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Sriya Anbil and Zeynep Senyuz

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The Regulatory and Monetary Policy Nexus in the Repo Market*

Sriya Anbil[†] Zeynep Senyuz[‡]

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Abstract

We examine the interaction of regulatory reforms and changes in monetary policy in the U.S. repo market. Using a proprietary data set of repo transactions, we find that differences in regional implementation of Basel III capital reforms intensified European dealers' window-dressing by 80%. Money funds eligible to use the Fed's reverse repo (RRP) facility cut their private lending almost by half and instead lent to the Fed when European dealers withdraw, contributing to smooth implementation of Basel III. In a difference-in-differences setting, we show that ineligible funds lent 15% less to European dealers as they find their withdrawal for reporting purposes inconvenient. We find that intermediation through the RRP led to quantity and not pricing adjustments in the market, which is consistent with the RRP facility anchoring market rates.

Keywords: repo, RRP facility, Basel III, monetary policy, Federal Reserve.

JEL Classification: C32, E43, E52

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[†]Federal Reserve Board, e-mail: sriya.l.anbil@frb.gov

[‡]Federal Reserve Board, e-mail: zeynep.senyuz@frb.gov

1 Introduction

The repurchase agreement (repo) market is perceived as a potential source of instability since the financial crisis of 2007-2009 (see [Gorton and Metrick \(2012\)](#), [Adrian and Shin \(2011\)](#), and [Copeland et al. \(2014\)](#) among others). In the aftermath of the crisis, the international regulatory authority at Basel implemented a series of major financial reforms. Meanwhile, the Federal Reserve (Fed) changed its monetary policy framework in response to the crisis. In this paper, we analyze the effects of these extensive changes in regulations and U.S. monetary policy on the repo market, a market that has been at the center of policy discussions.

We identify two exogenous shocks that affected the cash demand and supply in the repo market: (i) Basel III capital reforms and the (ii) Fed’s reverse repo (RRP) facility. The former shock incentivized European dealers, who are among the main cash borrowers in the repo market, to borrow less on financial reporting days.¹ The latter shock incentivized money market mutual funds (also referred to as money funds, or MMFs), who are the main cash lenders in the repo market, to shift some of their lending to the Fed. Together, these independent shocks that were intended to address different issues inadvertently interacted in the repo market, smoothing the implementation of Basel III.

We take advantage of two confidential data sets of repo activity measured at the daily and the intra-daily level in the triparty market—a major segment of the repo market where a third party provides custodial services for operational efficiency. We find that intermediation through the RRP facility led to quantity and not pricing adjustments among MMFs, consistent with the fact that the RRP offering rate is anchoring rates in the entire market. MMFs eligible to transact with the Fed (eligible funds) reduced their exposure to dealers, because they could substitute between lending to the Fed versus dealers in the market. We

¹European dealers refer to dealers in the European Union and in the United Kingdom.

find that the RRP facility contributed to smooth implementation of the Basel III capital reforms by serving as a backstop for money funds looking for alternatives when many of their counterparties withdraw from the market on their financial reporting days. However, for those MMFs ineligible to transact with the Fed (ineligible funds), the facility weakened their relationships with those counterparties who withdraw from the market.

The Basel III framework imposed new constraints on dealers that affected their balance sheet management. Prior to the implementation of the Basel III, non-U.S. dealers had already been reducing the size of their balance sheets on financial reporting days, as they were permitted to submit ratios based on quarter-end snapshots of their balance sheets, a phenomenon commonly referred to as “window-dressing (see, for example, [Allen and Saunders \(1992\)](#), [Lakonishok et al. \(1991\)](#), [Sias and Starks \(1997\)](#), and [Agarwal et al. \(2014\)](#), among others). Unlike non-U.S. dealers, U.S. dealers had no incentive to engage in window-dressing as they were reporting ratios based on daily averages (see [Munyan \(2015\)](#)). Capital reforms released by the Basel Committee on Banking Supervision introduced a leverage ratio, requiring banks to hold Tier 1 capital equivalent to at least 3% of their leverage exposure calculated using their on- and off-balance sheet assets, imposing formal constraints on both groups of dealers.

