

NO. 996
DECEMBER 2021

Repo over the Financial Crisis

Adam Copeland | Antoine Martin

Repo over the Financial Crisis

Adam Copeland and Antoine Martin

Federal Reserve Bank of New York Staff Reports, no. 996

December 2021

JEL classification: G01, G23, E42

Abstract

This paper uses new data to provide a comprehensive view of repo activity during the 2007-09 financial crisis for the first time. We show that activity declined much more in the bilateral segment of the market than in the tri-party segment. Surprisingly, we find that a large share of the decline in activity is driven by repos backed by Treasury securities. Further, a disproportionate share of the decline in repo activity is connected to securities dealer's market-making activity in Treasury securities. In particular, the evidence suggests that at least part of the decline is not driven by clients pulling away from securities dealers because of counterparty credit concerns.

Key words: repo, financial crisis, money markets

Copeland, Martin: Federal Reserve Bank of New York (email: adam.copeland@ny.frb.org, antoine.martin@ny.frb.org). The authors thank Darrell Duffie, Gary Gorton, and Arvind Krishnamurthy for their comments and suggestions. They also thank Noah Zinsmeister for excellent research assistance.

This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in this paper are those of the author(s) and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the author(s).

To view the authors' disclosure statements, visit
https://www.newyorkfed.org/research/staff_reports/sr996.html.

The 2007-09 financial crisis highlighted important vulnerabilities of the US repo market and several studies have shed some light on these events. These studies present a somewhat contrasting account of what happened, in part because the authors focus on different segments of the market, due to data limitations. For example, Gorton and Metrick (2012) highlight a sharp increase in haircuts in the bilateral segment of the repo market and take that as evidence of a generalized “run on repo”. Gorton et al. (2020) document a dramatic decline in net repo funding to banks and broker dealers. By contrast, Copeland et al. (2014b) and Krishnamurthy et al. (2014) show that aggregate volumes of activity in the tri-party segment of the market held up well, although repos backed by lower quality collateral did experience a decrease. Furthermore, both papers document how haircuts in the tri-party repo segment changed only slightly over the crisis.

In this paper, we use new data to provide for the first time a comprehensive view of repo activity during the 2007-09 financial crisis. Our data not only allows us to distinguish between the bilateral and the tri-party segment of the market, but also to study separately the interdealer and the dealer-to-client markets. We can do so for a variety of collateral classes. Consistent with previous studies, we find that the decline in overall repo activity is very large and it is much greater in the bilateral segment of the market than in the tri-party segment. Our data also allows us to provide new insights. Particularly surprising, we find that more than half of the decline in repo activity is attributable to repos backed by Treasury securities, the safest and most liquid asset class.

What are the causes of the decline in repo activity? We present analysis to demonstrate that a disproportionate share of this decline is related to securities dealer’s market-making activity in Treasury securities, rather than their funding strategies. We argue this decline is primarily driven by a decreased willingness by securities dealers to make markets, as opposed to the clients of those dealers reducing their exposure because of counterparty credit concerns. As a result, although the decline in repo activity was large in absolute terms, it does not appear to have been driven entirely by run dynamics.

In our analysis, we distinguish between the tri-party and the bilateral repo markets and between the interdealer and the dealer-to-client markets, because these segments have different economic roles. We discuss the difference between the tri-party and the bilateral repo markets first.

Securities dealers, who are central players in this market, use repo for two main reasons: First, as a key source of short-term funding and, second, to conduct market making activities. The economic motivations behind these two activities, funding versus market-making, are different. Repo activity associated with market-making is focused on price discovery of the securities being exchanged, while repo activity associated with funding is focused on counterparty credit risk.¹ The settlement platform that supports the triparty repo markets is designed to facilitate the settlement of general collateral repos; that is, repos that are backed by a set of securities, such as Treasuries, for example.² For that reason, this market is almost exclusively used for funding activities. By contrast, the bilateral market can more easily accommodate the settlement of repos backed by specific securities, such as the on-the-run 2-year Treasury, for example. This allows securities dealer to conduct market-making activities in the bilateral market, as well as obtain funding. We attribute differences between the bilateral and the triparty market as reflecting the impact of market making activities by dealers.

Another important difference within repo is whether the transaction is between two securities dealers or between a dealer and its client. It has long been recognized that there are often organizational differences between these two types of trades. In U.S. repo markets, this difference materializes in the institutional features of the market—repo trades executed between two securities dealers clear and settle through a central counterparty, whereas dealer-to-client repo trades do not. A central counterparty provides several services, including anonymity, settlement guarantees, and netting benefits, all of which are not typically available with dealer-to-client repo trades.³

Layering these distinctions on top of each other results in four distinct segments of the repo market. As a result, interpreting changes in overall repo activity is difficult if the researcher is unable to parse which segment of the repo market is driving the change. Similarly, it can be difficult to generalize results from one segment of the repo market, given the fundamental differences across the segments. To date, empirical work on repo over the financial crisis

¹Holmstrom (2015) provides a description of the fundamental differences between funding and market-making strategies.

²A general collateral repo trade is one where the parties to the trade, at the time of execution, agree that securities within a general asset class are to be delivered at the time of settlement.

³Recently, the central counterparty for inter-dealer trades has introduced a “sponsored-repo” service which allows for some types of dealer-to-client trades to be centrally cleared. This link, maintained by the central counterparty, provides details, as does Afonso, Cipriani, Copeland, Kovner, Spada, and Martin (2020).

has been limited in these ways, because only total repo activity or data on slices of the repo market have been analyzed. For example, Adrian and Shin (2010) looked at total repo activity, Gorton and Metrick (2012) analyze repo transactions involving low-quality securities in the inter-dealer market, and Copeland et al. (2014b); Krishnamurthy et al. (2014) both consider dealer-to-client funding trades (as captured in the tri-party repo market).

The first key finding from our work is that the well-known contraction in repo over the 2007-09 financial crisis was disproportionately concentrated in Treasuries, the safest and most liquid asset class. Indeed, the decline in Treasury activity was 20 percent (\$472 billion) over the latter half of 2008, compared to a 15 percent (\$328 billion) decline for all others asset class. This is surprising given that the prevailing flight-to-quality crisis narrative suggests that the use of Treasuries would be preferred.

The second key finding is that this decline in repo activity is associated with securities dealer's market-making activity. Indeed, for Treasury repo transactions, we find that in the market segments where securities dealers only implement funding strategies, repo activity slightly increased through the crisis. We build upon these facts by using a seemingly unrelated regression (SUR) approach to more formally document a shift in strategy by securities dealers from market-making to funding. Using dealer-level repo data, we use the SUR to measure how changes to the flow of securities onto a dealer's balance sheet predict changes to the flow of securities off of the balance sheet both before the Lehman Brothers bankruptcy event and after it. Comparing the estimated coefficients, we find that after the Lehman bankruptcy there is an increase in correlation between inflows of securities from clients and outflows of securities to segments of the repo market devoted to sourcing funds. These results provide supporting evidence that securities dealers shifted their repo activity from market-making towards funding strategies over the crisis.

The third and final key finding is that the decline in market-making is not due to the counterparty credit risk associated with dealers. We show this by using a panel dataset of dealer-level repo activity to test whether changes in repo activity are explained by changes in measures of the riskiness of individual securities dealer. We use two risk measures: credit default swap spreads associated with the securities dealers and the interest rate on commercial paper issued by securities dealers. In both cases, we do not find a statistically significant relationship between these risk measures and dealer-to-client repo activity. These results, along with

the finding that securities dealers were able to maintain their repo funding strategies, suggest that the decline in repo activity is not driven by concerns over the health of the securities dealers. The repo data we have collected does not contain information on securities dealers' clients, and so we cannot directly test whether securities dealers pulled away from specific types of clients. Evidence from our data and other academic research point towards another explanation—a drop in securities dealers' willingness to provide market-making services. Our analysis reveals that the largest securities dealers disproportionately account for the decline in repo activity. These dealers also disproportionately provide the market-making services demanded by clients. Our results on quantities complement those documented about prices in the asset-pricing literature; for example Musto, Nini, and Schwarz (2018) document an increase in arbitrage spreads for Treasuries over the financial crisis and relate these finding to a drop in liquidity.

The policy implications of these results are significant in that they suggest the dramatic decline in repo activity after the Lehman Brothers' bankruptcy was not indicative of a general disruption in repo funding conditions. Disruptions in funding conditions appear to have occurred for lower quality assets in both the bilateral and the tri party segment of the market. However, the very large decline in repo activity backed by Treasury securities does not appear to result from such disruptions. Hence, overall, the extent of funding disruptions in the repo market is considerably smaller than the decline in overall repo activity might suggest.

The very rapid decrease in Treasury repo volumes in the fall of 2008 foreshadows perhaps the events of March 2020 in the Treasury cash market in the following sense: While both the Treasury repo and cash markets are very deep and liquid, large shocks can create stress even in those markets, in part due to the key role dealers play in intermediating Treasury securities. Such stress can then transmit to other markets. Viewed in this way, our paper provides additional support for recent calls for reforms to improve the resiliency of the Treasury market.⁴ Our results argue for a focus on securities dealers' market-making capacity and better understanding how to support this activity during times of stress.

The remainder of the paper is organized in 3 sections. The next section provides background information on repo and introduces the data. Section 2 lays out the empirical analysis and Section 3 concludes with a discussion of the results and their implication for policy.

⁴See, for example, Duffie (2020), Liang and Parkinson (2020), and Group of Thirty Working Group on Treasury Market Liquidity (2021).

1 Institutional Background and Data

In this section, we provide the institutional background on U.S. repurchase and securities lending agreements and then describe our data sources.

