Dealer Financial Conditions and the Term Securities Lending Facility: Was Bagehot Right After All?*

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Abstract

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Keywords: G01, G28, E58, D44.
JEL Codes: lender of last resort, central banking, crises, illiquidity, insolvency, stigma.

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1. Introduction

Central banks typically offer secured loans – cash for loans and securities, or safer securities such as Treasuries for riskier ones – to *sound* financial institutions that find themselves temporarily illiquid.[1] Less frequently, but periodically, the financial system as a whole finds itself short of liquidity: securities that in normal times can easily be exchanged

[1] In 1985, for example, when a bug in the Bank of New York's clearing system for Treasury bills left it short of cash, the Federal Reserve stepped in immediately. The Bundesbank (in 1974) and the Bank of England (in 1995) adopted similar measures when failures of major banks threatened to dry up liquidity for others.

for cash or Treasuries become illiquid, putting stress on the entire system. In the last three decades, Japan, Norway, Sweden, and many developing economies, and in the past five years, the United States, the United Kingdom, and the Europe, have experienced widespread financial difficulties that have resulted in unprecedented scale of central bank actions in the form of offering loans secured by a wide range of collateral to almost the entire domestic financial sector (and often also to foreign institutions).[2]

The literature on such a lender-of-last-resort role played by central banks during aggregate liquidity shortages (sometimes referred to as a "panic") suggests a trade-off between the ex-post benefits of intervention and its ex-ante costs. In his celebrated work, *Lombard Street,* Walter Bagehot (1873) codified the nineteenth century's collective wisdom on central bank provision of liquidity. Bagehot suggested that in times of panic, the central bank should freely advance reserves to any private bank able to offer "what in ordinary times is reckoned a good security" as collateral, but that these advances should be charged a penalty rate to discourage applications from banks that do not need it.

While Bagehot was concerned primarily with the practical goal of conserving limited reserves, recent literature (see, especially, Diamond and Rajan, 2005) has stressed the incentive reasons for adopting such a policy: it is not easy to tell the difference between an illiquid and an insolvent institution. In those circumstances, a central bank can easily find itself lending to an insolvent institution, perhaps delaying its timely reorganization and recapitalization. While lending at penalty rates partially addresses this moral hazard concern, some (for instance, Acharya and Backus, 2009) have argued that participation in central bank's liquidity provision should be made *conditional* on adequate solvency estimates (such as maximum leverage ratio or minimum capital adequacy) of financial institutions.[3]

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[2] See Acharya and Backus (2009) for a summary of the interventions undertaken by the Federal Reserve and the European Central Bank during 2007-08 and "Timelines of Policy Responses to the Global Financial Crisis," by the New York Fed, available at http://www.newyorkfed.org/research/global_economy/policyresponses.html

[3] Acharya and Backus (2009) draw an analogy with private lines of credit, and recommend that central banks' liquidity facilities, like private lines of credit, should include a Material Adverse Change (MAC) clause that allows the lender to refuse credit if the borrower's credit quality has deteriorated materially. MAC clauses are indeed invoked by banks in practice (see Sufi, 2009) for firms that violate covenants.

Some evidence has now been provided to understand ways in which central bank provision of liquidity can provide benefits by relaxing funding constraints of some institutions and thereby improving prices of illiquid assets.[4] However, the ex-ante costs of such liquidity provision are less well-understood. Further, the assessment of central bank emergency facilities appears to have been concerned more with the risk of the collateral being lent against, rather than directly with the set of firms participating in the facilities in terms of their financial health. In this paper, we attempt to fill this gap in the literature by studying the composition of dealers (eligible financial firms) that borrowed from the Federal Reserve's Term Securities Lending Facility (TSLF) during 2008-09.

The TSLF was operational by the end of March 2008 (following the failure of Bear Stearns in mid-March even though it was announced prior to the failure) in order to provide liquidity to "primary dealers" in the financial sector, featuring not just the largest commercial banks but also investment banks and including non-US financial subsidiaries of commercial banks.[5] The liquidity was provided in the form of Treasury general collateral (GC) in exchange for other marketable securities of varying collateral quality. There were two types of TSLF auctions: In "Schedule 1" auctions, the permissible collateral being exchanged for GC was restricted to be of the highest quality (as eligible for the Fed's open market operations); in "Schedule 2" auctions, the permissible collateral was expanded to include lower quality securities such as investment grade corporate securities, municipal securities, private-label mortgage-backed securities and asset-backed securities.

The auctions were single-priced, so that accepted dealer bids were awarded at the same rate, which was the lowest rate that filled the auction (also called the stop-out rate). The auctions featured a minimum bid size and minimum bid rate, and also maximum bid and award amount constraints. We argue that the bidding behavior of dealers in the TSLF

Similarly, they recommend that central banks should verify that they are indeed lending to sound institutions.

[4] See, among others, Adrian, Burke, McAndrews (2009), Coffey et al (2009a, 2009b), Fleming, Hrung and Keane (2009, 2010), McAndrews, Sarkar and Wang (2009), Ashcraft, Garleanu and Pedersen (2010), and Adrian, Burke and Kimbrough (2011).

[5] Primary dealers must satisfy standards regarding business conduct, financial conditions and supervision, amongst others (see http://www.ny.frb.org/markets/pridealers_policies.html). Exact eligibility criteria for participation in the TSLF are described in http://newyorkfed.org/markets/tslf_faq.html.

auctions should reflect their demand for liquidity. Intuitively, the bid rate that a dealer submitted represents the dealer's opportunity cost to borrow a basket of Treasury general collateral against other pledged collateral. The bid rate could therefore be considered as roughly equivalent to the spread between the market financing rate for the pledged collateral and the Treasury general collateral financing rate over the term of the loan.[6] It also follows then that dealers should have an incentive to participate in the program when the spread was greater than the program's minimum fee, but that dealers should have relied solely on the private market when the spread was less than the minimum fee.

While other studies have provided evidence that the TSLF was effective at mitigating the strains in dollar funding markets (Fleming, Hrung, and Keane, 2009, 2010), our focus here is on the condition of the dealers that participated in the TSLF and what this reveals about the causes of the disruptions in private funding markets.

One possibility is that the shortage of aggregate liquidity is due to solvency concerns in the funding markets, that is, the primary reason for liquidity shortage is aggregate shortage of capital in the financial sector; funding markets perceive the under-capitalization of individual financial firms raising their private cost of liquidity in markets; but, that debt overhang problems (Myers, 1977 and/or Myers and Majluf, 1984) imply that bank owners do not raise sufficient capital on their own. In this case, the private cost of liquidity for financial firms – and in turn their participation in central bank facilities – should depend on their balance-sheet or solvency conditions.

Another possibility is that the shortage of aggregate liquidity is due to a pure panic, so that markets impose funding constraints on financial firms, relatively indiscriminately and without regard to their balance-sheet or solvency conditions. In this case, the private cost of liquidity for financial firms and their participation in central bank facilities should

[6] Cassola, Hortacsu and Justl (2008) provide a simple theoretical formalization of this argument while presenting their empirical analysis of European banks' demand for liquidity from the European Central Bank lender-of-last-resort operations. That financial firms' private cost of liquidity may exceed the social cost of provision of liquidity arises in a number of models, directly or indirectly rooted in agency problems between financial intermediaries and their own financiers. A long but incomplete list of such models is Kiyotaki and Moore (1997), Holmstrom and Tirole (1998), Diamond and Rajan (2000, 2005), and more recently, He and Krishnamurthy (2008, 2009), Brunnermeier and Pedersen (2009), and Acharya and Viswanathan (2011).

depend on aggregate conditions, and importantly, should be relatively insensitive to their individual balance-sheet or solvency conditions.

We test these alternative hypotheses of bidding behavior of dealers in the TSLF auctions using data on dealers' bid amounts and rates. Our main finding is that the observed *demand for liquidity* of a dealer - as measured by the likelihood of a dealer's participation in an auction, the bidding amount, and the bidding rate – was greater for dealers with weaker financial conditions.[7] Figure 1 summarizes our results well, even if informally. Figures 1a-1b plot for the four *least-capitalized* dealers their cumulative successful participation in the TSLF auctions relative to the average cumulative participation for *better-capitalized* dealers for Schedule 1 (Figure 1a) and Schedule 2 (Figure 1b).[8] For each of the four dealers, Day 0 is the day within the TSLF period on which their cumulative equity returns from beginning of January 2007 first dropped below -90%.[9] The *relative* cumulative successful participation is the cumulative number of auctions in which the failed bank is awarded funds beginning 100 days before Day 0 and continuing through 100 days after Day 0, minus the average cumulative successful participation for safe banks over the same 201-day period. Figures 1c-1d show the plots but for the ratio of amount awarded to the maximum permissible, for the four dealers relative to better-capitalized dealers.

Three striking patterns emerge. One, the four dealers that became highly under-capitalized in market value terms, participated more aggressively than their better-capitalized counterparts in both the TSLF auctions prior to Day 0. Second, this is particularly true for Schedule 2 auctions, where the four dealers participate more

[7] We find that the effect of dealer's financial conditions on bidding amount and bidding rates is present only when *not* conditioned on successful participation in the auctions. In other words, dealer financial conditions appear to have affected primarily the likelihood of participation of dealers in the TSLF auctions.

[8] For the four *least capitalized* dealers, Citigroup, Lehman, Merrill Lynch, and RBS, the cumulative equity return dropped below -90% within the TSLF period. The *better-capitalized* dealers never had their cumulative equity returns drop below -90% within this period, and are BNP Paribas, Dresdner, Cantor Fitzgerald, Credit Suisse, Daiwa, Deutsche, Goldman Sachs, HSBC, JP Morgan, Mizuho, Morgan Stanley, and UBS. Bear Stearns and Countrywide Financial are excluded because their cumulative equity returns dropped below -90% before the TSLF period. Bank of America and Barclays are excluded because they eventually reached the least capitalized status but only following the acquisitions of Countrywide Financial/Merrill Lynch and Lehman, respectively.

[9] The event days (Day 0) for the four least capitalized dealers are: 09/09/2008 (Lehman), 10/16/2008 (RBS), and 11/20/2008 (Citigroup and Merrill Lynch),

aggressively not just prior to Day 0, but steadily even afterwards.[10] Third, the amounts awarded in Schedule 2 auctions are by and large almost always greater for these four dealers than the healthier dealers. All of these patterns represent dealer-level demand for central bank liquidity since all dealers face identical auction terms throughout the TSLF period. Overall, these findings are consistent with the solvency-concern view of the crisis of 2007-08 that the private cost of liquidity was greater for more under-capitalized dealers, and not consistent with a pure-panic view.

In our formal tests, we proxy for the financial conditions of a dealer at the time of an auction by two measures: one, the dealer's *leverage*, the ratio of quasi-market value of assets (market value of equity + book value of non-equity liabilities) to market value of equity, and second, the *cumulative equity price decline* from a pre-crisis date (2nd January, 2007), as in Figure 1. These measures are of particular interest since they reflect market assessment of firms' balance-sheet condition and diverged significantly from regulatory capital levels, which were required to be met by all primary dealers on an ongoing basis.

We find that the effect of these dealer financial conditions on demand for liquidity in the TSLF auctions is robust to controlling for auction fixed-effects or analogous time-series variation in market conditions for repo financing, which account for fluctuations in aggregate funding conditions. Further, when we exploit the differential collateral eligibility across the two schedules of auctions, we find that in Schedule 2 auctions, where permissible collateral was of lower quality (especially since the collapse of Lehman Brothers on 15th September, 2008), more leveraged dealers were more likely to participate in auctions.

We also document that the demand for liquidity by a dealer was *declining* in the average level of distress of dealers at time of the auction. In other words, the effect of an increase in the risk of a dealer in the set of bidders is to depress the participation by other dealers (and as our earlier results show, to enhance its own demand for liquidity). This suggests that dealers with worse financial conditions "crowded out" dealers with better financial conditions in the TSLF auctions. This "crowding-out" effect is reminiscent of the theoretical channel in the literature wherein banks with weaker financial conditions demand

[10] Lehman Brothers does not participate after its collapse on 15th September, 2008.

liquidity with greater immediacy, but if the pool of liquidity is limited (as in a central bank auction, for example), then the stronger liquidity demand of weaker banks precludes banks with relatively better financial conditions from having access to liquidity or makes it costlier for these latter banks to access liquidity.[11]

We conduct several robustness checks. One, we confirm that the effect of dealer distress on participation is robust to a possible "stigma" effect that low-leveraged dealers avoid central bank auctions for the fear that participation might be considered by markets as a sign of weakness.[12] While prior participation in TSLF auctions explains future participation, the effects of dealer financial conditions on participation remain unaffected. Indeed, our results suggest that weak dealer conditions appear to mitigate the effect of stigma and induce highly leveraged borrowers to participate in auctions even if they have not done so in the recent past.

Second, we check if recently employed measures of downside market risk of financial firms' assets and their under-capitalization also explain participation in the TSLF. We find some support that these measures do explain the cross-sectional participation by dealers but their effect is hard to disentangle from our main measures, such as leverage.

Third, we examine participation in the Primary Dealer Credit Facility (PDCF), designed over the same period as the TSLF auctions to allow dealers to borrow funds (reserves, as against Treasury collateral as in the TSLF) from the Federal Reserve on an as-needed daily basis (rather than during scheduled auctions, as with the TSLF) against designated collateral. We find that participation in this "dealer discount window" is also explained by the same measures of dealer financial conditions, reaffirming our results for the TSLF auctions.

Finally, over a limited period where we have dealer-level data on private funding costs (such as LIBOR for the dealer or haircut faced by the dealer in borrowing against securitized assets), we confirm that the variables employed throughout our tests to capture

[11] This "crowding-out" effect in the literature is formalized as an interest-rate contagion in Diamond and Rajan (2005), and is empirically consistent with the rate contagion from weak to safe banks documented for deposit markets in Acharya and Mora (2011) and for the UK inter-bank markets in Acharya and Merrouche (2010).
[12] Evidence of a stigma effect in Discount Window borrowing has been documented by Armantier et al (2011).

dealer financial conditions are indeed related in the cross-section to dealer-level private funding costs.

