Permanent



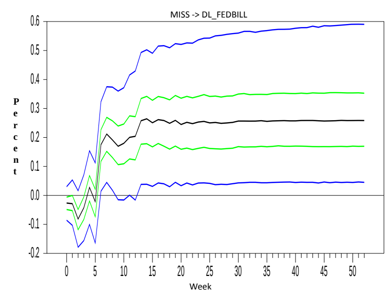
L_FEDR



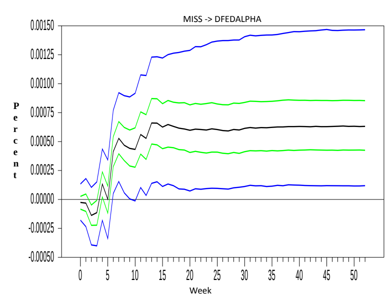
DL_FEDTALL



DL_FEDRR



DL_FEDBILL

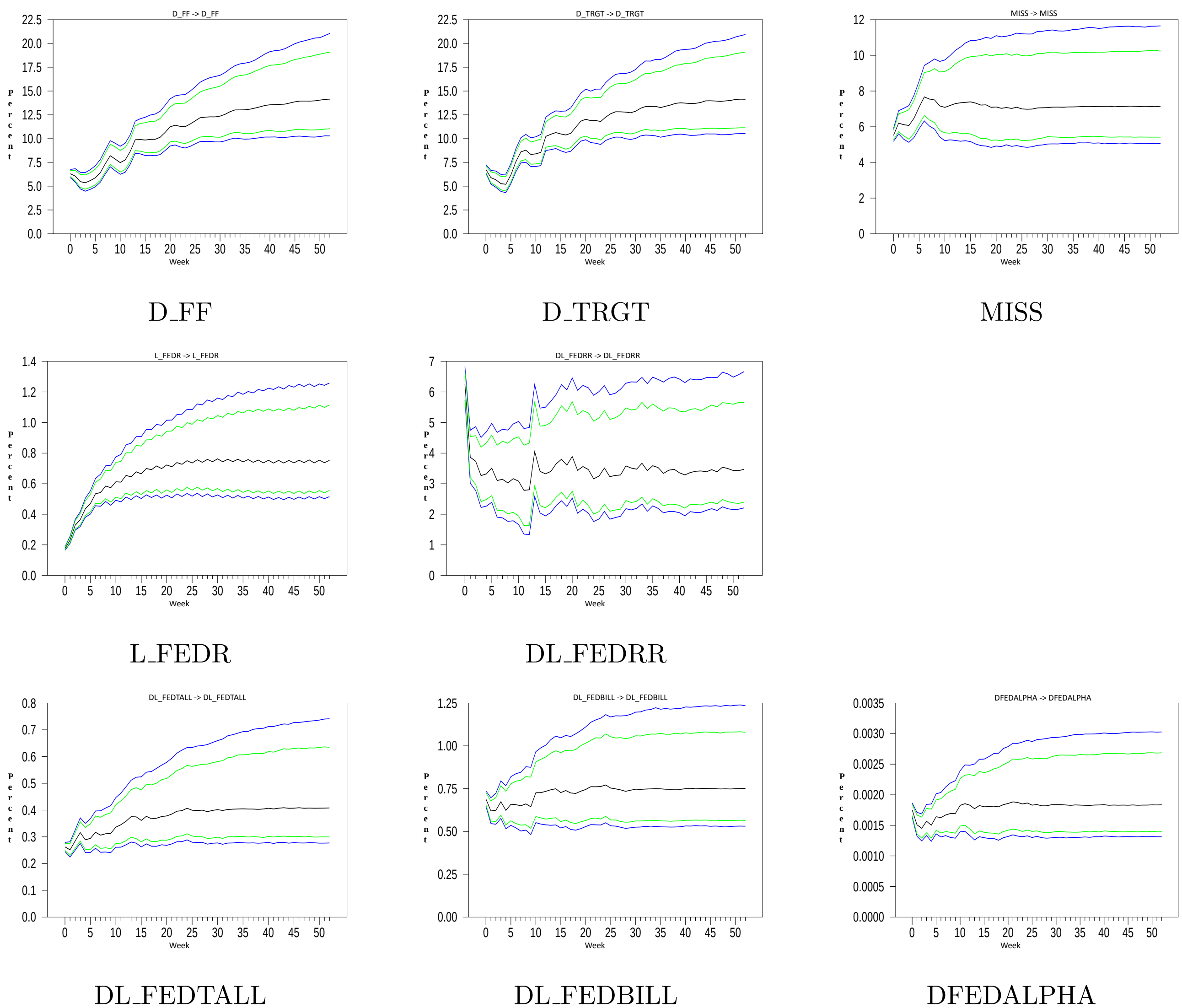


DFEDALPHA

Note: The figure plots impulse responses of system open market account holdings to average weekly target deviation shocks from a bivariate recursive VAR model with *MISS* ordered first. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 68% probability bands.

Figure 14: Responses to a Monetary Policy Shock

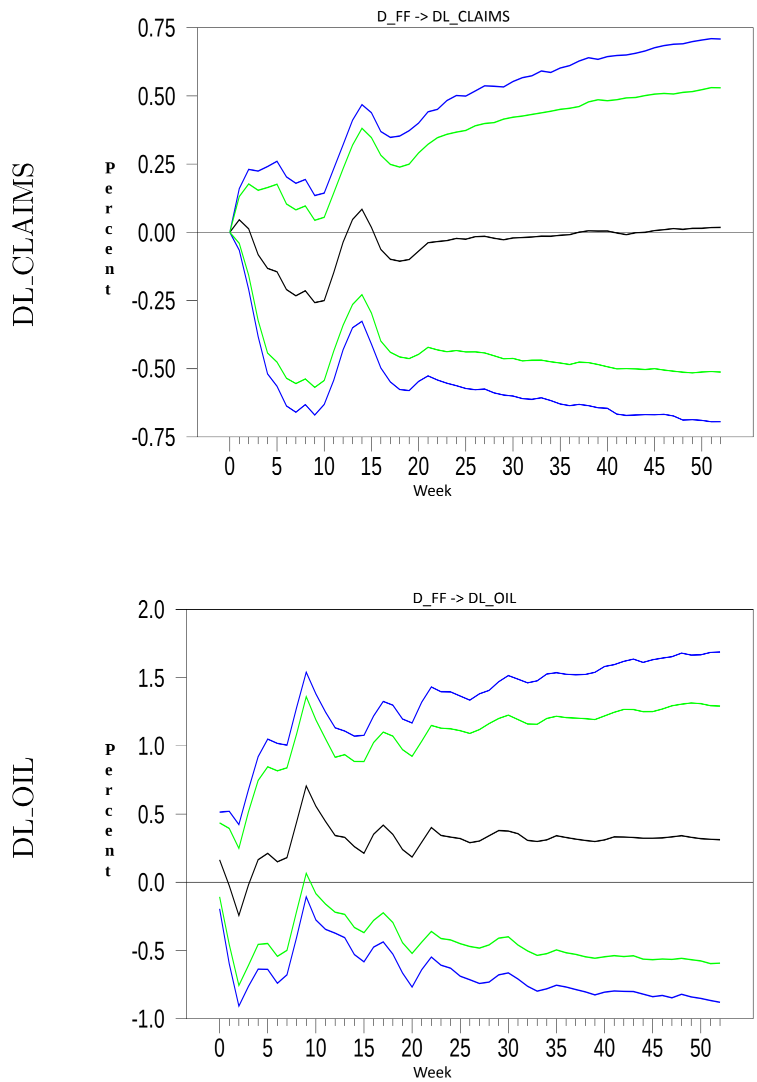
Shock to



Note: The figure plots impulse responses of monetary policy instruments to monetary policy instrument shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

