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Responses to the Financial Crisis, Treasury Debt, and the Impact on Short-Term Money Markets

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ABSTRACT

Several government programs have been introduced in the United States in response to the financial crisis. We examine the impact of responses involving Treasury debt on short-term money markets to provide an understanding of cross-policy-dynamics. Specifically, we study the Term Securities Liquidity Facility (TSLF) -- designed to address dislocations in repurchase (repo) rates by exchanging Treasury securities for poorer quality collateral held by market participants; the Supplemental Financing Program (SFP)--designed to help the Federal Reserve drain bank reserves through the issuance of special Treasury debt, with proceeds held at the Federal Reserve Bank of New York; Open Market Operations (OMOs) involving Treasury debt; and Treasury issuance which increased in response to cyclical fiscal policy, and due to programs such as the Troubled Asset Relief Program (TARP) and Treasury's Agency mortgage-backed security (MBS) purchase program. Our contribution is to consider each policy in light of the others, both to help guide policy response to future crises and to emphasize policy interactions as only the TSLF was designed to directly address stresses in short-term money markets. We find that while changes in Treasury collateral do impact repo rates, impacts are not equivalent across sources of Treasury collateral.

Keywords: Treasury debt, repo rates, money markets, financial crisis, monetary policy

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1.0 Introduction

The focus of this study is the impact of various sources of Treasury collateral on short-term money markets. Results also highlight the need to carefully consider the interaction between various policies which will often impact areas beyond their intended targets.

Since the fall of 2007, various government programs have been introduced in the United States in response to the financial crisis. We examine short-term money market impacts of responses involving Treasury debt. One such program, the Term Securities Liquidity Facility (TSLF) was introduced in March 2008, as money markets became severely impaired. The TSLF was specifically designed to address dislocations in repurchase (repo) rates by exchanging Treasury securities for poorer quality collateral held by market participants. A second program, the Supplemental Financing Program (SFP), introduced in the fall of 2008, was designed to help the Federal Reserve drain bank reserves through the issuance of special Treasury debt, with proceeds held at the Federal Reserve Bank of New York. Third, Open Market Operations (OMOs)—both permanent and temporary—which increase or decrease holdings of Treasury debt in the Federal Reserve's System Open Market Account (SOMA) also impact the supply of Treasury collateral. For example, over the course of the financial crisis, the Federal Reserve first sold Treasury holdings to maintain the size of its balance sheet, and then later, following the collapse of Lehmann Brothers on September 15th of 2008, bought Treasury securities as part of its Large Scale Asset Purchase (LSAP) program. Finally, and more incrementally, other Treasury debt issuance increased as the U.S. entered a recession in late 2007, fostering increased expenditures and lower tax receipts. Other debt issuance was also directly tied to the financial crisis through programs such as the

Troubled Asset Relief Program (TARP) and Treasury's Agency mortgage-backed security (MBS) purchase program. While the SFP, OMOs, and programs such as TARP were not aimed directly at dislocations in short-term money markets, they did impact the supply of Treasury securities available to be financed by money markets.

This work examines the impact of these responses on short-term money market rates using daily market data. In general, greater amounts of available Treasury collateral should lead to higher repo rates. Because all Treasury securities are equally suitable as collateral, and because each program we study had different transmission channels, different initiation periods, and different patterns of changes in supply, each program's effect can be measured against a common benchmark, the over-night Treasury general collateral (GC) repo market. Our study takes advantage of the fungible product generated by each of the separate policy actions—changes in the supply of US Treasury debt, to evaluate each in light of the others. Our results will increase the collective understanding of short-term money markets and thus can help guide policy response to future crises.

We find that Treasury collateral does generally impact overnight GC repo rates. However, not all sources of Treasury collateral have the same impact. The remainder of this paper is structured as follows: Section 2 provides background on secured funding markets, the various policy responses to the financial crisis that involved Treasury debt and relevant literature; Section 3 describes our data and method; regression results are presented in Section 4; Section 5 concludes.

2.0 Background and Literature Review

Secured funding markets allow for collateralized borrowing by participants. In these markets, the most common type of transaction is a repurchase agreement, or repo.

In a repo, a sale of securities is combined with an agreement to repurchase the same securities at a later date, typically at a higher price. The lender of funds takes possession of the borrower's securities over the term of the loan and can resell them in the event of a borrower default.

Of course volume in the repo market is primarily then a function of demand for funds (borrowers interest in transactions) and their asset position (borrowers capacity to engage). The latter is subject to market valuation of collateral and thus as illustrated via theoretic "liquidity spirals" in Brunnermeier and Pedersen (2009) and more tangibly in the popular press by Lowenstein (2000), tightening collateral requirements can cause rapid contractions in repo market activity for any particular firm, as well as generally. In fact this contraction occurred in the current financial crisis, as shown in Adrian and Shin (2009).