In closely related work, Krishnamurthy, Nagel and Orlov (2011) document that on average, dealer banks with a larger exposure to private debt (e.g., repo) funding of non-agency MBS and ABS resorted more to the Fed's emergency lending programs (TSLF, especially Schedule 2, and PDCF) for funding. Their finding is consistent with our starting hypothesis that bidding by a dealer at central bank auctions is linked to its private cost of liquidity. Our results highlight that the bidding behavior can also be explained by the financial conditions of dealers, in particular, by market-based measures of their leverage and equity returns. Our data and analysis are at auction-by-auction level whereas the data employed by Krishnamurthy et al. (2011) on collateral and funding of dealers is on a six-monthly basis (from Money Market Fund reports), preventing a fuller reconciliation of our results with theirs.

The robust composition effect in dealer participation in TSLF auctions – that more leveraged dealers exhibited greater demand for liquidity – is consistent with the important trade-offs that central banks face in their lender-of-last-resort role. In particular, our results are consistent with the incentive-based argument for Bagehot (1873)'s recommendation that central banks only lend against high quality collateral. While Bagehot's original concern was primarily with the growth of the central bank's balance-sheet, Bagehot's recommendation may be right after all even in the modern context when such growth is somewhat of a lesser concern,[13] and the primary concern, as in the recent financial crises, is about the delay in private recapitalization by financial firms.

Given our results, it may be worthwhile taking seriously the selection problem that central bank facilities end up with distressed dealers who have the greatest demand for liquidity, and its consequent effect in raising the price for liquidity for less distressed dealers. Central banks typically restrict participation in their facilities based on prior financial conditions (as indicated by CAMEL ratings of US banks, for example), the quality

[13] Note that the TSLF facility did not directly impact the size of the Federal Reserve balance-sheet as it simply swapped non-Treasury collateral for Treasuries rather than issuing additional reserves. In contrast, the PDCF borrowings from the Federal Reserve did directly increase the size of its balance-sheet as in such borrowings, the Federal Reserve lent reserves against eligible collateral.

of risk management and other criteria. Moreover, central banks monitor the financial health of participants in their facilities on an on-going basis through minimum capital requirements. Nevertheless, our results indicate considerable cross-sectional heterogeneity in the financial conditions of primary dealers participating in the TSLF, as assessed by private markets. Such heterogeneity provides important information about the use of central bank emergency lending facilities, and can be potentially deployed in eligibility criteria to ensure that a central bank's lender-of-last-resort role does not inadvertently ignore solvency concerns while addressing aggregate liquidity concerns.

The rest of the paper is organized as follows. Section 2 provides background information on the TSLF auctions. Section 3 describes our data and Section 4 presents the empirical results. Section 5 concludes. Details corresponding to the TSLF auctions, participating dealers and the PDCF borrowings are included in the Appendix.

2. The Term Securities Lending Facility

A. Background on the Repo Market

A repurchase agreement is a sale of securities coupled with an agreement to repurchase the same securities on a later date, typically at a higher price. A repo is thus broadly similar to a collateralized loan. As with a collateralized loan, the lender of funds has possession of the borrower's securities over the term of the loan and can sell them if the borrower defaults on its obligation. Most repos are arranged with a one-day term, but longer-term repos, such as one week or one month, are also conducted.

A *general collateral* repo is one in which the lender of funds is willing to accept any of a variety of securities as collateral. The class of acceptable collateral might be limited to Treasury securities, or it might include other types of securities, such as agency debt securities. The lender is concerned primarily with earning interest on its money and of having possession of assets that can be sold quickly with minimal transaction costs in the event of borrower default. Interest rates on overnight general collateral repos are usually

quite close to rates on overnight federal (fed) funds loans, reflecting the essential character of a general collateral repo as a device for borrowing and lending money.[14]

Repos play a crucial role in the efficient allocation of capital in financial markets. They are widely used by dealers to finance their market-making, risk-management, and speculative activities and they provide a safe and low-cost way for mutual funds, depository institutions, and others to lend funds. The importance of the repo market is suggested by its immense size: primary dealers reported financing $4.5 trillion in fixed income securities with repos as of March 4, 2008.

Repos are also frequently used in open market operations by the Fed (see, e.g., Edwards (1997)). Open market operations affect the supply of reserve balances in the banking system and thereby influence short-term interest rates. If the Fed wants to add reserves on a temporary basis, for example, it can purchase securities from dealers while agreeing to resell them on a later date. The Fed accepts three types of collateral in its repos, Treasury securities, agency debt securities, and agency mortgage-backed securities (MBS).

An important feature of repos is the "haircut" imposed by the lender of funds. The haircut is the difference between the market value of the pledged collateral and the amount of funds lent. A haircut of 5%, for example, implies that a dealer can borrow $95 for each $100 in pledged collateral. A haircut further protects the lender of funds against the risk of borrower default. The size of the haircut reflects the credit risk of the borrower and the riskiness of the pledged collateral.

B. Introduction of the TSLF

While dealers normally rely on private markets to finance their positions, such markets became severely impaired in early 2008. Lenders of funds became increasingly concerned about losing money on repurchase agreements because of worries about the value of the collateral as well as the credit risk of counterparties. Lenders responded by increasing

[14] A *special collateral* repo, in contrast, is one in which the lender of funds designates a particular security as the only acceptable collateral and is, consequently, a device for borrowing and lending *securities*. Special collateral repos are explained in Duffie (1996), Keane (1996), Jordan and Jordan (1997), and elsewhere.

haircuts – reducing the amount they were willing to lend for a given amount of collateral – and by halting lending against certain types of collateral altogether.[15]

Another response was for lenders to demand greater compensation for lending against riskier collateral. As shown in Figure 2, one month agency and agency MBS repo spreads to Treasury repo have historically been quite narrow, averaging 8 and 11 basis points between January 2005 and June 2007. That is, a dealer pledging agency debt securities as collateral has typically paid only slightly more interest to borrow funds than a dealer pledging Treasury securities. Such spreads widened out sharply as the financial crisis deepened, averaging 51 and 61 basis points, respectively, over January and February of 2008. Repo spreads for less liquid collateral are not widely available, but were undoubtedly wider.

Disruptions in the ability of dealers to finance themselves in the repo market compel them to seek alternative sources of funding, or to liquidate their positions. If a dealer cannot borrow elsewhere, and sales of securities are infeasible because of market illiquidity, a dealer might have to file for bankruptcy. It is widely reported that the inability of Bear Stearns to access the repo market was an important factor in its near collapse and purchase by J.P. Morgan Chase in March 2008 and in the subsequent collapse of Lehman Brothers six months later.[16]

It was in this environment of funding market stress that the TSLF was introduced. The facility allowed primary dealers to bid a fee to borrow a certain quantity of Treasury securities from the Fed for a term of 28 days, while agreeing to provide less liquid securities as collateral. That is, collateral which may be difficult to finance could be temporarily swapped for Treasury collateral, which is easier to finance. The Fed announced it would lend up to $200 billion in Treasury securities via this facility.

[15] See, for example, "Repo Market Funding," *Financial Times*, March 11, 2008, "Another Source of Quick Cash Dries Up – Firms Rethink Reliance on 'Repo' Financing as Conditions Tighten," *Wall Street Journal*, C1, March 17, 2008, and Gorton and Metrick (2009).

[16] See, for example, "The Bear Stearns Fallout: With Street Watching, 'Repo' Trading Is Light – Market That Turned on Bear Stearns Remains Cautious," *Wall Street Journal*, C6, March 18, 2008, and "TSLF Auction Could Be the Light at the End of the Repo Tunnel," *Financial Times*, March 27, 2008.

The TSLF increased the ability of dealers to obtain financing, especially dealers relying on the repo market for financing of less liquid collateral. The ability of dealers to obtain financing through the TSLF should have reduced the need for dealers to sell assets into illiquid markets to raise capital, potentially improving the liquidity of those markets. The ability to finance through the TSLF should also have reduced funding pressures on dealers, reducing the likelihood of a loss of confidence among lenders.

The TSLF grew quickly after its inception, with an initial auction size of $75 billion. Figure 3 shows that the program reached $150 billion within a month and peaked at the program's maximum announced size of $200 billion in late October to early November 2008. As funding markets improved, utilization declined and lending under the facility wound down to zero by mid August 2009. Authorization for lending under the TSLF officially expired on February 1, 2010.

C. How the TSLF Worked

Treasury collateral made available through the TSLF was allocated via auction. The day before each auction, the Fed announced the par value of the offering amount, the particular basket of Treasury securities it was willing to lend, and the collateral eligible for delivery against the Treasury securities. "Schedule 1" collateral consisted of the collateral eligible in the Fed's open market operations, that is, Treasury securities, agency debt securities, and agency MBS. "Schedule 2" collateral consisted of Schedule 1 collateral plus other investment grade debt securities.[17]

Auctions were typically held at 2 p.m. eastern time and were open for 30 minutes. Dealers could submit up to two bids. The minimum bid was $10 million, each bid could be for no more than 20 percent of the offering amount, and each dealer could be awarded no more than 20 percent of the offering amount. The auctions were single-priced, so that accepted dealer bids were awarded at the same rate, which was the lowest rate which filled

[17] Schedule 2 collateral originally included Schedule 1 collateral plus AAA/Aaa-rated non-agency residential MBS, commercial MBS, and agency collateralized mortgage obligations (CMOs). Eligible collateral was expanded to include AAA/Aaa-rated asset-backed securities (ABS) starting with the May 8, 2008 auction, and all investment grade debt securities starting with the September 17, 2008 auctions.

the auction (also called the stop-out rate). The minimum fee for Schedule 1 and Schedule 2 auctions was 10 and 25 basis points (per annum), respectively.

Shortly after the auction close, the Fed informed dealers of their firm's awards and posted summary auction results to the New York Fed's website. Loans settled on the business day following auction. Treasury collateral was allocated to dealers on a pro rata basis, so that a dealer awarded 10% of the offering amount received a 10% share of each Treasury security offered. The Fed reserved the right to substitute lent general collateral each day so as to avoid providing collateral that might trade with scarcity value in the repo market.[18]

To further mitigate credit risk, the Fed imposed a haircut on the collateral pledged by dealers, so that dealers had to pledge collateral with a market value greater than the market value of the Treasury securities being borrowed. Moreover, dealers had to ensure that the market value of their collateral remained sufficient on a daily basis. Dealers might therefore need to make collateral substitutions over the term of a loan if the pledged collateral deteriorated in value or fell out of the eligible collateral pool.

D. TSLF Options Program

On July 30, 2008, the Fed announced the introduction of auctions of options on $50 billion of draws on the TSLF. That is, the options allowed dealers to borrow Treasury securities from the TSLF. The Fed said such options would be offered for exercise "in advance of periods that are typically characterized by elevated stress in financial markets, such as quarter ends."[19] Draws on the TSLF through exercise of these options could be backed by the full range of Schedule 2 collateral. Over the course of the program, the Fed held six auctions for options with five exercise dates. Dealers exercised options on three

[18] The Fed selected securities for the collateral basket that were not trading with scarcity value (i.e., special) in the repo market, but repo market scarcity can change over the term of a loan, resulting in a substitution. One such substitution occurred April 9, 2008.
[19] See the Federal Reserve press release announcing the program, <http://www.federalreserve.gov/newsevents/press/monetary/20080730a.htm>.

occasions, with a maximum amount exercised of $47.2 billion.[20] Our paper does not consider participation in this program.

3. Data

A. TSLF

Our TSLF data comes from three sources. First, certain aggregate information about TSLF operations was released around the times of the operations.[21] Information announced in advance of an operation included the total quantity of Treasury collateral offered and the type of collateral that could be pledge against the Treasury securities. After the operation, the Fed disclosed the aggregate quantity bid, the quantity awarded, and the stop-out rate.

Second, on December 1, 2010, the Fed released additional information about transactions conducted to stabilize markets during the financial crisis.[22] For the TSLF, this includes information on individual dealer borrowings through the TSLF, including the name of the borrower and the amount lent (par value and market value). It also includes information on the collateral pledged against the Treasury collateral including the market value of the collateral pledged, the collateral type, and the collateral rating. The collateral information is provided as of the start date of a new loan and is aggregated to reflect all of a dealer's outstanding loans as of that date.

Third, we utilize a proprietary dataset with somewhat greater information than the data released December 1, 2010. In particular, while the dataset released in December 2010 includes quantities borrowed and lending fees (which are based on the stop-out rate), this additional data includes the particular fees bid and the associated quantities, regardless of

[20] This amount was for the options covering the September 2008 quarter-end. For the options covering November 2008 month-end, $8.0 billion was exercised, and for the options covering the 2008 year-end, $7.0 billion was exercised.
[21] This information is available on the New York fed's website at <http://www.newyorkfed.org/markets/tslf/termseclending_Historical.cfm>.
[22] This information is available on the Fed's website at <http://www.federalreserve.gov/newsevents/reform_tslf.htm>.

whether the bid was successful or not. Such information is available for each bid in instances when dealers submitted two bids.

Summary statistics across TSLF auctions, reported in Table I, indicate substantial variation in borrowing behavior over time. In Schedule 1 operations, for which the offering amount was always $25 billion, bid-to-cover ratios ranged from 0 to 2.1, the number of bidding dealers ranged from 0 to 14, and the stop-out rate ranged from the minimum fee of 10 basis points at numerous operations to 151 basis points at the September 18, 2008 operation (data for individual auctions are reported in the Appendix Table 1). In Schedule 2 operations, for which the offering amount ranged from $25 billion to $75 billion, bid-to-cover ratios ranged from 0 to 2.0, the number of bidding dealers ranged from 0 to 16, and the stop-out rate ranged from the minimum fee of 25 basis points at numerous operations to 322 basis points at the October 15, 2008 operation.