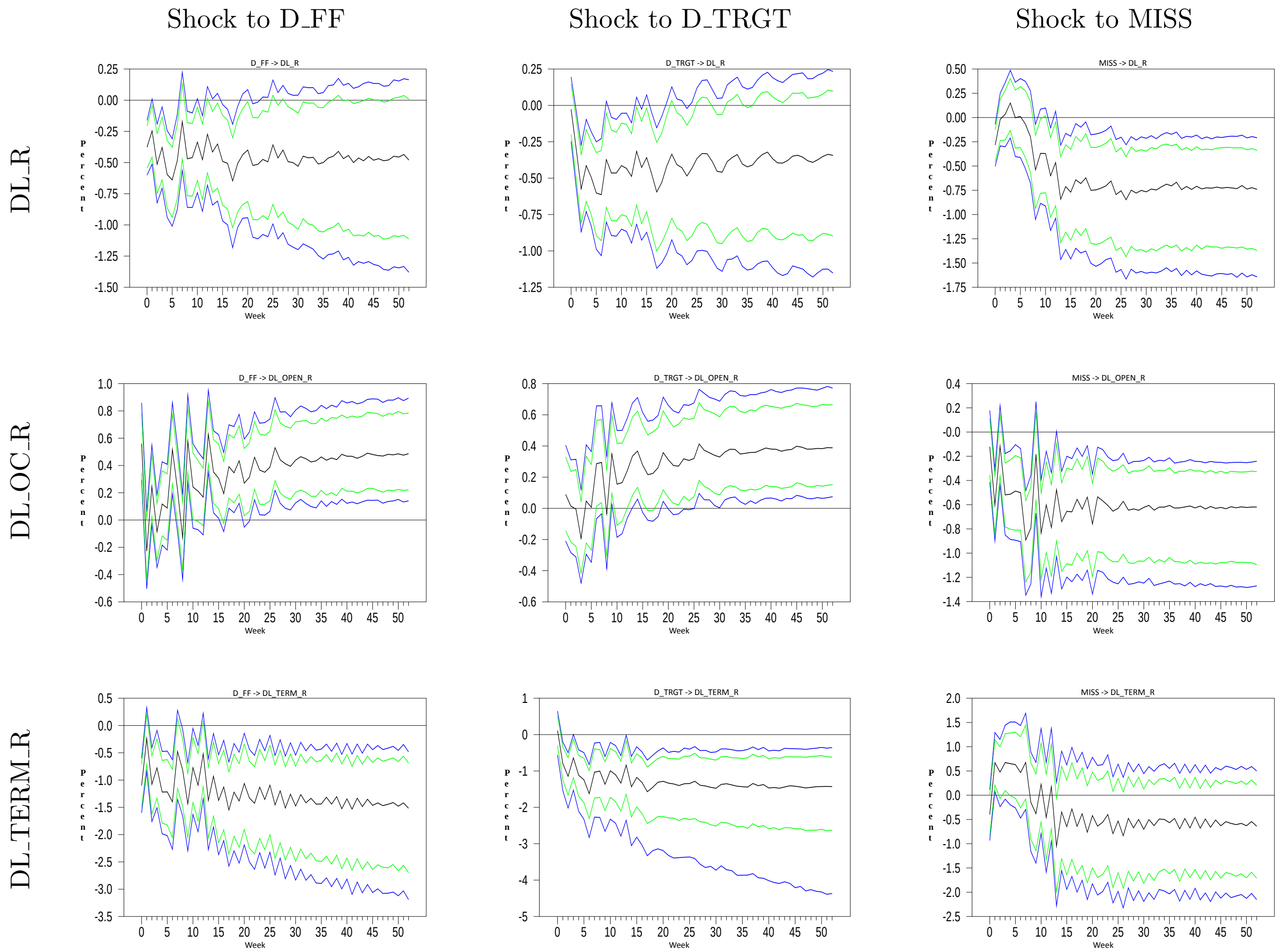
Figure 15: Response of Real Activity to a Shock to the Federal Funds Rate

Shock to DL_DFF



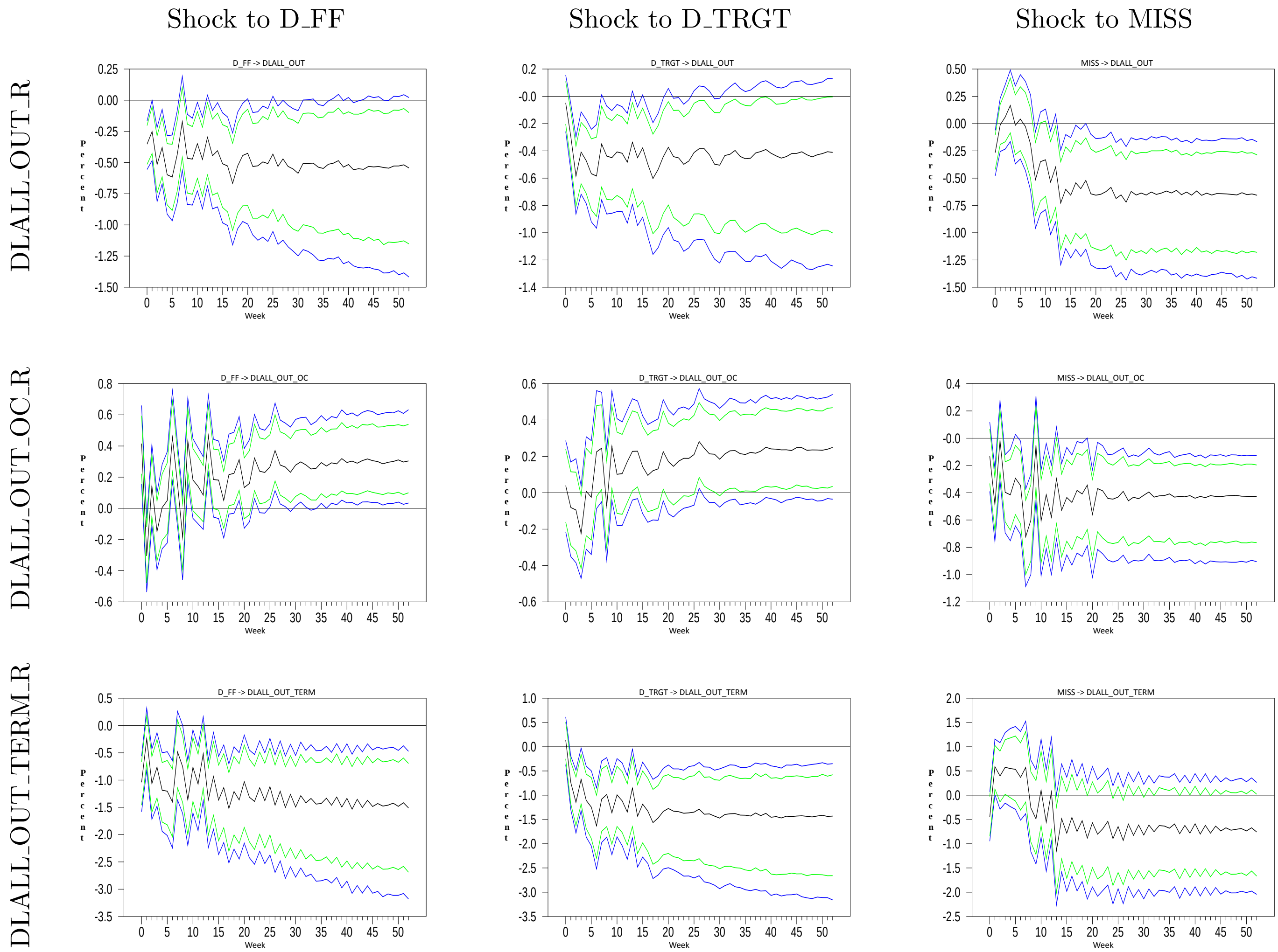
Note: The figure plots impulse responses of the four week average of initial jobless claims and the WTI spot price of crude oil to federal funds rate shocks from a recursive VAR model based on the benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 16: Response of Repo to Cost of Credit Shocks



