Key Mechanics of Tri-Party Repo Markets

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1. Introduction

During the financial crisis of 2007-2009, particularly around the failures of Bear Sterns and Lehman Brothers, it became apparent that the U.S. tri-party repo market, used by major broker-dealers to finance their securities inventories, has design weaknesses that could rapidly elevate and propagate systemic risk. Following the crisis, an industry-led effort sponsored by the Federal Reserve Bank of New York’s Payments Risk Committee has been working on improvements to the tri-party repo market infrastructure, with the main goal of lowering systemic risk. The objective of this paper is to describe some of the key mechanics of the market that contributed to its fragility and are delaying the reforms, particularly the collateral allocation process and the “unwind.”

The ability to allocate a dealer’s collateralizing securities efficiently to the various repos that finance those securities is important to a well-functioning tri-party repo market, as we will explain. In the U.S., collateral allocation currently involves considerable intervention by dealers. This intervention slows down the completion of the collateral allocation process. Collateral allocation is also complicated by the need for coordination between the Fixed Income Clearing Corporation (FICC), which clears interdealer (“GCF”) repos, and with the two clearing banks. We will explain this coordination. The length of the time necessary to allocate collateral in the tri-party repo market has been an important obstacle to the reform of this market.

The “unwind” is the settlement of expiring repos, which occurs before new repos are settled. (Some term repos are “unwound and rewound” each day even though they do not expire daily.) The unwind creates a need for intraday funding to tide a dealer over between the time at which it returns cash to investors and the time it gets new cash from the settlement of its new repos. In the

1 Copeland, Martin, and McLaughlin are at the Federal Reserve Bank of New York. Duffie is at the Graduate School of Business, Stanford University. The views expressed in the paper are those of the authors and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the authors. We are grateful for helpful discussions with Brian Begalle, Annik Bosschaerts, Richard Glen, John Jackson, Peter Kasteel, Jamie McAndrews, Larry Radecki, the editor Ken Garbade, and a number of market participants, who may or may not agree with any views expressed in this paper. Duffie has potential conflicts of interest that may be reviewed at his web page (www.stanford.edu/~duffie/). Among these, he is a member of the Board of Directors of Moody’s Corporation and has been retained as a consultant by the estate of Lehman Brothers Holdings Inc. on matters potentially related to the subject of this paper.
tri-party repo market, this intraday financing is provided by two banks, called “clearing banks,” which also play an essential role in facilitating settlement. The market’s reliance on intraday credit from the clearing banks is one of the three weaknesses of the tri-party repo market that were highlighted in a New York Fed white paper on infrastructure reform (Federal Reserve Bank of New York, 2010). This intraday reliance by dealers on credit from clearing banks creates potentially perverse dynamics that increase the fragility of the system.

The next section is a brief overview of the U.S. repo market and some of its important segments. Section 3 describes the tri-party repo market in more detail and summarizes the concerns that it has raised. Section 4 reviews the mechanics of tri-party repo transactions. Section 5 concludes.

2. U.S. Repo Markets

In this section, we describe a repo transaction and give an overview of different segments of the U.S. repo market. We distinguish between the bilateral and the tri-party markets, which differ mainly with respect to their business purposes and the manner in which they are settled. We also discuss sub-segments within these broad categories.

A repurchase agreement, or “repo,” is the sale of a security, or a portfolio of securities, combined with an agreement to repurchase the security or portfolio on a specific future date at a pre-arranged price. Abstracting from some legal distinctions concerning bankruptcy treatment, a repo is similar to a collateralized loan. Exhibit 1 illustrates a basic repo transaction. For the opening leg of the repo, an institution with cash to invest, the “cash provider,” purchases securities from an institution looking to borrow cash, the “collateral provider.”

The market value of the securities purchased typically exceeds the value of the cash. The difference is called the “haircut.” For example, if a cash loan of $95 is backed by collateral that has a market value of $100, then the haircut is 5%. For the closing leg of the repo, which occurs at the term of the repo, the collateral provider will repurchase the securities for $95 plus an amount corresponding to the interest rate on the transaction.

In most segments of the U.S. repo market, at least one of the counterparties is a securities dealer. Dealers use the repo market to finance their inventories of securities, among other purposes. In some cases, the collateral provider is a client of the dealer that wants to borrow cash. On these repos, the dealer is the cash provider. Repos involve a variety of other cash providers, including money market mutual funds (MMFs), asset managers, securities lending agents, and investors who are anxious to obtain specific securities as collateral in order to hedge

2 See Duffie and Skeel (2012).
3 We use the terms “dealer” and “securities dealer” interchangeably
or speculate based on changes in the market values of those securities. In the remainder of this section, we describe different segments of the U.S. repo market in more detail.

**Exhibit 1**

2.1 The bilateral repo market

In the bilateral repo market, a repo is typically settled when the collateral provider receives the cash and delivers collateralizing securities to the cash provider. This transfer is usually simultaneous, so this type of repo is sometimes called “delivery versus payment,” or “DvP.” For example, if a repo is collateralized by Treasury securities, then the collateral provider could instruct its custodian bank to deliver appropriate securities to the custodian bank of the cash provider through the Fedwire Securities service.

