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ABSTRACT

The Financial Crisis began and accelerated in short-term money markets. One such market is the multi-trillion dollar sale-and-repurchase ("repo") market, where prices show strong reactions during the crisis. The academic literature and policy community remain unsettled about the role of repo runs, because detailed data on repo quantities is not available. We provide quantity evidence of the run on repo through an examination of the collateral brought to emergency liquidity facilities of the Federal Reserve. We show that the magnitude of repo discounts ("haircuts") on specific collateral is related to the likelihood of that collateral being brought to Fed facilities.

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1 Introduction

The panics of the Global Financial Crisis took place outside of the traditional banking system. The largest institutions to fail or nearly fail—Bear Stearns, Lehman Brothers, AIG—were not traditional banks. Furthermore, the stress in the traditional-bank lending markets in late 2008 were preceded by turmoil in lightly regulated short-term money markets: sale and repurchase agreements (repo), asset-backed commercial paper (ABCP), structured investment vehicles (SIVs), collateralized debt obligations (CDOs), and other acronymic products. These non-bank institutions and markets go by a variety of names—shadow banking, market-based finance, securitized banking—but whatever we call them the challenge is the same: we do not have anywhere near the data needed to fully understand what happened.

This a major data gap, because an enormous new edifice of regulatory policy continues to be built on highly incomplete information. This gap will not easily be filled: in many cases, the raw data was simply not collected by anyone. Governments did not track—and in some cases stopped tracking—some of the markets. Furthermore, since most of these markets are operated over-the-counter, there are no centralized exchanges with comprehensive coverage. What we are left with is a hodgepodge of information from market makers, industry surveys, and government emergency programs. To make any progress, researchers must carefully combine these various sources. In this paper, we attack this problem by merging two unique data sets: first, information about the quantities of specific collateral used in Federal Reserve emergency programs and, second, trader supplied haircut data on various categories of bonds. With this combined dataset, we provide important evidence about the repo market, a major vector of crisis contagion.

Prior to the crisis, repo was a lightly regulated multi-trillion dollar market which funded nearly half of the asset holdings by the major investment banks. In a repo contract a lender makes a short term cash loan in exchange for collateral. The amount by which the loan is less than the value of the collateral is called the haircut. For instance, a bond with $100 value and 10% haircut will allow the borrower access to $90 in repo financing. An increase in the haircut for a type of collateral, then, is economically equivalent to a reduction in the quantity of securitized borrowing that can be done using a given amount of collateral. When repo contracts have short maturities, such reductions in borrowing can look just like old-fashioned runs on banks. Gorton and Metrick (2012) used evidence about haircut changes to infer such a "run on repo" during the crisis. But haircuts represent only *price* evidence consistent with a run. In this paper, we document *quantity* evidence of the run.

Repo is divided into two different markets: "tri-party repo" and "bilateral repo." In tri-party repo, a clearing bank stands between borrowers and lenders. Because the tri-party repo market is dominated by regulated institutions, the data there is relatively complete.[1] In contrast, bilateral

[1] See Copeland et al. (2010) for a discussion of the pre-crisis tri-party system.

repo is the home of hedge funds, many types of offshore institutions, and other unregulated cash pools. A 2004 industry survey found that bilateral repo was about three times as large as tri-party repo (see discussion in Gorton and Metrick (2015)). The situation is similar post-crisis. Baklanova et al. (2017) study a cross-section of bilateral repo transactions in the first quarter of 2015. They find that "...more than half the trades in terms of dollar volume involve a bank or a broker-dealer, followed by hedge funds. The results differ from that of tri-party repo, where the money market funds and cash reinvestment arms of securities lending agents are the largest participants."

