

Policy Issues in the Design of Tri-Party Repo Markets

(Preliminary)

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1. Introduction

The U.S. tri-party repo market is used by major broker-dealers to finance their securities inventories. During the financial crisis of 2007-2009, particularly around the failures of Bear Stearns and Lehman Brothers, it became apparent that this market suffers from design weaknesses that can rapidly elevate and propagate systemic risk in a crisis. 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 provide an overview of short-run and long-run policy issues facing the overhaul of this key

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financial-system infrastructure, including any lessons to be learned from a comparison with the tri-party repo market infrastructure used in Europe.

The primary goal of the current reforms is to reduce the intraday credit extension of the clearing banks to a much smaller, capped, amount. This will be achieved by simultaneously settling new and expiring repos. Our main conclusion is that achieving a successful reform may require a fundamental reengineering of the technology and procedures used for handling the collateral that dealers allocate to cash lenders to back the performance of their repos. Most importantly, automation is needed in several areas to improve stability, speed settlement finality, and reduce operational risk:

- Automation, to keep non-maturing repos locked up until maturity by enabling substitution of collateral into and out of repos in order to facilitate dealers' market making activities and to keep lenders collateralized at all times, is critical to reducing demands for intraday credit provided by clearing banks. This intra-day credit was destabilizing in 2008.
- Automation and centralization of the process of allocating a dealer's collateral to its lenders would reduce the time necessary to test whether a dealer has sufficient financing commitments and has a mix of collateral that meets the requirements of cash lenders, thereby speeding the finality of settlement of repo trades.
- Automation of a prioritization rule for determining the order in which trades settle would enhance market stability, notably during crises, by reducing lenders' uncertainty about dealers' decisions concerning repayments.

This paper focuses on near-term improvements to the current architecture of the U.S. tri-party repo market. It is not our objective here to explore completely different approaches to market architecture that have been considered or used elsewhere, such as the central clearing of repos or a liquidation facility for handling the collateral of failing borrowers.

We find a number of differences between the European and the U.S. tri-party repo market. In particular, the handling of collateral is much more standardized and automated in the European market, perhaps because of the demands that the European market places on the handling of collateral, given the fragmentation of settlement across national settlement platforms and across time zones.

The next section provides a brief overview of the U.S. tri-party repo market and a summary of the concerns that it has raised. Section 3 reviews the mechanics of tri-party repo transactions. Section 4 explains in more detail the sources of instability associated with this market that were revealed during the financial crisis. Section 5 discusses the proposed infrastructure reforms and some of the challenges that remain before reaching the goals of these reforms. Section 6 reviews the infrastructure of the European tri-party repo market, with a focus on differences with the U.S. market. Section 7 offers concluding observations and recommendations.

2. The U.S. Repo Market

A repurchase agreement, or “repo,” is the sale of a portfolio of securities combined with an agreement to repurchase that portfolio on a specific future date at a pre-arranged price. Abstracting from some legal distinctions concerning bankruptcy treatment, a repo is a collateralized loan. The security portfolio is the collateral. Putting aside the effect of any over-collateralizing “haircut,” the initial sale price of the portfolio is the loan amount, while the repurchase price is the loan amount plus interest. If the borrower defaults, the lender intends to avoid losses by relying on the collateral.

U.S. broker-dealers rely on the U.S. tri-party repo market to finance the majority of their securities inventories. The standard tri-party deal is a general-collateral (GC) repo that finances a portfolio of securities meeting the asset-type requirements of the cash lender. In May 2011, as indicated in Table 1, U.S. Treasuries and various

U.S. agency obligations (mortgage backed securities, debentures, and collateralized mortgage obligations) accounted for approximately 80% of U.S. tri-party repo collateral.² The total amount of financing provided in the U.S. tri-party repo market at this time, about \$1.6 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 May 10, 2011.

Asset Group		Collateral Share Concentration		
		Value (billions)	of Total	by Top 3 Dealers
Fed-eligible collateral	US Treasuries excluding Strips	\$441.21	27.1%	44.3%
	US Treasuries Strips	\$49.21	3.0%	50.8%
	Agency Debentures & Strips	\$159.98	9.8%	38.3%
	Agency MBS	\$508.30	31.2%	33.5%
	Agency CMOs	\$134.23	8.2%	44.0%
Non Fed-eligible collateral	ABS Investment Grade	\$24.92	1.5%	40.4%
	ABS Non Investment Grade	\$15.56	1.0%	44.8%
	CMO Private Label Investment Grade	\$19.30	1.2%	43.6%
	CMO Private Label Non Investment Grade	\$22.61	1.4%	56.1%
	Corporates Investment Grade	\$81.61	5.0%	40.4%
	Corporates Non Investment Grade	\$33.39	2.1%	44.6%
	Equities	\$93.39	5.7%	43.7%
	Money Market	\$25.71	1.6%	63.8%
	Other*	\$18.62	1.1%	
Total		\$1,628.04		

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

The underlying data include a total of 6,320 deals and 9,194 collateral allocations. Source: Tri-Party Repo Infrastructure Reform Task Force web site (http://www.newyorkfed.org/tripartyrepo/margin_data.html).

² The public release of these data was one of the recommendations of the Task Force (Recommendation 13). The data are available at http://www.newyorkfed.org/tripartyrepo/margin_data.html.

A “tri-party” repo involves three parties: a dealer seeking to finance its securities, a cash investor, and a tri-party clearing agent, a custodian bank that settles the transaction between accounts that it maintains on its books in the names of the cash investor and the dealer. In addition to settlement and custodial services, the clearing agent 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. We review the mechanics of tri-party repo transactions in Section 4 and the collateral allocation process in an appendix.

The cash investors in tri-party repos are primarily money-market mutual funds, securities lenders, and other institutional cash investors who seek interest income at short maturities. Together, money-market mutual funds and securities lenders account for over half of tri-party repo lending. Tri-party collateral providers are typically broker-dealers who seek streamlined low-cost short-term financing for their securities inventories. These dealers rely on a tri-party agent to conduct collateral management activities that they are not equipped to handle as efficiently on their own. Tri-party repos are also a convenient source of financing from cash investors who prefer to consolidate their cash accounts, rather than maintaining a cash account with each repo borrower.

As opposed to a tri-party repo, a delivery-versus-payment (DvP) repo, also known as a “bilateral repo,” does not settle on the books of a third-party agent. DvP repos, which are not the subject of this paper, are used for a wide range of purposes.³ Dealers tend to use the bilateral market for repos of specific securities that are in high demand, known as “specials,” or for providing collateralized financing to their clients. In order to conduct DvP repos, a cash investor would need to hire the services of a collateral manager, or of its custody bank, or build the infrastructure that would enable it to perform collateral valuation and margining on its own.

³ Gorton and Metrick (2010) review the performance of an interdealer DvP repo market during the financial crisis.

