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Repo run: evidence from the tri-party repo market

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Staff Report no. 506
July 2011

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Repo Runs: Evidence from the Tri-Party Repo Market

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JEL classification: E44, E58, G24

Abstract

This paper provides a quantitative account of the tri-party repo market during the recent financial crisis. Using data from July 2008 to January 2010, we show that the level of haircuts and the amount of funding were surprisingly stable in this market. The stability of the haircuts contrasts with evidence from the bilateral repo market, where, as shown by Gorton and Metrick (2011), haircuts increased sharply. During the crisis, adjustments in the volume of funding to dealers were not gradual; instead, the amount of funding in the tri-party repo market can decrease precipitously. Our findings suggest that runs in the tri-party repo market resemble traditional bank runs.

Key words: tri-party repo, wholesale funding, short-term funding

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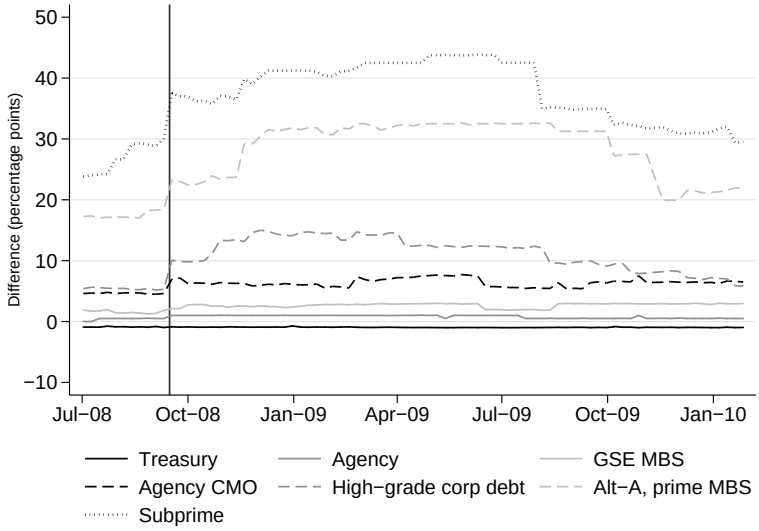
1 Introduction

The large US tri-party repo market serves a key source of short-term funding for securities dealers, is critical for secondary market liquidity in Treasuries and other securities, and plays an important role in the pricing and price discovery of cash and derivatives instruments. As such, it is important to understand the stability of this market during times of stress and the potential for runs on securities dealers. Indeed, the problems experienced by Bear Stearns and Lehman Brothers during the crisis were associated with a large and precipitous decrease in their tri-party repo funding. In this study of the behavior of haircuts and quantities in this market, we show that when a securities dealer's solvency is called into question, the main margin of adjustment is a decrease in the quantity of funding, as opposed to changes in the level of haircuts. Furthermore, the adjustment in funding appears to be highly nonlinear, in that funding does not seem affected until some critical threshold is reached, after which funding dramatically falls. After arguing that these run dynamics resemble those of traditional bank runs, we then document how they differ from runs observed in other repo markets.

The U.S. tri-party repo market has evolved into the main source of funding for securities dealers. Before the crisis, large dealers typically obtained several hundred billion dollars of funding in this market from cash investors, including money market mutual funds and securities lenders. Today, several dealers still have books exceeding $100 billion. Both before and during the crisis, this funding was mostly in overnight term.

We show that haircuts in the tri-party repo market barely moved during the crisis, in stark contrast with the behavior of haircuts in other repo markets, as documented by Gorton and Metrick (2011). Gorton and Metrick study an interdealer bilateral repo market and show that haircuts increased dramatically, similar to "haircut spirals" modeled in Brunnermeier and Pedersen (2009) (see also Adrian and Shin (2010)). In that sense, that market appears to have suffered from a generalized run. In the tri-party market, however, haircuts for all but the lowest-quality collateral changed very little. Even for low-quality collateral, the increase in haircut was much less pronounced than in the bilateral market. Figure 1 shows the differences

Figure 1: Differences in Haircuts between Bilateral Repo and Tri-Party Repo



Note: Difference in medians calculated as bilateral repo median minus tri-party repo median for each asset class. Vertical black line corresponds to Lehman Brothers' bankruptcy.

in the average haircut between the tri-party and the bilateral repo market. We discuss this figure in more detail later in the paper but note here that the increase in the spread between tri-party and bilateral repos is almost entirely driven by increases in bilateral repo haircuts. Furthermore, these spreads are sizable for high-grade corporate debt (over 10 percentage points in 2009) and enormous for Alt-A and subprime collateral (over 30 percentage points in 2009).

We also show that investors did not seem to make gradual adjustments to the quantity of funding they provided. Instead, funding was mostly stable during and after the crisis period, except in rare cases when funding dropped precipitously. We show that the Lehman's tri-party repo book decreased dramatically just days before the holding company declared bankruptcy.[1] In addition, we show that for four other events in which securities dealers suffered shocks, funding and haircuts remained remarkably stable. The lack of adjustment in haircuts and the potentially sharp adjustments in quantities make runs in the tri-party repo resemble traditional

[1]We do not have data for March 2008, but anecdotal evidence suggests that Bear Stearns' experience was similar to that of Lehman Brothers. See, for example, Friedman (2010).

bank runs (see Martin, Skeie, and von Thadden (2010) for a theoretical study).

Our paper is related to Gorton and Metrick (2011), who study the bilateral repo market. Our paper does not add new evidence on this market but allows for a comparison between the bilateral and the tri-party repo markets. Krishnamurthy, Nagel, and Orlov (2011) have data on the investments of money market mutual funds and securities lenders. Both of these types of investors represent a large share of cash invested in the tri-party repo market. Consistent with our paper, their study shows that funding appears mostly stable in the tri-party repo market, although they provide evidence of a sharp reduction in the amount of non-agency mortgage-backed securities (MBS) and asset-backed securities (ABS). This decline, which occurred before the beginning of our sample, could be interpreted as a generalized run on that particular asset class. Because our data are not limited to money market mutual funds and securities lenders, we are able to document the dealers' funding positions in the tri-party repo market, starting in July 2008.

In the remainder of the paper, section 2 provides an overview of the U.S. tri-party repo market, section 3 describes our main findings, section 4 discusses our results, and section 5 concludes.

2 The tri-party repo market in the United States

In the United States, a tri-party repo is a form of repo for which a third party, called the clearing bank, provides clearing and settlement services to the cash investor and the collateral provider.[2] Tri-party repos are popular in part because of the efficiency gains associated with the services provided by the clearing bank.

[2] Appendix C in Copeland, Martin, and Walker (2010) defines and provides a brief overview of repos. See also Garbade (2006).

2.1 Main actors in tri-party repo

Three main actors operate in the U.S. tri-party repo market: collateral providers, cash investors, and the clearing banks.

Collateral providers borrow cash from the cash investors and secure the transaction by posting collateral. Primary dealers, who are banks or securities broker-dealers that can trade directly with the Federal Reserve, supply the majority of collateral in the tri-party repo market.[3] Other dealers, some large hedge funds, and other institutions with large portfolios of securities also participate in the tri-party repo market, but they represent a small share of the total volume. We use the terms collateral providers and dealers interchangeably in this paper.

Dealers enter the tri-party repo market for at least two main reasons. First, they seek to economize on their use of capital and so prefer to borrow cash to purchase the securities they hold (Tuckman 2010). In turn, the securities can serve as collateral to obtain cash, providing one way in which securities dealers can obtain leverage.[4]

Second, dealers provide intermediation services to clients seeking cash, for example in their role as prime brokers to hedge funds. Such services are typically provided through a repo transaction, in which the dealer extends cash to the client against collateral. This collateral can be rehypothecated in the tri-party repo market, provided the client allows it.

The second set of actors is the cash investors, which are more numerous and diverse than the set of collateral providers.[5] Money market mutual funds represent between a quarter and a third of the cash invested in the tri-party repo market, while securities lenders represent

[3]For more information on primary dealers, see http://www.newyorkfed.org/markets/primarydealers.html.