Krishnamurthy et al. (2014) perform a careful study of repo quantities in the tri-party market and conclude that any runs were limited. However, the evidence in Gorton and Metrick (2015) shows that extrapolating from the tri-party market does not allow any inference for bilateral repo—thus leaving more than half of the market unknown. To study quantity evidence of a run on bilateral repo we exploit data from the emergency lending facilities set up by the Federal Reserve. These facilities allowed borrowers to bring collateral to the Fed in exchange for cash or Treasuries. Consistent with a run on repo, we show that an increase in haircuts on a given type of collateral in the repo market resulted in these assets being brought to the Fed as collateral against emergency loans. In a difference-in-differences setting, we use changes in bilateral repo haircuts to explain bank-collateral-level borrowing from three facilities—the Term Auction Facility (TAF), the Term Securities Lending Facility (TSLF), and the Primary Dealer Credit Facility (PDCF). Our finding is robust to including proxies for shocks to bank capital and counterparty risk.

We organize the paper as follows. In Section 2 we summarize the main features of the Fed emergency lending facilities. Section 3 discusses lending data provided by the Fed, the bilateral haircut data, and the merging of the two datasets. In Section 4 we present our empirical evidence: we show that changes in haircuts on specific asset classes caused borrowers to take those assets to the facilities. Section 5 concludes.

2 The Emergency Lending Facilities

During the 2007-2008 Financial Crisis the Federal Reserve introduced a number of temporary emergency facilities to address pressures in various financial markets. At one point there were nine temporary liquidity facilities in place.[2] In this paper we focus on three important facilities—the Term Auction Facility (TAF), the Term Securities Lending Facility (TSLF), and the Primary Dealer Credit Facility (PDCF)—that allowed depository institutions or primary dealers to borrow against collateral outside the usual discount window, and where detailed collateral data has been made available by the Fed.

Table 1 and Figure 1 summarize the main characteristics of the three programs. The TSLF was a

[2] https://www.newyorkfed.org/medialibrary/media/markets/Forms_of_Fed_Lending.pdf

security-for-security exchange. The borrower offered a bond as collateral, e.g., a mortgage-backed security, and received a Treasury bond in exchange. The TAF and the PDCF, on the other hand, lent cash against collateral. The TAF, like the regular discount window of the Federal Reserve, was only available to depository institutions; the TSLF and the PDCF were both open to primary dealers only. The PDCF, like the discount window, was a standing facility; the TAF and the TSLF were auction facilities. A standing facility is usually viewed as being subject to stigma, which may have limited the effectiveness of the PDCF. For more details on these programs, and concerns about stigma, see Fleming (2012) and Armantier et al. (2012).

The TAF opened on December 12, 2007 and the final auction was held March 8, 2010. Since the TAF was only open to depository institutions, the U.S. broker-dealers were excluded from using it.[3] Foreign banks with U.S. affiliates, however, were able to make use of the TAF. According to Benmelech (2012) "foreign banks accounted for 58 percent of TAF lending, with a total amount of $2.2 trillion, compared to $1.6 trillion for U.S. banks" (p. 4). Benmelech (2012) also notes that most of the financial institutions that were eligible pledged asset-backed and mortgage-backed securities (ABS), suggesting "that the meltdown of the structured finance market and the severe deterioration in the credit ratings of ABSs necessitated liquidity..." (p. 5). TAF borrowing peaked at nearly $500 billion in spring of 2009. We summarize the types of collateral brought to the facilities in Table 2.

The TSLF was introduced on March 11, 2008, right before Bear Stearns was acquired by JP Morgan on March 16, 2008. The first auction took place on March 27, 2008. Schedule 1 collateral (Treasuries, Agency MBS and Agency securities) auctions were suspended on July 1, 2009 and Schedule 2 collateral (investment-grade securities plus Schedule 1 collateral) auctions were suspended on February 1, 2010. The TSLF was designed to alleviate stress in financing collateral in money markets by allowing less-liquid, lower quality, collateral to be exchanged for Treasuries. Since the TSLF was a security-for-security exchange it did not increase the size of the Fed balance sheet and did not have to be sterilized. As a result, it could be increased in size quickly. TSLF borrowing reached $150 billion in its first month, and nearly $250 billion in September 2008.

The PDCF was announced on March 16, 2008 and closed on February 1, 2010. The PDCF can be thought of as simply an extension of the traditional discount window to allow access for non-bank primary dealers: it shared many of the same rules and institional arrangements as the discount window. At its peak in September 2008, total borrowing topped $150 billion. Adrian et al. (2009) provide more detail on the PDCF.