The failures of several dealers during the crisis highlighted the fact that the two major tri-party clearing banks, J.P. Morgan Chase (JPMC) and Bank of New York Mellon (BNYM), are not only agents, but are also the largest creditors in the tri-party market during the business day. In the U.S. market, maturing repos settle and all other repos are “unwound” early in the morning, when cash is sent back to investors and collateral is sent back to the dealers. New trades do not settle until the end of the business day at the same time other repos are “rewound”. Thus, dealers have a sizable need for financing during the roughly 10 hours between the morning settlement and the times at which the dealers receive funds from their lenders in the evening. During this period, the clearing banks provide financing to dealers, collateralized by the dealers’ securities. 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 bank could also be threatened if it decides instead to hold the collateral on its own balance sheet.

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 collateralizes 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. The PDCF provided an alternative source of financing for collateral that might otherwise be liquidated in a fire sale.

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 “run” on 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 the 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).

A further concern that arose at the failure of Lehman was the run on money market funds that was triggered when the Reserve Primary Fund announced large losses on its investments in Lehman paper. Approximately \$400 billion was withdrawn from prime money market funds by institutional investors in the span of only two weeks, out of total holdings of about \$1.3 trillion.⁴ 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. Faced with redemptions, money market funds must reduce the financing that they themselves provide to others, including tri-party repo borrowers.

The heavy reliance of some systemically important dealer banks on overnight financing leaves them vulnerable to a sudden reduction in financing opportunities. That systemic risk is beyond the scope of this paper, which focuses instead on the risks posed by the market infrastructure.

In summary, the key sources of systemic risk posed by the U.S. tri-party repo market that are of concern here are (1) the market’s reliance on intraday credit provided by the clearing banks, which heightens the risk that major dealers who rely heavily on

⁴ From Moody’s data, over the period from September 9, 2008 to September 23, 2008, holdings by institutional investors in prime money market funds dropped from \$1,330 billion to \$948 billion, while holdings by retail investors declined from \$755 billion to \$727 billion.

short-term repo financing may suddenly lose financing from cash investors or from their clearing banks, and (2) the vulnerability of the market to a dealer default, which could prompt fire sales of repo collateral and affect asset-market participants more generally. These risks are further detailed in Section 4.

In light of the systemic importance of the tri-party repo market, the large daylight exposures of clearing banks to a small set of primary dealers, and other concerns regarding risk-management practices in the tri-party repo market, in 2009 the Federal Reserve Bank of New York asked major market participants to design and recommend reforms of the infrastructure of the tri-party repo market. The U.S. Tri-Party Repo Infrastructure Reform Task Force, an industry group, has subsequently formulated preliminary recommendations (discussed in Section 5). While these reforms are in progress, we hope to shed more light here on the costs and benefits of various approaches to tri-party infrastructure design that may be relevant in judging these and longer-run policy choices.

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,⁵ the collateral requirements, 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 rather than being settled each day. A “term repo” has a tenor of more than one day. For term repos that are not maturing on a given day and for those “open” repos that mature on that day but will be rolled, there is no requirement to “unwind” on that day, that is, to return the cash to the lender and the collateral to the borrower. As we will discuss shortly, however,

⁵ 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 $\$100 \times 0.02 \times 3/360$.

market practice has been to unwind such repos each morning and to “rewind” them each afternoon.

To establish a tri-party trading relationship, a cash lender and a cash borrower execute a “master repo agreement” (MRA) that stipulates the terms of their upcoming tri-party repos. The borrower and lender each have, in addition, clearing agreements with the tri-party agent bank. A custodial undertaking, executed by the two MRA signatories as well as the clearing bank, establishes the tri-party agent for this lender-borrower relationship and documents the lender’s collateral eligibility criteria.

An annex to the custodial agreement also stipulates the “haircut,” the margin of additional market value of collateralizing securities to be pledged by the borrower as a cushion against declines in collateral value that could occur over the term of the transaction. For example, a 5% haircut means that, for each \$100 of a cash loan backed by the specified form of collateral, at least \$105 in market value of the collateral must be provided by the borrower. The haircut is typically based on the historical price volatility for the asset type and loan term.⁶ 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 equities and speculatively rated corporate bonds were 7.5% and 8%, respectively, reflecting their generally higher volatilities or lower liquidity. In some cases, the haircuts applied by clearing banks for the intra-day repo financing of dealer inventories exceed those charged by the cash investors.⁷

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,” as detailed in the Appendix.

⁶ As detailed in Copeland, Martin, and Walker (2011), haircuts also depend on the dealer.

⁷ See Valukas (2010), pages 1095-1102.

Table 2. Distribution of Investor Haircuts in Tri-party Repos as of May 10, 2011.

Asset Group		Cash Investor Margins Levels		
		10th Percentile	Median	90th Percentile
Fed-eligible collateral	US Treasuries excluding Strips	1.0%	2.0%	2.0%
	US Treasuries Strips	2.0%	2.0%	2.0%
	Agency Debentures & Strips	2.0%	2.0%	3.0%
	Agency MBS	2.0%	2.0%	5.0%
	Agency CMOs	0.4%	3.0%	5.0%
Non Fed-eligible collateral	ABS Investment Grade	3.0%	5.0%	10.0%
	ABS Non Investment Grade	2.0%	5.5%	10.0%
	CMO Private Label, Investment Grade	5.0%	5.0%	10.0%
	CMO Private Label, Non Investment Grade	2.0%	5.0%	10.0%
	Corporates, Investment Grade	2.0%	5.0%	8.0%
	Corporates, Non Investment Grade	2.0%	8.0%	13.9%
	Equities	5.0%	7.5%	15.0%
	Money Market Instruments	2.0%	5.0%	5.0%

The underlying data, which are common to those underlying Table 1, include a total of 6,320 deals and 9,194 collateral allocations.

Source: Tri-Party Repo Infrastructure Reform Task Force web site (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. 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. Some late-day trades are arranged. For example, a large fund complex may negotiate aggregate deals in the morning, but may not specify allocations to specific funds within their complexes until later in the day.

The dealer and cash investor negotiate the interest rate, the collateral, the tenor, and the size of the repo. The applicable haircuts will have already been set in the annex to the custodial agreement. In the past, cash investors have not systematically transmitted the terms of a deal to their clearing banks. This is changing with the implementation of three-way trade matching, which is mandated by the ongoing reform of the market.

In some cases, dealers attempt to accommodate unexpected changes in investors' available cash. For example, a dealer may allow some classes of investors, such as money market mutual funds, to deviate by up to 10% from the originally agreed deal size. A "fail" is said to occur if the dealer ultimately fails to fill the "deal shell" with collateral meeting the agreed terms. Dealers commonly attempt to avoid fails, if necessary by posting cash collateral if they have insufficient eligible securities. On rare occasions, the size of a deal must be renegotiated, or a dealer may fail. Dealers and investors have incentives to maintain the quality of their relationships, and thus try to minimize costs imposed on one another by unexpected failures or changes to a deal.

The clearing bank settles the opening legs of new repos as well as the closing legs of any repos that are to be settled on that day, acting as agent for the borrower and lender. As explained in the Appendix, the dealer and its clearing bank have some discretion regarding what 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 back and forth to the clearing accounts of the borrower and lender. The Appendix describes the collateral allocation process in more detail.