[4]Consider the stylized example of a dealer with $1 billion in capital. This dealer can use its capital to buy $1 billion in securities and repo these securities to obtain cash. If the haircut on the repo is 5 percent, the dealer can get $950 million in cash. With this cash, the dealer can buy new securities and repo them out to get more cash. Assuming the same haircut, the dealer can get an additional $902.5 million in cash in that way. Continuing this process, the dealer can obtain a portfolio of securities worth $20 billion with its $1 billion in capital. The formula to find the value of the portfolio of securities is: $1+0.95+0.95^2+...=\sum_{i=0}^{\infty}0.95^i=\frac{1}{1-0.95}=20$. This example provides an upper bound, as it assumes that the dealer is fully leveraged, which is not generally the case.

[5]Investors are single firms but can include the securities lending division of a bank as well as the asset management division. Similarly, a money market mutual fund complex is considered a single investor.

another quarter. Securities lenders use the tri-party repo market to re-invest the cash collateral they receive when they lend securities.[6]

According to FRBNY (2010), the top ten dealers "account for approximately 85 percent of the value of tri-party repo securities being financed, and the top ten cash investors provide about 65 percent of the funds invested. The largest individual borrowers routinely finance more than $100 billion in securities. At the peak of market activity, the largest dealer positions exceeded $400 billion. The largest cash investors individually provide more than $100 billion in tri-party repo financing daily."

The third set of actors is the clearing banks: JPMorgan Chase and the Bank of New York Mellon. The clearing banks play an important role as provider of clearing and settlement services. They take custody of securities used as collateral in a tri-party repo transaction, they value the securities and make sure that the specified haircut is applied, they settle the transaction on their books, and they offer services to help dealers manage the use of their collateral.[7] The tri-party repo clearing banks do not match dealers with cash investors, nor do they play the role of brokers in that market.

The clearing banks act as an agent to the collateral providers and the cash investors in all the roles noted above. In the U.S. tri-party repo market, the clearing banks also play the role of principal because they finance the collateral provider's securities during the day.[8] We describe

[6]In the United States, a security cannot be sold short by an institution that does not borrow the security to make delivery, an activity also known as "naked" short selling (SEC regulation SHO, see http://www.sec.gov/divisions/marketreg/mrfaqregsho1204.htm). The ban on naked short selling creates an important role for securities lending, which allows an institution that wants to sell a security short to borrow it. Custodial banks often provide the service of lending the securities of their clients. In the United States, most securities lending is done against cash collateral. Hence, securities lenders usually have large pools of cash that they seek to re-invest, on behalf of their clients. While investment strategies for these pools of cash may differ, they often resemble the investment strategies of money market mutual funds. This is in part due to the fact that many securities lending deals are "open," meaning that the lenders must return the cash collateral to the borrower as soon as that borrower returns the security. Hence, the securities lender is exposed to "redemption requests" that are somewhat similar to pressures faced by money market mutual funds.

[7]Each of these roles is considered in more detail in Copeland, Martin, and Walker (2010).

[8]One of the goals of the the Task Force on Tri-Party Repo Infrastructure is to sharply reduce the amount of intraday credit extended by the clearing banks in this market (http://www.newyorkfed.org/prc/report_100517.pdf). Copeland, Duffie, Martin, and McLaughin

the timing that leads to this extension of credit in the next section.

2.2 Timing of events

This section describes the timing of events in the tri-party repo market. This description focuses on market practice before the proposed reforms announced on May 17, 2010.[9] A particularly important step in the timing of a repo is the morning unwind, described below, which contributes to the fragility of this market.

2.2.1 Morning: Trade agreement

A cash investor and a collateral provider typically agree on a tri-party repo before 10 a.m. Anecdotal evidence suggests that 90-95 percent of a dealer's tri-party repos are arranged before that time. The agreement specifies the amount of cash the investor will provide, the interest rate, the term of the repo, and the acceptable collateral.

The majority of tri-party repos are believed to be overnight or "open" repos. Open repos roll over by default, unless one of the parties explicitly chooses to cancel the transaction. The haircut that applies to a particular collateral class is not negotiated at the trade level but, instead, is specified in the appendix of the custodial undertaking agreement between the three parties. Hence, changing haircuts requires amending the agreement. A trade agreed in the morning does not settle until the afternoon, around 6 p.m.

2.2.2 Afternoon: Collateral allocation

In the afternoon, after the close of Fedwire® Securities Service and the Depository Trust & Clearing Corporation (DTCC), the collateral provider knows the composition of its portfolio.

(2011) discuss policy issues related the the U.S. tri-party repo market.

[9]The report of the Task Force on Tri-Party Repo Infrastructure is available at http://www.newyorkfed.org/prc/report_100517.pdf . The Federal Reserve Bank of New York released a white paper commenting on the report and describing the weaknesses in that market. The white paper is available at http://www.newyorkfed.org/banking/nyfrb_triparty_whitepaper.pdf .

With this information, and with the information provided by the cash investors on the amount of financing they will provide and the securities they will accept as collateral, the dealers can allocate acceptable collateral to each trade. The clearing bank provide tools to make sure that only collateral acceptable to the investor gets allocated to repos and to guarantee that the haircut specified in the custodial agreement applies.[10]

The settlement of the initial leg of the repo trade occurs on the books of the clearing banks in the afternoon. Balances are transferred from the investor's balances account to the collateral provider's balances account, while securities are transferred from the collateral provider's securities account to the cash investor's securities account.

2.2.3 Next morning: The "unwind"

Between 8 and 8:30 a.m. the next morning, the clearing banks "unwind" tri-party repo trades. The unwind consists of sending the balances back to the investor's balances account and the securities back to the collateral provider's securities account on the books of the clearing bank. At the same time, the clearing banks extend intraday credit to the dealer since the securities are no longer financed by the tri-party investors.

All repos, including term repos and open repos that are rolled over, are unwound. Term trades are "rewound" every evening, at the same time as the initial leg of new repos is settled, but not necessarily with exactly the same collateral. Reallocating collateral for term trades could be desirable even if the repos were not unwound. The tri-party repo is considered "general collateral" financing, meaning that an investor may care about the class of collateral it receives but not about the specific issue. Hence, the collateralization of a trade could vary from day to day or even intraday, as the dealer's portfolio of securities changes.

The unwind is necessary because collateral providers need access to their securities during the day to satisfy delivery obligations and because the clearing banks had not previously invested in systems that would allow substitution of collateral in a repo. As part of the Task

[10] Copeland, Duffie, Martin, and McLaughin (2011) provides more details on this collateral allocation process.

Force reforms, the clearing banks plan to offer collateral substitution services.

Dealers often keep securities that are not financed through tri-party repos in custody at the clearing bank. The clearing banks employ a risk management concept called net free equity (NFE) to ensure that the value assigned to the dealer's securities on their books exceeds the value of the intraday loan. Using NFE, the clearing banks can allow dealers to buy and sell securities in an operationally efficient manner.

2.3 Empirical description

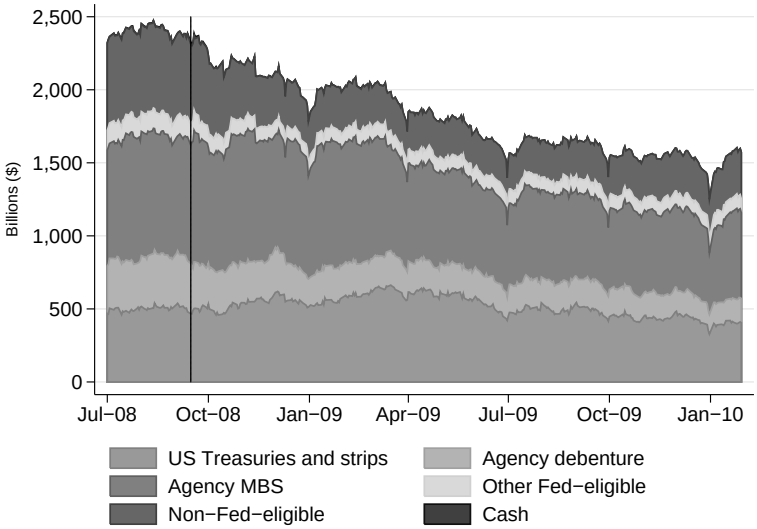
The Federal Reserve Bank of New York collects data on the tri-party repo market. The data to which we have access include the quantity and type of collateral posted in this market and the haircuts associated with various types of collateral. These data are not the universe of dealers and investors, but rather all the major players, that account for the vast majority of tri-party repo activity. For each dealer, we observe the daily total value of collateral posted and the amount of posted collateral associated with the haircut, by collateral class. For example, we observe that dealer X posted $102 billion of agency MBS on January 1, 2009, as collateral and that $2 billion of that collateral is for the haircut. Hence, we can deduce that dealer X borrowed $100 billion in cash, securing that loan with $102 billion in agency MBS.[11]