There are further differences between the facilities. The maturity of PDCF borrowing was overnight and the facility could be accessed daily. Maturities for borrowing from both the TAF and the TSLF were longer. TAF loan maturities were 28-84 days, while TSLF maturities were 28 days. The PDCF

[3]The remaining broker-dealer banks, Goldman and Morgan Stanley, became bank holding companies on September 22, 2008.

also accepted lower quality collateral than the TSLF.

2.1 Pricing

The three programs differed in how loans were priced and in how quantities were determined. Two of the programs, the TAF and the TSLF, allocated loans by holding regularly scheduled auctions. The third, the PDCF, was a standing facility. Figure 1 summarizes the rates paid and quantities borrowed from each program.

Both the TAF and the TSLF used similar auction mechanisms. Before each auction the Fed announced a maximum amount to be lent (the cap). Each eligible institution could submit up to two bids specifying the interest rate they would be willing to pay for a given amount of Fed Funds (in the case of the TAF) or Treasury collateral (in the case of the TSLF). The Fed then picked the lowest rate such that the total borrowing would be at or below the announced cap. All participants who received a loan paid this single rate on their borrowing. The Fed further imposed constraints on the total amount of borrowing done by any single institution.

What should we expect the interest rates on emergency loans to look like? TAF borrowers received Fed Funds (i.e., cash) in return for their collateral. Absent any risk or frictions in the Fed Funds market we would therefore expect the rate paid on TAF loans to track the effective Fed Funds rate. This is confirmed in Figure 1. The only exception is immediately after the Lehman failure when rates on TAF loans spiked well above the funds rate. The TAF maxed out in all auctions prior to the Lehman failure, after which the Fed increased the cap and the remaining auctions were all under-subscribed.

TSLF borrowers, in contrast, received Treasuries. As with TAF auctions, the Fed adjusted the borrowing cap in the TSLF auction-by-auction. Total borrowing was typically below the cap, with the exception of auctions immediately following the Lehman failure. Naturally, the auctions where the supply cap was binding were the ones where prices spiked.[4]

Unlike the auction-based facilities, the PDCF was a standing facility where each eligible institution (primary dealer) could get financing at the Fed discount window rate. There was a further penalty fee after 45 days of using the PDCF, but no daily cap. In the pre-crisis period the Fed discount window rate was set at target Fed Funds rate plus 100 basis points. In an attempt to reduce the stigma associated with borrowing from the discount window, the Fed reduced the prime rate spread to 25 basis points in 3/16/2008, where it stayed through the time-period studied in this paper.

[4]There is not a simple reference rate to compare to the TSLF rate. Outside extreme stress situations, we would expect arbitrage to keep the rate near zero, which is what we observe.

2.2 Haircuts

The three programs also differed in the haircuts applied to various types of collateral. The TSLF and the PDCF used a program-specific table, while the TAF used the discount window table. The haircuts depended both on type of collateral as well as maturity.

Because the characteristics in the haircut tables are not identical to categories reported in the Fed data we cannot calculate the exact haircuts applied to each type of collateral. We instead match the reporting categories to Fed haircut data and find equal-weighted averages. Table 4 in the Appendix shows that the average haircuts the Fed applied were small, and similar across the three programs.

Importantly for our empirical strategy, there were almost no changes in Fed haircuts in this sample period. The TAF used a fixed table for the duration of the program. The TSLF did not change haircuts within a category, but did expand the breadth of collateral eligible after the Lehman failure. The PDCF was the only program that changed haircuts within a category of collateral. However, the resulting haircut changes in terms of collateral categories used in our regressions are small in magnitude ($\approx 1\%$).

3 Data

Our empirical work studies bank-level changes in emergency borrowing from a given facility against specific types of collateral as a function of the change in bilateral repo haircuts. In this section we discuss data sources, and the data construction process. Specifically, we discuss the emergency borrowing data provided by the Fed and its match to the bilateral haircut data.