Summary statistics for dealer borrowing, reported in Table II, indicate substantial variation in bidding behavior across dealers. Citigroup Global Markets borrowed in 63 of the 91 TSLF operations, with average borrowing (across operations at which it did and did not borrow) of $2.1 billion at Schedule 1 operations and $3.8 billion at Schedule 2 operations. At the other extreme, two firms that were primary dealers over the life of the program never borrowed at all: Daiwa Securities America (now Daiwa Capital Markets America) and Mizuho Securities USA.[23]

Not only was there variation across dealers and auctions in borrowing amounts, but there is evidence of substantial variation in dealer behavior for a given auction as shown in Figure 4. The figure plots dealer bid rates for every dealer-auction pair for both Schedule 1 (Figure 4A) and Schedule 2 (Figure 4B) operations. For instances in which a dealer submitted two bids, we plot the average bid, weighted by bid amounts. The figure illustrates tremendous variation in dealer bid rates, especially after the failure of Lehman Brothers.

[23] To the extent possible, our analysis incorporates the 20 firms that were primary dealers at the start of the TSLF, including the five firms (Bear Stearns, Countrywide, Dresdner Kleinwort, Lehman Brothers, and Merrill Lynch) that were no longer primary dealers at the end of the program. Our analysis excludes the three firms that became primary dealers while the program was operating (Jefferies, RBC, and Nomura), because all three firms became primary dealers in June or July 2009 when the program was winding down (and none of the three firms ever borrowed via the program).

For example, at the September 18, 2008 Schedule 1 auction, 10 dealers submitted bids, ranging from 10 to 351 basis points. Similarly, at the October 15, 2008 Schedule 2 operation, 11 dealers submitted bids, ranging from 60 to 1500 basis points.

Summary statistics for the quality and type of collateral posted at Schedule 2 operations, reported in Table III, also varied considerably across dealers. Panel A of the table shows that some dealers only posted collateral with a composite rating of AAA whereas for other dealers (for example, Barclays Capital and Credit Suisse), only about one-half of their pledged capital was rated AAA. In Panel B of Table III, we see that Citigroup posted a relatively high share (63%) of agency-backed mortgage securities as collateral. Other heavy program borrowers, such as Deutsche Bank Securities, posted relatively less agency-backed mortgage securities as collateral (8%), but more non-agency backed securities (54%) and other securities. Barclays Capital posted high shares of both asset-backed securities (30%) and corporate securities (41%).

B. Repo Rates

Our source for repo rate data is the New York Fed's primary dealer survey. Each morning, before its typical open market operation time of 9:30, the trading desk at the New York Fed collects information from primary dealers on general collateral repo rates for Treasury securities, agency debt securities, and agency MBS. These data are used to help gauge funding market conditions and to set spreads for the Fed's open market operations. We primarily use data on one-month repo rates, which are averaged from indicative rates provided by a subset of primary dealers.

C. Firm Characteristics

Aside from the firm-specific information on dealers' participation in the TSLF, discussed above, we collected data on two primary measures of dealer balance-sheet conditions, namely the leverage and equity performance of dealers during the crisis:

(i) *Leverage* is measured by the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of non-equity liabilities) to market

value of equity as of the day preceding each TSLF auction, where the book value of non-equity liabilities is measured as the book value of assets minus the book value of equity. While book data are available on a quarterly frequency, the market value of equity is updated on a daily basis, so that the quasi-leverage measure also moves on a daily basis, driven on a daily basis within a quarter due to market equity fluctuations, and across quarters, also due to updated information on book value of non-equity liabilities. While in tables and figures, we refer to the measure as quasi-leverage, in the text we simply call it leverage for parsimony of expression.

(ii) *Cumulative equity price decline*, which measures the equity performance (return) of a firm from January 2, 2007 until the day preceding each auction.

Note that the primary dealers participating in the TSLF operations are often subsidiaries of larger financial firms. Leverage and equity performance are measured for the holding company in such instances. In other instances, leverage and equity returns are not available at all. Appendix Table 2 lists the number of observations available for each dealer for each of the two variables.

Summary statistics for the leverage and equity return variables are reported in Table IV.[24] Given that the TSLF was introduced and operated during the financial crisis, it is not surprising to see a mean cumulative equity return of -54% since January 2, 2007 with a worst performance of -99.8% (an essentially bankrupt dealer) and a best performance of 3.2%. The mean leverage is 49, i.e., quasi-market assets to equity ratio of close to 50:1, which varies from a low of 5 to a high of close to 600 (since for a bankrupt dealer, market value of equity approaches zero). The other statistics indicate substantial variation in leverage and returns from both the cross section and the time series, as the last two columns illustrate. That is, there is substantial variation in leverage and equity returns across dealers at given points in time, and over time for given dealers. The cross-sectional variation is the key variation we exploit in our empirical analysis, as we control for time-series variation through time fixed-effects and proxies for aggregate funding conditions.

[24] Summary statistics for risk variables, such as downside market exposure, also reported in the table, are discussed in Section 4E.

4. Results

We explain dealer bidding behavior with our measures of dealer financial conditions prior to TSLF Schedule 1 and Schedule 2 auctions. Let y_{it} be the proxy for bidding behavior and let x_{it} be a measure of financial condition of dealer *i* at the TSLF auction *t*. In most of the analysis, x_{it} is the dealer's leverage as of the day preceding the auction or the cumulative equity return from January 2, 2007 to the day preceding an auction.

We test six model specifications for each of the operation types. Because of the different quality of the collateral pledged, each specification is estimated separately for Schedule 1 and Schedule 2 operations. Our initial regression specification incorporates an auction fixed effect:

$$y_{it} = \alpha_0 + \gamma_t + \beta x_{it} + \varepsilon_{it} \quad (1)$$

Because of the high correlation between the two variables, we estimate (1) using leverage or equity returns separately. However, for completeness, we also estimate a version with both leverage and returns:

$$y_{it} = \alpha_0 + \gamma_t + \beta_1 Leverage_{it} + \beta_2 Equity\ return_{it} + \varepsilon_{it} \quad (2)$$

In (1) and (2), the auction fixed effect γ_t controls for any purely time-series variations that impact y_{it}. The next specifications involve replacing the auction fixed effect with the one-month repo spread in order to account for time-series variations only in the market funding conditions. The repo spread variable is omitted in (1) and (2) due to collinearity with γ_t. We also include the mean values of x_{it} to examine the strategic interaction between dealer bidding decisions.

$$y_{it} = \alpha_0 + \alpha_1 Repo\ Spread_t + \beta_1 x_{it} + \beta_2 \bar{x}_t + \varepsilon_{it} \quad (3)$$

$$y_{it} = \alpha_0 + \alpha_1 Repo\ Spread_t + \beta_1 Leverage_{it} + \beta_2 \overline{Leverage}_t + \beta_3 Equity\ return_{it} + \beta_4 \overline{Equity\ return}_t + \varepsilon_{it} \quad (4)$$

Leverage or returns enter separately in (3) and together in (4). As proxies for dealer bidding behavior y_{it}, we use the dealer's participation decision (section *A*), the bid amount (section *B*), and the bid rate (section *C*). We mainly employ ordinary least squares estimation, although we have also verified the robustness of our results with a probit estimation (results are available upon request). In additional analysis, we incorporate dealer's past bidding behavior (section D), alternative measures of x_{it}, in particular risk variables (section *E*), and bidding behavior in the PDCF facility (section *F*). Finally, in section *G*, we examine the correlation between dealer financial conditions (i.e. leverage and returns) and measures of dealer funding costs.

A. Participation

Our initial investigations relate a dealer's decision to participate in a TSLF auction to its financial condition (i.e. whether to bid in a TSLF auction or not). Participation is defined by an indicator variable equaling one if a dealer submitted a bid in an auction, and zero otherwise. The results, reported in Table V, support the hypothesis that firms with weaker financial conditions were more likely to participate in TSLF auctions. Leverage is positively and significantly related to participation in both Schedule 1 and Schedule 2 operations (column 1). Equity returns are negatively related to participation, albeit significantly for the Schedule 2 operations only (column 2). The stronger results for the Schedule 2 operations are not surprising given that such operations allowed dealers to pledge lower quality collateral, and firms with greater leverage and worse equity returns are likely to have been the ones with greater holdings of lower quality collateral. When we include both leverage and equity returns in the regressions (column 3), neither is significant, due to the high correlation between these variables, confirming that deterioration of market value of equity is the primary determinant of dealer's participation in auctions.

The mean leverage and mean equity return coefficients are also statistically significant in most model specifications (columns 4-6). Mean leverage is negatively related to participation and mean equity returns positively related. These results imply that a weakening of financial conditions of a firm's competitors in the auctions is associated with lower participation by the firm. That is, dealers tend to be "crowded out" of participating in

auctions as the level of distress of other dealers, and hence their aggressiveness in bidding, increases.

Lastly, the one month repo spread is positively related to participation as expected, indicating that dealers participate when their opportunity cost of funding in the private market is higher (columns 4-6).

B. Borrowing Amount

We proceed to examine how the quantity bid by a dealer varies with its financial condition. We define the quantity bid as the amount of a dealer's bid (across both bids if it submitted two) divided by the maximum possible auction award. Technically, each of a dealer's two bids could be as large as the maximum auction award, so that the ratio could conceivably be as large as two.[25] Empirically, the ratio rarely exceeded one. We cap the ratio at one, so that our dependent variable ranges between zero and one.

We again test six model specifications for each of the operation types. In particular, some of the specifications are conditional on a dealer bidding in an auction, which effectively drops all observations for which the dependent variable equals zero. While the earlier results showed that dealer participation was related to its financial condition, the results conditional on participation address whether financial conditions can further explain the quantity bid if a bid is submitted.

Our results, reported in Table VI, provide mixed evidence on the hypothesis that firms with weaker financial conditions tended to bid for larger quantities in TSLF auctions. In the unconditional specifications (columns 1 and 2 in both panels), the leverage variable is positive and statistically significant and the equity return variable is negative and statistically significant for both operation types. However, in the conditional specifications, the firm variables are generally insignificant (columns 3 and 4).

[25] If an auction were oversubscribed, then awards would be rationed at the stop-out rate. It follows that a dealer submitting two bids might want to increase the size of its less competitive bid to increase its award should the auction stop at the lower rate.

In the schedule 2 regressions (Panel B), we include in column 5 the proportion of collateral pledged by the dealer that is rated below A. Dealers with a high proportion of low-rated collateral (such as asset-backed securities, or ABS) may have greater funding needs due to the difficulty of borrowing against this collateral during the crisis. However, our results indicate that, once we control for leverage and equity returns, the proportion of collateral pledged that is rated below A does not explain the amount bid by dealers.

These results generally support the hypothesis that the decision to bid or participate in an auction is related to a firm's financial condition, but perhaps somewhat surprisingly, the particular quantity bid, conditional on bidding, is not related to the firm's financial condition.

C. Bid Rate

Our third measure of liquidity demand at the TSLF auctions is a dealer's bid rate. This variable is defined as the average bid rate, weighted by bid amount for instances in which a dealer submitted two bids. Bid rates are naturally not observed for dealers that did not submit bids, so the sample is necessarily conditional on a dealer having submitted a bid.

The results, reported in Table VII, are qualitatively supportive of the hypothesis that firms with weaker financial conditions bid higher rates, although the results are less robust in terms of statistical significance than the earlier participation results. Leverage is insignificantly related to bid rates in all specifications (columns 1, 3 and 5), although the coefficient has a positive sign throughout. Equity returns are negatively related to participation (columns 2, 4 and 6), but significantly so in only two of the specifications. As before, if we include the proportion of collateral tendered by the dealer in Schedule 2 auction that is rated below A, we find that dealer bid rates are unrelated to this proportion (columns 5 and 6), after controlling for financial conditions.

D. Prior Participation

Since the Federal Reserve provided funding against a variety of collateral, including collateral that was difficult to borrow against in the private market (see Figure 2), one might presume that the less healthy dealers would fully avail of this opportunity. Yet, the bid-

cover ratio was less than one in the auctions prior to the failure of Lehman. One reason might be the existence of "stigma" associated with borrowing from the Fed, as documented by Armantier, et al. (2011). In particular, a distressed dealer may hesitate to participate in the auctions for the fear of revealing its funding problems to markets and other participants.[26] Further, a relatively healthy dealer may hesitate to participate in the auctions for the fear of being put in the same category by markets and investors as other more distressed dealers.

To account for this stigma hypothesis, we augment specifications in Table VIII to include as an additional independent variable the number of auctions that the dealer participated in the two auctions prior to the current auction to explain dealer participation. As an alternative measure of stigma, we (separately) also include a dummy variable based on whether the dealer participated in prior two auctions. Our results are robust to employing the prior four auctions instead of the prior two auctions for measuring a dealer's prior participation. Since both market and dealer balance-sheet conditions were fluctuating at a rapid pace during our sample period, these time-varying measures of prior participation are better in our view to capture stigma related issues than a first-time participation dummy. We hypothesize that the presence of stigma might imply that participation is persistent; in other words, stigma might induce dealers not to participate if they have not done so in the past, but having participated once, the adverse signaling effect of further participation might be diluted.

Results for the regressions with prior participation are shown in Table VIII. Consistent with intuition, we find that prior participation strongly and positively predicts current participation in both schedule 1 and schedule 2 auctions. Importantly for our earlier results, the effects of leverage and equity returns remain statistically significant in explaining auction participation (columns 2, 3, 5 and 6), and when their coefficient estimates are compared to Table V, they are in fact of similar magnitude as in the specification where prior participation was not controlled for.

[26] As with the discount window, the names of borrowers are not revealed by the Federal Reserve in real time. Moreover, until after the crisis, borrower names were never revealed, even with a delay. Nonetheless, stigma is thought to exist because of a view that market participants are able to gather some information about who borrows from the Federal Reserve.

Further, when we examine the interaction of prior participation dummy with leverage and cumulative equity price decline, we find some evidence that weak dealer financing conditions *mitigate* the effect of prior participation. Specifically, the estimate of the interaction between leverage and the continuous prior bidding variable (column 2) is negative and significant, indicating that for dealers with higher leverage, participation is less persistent. Similarly, the estimate of the interaction between equity return and the continuous prior bidding variable (column 3) is positive and significant (in case of Schedule 1), indicating that for dealers with more negative equity returns, participation is less persistent.