For investors, we have the data in two different forms. For one clearing bank, denoted clearing bank A, we know the joint distribution of collateral and investors. For each investor, we observe the daily total value of collateral accepted by asset class, including the haircut and excluding accrued interest. For the other clearing bank, denoted clearing bank B, we know the joint distribution of investors and dealers. For each dealer, we observe the daily total amount of cash lent by investors. Both the investor and the dealer data are at a daily frequency, from July 1, 2008, to January 27, 2010.[12]

[11]The collateral valuations include accrued interest, and thus our calculations of cash borrowed will be overstated by the amount of accrued interest. This is a tiny amount, however, especially because we are considering a period of very low interest rates.

[12]The General Collateral Finance (GCF) repo market, a blind-brokered interdealer market run by the Fixed Income Clearing Corporation (FICC), settles in the tri-party repo market. Depending on the question, including

Figure 2: Tri-Party Repo Market Size ($ billions of collateral)



Note: July 17, 2008 excluded due to missing data from one clearing bank. Vertical line represents Lehman Brothers' bankruptcy.

Our data begin after the fall of Bear Stearns but before the Lehman Brothers' bankruptcy. Before Lehman declared bankruptcy, almost $2.5 trillion worth of collateral was posted in the tri-party repo market each day. This number is slightly down from a historic high of $2.8 trillion in April 2008 (FRBNY 2010). After Lehman Brothers declared bankruptcy, collateral posted in this market fell gradually until about July 2009, after which the amount of collateral posted in the tri-party repo market stabilized at a level slightly above $1.5 trillion (see figure 2). This decline is also seen in the amount of collateral posted after taking out haircuts and is thus not a product of haircuts changing over time. We believe the decline in collateral posted in tri-party repo reflects a number of outside processes, rather than reflecting problems with the

GCP repos along with regular tri-party repos could be considered double-counting. In the investor data, we observe GCF repos and so can remove these observations when appropriate. In the dealer data, however, we do not observe a breakdown between GCF and regular tri-party repo deals. Starting after our data end, the Tri-Party Repo Infrastructure Reform Task Force publishes snap shots of the tri-party repo market, including statistics on the nominal value of GCP repos (http://www.newyorkfed.org/tripartyrepo/index.html). In May 2011, the total amount of securities delivered to the FICC for GCP repos was $171.6 billion.

tri-party repo market itself. These include a general deleveraging by dealers in response to the financial crisis, runoff caused by maturing assets and a decline in new issuance, declines in valuations that reduced the size of dealers' portfolios, and the removal of agency MBS securities through the Federal Reserve's Large Scale Asset Purchase (LSAP) program.[13] Given that the quantity of collateral posted in the tri-party repo market stabilized during the summer of 2009, we divide our sample into two periods. We denote from July 2008 to June 2009 as the "crisis" period and from July 2009 to January 2010 as the "stable" period.

Across these two periods, the composition of collateral posted in tri-party repo did not change much (see table 1). Over three quarters of all collateral posted over the whole sample are composed of highly liquid securities, such as U.S. Treasuries, agency MBS, and agency debt. The next-largest asset class, corporate bonds, maintains a share of just over 5 percent of the market. However, the comparison between the stable period and the crisis period does obscure a substantial fall in non-Fed-eligible collateral.[14] As seen in figure 2, there was about $600 billion non Fed-eligible collateral in July and August of 2008. Starting around September 2008 (the same month Lehman Brothers declared bankruptcy), the amount of non Fed-eligible collateral posted in tri-party repo steadily fell until the first quarter of 2009, when it leveled out at around $300 billion.

From July 2008 to January 2010, there were 32 dealers active in our sample, a large number of which were primary dealers. Even within our sample of the larger dealers in tri-party repo, the dealer side of the market is quite concentrated, with the top five dealers accounting for 57 percent of collateral posted and the top 10 accounting of 86 percent. We separate dealers into two categories: "large" dealers with a daily average of more than $50 billion in posted collateral, and "small" dealers with a daily average of less than $50 billion.[15] On average, "large" dealers provide about $140 billion of collateral each day, using 11 different types of

[13]Background on the LSAP can be found at `http://www.newyorkfed.org/markets/funding_archive/lsap.html`.

[14]Fed-eligible securities are securities that can be settled on the Fedwire® Securities Service, while Non-Fed eligible, also called DTC-eligible, can be settled by the Depository Trust Company (DTC).

[15]The one exception is that we treat Lehman Brothers as a large dealer, because it averaged $173 billion before September 15, 2008.

Table 1: Composition of Tri-Party Repo Collateral (percent)

		Crisis	Stable	All
Fed-eligible collateral	Agency Debentures	12.6	11.4	12.2
	Agency MBS	37.4	36.3	37.1
	Agency Remic	4.1	4.6	4.2
	Ginnie Mae MBS Pools	0.9	1.2	1.0
	Ginnie Mae REMICs	0.3	0.3	0.3
	U.S. Treasuries and Strips	26.8	29.0	27.4
	sub-total	82.1	82.7	82.2
Non-Fed-eligible collateral	Asset-Backed Securities	2.2	2.4	2.2
	Commercial Paper	0.4	0.3	0.4
	Corporate Bonds	5.5	5.9	5.6
	DTC-Other	0.1	0.4	0.2
	Equity	4.1	4.0	4.1
	Money Market	1.3	1.6	1.4
	Municipal Bonds	0.9	0.7	0.9
	Other	0.1	0.1	0.1
	Private Label CMO	2.7	2.0	2.5
	Whole Loans	0.7	0.1	0.5
	sub-total	18.0	17.5	17.9

Note: "Crisis" is the period from July 2008 to July 2009, "Stable" is from July 2009 to January 2010 and "All" covers both sample periods. Fed-eligible securities are securities that can be settled on the Fedwire® Securities Service, while non-Fed eligible, also called DTC-eligible, can be settled by the Depository Trust Company (DTC).

collateral, while "small" dealers provide $10 billion using six types of collateral.

We find that large dealers tend to borrow from a number of investors. Using the investor data from clearing bank B, we find that the top five dealers of that clearing bank borrow from an average of 53 investors each. Yet dealers still rely significantly on specific investors; for the top five dealers, the largest investor's share of a dealer's overall borrowing is 19 percent. Not surprisingly, smaller dealers borrow from fewer investors. The median number of investors for the five dealers who borrow the smallest amounts is one. It should be noted that the composition and characteristics of dealers differ across clearing banks, so that the behavior of dealers of clearing bank B may not be entirely generalizable to that of clearing bank A.

Like the dealer side, there is concentration on the investor side, with roughly 70 percent of collateral posted being held by the largest 10 investors in our data. The largest 10 investors typically lend over $100 billion each day, across a number of dealers.[16] Using the investor data from clearing bank B, we find that the largest number of dealers to which an investor lent cash on a single day was 11. Small investors, which make up the majority of the investors in our data but account for only a small fraction of the cash lent, generally lend to a single dealer. The value-weighted median number of dealers to which an investor will lend cash on a single day is six. The statistics on the number of dealers to which an investor will lend are understated, however, since they are based on data from one clearing bank and the larger cash investors are active with both clearing banks.