On the monetary policy front, the Fed expanded its balance sheet substantially in response to the crisis and developed new tools to control interest rates. In October 2008, the Fed started paying interest on reserves (IOR) which became its primary policy tool. However, the IOR could not set an effective floor for the federal funds rate because of the fragmented market structure that emerged in the superabundant reserves environment. Five years later, the overnight RRP facility was introduced as a supplementary tool to enhance rate control. By offering a secured lending rate through the RRP operations which are avail-

able to a broad set of counterparties, the Fed effectively set a soft floor for overnight funding rates (see [Klee et al. \(2016\)](#) for the effects of the RRP facility on overnight funding rates).

First, using a daily proprietary triparty repo data from July 2008 through August 2016, we show that European dealers were reducing their borrowing by a total of 12% five days leading up to quarter-ends, and an additional 10% on quarter-ends prior to the Basel-III implementation. European dealers were reversing this strategy and increasing borrowing by 11% immediately on the two days after the quarter-end. While this seasonality is strongly pronounced for European dealers, we do not observe any significant pattern for U.S. dealers. Our findings for the pre-Basel III period are in line with that of [Munyan \(2015\)](#) who documents heterogeneity in repo activity of U.S. and non-U.S. dealers on financial reporting days. We show that after the Basel III implementation, European dealers intensified window-dressing by 80% on the quarter-end day. Total reduction in European dealers' repo borrowing around financial reporting days was mainly driven by adjustments to overnight rather than term activity. We also find some evidence of U.S. dealers stepping into the market on those days when European dealers withdraw after the Basel III was implemented.

Next, we turn to the supply side and show that the RRP facility was a shock to the cash supply in the repo market. We compare the behavior of eligible MMFs to that of ineligible MMFs and find that lending by eligible MMFs went down by 16% after the inception of the RRP. We estimate that, on quarter-ends, eligible MMF lending to dealers declines almost by half, as MMFs increase their usage at the RRP facility. On the contrary, we do not find any significant response by ineligible MMFs on these days, as they still need to invest their cash in the private market on days when European dealers withdraw for financial reporting purposes.

Putting the regulatory (demand-side) and monetary policy shocks (supply-side) together, we then analyze MMF-dealer relationships using our second proprietary data set of repo activity at the transaction-level. In a difference-in-differences (DID) setting, we rely on regional differences in the implementation of Basel III leverage ratio requirements to define our treatment group (European dealers) and control group (U.S. dealers). We find significant differences in the behavior of MMFs that are not eligible to transact with the Fed via the RRP facility compared with those that are. Ineligible MMFs lent 15% less to European dealers that withdrew from the repo market on reporting days compared with U.S. dealers, suggesting that it was inconvenient for ineligible MMFs to trade with dealers that window-dress. Moreover, eligible MMFs were more likely to lend to European dealers since they had access to the RRP which provided a convenient alternative when some of their counterparties disappeared from the market.

We show that the presence of the RRP facility contributed to smooth functioning of the repo market as market participants were adjusting to the new regulatory environment in the wake of Basel III. This adjustment took place through quantities, and not prices. When European dealers reduce the size of their balance sheets on reporting days, the RRP facility provided an alternative for money funds looking to invest their cash. Absence of pricing differences for eligible and ineligible money funds implies that the facility offering rate has been an anchor in the repo market. We also find that relationships between ineligible funds and European dealers weakened after European dealers intensified their window-dressing in response to Basel III. On the other hand, this inconvenience did not hurt relationships of eligible money funds with European dealers as these funds have the Fed as an effective trading counterparty standing ready to provide safe assets at a fixed rate. These results also

suggest that in the absence of RRP, intensified window-dressing by European dealers would likely have increased dealer funding costs.

Our work contributes to the growing literature on repo market dynamics. [Adrian and Shin \(2011\)](#) show that dealers rely on repo for short-term funding needs and adjust the size of their balance sheets mainly through their activity in this market. Focusing on different market segments, [Gorton and Metrick \(2012\)](#), [Copeland et al. \(2014\)](#), and [Krishnamurthy et al. \(2014\)](#) analyze the role of repo markets during the global financial crisis. As for the effects of RRP, [Anderson and Kandrak \(2016\)](#) argue that eligible funds were able to command higher rates immediately after changes in facility parameters during the initial months of testing. Using a panel data set of transactions of all MMFs over the life of the facility, we show that RRP did not lead to differential pricing by funds, consistent with the facility rate anchoring the market rates.