1.1 A definition of repurchase agreements

Repurchase agreements are legal contracts between two parties, which document the sale of a security coupled with a promise to repurchase that security at a future date at specified terms. A repo can be economically similar to a secured loan, where the security exchanged is considered collateral to protect the party lending cash. The difference in the security's price across the two dates can be transformed into an interest rate on the cash lent. Repurchase agreements can also be used to acquire specific securities temporarily. The price of borrowing that security is reflected in the interest rate paid on the cash; securities that are in scarce supply can even command negative interest rates (see Appendix A for more details on repos and the terms of trade).⁵

A particularly attractive feature of repos is their bankruptcy-remote status.⁶ If either party to a repurchase agreement defaults, the counterparty can resolve its position with the defaulting party within days, as opposed to having to wait for decisions by the executor of the bankruptcy estate. For example, if the party obligated to repurchase the security at a future date falls into default, the counterparty holding the security can liquidate it so as to recover the cash lent in the initial leg of the repo.⁷

The same economic outcome, with equivalent legal protections, can be achieved using a securities lending agreement rather than a repo (Ruchin, 2011). As a result, for the purposes on this paper, we group together transactions involving the simultaneous exchange of cash and securities which are legally documented as securities lending or repurchase agreements and,

⁵For more detail on the use of repo to acquire specific securities, see Duffie (1996) as well as the more recent work by D'Amico and Pancost (2020).

⁶See Garbade (2006) for a description of the evolution of repo contracts in the U.S., including their treatment when a party to the contract declares bankruptcy.

⁷See Appendix C in Copeland et al. (2010) for a more detailed description of the legal process. The value of conferring bankruptcy-remote status to repurchase agreements was debated after the crisis – see, e.g., Morrison et al. (2014).

henceforth, label both types of transactions as repos.⁸ In the data discussion which follows later in this section, we highlight where accounting for securities lending agreements is important. In addition, the economic outcomes achieved with repos can be approximated using legal documentation other than repurchase agreements and securities lending agreements; for example total return swaps. However, from discussions with market participants, this alternative became more attractive as substitute for repo only after the imposition of new regulations after the crisis.⁹ Further, even now, repo and securities lending agreements strongly dominate total return swaps as a legal method to document these types of transactions.

1.2 Overview of the structure of the U.S. repo market

Repos are traded over-the-counter (OTC). Similar to other OTC markets, the U.S. repo market can be split into two parts: dealer-to-client and inter-dealer trades. Across these two groups the matching technology and the clearing process differ.

The inter-dealer network is dense, with securities dealers willing to trade with a large number of other dealers. This dense trading network is supported and sustained by the clearing process for these transactions. Repos involving fixed income securities (the focus of this paper) between two securities dealers are cleared through a central counterparty, the Fixed Income Clearing Corporation (FICC).¹⁰ Although repo trades can only be cleared through FICC if both parties of the trade are members of FICC, the set of FICC members is large and inclusive of a wide variety of securities dealers. As such, for the purposes of this paper, it seems reasonable to assume that all securities dealers are FICC members.¹¹ Clearing a repo trade through FICC confers a couple of benefits. The first is that FICC novates the trade, inserting itself between the original parties of the trade. The effect of this legal maneuver is that the original parties are no longer exposed to one another and the counterparty risk shifts to the FICC. The second benefit is that securities dealers end up having to settle only their net position for each security at the end of the day, for their inter-dealer trades. For example, suppose a securities dealer, as part

⁸The universe of securities lending transactions includes the simultaneous exchange of one security for another; this type of transaction, which is more popular in European financial markets, is not included in this analysis.

⁹For more detail, see this article by Finadium.

¹⁰FICC is an affiliate of the Depository Trust & Clearing Corporation.

¹¹The current list of FICC GSD members is publicly available at this website.

of its market-making strategy, enters into repo and reverse repo contracts with other dealers throughout the day for a given security type.¹² All these inter-dealer trades will be cleared through FICC and as a result the securities dealer will only have to settle its net position with FICC, as opposed to settling gross positions with each of the other dealers.

Complementing these clearing and settlement benefits, there are specialized trading platforms aimed at improving repo trade execution between securities dealers. A significant benefit of these platforms is that they provide securities dealers anonymity and allow them to build up or take down large positions with minimal impact on prices. These platforms also provide information on market conditions as the trading screens show securities dealers at what prices other (anonymous) dealers are willing to enter into repo contracts.

In contrast, repo trades between dealers and their clients are not centrally cleared. Likely reflecting the costs of establishing and maintaining a trading relationship, most clients have a limited number of securities dealers with which they trade.¹³

1.3 General repo trading strategies

Layered on top of the differences between inter-dealer and dealer-to-client trades are differences in strategies. As mentioned in the introduction, securities dealers enter into repo contracts to implement funding or market-making strategies.

Befitting their intermediary status, securities dealers' funding strategies are often implemented in matched booked fashion.¹⁴ Specifically, a securities dealer will provide funding to a client using a reverse repo contract and then use the newly acquired securities in a repo (either with clients or a securities dealer) to source the necessary funding. Similarly, a securities dealer could provide funding in the inter-dealer repo market and acquire those funds from clients. Another common funding strategy involves the securities dealer acquiring a position in a security through outright purchases, and then funding those acquisitions by using those

¹²From a dealer's perspective, a repo transaction is when the dealer delivers securities and receives cash. A reverse repo transaction is when the dealer receives securities and delivers cash. As such, repos show up as liabilities on the dealer's balance sheet and reverse repos show up as assets.

¹³In recent years, market participants have described request-for-quote platforms that clients can use to attract bids from multiple dealers.

¹⁴See Infante and Vardoulakis (2021) for an analysis of the repo matched book strategy and how this strategy generates a liquidity buffer for securities dealers.

securities in a repo with clients or other securities dealers. When entering into these repo contracts, a primary concern for all participants is counterparty risk. The use of financial securities as collateral helps mitigate this risk. However, even when Treasuries are used, the large size of these trades can present participants with liquidity issues when dealing with default.¹⁵ The settlement infrastructure available in the tri-party repo market is particularly convenient for dealers. As noted earlier, this infrastructure supports repos against general collateral, so tri-party repos are used almost exclusively as a funding vehicle by dealers.

Securities dealers' market-making strategies are also often implemented in a matched-book fashion. For example, securities dealers can enter into a reverse repo to acquire specific securities from the inter-dealer market and then use a repo to deliver those securities to clients (or vice versa). In addition, securities dealers use repos to both source securities from clients and deliver those securities to other clients, as well as provide intraday market liquidity in inter-dealer markets.¹⁶ When entering into repo contracts for market-making purposes, a primary concern for securities dealers is price discovery of the securities being exchanged. Because these strategies typically require obtaining specific securities, they are not settled in on tri-party repo settlement platform.

1.4 Data description

We now describe our data and how it reflects the economic activity described above. Our focus is on the balance sheet of securities dealers, the main players in the U.S. repo and securities lending markets.¹⁷ As such, we will focus on tracking the evolution of securities dealers' repos

¹⁵This risk was recently highlighted in a white paper published by the Treasury Market Practices Group. In particular, note the "liquidity risk management practices" risk area discussed on page 4.

¹⁶Copeland (2015) presents evidence of securities dealers providing intraday liquidity in interdealer repo markets, as evidenced by these dealers having large gross positions which net down to tiny positions at the end of the day.

¹⁷A consistent message from discussions with market participants is that the vast majority of repo and securities lending contracts entered into by market participants involve a securities dealer. Reflecting this feature of the market, a joint study by the Federal Reserve, Office of Financial Research, and the Securities & Exchange Commission on the repo market reached out to securities dealers for data. Further, Baklanova et al. (2016) report that securities dealers account for 85 percent of the securities borrowing activity in their comprehensive sample of agent securities lending activity. There are instances where financial firms have established platforms to facilitate repo transactions where neither participant is a securities dealer (e.g., see the Direct Repo™ service). These innovations however account for tiny shares of overall activity.

(liabilities) and reverse repos (assets) over time and across segments.

In the U.S., there are two distinct inter-dealer segments, the General Collateral Finance Repo Service (GCF Repo[®]) and the Fixed Income Clearing Corporation Delivery-vs-Payment Service (FICC DVP), both of which are offered by FICC.¹⁸ The GCF Repo service settles on the tri-party platform and is designed for general collateral repo trades and, so, are used exclusively for funding transactions.¹⁹ In contrast, the FICC DVP service is designed for trades involving specific securities and so, is used to clear and settle both funding and market-making transactions.

We have obtained dealer-level daily data by asset class for both repo and reverse repo trades using the GCF Repo service, and aggregate level daily data on FICC DVP repo.²⁰ With both datasets we capture all inter-dealer trading for fixed income repos. Furthermore, the GCF Repo data provides a clean look at dealers' repo-funding strategies over the crisis.

In the U.S., dealer-to-client trades can be grouped into a tri-party repo (TPR) segment and an "all else" (nonTPR) segment, that settles bilaterally. The tri-party repo segment captures general collateral trades between dealers and their clients, where dealers are exclusively sourcing funds. Our tri-party repo data, which are confidential, are by dealer and asset-class and at the daily frequency. As with GCF Repo, the tri-party repo data provides a clean look at dealers' repo-funding strategies over the crisis. The set of remaining transactions captures securities dealers' market-making and funding activity.

Although we do not have direct data on the set of dealer-to-client trades which are not part of tri-party repo, we can capture this activity as a residual measure via an accounting exercise.²¹ Focusing first on the liability side, from the FR 2004C survey we obtain confidential total repo activity by security dealer and asset class. This is a weekly survey collected from primary dealers, and over the time period in which we are interested the survey collected securities financing activity for U.S. Treasuries, agency debt, agency mortgage-backed securities

¹⁸GCF Repo[®] Service (hereinafter, "GCF Repo") is a registered service mark of the Fixed Income Clearing Corporation.

¹⁹For details on the GCF Repo service, see (Copeland, 2015).

²⁰Both the GCF Repo and FICC DVP data are provided under a license granted to the Federal Reserve Bank of New York by FICC, an affiliate of the Depository Trust & Clearing Corporation. FICC, its affiliates, and third parties from which they obtained data have no liability for the content of this material.

²¹See Copeland, Davis, LeSueur, and Martin (2014a) for an early attempt at implementing this strategy.

	Assets	Liabilities	
Dealer-to-client	nonTPR	nonTPR	General collateral
		TPR	
Inter-dealer	GCF Repo	GCF Repo	
	FICC DvP	FICC DvP	

Figure 1: Repo Trades on a Securities Dealer Balance Sheet

Note: Trades on the asset side are reverse repos and those on the liability side are repos. TPR are dealer-to-client trades cleared and settled on the tri-party repo settlement platform, nonTPR are all dealer-to-client trades which are not cleared and settled on the tri-party repo settlement platform, and General Collateral denotes trades where at the time of execution the parties agree that any security within a general asset class can be delivered at the time of settlement.