3 Main Empirical Findings

In this section, we focus on haircuts and the stability of investor-dealer relationships in the tri-party repo market. We first document how haircuts differ across collateral classes and counterparties. Next, we detail how haircuts did not move during the recent financial crisis. Finally,

[16]To compute these numbers, we combined investors' positions across clearing banks. This entailed adding dollars of collateral held (from clearing bank A) and dollars of cash invested (from clearing bank B). Because of haircuts, these figures are not equivalent, but for these purposes this difference is not important.

we document how little investors and dealers alter the collateral-posted or cash-invested portions of their repo arrangements on a daily basis. This last result is particularly surprising, given the recent turmoil in financial markets and our understanding that the vast majority of tri-party repo contracts in our data are overnight.[17]

3.1 Haircuts in tri-party repo

If the dealer defaults on its repo agreement, the collateral securing the transaction partially protects the cash investor from losses. The haircut on a repo transaction, which measures how much a repo transaction is over collateralized, is a way for a cash investor to minimize losses from liquidating collateral in the event of default. Given that collateral classes differ in liquidity, we expect to see haircuts differ across collateral class.

Our data confirm that haircuts differ across collateral type, with more illiquid collateral commanding higher haircuts. We list average haircuts by collateral class in table 2 for the whole sample, as well as for the crisis and stable subperiods. The more liquid securities, such as U.S. Treasuries, agency debentures, and agency MBS, have lower haircuts relative to the less liquid securities, such as asset-backed securities and corporate bonds. Furthermore, the standard deviations of haircuts by collateral class increase as we move from more to less liquid collateral. This finding suggests that counterparty risk may play a role in the setting of haircuts, especially for the less liquid collateral classes.

To better illustrate the variance in haircuts by counterparty, in figure 3 we plot median haircuts by dealer and collateral class. In the figure, each dealer is randomly assigned a number consistent across asset classes. For example, dealer 20 has an average haircut of about 117 for both private label collateralized mortgage obligations (CMO) and asset-backed securities. Two features of figure 3 stand out. First, dealers face substantial heterogeneity in haircuts,

[17] While we lack maturity information in our data, industry contacts consistently report that the largest tenor in this market is, by far, overnight. For example, FitchRatings Fund & Asset Manager Rating Group reports in its Money Market Funds U.S.A. Special Report (Oct. 4, 2010) that 81.8 percent of repo allocations by Fitch-Rated taxable money market funds as of August 31, 2010, were overnight.

Table 2: Tri-Party Repo Haircuts: Mean and Standard Deviation

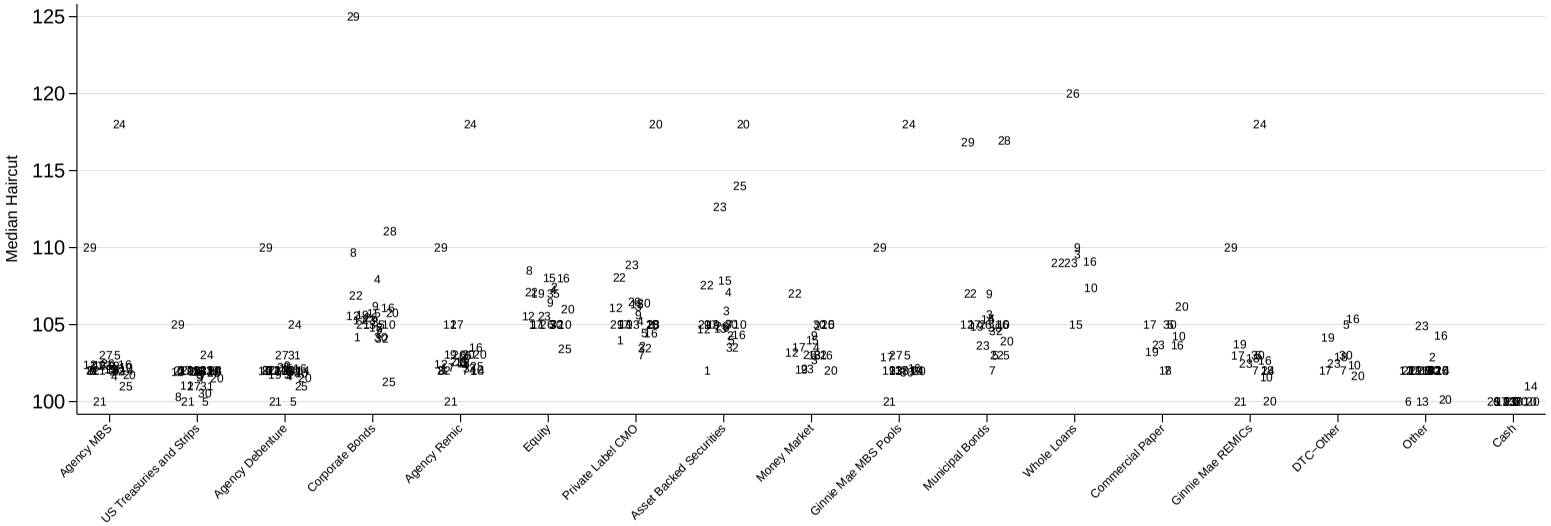
		Crisis		Stable		All	
		mean	sd	mean	sd	mean	sd
Fed-eligible collateral	Agency Debentures	101.9	0.49	101.9	0.39	101.9	0.47
	Agency MBS	102.3	0.60	102.0	0.40	102.2	0.56
	Agency Remic	103.1	1.31	102.6	0.53	103.0	1.14
	Ginnie Mae MBS Pools	102.0	0.42	101.9	0.23	102.0	0.36
	Ginnie Mae REMICs	102.5	1.09	102.2	1.18	102.4	1.12
	U.S. Treasuries and Strips	101.7	0.59	101.8	0.42	101.7	0.54
Non-Fed-eligible collateral	Asset-Backed Securities	107.1	3.90	105.8	1.73	106.7	3.40
	Commercial Paper	104.2	1.75	103.9	0.63	104.1	1.57
	Corporate Bonds	106.2	2.80	106.0	1.71	106.1	2.50
	DTC-Other	103.0	1.34	103.6	1.34	103.3	1.38
	Equity	106.3	1.57	108.5	2.28	107.0	2.08
	Money Market	103.8	1.29	104.1	1.19	103.9	1.26
	Municipal Bonds	107.7	7.74	105.3	3.76	107.1	7.04
	Other	104.3	76.9	102.3	1.03	103.8	66.47
	Private Label CMO	106.3	2.83	105.9	3.43	106.2	2.99
	Whole Loans	108.7	1.16	108.3	4.74	108.7	1.58
All		102.8	3.98	102.7	2.01	102.8	3.49

Note: "Crisis" haircuts are computed over July 2008 to July 2009, "Stable" haircuts over July 2009 to January 2010, and "All" haircuts over both sample periods. "sd" is standard deviation. Average haircuts are computed using the value of the collateral as weights. Fed-eligible securities are securities that can be settled on the Fedwire® Securities Service, while non-Fed-eligible, also called DTC-eligible, can be settled by the Depository Trust Company.

even for highly liquid assets such as U.S. Treasuries. Second, some dealers face high haircuts relative to their peers across all asset classes. While the use of collateral to secure loans can be thought of as a mechanism for minimizing counterparty risk, this figure nonetheless shows that differences among dealers is an important factor in the setting of haircuts.[18]

[18] An additional item of note is that haircuts on cash collateral are not zero for all dealers. Cash is sometimes included in a tri-party repo if a dealer does not have enough securities to pledge as collateral, for example, because fails were higher than expected. Cash would then make the difference between the value of the available securities and the amount of the repo. The fact that the haircut on cash is not always zero may be due to investors that assign the same haircut to all asset classes, consistent with the idea that some investors do not actively manage haircuts. It could also be the result of cash not being a perfect security. Perfecting a security means that a party has taken the legal steps necessary to establish a lien against the security. This is straightforward with noncash collateral but more difficult to accomplish with cash collateral. Consequently, investors could charge a nonzero haircut in hopes of discouraging the use of cash collateral. In practice, cash collateral is rarely used in tri-party repo.

Figure 3: Median Dealer Haircuts by Asset Class



Note: Two median haircuts, associated with the same dealer, of 126 and 135 for private label CMO and asset-backed securities, respectively, are not shown. Each dealer is assigned a number consistent across asset classes. The asset classes are ordered from left to right by total volume over the sample.