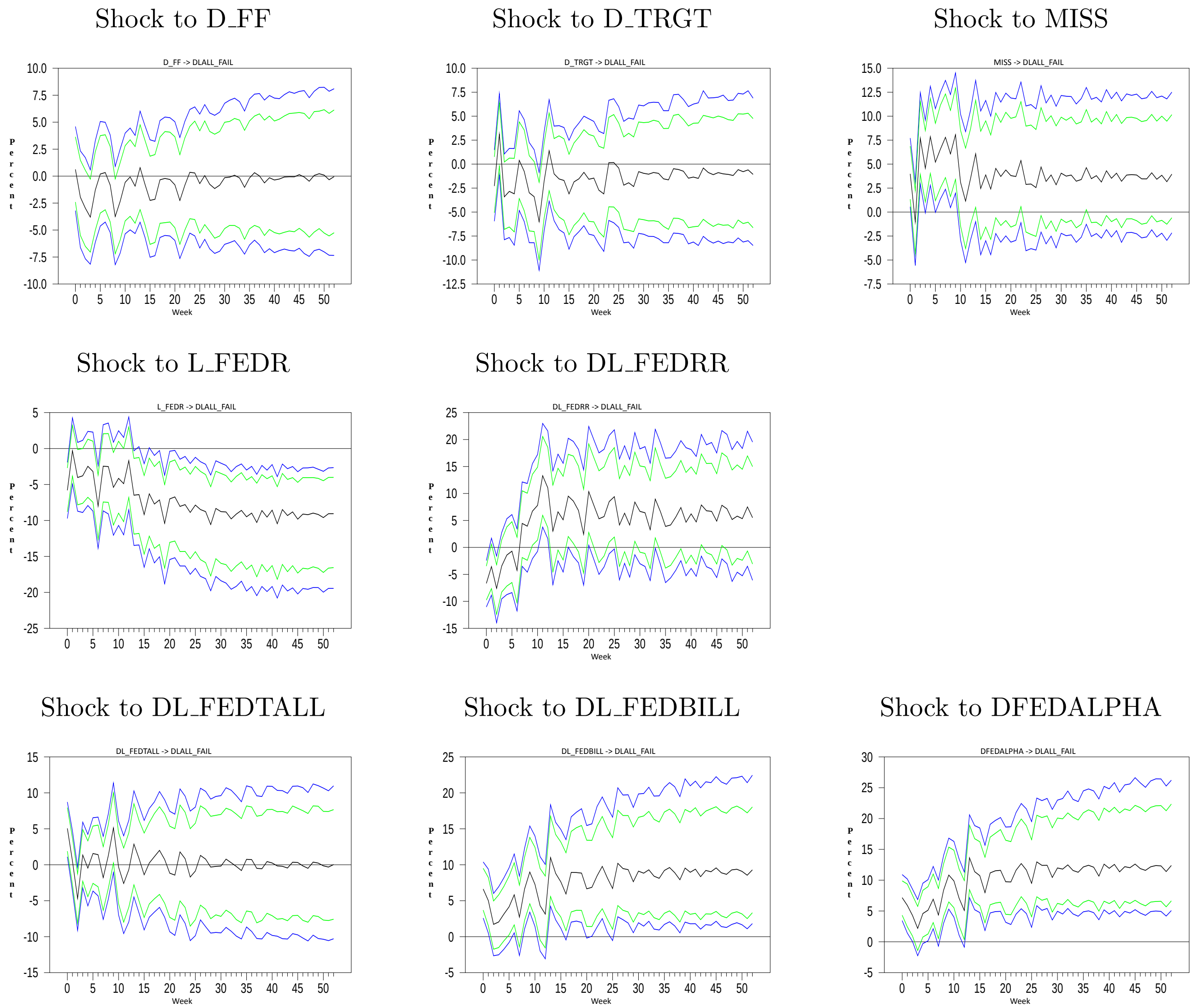
Note: The figure plots impulse responses of repo financing to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 17: Response of Securities Out to Cost of Credit Shocks



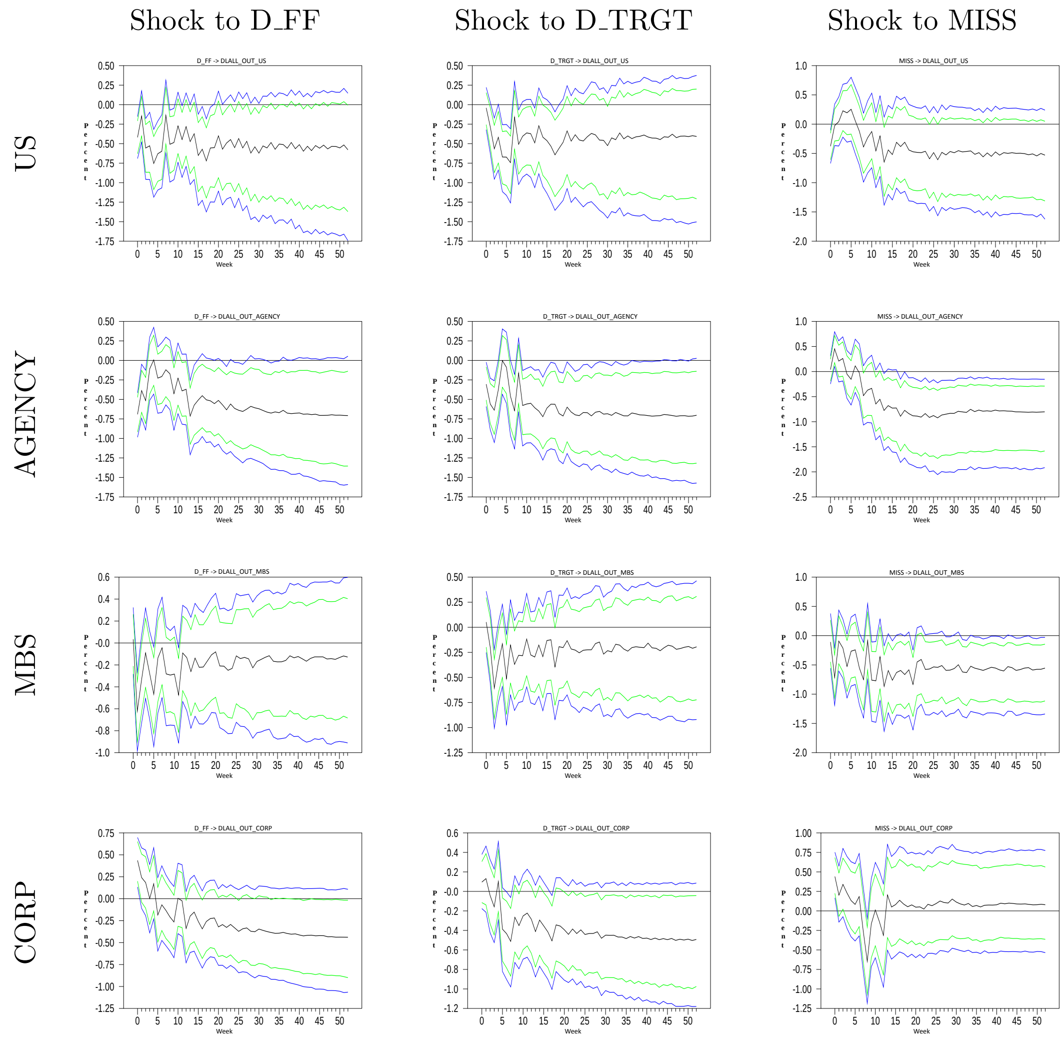
Note: The figure plots impulse responses of securities out to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 18: Response of Financing Fails to Cost of Credit Shocks



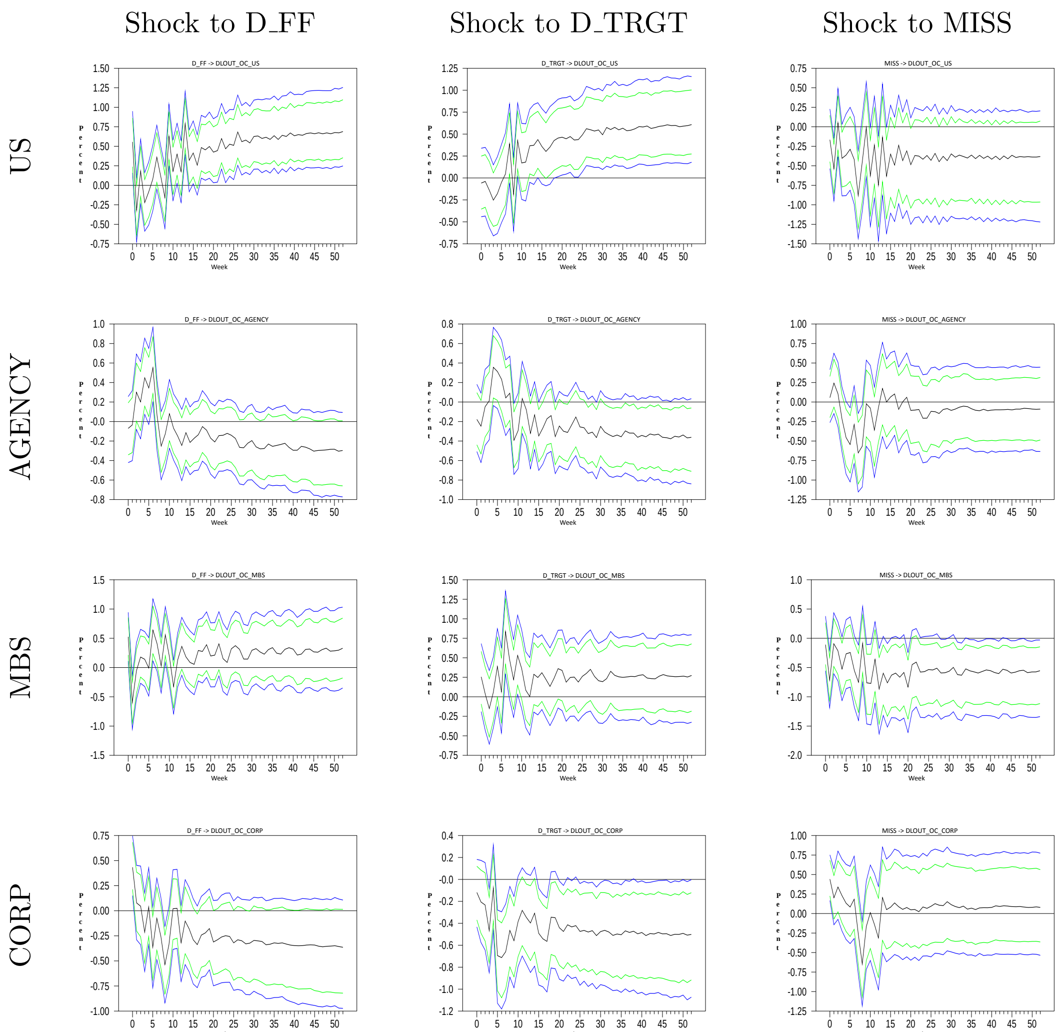
Note: The figure plots impulse responses of financing fails to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 19: Response of Securities Out By Collateral Class to Cost of Credit Shocks