Segmentation occurs in that some repos specify collateral to be used while others are "general"; for a general collateral (GC) repo, any set of a given type of security is acceptable as collateral by the lender.[1] Overnight GC repo rates tend to track rates on uncollateralized overnight federal fund loans; the spread between the overnight GC repo rate and the fed funds target rate typically being less than 10 basis points (bps). This reflects the use of GC repos as a mechanism for lending and borrowing money. In recent years, primary dealers have used repos to finance around $2-5 trillion in fixed-income securities.[2]

As a general rule, there should be a positive relationship between the supply of collateral and the interest rate that the borrower must pay to obtain funds (this is

[1] For example, a *Treasury GC repo* contains any Treasury security as collateral whereas with a special collateral repo, the lender of funds seeks a specific security.
[2] See http://www.newyorkfed.org/markets/primarydealers.html for information on primary dealer financing.

because scarce collateral is more valuable, so the borrower needs to pay less interest to borrow funds).[3] In fact, a literature on specialness and segmentation has evolved along with the repo market itself, both as narrowly defined with Duffie (1996), Jordan and Jordan (1997) and Fleming and Garbade (2004, 2007), and broadly to generic bond market demand and supply as seen in Greenwood and Vayanos (2008). Moreover, demand for particular bonds as collateral is a function of their liquidity, such that "on the run" issues (the latest issues) hold premium collateral status, as documented in Keane (1996) and Longstaff (2004).

2.1 The Term Securities Lending Facility (TSLF)

The TSLF was introduced on March 11, 2008 "to promote liquidity in the financing markets for Treasury and other collateral and thus to foster the functioning of financial markets more generally."[4] As the financial crisis progressed, funding markets came under unprecedented stress; liquidity and counter-party concerns led money market participants to seek out Treasury securities, and term funding became scarce. As a result, Treasury overnight GC rates plunged and the spread between the fed funds target rate and Treasury GC repo rates (as well as the spread between repo rates for other collateral such as Agency debt and Treasury GC repo rates) widened to extraordinary levels as part of a flight to liquidity as seen in Figure 1.[5]

‹Figure 1 here›

The TSLF addressed widening spreads by increasing the supply of Treasury collateral, intended to increase Treasury GC rates and decrease repo rate spreads.

[3] See Fleming, Hrung, and Keane (2009, 2010b) for more details regarding secured financing markets.
[4] See the Federal Reserve press release announcing the TLSF, at:
http://www.federalreserve.gov/newsevents/press/monetary/20080311a.htm
[5] Longstaff (2004) documents pre-crisis flight to liquidity premiums in somewhat in line with the time *t* time *s* transmission mechanism suggested by Krishnamurthy (2010), though whether these were priced correctly at market circa 2002-2007 is debatable--especially in light of the TSLF as a policy innovation.

Primary dealers with a trading relationship with the Federal Reserve Bank of New York were eligible to swap their holdings of less liquid collateral for Treasury securities held in the System Open Markets Account (SOMA) for a period of 28-84 days. The dealers bid a fee via a single-price auction to access the TSLF, with a minimum fee set by FRBNY.[6]

The TSLF was specifically designed to directly address money-market stresses. Also worth noting, the program's policy design is uniquely elegant in that it involves a security-for-security exchange and so does not expand the Federal Reserve's balance sheet. Thus there was no need to sterilize the impact of the TSLF and as a result the program was able to grow to a substantial size very quickly.[7] The top panel of Figure 2 shows that within one month of the first TSLF auction, the facility reached $150 billion. The facility peaked above $220 billion in December 2008 and wound down to zero by early August 2009. The TSLF officially expired on February 1, 2010.[8]

‹Figure 2 here›

2.2 Supplementary Financing Program (SFP)

The top panel of Figure 2 also documents SFP balances over the policy period from 2008-2010. U.S. Treasury announced the SFP on September 17, 2008, two days after the collapse of Lehman Brothers. The program was initiated at the request of the Federal Reserve with the aim of offsetting the balance sheet impact of the liquidity-providing efforts being implemented by the Federal Reserve during the financial crisis.[9] In other words, the program was designed to help the Federal Reserve drain bank reserves

[6] For more on the TSLF, see Fleming, Hrung, and Keane (2009).
[7] Note that the maximum amount of Treasury collateral that can be supplied via TSLF is limited to Treasury holdings in the SOMA account. In the spring of 2008, the Federal Reserve held around $700 billion in Treasury securities.
[8] The amounts presented and studied include amounts exercised in the TSLF Options Program. For more information on this program, see http://www.federalreserve.gov/newsevents/press/monetary/20080730a.htm .
[9] See http://www.ustreas.gov/press/releases/hp1144.htm and http://www.newyorkfed.org/markets/statement_091708.html.

accumulating through liquidity facilities that were introduced in response to the crisis. Because the level of bank reserves tends to impact the federal funds rate, such an offset to the increase in reserves was needed to help the Open Market Trading Desk meet the target for the federal funds rate set by the Federal Open Market Committee (FOMC).

The program consisted of the issuance of a series of Treasury bills, which were separate and distinct from regular Treasury debt issuance. SFP bills are essentially Cash Management Bills (CMBs). But whereas pricing of CMBs has tended to be punitive in as much as it requires potentially disruptive reductions of liquid reserves from primary dealers as documented in Seligman (2006) and Simon (1991), SFP proceeds are more likely to have facilitated less disruptive reductions because the reserves accumulating were in excess of what would normally been productive inventories. Further a by-product of the program was that it increased the amount of high-quality collateral available in the market, helping to alleviate the very same supply-side stresses in money markets that the TSLF was designed to address.