The morning unwind

Under current standard market arrangements, each morning the clearing banks “unwind” all tri-party repo trades, including term and rolling repos that are not maturing that day, between 8:00 AM and 8:30 AM. In the unwind process, the clearing bank returns the cash to the lender’s cash account and returns the assets serving as collateral to the dealers’ securities account. As explained in Section 2, 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 custody at the clearing bank, increasing their NFE.⁸

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 collateral, into a repo deal in order to extract a security for some other purpose, at multiple points in the business day. Through-the-day collateral substitution is prevalent in European tri-party repo markets. Clearing banks have only recently begun to develop extensive collateral substitution capabilities for the U.S. tri-party repo market.

⁸ The dealer’s clearing account agreement with its clearing bank establishes that the clearing bank has a lien on all securities and cash balances held in the dealer’s clearing account – whether they are pledged as collateral in tri-party repo agreements or are being held at the clearing bank in connection with other types of transactions beyond tri-party repos. In the event of a dealer’s failure to repay a loan extended to it by the clearing bank, the clearing bank’s close-out rights enable it to look to the assets in the dealer’s clearing account as a source of repayment.

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. This would leave the original tri-party cash investors exposed to the dealer.

A failure by a clearing bank to unwind a dealer's tri-party repos would almost certainly force a dealer into effective default. Cash investors would then retain the rights of title to the securities backing the repos, and could be forced to liquidate some or all of these securities. A concern is that U.S. money market mutual funds may 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.⁹

The afternoon collateral allocation process

In the afternoon, term and rolling repos must be rewound and new repo deals must be settled. This process, which also 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. As explained in more detail in the Appendix, the allocation process ensures that the package of collateral allocated to each repo deal meets the cash investor's collateral-mix requirements, and that the securities are allocated in sufficient amounts after applying haircuts.

⁹ In addition, SEC rules limit concentration risks based either on counterparty or on collateral categories. A repo exposure can be acceptable based on the counterparty limit, even when the collateral underlying the repo would fall afoul of the rules.

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 primarily due to the fact that some of a dealer's securities 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. A secondary reason for the late allocation is the considerable time spent by some dealers in "manually" intervening in the collateral allocation process, for reasons that we will describe in Section 4. On top of delays caused by these dealer interventions, the collateral allocation procedures used by clearing banks require some "run time," and thus further delay settlement.

Once the Fedwire Securities Service closes at 3:30 PM, dealers can no longer receive or send Fedwire-eligible securities such as Treasuries or Agencies. At this point, they are aware of their final holdings of these securities. This therefore sets the earliest time by which the dealers prefer to begin the tri-party repo allocation process for these securities. Most dealers, however, also trade in the "GCF repo" market, a blind-brokered interdealer DvP repo market that is available to netting member participants of the Fixed Income Clearing Corporation (FICC). These dealers prefer to wait for GCF trades to settle before they complete their tri-party repo allocations.¹⁰ Settlement of GCF repos can last until 5:00PM, or until 5:30 PM on certain days, and thus potentially cause significant delays to the completion of the collateral allocation process.¹¹

¹⁰ The settlement of FICC repos proceeds in several steps. First, FICC produces net GCF Repo Files. The files are then sent to the clearing banks, which create GCF loan shells in dealers' accounts. Dealers that "repoed securities out" must fill these shells, using a process that often involves manual intervention. The clearing banks must also exchange the files that specify the GCF repo collateral that FICC passes from JPMC dealers to BNYM dealers and vice versa. This is the interbank component of GCF. Once that process is complete, the clearing banks post the incoming GCF collateral to dealers' accounts. This process is important because collateral traded in GCF is typically rehypothecated via tri-party repos.

¹¹ The Task Force is moving the close of GCF from 3:30 to 3 PM as part of the changes supporting reform.

Equities can be allocated to repos from the accounts of dealers at the Depository Trust Company (DTC). DTC-eligible collateral must also be received before the tri-party repo market can completely settle. Currently, DTC-eligible collateral becomes available as late as 4:30 PM, although dealers could obtain delivery of some DTC-eligible collateral before 4:30 if all DTC liens against that collateral have been released.¹²

The collateral allocation process can begin before all DTC-eligible collateral is available and before all GCF repos are settled. The process cannot be completed, however, until these other steps are themselves complete.

Money market mutual fund complexes often agree to a certain amount of repos with a dealer in the morning, but are not able to specify the breakdown among specific funds until late in the day. Moreover, some money market mutual funds that lend cash in the tri-party repo market allow late redemptions and investments by their own investors. These late-closing funds may not know the amounts of cash that they will want to invest in tri-party repo deals until late in the day. The collateral allocation process does not conclude until the money market funds provide their breakdown and the late deal requests have been received.

Many tri-party repo agreements are negotiated on the basis of standard forms of collateral. This especially promotes the use of Fed-eligible collateral, which is relatively liquid. As indicated in Table 1, Fed-eligible collateral currently constitutes about 80% of tri-party repo collateral.

¹² Each day, DTC executes an end-of-day cash settlement among its participants. After the settlement is completed, DTC releases liens on securities that were collateralizing intra-day credit extended by DTC to a participant. DTC is delivering securities into and out of a dealer's account from early morning until essentially 3:00 PM. If a dealer is in overdraft at DTC during the day or at 3:00 PM, DTC will have in place a lien on securities in that dealer's account that are otherwise unencumbered. In this case, the dealer would not be able to pledge (at DTC) those specific securities to its clearing bank until it clears up its overdraft. The dealer could, for example, "pre-fund" DTC obligations by transferring cash into its DTC account, thereby obtaining the release of collateral.

A dealer's tri-party repo system may inform its repo traders of the amount of financing that it needs for each collateral type. These traders then contact cash lenders and negotiate trades accordingly. The dealer's back office can then send requests to the clearing bank to allocate specific securities to specific deals. This activity can involve manual instructions to allocate collateral to individual repo deals. The back offices of some dealers have several people dedicated to the collateral allocation process. In some cases, each person specializes in a single broad class of securities, such as Treasuries, Agencies, or equities.

While the clearing banks offer an automated collateral-allocation mechanism to dealers, some dealers choose to use their own algorithms for determining the allocations of their collateral to their tri-party repo deals. Bypassing the clearing banks' automated allocation mechanism, however, involves a relatively intensive process described in more details in the appendix.

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 place in which deal shell.¹³

¹³ Maintaining accurate data on a diverse portfolio of fixed-income securities, especially asset-backed securities (ABS), given the large number of potentially relevant data fields and the need for up-to-date ratings from multiple issuers, is a major challenge for nearly all market participants.

A more automated process, facilitating an efficient and fast collateral allocation, would require that the clearing banks make available collateral filters that are sufficiently fine-grained. With an automated process, a dealer would be unable to customize its collateral beyond the menu of securities recognized by its clearing bank's collateral allocation system. With an enriched and regularly updated menu, a moderate amount of customization could be accommodated within an automated collateral allocation process, such as that of the European tri-party repo market, which we describe in Section 6.

Another motive for a dealer to forgo 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 is therefore also promoted by the sophistication of the optimization algorithms used in these systems.