When the repo market first developed, all transactions were bilateral. Bilateral repos involve some operational complexities. They typically require that the cash provider is able to keep track of the securities collateral that it receives, make sure that this collateral is adequate and valued correctly, and finally ensure that the proper margin has been applied. This requires significant operational expertise and systems, especially for large investors who do many repos with a variety of counterparties. In an attempt to avoid this process, a collateral provider could offer to hold the securities, but segregate them for the benefit of the cash investors. Such repos are called “hold-in-custody” repos. Hold-in-custody repos are no longer popular because the cash investor...
may find it difficult to obtain its securities should the collateral provider default, and because of the potential for fraud. These complexities are alleviated in the tri-party repo market, described later.

There are two main sub-segments of the bilateral market, one in which dealers borrow cash and another in which dealers lend cash. We now describe each of these in more details.

### 2.1.1 The bilateral market for “special” securities

Some DvP repos are collateralized with a security that is in particular demand, for example because the cash provider would like to deliver the security against a short sale, or to cure a delivery failure. These sought-after securities are often called “special.” Special securities often include the most recently issued Treasury securities, which are called “on the run.” Investors are often willing to offer a lower interest rate on a repo that is collateralized by a special security.

Repos involving specific securities are typically bilateral. The cash investors in this segment of the market are usually hedge funds and dealers. When both repo counterparties are dealers, the repo does not provide net funding to the dealer community in aggregate, but redistributes the available cash and specific securities among dealers.

Copeland et. al. estimate the size of this segment of the repo market at almost $1 trillion in May 2012. Gorton and Metrick (2011) provide some related information about haircuts.

### 2.1.2 The bilateral market in which dealers lend cash

In another sub-segment of the bilateral market, dealers finance their client’s assets or lend cash to each other. Financing a client’s assets is particularly convenient if the dealer holds these same assets in custody because this allows the dealer to simply assert a lien on the securities that collateralize the repo. The securities obtained by the dealer in this process can then be rehypothecated in other repo transactions, if the collateral provider allows this.

Copeland et. al. estimate the size of this segment of the repo market at almost $2 trillion in May 2012.\(^4\) Copeland, Martin, and Walker (2010) provide some information about haircuts in this market.

### 2.2 The tri-party repo market

\(^4\) Note that adding up the size of the two segments of the bilateral repo market described here would double count the interdealer activity, since a dealer is borrowing and another one is lending. The available data does not allow us to separate that activity.
In the tri-party repo market, a third party called a clearing bank facilitates the settlement of the repo. There are two clearing banks handling tri-party repos in the United States: Bank of New York Mellon (BNYM) and JP Morgan Chase (JPMC). These clearing banks settle repo transactions on their own balance sheets. They maintain cash and securities accounts for dealers and cash investors. They settle the opening leg of a tri-party repo by transferring securities from the dealer’s securities account to the cash investor’s securities account, and by transferring cash from the investor’s cash account to the dealer’s cash account. Movements in the opposite direction occur on the closing leg of the repo.\(^5\)

In addition to settlement and custodial services, the clearing bank provides collateral management services such as daily revaluation of assets, daily re-margining of collateral, and allocation of the borrower’s collateral to its lenders in accordance with the lenders’ eligibility and risk-management constraints. As explained by Garbade (2006), clearing banks also ensure that the collateral will become available to cash investors if a dealer defaults.

There are two main sub-segments of the tri-party market, which we describe now in more detail.

### 2.2.1 Tri-party repos funded by non-dealers

The cash investors in this segment of the market are primarily money-market mutual funds, securities lenders, and other institutional cash investors, such as mutual funds, corporate treasurers, and state-and-local government treasurers. These investors seek interest income at short maturities. For some investors, overnight repos serve as a secured alternative to bank deposits. Together, money-market mutual funds and securities lenders account for over half of tri-party repo lending (Copeland, Martin, and Walker, 2010).

Dealers use the tri-party repo market mainly to obtain large-scale short-term financing at low-cost for their securities inventories. Dealers typically use only one of the two clearing banks to settle their tri-party repos. Large cash investors have accounts at both of the clearing banks in order to transact with dealers at each of them.

The tri-party market is a general collateral (GC) market, which means that an investor may care about the class of collateral that it receives but not about the specific securities.\(^6\) The tri-party market is the largest source of secured funding for U.S. dealers. In June 2012, as indicated in Table 1, U.S. Treasuries and various U.S. agency obligations (mortgage backed securities,

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\(^5\) We review the mechanics of tri-party repo transactions in Section 4.

\(^6\) This is in contrast to the market for “special” securities described above. Tri-party repo cash investors are typically not interested in specific securities. In addition, as we describe in section 4, the clearing bank’s collateral allocation process does not facilitate the allocation of specific securities to a repo. For these reasons, special securities are not financed in the tri-party market.
debentures, and collateralized mortgage obligations) accounted for approximately 85% of U.S. tri-party repo collateral. The total amount of financing provided in the U.S. tri-party repo market at this time, about $1.8 trillion, was down from a pre-crisis peak of about $2.8 trillion.