These results suggest that stigma-related concerns may have reduced the overall extent of participation in the TSLF auctions, but is not sufficient to explaining the full cross-sectional pattern of dealer participation as explained by dealer financing conditions. Weak dealer conditions in fact mitigate the effect of stigma and induce highly leveraged borrowers to participate in TSLF auctions even when they have not participated in the auctions in the recent past.

E. Risk Variables

The dealer condition variables we exploited so far – leverage and cumulative equity price decline –were aimed at capturing the erosion of capital base of the dealers. While market value of equity is undoubtedly forward-looking, potential risk exposure of dealers may also affect their funding conditions, especially if they are likely to be at risk in times of market-wide shocks. To this end, we explore the role of the following risk variables:[27]

(i) *Downside market exposure*: measured as *MES, or Marginal Expected Shortfall,* employed by Acharya, Pedersen, Philippon and Richardson (2009) as a measure of downside market-wide risk exposure of a firm's stock returns. We employ the MES calculated using the Brownlees and Engle (2010) methodology that allows for dynamic volatility and correlation modeling and measures the percentage of stock value that a firm would lose for a 2 percent negative correction to the daily market (Global MSCI index)

[27] All of these variables are based on calculations at the New York University Stern School of Business' VLAB website for systemic risk calculations: http://vlab.stern.nyu.edu/welcome/risk. We are grateful to Rob Capellini of VLAB for supplying the data to us.

return. Firms with high ex-ante MES are shown by these authors to be associated with more negative eventual returns when a crisis materializes.

(ii) *Stock return volatility*, is the estimate of forward-looking daily (annualized) volatility of a firm's stock returns, estimated using dynamic volatility models as in Brownlees and Engle (2010).

(iii) *Under-capitalization in market stress:* measured as *SRISK*, a measure employed by Acharya, Pedersen, Philippon and Richardson (2009) and Brownlees and Engle (2010), which calculates the under-capitalization of a firm in a 40% correction relative to the capital it would need to ensure that its quasi-assets to market equity ratio does not exceed 8%. This measure combines *MES* and leverage information, since for a given downside exposure given by the *MES*, a more leveraged firm today would be more under-capitalized in future.[28]

(iv) *Equity market capitalization:* measured as market value of equity of a firm. While this is mainly employed as a control variable, it could potentially capture whether too-big-to-fail firms are more likely to participate in the auctions.

Table IV reports descriptive statistics of the risk variables. Similarly to leverage and equity returns, the risk variables exhibit substantial heterogeneity in the cross-section and the time-series.

Table IX reports results from explaining the participation of dealer in an auction (Schedule 1 in Panel A, and Schedule 2 in Panel B) as a function of these variables individually as well as all jointly (last column). Overall, we find that the risk measures do explain auction participation by dealers: *Stock return volatility* and *Under-capitalization in market stress* in case of Schedule 1 participation, and in addition also *Downside market exposure* in case of Schedule 2 participation. In the horse-race, *Under-capitalization in market stress* (which also includes leverage in it) explains Schedule 1 participations the best, whereas the *Downside market exposure* measure explains Schedule 2 participations the best.

[28] Formally, $SRISK = k\,[D + (1\text{-}LRMES)*E] - (1\text{-}LRMES)*E$, where k is the required capitalization set at 8%, D is the book value of non-equity liabilities, E is the market value of equity, and $LRMES$ is an extrapolation from *MES*, which measures downside exposure to a 2% negative shock to the market, to a downside exposure to a 40% negative shock to the market, where $LRMES = 1 - exp(-18*MES)$.

Unfortunately, given the number of dealers in our auctions, further investigation of whether balance-sheet leverage conditions matter more or do forward-looking risk and systemic risk measures, is rendered difficult. One robust conclusion that emerges is that size of dealers, measured by their market value of equity, is *not* a significant determinant of auction participation, but measures of leverage or risk of dealers are.

F. Participation in the Primary Dealer Credit Facility (PDCF)

The TSLF auctions were not the only facility that the Federal Reserve designed during the crisis period to ease funding conditions for dealers. Another important facility for dealer funding was the Primary Dealer Credit Facility (PDCF) designed to allow dealers to borrow funds (as in reserves rather than Treasury securities) from the Fed on an as-needed daily basis (rather than during scheduled auctions, as with the TSLF) against designated collateral.[29] The introduction of the PDCF in March 2008 arose from the fact that participation in the Fed's Discount Window facility is restricted to depository institutions; indeed, the PDCF may be viewed as a Discount Window facility for dealers. Clearly, since dealers were eligible to participate in both the PDCF and TSLF, it appears plausible that a dealer's decision to participate in one facility was related to its decision to borrow in the other.

Summary statistics for dealer participation in the PDCF is provided in Appendix Table 3. Some dealers borrowed substantial amounts from the facility and were frequent participants. For example, Citigroup and Morgan Stanley participated, respectively, 174 and 122 times and borrowed an average of $10 billion per visit. In contrast, some dealers such as J P Morgan, Credit Suisse and Deutsche Bank, rarely borrowed from the PDCF.

We now examine whether dealer financial conditions influence participation in the PDCF. These results are reported in Table X. Dealer financial conditions are represented by the same set of variables used in the TSLF regressions: leverage, equity returns, and the risk variables. The results indicate that dealer financial conditions determine PDCF participation in a manner similar to TSLF participation. In particular, dealers with greater leverage and lower equity returns over the crisis are more likely to access the PDCF facility (columns 1, 2

[29] See Adrian, Burke and McAndrews (2011) for a description of the PDCF and its functions.

and 7). When we examine the effect of other risk variables (as in Section 4.E), we find that both *Downside market exposure* and *Stock return volatility* also help explain the PDCF participation (columns 3 and 4), though in a horse-race, the effect of leverage dominates (column 8).

These results confirm that dealer participation in the PDCF and TSLF is linked to a set of common factors related to dealer financing conditions, consistent with intuition that bidding behavior in both auctions reflects dealers' demand for liquidity and in turn their private costs of funding. The results also assuage the concern that there might be substitution effects between the two auctions which would preclude clean inference based on participation patterns in just one of the auctions.

G. *Do Our Distress Measures Reflect Funding Costs?*

We have assumed that our market-data based measures of distress, namely leverage and cumulative equity price return, are indeed related to the private costs of funding of dealers. Unfortunately, these private funding costs are not easily measured as high frequency funding data for insitutions is not readily available. Nevertheless, we provide some basic descriptitive statistics in Figure 5 indicating a correlation between distress measures and the private funding costs of dealers in our sample. In particular, for a subset (eight) of the dealers, we show the dealer's 1-month LIBOR borrowing rate as reported to the British Banker's Association (BBA), and the repo haircut paid by banks on tri-party repos using asset-backed securities (ABS) as collateral, over the period September 16, 2008 to October 31, 2008. We average these funding costs for each dealer during the period and relate them to the dealer's leverage averaged from June to August 2008, and the cumulative equity return from January 2 2007 until August 29, 2008.

Figure 5 shows a positive relationship between funding costs and leverage and a negative relationship between funding costs and cumulated equity returns. In other words, increases in measures of balance sheet distress and decreases in equity returns were associated with higher LIBOR rates and repo haircuts for dealers in our sample. This gives us confidence that dealers with distressed financial conditions indeed faced greater funding costs and this was reflected in their bidding behavior at the TSLF auctions.

5. Conclusion

Do central bank lender-of-last-resort (LOLR) facilities elicit greater and more aggressive participation from less capitalized financial firms? We answer this question by examining financial conditions of dealers that participated in the Federal Reserve's Term Securities Lending Facility (TSLF), a LOLR facility that provided liquidity against a range of assets as collateral, during 2008-09. We find that, in the cross-section, dealers with more leverage and lower returns prior to a TSLF auction were more likely to participate in the auction. These participation effects were stronger for auctions that allowed tendering of more illiquid collateral.

Our results suggest important composition effects in participation by financial firms when central banks lend against illiquid collateral. These effects are consistent with the important trade-offs that central banks face in their lender-of-last-resort role. In particular, the results are consistent with the incentive-based argument for Bagehot (1873)'s recommendation that central banks only lend against high quality collateral. While Bagehot's original concern was primarily with the growth of the central bank's balance-sheet, Bagehot's recommendation may be right after all even in the modern context when such growth is somewhat of a lesser concern, and the primary concern, as with recent financial crises, is the delay in private recapitalization by financial firms.

Central banks attempt to limit participation in their facilities to financial firms based on prior financial health and also monitor participants on an on-going basis. However, in a crisis situation, financial conditions may change rapidly and regulatory capital ratios, which are based on book values and static risk assessments of assets, can appear "stale" and far too slow-moving relative to market assessments of financial firm solvency. Our results indicate that it may be prudent for central bankers to remain cognizant of the selection problem that lender-of-last-resort facilities end up with less-capitalized financial firms who have the greatest demand for liquidity, and the effect that this selection problem has in terms of raising the price for liquidity for relatively better-capitalized firms.

Finally, it is perhaps important to establish a direct incentive effect, if any, of successful participation in the central bank auctions such as the TSLF, on the decision of

financial firms to recapitalize and on their future leverage, equity returns, and credit risk more generally. Conversely, it would be interesting to examine the effect of recapitalizations of the system such as TARP II on auction participations and the selection patterns we have documented. We hope to investigate these important issues in future work.

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Table I. Auction Summary Statistics

SCHEDULE 1 AUCTIONS	Mean	Standard Deviation	Minimum	Maximum
Amount Offered (Billions of Dollars)	25.0	0.0	25.0	25.0
Amount Submitted (Billions of Dollars)	21.2	17.6	0.0	51.7
Amount Accepted (Billions of Dollars)	15.3	10.3	0.0	25.0
Stop-Out Rate (Basis Points)	17.1	25.4	10.0	151.0
Bid-to-Cover Ratio	0.8	0.7	0.0	2.1
Number of Bidding Dealers	5.9	4.6	0.0	14.0

SCHEDULE 2 AUCTIONS	Mean	Standard Deviation	Minimum	Maximum
Amount Offered (Billions of Dollars)	47.9	16.9	25.0	75.0
Amount Submitted (Billions of Dollars)	28.8	21.5	0.0	86.1
Amount Accepted (Billions of Dollars)	24.8	16.1	0.0	75.0
Stop-Out Rate (Basis Points)	48.0	70.7	25.0	322.0
Bid-to-Cover Ratio	0.7	0.5	0.0	2.0
Number of Bidding Dealers	7.3	4.5	0.0	16.0

Notes: The table reports summary statistics for the 33 Schedule 1 and 58 Schedule 2 TSLF auctions. TSLF Options Program auctions are excluded. The stop-out rate represents the lowest rate at which bids are accepted. The bid-to-cover ratio represents the ratio of the amount submitted to the amount offered.

Table II. Dealer Borrowing Summary Statistics

	Schedule 1		Schedule 2	
Dealer	Average Amount Borrowed	Number of Borrowings	Average Amount Borrowed	Number of Borrowings
Citigroup Global Markets Inc.	2,086.0	20	3,780.5	43
RBS Securities Inc.	1,610.2	14	3,298.3	43
Deutsche Bank Securities Inc.	2,746.4	20	2,546.4	31
Credit Suisse Securities (USA) LLC	1,591.7	11	2,965.5	41
Goldman, Sachs & Co.	1,221.0	15	2,444.8	36
Barclays Capital Inc.	1,732.9	21	1,700.4	43
Merrill Lynch Government Securities Inc.	609.5	5	2,298.3	33
UBS Securities LLC.	437.6	4	1,631.0	17
Morgan Stanley & Co. Incorporated	517.3	6	1,224.1	25
Lehman Brothers Inc.	394.6	5	1,275.9	13
Banc of America Securities LLC	837.5	8	819.8	14
J.P. Morgan Securities LLC	574.7	7	580.1	14
BNP Paribas Securities Corp.	718.2	9	99.4	10
Countrywide Securities Corporation	96.7	5	59.7	5
HSBC Securities (USA) Inc.	0.0	0	51.7	11
Cantor Fitzgerald & Co.	60.6	4	10.3	5
Bear, Stearns & Co., Inc.	0.0	0	34.5	2
Dresdner Kleinwort Securities LLC	32.5	2	0.0	0

Notes: The tables reports the average amount borrowed and the number of borrowings by dealer for the 33 Schedule 1 and 58 Schedule 2 operations. Borrowings through the TSLF Options Program are excluded. Dealers that never borrowed from the program are excluded. Dealers are ordered in the table based on the weighted average quantity borrowed across the Schedule 1 and Schedule 2 operations, with weights based on the number of Schedule 1 and Schedule 2 operations (i.e., 33 and 58).