Another way in which SFP is different from CMBs is in the utilization of funds from issuance. CMB proceeds are like regular Treasury issuance and certain classes of tax payments in that they are deposited in Treasury's General Account (TGA) at the Federal Reserve Bank of New York (FRBNY), the account that pays most Federal outlays; the TGA can be thought of as Treasury's "checking account." As the TGA is a liability item on the Federal Reserve's balance sheet, along with bank reserves, an increase in the TGA will decrease bank reserves, holding the size of the overall balance sheet constant. The proceeds from the "SFP bills" were placed in a separate account at FRBNY, so that the account would not accept tax receipts and would not pay any

outlays. However, similar to the TGA, an increase in the Supplementary Financing Account (SFA) decreases bank reserves.[10]

The SFA quickly increased up to its peak value of $560 billion by October 20, 2008, when the stresses in funding markets were still unprecedented. The peak amount of Treasury collateral supplied by the SFP was more than double the peak amount supplied by the TSLF. While the SFP is a very effective method for quickly draining bank reserves, one drawback to the SFP as a policy instrument is that it is subject to the federal debt ceiling; as such, balances were soon reduced due to debt ceiling concerns. The SFA decreased to $200 billion by early February 2009 and remained at that level into the third quarter of 2009. In mid-September 2009, again driven by concerns related to the debt ceiling, the Treasury announced a further decrease in the SFP balance to $15 billion by the fourth quarter of 2009. The SFA briefly had a zero balance, and after the federal debt ceiling was increased in February 2010, the SFA was raised to $200 billion again by mid- April 2010 and remained at the level through the end of our sample period. The second panel of Figure 2 shows the combined impact of both programs over the period of observation; at their peak in October 2008, the combined magnitude of the two programs exceeded $750 billion.

2.3 Open Market Operations (OMO)

2.3.1 Permanent Operations

The Federal Reserve's SOMA portfolio traditionally consists primarily of Treasury securities. These holdings tend to grow over time so as to roughly match growth in currency demand. A permanent OMO to purchase Treasury securities

[10] Amounts held in the TGA and SFA can be found on the Daily Treasury Statement and on the Federal Reserve's weekly H4.1 release.

decreases the amount of Treasury collateral available for private parties to utilize in Treasury-securitized repo finance. Figure 3 shows that prior to the crisis in the fall of 2007, the Federal Reserve conducted a number of OMOs, of which the permanent OMOs were all confined to be purchases under $5 billion in size.

‹Figure 3 here›

As the crisis intensified, the Federal Reserve's balance sheet began to take on riskier assets as emergency liquidity facilities were introduced. These assets collateralized the funds provided to financial institutions via the liquidity facilities. In an effort to maintain the size of its balance sheet, the Federal Reserve began allowing its Treasury holdings to mature and also to sell its holdings. These sales increased the supply of Treasury collateral available to the public. As the first two panels of Figure 3 reveal, the Federal Reserve sold a greater amount of its Treasury bill holdings than coupon holdings. In the fall of 2008, the Federal Reserve no longer sought to maintain the size of its balance sheet and Treasury redemptions/sales were discontinued.

In March 2009, the FOMC announced that it would purchase $300 billion in longer-dated Treasury securities as part of its Large Scale Asset Purchase program.[11] The purpose of these purchases was to "help improve conditions in private credit markets", not the repo market.[12] These purchases commenced later that month and were completed by the end of October 2009. By the end of the purchases, total SOMA Treasury holdings were similar to their pre-crisis levels, albeit reweighted toward coupon holdings (middle panel of Figure 4).

[11] See http://www.federalreserve.gov/newsevents/press/monetary/20090318a.htm for the announcement. The Federal Reserve also purchased $1.25 trillion in Agency MBS and around $172 billion in Agency debt.
[12] http://www.newyorkfed.org/markets/funding_archive/lsap.html. Gagnon et. al (2010) examine the impact of LSAPs on domestic interest rates, and Neely (2010) examines their impact on foreign interest rates and exchange rates.

Note that within our observation period, there are only seven operations involving bill sales so it may be difficult to identify the full relationship between repo rates and changes in bills availability due to SOMA sales. By contrast, changes in SOMA's Treasury coupon holdings exhibit fuller variation dynamics in that holdings were both purchased and sold over our sample period.

2.3.2 Temporary Operations

The bottom panel of Figure 3 details the magnitude and frequency of temporary operations impacting Treasury collateral.[13] Temporary OMOs are conducted by the Open Market Trading Desk of the FRBNY to adjust the aggregate supply of bank reserves to foster conditions in the market consistent with the FOMC's policy directive for the federal funds rate. These operations consist of short-term repurchase and reverse repurchase agreements which impact daily trading in the federal funds market. An operation that drains reserves will add OMO-eligible collateral (Treasury, Agency debt, and Agency MBS) to the market, and vice versa. Upon maturity of the operation, the movement of collateral is reversed. The term of these operations ranges from overnight to 28 days. For more on temporary OMOs, see Carpenter and Demiralp (2006), Hilton and Hrung (2010), and Friedman and Kuttner (2010).

As the bottom panel of Figure 3 highlights, the active daily management of bank reserves via temporary OMOs by the trading desk is concentrated prior to and through the initial phases of the crisis. By the end of 2008, when the FOMC adopted a target range of 0-25 bps for the fed funds rate instead of an explicit target rate, the trading desk stopped conducting temporary OMOs for the remainder of the sample period, aside from

[13] Excluded are operations involving Agency debt and MBS.

some small-scale operations at the end of 2009. We do not have information on the breakdown of temporary OMOs into Treasury bills and coupon securities categories.