(MBS), and corporate securities.²² We then subtract out securities dealers’ tri-party repo activity as well as total interdealer activity from GCF Repo and FICC DVP. The residual from this exercise is the total amount of dealer-to-client repo activity outside of tri-party. The details behind this approach are provided in Appendix C.1. Figure 1 provides an illustration of our data; on the liabilities side the “nonTPR” balance sheet entry is the residual from FR 2004C total repo measure minus the GCF Repo, FICC DVP, and TPR measures of activity.

A similar exercise can be done for the asset-side of the balance sheet. We take total reverse repo from FR 2004C, and subtract out all interdealer activity to arrive at a measure of total

²²The survey has been expanded to include information on repo and securities lending activity involving a broader set of securities. (For example, see the changes implemented in March 2013.) From this survey, we use the measures which include all cash-for-securities trades documented as repurchase agreements or as securities lending agreements. Broadening our focus to capture securities lending agreements is important because securities dealers enter into a significant number of securities lending agreements involving Treasuries.

dealer-to-client reverse repo activity. (Because securities dealers use tri-party repo to only source funds, that segment of the market does not appear on the asset-side of dealers' balance sheets.)

How the combination of our data informs us is illustrated in Figure 1. On the liabilities side, our measures identify inter-dealer activity (the sum of GCF Repo and FICC DVP) as well as dealer-to-client activity (the sum of TPR and nonTPR). Further, for each of these segments, we can differentiate between funding and market-making activity because TPR and GCF Repo, being designed for general collateral repos, provide clean measures of funding activity.²³ On the asset side, we can also differentiate between inter-dealer and dealer-to-client activity. However, because there is no TPR or equivalent segment for reverse repos, it is difficult to distinguish funding versus market-making activity for dealer-to-client trades on this side of the balance sheet. As a result, most of our analysis will focus on the liabilities side of the balance sheet.

Because our tri-party repo data start on July 1, 2008, our analysis starts in July 2008 and continues through the end of 2008. Further, our analysis is focused on primary dealers because of data considerations.²⁴ However, because primary dealers are the largest securities dealers and account for the lion's share of repo and securities lending activity, our analysis of this subset of dealers should still inform us of what happened to the market as a whole.²⁵ Finally, except in tri-party repo, we are missing repo activity involving equities and other types of securities. We exclude these missing asset classes from our analysis. In tri-party repo, this excluded activity accounts for only 14.5 and 10 percent of total repo activity in 2008 and 2009, respectively. Further, the time-series of this activity mirrors that of corporate bonds—a sharp drop-off in activity in the latter half of 2008 with little-to-no recovery in 2009 (see figure C5 in the appendix to see the time-series and Copeland, Martin, and Walker (2014b) for more detailed analysis of this tri-party repo activity over the crisis).

²³To provide more context, in the appendix we provide and discuss a map of the U.S. repo markets (see figure B4).

²⁴Although the interdealer data and tri-party repo data capture all activity in those segments, the FR 2004C survey only capture activity by primary dealers.

²⁵In the latter half of 2008, primary dealers accounted for more than 95 percent of all repo borrowing in tri-party repo. In GCF Repo, primary dealers accounted for an average of 78 percent of all repo borrowing and 78 percent of all repo lending.

2 Empirical Findings & Analysis

In this section we present our main empirical findings.

2.1 Aggregate empirical findings

We begin with an aggregate analysis of repo activity by asset class and segment. Our focus is on the second half of 2008, where we compare activity before and after the bankruptcy of Lehman Brothers on September 15. We chose this period because it encompasses the most dramatic contraction in repo and reverse repo activity over the crisis (see Figure 2). Indeed total repo declined over a trillion from \$4.5 trillion on July 23rd to \$3.3 billion on December 10th.

Because dealers de-levered during the crisis, and especially after the Lehman Brothers' bankruptcy, we expect a decline in repo activity over the latter half of 2008. The simultaneous decline in both repo and reverse repo indicates dealers delevered largely through a decrease in matched-book activity.²⁶ Note however, this does not tell us whether the decline in the latter half of 2008 is due to a pullback from funding or market-making strategy.

A striking fact illustrated in Figure 2 is that Treasuries account for a large amount of the decline in activity. This result seems to be at odds with the flight-to-quality narrative, which would predict an increase in the share of repo involving U.S. Treasuries. Instead, over the latter half of 2008 our data highlight a larger percent decline in U.S. Treasury securities financing activity relative to all other asset classes. We report this decline in Table 1, which documents repo activity on the liability side of securities dealers' balance sheets, in aggregate. Note the decline in Treasury activity was 20 percent (\$472 billion) from the pre- to post-Lehman periods, compared to a 15 percent (\$328 billion) decline for the all others asset class. The disproportionate decline in Treasuries repo activity relative to all other asset classes is particularly odd given that repo activity for agency mortgage-backed securities (MBS) declined by only 6 percent (\$59 billion) over this period.²⁷ Agency MBS are usually considered close to

²⁶Repo declined by more than reverse repo, corresponding to a decrease in the amount of securities held in long inventory that dealers finance through repo, as well as a reduction in leverage.

²⁷Consistent with Krishnamurthy et al. (2014), we find a dramatic decline in repo and securities lending activity involving corporate debt securities.

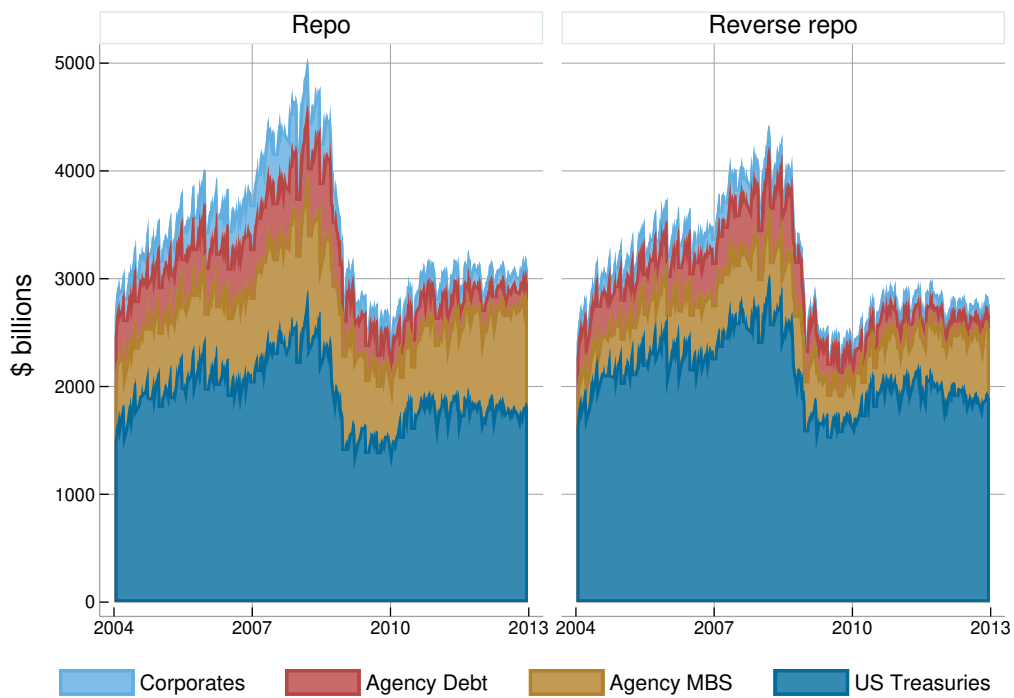


Figure 2: Repo and Reverse Repo, by Asset Class

Note: Repo is the “total securities out” value of financing activity reported in FR 2004C, and reverse repo is the “total securities in” value. Reverse repos show up as assets on the balance sheet and repos show up as liabilities. Agency MBS is agency mortgage-backed securities.
Source: FR 2004C

Table 1: Repo by Asset Class and Period

Asset Class	Levels (\$ billions)		Difference	
	Pre-Crisis	Crisis	\$ billions	percent
All Asset Classes	4,646	3,848	-798	-17
U.S. Treasuries	2,400	1,930	-470	-20
All Others	2,246	1,918	-328	-15
Agency Debt	743	541	-202	-27
Agency MBS	1,140	1,126	-13	-1
Corporates	363	250	-113	-31

Note: The pre-crisis period is from July 1 to September 13 of 2008 and the crisis period is from October 15 to December 17 of 2008. The All Others asset class is composed of agency debt, agency mortgage backed securities (MBS), and corporate bonds.

Source: FR 2004C and authors' calculations.

Treasuries in terms of credit quality and are traded in substantial amounts on the secondary market. As a result, one might expect similar outcomes across the two asset classes.²⁸

Taking a deeper dive, we analyze the decline in repo activity in each of the 4 segments of the market described in Section 1.4. In Table 2, we report total repo activity on the liability side of securities dealers' balance sheets by segment. Looking at repo activity across all asset classes, we see that the decline is disproportionately concentrated in the FICC DVP and nonTPR segments, which contracted 24 and 31 percent respectively. These two segments are where securities dealers implement their market-making strategies. In contrast, in GCF Repo and TPR, where securities dealers solely implement funding strategies, we find dramatically different results; over the pre-crisis to crisis period, GCF Repo activity increased by 7 percent and TPR activity declined by only 10 percent.

This pattern is made more stark when looking only at repos involving Treasuries (see rows 4 through 8 in Table 2). Repo activity in the FICC DVP and nonTPR activity segments de-

²⁸Securities in the agency debenture (a.k.a. agency debt) asset class are also typically considered close to Treasuries in terms of credit quality, although during the financial crisis there were concerns about the credit quality of some agencies. E.g., the federal government placed the Federal National Mortgage Association, an active issuer of agency debt, into conservatorship on September 7, 2008. Perhaps more importantly, the agency debt asset class differs substantially from Treasuries with regard to liquidity, which can lead to disparate outcomes across these two asset classes. Krishnamurthy (2010) reports on the difference in liquidity risk between the agency debt and Treasury securities during the crisis.