We analyze the degree to which differences in assets or dealers are driving the level of haircuts by regressing haircuts on dummies for asset classes and for dealers and then compare the estimated coefficients (see table 3). The coefficient estimates for dealers and collateral class have been ranked from smallest to largest. The coefficients on the dealer dummy variables range from 1.1 to 14.7, quite a wide range. But the three largest estimated coefficients look like outliers and in fact these three are small dealers. Ignoring the three largest estimated coefficients, the coefficients on the dealer dummy variables range from 1.1 to 3.8. By comparison, the coefficients on the collateral class dummy variables range from 0.1 to 6.9. For treasuries, agency debt, and agency MBS–the vast majority of collateral posted in this market–the coefficients range from only 0.1 to 0.4. These findings suggest that the counterparty in a tri-party repo is a main driver in setting haircuts. Given the existence of collateral, the importance of counterparty risk may seem surprising, but it has been highlighted by market participants. For example, "Craig Delany, a managing director at JPMorgan's Investment Bank ... stated that, in triparty repos, typically investors look to the counterparty (i.e., broker dealer) first and the collateral second when setting haircuts. In other words, a haircut may not be sufficient for an investor if it has serious concerns about the viability of its counterparty" (Valukas 2010).

This regression also highlights the lack of movement in haircuts over time. In our sample of 85,246 observations, this regression, which captures only simple means effects, is able to explain 31 percent of the variation in haircuts, because average haircuts are remarkably stable in our sample (see figure 4). For the three asset groups that make up the majority of collateral posted in this market–treasuries, agency debentures and agency MBS–haircuts hardly moved over the second half of 2008.[19] After the Lehman Brothers' bankruptcy, haircuts for non-Fed-eligible collateral did rise, although the increase was only, roughly, from 105 to 107.

As highlighted in the introduction, this lack of change in haircuts is very different from the large change in haircuts documented in Gorton and Metrick (2011) for an interdealer repo market for low-quality collateral. To further explore the difference in haircut dynamics in

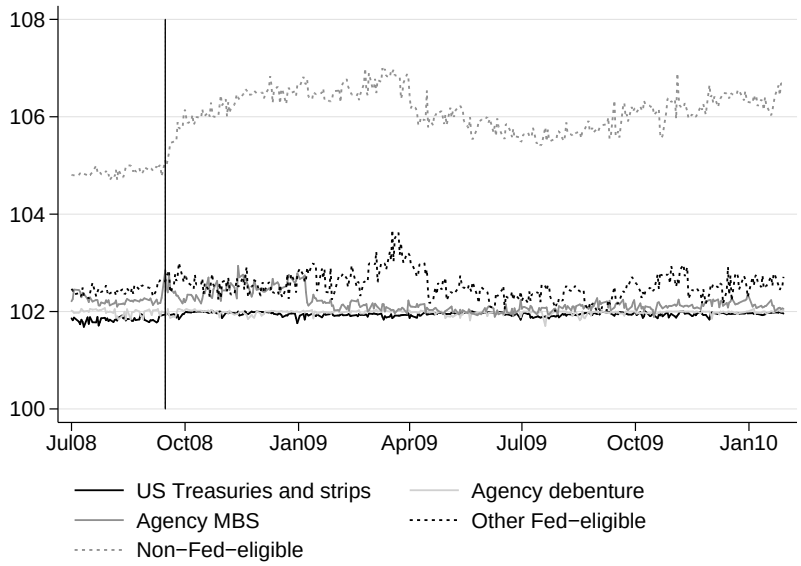
[19] In Copeland, Martin, and Walker (2010) we provide fan charts of haircuts for four general collateral classes. Even at the 25th/75th percentile, we do not see large changes in haircuts.

Table 3: Coefficients on Haircut Decomposition

Variable	Coefficient			Variable	Coefficient	
	estimate	std. err			estimate	std. err
dealer 1	1.09	0.04		Agency Debenture	0.10	0.03
dealer 2	1.12	0.15		Agency MBS	0.44	0.03
dealer 3	1.32	0.07		Ginnie Mae MBS Pools	0.89	0.03
dealer 4	1.35	0.05		Agency Remic	0.95	0.03
dealer 5	1.38	0.09		Ginnie Mae REMICs	1.48	0.04
dealer 6	1.40	0.03		DTC-Other	1.74	0.04
dealer 7	1.42	0.03		Money Market	2.16	0.03
dealer 8	1.46	0.10		Other	2.45	0.16
dealer 9	1.49	0.03		Commercial Paper	2.46	0.05
dealer 10	1.55	0.03		Municipal Bonds	3.83	0.06
dealer 11	1.58	0.08		Corporate Bonds	4.01	0.04
dealer 12	1.63	0.02		Equity	4.38	0.05
dealer 13	1.78	0.04		Asset Backed Securities	5.00	0.08
dealer 14	1.93	0.07		Private Label CMO	5.37	0.09
dealer 15	2.03	0.14		Whole Loans	6.86	0.12
dealer 16	2.08	0.03				
dealer 17	2.10	0.07		constant	99.09	0.07
dealer 18	2.14	0.04		clrbnk	0.53	0.06
dealer 19	2.31	0.03				
dealer 20	2.45	0.06				
dealer 21	2.76	0.07				
dealer 22	2.83	0.07				
dealer 23	2.84	0.14				
dealer 24	2.88	0.07				
dealer 25	2.88	0.07				
dealer 26	3.04	0.24				
dealer 27	3.77	0.18				
dealer 28	3.84	0.09				
dealer 29	9.01	0.15				
dealer 30	9.89	0.25				
dealer 31	14.69	0.38				

Note: clrbnk is a dummy variable equal to 1 for trades settled by one of the clearing banks. The dealer with the lowest average haircuts and U.S. Treasuries and Strips were the excluded dummies for dealer and asset classes, respectively. There are 85,256 observations and the R-squared for the regression is 0.31.

Figure 4: Median Haircuts by Asset Type



Note: Vertical line denotes the date of Lehman Brothers' bankruptcy filing.

tri-party repo versus bilateral repo markets, we use confidential survey data on haircuts of bilateral repos from the Markets Group at the New York Federal Reserve.[20] These haircuts reflect what dealers charge their customers, the majority of which are prime-brokerage clients. The bilateral repo market is one in which dealers provide liquidity and hedge funds, real estate investment trusts, and banks provide collateral. To some extent, the securities that dealers obtain as collateral in the bilateral repo market are rehypothecated by the dealer and used as collateral in the tri-party repo market. In these cases, the dealer's role is to serve as an intermediary between cash investors in tri-party repo (e.g., mutual funds and securities lenders) and a dealer's prime-brokerage clients (e.g., hedge funds).

To compare haircuts in the tri-party and the bilateral repo markets, we first need to match asset classes for the collateral used in both markets as best we can. Table 4 provides the descriptions of the collateral classes we were able to match with some degree of confidence,

[20]See Fleming, Hrung, and Keane (2010) for a description of these data.

Table 4: Matching of asset classes

Dealers as cash providers (bilateral)	Dealers as collateral providers (tri-party)
Treasury	US Treasuries and Strips
Agency	Agency Debentures
GSE MBS	Agency MBS
Agency CMO	Agency Remic
High-Grade Corp Debt	Corp Bonds
Alt-A, Prime MBS	Private Label CMO
Subprime	Asset Backed Securities

from most- to least-liquid collateral. While the match is not perfect, the collateral classes are roughly similar. We then graphically present the differences in median haircuts between the two repo markets, or haircut spread, in figure 1. A positive spread of 10 indicates that the haircut is lower in the tri-party repo market by 10 percentage points compared to the bilateral repo market (e.g., haircuts of 105 versus 115). As detailed in the figure, the spread between the median haircuts in the bilateral and the tri-party repo market increases with lower-quality collateral. The median haircut is higher in the bilateral repo market for all collateral classes except Treasuries. After the Lehman Brothers' bankruptcy, these haircut spreads increased, reaching more than 40 percentage points for subprime collateral. In general, the haircut spreads increased during the fall of 2008, peaked sometime in the first half of 2009, and were close to their July 2008 level at the beginning of 2010.

The different behavior of haircuts in the bilateral and the tri-party repo markets is a puzzle. We offer some potential explanations in section 4.