4. Weaknesses of the tri-party repo market revealed by the financial crisis

The FRBNY's white paper (2010) emphasizes three weaknesses of the tri-party repo market that were highlighted by the financial crisis: the market's reliance on intraday credit from the clearing banks, the pro-cyclicality of risk management practices, and the lack of effective and transparent plans to support the orderly liquidation of a defaulted dealer's collateral. This section focuses mainly on the risks associated with the provision of intraday credit to dealers by the clearing banks, a systemic risk that motivates some key aspects of the proposed reforms.

Market dependence on intraday credit from clearing banks

As explained in Section 3, the clearing banks currently unwind all repos every morning by 8:30 AM, whether they are maturing that day or not. As a result, clearing

banks extend intraday credit to dealers for the total value of the tri-party repo market, which was approximately \$2.8 trillion at the peak of the market and was \$1.6 trillion in May 2011. The large credit exposures that clearing banks have to dealers, although secured by the dealers' assets, is a systemic risk, given the size and centrality of the clearing banks in the financial system. Whether instigated by concerns over a dealer's solvency or over the credit quality of collateral, the current approach to daily unwinds could contribute to behavior by cash investors or clearing banks that leads to a sudden loss of financing to one or more dealers.

Each morning, the unwind transfers the risk of a dealer's potential default from cash investors to the clearing bank, provided the clearing bank agrees to the unwind. In the evening, this exposure to the dealer is transferred from the clearing bank back to cash investors (including new investors). This handoff works well when all parties believe that the dealer will continue to obtain financing, but creates incentives for each party to be among the earliest to withhold credit from a troubled dealer in a stressed environment, so that they are not left holding the dealer's collateral.

For example, suppose that cash investors become concerned that a clearing bank may refuse to unwind the repos of a certain dealer. Because that would force the dealer into default, cash investors would be reluctant to finance the dealer the day before. The inability of the dealer to obtain financing from cash investors would likewise force the dealer into default. Similarly, a clearing bank would be reluctant to unwind the repos of a dealer that is not likely to obtain financing from cash investors at the end of the day. This would therefore also be a self-fulfilling expectation.

A different form of systemic risk associated with the provision of intraday credit by a clearing bank is the danger that a dealer's default could destabilize its clearing bank. The largest exposure of a single clearing bank to an individual dealer exceeded \$400 billion at the peak of the market, before the crisis. Today, several dealers still have tri-party repo books that range in size between \$100 billion and \$250 billion.

The default of such a large dealer could have severe negative consequences for a clearing bank. If the clearing bank had to take possession of a defaulting dealer's assets, this would increase the size of the clearing bank's balance sheet significantly, putting pressure on its regulatory capital ratio. The clearing bank would have the option of selling these assets into a potentially stressed market (likely at a loss) or financing them on its own balance sheet, in which case it would be exposed to uncertain changes in their market values. Either option, a fire sale or extra balance-sheet stress, is potentially dangerous to the clearing bank's viability and thus to the financial system as a whole.

The risk of a dealer's failure could therefore raise concerns about the clearing bank's financial health and lead cash investors to hesitate before funding the repos of *any* dealer relying on that clearing bank. Any serious risk to a clearing bank is particularly salient to cash investors because they normally leave most of their cash on deposit at the clearing bank during the day, between the unwinding and rewinding of their repos, and thus have large unsecured exposures to the clearing bank during the day. As a result, problems at one dealer that could destabilize a clearing bank could propagate to other dealers at that clearing bank through a run on that clearing bank.

Failures of coordination between cash investors and clearing banks associated with the self-fulfilling expectations described above are exacerbated by a similar coordination problem among cash investors. Each investor, once concerned that others may run, has a clear incentive to run.¹⁴ Given the importance to dealers of tri-party repo financing, cash investors understand that the dealer may not survive if other such investors were to refuse to fund a dealer. These dynamics, analyzed by Martin, Skeie, and von Thadden (2010), are similar to those of traditional bank runs.

¹⁴ This dynamic is exacerbated by the short tenor of most tri-party financing. Laddered, longer-maturity repos would protect dealers against this type of risk.

Ironically, the revisions of Rule 2a7 of the Investment Company Act, designed to lower risks to money market funds, push those funds into shorter-term assets, thus exacerbating the reliance of dealers on short-term financing. This concern, however, may be mitigated to some degree by the “Basel III” liquidity coverage and net stable funding ratio requirements, which should incent banks (including broker dealer affiliates of bank holding companies) to increase their reliance on term funding. There is some tension between the revisions of Rule 2a7, which tends to increase the demand for short-term assets, and Basel III, which tend to decrease the supply of these assets.

Stress in the tri-party repo market during the crisis

During the financial crisis, repo market stresses were manifested much differently in the tri-party market than in other repo markets. Gorton and Metrick (2010) and Copeland, Martin, and Walker (2010) provide evidence that the U.S. bilateral repo market experienced large increases in haircuts. A “haircut run” forces levered investors to quickly sell assets in order to meet higher collateral requirements. The price impact of such fire sales can in turn heighten price volatility and lower the perceived credit quality of collateral, potentially causing further increases in haircuts, an adverse “margin spiral” that has been analyzed by Adrian and Shin (2010).

In contrast to the increases in haircuts that were witnessed during the financial crisis in bilateral repo markets, haircuts applied by cash investors in the tri-party repo barely moved. Until now, this difference has not been well explained. It may be related in part to the lower average degree of leverage of cash lenders in the tri-party market relative to those of the bilateral market. Copeland, Martin, and Walker (2010) analyze supervisory data provided by the clearing banks, focusing on a sample drawn from trades made between July 2008 and January 2010. During that period, tri-party repo haircuts were remarkably stable for all asset classes other than those of the lowest quality. Even for low-quality assets, increases in haircuts were generally mild. In short, there is little evidence of a generalized haircut run on

the tri-party repo market during the financial crisis.¹⁵ The haircuts applied to intraday credit to dealers from clearing banks did, however, increase substantially in some cases.¹⁶

Other than Bear Stearns and Lehman Brothers, major dealers did not appear to have difficulty obtaining financing in the tri-party repo market during the crisis. While the overall size of the market decreased between mid 2008 and early 2010, most of the reduction in market size appears to have been the result of an effort by dealers to reduce leverage. Some of the reduction in tri-party volumes may be due to the reduced supply of eligible securities caused by large purchases of assets by the Federal Reserve that were not put out on repo. The creation of the primary dealer credit facility (PDCF) is also likely to have helped stabilize the market, as explained by Adrian, Burke, and McAndrews (2010), and in particular to have reduced dealers' reliance on the tri-party repo market.

In contrast to other dealers, Bear Stearns and Lehman Brothers did experience precipitous declines in their tri-party repo financing, contributing to their financial distress. Lehman's financing difficulties were not overcome by the presence of the PDCF. These declines in financing opportunities to Lehman and Bear Stearns share some similarities with traditional bank runs and underscore the fragility of the tri-party repo market.