2.4 Treasury Issuance

As in previous recessions, federal tax revenue declines contributed to counter cyclical fiscal policy. US federal tax receipts began to fall beginning in late 2007. This required increased debt issuance to cover budgetary short-falls. In addition federal outlays increased, widening the budget gap and necessitating a further increase in debt issuance. Beyond both of these traditional "automatic stabilizer" channels, increased outlays due to programs directly related to the financial crisis, such as the Troubled Asset Relief Program (TARP) and Treasury's Agency mortgage-backed security (MBS) purchase program, enhanced federal funding requirements. TARP expended around $380 billion (it has been repaid around $175 billion as of March 31, 2010), and Treasury's Agency MBS purchase program purchased a total of $221 billion from September 2008 through December 2009.[14] Figure 4's three panels provide a look at cumulative budget gaps, SOMA Treasury Holdings and the quantity of marketable outstanding Treasury obligations (net of SFP) from January 2007 and through April 2010.

‹Figure 4 here›

The U.S. Treasury responded to this funding need by increasing the number of securities, as well as increasing the frequency of debt auctions. Table 1 shows that for 2009 compared to 2006, Treasury added a 52-week bill as well as a 7-year note, both of which were auctioned monthly. And the frequency of auctions was increased from

[14] Information on TARP and Treasury's Agency MBS purchase program can be found at http://www.financialstability.gov.

quarterly to monthly for the 3-year note, 8 times/year to monthly for the 10-year note, and twice/year to monthly for the 30-year bond.

‹Table 1 here›

Further, as highlighted in Figure 4, the level of outstanding marketable Treasury debt (excluding SFP) increased substantially over the course of 2008-2009. Note in the top panel of the figure that there are seasonal fluctuations in the level of outstanding Treasury debt, so that the level does not monotonically increase. For example, April tax season typically results in net pay-downs of Treasury debt, and a decrease in the level of outstanding Treasury securities.

3.0 Data and Methods

We analyze daily data from January 2007 through May 2010. This sample period encompasses a period pre-crisis as well as the several direct and indirect policies described in the last section: the TSLF and LSAP program, the rapid expansion of outstanding publicly held Treasuries from below five trillion to close to eight trillion dollars, and the initiation of the SFP, which is currently ongoing at a level of roughly 200 billion dollars. All these data are publicly available.

Our dependent variable is the change in the spread between the overnight Treasury GC repo rate and the fed funds rate target set by the FOMC ("the spread", or the "FF-Repo spread") which was previously documented in Figure 1. Examining this spread rather than the change in GC repo rates accounts for the role the fed funds rate typically serves--as a ceiling for repo rates. This is because fed funds transactions are uncollateralized, and collateralized borrowing is typically less expensive than uncollateralized borrowing. So as the fed funds target changes, repo rates also change irrespective of the level of relevant collateral. For the sub-period where the fed funds

target was the range of 0-25 bps (since mid-December 2008), we treat the target rate as-if set as 25 bps.[15]

Data for GC rates come from Bloomberg. As noted in Fleming, Hrung, and Keane (2010a, b), overnight rates are impacted by the amount of collateral available on a given day, so that expectations and other potential sources of endogeneity are less of a concern.

The change in the rate spread is related to changes in Treasury collateral, broken into TSLF, SFP, SOMA bills, SOMA coupons (notes and bonds), temporary OMOS, Treasury bills, and Treasury coupon securities (notes and bonds) categories.[16] While all Treasury securities are eligible to serve as collateral in a Treasury GC repo, the different types of securities could have different impacts on GC rates. For example, as the TSLF was targeted at and introduced during a time of great stress in funding markets, rate spreads were much wider than typical. As a result, there is more scope for a large TSLF impact than if rate spreads were at typical levels (less than 10 bps). However, the SFP was initiated in the fall of 2008, when funding markets were facing unprecedented stress following the bankruptcy of Lehman Brothers and, as noted above, the SFP at its peak actually provided more than twice the amount of Treasury collateral as the TSLF at its peak. So the SFP may impact FF-Repo spreads in ways that are similar to the TSLF even though the SFP was not directed at stresses in funding markets.

Also worth considering, bills (including SFP bills) may have more of an impact than notes and bonds. This is because some investors, such as money market mutual funds, need the hold down the weighted-average-maturity of their portfolios. Therefore,

[15] Our results are not significantly affected if 12.5 bps is used as the target rate for this sub-period.
[16] The TSLF auctions alternated in terms of the types of collateral which could be exchanged for Treasury securities. Previous studies (Fleming, Hrung, and Keane (2010a,b)) have examined the two types, or "schedules" separately. However, we are concerned only with the amount of Treasury collateral supplied, not the type of collateral withdrawn from the market, so we do not distinguish between Treasury collateral provided by the different auctions.

they typically invest in short-term instruments such as repo or Treasury bills, but not Treasury notes and bonds. As a result, an increase in bills can divert funds away from repo markets and drive up repo rates in addition to the impact due to increased collateral supply, as primary dealers (the holders of securities) need to pay more to borrow funds. On the other hand, a corresponding increase in notes and bonds will not result in a direct diversion of funds.

We also include calendar dummy variables for quarter ends/starts and year ends/starts, as demand for collateral is impacted by dealer reporting requirements on these dates. Other variables that we examine include measures of stress such as the Chicago Board Options Exchange Volatility Index (VIX), which measures the implied volatility of the S&P 500 index options, and various interest rate spreads.

Table 2 presents summary statistics for the variables studied. Note the wide disparities between the mean values and the minimum and maximum values for the variable levels as well as changes of the variables in the table. The large range of values reflects the extreme distortions in financial markets experienced over our sample period.