3.1 Data Provided by the Fed

The Fed provides loan-level data for each of the three emergency facilities discussed above. For each loan they report borrower bank name, loan date, clearing date, maturity date, interest rate, and value of collateral submitted. The amount of collateral provided by the borrower is further broken down by collateral type (Treasury, MBS, Corporate, Loans, etc.) and collateral rating (AAA, AA, etc.). The two sets of categories are slightly different across the three programs, as evident in the two panels of Table 2. These tables show the prevalence of various types of collateral in the programs. Note that the totals over type and rating do not always add up to the same number. This is because many types of collateral did not have a credit rating. In the case of the TAF, the Fed data reports all collateral brought to the discount window, including collateral held against standard discount window borrowing. The Appendix contains more detail on the Fed data.

3.2 Bilateral Haircut Data, Matching Haircuts to Fed Collateral Categories

We use the same bilateral repo haircut data as Gorton and Metrick (2012).[5] The haircuts are on transactions between high-quality dealer banks and would be higher for hedge funds and other non-dealer counterparties.

In order to study the relationship between private-market repo haircuts and corresponding borrowing from the emergency facilities, we need to match private-market repo haircut data with the borrowing data provided by the Fed. While the Fed collateral data is reported by both type and rating of collateral, the categories in our private-market data are a mixture of collateral quality and collateral type. Because of this incongruity we perform the regression analysis based on two separate matches—one by collateral rating and the other by collateral type.

We seek to match each Fed collateral category to every repo haircut category that could contain the collateral in question. In other words, we pick the haircut data categories so as to maximize the probability that the true haircut is included in the match. This minimizes the probability of missing a haircut change, but potentially introduces noise by including irrelevant haircut changes.

One observation in the regressions is the amount of borrowing from a specific facility against a given type of collateral, normalized by bank size. The effective haircut used in the regressions is a simple average of haircuts matched to that type of collateral. Note that a number of the Fed collateral categories are matched to no haircut data. In most cases this is because these assets did not have active repo markets, such as commercial loans or equity. In other cases—notably Treasuries—the haircuts never increased from zero so there would be no right-hand-side variation to exploit in the regressions.

The program-by-program match is reported in the Tables 1-3 of the Appendix. In the following we briefly describe the quality of match for each program.

- **TAF.** The collateral type categories Commercial Loans, Commercial and Residential Mortgages, and Consumer Loans are the major categories not matched to haircut data. Overall, 39% of the outstanding collateral is matched to haircut data based on collateral type.

  In terms of collateral rating categories, Other Investment Grade (22% of the collateral) and Treasury/Agency (10% of the collateral) are not matched to haircut data, with 68% matched to haircut data.

- **TSLF.** Here we have the best match with haircut data. The majority of borrowing was collateralized by Agency and non-Agency MBS, both of which are matched to the haircut data. Only Muni, Treasury, International, and Other are not matched, accounting for a total

[5] All data used for this paper, and an Appendix containing a detailed description of the data construction process are available at `http://faculty.som.yale.edu/andrewmetrick/data.html`

of 4% of the collateral provided.

Similarly, only 5% of collateral outstanding is not matched by rating.

- **PDCF.** The unmatched collateral type categories Treasury, Equity, Municipal, and Other represent an average of 51% of the collateral outstanding. An average of 58% of outstanding collateral is matched by rating.

3.3 Matching Borrower Data

We match each borrower name to the corresponding bank holding company (if applicable.) We then match the resulting holding company level borrowers to Bankscope identifiers, Bloomberg tickers, and Markit CDS identifiers. We merge in total assets in 2007 from Bankscope, daily market cap data from Bloomberg, and daily 5-year CDS rates from Markit. In all, 58% of the total loan volume outstanding corresponds to borrowers that are have total assets, market cap, and CDS data available.

We collapse borrowing from the TAF to the bank holding company level before matching to total assets, CDS, and market cap data. TSLF and PDCF borrowing is reported on the broker-dealer level.

3.4 Data Construction

As summarized in Table 1, the three programs operated on separate schedules. The PDCF was accessible daily, the TSLF held weekly auctions, and the TAF loans held biweekly auctions. Correspondingly, we study borrowing from each program at the associated frequency: daily, weekly, or biweekly.