Another strand of literature that is related to our work is on trading relationships. [Han and Nikolaou \(2016\)](#) analyze relationship structure in the repo market and find that strong relationships matter for terms of repo trades between money funds and dealers, as well as for absorbing funding shocks. Our findings on relationship dynamics in the repo market highlight the importance of changing incentives in response to the new policy environment and quantify their effects on relationship strength of money funds and dealers. Several studies find evidence for the importance of relationships in other financial markets as well (see for example, [Afonso et al. \(2014\)](#) and [Cocco et al. \(2009\)](#) for the interbank market; [Hendershott et al. \(2016\)](#) and [DiMaggio et al. \(forthcoming\)](#) for fixed-income trading; [Chernenko and Sunderam \(2014\)](#) for money market fund lending; and [Dass and Massa \(2011\)](#), and [Bharath et al. \(2011\)](#) on bank-firm relationships).

The rest of the paper is as follows. Next section reviews repo market mechanics, the new financial regulations, and the Fed’s changing monetary policy implementation. Section 3 describes the two proprietary data sets of repo activity at the daily and intra-daily level. Section 4 documents window-dressing in response to Basel III regulations and section 5 identifies the effects of the RRP facility on MMF lending. Section 6 lays out the DID setting to analyze implications for trading relationships and pricing in the repo market. Section 7 concludes.

2 The Repo Market and the Policy Environment

2.1 Review of Repo Market Mechanics

A repo is a secured loan contract that is collateralized by a security. A repo transaction facilitates the sale and future repurchase of the security that serves as collateral between the two parties: (1) the borrower who owns a security and seeks cash and (2) the lender who receives the security as collateral when lending the cash. The cash borrower sells securities to the cash lender with the agreement to repurchase them at the maturity date. Over the course of the transaction, the cash borrower retains the ownership of the security. On the maturity date, the borrower returns the cash with interest to the lender and the collateral is returned from the lender to the borrower.²

The market value of the securities used as collateral in a repo transaction typically exceeds the value of the cash lent. The difference between the market value of the security and the

²From the cash borrowers perspective, this transaction is called a repo, and from the cash lender’s perspective, it is called a reverse repo. Fed transactions in the repo market are defined as the opposite of market convention. If executed by the Fed, a cash out/securities in transaction is called a repo and a cash in/securities out transaction is called a reverse repo.

cash lent in a repo transaction against that collateral is referred to as a haircut. Haircuts help protect the cash lenders against a decline in the market price of the security used as collateral. In the event of a default, the ownership of the collateral switches to the cash lender who can sell it to recover the loan amount.

A general collateral (GC) repo is the most common type of repo transaction involving securities that meet the predetermined eligibility criteria to be accepted as collateral. Also known as Fedwire-eligible collateral, this class of assets typically consists of U.S. Treasury securities, agency debt and agency mortgage-backed securities (MBS).

The repo market can be divided into two broad segments: the bilateral market and the triparty market. In the bilateral market, lenders and borrowers usually interact directly to negotiate the terms and settle the trade. Hedge funds and other investment managers are the primary borrowers in the bilateral market who seek funding from dealers or money funds. In the triparty market, lenders and borrowers use the services of a third party to act as a custodian, providing operational efficiencies over the course of the transaction. In the current triparty repo platform, two clearing banks—Bank of New York Mellon (BONY) and J.P. Morgan (JPM)—provide custodial services such as collateral valuation and trade settlement in repo transactions. The clearing banks are responsible for the movement of cash and collateral over the course of the repo trade. In the event of a default, the clearing bank would transfer the collateral to the lender’s custodial account (see [Copeland et al. \(2014\)](#) for more details on the mechanics of the triparty repo market).

The overall daily triparty repo market volume, including overnight and term trades, is estimated to be around \$1.8 trillion, with more than \$1.5 trillion of the volume consisting of transactions involving GC. The primary cash lenders in the repo market are mutual funds, government-sponsored enterprises (GSEs), and other banks. [Figure 1](#) shows the monthly

overnight GC triparty volumes by lender types. As shown by the blue shaded bars, mutual funds account for about 80% of overnight cash lending. The repo market is also an important investment platform for GSEs, which constitute about 10% of the total monthly volume. All other types of cash lenders account for the remaining 10% of the volume. On the demand side, main cash borrowers include banks and securities dealers. Figure 2 shows monthly triparty repo borrowing by U.S. dealers and European dealers since the beginning of 2011. We observe parallel borrowing activity by the two groups suggesting that, on average, they have been affected similarly by the market factors.