‹Table 2 here›

We estimate the following regression and the results are presented in Table 3-4:

$$\Delta\text{FF target-GC repo rate spread}_t=\alpha+\beta*\Delta\text{Treasury Collateral}_t+\gamma*\Delta X_t+\varepsilon_t$$

where we first combine all sources of Treasury collateral before breaking out the sources of Treasury collateral. We expect the coefficients on Treasury collateral will be negative so that an increase in Treasury collateral will lead to an increase in the GC rate and therefore, a *decrease* in the spread. However, as mentioned above, the magnitudes of the coefficients could differ.

The variable X_t represents a vector that includes calendar effects such as quarter-end/start, year-end/start, as well as other variables such as the change in the VIX index, the change in the Merrill Lynch Global Financial Bond index option-adjusted spread (OAS), the change in the 1 Month spread between AA financial and non-financial commercial paper (CP), and the change in the 1 Month LIBOR-OIS (LOIS) spread.[17]

We examine the VIX and the various interest rate spreads as these measures reached unprecedented levels as market conditions deteriorated and may be associated with funding market stress. We focus on the 1 month tenor for the CP spread and the LOIS spread because term funding became very scarce as counter-party and liquidity concerns escalated. These concerns may be reflected in overnight collateralized borrowing, such as the GC rate. We expect that changes in the VIX and the various interest rate spreads will be positively related to the change in the spread.

4.0 Results

Table 3 shows results for the sample period from January 2007 through May 2010. The first column shows that when all sources of Treasury collateral are combined, the relationship with the spread is, as expected, negative and statistically significant.

‹Table 3 here›

[17] The year-end and year-start dummy variables are additive to the quarter-end and quarter-start dummy variables, respectively. LIBOR stands for the London Interbank Offered Rate which is a daily reference rate for inter-bank unsecured borrowing. OIS stands for Overnight Indexed Swap which is referenced to the daily federal funds rate.

Taylor and Williams (2009) employ a LOIS spread as a dependent variable, however they express some concern about LIBOR validity due to the self-reported nature of rates by surveyed banks. McAndrews, Sarkar, and Wang (2008), however do document that LIBOR reports are in line with expected market reactions. Similarly, Gorton and Metrick (2009) devote a good deal of work to documenting LOIS and several other asset-class spreads and include documentation of exploding haircuts in their descriptive analysis of several dimensions of the 2007-2008 period. As compared to our current work, all three papers focus primarily on the early 2007-2008 time period, and in the cases of the first two papers, the Term Auction Facility, which was introduced by the Federal Reserve in late 2007.

The second column breaks out the sources of Treasury collateral into seven categories: TSLF, SFP, SOMA bills, SOMA notes and bonds, temporary OMOs, Treasury bills, and Treasury notes and bonds.[18] We find that that five of the Treasury collateral coefficients have the expected negative sign. Three of the negative coefficients are statistically significant, and another has a t-stat above 1.5 in magnitude. The largest coefficient estimate in terms of magnitude is for the TSLF. The estimate suggests that every $1 billion increase in Treasury collateral due to TSLF is correlated with a narrowing of the FF-Repo spread by roughly 0.83 basis points. This is not entirely surprising given that the program was introduced during a time of great stress in funding markets with wide spreads between the Treasury GC repo rate and the fed funds target.

For the negative coefficients, the SFP coefficient is the next largest coefficient, followed by the SOMA notes and bonds coefficient, then the Treasury bills and the Treasury notes and bonds coefficients being the smallest in magnitude. The TSLF coefficient is statistically different from the Treasury bills and notes and bonds coefficients at the 90% confidence level. We find no evidence of a difference in impact between Treasury bills and Treasury notes and bonds on the spread. The positive sign and insignificance for the SOMA bills coefficient is not entirely surprising. As noted above, this variable takes on non-zero values on only seven dates, and is never negative. The temporary OMO coefficient estimate is positive, but small in magnitude and insignificant.

Given the purpose of the program, it is likely that most, if not all, of the Treasury collateral supplied by the TSLF was employed in funding markets, while the smaller

[18] We can reject the null hypothesis of equal coefficients between columns one and two at the 95% confidence level.

magnitude of the other collateral coefficients suggests that a smaller fraction of the collateral supplied by the SFP and other Treasury issuance was employed in funding markets as collateral. Nevertheless, the results show that responses to the crisis which were not directly aimed at funding markets impacted short-term money markets.

For the other coefficients in the second column, we see that the OAS and LOIS spread coefficients are positive. This is consistent with flight-to-quality responses in times of stress; as stresses increase, market participants prefer to transact with high quality collateral such as Treasuries, which drives down the Treasury GC repo rate and increases the spread. The coefficient for changes in the VIX is small, negative, and not statistically significant, which may not be surprising given that this measure is related to stresses in equity markets.

The third column in Table 3 includes the lagged spread as an independent variable. A few changes in the coefficient estimates are notable. First, the magnitudes of all of the Treasury collateral coefficients are now smaller, except for the SOMA bills coefficient. And the coefficients have smaller t-statistics in absolute value, except for the SOMA bills coefficient, but the TSLF and Treasury notes and bonds coefficients are still significant at the 90% confidence level or above. The lagged spread coefficient suggests some degree of reversion so that--for example, a widening of the spread on any given day is followed by somewhat of a reduction on the following day, all else equal.