For each program, we construct a borrower-collateral level panel data set of collateral brought to the Fed. For each collateral category, we calculate the private-market repo haircut as the equal-weighted average of all the matched repo haircuts. Because we have two separate haircut matches, we end up with two borrower-collateral level panel data sets. In regression analysis we use the two panels in parallel.

The timing in the regressions is contemporaneous. That is, we regress changes in bank-collateral level borrowing on changes in the right hand side variables during the same daily, weekly, or biweekly period. Because TAF auctions were held on Monday mornings we use the preceding two weeks changes in the explanatory variables.

The Appendix provides more detail on the specifics of data available from the Fed, and our procedure of constructing the panel.

4 Empirical Results

We now turn to examining the determinants of the timing of specific collateral being pledged at the various Federal Reserve emergency lending facilities by specific borrowers. We use the change in haircuts on various asset classes in the bilateral repo market to see if these changes cause that specific type of collateral to be pledged at emergency lending facilities.

Our empirical strategy is to use cross-sectional variation within collateral-specific haircuts to account for changes in borrowing from Fed facilities. We estimate regressions of the form

$$\Delta\text{Amount}_{i,j,t} = \beta_{HC}\Delta\text{Haircut}_{j,t} + \beta X_{i,t} + \beta_{\mathbb{I}}\mathbb{I}_{\text{Lehman}}\Delta\text{Haircut}_{j,t}X_{i,t} + \beta_{\text{L}}\mathbb{I} + \epsilon_{i,j,t},$$

where i indexes borrowers, j indexes collateral type, and t measures time at the appropriate intervals. $\mathbb{I}$ is a dummy variable equal to one on all dates on or after the Lehman bankruptcy of September 15th, 2008. We include the most granular fixed effects possible on bank-collateral level. Standard errors are clustered both on time and on borrower.

This main regression tests the hypothesis that emergency borrowing, by category, co-moves with corresponding haircuts by category. The underlying mechanism for such co-movement comes from market prices and borrowing constraints: if the market-based haircuts increase on a category of assets, then the bank must fund the additional amount itself. For example, suppose that initially there was a zero haircut so that a lender lent $100 and received a bond with a market value of $100 as collateral. If, the next day, haircuts for that type of bond rise to ten percent, then the bank must return $10 to the lender. Where does this $10 come from? One possibility is to sell the bond rather than fund it in the repo market (i.e., in a fire sale). Another possibility is to use the bond as collateral (if it is eligible) and borrow from an emergency lending facility and repay the repo lender.

The control variables $X_{i,t}$ seek to allow for alternative explanations of emergency borrowing. First, it could be that banks were driven to use emergency facilities because of shocks to equity value, perhaps from decline in the value of MBS on their balance sheets. We allow for this channel by including changes to each borrower's market capitalization, measured as percentage change over the August 2007 market cap. Second, banks could be borrowing from the facilities because they had become wary of counterparty risk. We include the change in the Libor-OIS spread as a general measure of counterparty risk, and the change in each bank's five year CDS rate to measure each borrower's specific risk as perceived by the market.

Figure 2 shows the time series of aggregate market cap of borrowers in the sample, and the value-weighted CDS index. As we would expect, these two series are strongly negatively correlated during the crisis. Figure 2 also plots the Libor-OIS spread, and the aggregate haircut index.

4.1 Bilateral Haircuts and Collateral Taken to Fed

Our results are summarized in Table 3. Here we are exploiting the full cross-sectional data available. Namely, the dependent variable measures the total change in total borrowing from a specific program by a given bank in a given period, using a specific type of collateral. In order to maintain comparability across banks we normalize borrowing in each category by the bank's total assets in 2007. In other words, quantities on the left-hand-side are always expressed as shares of total assets for the financial institution. Observations in each regression are weighted by bank size.

Consistent with our hypothesis, we find that changes in haircuts have strong explanatory power over emergency borrowing after the Lehman failure, particularly in the case of the TSLF and the TAF. For instance, consider the results in the third column of Table 3. The coefficient on the change in the haircut interacted with the Lehman dummy is 22.7. This means that a 10% increase in haircuts associated with a given collateral type would increase borrowing by $10\% * 22.7/1000 = 0.227\%$ in terms of the bank's total assets in 2007. For example, Goldman Sachs' total assets at the end of 2007 were $1,119,796 million, implying that the increase would result in an extra $2.5 billion of that collateral type being taken to the TSLF over the week.