The triparty GC repo market also includes the overnight RRP operations by the Fed and transactions in the General Collateral Finance (GCF) segments. The Fed participates in the triparty repo platform by conducting temporary open market operations. These RRP operations as well as other design features of the Fed’s new monetary policy framework are described in the next section. GCF is a blind-brokered, interdealer repo platform, which provides funding for dealers that may not have sustainable access to cash in the broader triparty market. Figure 3 shows an organizational diagram of the triparty GC repo market with three segments: (i) triparty market where BONY and JPM serve as the custodian banks (70% of volume), (ii) interdealer GCF market (15% of volume), and (iii) transactions with the Fed via the RRP facility (15% of volume).³

2.2 The New Regulatory Framework

Banks have historically modified the composition or size of their balance sheets ahead of their quarter-end filings to report more favorable ratios to their regulators or to the public. This so-called “window-dressing” strategy dates back to the 1800s, and took place in a variety of

³These percentages are the approximate shares of each segment from 2014 to 2016. GCF volume significantly dropped since mid-2016 when Fixed Income Clearing Corporation suspended its clearing service.

ways (see, for example, [Allen and Saunders \(1992\)](#)). Prior to the crisis, while an important motivation for window-dressing was to improve the profitability measures mainly for public reporting, financial intermediaries started focusing more on the capital and liquidity measures in the more stringent post-crisis regulatory environment.

[Adrian and Shin \(2010\)](#) and [Adrian and Shin \(2011\)](#) show that dealers adjust the size of their balance sheets mainly through short-term repo borrowing and that dealer leverage is pro-cyclical. Dealers used to operate with substantial leverage as they were not subject to binding limits prior to the crisis. Pre-Basel III leverage requirements for U.S. dealers excluded all off-balance sheet items, hence they were less restrictive. Meanwhile, European banks did not have to meet a regulatory leverage ratio. When regulators responded to the crisis with requirements of higher quality assets and lower leverage, the dealers were prompted to reevaluate their risk management practices and adjust their balance sheet management. As a result, dealer risk-taking has moderated since the crisis (see [Adrian et al. \(2013\)](#)).

Among the new regulations, the Basel III capital and liquidity reforms significantly changed the regulatory landscape for financial intermediaries. Basel III capital reforms introduced a leverage ratio, which requires banks to hold Tier 1 capital equal to 3% of an exposure measure which includes on-balance sheet assets and certain off-balance sheet items, including repo transactions.

The calculation of the leverage ratio is different among dealers based on their jurisdictions. In the United States, it was implemented as the Supplementary Leverage Ratio (SLR), and calculated on a daily basis. For European banks, the leverage ratio was computed as an average of the three month-end values over the quarter until October 2014 when the rule was amended to require only quarter-end reporting.⁴ This difference in regional

⁴U.K. dealers have been reporting their leverage ratios based on quarter-end snapshots of their balance sheet until they switched to reporting based on daily averages in January 2016.

implementation created different incentives for European versus U.S. dealers. If the leverage ratio is calculated on a month- or quarter-end basis, then banks are likely to contract the size of their balance sheets on these dates and expand it on other days. While the European banks are incentivized to engage in window-dressing, U.S. dealers which report leverage ratios that are calculated on a daily basis do not have any reason to contract their balance sheets on reporting days.⁵

Another regulation that may have incentivized some foreign banking organizations (FBOs) to engage in quarter-end deleveraging has been the Dodd-Frank Wall Street Reform and Consumer Protection Act. The act required FBOs with \$50 billion or more in U.S. non-branch/non-agency assets as of July 1, 2015, to establish an intermediate holding company. For the largest FBOs, the threshold to comply with the SLR was \$250 billion, which likely incentivized some FBOs close to the threshold to reduce their repo activity to get below this level by the compliance date. Since there are no FBOs in our data set with total assets below \$250 billion, there are no implications of this particular regulation for our analysis.

Finally, in 2011 the Federal Deposit Insurance Corporation (FDIC) expanded its deposit insurance assessment base to include reserve balances of banks held at the Fed. This change made short-term funding more costly for FDIC-insured U.S. banks relative to that of U.S. branches and agencies of foreign banks. While this change incentivized U.S. dealers to reduce their overall repo borrowing (see [Kreicher et al. \(2013\)](#)), the reduction was not specific to financial reporting days.