Table III. Summary Statistics of Collateral Pledged Against Schedule 2 Borrowings

Panel A: Distribution by Collateral Rating

Dealer	AAA	AA	P1-A1	A	P2-A2	BAA-BBB
Citigroup Global Markets Inc.	88.47	5.02	0.36	3.72	0.00	2.43
RBS Securities Inc.	75.38	4.26	13.11	3.61	0.00	3.64
Deutsche Bank Securities Inc.	73.46	4.65	5.26	8.22	0.00	8.41
Credit Suisse Securities (USA) LLC	54.69	4.64	5.54	14.29	0.00	20.84
Goldman, Sachs & Co.	88.33	5.28	0.00	3.11	0.00	3.28
Barclays Capital Inc.	52.67	9.71	0.00	15.95	0.00	21.67
Merrill Lynch Government Securities Inc.	80.42	7.45	1.33	3.37	0.00	7.43
UBS Securities LLC.	84.86	3.18	0.00	6.04	0.00	5.92
Morgan Stanley & Co. Incorporated	51.05	11.29	29.54	5.27	0.00	2.86
Lehman Brothers Inc.	100.00	0.00	0.00	0.00	0.00	0.00
Banc of America Securities LLC	90.91	5.03	0.00	2.34	0.00	1.71
J.P. Morgan Securities LLC	80.15	1.65	14.16	1.82	0.00	2.21
BNP Paribas Securities Corp.	93.17	0.37	0.00	4.22	0.00	2.24
Countrywide Securities Corporation	100.00	0.00	0.00	0.00	0.00	0.00
HSBC Securities (USA) Inc.	60.66	13.94	0.49	17.72	0.00	7.18
Cantor Fitzgerald & Co.	100.00	0.00	0.00	0.00	0.00	0.00
Bear, Stearns & Co., Inc.	100.00	0.00	0.00	0.00	0.00	0.00

Panel B: Distribution by Collateral Type

Dealer	Treasury & Agency Debt	MBS-CMO: Agency Backed	MBS-CMO: Other	Asset-Backed	Corporate	Municipal	Other
Citigroup Global Markets Inc.	1.97	62.99	17.89	3.31	1.38	12.37	0.08
RBS Securities Inc.	0.09	46.92	22.43	13.17	17.39	0.00	0.00
Deutsche Bank Securities Inc.	0.00	8.17	54.10	17.39	20.30	0.03	0.00
Credit Suisse Securities (USA) LLC	0.26	28.52	20.95	10.46	39.57	0.22	0.01
Goldman, Sachs & Co.	0.00	68.38	16.10	4.86	4.66	6.00	0.00
Barclays Capital Inc.	0.23	8.45	18.57	29.87	41.33	1.55	0.01
Merrill Lynch Government Securities Inc.	0.26	49.39	19.40	16.32	6.62	8.01	0.00
UBS Securities LLC.	2.10	18.84	60.63	9.24	8.71	0.45	0.03
Morgan Stanley & Co. Incorporated	0.62	15.74	25.70	12.81	37.39	7.71	0.02
Lehman Brothers Inc.	0.00	58.32	35.05	6.64	0.00	0.00	0.00
Banc of America Securities LLC	0.02	16.89	71.89	6.52	0.56	4.12	0.00
J.P. Morgan Securities LLC	0.00	13.84	69.56	1.64	14.97	0.00	0.00
BNP Paribas Securities Corp.	11.64	17.57	70.79	0.00	0.00	0.00	0.00
Countrywide Securities Corporation	4.33	58.37	35.64	1.66	0.00	0.00	0.00
HSBC Securities (USA) Inc.	7.03	0.26	15.49	33.10	15.58	26.10	2.45
Cantor Fitzgerald & Co.	0.00	100.00	0.00	0.00	0.00	0.00	0.00
Bear, Stearns & Co., Inc.	0.00	0.00	100.00	0.00	0.00	0.00	0.00

Notes: Panel A reports the estimated proportions of collateral pledged against TSLF Schedule 2 borrowings, grouped by the ratings assigned to the collateral asset. The rating is based on a composite credit rating of the pledged collateral, based on ratings information used by the borrower's clearing bank. Panel B reports the estimated proportions of collateral pledged against TSLF Schedule 2 borrowings, grouped by the collateral type. Borrowings through the TSLF Options Program are excluded. Dealers that never borrowed in a Schedule 2 operation are excluded. Dealers are ordered in the same manner as Table II.

Table IV. Dealer Financial Condition Summary Statistics

	Mean	Standard Deviation	Minimum	Maximum	Average Standard Deviation of the Cross-Section	Average Standard Deviation of the Time Series
Quasi-leverage	49.3	58.1	4.9	595.6	47.9	27.7
Equity return (%)	-53.9	25.0	-99.8	3.2	21.1	15.6
Downside market exposure (%)	7.2	3.9	1.9	63.7	3.1	3.4
Stock return volatility (%)	8.5	28.0	0.2	579.3	12.1	19.3
Under-capitalization in market stress (Mil.$)	114,555.7	77,480.8	-1,069.7	282,839.0	78,910.5	15,151.4
Equity market capitalization (Mil.$)	54,503.6	45,945.7	1,208.7	209,461.9	42,313.9	17,823.0

Notes: The table reports summary statistics for dealer quasi leverage and cumulative equity returns (in %) for the day before each of the 91 TSLF auctions. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Downside market exposure is the percentage of stock value that a firm would lose for a 2 percent negative correction to the daily market (Global MSCI index) return. Stock return volatility is an estimate of forward-looking daily (annualized) volatility of a firm's stock returns. Under-capitalization in market stress is defined as the amount of capital needed to ensure that a firm's quasi-assets to market equity ratio does not exceed 8% in the event of a 40% correction in the firm's stock price. The average standard deviation of the cross-section equals the average of the standard deviations calculated across dealers for each auction. The average standard deviation of the time series equals the average of the standard deviations calculated across auctions for each dealer.

Table V. Explaining Whether a Dealer Bids

Panel A: Schedule 1

	(1)	(2)	(3)	(4)	(5)	(6)
Quasi-leverage	0.00142**		0.000924	0.00142**		0.000933
	(0.000591)		(0.000697)	(0.000585)		(0.000736)
Mean quasi-leverage				-0.00636***		0.00154
				(0.00113)		(0.00149)
Equity return		-0.358	-0.250		-0.358*	-0.246
		(0.215)	(0.247)		(0.204)	(0.238)
Mean equity return					1.331***	1.519***
					(0.229)	(0.370)
One month repo spread				0.00483***	0.00507***	0.00546***
				(0.000914)	(0.000958)	(0.000949)
Auction fixed effects	YES	YES	YES			
Constant	0.684***	0.624***	0.624***	0.468***	0.729***	0.756***
	(0.114)	(0.144)	(0.143)	(0.0735)	(0.104)	(0.125)
Observations	538	540	538	538	540	538
Adjusted R-squared	0.286	0.284	0.294	0.181	0.214	0.227

Panel B: Schedule 2

	(1)	(2)	(3)	(4)	(5)	(6)
Quasi-leverage	0.00243***		0.00143**	0.00243***		0.00144**
	(0.000649)		(0.000605)	(0.000596)		(0.000630)
Mean quasi-leverage				-0.00179		0.00621***
				(0.00128)		(0.00171)
Equity return		-0.682***	-0.530**		-0.682***	-0.524**
		(0.222)	(0.220)		(0.195)	(0.210)
Mean equity return					1.048***	1.945***
					(0.237)	(0.331)
One month repo spread				0.00525***	0.00476***	0.00521***
				(0.000729)	(0.000755)	(0.000714)
Auction fixed effects	YES	YES	YES			
Constant	0.744***	0.603***	0.599***	0.271***	0.516***	0.706***
	(0.101)	(0.138)	(0.135)	(0.0587)	(0.0977)	(0.119)
Observations	916	919	916	916	919	916
Adjusted R-squared	0.279	0.288	0.317	0.182	0.198	0.261

Notes: The table reports results of OLS regressions. The dependent variable is an indicator variable equal to one if a dealer submitted a bid in an auction and zero otherwise. Panel A shows the results for Schedule 1 auctions and Panel B for Schedule 2 auctions. Quasi-leverage and cumulative equity returns are tabulated for each dealer and auction. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Mean quasi-leverage and mean cumulative equity return are the averages across all dealers for each auction. The repo spread is the difference between the one month repo rate for agency MBS collateral and the one month repo rate for Treasury general collateral (GC). Quasi-leverage and equity return are measured as of the day preceding an auction and the repo spread is measured as of the morning before an auction. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%, 5% and 10% levels, respectively.

Table VI. Explaining Bid Amounts

Panel A: Schedule 1

	(1)	(2)	(3)	(4)
Conditional on bidding			YES	YES
Quasi-leverage	0.00116**		8.66e-05	
	(0.000498)		(0.000757)	
Equity return		-0.306*		-0.105
		(0.165)		(0.244)
Auction fixed effects	YES	YES	YES	YES
Constant	0.451***	0.398***	0.666***	0.634***
	(0.100)	(0.116)	(0.0882)	(0.105)
Observations	538	540	189	190
Adjusted R-squared	0.230	0.231	-0.008	-0.001

Panel B: Schedule 2

	(1)	(2)	(3)	(4)	(5)
Conditional on bidding			YES	YES	YES
Quasi-leverage	0.00155***		0.000583		0.000159
	(0.000376)		(0.000488)		(0.758)
Equity return		-0.455***		-0.424**	-0.254
		(0.126)		(0.166)	(0.209)
Proportion of collateral rated below A					-0.00246
					(0.583)
Auction fixed effects	YES	YES	YES	YES	YES
Constant	0.240***	0.143	0.332***	0.195*	0.272**
	(0.0818)	(0.101)	(0.0844)	(0.106)	(0.0258)
Observations	916	919	410	411	366
Adjusted R-squared	0.290	0.304	0.279	0.335	0.361

Notes: The table reports results of OLS regressions. The dependent variable is the ratio of the total amount a dealer bid in a given auction to the maximum award amount. If a dealer did not bid, the bid ratio is 0 in the unconditional regressions and undefined in the conditional regressions. Panel A shows the results for Schedule 1 auctions, and Panel B for Schedule 2 auctions. Quasi-leverage and cumulative equity returns are tabulated for each dealer and auction. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Quasi-leverage and equity return are measured as of the day preceding an auction. The proportion of collateral rated below A is the proportion the dealer pledged against Schedule 2 borrowings. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%, 5% and 10% levels, respectively.

Table VII. Explaining Bid Rates

	Schedule 1		Schedule 2			
	(1)	(2)	(3)	(4)	(5)	(6)
Quasi-leverage	0.0818		0.164		0.0708	
	(0.0683)		(0.201)		(0.743)	
Equity return		-12.54		-211.4*		-154.5*
		(13.73)		(103.6)		(0.0884)
Proportion of collateral rated below A					1.058	1.448
					(0.498)	(0.400)
Auction fixed effects	YES	YES	YES	YES	YES	YES
Constant	10.46***	9.787**	96.50***	22.54	105.9***	46.74
	(2.744)	(4.359)	(30.39)	(43.75)	(0.00481)	(0.264)
Observations	189	190	410	411	362	363
Adjusted R-squared	0.482	0.480	0.298	0.364	0.443	0.477

Notes: The table reports results of OLS regressions. The dependent variable is the bid rate. If a dealer submitted two bids in an auction, then the average bid rate weighted by bid amount is used. Quasi-leverage and cumulative equity returns are tabulated for each dealer and auction. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Quasi-leverage and equity return are measured as of the day preceding an auction. The proportion of collateral rated below A is the proportion the dealer pledged against Schedule 2 borrowings. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%,

Table VIII. Explaining Dealer Bidding with Prior Bidding Behavior

Panel A: Schedule 1

	(1)	(2)	(3)	(4)	(5)	(6)
Continuous Prior Bidding Variable	0.334***	0.351***	0.400***			
	(0.0274)	(0.0350)	(0.0450)			
Dummy Prior Bidding Variable				0.486***	0.510***	0.613***
				(0.0690)	(0.0791)	(0.101)
Quasi-leverage		0.00102***			0.00118***	
		(0.000266)			(0.000321)	
Quasi-leverage * Continuous Prior Bidding		-0.000635*				
		(0.000364)				
Quasi-leverage * Dummy Prior Bidding					-0.00110	
					(0.000704)	
Equity Return			-0.240***			-0.310***
			(0.0676)			(0.0850)
Equity Return * Continuous Prior Bidding			0.157*			
			(0.0831)			
Cumulative Equity Return * Dummy Prior Bidding						0.309
						(0.193)
Auction fixed effects	YES	YES	YES	YES	YES	YES
Constant	0.208**	0.187**	-0.0143	0.385***	0.236*	0.269**
	(0.0735)	(0.0735)	(0.107)	(0.0977)	(0.114)	(0.0966)
Observations	514	500	502	514	500	502
Adjusted R-squared	0.505	0.516	0.510	0.436	0.446	0.444

Panel B: Schedule 2

	(1)	(2)	(3)	(4)	(5)	(6)
Continuous Prior Bidding Variable	0.389***	0.406***	0.411***			
	(0.0231)	(0.0319)	(0.0480)			
Dummy Prior Bidding Variable				0.624***	0.622***	0.611***
				(0.0760)	(0.101)	(0.143)
Quasi-leverage		0.00171***			0.00199**	
		(0.000425)			(0.000718)	
Quasi-leverage * Continuous Prior Bidding		-0.000772**				
		(0.000280)				
Quasi-leverage * Dummy Prior Bidding					-0.00124	
					(0.000864)	
Equity Return			-0.163**			-0.267**
			(0.0681)			(0.121)
Equity Return * Continuous Prior Bidding			0.0636			
			(0.0592)			
Cumulative Equity Return * Dummy Prior Bidding						0.0735
						(0.182)
Auction fixed effects	YES	YES	YES	YES	YES	YES
Constant	0	-0.0425***	-0.0735*	0	-0.0496**	-0.120*
	(1.11e-08)	(0.0147)	(0.0360)	()	(0.0215)	(0.0596)
Observations	898	878	881	898	878	881
Adjusted R-squared	0.577	0.592	0.579	0.496	0.510	0.499

Notes: These are OLS regressions. The dependent variable is an indicator variable equal to one if a dealer submitted a bid in an auction and zero otherwise. Panel A shows the results for Schedule 1 auctions, and Panel B for Schedule 2 auctions. All variables are measured as of the day preceding an auction. The continuous prior bidding variable is the number of auctions in which a dealer bid out of the prior 2 auctions. The dummy prior bidding variable is an indicator variable equal to one if a dealer bid at least once in the prior two auctions, 0 otherwise. Quasi-leverage and cumulative equity returns are tabulated for each dealer and auction. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e. the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%, 5% and 10% levels, respectively.