Table 1. Composition and Concentration of Tri-party Repo Collateral as of June 11, 2012.

<table>
<thead>
<tr>
<th>Asset Group</th>
<th>Collateral Value (billions)</th>
<th>Share of Total</th>
<th>Concentration by Top 3 Dealers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fed-eligible collateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>US Treasuries excluding Strips</td>
<td>$578.24</td>
<td>32.1%</td>
<td>30.2%</td>
</tr>
<tr>
<td>US Treasuries Strips</td>
<td>$47.17</td>
<td>2.6%</td>
<td>49.6%</td>
</tr>
<tr>
<td>Agency Debentures &amp; Strips</td>
<td>$106.99</td>
<td>5.9%</td>
<td>36.6%</td>
</tr>
<tr>
<td>Agency MBS</td>
<td>$680.82</td>
<td>37.8%</td>
<td>30.9%</td>
</tr>
<tr>
<td>Agency CMOs</td>
<td>$126.04</td>
<td>7.0%</td>
<td>43.9%</td>
</tr>
<tr>
<td>Non Fed-eligible collateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ABS Investment &amp; Non Investment Grade</td>
<td>$35.33</td>
<td>2.0%</td>
<td>45.5%</td>
</tr>
<tr>
<td>CMO Private Label Investment &amp; Non</td>
<td>$34.13</td>
<td>1.9%</td>
<td>47.2%</td>
</tr>
<tr>
<td>Investment Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corporates Investment &amp; Non Investment</td>
<td>$63.81</td>
<td>3.5%</td>
<td>31.6%</td>
</tr>
<tr>
<td>Grade</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equities</td>
<td>$80.85</td>
<td>4.5%</td>
<td>39.8%</td>
</tr>
<tr>
<td>Money Market</td>
<td>$25.17</td>
<td>1.4%</td>
<td>60.8%</td>
</tr>
<tr>
<td>Other*</td>
<td>$22.01</td>
<td>1.2%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>$1,628.04</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Other includes CDOs, International Securities, Municipality Debt, and Whole Loans

The underlying data include a total of 7,104 deals and 10,282 collateral allocations.
2.2.2 The GCF repo market

The GCF (General Collateral Finance) Repo® market is a blind-brokered interdealer market, meaning that the dealers involved in the transactions do not know each other’s identity. GCF trades are arranged by inter-dealer brokers, who preserve the participant’s anonymity. Only securities that settle on the Fedwire Securities service can serve as collateral for a GCF repo transaction. GCF repo trades are settled on the books of the clearing bank using the tri-party repo infrastructure and, thus, are an integral part of the tri-party repo settlement. Fleming and Garbade (2003) provide an overview of the GCF market.

The GCF market plays several roles for dealers. Some dealers use the GCF market for a substantial share of their inventory financing, on an ongoing basis. Dealers can also use GCF repos to fine tune their financing at the end of the day, lending cash if they happen to have secured more financing than they need, or borrowing cash if they are short. Finally, dealers also use GCF repo for collateral upgrades, by borrowing cash against agency MBS collateral and reinvesting the cash against Treasury securities. They may choose to do this because they find it easier to finance Treasury securities than Agency MBS outside of the GCF market or because they need to make a pledge to a central counterparty that accept only Treasuries as collateral, for example.

The data shown in Table 1 do not include the GCF market because that market does not provide net financing to the dealer community in aggregate. Instead, it allows dealer to redistribute cash among themselves. The NY Fed provides some data regarding the GCF market, as does DTCC.7

Exhibit 2 provides a graphical representation of the different segments of the market that we have described.

[Exhibit 2, found on last page, to be placed here]

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3. Tri-Party Repo Transactions

As explained in Section 2, a repo is effectively a collateralized loan. The key terms are therefore, the identities of borrower and lender, the maturity date, the cash loan amount, the interest rate, the collateral eligibility and margin schedules, and the treatment of the contract in the event of the failure of either party. For tri-party repos, the time to maturity, or “tenor,” is commonly one day. Many such “overnight” repos, however, are “rolled” for a number of successive days. A “term repo” has a tenor of more than one day.

To establish a tri-party trading relationship, a cash lender and a cash borrower execute a “master repo agreement” (MRA) that stipulates the key elements of their prospective tri-party repos, such as how a repo may be terminated, how margins will be maintained, or conditions under which the collateral backing the repo can be replaced by other collateral. The borrower and lender each have, in addition, clearing agreements with a tri-party clearing bank, either JPMC or BNYM. A custodial undertaking agreement (CUA), executed by the two MRA signatories as well as the clearing bank, establishes the clearing bank as the tri-party agent for this lender-borrower relationship and documents the lender’s collateral eligibility criteria. Like repos, clearing agreements are exempt from bankruptcy stays, allowing these agreements to terminate in the event of bankruptcy, giving the holder of the collateral the immediate right to use or dispose of the collateral.