5 Conclusion

Ten years after the bankruptcy of Lehman Brothers, there are still many open questions about the panics of the Global Financial Crisis. Scholars of the crisis have identified several aspects of short-term money markets as crucial to crisis propagation, but large data gaps prevent a full understanding. To fill one important gap, we combine price data from private repo markets with quantity data from emergency lending programs of the Federal Reserve. We use these data to study whether the change in repo haircuts can be traced to changes in the collateral brought to Fed programs. We find evidence of a strong relationship, thus supporting the run on repo as a propagation mechanism in the crisis.

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6 Tables and Figures

	TAF	TSLF	PDCF
Full Name	Term Auction Facility	Term Securities Lending Facility	Primary Dealer Credit Facility
Program Active	12/2007-4/2010	3/2008-8/2009	3/2008-5/2009
Loan Term	28 or 84 days	28 days	overnight
Timing	Bi-weekly auctions, typically on Monday morning. Loans settle Thursdays.	Weekly auctions, typically Wednesday or Thursday afternoon. Loans settle day after auction.	Standing facility. Daily borrowing.
Eligible Institutions	Prime credit eligible depository institutions	Primary dealers	Primary dealers
Accepted Collateral	Any collateral accepted at Discount Window	Originally, Treasury, Agency, and AAA rated MBS and ABS. Starting 9/14/2008 collateral that can be pledged on the tri-part repo market.	Originally, investment-grade securities. Starting 9/14/2008 collateral that can be pledged on the tri-party repo market.
Borrowers Receive	Fed Funds	General Collateral	Fed Funds
Haircut	Discount Window haircuts.	Open Market Operation haircuts for collateral that is eligible for OMOs	Open Market Operation haircuts for collateral that is eligible for OMOs
Prepayment	Not allowed.	Not allowed.	Not applicable.
Pricing	Fed announced maximum lending amount per auction. Eligible institutions submitted bids in terms of quantity and interest rate. Maximum of two bids per participant, and limit on total amount awarded to single institution. The auction rate was set as the lowest rate such that total borrowing would be at or below cap. All borrowers paid the same rate.	Fed announced maximum lending amount per auction. Eligible institutions submitted bids in terms of quantity and interest rate. Maximum of two bids per participant, and limit on total amount awarded to single institution. The auction rate was set as the lowest rate such that total borrowing would be at or below cap. All borrowers paid the same rate.	Loans made at the prime credit rate, subject to a further usage fee after 45 days of borrowing. No quantity limit. Prime credit rate was lowered to Fed Funds Target + 25bps in 3/2008.

Table 1: Characteristics of the three emergency liquidity programs. Source: FAQs on Federal Reserve website (`https://www.federalreserve.gov/monetarypolicy/expiredtools.htm`)

Table 2: Types of Collateral Used in the Programs. Average Amount of Collateral Outstanding in the Category. Classifications as reported in Fed data. Amounts in millions USD. Sample runs from start of programs until end of haircut data in 2/2009.

Panel A.

	Total			After Lehman Failure			Match
Collateral Type	TAF	TSLF	PDCF	TAF	TSLF	PDCF	
ABS	39,258	14,382	2,110	59,146	21,755	3,179	1
Commercial Mortgages	19,178			39,131			
Commercial Loans	52,313			106,118			
Consumer Loans	17,568			42,018			
Corporate Instruments	19,597	17,915	6,235	30,675	38,755	12,923	1
Equity			6,083			13,614	
International	10,384	16	38	16,329	34	84	
Agency MBS	6,357	93,920	2,066	14,965	124,239	613	1
Other MBS	16,357	50,512	2,282	22,966	35,827	2,372	1
Munis	6,634	3,569	3,899	10,424	7,720	8,366	
Other		2	2,583		5	5,782	
Residential Mortgages	17,147			36,975			
Treasury, Agency	4,560	4,273	338	6,488	2,042	641	
Total	209,353	184,590	25,634	385,234	230,378	47,574	

Panel B.