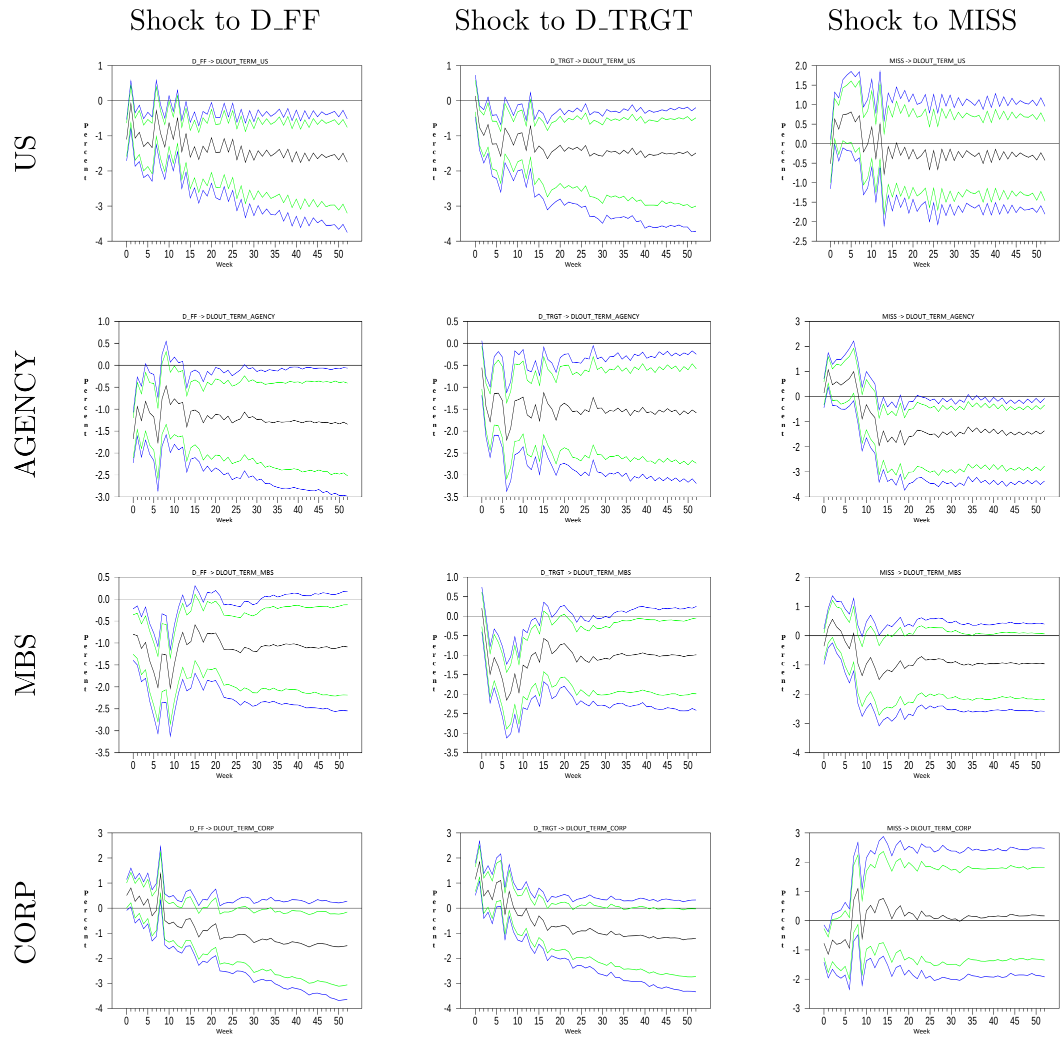
Note: The figure plots impulse responses of collateralized financing by collateral class to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 20: Response of Overnight and Continuing Securities Out By Collateral Class to Cost of Credit Shocks



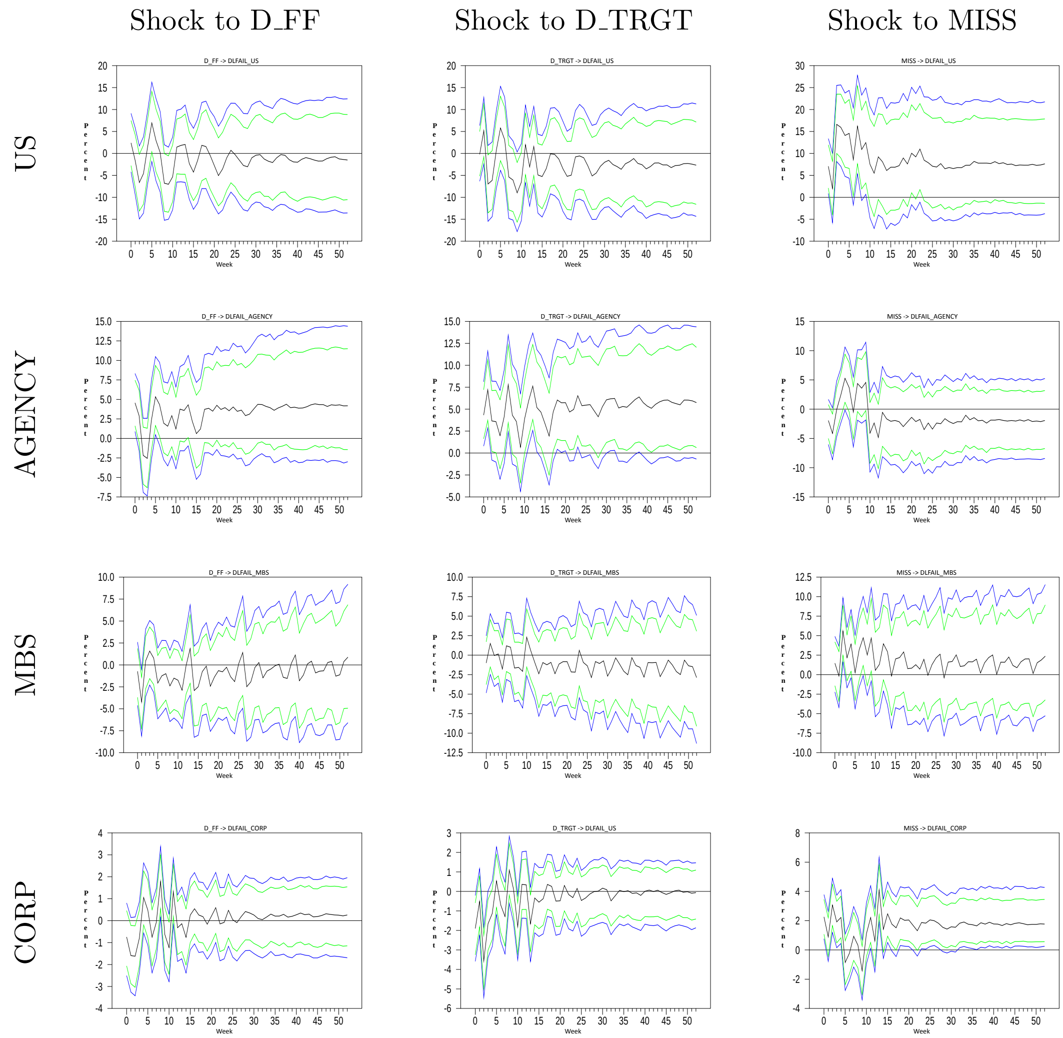
Note: The figure plots impulse responses of overnight and continuing collateralized financing by collateral class to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 21: Response of Term Securities Out By Collateral Class to Cost of Credit Shocks