An annex to the custodial agreement stipulates the haircuts applicable to each class of collateral that is acceptable by the investor. Hence, the haircut is not negotiated on a trade-by-trade basis. The haircut may depend on a number of factors, including the historical price volatility for the asset type, the loan term, and the identity of the dealer. Table 2 provides summary statistics of the cross-sectional distribution of overnight haircuts set in the U.S. tri-party repo market in May 2011. The median haircut applied to U.S. Treasuries was 2%, while the median haircuts of corporate bonds and equities were 8% and 5%, respectively, reflecting the generally higher volatility or lower liquidity of these respective classes of securities. The annex to the custodial agreement may also specify concentration limits, such as “no more than 40% Agencies and no more than 25% corporate bonds”.

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8 The interest rate is quoted on a standard money-market basis. For example, in U.S. dollars, the “actual/360” money-market convention implies that a loan of $100 for 3 days at an interest rate of 2% is repaid with interest of $100 x 0.02 x 3/360.
9 The annexes of the CUA contain schedules that define the eligible collateral for a particular type of repo, as well as the haircut for each collateral type, as discussed in more details in section 4.2.
10 Clearing agreements are “securities contracts,” exempt from automatic stays, preferences, and other bankruptcy rules. See Duffie and Skeel (2012).
11 Copeland, Martin, and Walker (2010) indicate that haircuts depend on the dealer.
12 Monthly data going back to May 2010 is available at http://www.newyorkfed.org/tripartyrepo/margin_data.html
Once these various contracts are in place, dealers can engage in tri-party repo transactions with cash investors. They negotiate the interest rate, the type of eligible collateral, the tenor, and the size of each repo. Typically, a dealer’s repo traders call investors in the morning to arrange new repos. Industry participants report that 80% to 90% of tri-party repo funding is arranged before 10:00 AM. In some cases, such as for a large fund complex, a deal is negotiated in the morning, but the allocation to specific funds within the complex is not specified until later in the day. Some trades are arranged later in the day. For example, money market mutual funds (MMFs) that accept redemptions from their investors until late in the afternoon would not know the amount of cash they will invest until that time.

Table 2. Distribution of Investor Haircuts in Tri-party Repos as of June 11, 2012.

<table>
<thead>
<tr>
<th>Asset Group</th>
<th>Cash Investor Margins Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10th Percentile</td>
</tr>
<tr>
<td>Fed-eligible collateral</td>
<td></td>
</tr>
<tr>
<td>US Treasuries excluding Strips</td>
<td>2.0%</td>
</tr>
<tr>
<td>US Treasuries Strips</td>
<td>2.0%</td>
</tr>
<tr>
<td>Agency Debentures &amp; Strips</td>
<td>2.0%</td>
</tr>
<tr>
<td>Agency MBS</td>
<td>2.0%</td>
</tr>
<tr>
<td>Agency CMOs</td>
<td>2.0%</td>
</tr>
<tr>
<td>Non Fed-eligible collateral</td>
<td></td>
</tr>
<tr>
<td>ABS Investment &amp; Non Investment Grade</td>
<td>3.0%</td>
</tr>
<tr>
<td>CMO Private Label, Investment &amp; Non</td>
<td>2.0%</td>
</tr>
<tr>
<td>Investment Grade</td>
<td></td>
</tr>
<tr>
<td>Corporates, Investment &amp; Non</td>
<td>2.0%</td>
</tr>
<tr>
<td>Investment Grade</td>
<td></td>
</tr>
<tr>
<td>Equities</td>
<td>5.0%</td>
</tr>
<tr>
<td>Money Market Instruments</td>
<td>2.0%</td>
</tr>
</tbody>
</table>

The underlying data, which are common to those underlying Table 1, include a total of 7,104 deals and 10,282 collateral allocations.

In some cases, dealers attempt to accommodate unexpected changes in an investor’s available cash. For example, a dealer may allow some classes of investors, such as MMFs, to deviate by up to 10% from the originally agreed deal size. If a dealer lacks sufficient amounts of eligible securities, it will typically post cash collateral, which is generally acceptable. In this case, however, the dealer pays interest on this component of repo without borrowing any net amount of cash. Dealers and investors have incentives to maintain the quality of their relationships and, thus, try to accommodate each other’s needs in unexpected circumstances.

Each day, a clearing bank settles the opening legs of new repos as well as the closing legs of any repos to be settled on that day, acting as agent for both the borrower and lender. As explained in Section 4, the dealer and its clearing bank have some discretion regarding the specific packages of collateral to allocate to each repo deal, subject to meeting the deal’s collateral requirements. The clearing bank is heavily involved in the collateral allocation process and in the transfers of cash and securities between the accounts of the borrower and lender.

The role of the clearing banks as intraday investors in the tri-party repo market

The financial strains experienced by several dealers, including Bear Stearns and Lehman Bros., during the financial crisis of 2007-2009 highlighted the fact that the two tri-party clearing banks are not only agents, but are also the largest creditors in the tri-party market during each business day. This daytime exposure is associated with the “unwind” of repos, a process by which the clearing banks send cash back to investors and collateral back to the dealers, whether a repo is expiring or not. This daytime exposure is associated with the “unwind” of repos, a process by which the clearing banks send cash back to investors and collateral back to the dealers, whether a repo is expiring or not. 13

Between the time of the “unwind” and the time at which new trades are settled near the end of the business day, dealers must finance the securities that serve as repo collateral. During this transition period, the clearing banks provide financing to dealers, collateralized by the dealers’ securities. 14 This provision of intraday credit creates multiple risks.