Table IX. Using Risk Variables to Explain Whether a Dealer Bids

Panel A: Schedule 1

	(1)	(2)	(3)	(4)	(5)	(6)
Quasi-leverage	0.00142**					-0.000478
	(0.000591)					(0.000781)
Downside market exposure		1.577				0.364
		(1.094)				(1.209)
Stock return volatility			2.794**			2.059
			(0.999)			(1.821)
Under-capitalization in market stress				1.57e-06***		1.74e-06***
				(4.64e-07)		(5.56e-07)
Equity market capitalization					-1.69e-07	-6.61e-07
					(1.60e-06)	(1.45e-06)
Auction fixed effects	YES	YES	YES	YES	YES	YES
Constant	0.684***	0.605***	0.704***	0.589***	0.749***	0.586***
	(0.114)	(0.152)	(0.112)	(0.120)	(0.163)	(0.190)
Observations	538	538	538	538	538	538
Adjusted R-squared	0.286	0.274	0.268	0.327	0.260	0.330

Panel B: Schedule 2

	(1)	(2)	(3)	(4)	(5)	(6)
Quasi-leverage	0.00243***					0.00133
	(0.000649)					(0.000886)
Downside market exposure		3.400**				4.357**
		(1.516)				(1.783)
Stock return volatility			3.040*			-5.975**
			(1.593)			(2.425)
Under-capitalization in market stress				1.62e-06**		6.55e-07
				(6.88e-07)		(7.43e-07)
Equity market capitalization					-5.69e-07	3.73e-07
					(1.36e-06)	(1.11e-06)
Auction fixed effects	YES	YES	YES	YES	YES	YES
Constant	0.744***	0.542***	0.778***	0.699***	0.882***	0.447**
	(0.101)	(0.146)	(0.104)	(0.127)	(0.155)	(0.182)
Observations	916	916	916	916	916	916
Adjusted R-squared	0.279	0.272	0.217	0.270	0.207	0.329

Notes: These are OLS regressions. The dependent variable is an indicator variable equal to one if a dealer submitted a bid in an auction and zero otherwise. Panel A shows the results for Schedule 1 auctions, and Panel B for Schedule 2 auctions. All variables are measured as of the day preceding an auction. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Downside market exposure is the percentage of stock value that a firm would lose for a 2 percent negative correction to the daily market (Global MSCI index) return. Stock return volatility is an estimate of forward-looking daily (annualized) volatility of a firm's stock returns. Under-capitalization in market stress is defined as the amount of capital needed to ensure that a firm's quasi-assets to market equity ratio does not exceed 8% in the event of a 40% correction in the firm's stock price. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%, 5% and 10% levels, respectively.

Table X. Explaining Dealer Borrowing from the Primary Dealer Credit Facility

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Quasi-leverage	0.00254***						0.00148**	0.00330**
	(0.000903)						(0.0357)	(0.0152)
Equity return		-0.612**					-0.471*	
		(0.0225)					(0.0934)	
Downside market exposure			1.000**					-1.366
			(0.0250)					(0.418)
Stock return volatility				1.460***				-0.179
				(0.00389)				(0.904)
Under-capitalization in market stress					-8.05e-07			-5.44e-08
					(0.538)			(0.936)
Equity market capitalization						-3.42e-06		-2.17e-06
						(0.108)		(0.228)
Auction fixed effects	YES	YES	YES	YES	YES	YES	YES	YES
Constant	0.858***	0.699***	0.941***	0.997***	1.087***	1.140***	0.685***	0.990***
	(0)	(0.00259)	(0)	(0)	(1.08e-06)	(6.50e-10)	(0.00134)	(1.21e-05)
Observations	1,631	1,651	1,631	1,631	1,631	1,631	1,631	1,631
Adjusted R-squared	0.568	0.592	0.517	0.511	0.508	0.556	0.608	0.599

Notes: These are OLS regressions. The dependent variable is an indicator variable equal to one if a dealer borrowed from the PDCF facility on a given day and zero otherwise. All variables are measured as of the day preceding the borrowing day. Quasi-leverage is the ratio of a firm's quasi-market value of assets (i.e., the market value of equity plus the book value of debt) to market value of equity. Cumulative equity returns are measured from January 2, 2007. Downside market exposure is the percentage of stock value that a firm would lose for a 2 percent negative correction to the daily market (Global MSCI index) return. Stock return volatility is an estimate of forward-looking daily (annualized) volatility of a firm's stock returns. Under-capitalization in market stress is defined as the amount of capital needed to ensure that a firm's quasi-assets to market equity ratio does not exceed 8% in the event of a 40% correction in the firm's stock price. Standard errors clustered by dealer are reported in parentheses. Coefficients marked ***, **, and * are significant at the 1%, 5% and 10% levels, respectively.

Figure 1A: Relative Cumulative Successful Participation of "Failed" Banks

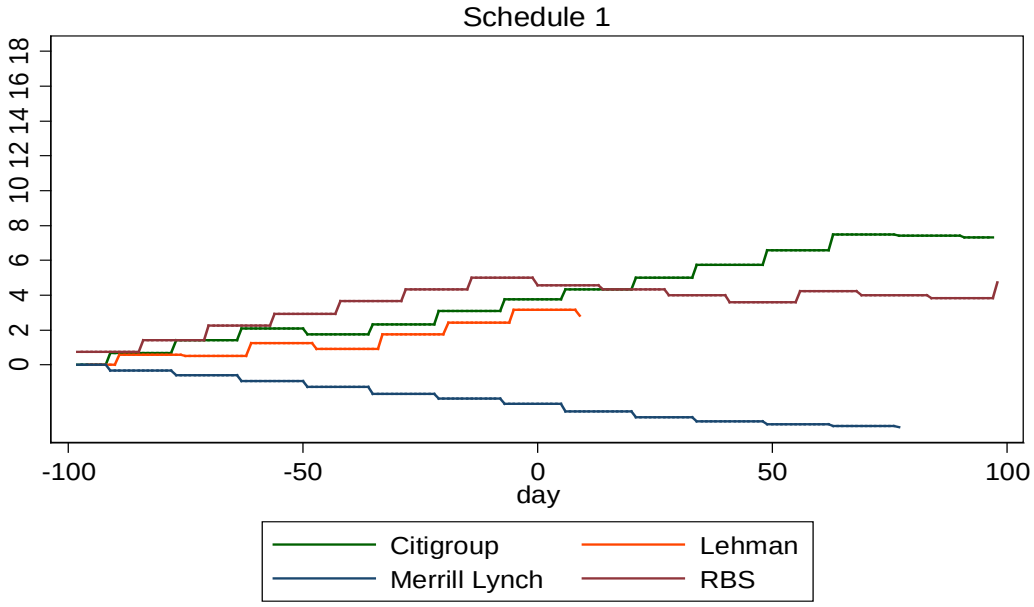
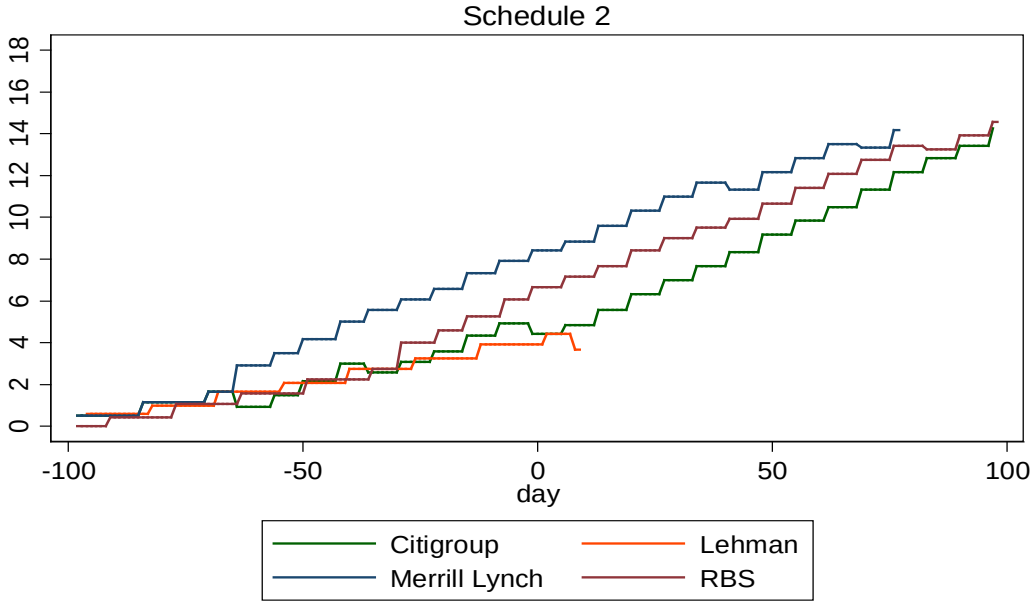


Figure 1B: Relative Cumulative Successful Participation of "Failed" Banks



Notes: These figures plot four "failed" banks' cumulative successful participation relative to the average cumulative participation for "safe banks" for Schedule 1 and Schedule 2. Failure is defined as the cumulative equity return dropping below -90% within the TSLF period. The four failed banks are: Citigroup, Lehman, Merrill Lynch, and RBS. The safe banks are BNP Paribas, Dresdner, Cantor Fitzgerald, Credit Suisse, Daiwa, Deutsche, Goldman Sachs, HSBC, JP Morgan, Mizuho, Morgan Stanley, and UBS. Bear Stearns and Countrywide Financial are excluded because although they are failed banks, their cumulative equity returns drop below -90% before the TSLF period. Bank of America and Barclays are excluded because they "failed" due to acquisitions of Countrywide Financial/Merrill Lynch and Lehman, respectively. For each bank, Day 0 is the day within the TSLF period on which their cumulative returns first drop below -90%. The relative cumulative successful participation is the cumulative number of auctions in which the failed bank is awarded funds beginning 100 days before Day 0 and continuing through 100 days after Day 0, minus the average cumulative successful participation for safe banks over the same 201-day period. Figure 1A plots the relative cumulative successful participation for Schedule 1 auctions and Figure 1B plots Schedule 2 auctions. The event days for each bank are: 11/20/2008 (Citigroup and Merrill Lynch), 09/09/2008 (Lehman), and 10/16/2008 (RBS).

Figure 1C: Relative Award Amount Ratio of "Failed" Banks

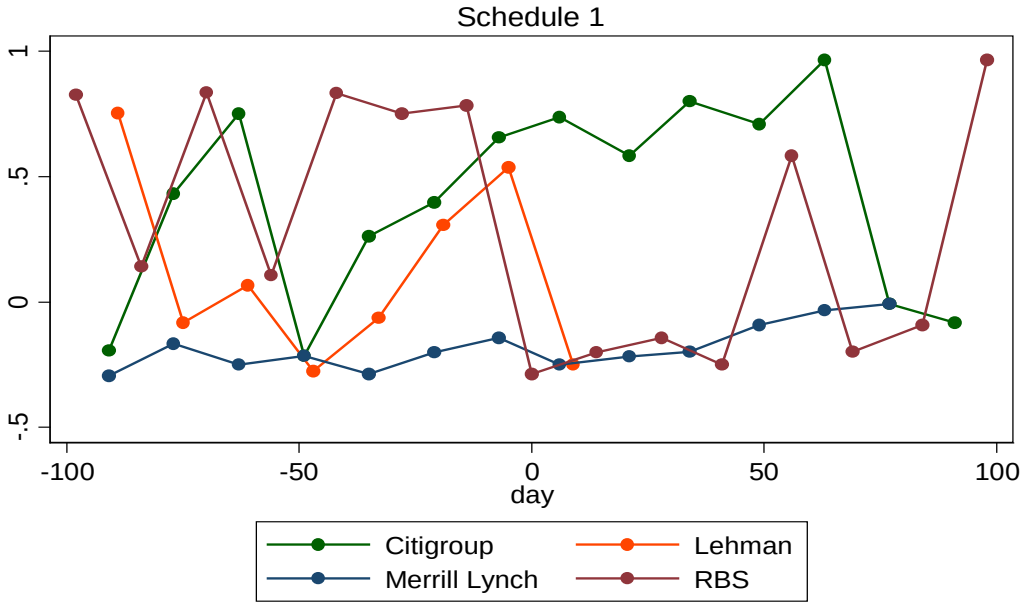
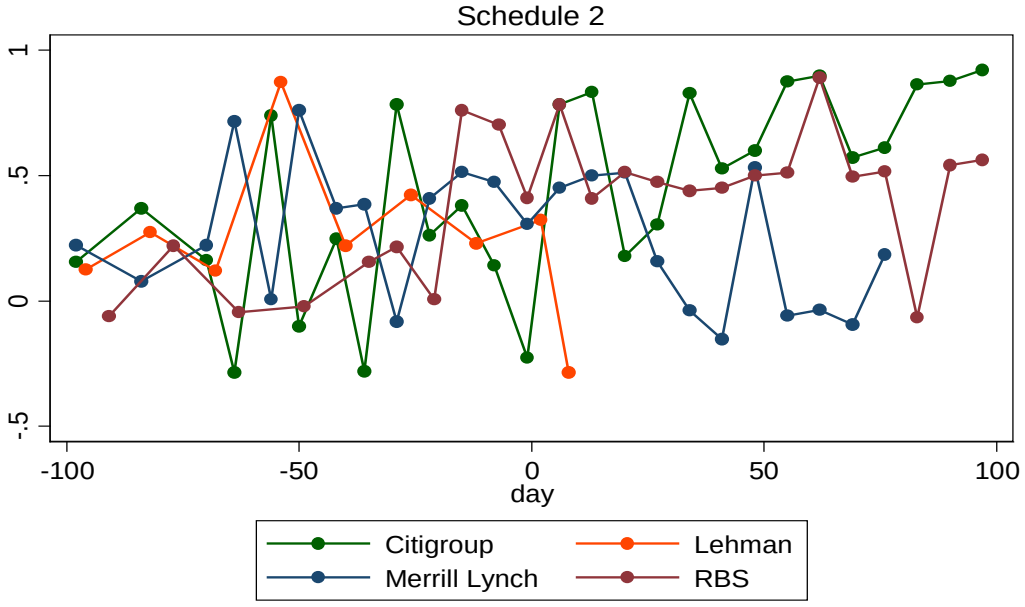
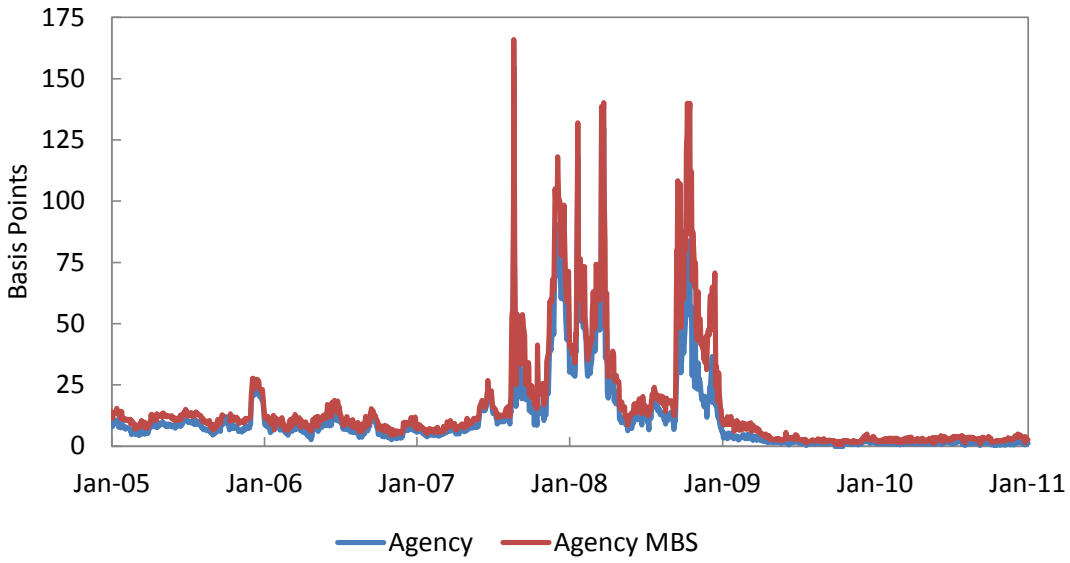