3.2 Investor-dealer relations in tri-party repo

The previous section established that haircuts barely moved in the tri-party repo market over our sample period. It is possible, however, that investors managed their risk in the tri-party repo market by altering the quantity repoed, rather than the haircut charged. This margin of

adjustment informs us about the relationship between the investor and the dealer: can dealers rely on investors to provide a stable source of funding, and can investors count on dealers to provide them with a stable return on cash? As we show in this section, we find a lot of persistence between dealers and investors; from day to day, investors will consistently lend the same amount to a dealer and accept the same amount and type of collateral. We interpret this result to reflect strong relationships between the typical investor and dealer.

To measure the persistence of the dealer-investor relationship, we would ideally want data on the amount dealers borrow from investors by collateral type. Because we do not have these data, we examine the dynamics of the relationship between dealers and investors from two viewpoints. We start by looking at dealers and the day-to-day change in the collateral they post and then look at investors and the day-to-day change in the collateral they accept.[21]

For each dealer, we look at the level of, and change in, the daily value of collateral posted.[22] We report the results in table 5, where we continue to divide dealers into small and large categories. The top panel of table 5 describes the distribution of collateral posted by dealers. For each dealer, we computed the median value of collateral posted in each month, as well as the differences between the 75th and the 25th, the 90th and the 10th, and the 99th and the 1st percentiles. For each of these statistics, we then calculated the median value across all large and small dealers and reported these numbers in table 5. Large dealers posted a median amount of $124 billion each day, while small dealers posted a median amount of $5 billion. The differences in percentiles further describe the distribution of collateral posted by dealers in a month. These statistics describe a fairly narrow distribution, suggesting that among the group of large dealers, a fairly similar total amount of collateral is posted by a dealer within a month, in the tri-party repo market.

The middle and bottom panels describe the distribution of the day-to-day change in collat-

[21]For this quantity analysis, we dropped the six quarterly end dates in our sample. Rather than being meaningful economic phenomenon, the seasonal variation at quarter-end is likely due to window-dressing efforts by financial institutions that report quarter-end results.

[22]If a dealer exited the market on a particular day, the change in market value would be a missing value. By and large, only small dealers did not consistently finance securities in tri-party repo in our sample.

Table 5: Distribution of the Level and Change in Collateral Posted by Dealers

	Dealer Type	
	Large	Small
Distribution of collateral posted ($million)		
Median	123,548	5,433
75th - 25th	9,432	523
90th - 10th	15,819	995
99th - 1st	26,466	1,594
Distribution of the daily change in collateral posted ($million)		
Median	-1	0
75th - 25th	6,424	253
90th - 10th	13,067	690
99th - 1st	22,903	1,456
Distribution of the daily change in collateral posted (percent)		
Median	0	0
75th - 25th	4.4	4.6
90th - 10th	8.7	12.8
99th - 1st	16.7	27.9

Note: The statistics "Xth - Yth" denote the difference of the Yth percentile from the Xth percentile of the relevant distribution for a dealer in a given month. Each cell is a median value across all months and dealers of the same type. We exclude Lehman Brothers for this exercise.

eral posted by dealers in amounts and percentages. In the middle panel, the almost zero median values for both types of dealers mean that dealers typically post the same total amount of collateral each day. Furthermore, for both types of dealers, this distribution of the daily change in collateral posted is narrow. For large dealers, for example, the difference between the 90th and 10th percentiles is only $13.1 billion, small compared to the total amount of collateral an average large dealer posts. The bottom panel reaffirms this result, showing that in percentage terms, the differences are small between the 90th and the 10th percentiles of the distribution. These results suggest that from day to day dealers only rarely decide to change substantially how much they finance in tri-party repo.

We also compute the daily change in the amount a dealer finances for each asset class but did not report them in a table. Looking at collateral by asset class might be important, because in reaction to negative news, an investor may ask for higher-quality collateral. Hence, a dealer still might borrow the same amount of cash from day to day but be required to post higher-quality collateral. For the most part, even at this level of detail, there is little day-to-day change in collateral posted. For large dealers, the median daily change is less than $5,000 in absolute value, and the difference between the 75th and the 25th quartiles on the distribution of the daily change in securities financed is $258 million, about 7 percent of the average value invested at the dealer/asset-class level. Unlike at the dealer level, however, we do see more dramatic changes in the tail of the distribution. The difference between the 99th and the 1st percentiles for large dealers is $1.5 billion, or 44 percent of the average amount financed at the dealer/asset-class level.

The above analysis confirms that dealers typically borrow similar amounts from day to day, using essentially the same portfolio of general collateral. Hence there is substantial stability on the dealer side of the market from day to day, implying that a predictable amount of securities is supplied to the tri-party repo market. Nevertheless, these statistics do not directly address the investor's side of the market. In particular, do investors typically lend to the same set of dealers? To answer this question, we examine whether investors invest the same amount of

cash from day to day, using all our investor data.

Given the heterogeneity on the investor side, we categorize investors by the daily amount invested, with cutoffs of $100 million, $10 billion, and $100 billion. As discussed previously, investors in the largest category (average daily amount invested greater than $100 billion) dominate this side of the market. Nevertheless, it is interesting to analyze the behavior of the smaller cash investors. This analysis combines investors' positions across the two clearing banks, which means we need to combine dollars of collateral held by an investor on clearing bank A with dollars of cash invested by an investor on clearing bank B. Because of haircuts, these two measures are not exactly the same, but for our purposes this difference is not important.[23]

For the group of smallest investors, the typical total cash amount lent is $14 million a day (see table 6). In contrast, for the largest investor group, the typical investor lends $134 billion a day. Like dealers, investors do not often significantly change the amount they invest in the tri-party repo market from day to day. For all groups of investors, the median change in amount invested is tiny, and the difference between the 75th and the 25th quartiles on the distribution of the daily change in amount invested is a small amount for each investor group. Unlike dealers, however, we do see large changes in the amount lent from day to day in the tail of the distribution. With the exception of the smallest investors, the difference between the 90th and the 10th percentiles as well as the 99th and the 1st percentiles is fairly large both in amount and percentage (see the middle and bottom panels of table 6). Hence, ony on rare occasions do investors make large changes to the amount of cash they lend in tri-party repo.

Interestingly, the smallest group of investors acts quite differently from larger investors and provides extraordinarily stable funding. One explanation for this difference could be the predictability of payment flows for smaller investors relative to larger investors. If payment flows are more predictable for smaller investors, it could be easier for them to select the amount they would like to continually roll over in the tri-party repo market or to use term contracts

[23] We drop GCF repo and Federal Reserve Bank of New York cash investments and exclude cash investments to Lehman Brothers.

Table 6: Distribution of the Level and Change in Investors' Daily Cash Investment

	Daily Cash Investment (in millions)			
	<$100	($100,$10,000)	($10,000,$100,000)	>$100,000
Distribution of daily cash invested ($million)				
Median	14	588	35,215	133,682
75th - 25th	0	100	3,597	7,845
90th - 10th	1	200	7,225	13,765
99th - 1st	1	298	11,035	18,975
Distribution of the daily change in cash invested ($million)				
Median	0	0	0	20.6
75th - 25th	0	31	1,758	4,895
90th - 10th	0	116	4,581	9,768
99th - 1st	2	300	11,527	16,549
Distribution of the daily change in cash invested (percent)				
Median	0.0	0.0	0.0	0.0
75th - 25th	0.0	5.8	4.6	3.9
90th - 10th	0.0	19.8	12.6	7.4
99th - 1st	17.8	51.5	30.1	12.1

Note: The statistics "Xth - Yth" denote the difference of the Yth percentile from the Xth percentile of the relevant distribution for an investor on a clearing bank in a given month. Each cell is a median value across all months and investors of the same type. Transactions with Lehman Brothers and the Federal Reserve Bank of New York are excluded from these calculations, as well as GCF repos.

instead of overnight deals.

3.3 Event Study

Up to this point, we have looked at haircuts and volumes of collateral posted independently. In this section, we look at the changes in both variables around stress dates for specific dealers, including the Lehman Brothers' bankruptcy.