Table 2: Breakdown of Repo by Asset Class, Segment, and Period

Asset Class	Market	Segment	Levels (\$ billions)		Difference	
			Pre-Lehman	Post-Lehman	\$ billions	percent
All Asset Classes	Inter-dealer	FICC DVP	1,054	806	-248	-24
		GCF Repo	335	357	23	7
	Dealer-to-client	TPR nonTPR	2,095 1,505	1,888 1,036	-207 -470	-10 -31
U.S. Treasuries	Inter-dealer	FICC DVP	874	672	-202	-23
		GCF Repo	118	178	61	52
	Dealer-to-client	TPR nonTPR	435 973	467 613	32 -360	7 -37
All Others	Inter-dealer	FICC DVP	180	134	-46	-26
		GCF Repo	217	179	-38	-18
	Dealer-to-client	TPR nonTPR	1,660 532	1,421 423	-239 -110	-14 -21
Agency MBS	Inter-dealer	FICC DVP	—	—	—	—
		GCF Repo	156	142	-15	-10
	Dealer-to-client	TPR nonTPR	852 131	847 138	-5 7	-1 5

Note: The pre-crisis period is from July 1 to September 13 of 2008 and the crisis period is from October 15 to December 17 of 2008. The U.S. Treasuries asset class includes Treasuries and Treasury STRIPS, the All Others asset class is composed of agency debentures, agency mortgage backed securities (MBS), and corporate bonds. TPR is tri-party repo and nonTPR are all dealer-to-client trades which are not tri-party repo.

Source: FR 2004C, FRBNY, FICC, and authors' calculations.

creased by 23 and 37 percent, respectively. In marked contrast, repo activity in GCF Repo and TPR increased by 52 and 7 percent respectively. The associated dollar values are substantial—the total decline in FICC DVP and nonTPR is \$562 billion and the total increase in GCF Repo and TPR is \$93 billion.

In contrast to the above results, activity for repos involving nonTreasury securities (“All Others” in Table 2) decreased across the board, although once again the declines were stronger in the segments devoted to market-making activity. Within the nonTreasury asset class, agency MBS is an exception (as noted above) in that there is little change in agency MBS activity within each segment. Given that repos involving agency MBS are almost all driven by funding strategies and these securities are considered almost as high credit-quality as Treasuries, it is no surprise that the pattern of repo activity involving agency MBS mirrors that of Treasury repo funding activity as observed in the GCF Repo and TPR segments.

Taken together, these results have two important implications. First, they demonstrate that flight-to-quality flows did occur in repo, but only for those transactions associated with funding strategies. Indeed, those flows were strong enough that overall funding activity involving Treasuries *increased* over the latter half of 2008 (and agency MBS repo activity remained roughly flat) whereas total repo activity dramatically declined.

Second, repo trading involving market-making strategies declined dramatically. This is especially true for market-making in Treasuries, demonstrating that this decline is not about the underlying credit quality of the securities involved. To better understand the economic drivers behind this decline in market-making, in the next section we study a panel dataset of dealer-level repo activity.

2.2 Dealer-level empirical findings on Treasury repo

In this section we analyze repo and reverse repo activity at the level of the securities dealer, with a focus on those trades involving Treasuries. We begin by describing this panel dataset. We then explore whether clients pulled away from dealers by presenting an analysis of counterparty risk and securities dealers’ repo activity. Finally, we consider the role of securities dealers in the decrease in bilateral repo activity.

2.2.1 Summary statistics

In the previous section, which focused on aggregate trends, we were able to observe repo activity in each of the four repo segments: FICC DVP, GCF Repo, TPR, and nonTPR. Our FICC DVP data, though, are aggregated across dealers and so we do not have a measure of this repo activity at the securities dealer level. We can however, construct a measure of Treasury repo activity for FICC DVP plus nonTPR at the securities dealer level.²⁹ This is still useful for our analysis, because in the previous section we establish that changes in both of these segments predominantly reflect changes in market-making behavior, and that both segments had similar aggregate changes from the pre- to post-Lehman periods. To simplify the description of our results, we label this combined segment bilateral repo (or bilateral reverse repo), distinguishing it from tri-party repo and GCF Repo, both of which are segments where funding strategies, using general collateral repo, are implemented on a tri-party settlement system.

We continue to focus on the second half of 2008. The data are weekly snapshots of Treasury repo activity outstanding, and after excluding the two weeks which encompass quarter-ends, our panel includes 21 weeks.³⁰ In the data there are 19 securities dealers, all of which, except Lehman Brothers, appear throughout the sample.³¹ Given the bankruptcy of Lehman Brothers in September 2008, we exclude it from the analysis and as a result, we have a 378 observations (18 dealers times 21 weeks).

In this sample period, the average total repo for a securities dealer is \$113.6 billion dollars, and the average total reverse repo is \$123.4 billion (see Table 3). On the asset-side of balance sheet, average bilateral reverse repo, at \$115.5 billion, accounts for almost all reverse repo activity. On the liability side, bilateral repo also dominates, although to a lesser extent, with an average daily amount of \$81.5 billion. Tri-party repo activity is also quite large, at \$24.0 billion, followed by a relatively small amount of GCF Repo activity at \$8.0 billion.

²⁹We construct this measure by taking a dealer's total repo activity and subtracting out its observed activity in GCF Repo and TPR.

³⁰Repo activity on quarter-end is often driven by specific issues related to regulation (Munyan, 2017; Anbil and Senyuz, 2018), and so are not informative for our analysis.

³¹As discussed in the previous section, we focus on those dealers which are designated as primary dealers by the Federal Reserve because of data concerns. Specifically, these entities report total repo activity which we use in the calculation of bilateral repo activity.

Table 3: Summary statistics on securities dealers' Treasury repo activity (\$ millions)

Variable	Mean	SD
<i>Repo</i>		
Bilateral	81,486.2	61,381.5
GCF Repo	8,040.3	8,593.9
TPR	24,035.6	20,943.5
Total	113,562.2	78,808.5
<i>Reverse repo</i>		
Bilateral	115,541.3	81,986.0
GCF Repo	7,863.9	8,771.4
Total	123,405.2	85,032.3

Note: SD is standard deviation, and TPR is tri-party repo. Bilateral is equal to Total minus GCF Repo minus TPR.

Source: FR 2004C, FRBNY, FICC, and authors' calculations.

2.2.2 Analysis of counterparty risk

We first examine whether the declines in bilateral repo are related to changes in the counterparty risk associated with the securities dealers. This analysis tests the hypothesis that clients of dealers were driving the decline in this activity because of concerns about dealer default.³² We use two measures which capture the riskiness of a dealer: credit default swap (CDS) spreads and commercial paper interest rates.

We obtain daily CDS spread data from the Markit Group, a financial information services firm. To get CDS data on the largest set of dealers over our sample period, we use spreads of five-year modified restructuring U.S. dollar-denominated CDS contracts. We merge the CDS data to the panel dataset on dealer-level repo activity described above. We find that the CDS spreads match to 13 of the 18 securities dealers. Whereas the 13 matched dealers include both small and large dealers (in terms of repo activity), the 5 dealers which did not match are mostly small securities dealers.

We then use regression analysis to explore whether this CDS spread is correlated with bilateral repo activity. We focus on the liability side of dealers' balance sheets (we focus

³²The rapid withdrawal of clients from a dealer can result in the failure of that securities dealer, for details see Duffie (2010).

Table 4: Credit Default Swap Regression Results

Variable	$\Delta BilRepo$	$\Delta \log(BilRepo)$
ΔCDS	3,704.4 (154,055.9)	-1.476 (1.838)
Constant	-533.1 (388.1)	-0.014 (0.005)
Observations	234	234
R-square	0.00	0.01

Note: ΔCDS is the change in credit default swap rates, $\Delta BilRepo$ is the change in bilateral repo, and $\Delta \log(BilRepo)$ is the change in the log of bilateral repo.

Source: Markit Group, FR 2004C, FRBNY, FICC, and authors calculations.

on repo activity) because clients delivering cash against securities are especially sensitive to the riskiness of the dealers, however the results presented below continue to hold if we use bilateral reverse repo activity. Given that bilateral repo and the CDS spread are trending in opposite directions over this time period, we take first differences and consider whether changes in CDS spreads are correlated with changes in bilateral repo. Let $CDS_{i,t}$ denote the CDS spread of dealer i in week t and let $BilRepo_{i,t}$ denote the level of outstanding bilateral repo activity. Although the change in CDS spreads is best expressed as a level difference ($\Delta CDS_{i,t} = CDS_{i,t} - CDS_{i,t-1}$), we consider both the change in the level of bilateral repo activity ($\Delta BilRepo_{i,t} = BilRepo_{i,t} - BilRepo_{i,t-1}$) as well as the change in the log level of bilateral repo activity ($\Delta \log(BilRepo)_{i,t} = \log(BilRepo)_{i,t} - \log(BilRepo)_{i,t-1}$) in our analysis. Formally, we estimate

$$Y_{i,t} = \alpha_0 + \alpha_1 \Delta CDS_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where Y is $\Delta BilRepo_{i,t}$ or $\Delta \log(BilRepo)_{i,t}$ and $\varepsilon_{i,t}$ is an error term. The results from both regressions are reported in Table 4, and show that we do not find an estimate of α_1 that is significantly different from zero in either specification. Furthermore, in both specifications the change in CDS spreads provide little-to-no explanatory power, as evidenced by very low R-square statistics.

We now turn to the commercial paper (CP) data which are confidential and obtained from the Depository Trust & Clearing Corporation (DTCC). These data include the total value and

associated interest rate of commercial paper issuance by securities dealer (or its associated bank holding company) in our sample period. Using these data, we compute weekly average interest rates on commercial paper issued by securities dealer, where the averages are weighted by the issuance amount. We merge these weekly interest rates with the repo panel dataset. With the exception of a few of the smaller securities dealers, we were able to match CP rates to the securities dealers in our sample for most weeks in the sample period.