The exposure of a clearing bank to a single dealer can routinely exceed $100 billion, according to the Federal Reserve Bank of New York (2010). In the event that a dealer fails, its clearing bank could, in an unexpected situation, discover that the market value of the collateral provided by the dealer is insufficient to cover the amount owed to the clearing bank. The stability of the clearing banks...
clearing bank could also be threatened if it decides instead to hold the collateral on its own balance sheet, thereby increasing its leverage.

The vulnerability of a clearing bank to a troubled dealer is intensified by “wrong-way” risk, meaning that in a crisis situation, the failure of a dealer may be correlated with a sudden reduction in the market value of some of the securities that collateralize its tri-party repos. Moreover, an attempt by a clearing bank to lower its exposure to a failed dealer through a sudden fire sale of the collateral could itself cause an adverse impact on the price of that collateral, and thus exacerbate the losses to the clearing bank and to other market participants who hold positions in the same or similar assets. This danger buttresses the importance of the Primary Dealer Credit Facility (PDCF), introduced by the Federal Reserve Bank of New York during the financial crisis (Adrian, Burke, and McAndrews, 2009). The PDCF provided an alternative source of financing for collateral that might otherwise have been liquidated in a fire sale, potentially destabilizing markets more broadly and eroding the capital of holders of these assets.

As explained by Duffie (2010), the exposure of tri-party clearing banks to securities dealers also represents a potential danger to any dealer whose credit quality becomes suspect. A clearing bank refusing to unwind the repos of such a dealer could suddenly and fatally restrict the dealer’s ability to finance itself. In Section 4, we explain how the daily morning handoff of dealer exposure from cash lenders to the clearing bank creates an incentive for the clearing bank to pull away from granting credit to a dealer in the event of concerns over the dealer’s credit quality. In the case of Lehman Brothers, such instances are documented by Valukas (2010) and by the report of the Financial Crisis Inquiry Commission (2011).

Concerns over the failure of a large dealer arise in part from the stress that is likely to propagate to other financial markets, as was the case with the run on money market funds following the failure of Lehman Brothers. This run was triggered when the Reserve Primary Fund announced large losses on its investments in Lehman paper. From September 9, 2008 to September 30, 2008, institutional investors withdrew approximately $450 billion (about one third of their assets) from so-called “prime” MMFs. Significantly greater redemptions would likely have occurred had the U.S. Treasury not quickly guaranteed the performance of money market funds, an action that it has pledged not to take in the future (McCabe, 2010).

4. Key Market Mechanics
This section describes two key tri-party repo market processes that played an important role in the market’s fragility during the crisis of 2008-2009 and have delayed the current market reform. The first is the afternoon collateral allocation process. The redesign of this process has proved to more complicated than expected by the industry task force charged with the reform, and is a focus of the ongoing market reform. The second, the morning “unwind,” is the process by which

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15 The data are illustrated in Duffie (2012).
clearing banks return cash to lenders’ cash accounts and collateralizing assets to dealers’ securities accounts.

4.1. The Afternoon Collateral Allocation Process

In the afternoon, new repo deals must be settled. This process, which occurs on the books of the clearing bank, consists of transfers of cash from the clearing accounts of the investors to those of the dealers, and transfers of securities from the clearing accounts of the dealers to those of cash investors. The dealer’s objective is to allocate its collateral to lenders in a manner that is efficient from the viewpoint of financing costs and collateral usage, while meeting each lender’s criteria for acceptable portfolios of collateral. This can be a relatively high-dimensional and complex mathematical programming problem because of the number of deals available to each dealer as well as the number and types of constraints on collateral imposed by individual cash lenders. The allocation process is the responsibility of the dealer’s clearing bank, although in many cases a dealer may become involved. This section provides an overview of the allocation process in a typical U.S. tri-party repo setting, leaving out many details.

The dealer’s problem

A larger dealer might have tri-party repo relationships with, say, 20 or more significant cash investors. Each such relationship can involve many different deals on a given day. For example, the tri-party repo relationship between a dealer and an asset manager responsible for a mutual-fund complex could involve cash loans to the dealer from each of a number of mutual funds in the complex. Even a particular mutual fund may lend cash to the dealer through more than one tri-party repo deal on a given day. Each deal represents, in effect, a loan of cash for a given term, collateralized by a portfolio of securities meeting requirements that are stipulated in the tri-party agreement negotiated in advance by the cash investor and the dealer. The interest rate on the loan depends on the types of eligible securities identified as eligible collateral.