⁵Basel III also introduced two liquidity measures: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR required banks to hold high-quality liquid assets sufficient to meet a 30-day liquidity stress scenario, and the NSFR complemented it by promoting liquidity buffers over a longer horizon. LCR requirements may have affected aggregate repo activity for collateral other than Treasury securities since these transactions reduce a bank's LCR, but there are no consequences for repo backed by Treasury collateral. Moreover, all banks are required to be compliant with LCR on a daily basis, so there are no implications for quarter-end repo activity.

2.3 Fed's RRP Facility

Historically, the Fed used to adjust the level of scarce reserve balances in the banking system through open market operations to control the level of the effective federal funds rate. During the global financial crisis and its aftermath, the Fed has increased the size of its balance sheet through several liquidity facilities and large-scale asset purchases (LSAPs). As a result, reserves in the financial system have reached unprecedented levels forcing changes in the Fed's monetary policy implementation framework.⁶

In October 2008, the Fed started paying IOR to banks that have accounts at the Fed, and the IOR became the primary tool of the new policy framework. However, the IOR could not set an effective floor for the federal funds rate because of the fragmented market structure that emerged in the superabundant reserves environment. In September 2013, the Fed introduced the overnight RRP facility as a supplementary tool of its new policy framework to enhance monetary control.⁷

The Fed has been offering overnight RRP on a daily basis at a preannounced rate since September 2013. Through this facility, the Fed borrows cash from eligible counterparties in exchange for Treasury securities in its portfolio. These transactions take place with the agreement to repurchase the same security at a specified price at a specific time in the future. Overnight RRP are offered to a broad set of financial institutions including nonbank cash lenders in the repo market, such as MMFs.⁸

⁶See [Ihrig et al. \(2015\)](#) for details of the Fed's monetary policy implementation framework during and after the crisis.

⁷Further details on monetary policy normalization are available on the Federal Reserve Board's website at <http://www.federalreserve.gov/monetarypolicy/policy-normalization.htm>.

⁸There are currently more than 150 RRP counterparties including MMFs, GSEs, primary dealers and other banks. A list of RRP counterparties and information on eligibility requirements can be found at <https://www.newyorkfed.org/markets/rrp-counterparties.html>.

Figure 4 shows the composition of participating counterparties at the overnight RRP operations since January 2014. MMFs have been the primary participants, accounting for the majority of takeup at the facility. MMFs are the biggest cash lenders in the money market for overnight Treasury GC repo and view overnight RRP as a low-return and low-risk investment compared with lending to dealers.⁹

The RRP facility provides a convenient alternative investment vehicle for MMFs that compare the facility's offering rate with other rates in the market and determine whether to bid in the overnight RRP operation offered each day. This way, the offering rate at the facility should help establish a floor for overnight funding rates, as MMFs would be unwilling to lend in the market at any rate below the RRP rate. Klee et al. (2016) show that the overnight RRP facility has been affecting repo market dynamics by setting a soft floor for overnight funding rates and reducing the repo rate volatility. Moreover, when dealers withdraw from overnight funding markets on quarter-ends for financial reporting purposes, the RRP facility provides an alternative investment vehicle for MMFs.

Figure 5 shows the daily RRP takeup after the individual bid size increased to \$5 billion on December 23, 2013.¹⁰ Average daily volume was around \$100 billion for our sample, which ends in August 2016. Seasonal spikes correspond to quarter-ends, when total RRP takeup hit record levels as MMFs shift their lending to the Fed due to reduced demand for repo financing (see Frost et al. (2015) for further details of the overnight RRP facility).

Investment capacity at the facility proved to be an important factor affecting repo rates, especially on quarter-ends. Before the September 2014 quarter-end, the Fed introduced

⁹Among other counterparties, GSEs account for most of the remaining takeup, with Fannie Mae and Freddie Mac increasing their facility usage on days ahead of their principal and interest payment dates.