In addition to the Lehman Brothers' bankruptcy, we identify four other dates of adverse shocks to individual dealers (or to their bank holding-company affiliates). We classify event dates into two categories: receipt of government assistance and negative earnings announcements. We limit our focus to three weeks before and after the event date and consider what happens to haircuts and collateral volumes in the market. To analyze haircuts, we compute the value-weighted mean haircut for the stressed dealer as well as the value-weighted mean haircut for a set of other large dealers.[24] The difference, or spread, between these two average haircuts measures how much the haircuts faced by the stressed dealer differ from those of comparable dealers in the tri-party repo market. For collateral posted, we first calculate the daily percentage change in collateral posted by each large dealer. We then compare the change in collateral posted for the stressed dealer to the mean and standard deviation of the change in collateral for all other large dealers.

We start by looking at the dynamics in haircuts and collateral posted for Lehman Brothers around the date of its bankruptcy. In figure 5 we plot the spread in average haircuts between Lehman Brothers relative to all other large dealers, where in the figure $t = 0$ denotes the day of the event (or the first business day following the event, if it occurred on a weekend). Surprisingly, the haircuts faced by Lehman Brothers barely moved until the event date. The Friday before Lehman declared bankruptcy, the average haircut Lehman faced was a little more than one percentage point greater than those faced by other large dealers! Most of the change

[24] If event windows overlapped with one another, the dealers involved in these events were excluded from the set of comparable dealers.

Figure 5: Haircut Spread; Lehman Brothers

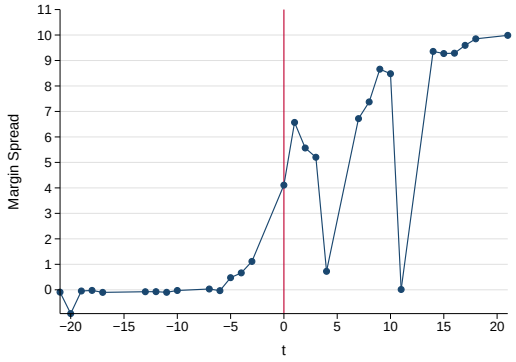
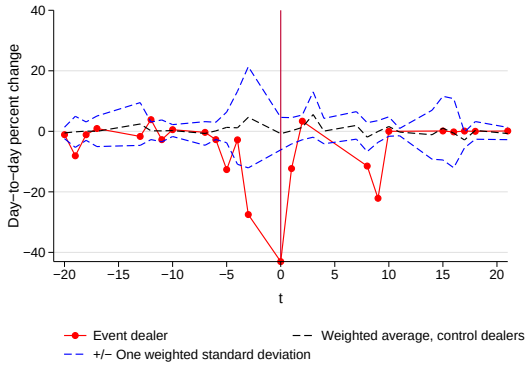


Figure 6: Percentage Change in Quantities; Lehman Brothers



Note: Seven observations after 9/15/2008 with large percent changes were dropped for stylistic reasons. These large changes were mainly driven by the small value of Lehman's book during this period.

in haircut in the last days before the bankruptcy is explained by a change in composition of Lehman's tri-party repo book toward lower-quality collateral. Postbankruptcy haircuts are harder to interpret because Lehman Brothers was using the Federal Reserve's primary dealer credit facility to fund itself and posting only small amounts of collateral.

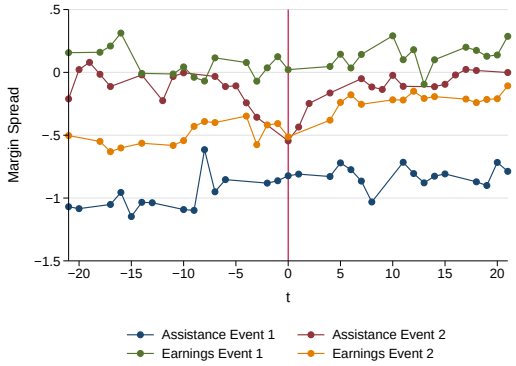
The collapse in the amount of collateral posted by Lehman Brothers is illustrated in figure 6. Significantly, the collapse in collateral was not at all gradual, but rather concentrated in the week before the firm declared bankruptcy. The Valukas Report cites sources describing much of the decline in collateral posted in tri-party repo as part of a self-imposed trend,

although there were additional declines that may have been unplanned (Valukas 2010). We can think of five reasons for the decrease in collateral posted by Lehman Brothers in the tri-party repo market. First, investors in this market may have pulled back funding to protect themselves against the increased risk of a Lehman Brothers' default. The Valukas Report notes that Fidelity, a large tri-party repo investor,"requested back" its overnight tri-party repo deals on September 12 (Valukas 2010). Hence, Lehman Brothers may have been forced to finance its securities in other markets (e.g. the GCF repo market described in section 2) or not at all. Second, Lehman Brothers was forced to post additional collateral with counterparties over this time, which may have reduced its tri-party repo portfolio. Third, in reaction to rumors of Lehman Brothers' upcoming demise, hedge funds and other Lehman Brothers' clients were moving their business to other broker-dealers, and thus withdrawing their collateral from Lehman Brothers. As described in Duffie (2010), losing clients has an impact on a dealer's balance sheet. In particular, Lehman Brothers would have had a smaller portfolio of securities to post as collateral in tri-party repo. Fourth, the wind down or deleveraging of the short-dated (primarily overnight) matched books in Treasuries, agency debt, and agency MBS likely played a part in the decline of tri-party funding over the course of the last few days before the actual bankruptcy. A similar deleveraging in other asset classes may also have played a role, albeit to a lesser extent. Fifth, and finally, in facing a run by investors, Lehman Brothers may have been selling collateral to raise money.

As shown in figures 5 and 6, leading up to its bankruptcy filing, Lehman Brothers experienced almost no change in the haircuts it faced but suddenly and dramatically decreased the amount of collateral posted (and so cash borrowed) in tri-party repo.

We now examine what happened to other dealers who suffered adverse shocks. In figure 7, we once again plot the difference between the weighted-average haircut faced by the stressed dealer and the weighted-average haircut faced by other comparable large dealers. Mirroring what what we saw with Lehman Brothers, haircuts of stressed dealers hardly moved during these periods of stress. Indeed, somewhat surprisingly, in the case of Assistance Event 1, the

Figure 7: Haircut Spread: Adverse Events



Note: An assistance event is an event in which a dealer received government assistance. An earnings event is an event in which a dealer announced large negative earnings. The event date is denoted by $t = 0$.

stressed dealer paid consistently less than the control group throughout the event window.[25]

Turning to collateral, in figures 8 through 11 we plot the percentage change in collateral posted for the stressed dealers. As we did in figure 6, as a point of comparison we plot the mean and standard deviation of the percentage change in collateral posted by other large dealers. As illustrated across these four figures, the four stressed dealers were able to maintain stable funding, in line with the experiences of the other large dealers. Daily percentage changes in the amount of cash borrowed by stressed dealers are generally within one standard deviation of the mean percentage change, even around the event date. Although there is some variation from day to day, no sharp declines occur in the week before or after the event date. This finding suggests that quantities were relatively stable for these four stressed dealers, in contrast to what we observed for Lehman Brothers.[26] While four events are not a large sample, the results do not suggest systematic differences based on the type of adverse event a dealer experienced.

[25]Our results are robust to different control groups and are not driven by the exclusion of overlapping event dates.

[26]Bolstering this result, we were able to examine the number of investors in one of the stressed dealers around its event date and found that the number of investors remained roughly constant during the days leading up to and following the stress event.