Each cash investor has a “rule set” governing the portfolio of collateral that is acceptable under its repo agreement. The rule set is a collection of restrictions on the acceptable types of collateral (defined by issuer type, issuer, security identifier such as CUSIP, maturity, credit quality, currency, and many other properties), as well as concentration limits across types of securities. A basic rule set simply specifies the acceptable types of collateral and the associated haircuts. Indeed, for treasuries, agency debt, and agency MBS, which constitute the majority of the U.S. tri-party repo market, deals are often arranged with a specific security type in mind. The rule set is part of the custodial undertaking agreement among the cash investor, collateral provider, and clearing bank.

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16 In addition, following the unwind that we describe in the next section, term and rolling repos must also be rewound.
Typical rule sets have evolved, becoming more complicated over time, especially for repos that may be backed by equities or non-Fedwire eligible collateral.\(^\text{17}\) For example, a rule set might specify that: “Only U.S. Treasuries, agency securities, and investment-grade U.S.-dollar corporate bonds are acceptable. No more than 30% of the portfolio may be corporate bonds.” The language of a tri-party repo master agreement is of course more precise than this description, which is merely for illustrative purposes.

**Timing**

With the current market infrastructure, the collateral allocation process takes several hours, extending from about 3:00PM to 6:00PM, or to 6:30 PM for some dealers. The lateness of the allocation process is due to a number of factors that we now describe.

Some of a dealer’s Fedwire-eligible securities, primarily treasuries and agencies, are not available in its “box,” the set of securities to which it holds title, until the 3:30PM close (for interbank transactions) of the Fedwire® Securities Service operated by the Federal Reserve System. Given the limited visibility of their holdings of Fedwire-eligible securities that is possible before 3:30PM, dealers prefer to begin allocating these securities to tri-party deals no earlier than this time.

Most dealers also trade in the “GCF repo” market. A dealer may choose to (or, depending on its available securities, need to) wait for its GCF trades to settle before completing some of its tri-party repo allocations. Settlement of GCF repos can last until 4:30PM, or until 5:00 PM on certain days. This can lead to significant additional delays in the completion of the tri-party collateral allocation process.

Equities can be allocated to repos from the accounts that dealers hold at the Depository Trust Company (DTC). As with the handoff of GCF repo collateral, DTC-eligible collateral may need to be received before some tri-party repo deals can be settled. Currently, DTC-eligible collateral becomes available as late as 4:30 PM, although dealers may obtain delivery of some DTC-eligible collateral before 4:30 if all DTC liens against the collateral have been released.

Although the tri-party collateral allocation process can begin before all DTC-eligible collateral is available and before all GCF repos are settled, it usually cannot be completed until these other steps are themselves complete. In addition to delays caused by the timing of the “handoffs” of collateral involving Fedwire, DTC, and FICC, the collateral allocation process itself takes considerable time because many dealers choose to “manually” intervene in this process, for reasons that we will describe shortly.

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\(^\text{17}\) Fedwire eligible collateral is collateral that is settled on the Fedwire Securities Service.
Mechanics of the allocation process
The allocation process for each dealer has two basic steps. In the first step, the dealer’s allocation decision problem is solved, manually or with the assistance of mathematical programming software. The solution is a set of portfolios of securities, one for each repo. The second step is the transfer of title of securities out of the dealer’s box and into the collateral accounts held at the clearing bank by each of the cash lenders, against transfers of cash from accounts of the cash investors at the clearing bank into the cash account at the clearing bank of the borrowing dealer.

To facilitate the first step, the clearing banks make their collateral allocation systems available to the dealers. A common algorithm orders the repo deals, typically from least to most restrictive in their collateral concentration limits, and ranks the collateral, typically from lowest to highest quality. The repo “deal shells” are then allocated collateral, one by one, with assets in rank order. Some dealers, particularly small dealers, use this algorithm to allocate their entire tri-party repo books.

Some dealers feel that they can achieve a better collateral allocation with a “script,” each step of which uses the ranking-based algorithm described above, but applied only to a restricted set of deals and a restricted set of collateral. For example, one step could be to allocate a dealer’s Treasury collateral to deals that accept only Treasuries. By this approach, the dealers can better control the allocation process. This method has the benefit of not requiring a CUSIP-level specification of the allocation of securities.

Box 1 provides some additional details on collateral allocation algorithms.

If an allocation algorithm is unable to populate all of the deals with the initially available pool of dealer collateral, the dealer may then “upgrade” the collateral pool. For example, in order to achieve a feasible allocation, the dealer could upgrade the basket of available securities by adding some U.S. Treasuries, which are typically accepted in most deals. A dealer may even complete a collateral package with cash. The dealer’s upgrade schedule can be priority ranked, with the most desired to allocate ranked first.

If, even with upgrades, there is an insufficient amount and mix of collateral to cover all deals, some rationing algorithm must be used, unless the dealer is able to renegotiate some trades. A dealer could have sufficient amounts of financing, but nevertheless fail on some deals because of insufficient collateral. In such a case, the dealer can prioritize specific clients, or give preference to older deals or to deals that can be collateralized with securities from markets that have already closed.