We use the spread of commercial paper interest rates to the effective funds rate as a proxy for counterparty risk associated with each dealer, and look to see whether variation in this spread is associated with variation in bilateral repo activity. As we did in the CDS analysis, we consider securities dealers' liabilities and so use bilateral repo, but note that our results continue to hold if we use bilateral reverse repo. There isn't a trend in commercial paper rates, and so we first consider whether the level of CP spreads is correlated with log level of bilateral repo activity, controlling for dealer fixed-effects. We then consider first differences, regressing the change in CP rates on the change in the log of bilateral repo activity. Letting $CP_{i,t}$ denote the CP spread of dealer i on week t , we define the change in this variable as $\Delta CP_{i,t} = CP_{i,t} - CP_{i,t-1}$. The two regressions we estimate are

$$\log(BilRepo)_{it} = \alpha_0 + \alpha_1 CP_{it} + \eta_i + \varepsilon_{it}, \text{ and} \quad (2)$$

$$\Delta \log(BilRepo)_{it} = \beta_0 + \beta_1 \Delta CP_{it} + \mu_{it}, \quad (3)$$

where η_i are securities-dealers fixed-effects, and ε_{it} and μ_{it} are error terms. In neither specification do we find a statistically significant relationship between CP rates and bilateral repo activity (see Table 5).

Given that neither the CDS spreads or commercial paper interest rates are associated with the changes in bilateral repo activity, we deduce that the decline in market-making by dealers in repo does not seem to be driven by client concerns over the riskiness of dealers. This interpretation accords with the previous result that securities dealers were able to continue to implement their funding strategies with clients (and in the interdealer market) throughout the crisis.

Table 5: Commercial Paper Regression Results

Variable	$\log(BilRepo)$	$\Delta\log(BilRepo)$
CP	-0.031 (0.061)	
ΔCP		-0.0004 (0.0194)
Constant	25.258 (0.044)	-0.0197 (0.0063)
Bank FE	Yes	No
Observations	255	221
R-sqaure	0.93	0.00

Note: CP is commercial paper interest rate and ΔCP is the change in this interest rate from one week to the next. Bank FE is bank fixed effects. For the “Level” column the dependent variable is the level of bilateral repo and for the “Change in log-level” column the dependent variable is the change in the log-level of bilateral repo. Source: DTCC, FR 2004C, FRBNY, FICC, and authors calculations.

2.2.3 Cross-sectional analysis

Given that changes in securities dealers’ riskiness does not explain the changes in bilateral repo, we look for evidence that dealers themselves are driving the decrease in this activity. To this end, we analyze differences across dealers. In particular, we examine whether the size of a dealer, as measured by its overall activity, is correlated with the declines in bilateral repo activity. The motivation for this analysis comes from the well-known concentration in prime brokerage services. If the declines in bilateral repo activity mainly reflect declines in dealers’ willingness to make markets, then we should see a disproportionate decrease in repo activity by the larger dealers, which dominate the provision of this service to the market.

We start by using the pre-Lehman period to categorize securities dealers into quartiles based on the total bilateral Treasury repo activity (we continue to focus on the liability side of securities dealers balance sheets). We then sum up bilateral Treasury repo in these quartile categories in both the pre- and post-Lehman periods, and compute the difference (see the first three columns of Table 6). We find bilateral repo activity of dealers in the largest quartile fell \$343 billion over this period. Further, this decline is disproportionate compared to other quartiles, as shown by the decline in the share of total activity accounted for by each quartile (see the last three columns of Table 6). Whereas the second and third quartile of dealers

Table 6: Changes to Treasury bilateral repo, by dealer quartile

Quartile	Sum of Activity			Share of Total		
	pre-Lehman	post-Lehman	difference	pre-Lehman	post-Lehman	difference
	(\$ billions)			(percent)		
1	47.6	27.5	-20.0	2.6	2.1	-0.4
2	377.7	310.5	-67.2	20.5	24.2	3.8
3	474.0	342.7	-131.3	25.7	26.6	1.0
4	947.3	604.1	-343.2	51.3	47.0	-4.3

Note: prct pts is percentage points. The pre-crisis period is from July 1 to September 13 of 2008 and the crisis period is from October 15 to December 17 of 2008.

Source: FR 2004C, FRBNY, FICC, and authors' calculations

increased their share of total Treasury repo across the two periods, the fourth quartile's share fell 4.3 percentage points, from 51.3 to 47 percent.

To better understand this cross-sectional difference in the decline of bilateral repo, we focus on the role of dealers as intermediaries and analyze how the inward flows of Treasury securities onto dealers' balance sheets are associated with the outward flows of Treasury securities off of the balance sheet.³³ In particular, we consider the correlations of Treasury securities reverse repos and repos at the securities dealer level by market segment, because these associations reveal the strategies pursued by dealers. If bilateral reverse repos are highly correlated with bilateral repos, then it is likely that dealers are entering into back-to-back bilateral trades to support their clients (e.g., sourcing specific securities). If bilateral reverse repos are highly correlated with tri-party repo, then dealers are likely funding clients. Because our focus is on the change in dealers' strategies over 2008, we separately consider the pre and post Lehman bankruptcy periods. For each period, we separately regress the weekly change of bilateral repo, tri-party repo, and GCF repo, onto the change of bilateral reverse repo and GCF reverse

³³In their analysis of the impact of the Federal Reserve's liquidity facilities on securities dealers behavior, Carlson and Macchiavelli (2020) consider the association between inward and outward flows of securities. Whereas they consider the flow in aggregate (total repo) for securities dealers, we focus on the flows across various repo segments.

repo. Formally, we use a seemingly unrelated regression approach to estimate

$$\Delta \text{bilateral repo}_{jt} = \alpha_0 + \alpha_1 \Delta \text{bilateral reverse repo}_{jt} + \varepsilon_{jt}^0, \quad (4)$$

$$\Delta \text{tri-party repo}_{jt} = \alpha_2 + \alpha_3 \Delta \text{bilateral reverse repo}_{jt} + \alpha_4 \Delta \text{GCF reverse repo}_{jt} + \varepsilon_{jt}^1, \quad (5)$$

$$\Delta \text{GCF repo}_{jt} = \alpha_6 + \alpha_7 \Delta \text{bilateral reverse repo}_{jt} + \alpha_8 \Delta \text{GCF reverse repo}_{jt} + \varepsilon_{jt}^2, \quad (6)$$

where $(\varepsilon^0, \varepsilon^1, \varepsilon^2)$ are error terms. Note that we do not include GCF reverse repo for the bilateral repo regression, because institutional features prevent securities received through GCF Repo to be re-delivered outside of the tri-party repo settlement system.³⁴

We collect all the coefficients in Table 7, where period 1 and 2 are the pre and post Lehman bankruptcy periods, respectively. Starting with the regression where bilateral repo is the dependent variable, we find that in the pre-Lehman bankruptcy period a change of \$1 to bilateral reverse repo is associated with an increase of \$0.614 to bilateral repo. Strikingly, this coefficient falls by one-third in the post-Lehman bankruptcy period, implying that a change of \$1 to bilateral reverse repo is associated with an increase of \$0.422 to bilateral repo. This suggests a shift in dealers' strategies away from trades that entail entering into back-to-back bilateral repos and towards more funding-based strategies, where securities received via bilateral reverse repo are then delivered out via tri-party repo or GCF repo. Indeed, this shift in strategy can also be seen in the regressions where tri-party repo is the dependent variable (see the third column of Table 7). In the first period, a change of \$1 in bilateral reverse repo is correlated with an increase of only \$0.122 in tri-party repo. In the second period, this coefficient more than doubles to 0.273, suggesting that dealers' are changing their strategies to place more emphasis on client funding trades. For GCF reverse repo, we do not find statistically significant changes to the coefficients for bilateral reverse repo or GCF reverse repo across the two periods.

To determine if this switch in strategies is common to all dealers, we redo the analysis above, but splitting the dealers into two groups based on whether their total repo activity in the pre-Lehman period was above or below the median amount. For the dealers with total bilateral

³⁴Both tri-party repo and GCF Repo trades are settled on a tri-party repo settlement platform. A feature of this platform is that securities which have been delivered to satisfy a repo obligation cannot be moved off of the platform. Hence, a security received from a GCF Repo trade can be re-used to satisfy obligations from tri-party repo trade, as both trades are settled on the same platform. But, this security cannot be used to satisfy a repo obligation that needs to clear and settlement off the tri-party repo settlement. This is a deliberate feature of the platform (Garbade, 2006).

Table 7: Treasury securities flow regression results

	Δ Bilateral repo		Δ Tri-Party repo		Δ GCF repo	
	period 1	period 2	period 1	period 2	period 1	period 2
<i>All Dealers</i>						
Δ Bilateral reverse repo	0.614*** (0.059)	0.422*** (0.050)	0.122*** (0.052)	0.273*** (0.044)	0.119** (0.040)	0.113*** (0.029)
Δ GCF reverse repo			0.513*** (0.121)	0.536*** (0.110)	0.258*** (0.084)	0.253*** (0.081)
Constant	-183.8 (472.8)	-1,331** (531.2)	60.18 (418.7)	113.0 (450.1)	-43.73 (316.6)	586.1** (298.4)
Observations	95	198	95	198	95	198
R-square	0.531	0.266	0.177	0.183	0.130	0.089
<i>Larger Dealers</i>						
Δ Bilateral reverse repo	0.644*** (0.078)	0.427*** (0.132)	0.104 (0.070)	0.295*** (0.059)	0.134** (0.054)	0.107*** (0.040)
Δ GCF reverse repo			0.539*** (0.173)	0.578*** (0.161)	0.234* (0.120)	0.211* (0.124)
Constant	-397.9 (823.7)	-2,013** (962.6)	435.2 (731.7)	500.4 (814.3)	-17.49 (563.2)	874.4 (549.3)
Observations	50	99	50	99	50	99
R-square	0.574	0.287	0.172	0.212	0.131	0.074
<i>Smaller Dealers</i>						
Δ Bilateral reverse repo	0.296*** (0.102)	0.338*** (0.090)	0.324*** (0.093)	0.126 (0.079)	-0.0247 (0.062)	0.162*** (0.048)
Δ GCF reverse repo			0.468*** (0.144)	0.395*** (0.134)	0.291*** (0.085)	0.365*** (0.079)
Constant	30.16 (356.2)	-713.6 (444.1)	-339.4 (318.6)	-319.2 (377.8)	-84.96 (212.7)	309.2 (231.0)
Observations	45	99	45	99	45	99
R-square	0.158	0.125	0.312	0.083	0.263	0.194

Note: Each column is a separate regression, labelled with the dependent variable. Independent variables are listed in each row. There are three panels: The upper panel presents results for a sample including all dealers, the middle panel presents results for a sample including only large dealers (those with above median repo activity in period 1), and the lower panel presents results for a sample of only small dealers (those with below median repo activity in period 1). Standard errors are in parenthesis. Period 1 is the pre-crisis period from July 1 to September 13 of 2008 and period 2 is the crisis period from October 15 to December 17 of 2008.