Figure 8: Percentage Change in Quantities: Assistance Event 1

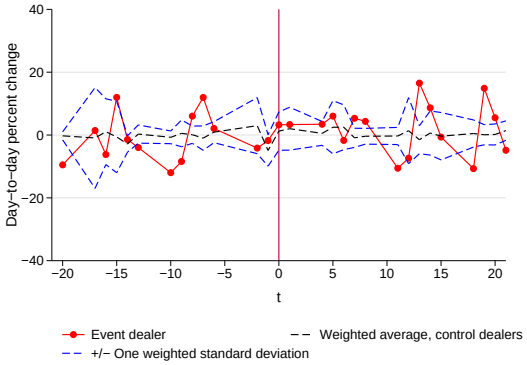


Figure 9: Percentage Change in Quantities: Assistance Event 2

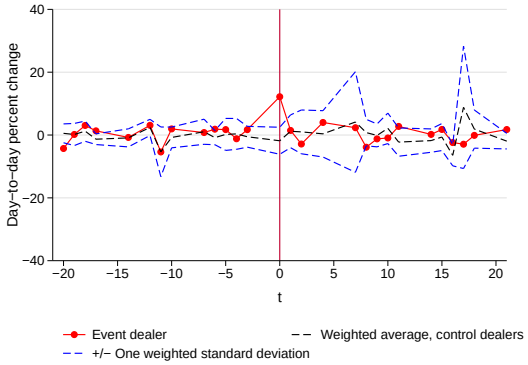


Figure 10: Percentage Change in Quantities: Earnings Event 1

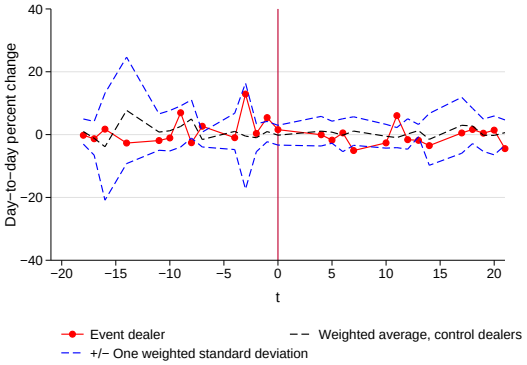
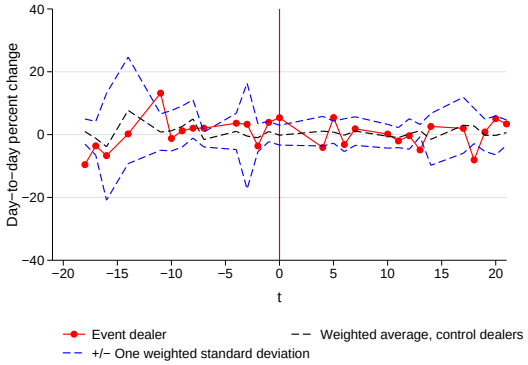


Figure 11: Percentage Change in Quantities: Earnings Event 2



Note: An assistance event is an event for which a dealer received government assistance. An earnings event is an event in which a dealer announced large negative earnings. The event date is denoted by $t = 0$.

4 Discussion of results; Policy analysis

In this section, we briefly consider three questions. Why did haircuts in the bilateral repo market increase so much? Why did haircuts in the tri-party repo market increase so little? How can we characterize runs in the tri-party repo market?

4.1 Why did haircuts in the bilateral repo market increase so much?

According to Gorton and Metrick (2011), haircuts in the bilateral repo market increased when the securities being repoed became "informationally-sensitive." Increasing haircuts reduces the information sensitivity of the security from the perspective of the cash provider, as it reduces the likelihood that selling the securities will not cover the face value of the repo. This explanation is consistent with the fact that haircuts in the bilateral market increased more for less liquid securities, as shown in figure 1.

The increase in haircuts could also reflect an increase in riskiness of the dealers' counterparties, notably hedge funds and other dealers, during the crisis. Hence, the increase in haircut during the crisis would simply reflect the increased risk taken by dealers when providing cash to their clients or to other dealers through repos. However, while this possibility could explain the increase in haircut in the bilateral repo market we consider, it does not explain why haircuts increased so much in the interdealer market, which Gorton and Metrick consider, compared to the tri-party repo market. Indeed, in both markets, dealers are borrowers.

Another possibility is that dealers offering prime brokerage services enjoyed "monopoly rents" at the height of the crisis. According to industry analysts, before the fall of Bear Stearns many hedge funds had only one prime broker. The fall of Bear made these institutions realize the risk of such a situation, and many tried to diversify their source of prime brokerage services. However, establishing such relationships can take time and, because of the rush of new demands for services, some prime brokers turned down requests. In this environment, and at the height of the crisis, it is possible that dealers were able to negotiate very favorable

terms from their prime brokerage clients when lending cash. This explanation, however, may not explain why haircuts increased in the interdealer market studied in Gorton and Metrick (2011).

The bilateral repo market we consider and the one Gorton and Metrick study have one thing in common. In both cases, dealers are the cash lenders. Dealers are particularly adept at financing and liquidating collateral. They are thus more likely to be willing to continue to lend to a counterparty while taking a higher haircut to protect themselves from the risk of default. This is not the case for some of the tri-party repo market cash investors, as we detail in the next section.

4.2 Why did the haircuts in the tri-party repo market increase so little?

Some cash investors appear to be reluctant or unprepared to take possession of the collateral and prefer to withdraw funding if they think a dealer is not creditworthy, as noted in section 3.1. The level of haircuts and the type of collateral may be unimportant for such investors, and they may not manage either carefully. For example, SEC rules prevent money market mutual funds from holding outright some of the securities they accept as collateral.[27]

In addition, major categories of tri-party repo investors, such as money market mutual funds and commingled securities lending cash reinvestment pools, have to worry that they may face withdrawal pressures from their own investors. As a result, they are very intolerant of liquidity and credit risk. Upon learning that a money fund in which they have invested is financing a dealer perceived to be having creditworthiness issues or was financing a dealer now in default, these investors may preemptively withdraw their funds, regardless of the risk that liquidating the collateral actually represents. This "headline" risk, the risk that a money fund may find itself in the headline of a news story, is another reason why money funds may not use haircuts to manage their risk.

[27]For example, a money market mutual fund may not be able to hold a 20-year Treasury bond, as the remaining maturity of money market mutual fund's assets must not exceed 13 months.

Another potential explanation is that tri-party repos were mainly overnight and the clearing bank would unwind repos every morning. Hence, the cash investors were exposed to the dealers only overnight, from approximately 6 p.m. to 8 a.m. the next day. Cash investors may have felt that they could always pull away from a troubled dealer before it would have to declare bankruptcy, making the management of haircuts less important.

4.3 How can we characterize runs in repo market?

The behavior of haircuts in the bilateral repo market can be associated with a marketwide run, or at least a generalized run on some asset classes, as suggested by Gorton and Metrick (2011). In contrast, we argue that runs in the tri-party repo market are runs on specific institutions and, as such, resembled traditional bank runs.

Cash investors are able to run on a specific dealer because much of the cash in the tri-party repo market is invested overnight. This feature of the market is partly driven by the need of cash investors to respond to their own investors' redemptions. Our data show that while large investors provide a stable amount of funding to the market, this amount occasionally fluctuates sharply, consistent with the need to meet a large redemption. During normal times, these potential needs for cash "withdrawals" are most likely not correlated and so the aggregate supply of funds to dealers remains stable. During a crisis, however, there is the potential for all cash investors to withdraw their funding from one dealer at the same time, which would result in a traditional bank run. This behavior resembles the motivation for banking provided by Diamond and Dybvig (1983), who focused on retail bank deposits.

Of course, given the collateralized nature of repos, cash investors can respond to changes in the perceived riskiness of a dealer by changing the applicable haircut. But as this paper documents, cash investors do not seem to use haircuts as a margin of adjustment when negotiating tri-party repos. Consequently, changes to dealer funding are driven mainly by changes in quantities of cash made available. During the crisis, most dealers were able to maintain a very stable amount of funding, even during relatively stressful times. The one key exception,

of course, is Lehman Brothers, whose tri-party repo book decreased sharply in the days leading up to its bankruptcy. This decrease in funding is consistent with the view that the run on Lehman resembled a traditional bank run.

5 Conclusion

This paper provides an empirical investigation of the tri-party repo market during the crisis, focusing on the behavior of haircuts and quantity of funding. This market is a key source of funding for large dealers, and sharp decreases in the funding obtained in this market contributed to the difficulties experienced by Bear Stearns and Lehman Brothers. Because the tri-party repo market is so large, and so central to dealer funding, it is important to understand its potential vulnerability to runs. Our paper provides evidence of such runs.

Our main findings are that during the crisis haircuts barely moved in the tri-party repo market and that funding was very stable for most dealers, with some dramatic exceptions. The behavior of haircuts contrasts sharply with that in the bilateral market studied by Gorton and Metrick (2011), in which haircuts increased significantly during the crisis. The difference between Lehman, which saw a precipitous decline in its tri-party repo book, and other dealers, who barely saw any change at all, even during stressful times, is consistent with traditional bank run dynamics.

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