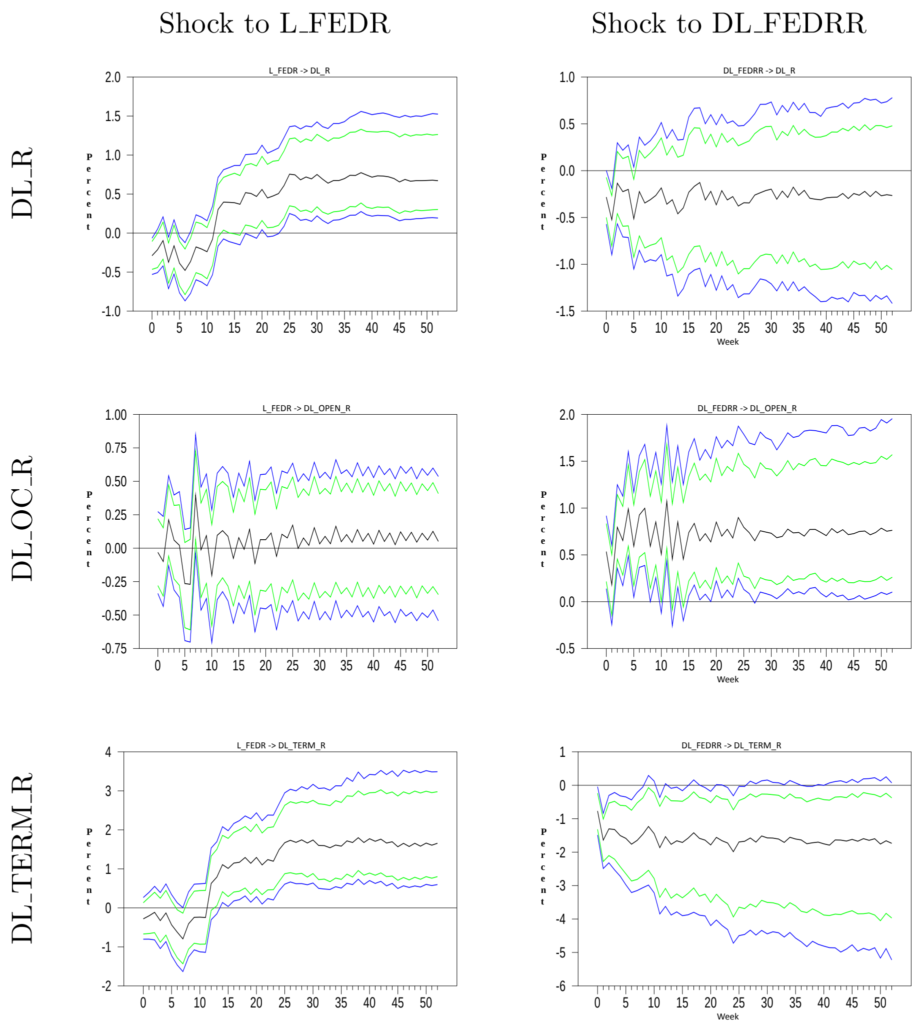
Note: The figure plots impulse responses of term collateralized financing by collateral class to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 22: Response of Financing Fails By Collateral Class to Cost of Credit Shocks



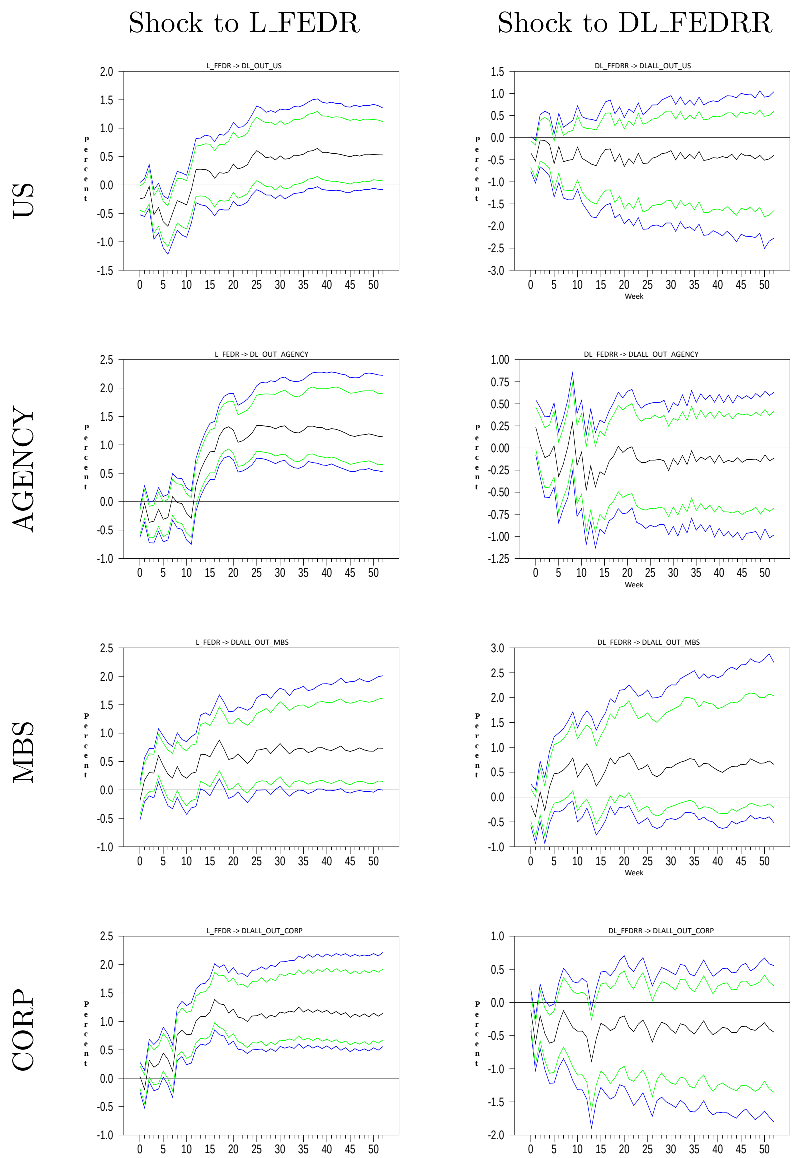
Note: The figure plots impulse responses of financing fails by collateral class to monetary policy shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 23: Response of Repo to Temporary Open Market Operation Shocks



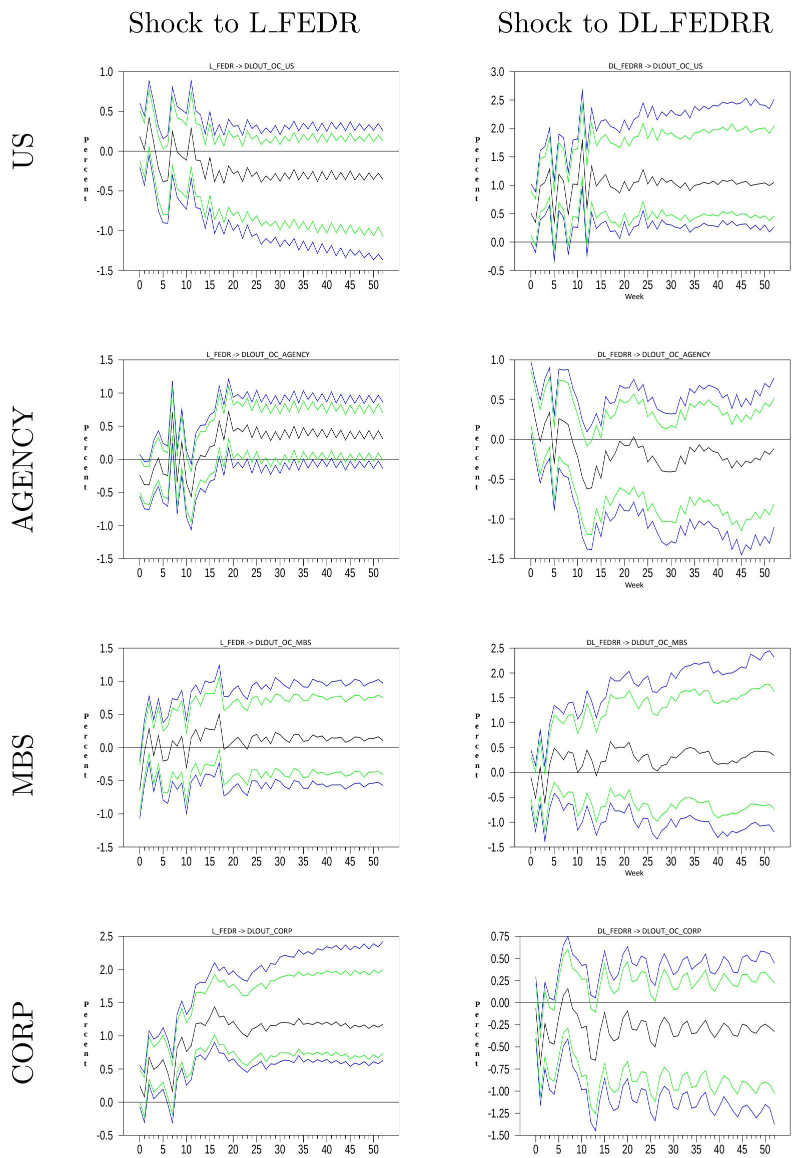
Note: The figure plots impulse responses of repo financing to temporary liquidity injection and withdrawal shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 24: Response of Securities Out By Collateral Class to Temporary Open Market Operation Shocks