Source: FR 2004C, FRBNY, FICC, and authors' calculations

repo activity above the median, we see the same pattern discussed above. For the bilateral repo regression, the coefficient on bilateral reverse repo falls by one-third, from 0.644 to 0.427 (see the middle panel of Table 7). Hence, there is an decline in the positive association between bilateral reverse repo and bilateral repo for large dealers across the two periods. Further, the positive association between bilateral reverse repo and tri-party repo increased across the two periods, from a statistically insignificant 0.104 to a statistically significant 0.295 (see the middle two columns of the middle panel of Table 7).

In contrast, these changes in coefficients are not seen for the set of small dealers (see the lowest panel in Table 7). In particular, the correlation between bilateral repo and bilateral reverse repo remains roughly unchanged at 0.3, consistent with the idea that smaller dealers are not changing their repo strategies significantly. Somewhat strikingly, the coefficient on bilateral reverse repo for the tri-party repo regressions goes from positive to insignificant between periods 1 and 2, the opposite direction seen with large dealers. This change, however, may just reflect that smaller dealers looked to source more funding from GCF Repo over the latter half of 2008. Indeed, the coefficient on bilateral reverse repo for the GCF repo regressions goes from insignificant to positive between periods 1 and 2.

In summary, these econometric results support the hypothesis that the decline in bilateral repo activity is being driven by the large dealers, which dominate the prime dealer business during this period of time. These results are consistent with the hypothesis that these large dealers are moving away from market-making repo activity while continuing to source funds using repo.

2.2.4 Bilateral repo: inter-dealer versus dealer-to-client trades

The results presented above suggest that the large decline in Treasury repo was driven by a decline in the market-making behavior by securities dealers. In providing these services, a dealer enters into trades with clients as well as with other dealers. Given the different risk profiles of dealer-to-client and inter-dealer trades, an interesting question is whether the decline in bilateral Treasury repo is driven by either type of trade. Singh (2011) claims there was a contraction in the length of the collateral intermediation chain, a claim that would imply a fall in inter-dealer transactions, but not necessarily dealer-to-client transactions.

To investigate this issue, we turn back to our aggregated repo data and consider the ratio

of these specific securities, they are not often used in general collateral repo transactions, but rather are part of securities dealers' market-making activity. Using these data, then, we can directly measure the decline in securities dealers market-making activity.

Consistent with our main results, we find a dramatic decline in repo and reverse repo involving on-the-run Treasury securities. Focusing on repo, we observe a decline of \$155 billion in 2008, from \$286 billion in the second quarter to \$131 billion in the fourth quarter (see figure 4a).³⁵

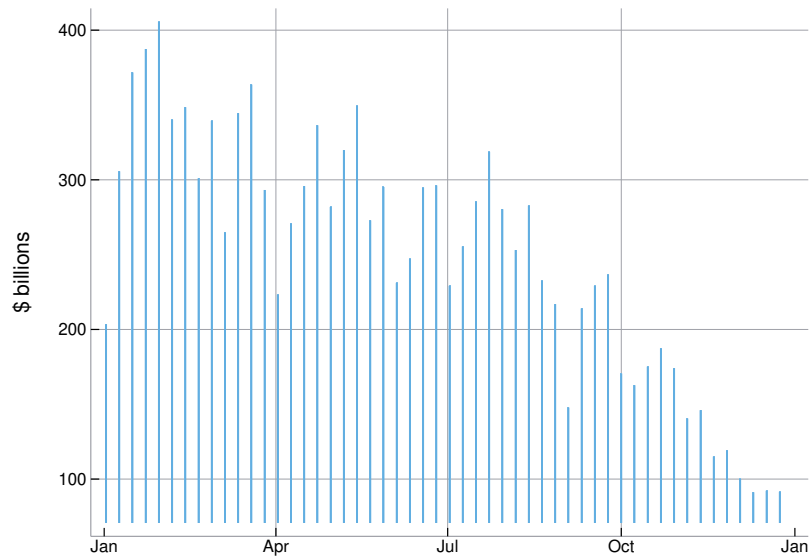
We also find that the change in the distribution of this activity across dealers is consistent with our results above that larger dealers are disproportionately driving the decline. Specifically, there is a narrowing in the distribution of of-the-run Treasury gross activity over 2008. This is illustrated in the box plot in Figure 4b which shows the 25th, 50th, and 75th percentiles of the distribution, and where we observe the 75th percentile of the distribution falling by more than the median or 25th percentiles over the latter half of 2008.

3 Discussion and Conclusion

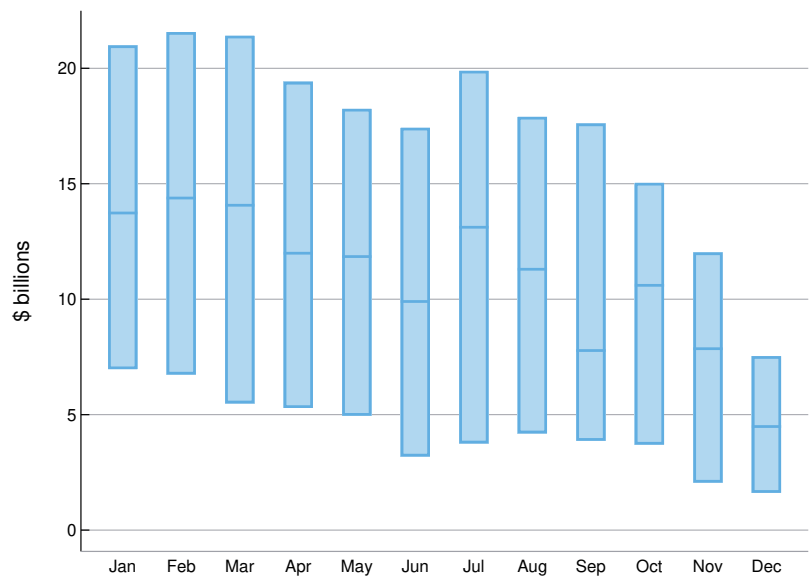
After the 2007-09 financial crisis, both policy makers and researchers focused on understanding the dangers of short-term funding and its fragility in times of stress, especially for nonbank institutions such as securities dealers.³⁶ When illuminating these dangers, both the runs on Bear Stearns and Lehman Brothers are mentioned as well as the large and rapid decline in repo activity in 2008 (as illustrated in Figure 2). The results presented here, however, tell a more nuanced story about the drivers behind the decline in repo. While disruptions in funding conditions appear to have occurred for lower quality assets in both the bilateral and the tri party segment of the market, such disruptions can only account for less than half of the decline in repo activity following the bankruptcy of Lehman Brothers. The majority of the decline in repo volume comes from a decrease in repo activity backed by Treasury securities, which does not appear to result from funding disruptions. Hence, overall, the extent of funding disruptions in the repo market is considerably smaller than the decline in market activity might suggest.

³⁵Similar numbers are calculated when focused on reverse repo activity.

³⁶The Federal Reserve Banks of Boston and New York held a "Risks of Wholesale Funding" conference on August 13, 2014. In his keynote remarks, President & CEO of the Boston Federal Reserve Bank, Eric S. Rosengren cautioned about the inherent risks of securities dealers' funding models during times of crisis.



(a) Total repo activity over dealers



(b) Distribution of repo activity across dealers; 25th, 50th, and 75th percentiles

Figure 4: Repo activity involving on-the-run Treasuries by primary dealers, 2008
Source: FR2004SI and authors' calculations.

Securities dealers as a group were able to continue to fund themselves using Treasuries as collateral throughout the crisis, not just in tri-party repo as documented previously by Copeland, Martin, and Walker (2014b), but more generally. Of course, specific institutions did lose their access to funding in repo, with Bear Stearns and Lehman Brothers being the most prominent. This loss of funding, however, was specific to the institution, rather than a consequence of problems with the repo market overall. This implies that concerns over the stability of repo as source of short-term funding should focus on understanding the drivers behind institution-specific runs by depositors.

Instead of a collapse in short-term funding, our results indicate that the massive decline in repo was mostly driven by a pull-back in market-making in Treasuries by securities dealers. While our approach considers quantities, the price effects of this pull-back by securities dealers has been documented in the asset-pricing literature as a decrease in the liquidity of Treasuries over the crisis (e.g., see Musto, Nini, and Schwarz (2018)).

The decline in the liquidity of Treasuries is problematic as it impairs market functioning. Recent disruptions in Treasury markets in March 2020 due to concerns over the economic impact of COVID has revived calls to improve the resiliency of the Treasury market (see, e.g., Duffie (2020), Liang and Parkinson (2020), and Group of Thirty Working Group on Treasury Market Liquidity (2021)). Liang and Parkinson (2020) and Group of Thirty Working Group on Treasury Market Liquidity (2021) both recommend that the Federal Reserve should introduce a standing repo facility available to a broad set of market participants. Such a facility would make dealers, as well as other market participants, confident that they can finance their Treasury holdings. In particular, this should make dealers more willing to make markets, including during stressed times. The FOMC announced in July 2021 the establishment of a standing repo facility.³⁷ However, this facility is only available to primary dealers and will be expanded over time to include additional depository institutions. The aforementioned authors recommend a broader set of counterparties. Caglio, Copeland, and Martin (2021) presents evidence of the potential benefits of a standing repo facility open to a broad set of dealers.