Other sources of weakness

Another weakness of the tri-party repo market is the current lack of effective and transparent plans to support the orderly liquidation of a defaulting dealer's collateral. This weakness did not significantly exacerbate the financial crisis of 2007-2009—but only because the central bank stepped in to provide a liquidity

¹⁵ Krishnamurthy, Nagel, and Orlov (2011) provide evidence of a sharp reduction in the amount of non-Agency MBS/ABS financed in the tri-party repo market, which could be interpreted as a generalized run on that particular asset class.

¹⁶ See Valukas (2010), pages 1095-1102.

backstop for dealers, in the form of the PDCF. This in turn assured lenders and the clearing banks that dealers had an alternative source of financing, and likely helped to forestall a run in the tri-party market.

In the cases of Bear Stearns and Lehman, central bank lending was also a bridge enabling the broker-dealer operations of these two firms to continue briefly, until they could be acquired by another firm.

- Bear Stearns' failure was averted by its acquisition by JPMorgan Chase, which was in turn facilitated by a loan from the central bank against some Bear assets. This orderly resolution of Bear averted a default that would have required its tri-party lenders or its clearing bank to take possession of its collateral, and to finance or liquidate it. The central-bank financing also bought the time that an acquirer needed to consummate the transaction.¹⁷
- In the case of Lehman Brothers, the U.S. broker-dealer subsidiary of Lehman continued to operate in the week following the bankruptcy of the holding company. The broker-dealer obtained considerable funding from the PDCF for three days, until it was purchased by Barclays. As with the case of Bear, the resolution of the broker-dealer through its acquisition by a healthy firm averted a dealer default that could have further destabilized markets that were already under severe stress, thus avoiding an even deeper financial crisis.

Under the Dodd Frank Act, passed in July 2010, the provision of liquidity to facilitate the resolution of a large troubled non-bank financial institution is no longer the preserve of the central bank. This authority now rests with the Treasury Department and is to be used only in connection with the Federal Deposit Insurance

¹⁷ The FRBNY initially made a non-recourse loan to Bear Stearns' clearing bank (JP Morgan Chase) against its collateral portfolio, before the PDCF was operating.

Corporation's special resolution scheme, subject to the oversight of the Financial Stability Oversight Council.

5. Proposed reforms and challenges

This section focuses on reforms that have been proposed by the industry in response to the weaknesses described in the previous section. First, we describe the main elements of these reforms, which focus on reducing the level of intraday credit provided by tri-party clearing banks. In order to complete these reforms, there will need to be revisions in the collateral allocation process, including the process through which dealers learn the exact set of securities available to them as collateral. We will also describe some complications associated with revisions to the allocation process that are likely to prevent the completion of some of these reforms by the originally planned date of October 2011. Finally, we discuss some alternatives to the current tri-party repo infrastructure.

The Task Force on Tri-Party Repo Infrastructure and its proposals

The Task Force on Tri-Party Repo Infrastructure (Task Force) is an industry group formed in September 2009 under the auspices of the Payments Risk Committee (PRC),¹⁸ sponsored by the Federal Reserve Bank of New York.¹⁹ The Task Force's membership consists of the largest players in the tri-party repo market, including large dealers, representatives of money market mutual funds and securities lenders, and the two clearing banks. Representatives of the Federal Reserve, the Treasury Department, and the Securities and Exchange Commission serve as technical advisors and observers.

The Task Force released a report on May 17, 2010 detailing a number of recommendations for how to strengthen and increase the inherent stability of the

¹⁸ See <http://www.newyorkfed.org/tripartyrepo/>

¹⁹ See <http://www.newyorkfed.org/prc/>

infrastructure supporting the tri-party repo market.²⁰ The first recommendation, on which we focus, is to

“Implement operational enhancements to achieve the ‘practical elimination’ of intraday credit by the Clearing Banks, where ‘practical elimination’ is defined as a point beyond which the residual amounts of intraday credit extensions are both small and can be governed by transparent bilateral arrangements, known in advance to participants.”

A footnote to this recommendation clarifies that the clearing bank’s credit extension should not exceed 10% of a dealer’s notional tri-party book.

Specific steps proposed for implementing this and other recommendations were laid out in a document released by the Task Force on December 3, 2010.²¹

- The clearing banks would introduce collateral “auto-substitution” functionality early in 2011, with full adoption planned for June 2011, in order to facilitate a lockup of collateral until maturity date, and thereby reduce the demand for clearing bank credit.
- Three-way trade confirmation between dealers, investors, and the clearing banks would be required to settle trades as of August 2011. This confirmation would provide to clearing banks the data needed to ensure that they could identify term and rolling trades that should not be unwound prior to maturity.
- The settlement, or “unwind,” of tri-party repos would move from 8:30 AM currently, to 10:00 AM in July 2011, and then to 3:30 PM in August 2011.

²⁰ The report can be found at http://www.newyorkfed.org/prc/report_100517.pdf

²¹ See http://www.newyorkfed.org/tripartyrepo/pdf/tpr_proposal_101203.pdf

- By August 2011, the clearing banks' technology would be modified to facilitate the simultaneous settlement of maturing and new trades. This would further reduce the amount of credit extended by the clearing banks, by essentially eliminating time gap between the unwind of maturing trades and settlement of new trades.
- By October 2011, clearing banks would provide intraday credit for up to only 10 percent of a dealer's tri-party repo book. This credit would be provided only on a pre-committed, contractual basis, rather than on a discretionary basis as is done today.

The Task Force will meet the first three of these steps on time, but will be delayed beyond the end of 2011 in reaching the last two of these milestones.²² Each of these steps is a critical prerequisite to improving the stability of the infrastructure supporting the tri-party repo market. Auto-substitution will enable a dealer to make deliveries of securities during the day by extracting them from the repos that they are currently backing. Three-way confirmation, which is in any case a sound market practice, will provide clearing banks with the information they need to limit the trades they unwind to those maturing that day. Moving the unwind to the afternoon will allow clearing banks to know whether a dealer has sufficient financing before unwinding the dealer's expiring repos, significantly lowering the exposure of the clearing bank to the dealer. Finally, these capabilities will allow significant netting of cash payments that are due to and from a lender on maturing and new repos with the same dealer, which will further reduce the amount of credit that clearing banks will provide to dealers.

²² An exception to the on-time completion of the first objective, auto-substitution, is a delay in the auto-substitution functionality supporting GCF trades between dealers at different clearing banks.

Challenges to the proposed reforms

It is now apparent that the full set of reforms proposed by the Task Force will not be achieved by the original target date of October 2011. Several challenges remain to be overcome.

In order to achieve a near-simultaneous maturation and settlement of tri-party repos, clearing banks will need the ability to perform projected collateral allocations for their dealer clients, and to implement this projected allocation immediately upon the unwind of the dealer's maturing repos. As explained in Section 2 and in more detail in the Appendix, collateral allocations assign eligible packages of a dealer's securities to newly settling repos. If collateral allocations can be done on a "projected" basis, that is, in advance of the time of maturation of the dealer's repos, the clearing banks can arrange a rapid-fire sequence of maturations and settlements of new repos. If the projected collateral allocations are efficient from the viewpoint of the dealer's objectives, then concerns over the optimality of collateral allocations need not crop up in during the allocation process, or induce intervention by dealers, delaying that process. The ability to perform "projected" allocations is part of the improvements planned by the clearing banks, in order to complete the proposed reforms.