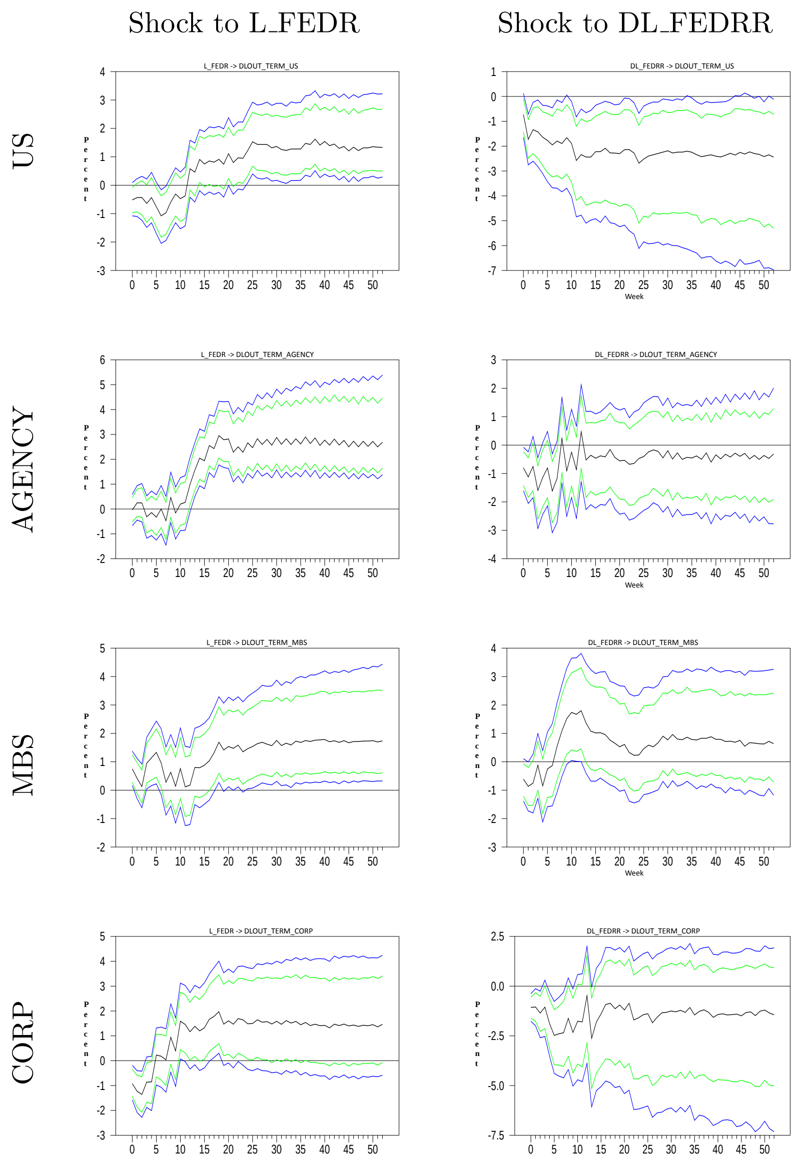
Note: The figure plots impulse responses of collateralized financing by collateral class to temporary liquidity injection and withdrawal shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 25: Response of Overnight and Continuing Securities Out By Collateral Class to Temporary Open Market Operation Shocks



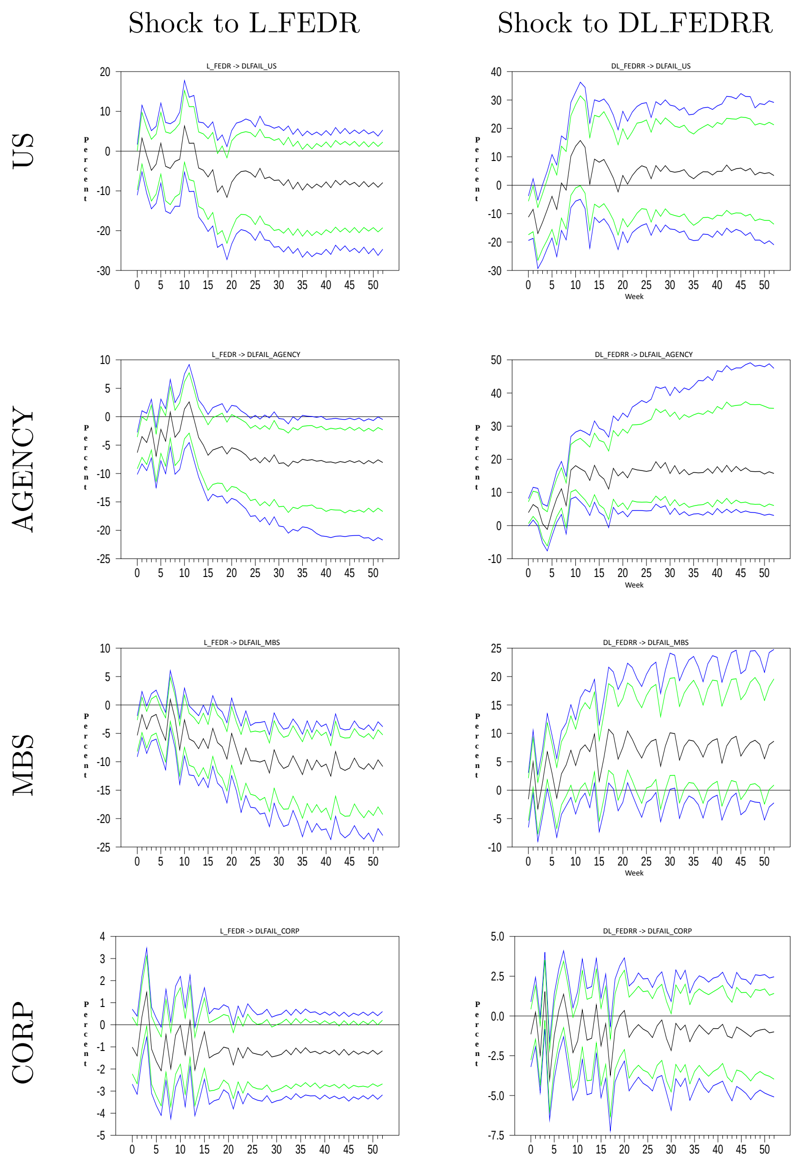
Note: The figure plots impulse responses of overnight and continuing collateralized financing by collateral class to temporary liquidity injection and withdrawal shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 26: Responses of Term Securities Out By Collateral Class to Temporary Open Market Operation Shocks