Duffie (2020), Liang and Parkinson (2020), and Group of Thirty Working Group on Treasury Market Liquidity (2021) all recommend an expansion of central clearing for the Treasury market. Expanding central clearing would reduce the risks faced by market participants and

³⁷See <https://www.federalreserve.gov/newsevents/pressreleases/monetary20210728b.htm>.

should enhance dealers' ability to make markets during times of stress. Duffie (2020) also notes that central clearing could support more "all-to-all" trading in the Treasury market. This could make the market more resilient as it would reduce the dependency on dealer intermediation.

This paper provides additional support for these reforms and argues for a focus on securities dealers' market-making capacity and a better understanding how to support this activity during times of stress.

References

- Adrian, Tobias and Hyun Song Shin (2010), “Liquidity and leverage.” *Journal of Financial Intermediation*, 19(3), 418–437.
- Afonso, Gara, Marco Cipriani, Adam Copeland, Anna Kovner, Gabriele La Spada, and Antoine Martin (2020), “The market events of mid-september 2019.” FRBNY Staff Report no. 918.
- Anbil, Sriya and Zeynep Senyuz (2018), “The regulatory and monetary policy nexus in the repo market.” FEDS working paper no.2018-027.
- Baklanova, Viktoria, Cecilia Caglio, Frank Keane, and Burt Porter (2016), “A pilot survey of agent securities lending activity.” FRBNY Staff Report, #790.
- Caglio, Cecilia, Adam Copeland, and Antoine Martin (2021), “The value of internal sources of funding liquidity: U.S. broker-dealers and the financial crisis.” FRB of New York Staff Report No. 969.
- Carlson, Mark and Marco Macchiavelli (2020), “Emergency loans and collateral upgrades: How broker-dealers used federal reserve credit during the 2008 financial crisis.” *Journal of Financial Economics*, 137, 701–722.
- Copeland, Adam, ed. (2015), *A Primer on the GCF Repo®Service*. FRBNY Economic Policy Review.
- Copeland, Adam, Isaac Davis, Eric LeSueur, and Antoine Martin (2012), “Mapping and sizing the U.S. repo market.” Liberty Street Economics blog post, June 25, 2012.
- Copeland, Adam, Isaac Davis, Eric LeSueur, and Antoine Martin (2014a), “Lifting the veil on the U.S. bilateral repo market.” Liberty Street Economics blog post, July 9, 2014.
- Copeland, Adam, Antoine Martin, and Michael Walker (2010), “The tri-party repo market before the 2010 reforms.” FRB of New York Staff Report No. 477.
- Copeland, Adam, Antoine Martin, and Michael Walker (2014b), “Repo runs: Evidence from the tri-party repo market.” *Journal of Finance*, 27, 2343–2380.

- D’Amico, Stefania and N. Aaron Pancost (2020), “Special repo rates and the cross-section of bond prices: The role of the special collateral risk premium.” FRB of Chicago Working Paper No. WP-2018-21.
- Duffie, Darrell (1996), “Special repo rates.” *Journal of Finance*, 51(2), 493–526.
- Duffie, Darrell (2010), “The failure mechanics of dealer banks.” *Journal of Economic Perspectives*, 24(1), 51–72.
- Duffie, Darrell (2020), “Still the world’s safe haven? Redesigning the U.S. treasury market after the covid-19 crisis.” Hutchins Center Working Paper # 62.
- Garbade, Kenneth D. (2006), “The evolution of repo contracting conventions in the 1980s.” *FRBNY Economic Policy Review*, 12(1).
- Gorton, Gary and Andrew Metrick (2012), “Securitized banking and the run on repo.” *Journal of Financial Economics*, 104, 425–451.
- Gorton, Gary B., Andrew Metrick, and Chase P. Ross (2020), “Who ran on repo?” *AEA Papers and Proceedings*, 110, 487–92.
- Group of Thirty Working Group on Treasury Market Liquidity (2021), “U.S. treasury markets: Steps toward increased resilience.” Group of Thirty; <https://group30.org/publications/detail/4950>.
- Holmstrom, Bengt (2015), “Understanding the role of debt in the financial system.” MIT working paper.
- Infante, Sebastien and Alexandros Vardoulakis (2021), “Collateral runs.” *Review of Financial Studies*, (forthcoming).
- Kahn, R. Jay and Luke M. Olson (2021), “Who participates in cleared repo?” OFR Brief Series 21-10.
- Krishnamurthy, Arvind (2010), “How debt markets have malfunctioned in the crisis.” *Journal of Economic Perspectives*, 24(1), 3–28.

- Krishnamurthy, Arvind, Stefan Nagel, and Dmitry Orlov (2014), “Sizing up repo.” *Journal of Finance*, 27, 2381–2418.
- Liang, Nellie and Pat Parkinson (2020), “Enhancing liquidity of the U.S. treasury market under stress.” Hutchins Center Working Paper No. 72.
- Morrison, Edward R., Mark J. Roe, and Christopher Sontchi (2014), “Rolling back the repo safe harbors.” *The Business Lawyer*, 69.
- Munyan, Benjamin (2017), “Regulatory arbitrage in repo markets.” OFR working paper no. 15-22.
- Musto, David, Greg Nini, and Krista Schwarz (2018), “Notes on bonds: Illiquidity feedback during the financial crisis.” *The Review of Financial Studies*, 31(8), 2983–3018.
- Ruchin, Andre (2011), “Can securities lending transactions substitute for repurchase agreement transactions?” *The Banking Law Journal*, 5, 450–480.
- Singh, Manmohan (2011), “Velocity of pledged collateral: Analysis and implications.” IMF working paper WP/11/256.

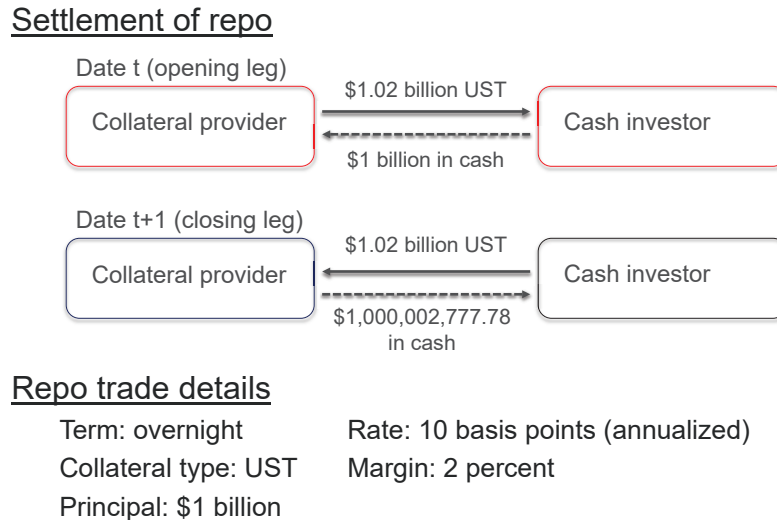


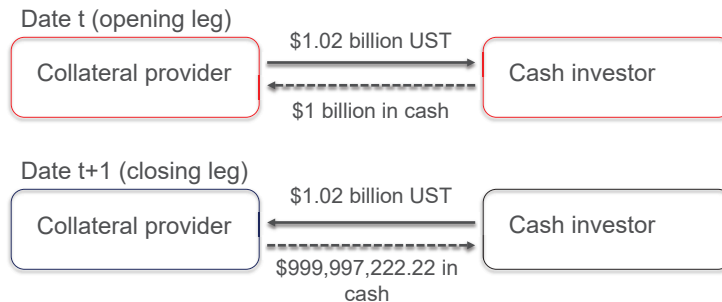
Figure A1: Repo settlement

A Details about repo settlement and terms of trade

A repurchase agreement is an agreement to sell securities for cash at date t , as well as an agreement to repurchase those securities for a specified price at a future date. For this discussion, we label the party delivering the security and receiving cash on date t as the collateral provider, and the party receiving the security and delivering cash on date t as the cash provider. The settlement of this contract involves two legs. The opening leg occurs on date t when the collateral provider delivers securities and receives cash. The closing leg occurs when this transaction is unwound, or the collateral provider receives securities and delivers cash. In figure A1 we provide a schematic of this settlement process and include the terms of trade negotiated between the two parties to the trade. As noted in the figure, there are five terms which are negotiated: the maturity of the trade, the securities eligible to be delivered, principal amount, the rate earned on the principal amount, and the margin.

Sometimes the parties to trade allow for any security within an asset to be delivered (e.g., any Treasury security). These types of trades are called “general collateral” repos. Otherwise, the parties to a trade negotiate which type of security can be delivered (as identified by its CUSIP or ISIN). For general collateral repos, the negotiated rate on the cash reflects the value

Settlement of repo



Repo trade details

Term: overnight	Rate: -10 basis points (annualized)
Collateral type: UST	Margin: 2 percent
Principal: \$1 billion	

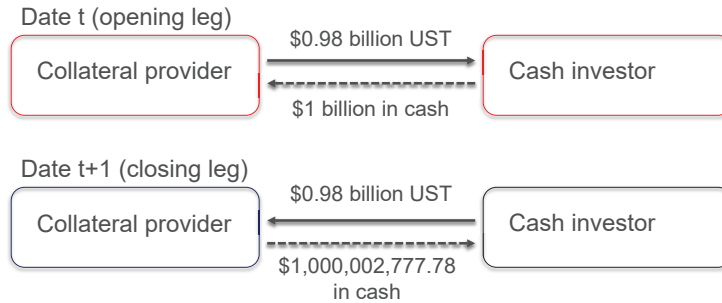
Figure A2: Repo with a negative rate

of investing cash on a secured basis over the maturity of the contract. For overnight repos, for example, the general collateral rate is often in the neighborhood of the interest rate the Federal Reserve pays on reserves.

In cases where one party is seeking to borrow a specific security, the negotiated rate on the cash is often below the general collateral repo rate, as the collateral provider seeks compensation for lending out a security in demand. Further, when a specific security is in scarce supply, the negotiated rate can go negative. In figure A2 we provide an example of a trade with a negative rate.