Figure 1D: Relative Award Amount Ratio of "Failed" Banks



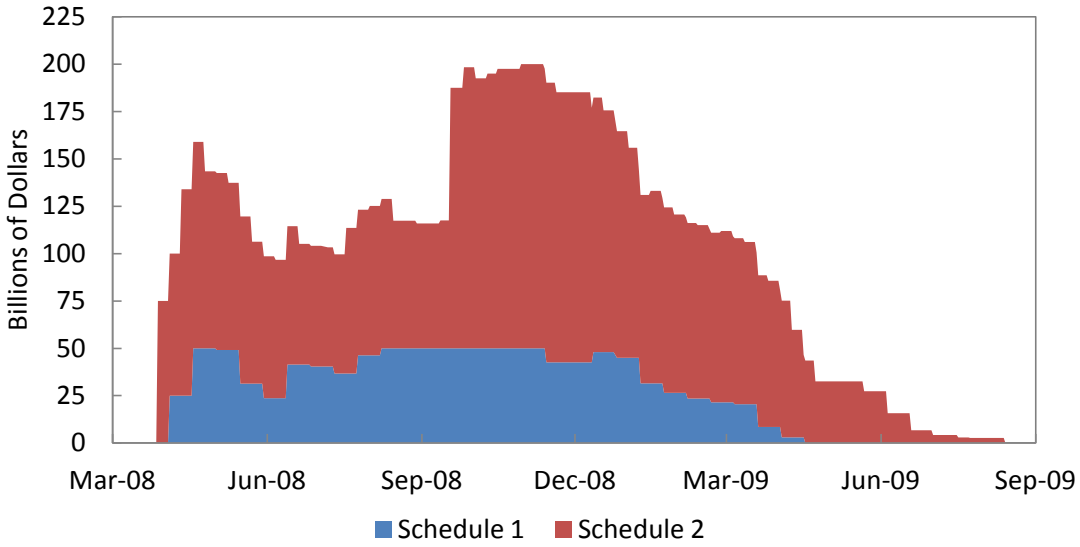
Notes: These figures plot four "failed" banks' award amount ratios relative to the average award ratio for "safe banks" for Schedule 1 and Schedule 2. The award ratio is the amount rewarded divided by the maximum award allowed. Failure is defined as the cumulative equity return dropping below -90% within the TSLF period. The four failed banks are: Citigroup, Lehman, Merrill Lynch, and RBS. The safe banks are BNP Paribas, Dresdner, Cantor Fitzgerald, Credit Suisse, Daiwa, Deutsche, Goldman Sachs, HSBC, JP Morgan, Mizuho, Morgan Stanley, and UBS. Bear Stearns and Countrywide Financial are excluded because although they are failed banks, their cumulative equity returns drop below -90% before the TSLF period. Bank of America and Barclays are excluded because they "failed" due to acquisitions of Countrywide Financial/Merrill Lynch and Lehman, respectively. For each bank, Day 0 is the day within the TSLF period on which their cumulative returns first drop below -90%. The relative award ratio is the failed bank's award ratio minus the average award ratio for safe banks. The figures plot the award ratio for each auction within the 100 days before and after Day 0. Figure 1A plots the award ratio for Schedule 1 auctions and Figure 1B plots Schedule 2 auctions. The event days for each bank are: 11/20/2008 (Citigroup and Merrill Lynch), 09/09/2008 (Lehman), and 10/16/2008 (RBS).

Figure 2: Repo Spreads



Note: The figure plots one month agency and agency MBS repo spreads to the one month Treasury repo rate.

Figure 3: TSLF Amounts Outstanding



Notes: The figure plots TSLF amounts outstanding over time, stacked by schedule. The last TSLF auction was held January 7, 2010, but there was no borrowing after the July 16, 2009 auction. Amounts borrowed through the TSLF Options Program are excluded.

Figure 4A: Dealer Bid Rates in Schedule 1 Auctions

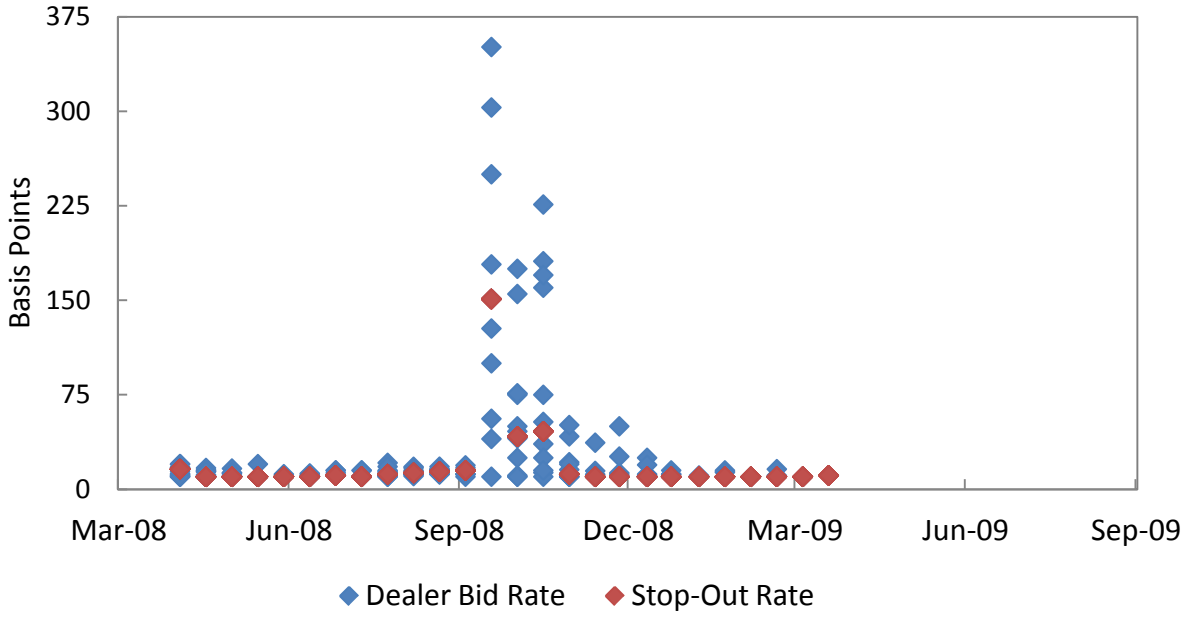
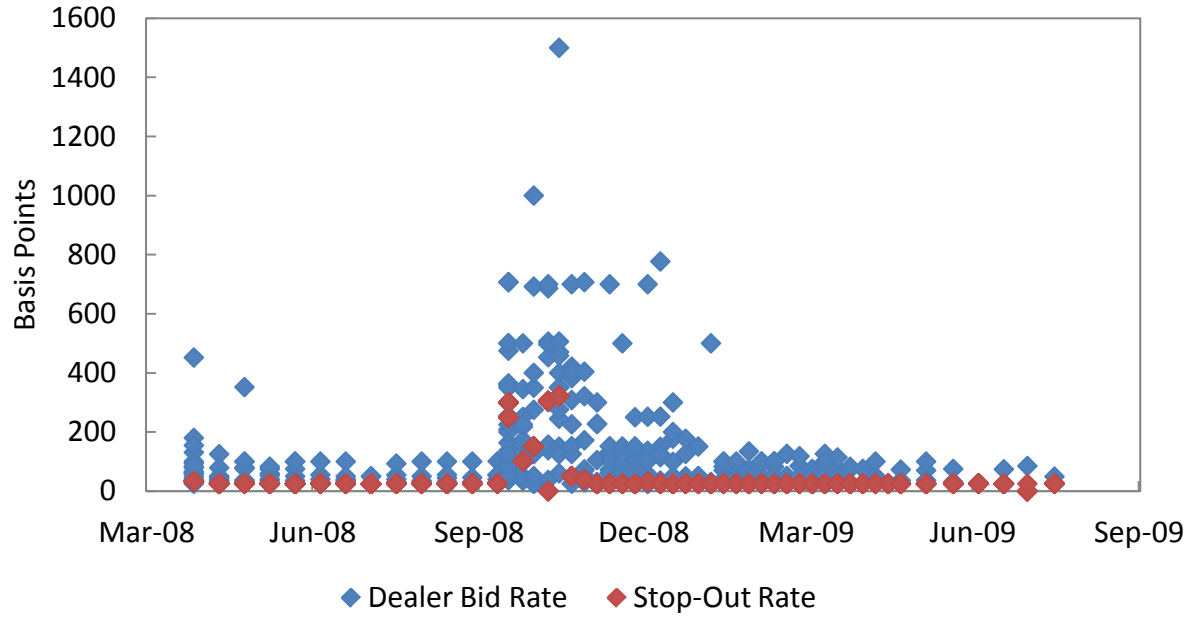
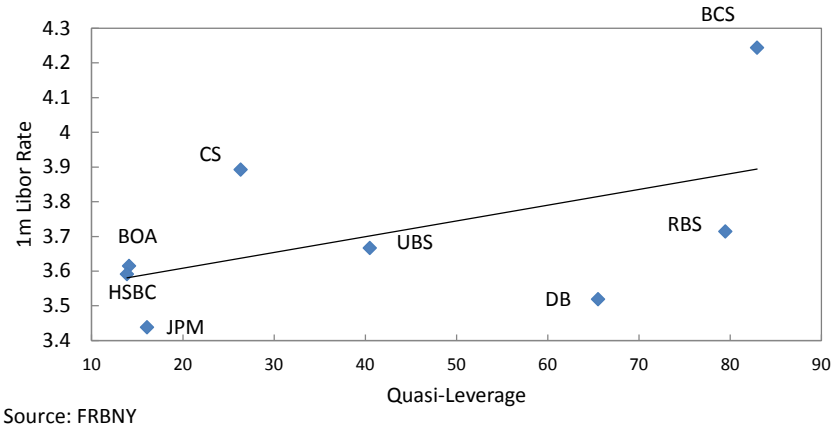


Figure 4B: Dealer Bid Rates in Schedule 2 Auctions



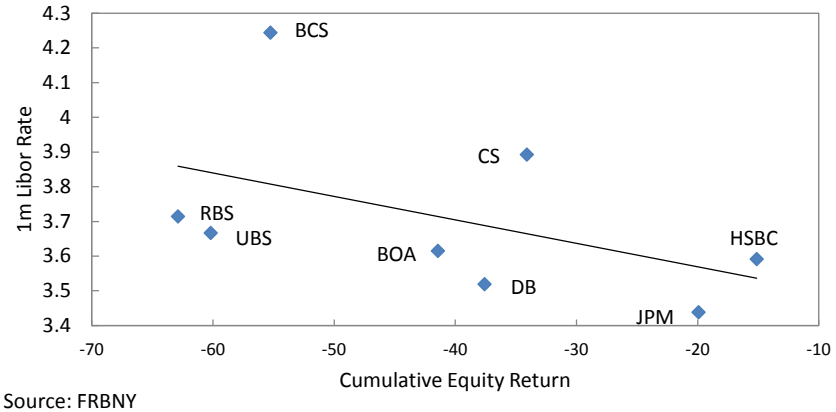
Notes: The figures plot dealer bid rates in TSLF Schedule 1 (Panel A) and Schedule 2 (Panel B) auctions. Each blue diamond represents a dealer's average bid rate, weighted by bid amount. Each red diamond represents an auction's stop-out rate. The last Schedule 1 (Schedule 2) auction was held June 25, 2009 (January 7, 2010), but no bids were made after the March 19, 2009 (July 16, 2009) auction.