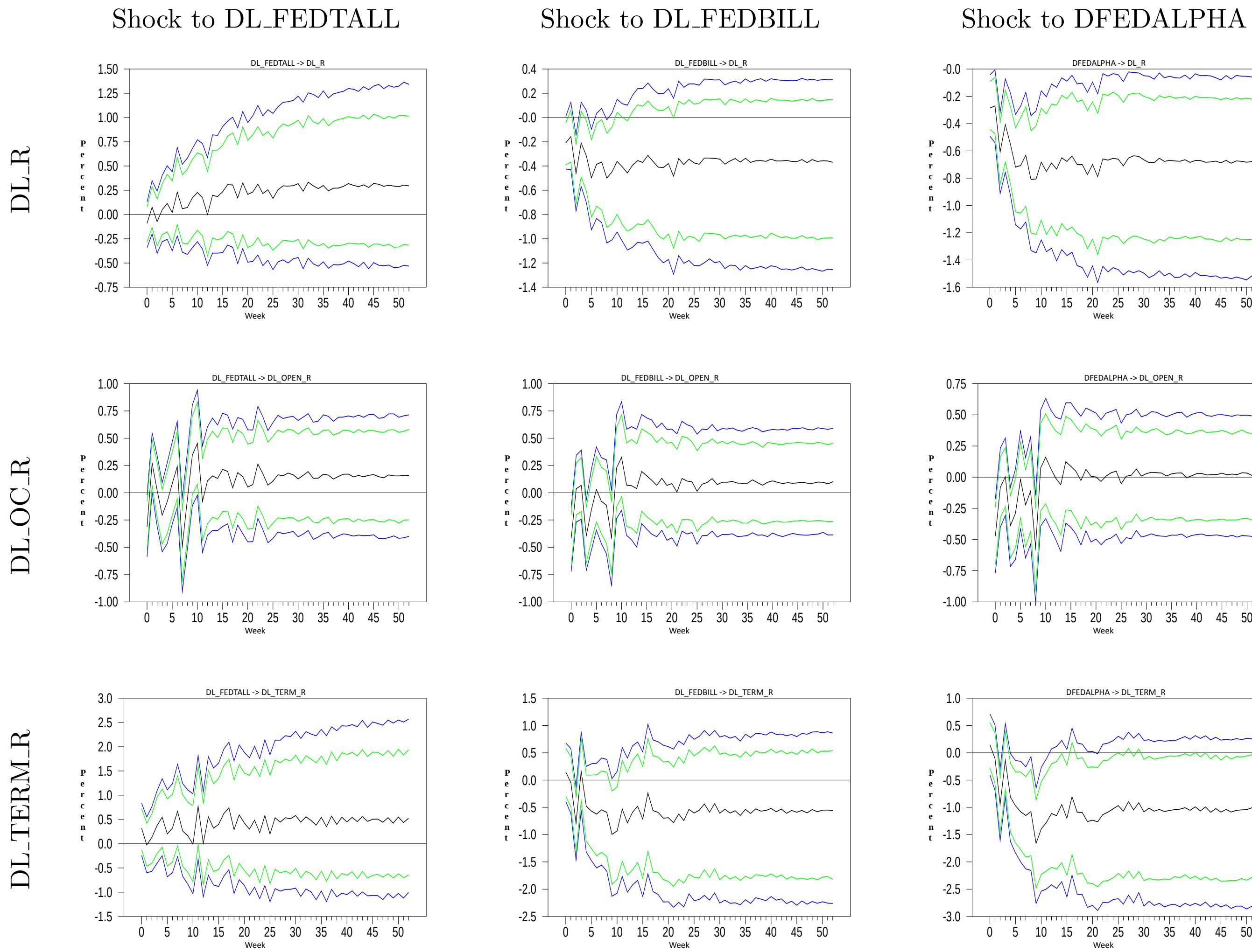
Note: The figure plots impulse responses of term collateralized financing by collateral class to temporary liquidity injection and withdrawal shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 27: Response of Financing Fails By Collateral Class to Temporary Open Market Operation Shocks



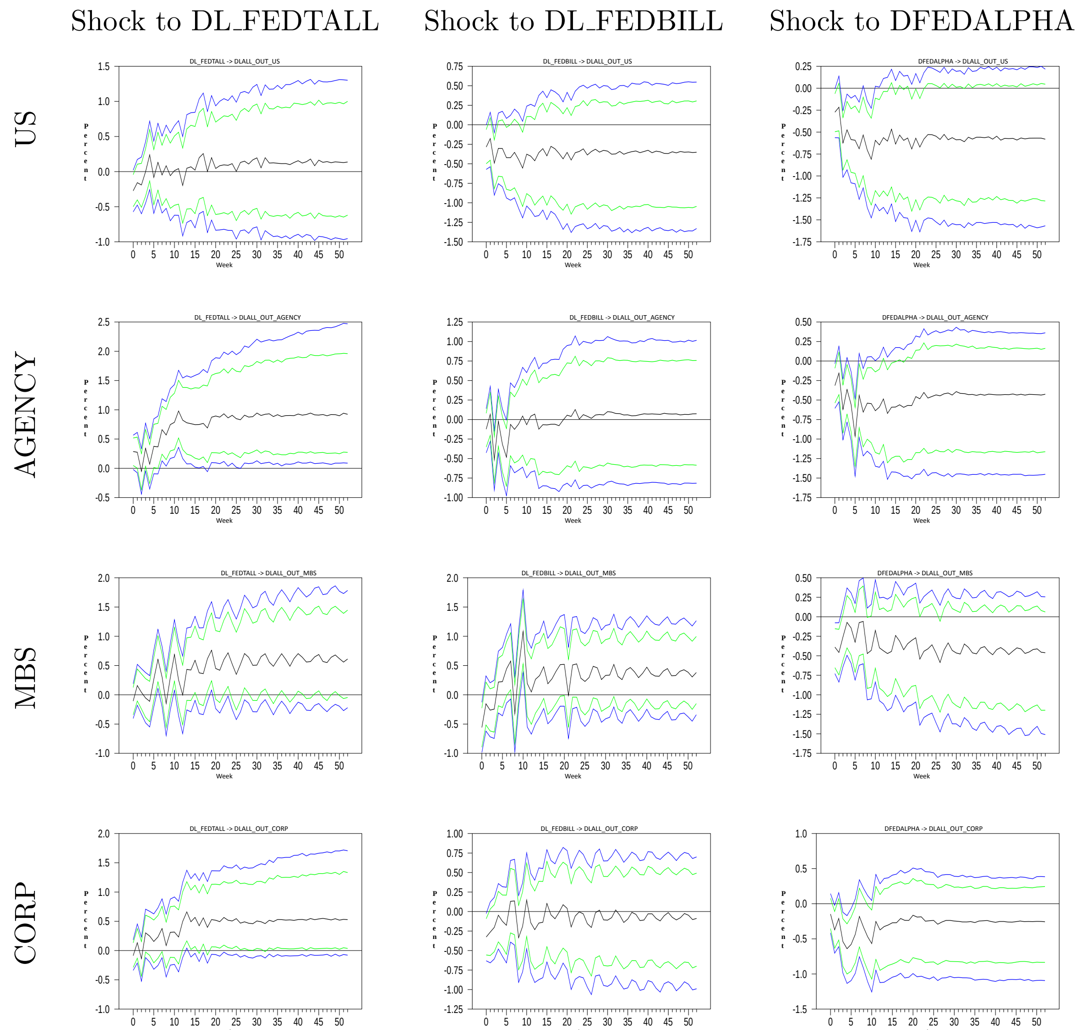
Note: The figure plots impulse responses of financing fails by collateral class to temporary liquidity injection and withdrawal shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 28: Response of Repo to Permanent Open Market Operation Shocks



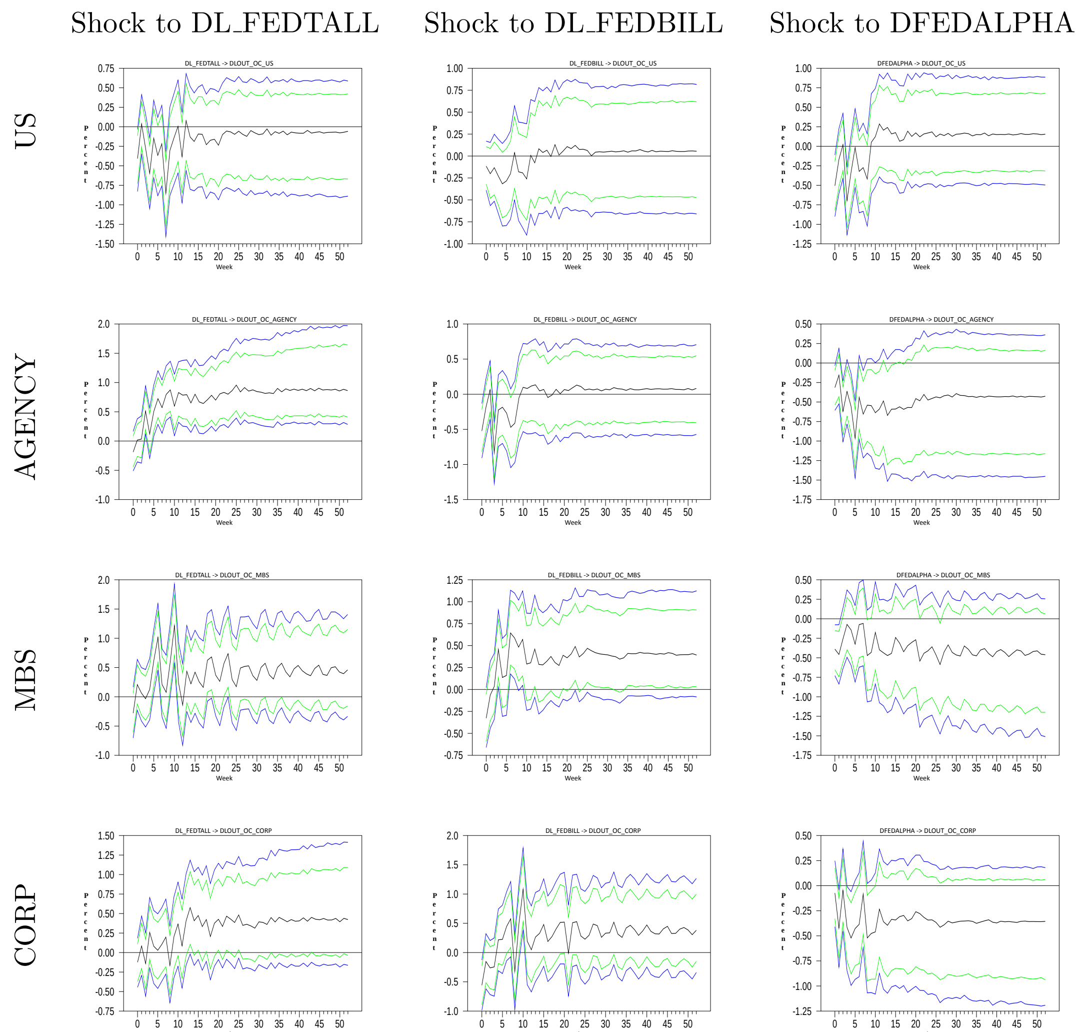
Note: The figure plots impulse responses of repo financing to permanent liquidity injection shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 29: Response of Securities Out By Collateral Class to Permanent Open Market Operation Shocks