The margin reflects the value of the securities relative to the principal amount, and is computed as the ratio of securities value over principal amount minus 1. From discussions with market participants, we have learned that margins are usually set so that the higher credit-quality party to the trade is overcollateralized. For example, in general, when a securities dealer is trading with a leveraged client, the securities dealer is overcollateralized, whereas when a securities dealer is trading with a mutual fund, the mutual fund is overcollateralized. In figure A1, the margin is a positive value and so the cash provider is overcollateralized. In figure A3, we provide an example of a trade with a negative margin, which results in the collateral provider being overcollateralized.

Settlement of repo



Repo trade details

Term: overnight Rate: 10 basis points (annualized)
Collateral type: UST Margin: -2 percent
Principal: \$1 billion

Figure A3: Repo with a negative margin

B Map of repo activity

To complement the schematic of how repo activity shows up on a securities dealer's balance sheet (figure 1), we provide a map of the repo market in figure B4. Given their central role in this market, we place securities dealers in the center of the map. The movement of cash is from left to right and the movement of securities is from right to left. The repo transactions on the left-hand side of the map capture dealer-to-client trades, where dealers deliver securities and receive cash (these are booked as liabilities on the dealer's balance sheet). The repo transactions on the right-hand side of the map capture dealer-to-client trades where dealers deliver cash and receive securities (these are booked as assets on the dealer's balance sheet). Finally, both the interdealer markets, FICC DVP and GCF Repo, are marked above and below the securities dealer's box, respectively.

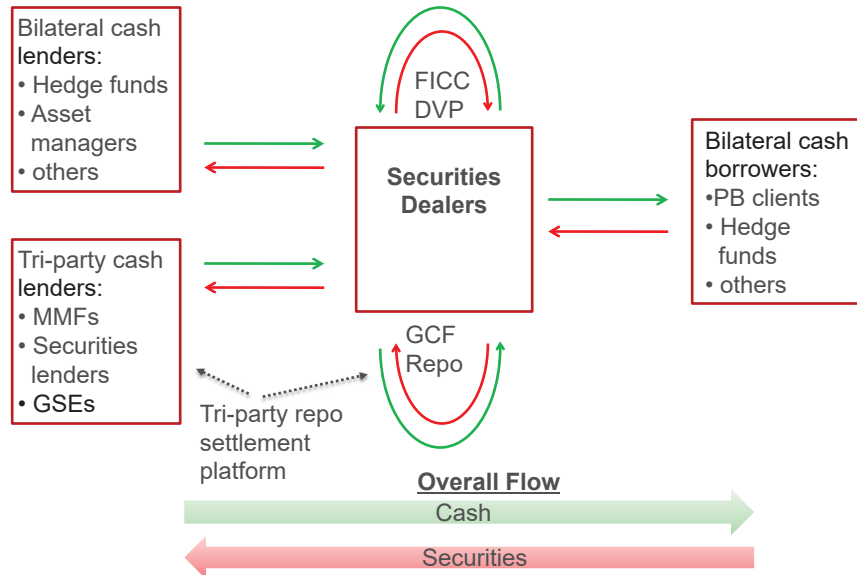


Figure B4: Map of the U.S. Repo Market

Source: Adapted from Copeland, Davis, LeSueur, and Martin (2012)

C Data details

C.1 Computing measures of nonTPR activity

In this section, we detail the computation of nonTPR dealer-to-client activity used in the aggregate analysis. Furthermore, we detail how bilateral repo activity (nonTPR plus FICC DVP), used in the panel data set of securities dealers over time, is computed.

Our approach has been to divide the repo market into four segments. There are two inter-dealer segments, FICC DVP and GCF Repo, as well as two dealer-to-client segments, tri-party repo (TPR) and those dealer-to-client trades that are *not* cleared and settled in tri-party repo (nonTPR). For the aggregate level analysis, which is by asset class, we have data on FICC DVP, GCF Repo, and tri-party repo activity. We also have total repo activity by asset class. Our approach, then, is to back-out nonTPR activity by subtracting FICC DVP, GCF Repo, and TPR activity from total repo, for both repo assets as well as repo liabilities, by asset class.

This approach is not straightforward for a number of reasons. First, the measures of repo

activity across the various datasets need to be made comparable. All repo activity is measured by the value of the cash and is on a gross basis. Further, the total repo activity is gathered for only primary dealers. Given these constraints, our approach is to measure repo activity for primary dealers only. Given that primary dealers strongly dominated repo activity during the sample period, we argue that studying this subset of dealers still provides us with a representative view of what happened to the market overall. Indeed, in the latter half of 2008 primary dealers accounted for more than 95 percent of all funding in tri-party repo. In GCF Repo, primary dealers were responsible for an average of 78 percent of all repo borrowing activity (and similarly accounted for 78 percent of all repo lending activity).

Because we observe dealer-level repo activity for both GCF Repo and TPR, it is straightforward to identify primary dealer activity in those segments. The FICC DVP measure, however, is aggregated across all dealers and so lumps together primary dealers and all other dealers. As a consequence, our measure of nonTPR activity is a lower bound.

Second, in the sample period, the TPR data from one of the tri-party repo settlement banks does not distinguish between the settlement of tri-party repo trades and a dealer's net GCF Repo position at the end of the day (which also settled on the tri-party repo settlement platform). From the GCF Repo data, however, we are able to compute a dealer's net position by asset class and subtract it from the effected repo activity figure. Further, both the total repo and TPR figures include pledge trades. During the sample period, our understanding is that pledge trades were quite small relative to repo activity and so our TPR measures will be at most slightly high. This issue does not effect our nonTPR measure as pledge trades are also captured in total repo (and so cancel out).

Third and finally, the aggregated nature of the FICC DVP data is slightly problematic because this service allows dealers to clear repos involving Treasuries and agency debentures. Although we do not have a breakdown of activity across these two asset classes, we know from conversations with market participants that the agency debenture activity that was cleared on FICC DVP was small. This has remained true in the post-crisis years—in recent work by Kahn and Olson (2021) on cleared repo, the authors, who have access to transaction-level FICC DVP repo data, state “In practice, nearly all transactions in (FICC) DVP use Treasury collateral” (page 3). We address this issue by arriving at an estimate of the share of agency debenture repo on FICC DVP. This estimate is the ratio of agency debenture repo over the sum

of Treasury and agency debenture repo for the FICC DVP and nonTPR segments. This ratio is computed using our accounting technique; we subtract out the TPR and GCF Repo aggregate amounts from the total repo aggregates. We then determine that agency debenture accounts for 17 percent of the total Treasury and agency debenture repo in aggregate, and apply this share to the FICC DVP data. (In the first column of Table 2, comparing the FICC DVP row for Treasuries and All Others, note that $180/(180+874)$ is 17 percent.)

Our accounting approach to arriving at measures of repo activity for each market segment differs slightly from the approach described in Copeland et al. (2014a) in two main ways. First, we focus on primary dealers whereas that work aimed to compute repo activity across all dealers. Second, Copeland et al. (2014a) used publically available data on tri-party repo and GCF Repo (which starts in 2010) whereas we use confidential data. The advantages of the confidential data are that it starts in 2008 and so includes the financial crisis, it includes a measures of the value of cash in repo activity, and it is at a daily frequency, which allows for easy alignment with the weekly primary dealer data.

For the construction of a panel dataset of dealer-level repo activity by asset class and week, we can no longer distinguish between FICC DVP and nonTPR. This is because the FICC DVP data is aggregated across dealers. As such, we subtract TPR and GCF Repo from total repo for each dealer, and arrive at a measure of the sum of nonTPR and FICC DVP, which we label bilateral repo. Note that the (small) issue of distinguishing Treasury and agency debenture repo in FICC DVP discussed above does not apply here, because the three datasets used, TPR, GCF Repo and total repo, all report repo activity by dealer and asset class.

C.2 Repo activity excluded from analysis

In figure C5 we illustrate the tri-party repo activity that is excluded from this paper's analysis (see section 1.4). We exclude this information because given our data sources, we are only able to observe repo activity using these types of securities in tri-party repo. These securities are not eligible to be cleared in FICC and so any interdealer repo activity using these securities is cleared and settled bilaterally, just like dealer-to-client trades. Further, the FR 2004C survey, from which we learn total repo activity, did not collect information on repo activity involving these asset types until after our sample period. The exclusion of this activity does not seem problematic, as the excluded asset classes accounted for only 14.5 percent and 10 percent of

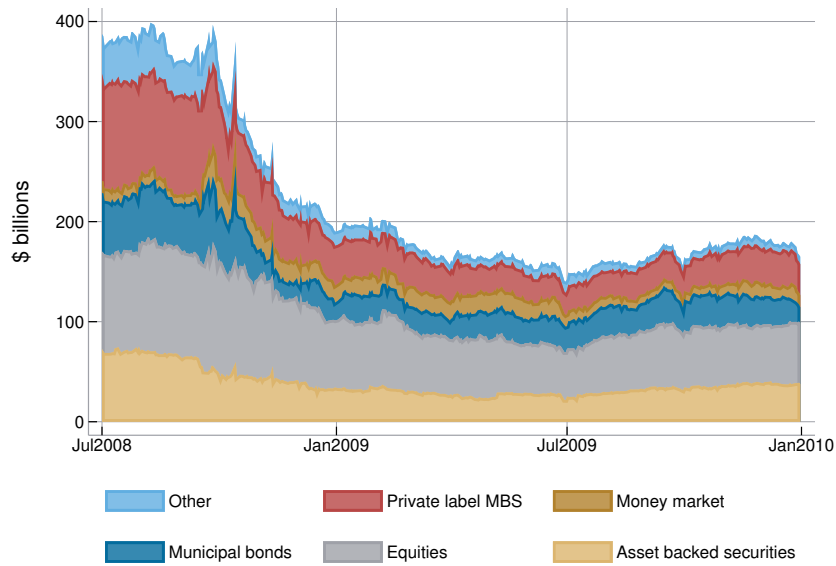


Figure C5: Excluded tri-party repo activity, by asset class

Note: MBS is mortgage-backed securities.

Source: Federal Reserve.

total tri-party repo activity in 2008 and 2009, respectively.