‹Table 4 here›

Table 4 presents results for other sample periods. The first column presents results from January 2007 through mid-December 2008. The sample excludes observations after the FOMC adopted a target range of 0-25 bps for the fed funds rate instead of an explicit target rate. This sample thus avoids the need to pick a target rate

against which to benchmark the GC rate. Also, given the low level of interest rates, it is highly unlikely that the FF-Repo spread will be greater than 25 bps, so that any increases in repo rates may be biased downward when the post-2008 sample is included.[19] For many reasons then, sensitivity of the dependent variable is quite different after December 16th 2008, however, excluding observations after December 2008 omits useful variation in Treasury collateral over the course of 2009 through May 2010. For example, this sample period misses the decline in TSLF outstanding over the first half of 2009, as well as the decline and subsequent build-up of the SFP after September 2009 (Figure 2). The results for the Treasury collateral coefficients show that only the TSLF coefficient is negative and statistically significant over this sample period. In fact, the Treasury notes and bonds coefficient is even positive.

The second column begins the sample period in January 2008. Excluding observations from 2007 reduces the number of observations where programs like the TSLF and SFP were not in existence. Values for these variables were zero over the excluded period and therefore, there is no identifying variation. The results in the second column show that most of the regression results are not dramatically different from the results from the third column of Table 3.

5.0 Discussion and Conclusion

In this study, we investigate the impact of Treasury collateral on overnight Treasury GC repo rates. In general we find the expected relationship, increases in Treasury collateral increase repo rates and narrow the spread between repo rates and the fed funds target. These results are related to studies investigating the impact of Federal Reserve emergency liquidity facilities which were introduced in response to the financial

[19] Fleming and Garbade (2004) document a period of negative repo rates in the fall of 2003.

crisis that began in the fall of 2007. We find that the TSLF, which was introduced specifically to address stresses in short-term funding markets was effective in alleviating the dislocations due to the increased demand for Treasury collateral as the crisis progressed. We also find that programs like the SFP and general Treasury issuance, which were aimed at the financial crisis but not short-term funding markets, in fact did impact repo rates. However, we find that OMOs by the Federal Reserve (both temporary and permanent) which also impact the level of Treasury collateral, did not alleviate funding market stresses during our sample period.

These results also highlight the need to carefully consider the impact of policies beyond their intended target. For example, the SFP was primarily intended to the help drain the level of bank reserves. Fortunately, this program also increased the supply of Treasury collateral available to the repo market; however, future policies may not always work to reinforce each other.

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Table 1: Treasury Issuance-- 2006 versus 2009

Marketable U.S. Treasury Securities

	2006		2009	
Type	**Maturities**	**Schedule**	**Maturities**	**Schedule**
Bills:				
	Cash-Management Bills	As Needed	Cash-Management Bills	As Needed
	4-week	Weekly	4-week	Weekly
	13-week	Weekly	13-week	Weekly
	26-week	Weekly	26-week	Weekly
			52-week	Monthly
Notes:				
	2-years	Monthly	2-years	Monthly
	3-years	Quarterly	3-years	Monthly
	5-years	Monthly	5-years	Monthly
	10-years	8 times a year	7-years	Monthly
			10-years	Monthly
Bonds				
	30-years	2 times a year	30-years	Monthly
Inflation-Indexed:				
	5-year Notes	2 times a year	5-year Notes	2 times a year
	10-year Notes	4 times a year	10-year Notes	4 times a year
	20-year Bonds	2 times a year	20-year Bonds	2 times a year

Table 2: Summary Statistics

Summary Statistics

	Mean	Std. Dev.	Min	Max
(FF target-GC rate) (bps)	25.3	37.4	-30.0	300.0
OAS (bps)	266.7	169.6	59.0	686.0
VIX (%)	26.5	12.6	9.9	80.9
1 Month AA Financial-Non-Financial CP (bps)	16.2	26.7	-14.0	236.0
1 Month LIBOR-OIS (bps)	35.9	49.2	3.7	337.8
Δ(FF target-GC rate) (bps)	-0.029	21.91	-220.0	195.0
ΔTSLF ($b)	0.000	4.75	-37.5	75.0
ΔTsy Bills ($b)	0.834	10.54	-55.0	70.0
ΔTsy Notes and Bonds ($b)	3.171	14.55	-54.8	99.0
ΔSFP ($b)	0.234	8.03	-75.0	60.0
ΔSOMA Bills ($b)	0.104	1.18	0.0	17.9
ΔSOMA Notes and Bonds ($b)	-0.298	1.54	-8.5	5.0
ΔTemporary OMOs ($b)	0.024	4.38	-24.0	25.0
ΔOAS (bps)	0.218	4.58	-37.0	41.0
ΔVIX (%-age points)	0.024	2.56	-17.4	16.5
Δ1 Month AA Financial-Non-Financial CP (bps)	0.008	14.69	-106.0	146.0
Δ1 Month LIBOR-OIS (bps)	0.007	6.20	-44.2	50.4

Sample: 1/2/07-5/28/10
obs. = 853

Table 3: Main Regression Results - Full Observation Period Sample

First-Difference Regression

Dependent Variable: Δ(FF target-GC rate) (bps)