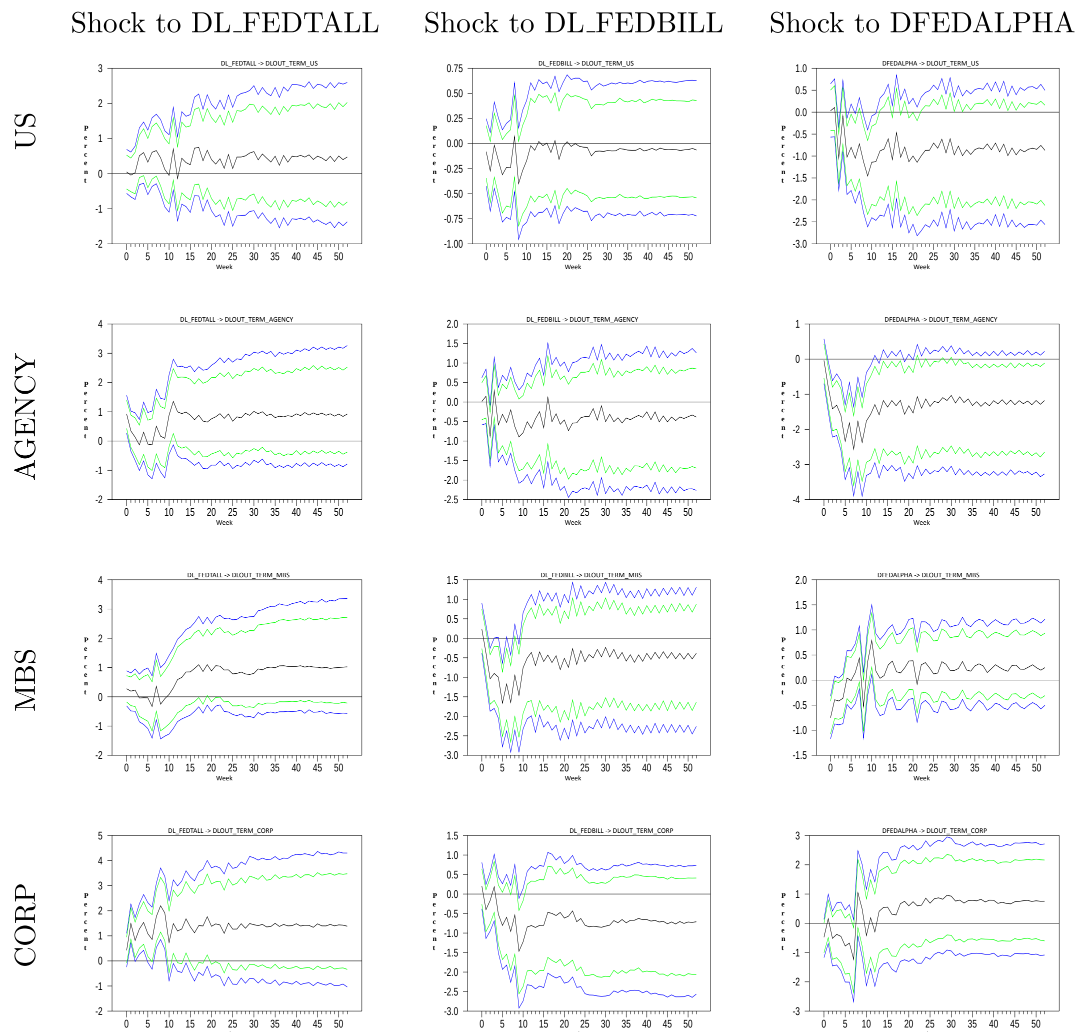
Note: The figure plots impulse responses of collateralized financing to permanent liquidity injection shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 30: Response of Overnight and Continuing Securities Out By Collateral Class to Permanent Open Market Operation Shocks



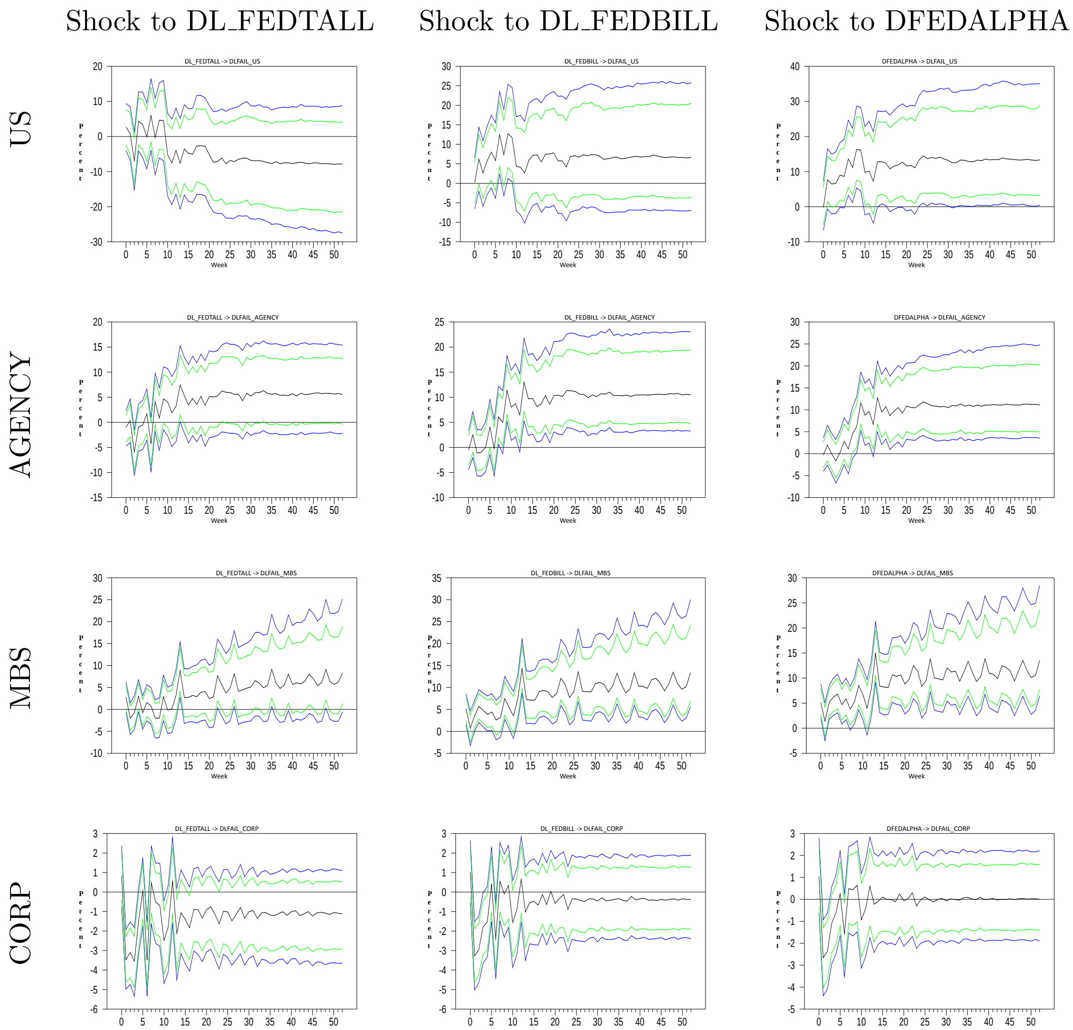
Note: The figure plots impulse responses of overnight and continuing collateralized financing by collateral class to permanent liquidity injection shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 31: Response of Term Securities Out By Collateral Class to Permanent Open Market Operation Shocks



Note: The figure plots impulse responses of term collateralized financing to permanent liquidity injection shocks by collateral class from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.

Figure 32: Response of Financing Fails By Collateral Class to Permanent Open Market Operation Shocks



Note: The figure plots impulse responses of financing fails by collateral class to permanent liquidity injection shocks from a recursive VAR model based on the modified benchmark ordering. The black line is the median of the simulated responses, the blue line represents 90% probability bands, and the green line represents 84% probability bands.