	Total			After Lehman Failure			Match
Collateral Rating	TAF	TSLF	PDCF	TAF	TSLF	PDCF	
A	8,243	6,568	1,570	14,486	14,207	3,012	1
A1-A3		5,793	167		12,532	341	
AA	10,704	6,048	1,562	17,047	13,083	3,058	1
AAA	45,588	59,303	5,098	67,349	47,359	7,744	1
BBB-B	5,748	8,030	3,765	10,613	17,371	7,455	1
CCC or lower			1,093			2,446	1
Equity			6,083			13,614	
Agency MBS		93,920	2,066		124,239	613	1
Other Investment Grade	22,592			30,807			
Treasury, Agency	10,272	4,273	338	20,691	2,042	641	
Total	103,148	183,934	21,742	160,993	230,833	38,924	

Table 3: Bank-Collateral Level Regressions Data from 12/21/2007 to 1/30/2009. Biweekly regressions for TAF, weekly regressions for TSLF, and daily regressions for PDCF. The left hand side variable is the change in amount borrowed by a given bank from a given program, collateralized by a type of collateral, normalized by borrower total assets in 2007. Regression observations weighted by borrower 2007 total assets. Standard errors in all specifications double-clustered by corresponding time period and borrower. Fixed effects included on the borrower-collateral level. The two regressions for each program reflect the haircut match on collateral rating and collateral type, respectively.

	TAF		TSLF		PDCF	
	Rating	Type	Rating	Type	Rating	Type
Δ Haircut	-0.404	-0.138	0.723	0.346	-0.00405	0.0122
	(0.263)	(0.177)	(1.144)	(0.426)	(0.00165)	(0.0215)
Lehman X Δ Haircut	2.447	4.084	22.68	16.16	1.192	2.445
	(1.272)	(1.732)	(4.028)	(5.163)	(0.988)	(2.791)
Lehman	0.00656	0.0213	-0.0558	-0.0365	0.00380	0.00395
	(0.0194)	(0.0256)	(0.0428)	(0.0690)	(0.00549)	(0.00909)
Δ Libor-OIS Spread	0.0177	0.00415	0.910	1.203	0.0234	0.0641
	(0.0826)	(0.120)	(0.461)	(0.562)	(0.0446)	(0.100)
Lehman X Δ Libor-OIS	0.0177	0.0179	-0.922	-1.147	0.0782	0.141
	(0.0760)	(0.117)	(0.487)	(0.599)	(0.0769)	(0.131)
Δ Market Cap	0.0802	0.0619	0.489	0.532	-0.0178	0.0523
	(0.0808)	(0.177)	(0.610)	(0.749)	(0.0155)	(0.105)
Lehman X Δ Market Cap	-0.0961	0.185	-0.782	-0.626	-0.720	-1.701
	(0.149)	(0.410)	(0.692)	(0.878)	(0.494)	(1.060)
Δ CDS	-0.0122	-0.0188	-0.0979	-0.0778	-0.00630	0.00638
	(0.0465)	(0.0684)	(0.0694)	(0.0720)	(0.00767)	(0.0237)
Lehman X Δ CDS	0.0252	0.0174	0.145	0.228	-0.122	-0.247
	(0.0456)	(0.0749)	(0.111)	(0.151)	(0.0705)	(0.158)
Observations	4383	3450	3057	2464	19418	10141
R^2	0.017	0.016	0.032	0.028	0.024	0.024

Standard errors in parentheses

Figure 1: Auction Prices and Quantities. All rates reported in annualized percent terms. TSLF and TAF rates calculated as value-weighted averages across loans. Auction limits and total amounts borrowed reported in billions of USD.