	Coefficient	t-stat	Coefficient	t-stat	Coefficient	t-stat
Constant	0.69	1.21	0.38	0.60	4.02	4.82
ΔAll Tsy Collateral	-0.18	-3.28				
ΔTSLF			-0.83	-1.99	-0.71	-1.85
ΔTsy Bills			-0.12	-1.59	-0.06	-0.79
ΔTsy Notes and Bonds			-0.12	-2.34	-0.10	-2.07
ΔSFP			-0.27	-2.57	-0.15	-1.51
ΔSOMA Notes and Bonds			-0.18	-0.63	0.09	0.45
ΔSOMA Bills			0.54	0.88	1.45	2.10
ΔTemporary OMOs			0.03	0.17	0.08	0.45
ΔOAS	0.31	1.18	0.41	1.51	0.52	1.91
ΔVIX	0.13	0.42	0.10	0.31	0.03	0.09
Δ1 Month AA Fin-Non-Fin CP	-0.02	-0.33	-0.01	-0.23	-0.01	-0.23
Δ1 Month LIBOR-OIS	0.41	1.90	0.41	1.88	0.40	1.76
Quarter-End	35.64	3.86	34.26	3.84	33.38	3.65
Quarter-Start	-37.22	-3.59	-37.34	-3.59	-33.47	-3.67
Year-End	34.87	0.72	33.68	0.68	35.75	0.71
Year-Start	-30.01	-0.66	-31.22	-0.69	-24.78	-0.65
$(\text{FF Target-GC})_{t-1}$					-0.15	-3.48

Sample: 1/2/07-5/28/10

*t-stat calculated from Newey-West standard errors

Table 4: Regression Results for Two Sub-Sample Periods

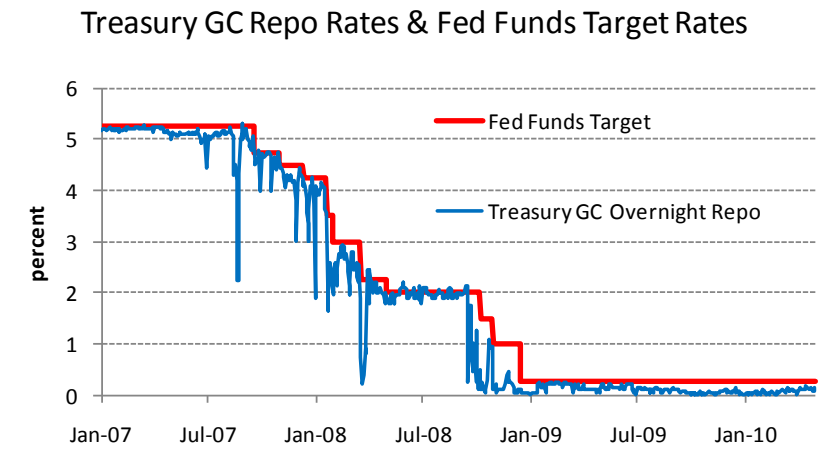
First-Difference Regression

Dependent Variable: Δ(FF target-GC rate) (bps)

	Coefficient	t-stat	Coefficient	t-stat
Constant	4.24	4.47	3.77	4.09
ΔTSLF	-0.88	-2.00	-0.72	-1.93
ΔTsy Bills	-0.06	-0.50	-0.05	-0.66
ΔTsy Notes and Bonds	0.07	0.41	-0.04	-1.33
ΔSFP	-0.12	-0.80	-0.17	-1.75
ΔSOMA Notes and Bonds	1.22	1.21	0.12	0.56
ΔSOMA Bills	1.23	1.90	1.30	2.04
ΔTemporary OMOs	0.11	0.67	-0.03	-0.12
ΔOAS	0.88	1.93	0.49	1.74
ΔVIX	-0.15	-0.34	-0.01	-0.04
Δ1 Month AA Fin-Non-Fin CP	-0.02	-0.41	0.01	0.28
Δ1 Month LIBOR-OIS	0.35	1.48	0.37	1.61
Quarter-End	46.77	4.60	24.70	2.43
Quarter-Start	-50.47	-5.02	-30.96	-2.54
Year-End	139.83	14.48	-20.35	-2.09
Year-Start	-58.69	-1.03	-39.01	-0.77
$(FF\ Target\text{-}GC)_{t-1}$	-0.15	-3.32	-0.13	-3.43
	Sample: 1/2/07-12/16/08		**Sample: 1/2/08-5/28/10**	

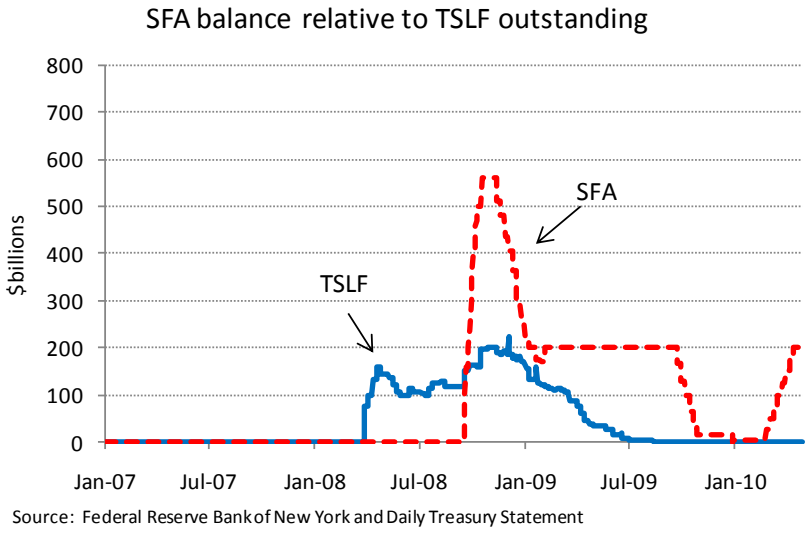
*t-stat calculated from Newey-West standard errors