A separate challenge is that cash investors have some early-morning liquidity demands that they will no longer be able to meet with the proceeds of maturing tri-party repos, given that, post-reform, tri-party repos will not mature and release their cash until 3:30PM or later. In the current regime of morning unwinds of all trades, investors have access to all of their cash when it is returned to their accounts at around 8:30 AM.

Some cash investors take advantage of this early access to cash when meeting margin calls and when meeting their own investors' cash redemption requests. Meeting these early-morning cash needs from maturing repos will become much more difficult or impossible. The Task Force has set itself the longer-term goal of

returning cash to investors as quickly as possible after the 3:30 PM start of the settlement window, to give them enough time to utilize cash from maturing repos to make payments, reinvest with another dealer, or invest in another instrument before Fedwire cash movements end for the day at 6:00 PM. Because the allocation of collateral of some types can begin only after the close of GCF repo trading activity and the 3:30PM daily close of Fed's securities wire, completing the proposed reforms will require a substantial reduction of the duration of the collateral allocation process used for triparty repo settlement, which currently can take as long as three hours.

Under current planning for the post-reform market infrastructure, a large batch of unwinds, coupled with an essentially simultaneous batch of settlements of opening legs of new repos backed largely by the collateral released in these unwinds, will occur almost immediately after 3:30 PM. The remaining settlements would then be completed in a sequence of subsequent batches, facilitated by new collateral arriving from GCF repo settlements, the release of DTC collateral, and additional collateral and cash provided by the dealer.

This new approach will require a fundamental re-engineering of the information technology of the clearing banks and FICC, including a significant streamlining of the collateral allocation process. In particular, the FICC and the clearing banks will need to share information in real time for collateral substitution and to get a more complete picture of a dealer's available collateral around 3:30PM. This will also require changes in market practice on the part of all market participants. It will be difficult to continue the practice by which some dealers "manually" intervene in their collateral allocations, given the need to move to a much shorter time window for settlements.

6. Comparison with the European Tri-Party repo market

It is useful to compare the design of the U.S. tri-party repo market with the European model, which does not rely on similarly large intra-day extensions of credit by clearing banks. The collateral that is eligible within this market is not limited to European securities; it also includes American and Asian collateral. The European tri-party repo market did not appear to experience as much instability during the financial crisis as the U.S. market did. In this section, we describe the key participants and the basic mechanics of the European tri-party repo market. We also compare and contrast the U.S. and European tri-party repo markets.

Key participants

The European tri-party repo market is a financing market in which leveraged players such as broker-dealers and the investment-banking or asset-management affiliates of commercial banking organizations obtain secured financing for their securities inventories. European tri-party repo market activity appears to be less dominated than the U.S. market by the structural needs of financial institutions for secured financing, however. Interviews with market participants indicate that client activity represents a larger share of volume in the European market; banks who provide custodial services to asset management firms commonly repo out their assets and excess cash as a means to provide cash-management and return-augmentation services to those clients.

These distinctions between European and U.S. practice may reflect in part the prevalence of the universal banking model of the European financial services industry, whereby a larger share of securities are held in the banking system than is the case in the U.S., where leveraged broker-dealers hold a major share of U.S. securities issuance. Further, the two international central securities depositories (ICSDs) handling tri-party repo clearing, Euroclear and Clearstream, have membership criteria that allow participation by a somewhat limited set of non-bank participants. A lender without direct access to an ICSD will typically conduct its tri-party repo transactions through a bank that acts as its agent.

Cash investors in the European tri-party repo market include central banks, supra-national institutions, and deposit-rich commercial banks. In some cases, non-financial corporations also provide cash, as explained by Chailloux (2005). Pension funds and insurers are reported to be entering this market to invest cash for relatively long terms. Money market mutual funds play a smaller role in the European financial system than they do in the U.S., and likewise represent a smaller share of tri-party repo cash investors. Also, prior to the failure of Lehman, securities lending in Europe was predominantly done against securities collateral. Hence, securities lending agents did not have pools of cash collateral comparable in size to those of their U.S. counterparts that were directed into instruments such as tri-party repos. (Information received from market participants suggests that securities lending is increasingly executed against cash collateral in Europe since the financial crisis.)

The four main providers of tri-party repo agent services in the European market are the two ICSDs, Euroclear and Clearstream, and the European affiliates of the two U.S. clearing banks, JP Morgan Chase (JPMC, London) and Bank of New York Mellon (BNYM, Brussels). As the main repositories of fixed-income securities, the two ICSDs facilitate most of the tri-party repos done against relatively liquid fixed-income collateral. BNYM and JPMC primarily facilitate tri-party repos backed by equity collateral and less liquid fixed-income assets, although they also process some trades that are backed by more liquid fixed-income securities.

Euroclear and Clearstream are the largest providers of tri-party agent services to market participants. However, these ICSDs are not well integrated with each other or with the national central securities depositories (CSDs) in each country in an operational sense. Securities must be moved from the national CSD into an account at an ICSD in order to be financed through tri-party repo at the ICSD, but the fragmented nature of the securities settlement landscape in Europe has historically made such movements relatively costly and time-consuming. Over the past few years, however, some national CSDs have been reorganized as affiliates of either

Euroclear or Clearstream, improving their links to the ICSD with which they are affiliated and reducing the costs associated with movements of securities between the ICSD and the national CSD. A significant fraction of transactions occur between borrowers and lenders at the same tri-party agent bank, with little activity settling across these two service providers.

Fragmentation is not an issue in the United States, because both clearing banks have a Fedwire and a DTC account, in which reside the securities they settle for the tri-party repo market. While many cash investors have an account with only one clearing bank, the largest cash investors typically have accounts with both clearing banks, and can therefore lend to any collateral provider.

Basic mechanics

The European and U.S. tri-party repo markets also differ with respect to size, settlement conventions, and the distribution of trades between overnight and term repos. The International Capital Market Association (ICMA) provides data on the repo market in Europe. At the close of business on December 8, 2010, the total value of repos and reverse repos outstanding on the books of the 57 institutions that participated in the ICMA survey was EUR 5,908 billion, of which 51% was in the form of repos. The share of tri-party repos was reported to be 11.5% of the total (ICMA, 2011). Hence, the European tri-party repo market is smaller than its U.S. counterpart.