The collateral allocation systems used by the clearing banks do not have collateral-type filters that are sufficiently fine-grained to meet the collateral requirements of some cash investors. For
example, some investors may accept residential mortgage-backed securities (RMBS) but not commercial mortgage-backed securities (CMBS). If the clearing bank’s system is unable to distinguish between these two types of mortgage-backed securities, the collateral allocation process may require a dealer’s manual intervention. Similarly, a clearing bank’s system for distinguishing between the credit ratings of corporate bonds may not be sufficiently fine-grained to accommodate the rules applied by some cash investors. In such instances, dealers must manually allocate collateral to some of their deals at the CUSIP level, specifying exactly which collateral to allocate to each repo.

Box 1: Collateral Allocation Algorithms

For purposes of software input, a cash lender’s rule set is converted into a combination of mathematical restrictions. For example, a concentration limit, at least for the illustrative case given above, can be specified in terms of a linear inequality constraint of the form

\[ C(k,n): \ b(1,k,n)x(1,n) + b(2,k,n)x(2,n) + \ldots + b(m,k,n)x(m,n) \leq c(k,n), \]

where \( x(i,n) \) is the market value of security number \( i \) allocated to deal \( n \), \( b(i,k,n) \) is the contribution of security \( i \) to constraint \( k \) of deal \( n \), and \( c(k,n) \) is the constraint maximum, such as the allowable market value of securities that may be allocated under the \( k \)-th constraint of deal \( n \).

For instance, if the cash loan size of deal \( n \) is $100 million and if the \( k \)-th constraint on this deal specifies that no more than 30% of the collateral (after haircuts) may be investment corporate bonds, and if the associated haircut implies multiplication by a factor of 1.05, then \( c(k,n) = $31.5 \) million and \( b(i,k) = 1 \) if the \( i \)-th security in the dealer’s box is a corporate bond, and otherwise \( b(i,k) = 0 \).

Constraints that rule out securities of a particular type, such as speculatively rated corporate bonds, can be specified by a constraint of the form “\( x(i,n) = 0 \)” for any security \( i \) of the excluded type.

Rules can be combined via “logical and” and “logical or” operations. For example, a rule set could require:

\[ [C(1,n) \text{ AND } C(2,n) \text{ AND } C(3,n)] \text{ OR } [C(1,n) \text{ AND } C(4,n)], \]

meaning that the allocation to the \( n \)-th deal must meet all of restrictions \( C(1,n) \), \( C(2,n) \), and \( C(3,n) \), or alternatively can be satisfied by meeting restrictions \( C(1,n) \) and \( C(4,n) \).
There can also be cross-deal concentration limits associated with groups of deals from the same dealer client. Of course, there are also cross-deal constraints associated with the dealer’s total available amounts of each security, which can be specified in the form

\[ x(i,1) + \ldots + x(i,N) \leq v(i), \]

where \( N \) is the total number of deals to be populated with collateral and \( v(i) \) is the total market value of security \( i \) in the dealer’s box that is available for allocation. Of course, there is also a non-negativity restrictions on \( x(i,n) \) for all \( i \) and \( n \).

This mathematical description of the problem constraints is not necessarily descriptive of the software or methods actually used by clearing banks, but rather is used here to illustrate the underlying nature of the problem.

For a given dealer, a simple allocation algorithm could begin by determining preliminary allocations, deal by deal, taking some particular dealer-specified ordering of the deals, or “deal sort,” such as largest-deal-first. The dealer may also rank the available collateral in the order that it wishes to have the collateral allocated, with the most desired to allocate ranked first. Dealers often prefer to conserve their most liquid securities, such as U.S. Treasuries, by first allocating relatively illiquid securities.

For example, a simple algorithm would allocate securities, type by type, with the highest-ranked security allocated first, to deals in the given deal order, until the available quantity of the given type of security is exhausted or until each deal has the maximum amount of that security consistent with its concentration limits. This iterative algorithm is not an explicit optimization, beyond the desired effects of security rankings and deal order.

An explicit optimization algorithm could, for instance, maximize the total quantity of financing from deals that can be collateralized with the available pool of securities. Alternatively, the algorithm could be designed to minimize the dealer’s net interest expense for financing the dealer’s securities (the “cost of carry”), or could minimize the use of margin (that is, other things equal, show preference to deals with lower average haircuts). Various forms of optimization criteria could be tried, allowing the dealer to select the preferred allocation among the resulting outputs.
Another motive for a dealer to override its clearing bank’s automated collateral-allocation mechanism and manually intervene is a belief by the dealer that it can achieve a more efficient allocation of its collateral. Ideally, the allocation process maximizes the amount of financing that can be obtained from a given pool of collateral, or minimizes the dealer’s all-in net cost of financing, including the effect of haircuts, or achieves some related efficiency objective. The use of the clearing banks’ automated allocation systems, and avoidance of “manual overrides,” is therefore promoted by the sophistication of the optimization algorithms used in these systems.