Figure 5A: Dealer Quasi-Leverage and One Month Libor Rates



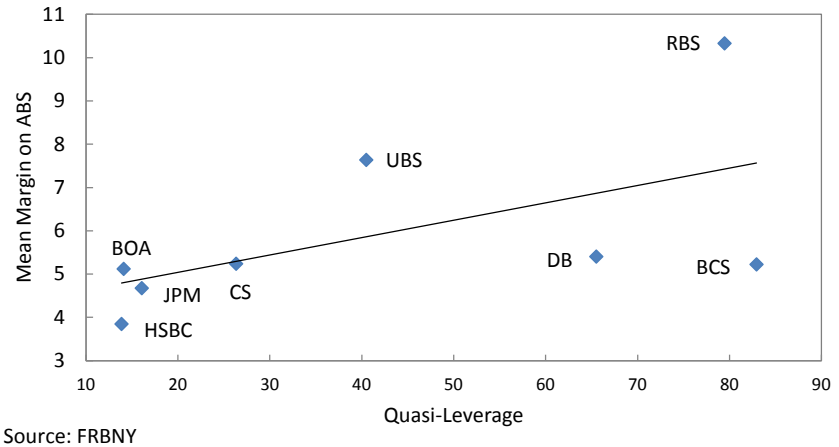
Source: FRBNY

Figure 5B: Dealer Cumulative Equity Return and One Month Libor Rates



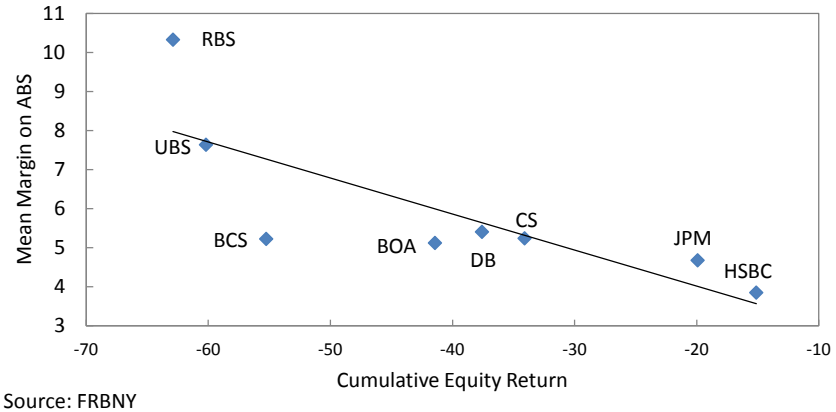
Source: FRBNY

Figure 5C: Dealer Quasi-Leverage and Repo Haircut



Source: FRBNY

Figure 5D: Dealer Cumulative Equity Return and Repo Haircut



Source: FRBNY

Notes: The figures plot the mean quasi-leverage and cumulative equity returns of banks that participated in TSLF auctions against their mean one month Libor rates (upper panel) and mean repo haircut (lower panel). The lines indicate the best fit for the scatter points. The quasi-leverage is averaged from June to August 2008. The equity return is cumulated from January 2007 until August 29, 2008. The Libor rate and repo haircut are averaged from September 16, 2008 to October 31, 2008. Quasi-leverage is defined as the ratio of a firm's book value of debt to the sum of the book value of debt and the market value of equity. The Libor rate is the rate reported by the bank to the British Banker's Association (BBA). The repo haircut is the haircut paid by banks on tri-party repos using asset-backed securities (ABS) as collateral. The bank ticker symbols are: BOA=Bank of America Securities, BCS=Barclays Capital, CS=Credit Suisse Securities, DB=Deutsche Bank Securities, HBC=HSBC Securities, JPM=J.P. Morgan Securities, RBS=RBS Securities, UBS=UBS Securities.

Appendix Table A1. TSLF Auction Results

Auction Date	Schedule	Term	Offer Amount	Submitted Amount	Accepted Amount	Bid-to-Cover	Stop-Out Rate
3/27/2008	2	28	75	86.1	75.0	1.15	33
4/3/2008	1	28	25	46.9	25.0	1.88	16
4/10/2008	2	28	50	34.0	34.0	0.68	25
4/17/2008	1	28	25	35.1	25.0	1.40	10
4/24/2008	2	28	75	59.5	59.5	0.79	25
5/1/2008	1	28	25	24.1	24.1	0.96	10
5/8/2008	2	28	50	28.8	28.8	0.58	25
5/15/2008	1	28	25	7.2	7.2	0.29	10
5/22/2008	2	28	75	46.1	46.1	0.62	25
5/29/2008	1	28	25	16.4	16.4	0.66	10
6/5/2008	2	31	50	26.9	26.9	0.54	25
6/12/2008	1	28	25	27.2	25.0	1.09	10
6/19/2008	2	28	75	36.8	36.8	0.49	25
6/26/2008	1	28	25	15.4	15.4	0.62	11
7/3/2008	2	25	50	26.1	26.1	0.52	25
7/10/2008	1	28	25	21.3	21.3	0.85	10
7/17/2008	2	28	75	51.8	50.8	0.69	25
7/24/2008	1	28	25	51.7	25.0	2.07	12
7/31/2008	2	28	50	28.1	28.1	0.56	25
8/7/2008	1	28	25	39.5	25.0	1.58	13
8/14/2008	2	28	75	39.3	39.3	0.52	25
8/21/2008	1	28	25	44.7	25.0	1.79	14
8/28/2008	2	28	50	26.7	26.7	0.53	25
9/4/2008	1	28	25	45.0	25.0	1.80	15
9/11/2008	2	28	75	40.9	40.9	0.54	25
9/17/2008	2	14	35	64.4	35.0	1.84	250
9/17/2008	2	28	35	71.3	35.0	2.04	300
9/18/2008	1	28	25	49.6	25.0	1.98	151
9/25/2008	2	27	38	61.2	37.5	1.63	102
10/1/2008	2	28	35	66.7	35.0	1.90	151
10/2/2008	1	28	25	49.0	25.0	1.96	42
10/9/2008	2	27	38	62.8	37.5	1.67	305
10/15/2008	2	28	38	73.7	37.5	1.96	322
10/16/2008	1	28	25	44.0	25.0	1.76	46
10/22/2008	2	28	38	47.3	37.5	1.26	50
10/29/2008	2	29	38	53.1	37.5	1.42	38
10/30/2008	1	28	25	30.8	25.0	1.23	12
11/5/2008	2	28	38	43.0	37.5	1.15	25
11/12/2008	2	28	38	35.1	35.1	0.94	25
11/13/2008	1	28	25	17.6	17.6	0.70	10
11/19/2008	2	28	38	32.5	32.5	0.87	25
11/26/2008	1	28	25	31.0	25.0	1.24	10
11/26/2008	2	28	38	37.7	37.5	1.00	25
12/3/2008	2	29	38	45.6	37.5	1.21	31
12/10/2008	2	28	38	26.9	26.9	0.72	25
12/11/2008	1	28	25	23.0	23.0	0.92	10
12/17/2008	2	28	38	25.7	25.7	0.69	25
12/24/2008	1	28	25	22.0	22.0	0.88	10

12/24/2008	2	27	38	29.5	29.5	0.79	25
12/31/2008	2	27	38	28.8	28.8	0.77	25
1/7/2009	2	28	38	15.5	15.5	0.41	25
1/8/2009	1	28	25	9.5	9.5	0.38	10
1/14/2009	2	28	38	27.9	27.9	0.74	25
1/21/2009	2	28	38	25.8	25.8	0.69	25
1/22/2009	1	28	25	17.0	17.0	0.68	10
1/28/2009	2	28	38	25.0	25.0	0.67	25
2/4/2009	2	28	38	14.0	14.0	0.37	25
2/5/2009	1	28	25	6.8	6.8	0.27	10
2/11/2009	2	28	38	26.9	26.8	0.72	25
2/18/2009	2	28	38	23.8	23.8	0.63	25
2/19/2009	1	28	25	15.0	15.0	0.60	10
2/25/2009	2	28	38	25.9	25.9	0.69	25
3/4/2009	2	28	38	11.2	11.2	0.30	25
3/5/2009	1	28	25	5.5	5.5	0.22	10
3/11/2009	2	28	38	24.8	24.8	0.66	25
3/18/2009	2	28	38	18.2	18.2	0.49	25
3/19/2009	1	28	25	3.0	3.0	0.12	11
3/25/2009	2	28	38	23.0	23.0	0.61	25
4/1/2009	2	21	38	6.2	6.2	0.17	25
4/2/2009	1	28	25	0.0	0.0	0.00	10
4/8/2009	2	28	38	9.4	9.4	0.25	25
4/15/2009	2	21	38	5.0	5.0	0.13	25
4/16/2009	1	28	25	0.0	0.0	0.00	10
4/22/2009	2	29	75	18.2	18.2	0.24	25
4/30/2009	1	28	25	0.0	0.0	0.00	10
5/6/2009	2	29	75	14.4	14.4	0.19	25
5/14/2009	1	28	25	0.0	0.0	0.00	10
5/21/2009	2	28	75	13.0	13.0	0.17	25
5/28/2009	1	28	25	0.0	0.0	0.00	10
6/4/2009	2	27	75	2.8	2.8	0.04	25
6/11/2009	1	28	25	0.0	0.0	0.00	10
6/18/2009	2	28	75	4.0	4.0	0.05	25
6/25/2009	1	28	25	0.0	0.0	0.00	10
7/1/2009	2	15	38	0.3	0.3	0.01	25
7/16/2009	2	28	75	2.7	2.7	0.04	25
8/13/2009	2	28	75	0.0	0.0	0.00	25
9/10/2009	2	28	75	0.0	0.0	0.00	25
10/8/2009	2	28	50	0.0	0.0	0.00	25
11/5/2009	2	28	25	0.0	0.0	0.00	25
12/3/2009	2	35	25	0.0	0.0	0.00	25
1/7/2010	2	28	25	0.0	0.0	0.00	25

Note: The table reports data for all 91 auctions (excluding TSLF Options Program auctions) over the life of the Term Securities Lending Facility. Terms are in days, amounts are in billions of dollars, par value, and rates are in basis points.

Appendix Table A2. Dealer Sample

Firm Entity	Primary Dealer	Start	End	Schedule 1 (Total Auctions = 33)			Schedule 2 (Total Auctions = 58)		
				Primary Dealer	Leverage	Equity Return	Primary Dealer	Leverage	Equity Return
Bank of America Corporation	Banc of America Securities LLC	3/27/2008		33	33	33	58	58	58
Barclays PLC	Barclays Capital Inc.	3/27/2008		33	33	33	58	58	58
Bear Stearns Companies, Inc.	Bear, Stearns & Co., Inc.	3/27/2008	10/1/2008	13	5	5	16	5	5
BNP Paribas	BNP Paribas Securities Corp.	3/27/2008		33	33	33	58	58	58
Cantor Fitzgerald L.P.	Cantor Fitzgerald & Co.	3/27/2008		33	0	0	58	0	0
Citigroup, Inc.	Citigroup Global Markets Inc.	3/27/2008		33	33	33	58	58	58
Countrywide Financial	Countrywide Securities Corporation	3/27/2008	7/15/2008	8	7	7	8	7	7
Credit Suisse Group	Credit Suisse Securities (USA) LLC	3/27/2008		33	33	33	58	58	58
Daiwa Securities Group	Daiwa Securities America Inc.	3/27/2008		33	33	33	58	58	58
Deutsche Bank AG	Deutsche Bank Securities Inc.	3/27/2008		33	33	33	58	58	58
Allianz SE/Commerzbank	Dresdner Kleinwort Wasserstein Securities LLC.	3/27/2008	6/26/2009	33	33	33	50	58	58
The Goldman Sachs Group, Inc.	Goldman, Sachs & Co.	3/27/2008		33	33	33	58	58	58
HSBC Holdins plc	HSBC Securities (USA) Inc.	3/27/2008		33	33	33	58	58	58
Jefferies Group, Inc.	Jefferies & Company, Inc.	6/18/2009		1			9		
J.P. Morgan Chase & Co.	J. P. Morgan Securities Inc.	3/27/2008		33	33	33	58	58	58
Lehman Brothers Holdings Inc.	Lehman Brothers Inc.	3/27/2008	9/22/2008	13	11	13	15	12	15
Merrill Lynch & Co.	Merrill Lynch Government Securities Inc.	3/27/2008	2/11/2009	23	20	20	35	30	30
Mizuho Financial Group, Inc.	Mizuho Securities USA Inc.	3/27/2008		33	33	33	58	58	58
Morgan Stanley	Morgan Stanley & Co. Incorporated	3/27/2008		33	33	33	58	58	58
Nomura Holdings Inc.	Nomura Securities International, Inc	7/27/2009		0			6		
Royal Bank of Canada	RBC Capital Markets Corporation	7/8/2009		0			7		
The Royal Bank of Scotland Group plc	RBS Securities Inc. (Greenwich Capital through 4/1/09)	3/27/2008		33	33	33	58	58	58
UBS AG	UBS Securities LLC.	3/27/2008		33	33	33	58	58	58

Notes: The table reports the dates each firm was a primary dealer during the TSLF period and the number of Schedule 1 and Schedule 2 auctions on which the firm was a primary dealer. The table also lists the number of auctions for which we have a firm's quasi-leverage and cumulative equity returns.

Appendix Table A3. Primary Dealer Credit Facility Borrowing

Dealer	Number of Borrowings	Average Amount Borrowed	Maximum Amount Borrowed
Citigroup Global Markets Inc.	174	10.1	18.6
Morgan Stanley & Co. Inc.	122	11.2	47.6
Banc of America Securities LLC	118	5.4	11
Mizuho Securities USA Inc.	108	0.4	2.2
Merrill Lynch Government Securities Inc.	99	15	33.2
Countrywide Securities Corp.	75	1	1.7
Barclays Capital Inc.	74	5.5	47.9
Bear, Stearns & Co., Inc.	69	13.9	28.5
Cantor Fitzgerald & Co.	61	0.5	0.7
Goldman, Sachs & Co.	52	8.3	18
BNP Paribas Securities Corp.	43	1.5	4.6
Lehman Brothers Inc.	10	8.3	28
UBS Securities LLC	8	4.4	6.5
J.P. Morgan Securities Inc.	3	1	3
Credit Suisse Securities (USA) LLC	2	0.8	1
Daiwa Securities America Inc.	1	0.4	0.4
Deutsche Bank Securities Inc.	1	0.5	0.5
Dresdner Kleinwort Securities LLC	1	0.1	0.1
All primary dealers	1021	7.2	47.6

Notes: Amounts in billions of dollars. Excludes other broker-dealer credit (that is, lending to the London-based subsidiaries of broker-dealers). Not listed are dealers that never borrowed from the facility, two of which (Greenwich Capital Markets, Inc. and HSBC Securities (USA) Inc.) were primary dealers throughout the program, and three of which (Jefferies & Company, Inc., Nomura Securities International, Inc., and RBC Capital Markets Corp.) became primary dealers late in the life of the program, in June or July 2009.