Figure 1: The Repo-Fed Funds Spread: 2007-2010

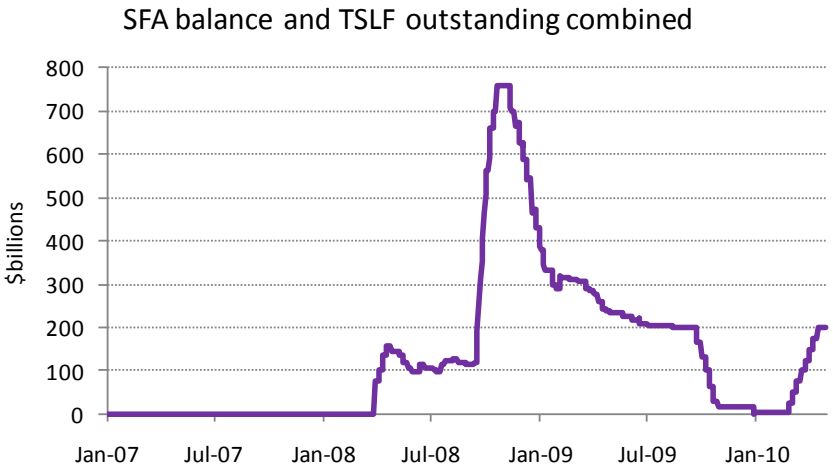


Source: Federal Reserve Bank of New York and Bloomberg

Figure 2: The Term Securities Lending Facility & Supplemental Financing Account Programs in Perspective: 2007 -2010

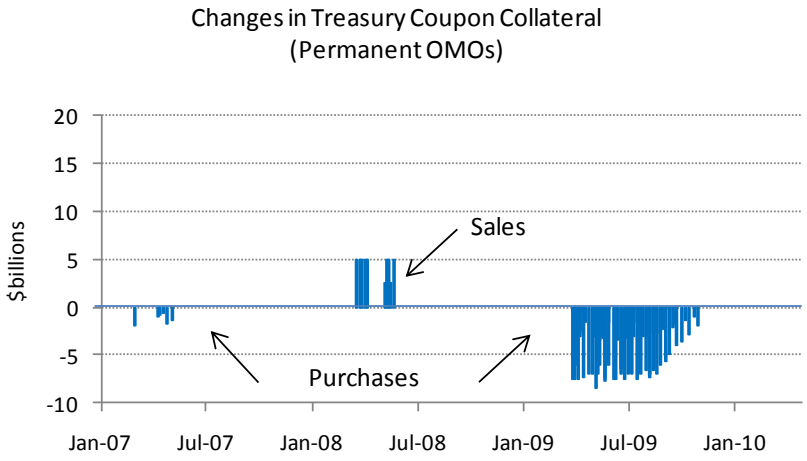


Source: Federal Reserve Bank of New York and Daily Treasury Statement

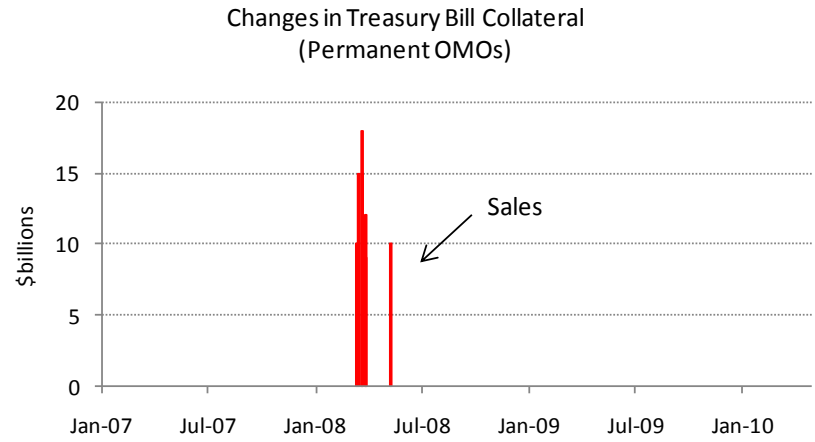


Source: Federal Reserve Bank of New York and Daily Treasury Statement

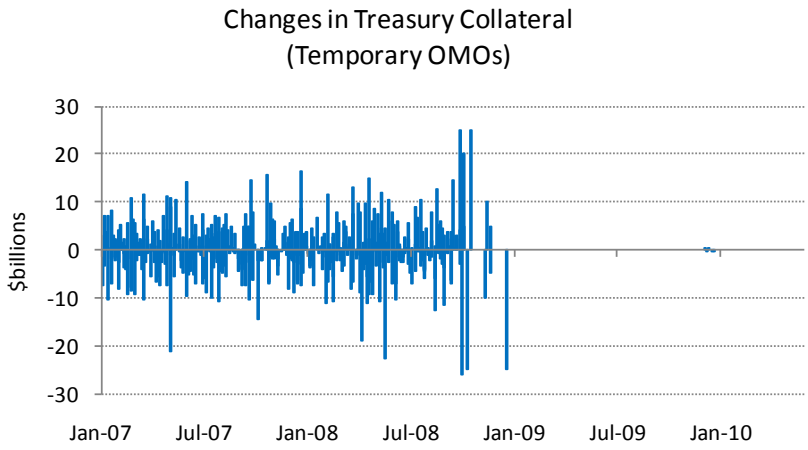
Figure 3: Permanent and Temporary OMO Impacts on Treasury Collateral: 2007-2010



Source: Federal Reserve Bank of New York



Source: Federal Reserve Bank of New York



Source: Federal Reserve Bank of New York

Figure 4: Federal Receipts and Outlays, SOMA Holdings, & Marketable Treasury Collateral: 2007 – 2010