Most tri-party repos in Europe settle on a T+1 (meaning settlement one day after the transaction) or T+2 basis, as compared to the T+0 settlement convention of the U.S. One reason for this difference is that most cash securities transactions in Europe settle on a T+3 basis. This means that T+1 or T+2 repo settlement allows sufficient time to finance the purchase of securities with repo trades that are executed after the securities trades. Another reason is the fragmentation of the settlement infrastructure in Europe across national borders, which causes transfers of collateral from a national securities depository to Euroclear or Clearstream to

take up to two days.²³ In any case, same-day-settlement repos are reportedly becoming more common in Europe.²⁴

The majority of European tri-party repo settlement occurs at night, while markets are closed. This facilitates the optimization of the collateral allocation across tri-party repo deals. Nevertheless, some allocation and optimization does occur intraday. This settlement process is similar to that of the U.S. market, although the European collateral allocation process is completely automated and driven by the tri-party agent based on the collateral specifications of each lender. European tri-party repo agents have also built collateral substitution capabilities, allowing securities to be extracted from the repos that they collateralize and to be replaced by other eligible securities as needed to facilitate deliveries. These collateral allocation and substitution process are automated and rule-based.

In addition, the European tri-party repo market supports intraday settlement. Intraday settlement helps reduce fails. For example, a repo borrower with insufficient cash to settle an expiring repo during the overnight batch settlement process could obtain that cash and settle the repo during one of the intraday batches.

European tri-party settlement agents provide some intraday credit to market participants. However, while data are not available, interviews with market participants indicate that these extensions of credit are much smaller than those in the U.S. market, and are made by tri-party agents to both repo borrowers and repo lenders. Much of the intraday credit extended by tri-party agents in Europe is required to manage time-zone differences between counterparties, or to accommodate differences between the cash and collateral settlement times in different national settlement systems. If a European repo cash lender receives

²³ The transfer of collateral (often free of payment) between the respective local custodians (depositories) and Euroclear or Clearstream often can be achieved within one business day.

²⁴ Interviews with Euroclear staff suggest that as much as 15 percent of the tri-party repo activity that they service is now comprised of same-day-settlement trades, and that this activity is growing.

credit from the tri-party agent, this is typically in order to assist the settlement of the opening leg of a tri-party repo. The repo borrower is more likely to receive credit from the tri-party agent in order to settle the closing leg. These forms of secured credit are always capped in amount.

While no good measures of term tri-party trade volume is yet available in the U.S., interviews with a number of market participants that transact in both tri-party repo markets indicate that term trades represent a much higher share of the volume in the European tri-party repo market than in the U.S. — reaching 75 or 80 percent according to some estimates, as indicated by Table 3.

Table 3. Distribution of maturities in the European tri-party repo market.

Maturity	Share of total
1 day	20.9%
2 days to a week	18.9%
1 week to 1 month	22.7%
1 month to 3 months	15.2%
3 months to 6 months	5.4%
6 months to 12 months	3.6%
More than 12 months	1%
Forward-start	6.7%
Open	5.7%

Source: ICMA (2011).

European cash investors generally prefer secured to unsecured lending, and price secured transactions accordingly. This has been particularly prevalent following the financial crisis and amid a regulatory environment in which secured loans receive more favorable regulatory capital treatment than do unsecured loans. Overnight trades are less attractive in Europe, given the time and transaction costs required for movements of securities between depositories.

Cause of differences between the U.S. and European tri-party repo markets

Differences between the tri-party repo market in the U.S. and Europe appear to stem largely from the relative complexity of the European repo market environment, particularly with respect to settlement. Trading in Europe occurs in several different time zones and currencies, with different time cutoffs for settlement across different national settlement systems. Trades can also occur on a cross-currency basis. Furthermore, as noted above, the clearing and settlement landscape in Europe is relatively fragmented. Each country has its own central securities depository, and linkages are not yet well established between these national settlement systems, or between them and the ICSDs. In this sense, the European tri-party market is a single market for cash, but not for collateral – cash can be lent anywhere, but an Italian or a German bond can generally be financed only in an ICSD or via its national CSD. Target2-Securities (T2S) and Collateral Central Bank Management 2 (CCBM2)²⁵ are ongoing initiatives to improve the integration of European settlement systems and streamline the ability of European borrowers to mobilize collateral across national boundaries.

Likely for these reasons, we observe a much greater demand for standardization and automation in the settlement infrastructure of the European tri-party repo market than is present in the U.S. First, there is no daily unwind, as is the case in the U.S. market. Instead, service providers have developed sophisticated technology to facilitate the automated withdrawal of securities and simultaneous substitution of other securities into a cash lender's clearing account, so that the collateral provider can withdraw securities at essentially any time, as needed to satisfy delivery obligations, while keeping the cash lender fully collateralized at all times before a repo matures. Second, collateral allocation decisions that make efficient use of the borrower's collateral are done by the tri-party settlement banks, according to the pre-settlement instructions by lenders and borrowers.

²⁵ See "Triparty Repo in CCMB2," a slide presentation by Simonetta Rosati of the ECB at the COGESI Meeting in Frankfurt, May 18, 2011. (http://www.ecb.europa.eu/paym/groups/pdf/Integration_Triparty_repo_CCBM2.pdf?638402490eb13103feec769493e5971)

The European tri-party repo market did not appear to suffer as much disruption during the financial crisis as did the U.S. tri-party repo market. This may in part reflect the higher degree of automation of tri-party settlement in Europe. Further, the broad and ongoing access of European financial institutions to ECB secured financing for a wide range of collateral through monetary policy operations may have mitigated some stresses in the European repo market during the financial crisis, according to the analyses of Cassola, Hortacsu, and Kastl (2009) and Hordahl and King (2009).²⁶ The ECB's monetary policy operations served as a significant backstop for banks having funding problems in Europe. As such, they may have helped these institutions to a greater extent than the backstops available in the U.S., such as the PDCF, did for broker-dealers. Hence, collateral providers may not have been as dependent on repo financing in Europe as they were in the U.S.

Hordahl and King (2009) emphasize, in addition to automation, the relatively plentiful supply of sovereign bonds as collateral in the European market, in comparison with the relatively tight supply of U.S. treasuries in the U.S. tri-party repo market.²⁷ Further, because a relatively large fraction of cash investors in European tri-party repos are banks, who had access to the ECB to finance any collateral that would receive in the event of a repo borrower default, these European cash investors had less incentive to run from weak borrowers than did U.S. cash investors. This represents an additional source of market stability.

²⁶ Hordahl and King (2009) write, "The ability to post less liquid collateral (including non-marketable loans) with the ECB may have resulted in greater availability of government securities for repo transactions among banks in the euro area relative to the United States. In addition, market initiatives such as Euro GC Pooling have contributed to mobilizing GC collateral in the euro area, generating sharp growth rates as the crisis progressed. This system enables repo transactions via a CCP and offers an automated cross-border collateral management system that allows reuse of GC collateral and pledging of collateral with the ECB. While the outstanding volume in Euro GC Pooling had fluctuated around €10–15 billion prior to mid-2007, it thereafter rose quickly to reach €50 billion by September 2008."