4.2. The Morning Unwind
Under market arrangements in place during the crisis, each morning the clearing banks would “unwind” all tri-party repo trades, including term and rolling repos not maturing that day, between 8:00 AM and 8:30 AM. As explained in Section 3, the return of cash to investors creates a need by dealers for another source of financing until the day’s trades and other outstanding trades are settled in the evening. This financing is provided by the clearing banks, which extend intraday secured credit to the dealers, in the form of repos, to finance essentially all of their securities until the lenders’ funds settle in the evening. The clearing banks apply a risk-management concept known as Net Free Equity (NFE) to ensure that the market value of the dealer’s securities that are held at the clearing bank, including the effect of haircuts, exceeds the value of the intraday loans provided to the dealer. Dealers may also keep securities that are not financed through tri-party repos in their accounts at the clearing bank, increasing their NFE.

A complete unwind of all repos, and not merely those maturing, is operationally simple. An alternative would be a process by which dealers could substitute collateral (including cash) into repo deals without unwinding them, in order to extract a needed security, possibly at multiple points in the business day. Through-the-day collateral substitution is prevalent in European tri-party repo markets. By contrast, the U.S. clearing banks have offered some automated collateral substitution capabilities to U.S. tri-party repo market participants only since June 2011.

Unwinds are at the discretion of the clearing bank. This significant fact was not well understood by some market participants before the recent financial crisis. In the event that a clearing bank becomes concerned about a dealer’s credit quality, fearing for example that the dealer might declare bankruptcy during the coming day, the clearing agreement between a dealer and a tri-party clearing bank normally gives the clearing bank the right to protect itself by not unwinding.

18 On August 22, 2011, the unwind moved to 3:30 PM. As of the end of 2011, one clearing bank does not systematically unwind the term repos of some investors.
This would leave the original tri-party cash investors exposed to the dealer, but continuing to hold the dealer’s collateral.

A failure by a clearing bank to unwind a dealer’s tri-party repos would almost certainly force a dealer into default, as the dealer would not be able to deliver promised securities. Moreover, investors would likely refuse to continue funding the dealer. Cash investors would then have possession of the securities backing the repos, and could be forced to liquidate some or all of these securities. A special concern is that U.S. money market mutual funds accept as repo collateral some types of securities that they are not permitted, under Rule 2a7 of the Investment Company Act, to hold on their balance sheets. For example, a money market mutual fund may not be able to hold a 10-year Treasury note, given the regulatory maximum maturity of 13 months for a money market mutual fund’s assets.

5. Conclusion

We have provided an overview of the U.S. tri-party repo market, one of the most critical components of the financial system. We reviewed some key mechanics that played a role in the systemic weaknesses of this market that were revealed during the financial crisis of 2007-2009 and have proven an obstacle to industry reform efforts, which started in September 2009 and are currently incomplete.

The collateral allocation process currently requires a considerable amount of time, in part due to the desire of some dealers to intervene in this process. In addition, the need to settle the GCF market before the rest of the tri-party repo market extends the duration of the process. Settling GCF also requires coordination between the FICC and the clearing banks and communication between their systems. A similar form of coordination is required with DTC. The time necessary to allocate collateral makes it difficult to simultaneously settle new and expiring repos, and thus to reduce the dealers’ reliance on credit from their clearing banks. This has been an obstacle to the ongoing reforms of the tri-party repo market.

The daily time gap between the unwind and rewind of repos in the tri-party market drives much of the demand for clearing bank intraday credit and, thus, contributes to the fragility of the market in several ways. First, the gap between unwind and rewind means that there is a twice-daily transfer of exposure from a dealer’s investors to its clearing bank, and then from its clearing bank back to its investors. This handoff can create a perverse dynamic if the dealer comes under stress, as both the cash investor and the clearing banks may want to be the first to reduce their exposure to the dealer. Second, if a dealer declares bankruptcy during a portion of the day at which its clearing bank is exposed, the clearing bank could be weakened. This could create spillovers to other dealers that use this clearing bank for their tri-party activity, as investors may not want to be exposed to the clearing bank. This could also lead cash investors,
whose cash accounts are deposits at the clearing banks, to demand their cash on short notice, further exposing the clearing bank or promoting a fire sale of some of the collateral. Finally, a dealer failure could disrupt the clearing bank’s ability to function and, thus, undermine its ability to conduct other important payment, clearing, and settlement activities. This could destabilize not only the tri-party repo market but also serve as a channel for transmitting systemic risk more broadly throughout U.S. and even global financial markets.

Improving the collateral allocation process and eliminating the time gap between the unwind and re-wind of collateral would contribute to a reduction of risk in the financial system. In principle, a collateral allocation process that allows for the simultaneous settlement of new and expiring repos would eliminate the gap between unwind and re-wind, which gives rise to the dealers’ need for intraday credit. As an objective, the clearing banks could design a collateral allocation system that would achieve the various optimization objectives desired by dealers, without giving them a significant incentive to manually intervene in the collateral allocation process. The resulting collateral allocation process would also need to be transparent to investors, allowing them to evaluate their own settlement risks.

References:


Exhibit 2: The U.S. repo market

Bilateral cash markets

Investors:
- Hedge funds
- others

Securities dealers

Tri-party cash markets

Investors:
- MMFs
- Securities lenders
- others

Tri-party repo markets

Bilateral repo markets

GCF

Opening leg
Cash

Opening leg
Securities