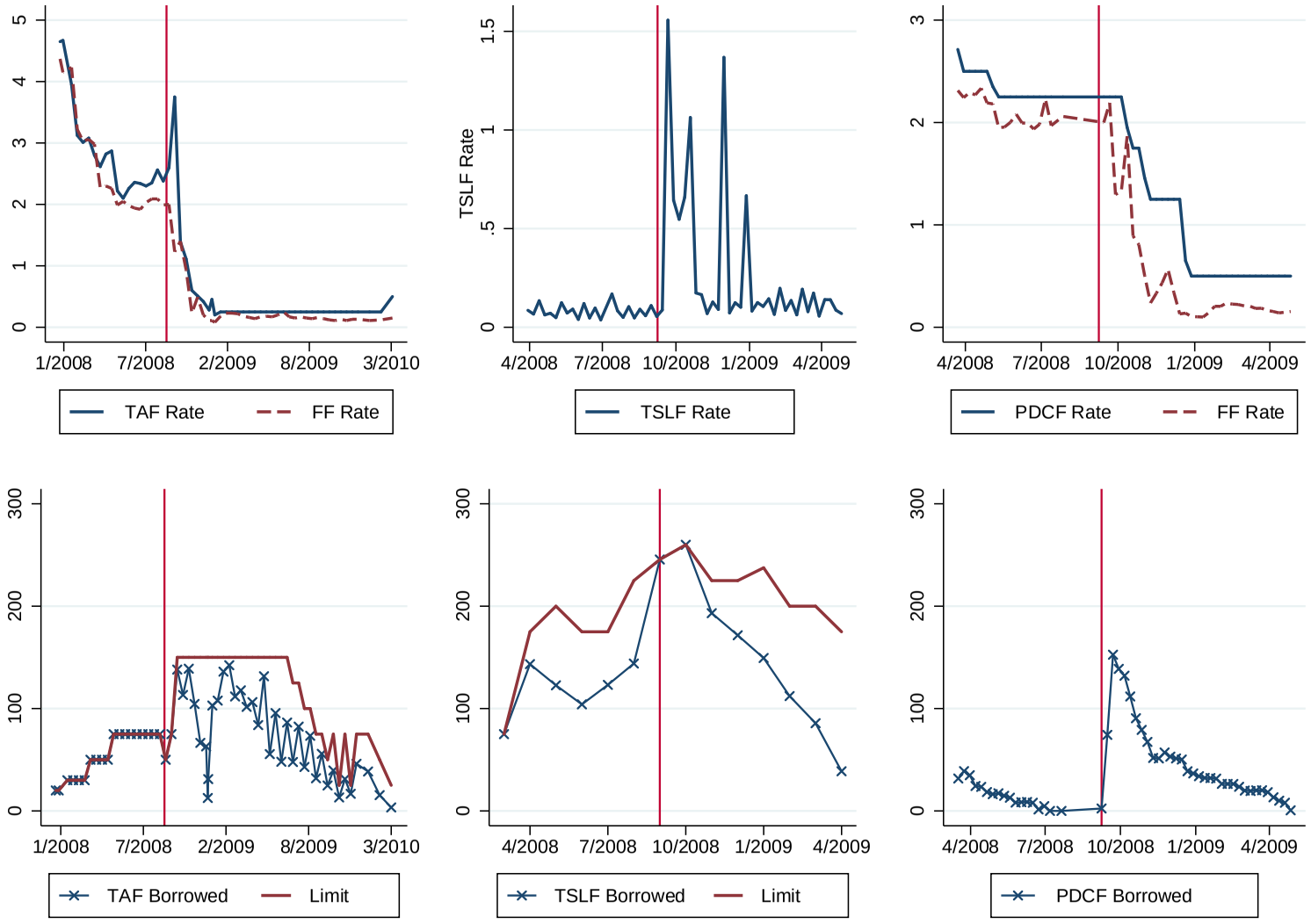

Figure 2: Haircut Index. Matched borrowers' market cap and value-weighted CDS rate. Fed Funds target and effective rate. Libor-OIS, GC Repo-Treasury, and GC Repo-Fed Funds spreads. Red vertical line depicts the Lehman failure. Haircut index is the equal-weighted average of haircuts in nine categories. Market cap is in billions USD. CDS in percent. Effective and target Fed Funds rate in percent. Libor-OIS and General Collateral-1m Treasury spreads in percent.