²⁷ Various initiatives of the Federal Reserve Bank of New York, including the Term Securities Lending Facility²⁷ (TSLF), increased the relative supply of Treasuries to market participants during the financial crisis. See <http://www.newyorkfed.org/markets/tslf.html>

In summary, potentially important points that distinguish between the U.S. and European tri-party repo markets with respect to market stability include:

- European borrowers are more likely to be banks, who have access to the ECB for backstop financing for a wide range of collateral in their trading operations, and who are less reliant on tri-party repo for structural financing needs. By contrast, U.S. borrowers are more likely to be securities dealers, who rely heavily on short-term tri-party repo for structural financing of their securities inventories, and are not as integrated with their bank affiliates so must fund themselves independently.
- European cash lenders are more likely to be banks, who have access to ECB liquidity for financing collateral they might receive from a failed borrower. By contrast, U.S. cash lenders are more likely to be money-market funds, who may only hold short-term assets, and may hold only a limited range of collateral on their balance sheets. Institutional investors in money market funds are particularly prone to flight from a weakening borrower.
- European tri-party repos tend to have somewhat longer maturities.
- U.S. tri-party repo collateral more frequently includes structured assets, such as asset backed securities (ABS).
- European collateral allocation and optimization processes are more standardized and automated, and function as straight-through processes.

7. Conclusion

This paper provides an overview of the nature and impetus of reforms to the U.S. tri-party repo market, one of the most critical components of the financial system. We review some key systemic weaknesses of this market that were revealed during the financial crisis of 2007-2009. We describe the ongoing reform of this market's infrastructure that began in September 2009, as well as some of the associated challenges to these reforms that remain.

A more automated collateral management process, including straight-through processing, would reduce the time necessary to test whether a dealer has sufficient financing commitments and an adequate mix of collateral for the financing that it will require. This would allow for the simultaneous settlement of new and maturing repos, providing for a sizable reduction in the amount of intraday credit extended by clearing banks.

A further benefit of straight-through processing of collateral allocations is the ability to avoid the real-time involvement of dealers in these allocations. While dealers may currently derive private benefits from manually allocating some of their collateral, tri-party repo market participants would collectively benefit from an infrastructure in which this practice is avoided. Among other costs, manual intervention by dealers slows the settlement process, delaying the return of cash to lenders.

From a systemic-risk viewpoint, reliable automation increases transparency regarding the ability of dealers to finance their securities and reduces the chance of delays in the provision of liquidity whose timeliness during a crisis may be critical to systemically important borrowers and lenders. Reliable automation would therefore also contribute to the confidence of market participants, lowering the likelihood of a self-fulfilling prediction of gridlock in the provision of liquidity to key market participants.

The European tri-party repo market is significantly more standardized and automated than its U.S. counterpart, likely due to the high frictional costs associated with the fragmentation of settlement across various European national depositories and across multiple time zones. The relative degree of standardization and automation in Europe may also stem in part from the need for new infrastructure that was triggered by the creation of the European Monetary Union. During the financial crisis of 2007-2009, the European market did not appear to suffer from the degree of stress that the U.S. market experienced.

Our main conclusion is that achieving a successful reform of the U.S. tri-party repo market will require a fundamental reengineering of the systems used for collateral allocation and substitution. Even after the currently proposed reforms are complete, we believe that continued investment in the collateral-management systems of the tri-party repo agents will be needed over time in order to keep pace with the evolution of this critically important financing market. Over the longer term, market participants should remain open to the adoption of significantly different approaches to market infrastructure that might further improve the efficiency and stability of the tri-party market. Maintaining the efficiency and robustness of this infrastructure will be crucial to the safety and soundness of this systemically important market.

Appendix: The Collateral Allocation Process in the United States

Central to tri-party repo operations is the allocation of securities from each dealer's "box," the inventory of securities to which the dealer has title, to individual tri-party repo deals. Each deal is effectively a cash loan to the dealer collateralized by a portfolio of the dealer's securities. The dealer's objective is to obtain an allocation 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 tri-party repo agent bank, although in many cases a dealer may become directly involved in the allocation decisions.

We now provide an overview of the allocation process in a typical U.S. tri-party repo setting, leaving out many details.

A major U.S. tri-party repo agent bank may have 50 or more client dealers. 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 repo master agreement negotiated in advance by the cash investor and the dealer. The interest rate on the loan is determined by the types of eligible securities that are identified in the master agreement as eligible collateral. Tri-party repo trades are done on a general-collateral (GC) basis – meaning that once the trade is executed and the rate is agreed, the interest rate will not vary based on the actual selection or mix of securities that collateralize the repo – any security within the eligible basket is equally acceptable in a GC repo transaction, subject to a lender’s pre-specified concentration limits.

In the U.S. tri-party repo market, a dealer’s portfolio of collateral is currently allocated across all of its lenders once a day, in the afternoon. The process typically starts around 3:30PM, when Fedwire Securities closes, and can continue until 6:00PM, or 6:30PM for large dealers. The length of the settlement process is driven by several factors. Dealers that are due to receive securities from GCF repo must wait until that system has settled, which can occur as late as 5:00PM or 5:30PM. Large dealers often allocate collateral to a large number of deals, one at a time, using a process that takes the initial clearing bank allocation as a starting point, adjusting as desired to improve the allocation across cash lenders. In some cases, a dealer may allocate collateral to some deals manually, at the CUSIP level.

The tri-party agent bank or the dealer must keep track of the dealer's current inventory of available securities, the existing deals, and the new deals that will settle during the day. In order to be confident of the quantities of securities in the dealer's box that are available to be allocated, one of them must also forecast the securities that will be delivered into the dealer's box, or are committed to be delivered from the dealer's box, on each of the next several days, in light of the standard settlement cycles of the various types of securities.

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 deal waiting to be populated with collateral. 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. At a high level, the allocation process orders the repo deals, typically from least to most restrictive, and the collateral, typically from lowest to highest quality. The process then fills the deals, one by one, with the assets, in the determined order. Some dealers, particularly small ones, use this method to allocate their whole tri-party repo book.

Some dealers feel that they can achieve a better collateral allocation with the use of a "script," each step of which uses the method described above, but for 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 doing each step on a restricted set of deals and securities, 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.

The transfers of cash and collateral associated with the second step are reversed (after adding interest to the cash side) in order to close the repo deal. Dealers typically use one of the clearing banks as their custodian for the securities they finance in tri-party repo. Large investors have accounts at both of the major clearing banks so that they can transact with dealers at each of the clearing banks.

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.²⁸ 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.

Typical rule sets have evolved, becoming more complicated over time, especially for repos that may be backed by equities or non-Fed eligible collateral. 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. No more than 5% of the corporate bonds may be of a single issuer. No bonds issued by ABC Corp. or XYZ Corp. are acceptable.”

The language of a tri-party repo master agreement is of course more precise than this description, which is merely for illustrative purposes.

²⁸ Appendix B in Copeland, Martin, and Walker (2010) gives a list of collateral that can be found in a rule set.

For purposes of software input, a 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

$$C(k,n): \quad b(1,k,n)x(1,n) + b(2,k,n)x(2,n) + \dots + b(m,k,n)x(m,n) \leq c(k,n),$$

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 is obtained through 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 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

$$x(i,1) + \dots + x(i,N) \leq v(i),$$

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 .

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. Cash investors are in many cases happy to negotiate master repo agreements that allow relatively illiquid collateral, subject of course to haircuts and concentration limits, because this typically implies a higher interest rates.

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 optimizations could be tried, allowing the dealer to select the preferred allocation among the resulting outputs.

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.

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