¹⁰Takeup at the facility was very low in the first few months of testing, during which the facility parameters were modified frequently. Over the next few months, market participants adapted to the new facility and following an increase in the individual bid amount to \$5 billion, takeup increased significantly.

an overall cap of \$300 billion which led to a sharp drop in money market rates as cash lenders scrambled for alternative investments. A series of term RRP were conducted ahead of quarter-ends to provide extra capacity to RRP counterparties until the end of 2015. Throughout the paper RRP refers to the sum of overnight and term operations.¹¹

3 Data and Preliminary Analysis

3.1 Triparty Repo Dealer Borrowing Data

We consider transactions in the triparty market excluding the interdealer GCF segment, and RRP trades with the Fed. To measure the extent of window-dressing activity by dealers described earlier, we use a proprietary data set of daily repo borrowing by each dealer in the triparty market, which is available daily from July 1, 2008. These data are reported by two custodian banks—BONY and JPM—to the Federal Reserve Bank of New York (FRBNY). Beginning on January 2, 2011, the data set also includes information on the maturity of transactions, allowing us to also distinguish overnight activity from longer term trades. This information may provide further insight into dealer strategies around financial reporting days.¹² We end our sample on August 1, 2016.

Table 1 reports summary statistics for all collateral types used in triparty repo transactions from January 2, 2011 to August 1, 2016, the period for which we have the maturity breakdown of trades. Since 2011, the average daily volume in the triparty repo market has been around \$1.3 trillion for GC (Treasury securities, agency debt and agency MBS) and

¹¹The cap at the overnight RRP was lifted in December 2015. There have been no term RRP operations spanning quarter-ends since then. Currently, the overnight operations are limited by the value of the Fed’s Treasury portfolio, which stand at around \$2 trillion.

¹²We exclude continuing trades which account for about 7% of the total triparty volume.

around \$300 billion for all other collateral (non-GC). U.S. Treasury securities account for nearly 40% of the total collateral pledged in the market, while the share of agency MBS is around 30%. About 60% of the total triparty repo volume corresponds to overnight activity in the triparty repo market.

Figure 6 displays a time-series of triparty GC repo volumes (excluding the GCF and RRP segments), along with the non-GC volume for the longer sample, from July 1, 2008, to August 1, 2016. The average daily triparty repo volume for GC was around \$1.8 trillion at the beginning of our sample in July 2008. At that point, prior to the bankruptcy of Lehman Brothers in the fall of 2008, the leverage of dealers had already been declining amid heightened risk aversion. After the Fed completed its first round of LSAPs in March 2010, repo activity generally trended up until the peak in mid-2012. The decline in repo activity after this date may be attributed to the release of proposals for more stringent Basel III regulatory requirements that increased balance sheet costs, and to the final round of LSAPs conducted by the Fed, which reduced the available supply of collateral in repo transactions. In addition, the persistent low rate environment as well as more conservative internal risk control measures likely contributed to lower repo volumes during this time. As of mid-2016, the daily triparty GC repo volume stood at around \$1.4 trillion.

The transaction volume for non-GC repo substantially dropped in the fall of 2008 when strains in money markets became extreme. The drop in non-GC repo volume was steeper and faster than the drop in GC repo volume, likely reflecting the higher risk associated with the securities used as collateral in these transactions. Since mid-2009, non-GC repo volume has been pretty stable, with an average daily volume of about \$250 billion.

Another observation from Figure 6 is that repo borrowing exhibits seasonality. There are pronounced drops in the transaction volume around quarter-ends although the steepness and

the sharpness of these drops vary over time. This seasonal pattern is due to the temporary adjustment of repo activity by certain dealers around financial reporting days.

3.2 Triparty Repo Transaction-level Data

To examine MMF dealer trading relationships, we use a second proprietary data set of daily triparty repo transactions for each lender borrower pair. These data are reported by BONY to the FRBNY, which acts as custodian for about 80% of trades in the triparty repo market. Although this transaction data set is available from August 1, 2012, we start our sample from January 2, 2013, to exclude the early stage of data collection period.¹³

Since our goal is to analyze MMF-dealer relationships, it is necessary to identify from among all MMF lenders in the data set those funds that are eligible to lend to the Fed via the RRP facility. However, identification of eligible lenders poses a challenge as lender names are not uniform throughout the data set. For example, there are frequent occurrences of different strings that refer to the same lender. Therefore, we manually match all appropriate lender strings to a single lender and identify specific lender types. Then, using the confidential monthly Securities and Exchange Commission Form N-MFP filings for MMFs, we identify MMFs at the fund level. It is crucial to identify MMFs at the fund level rather than at the complex level in order to parse out those funds that are eligible to lend to the Fed from those that cannot. From N-MFP filings, we extract data on fund flows, assets under management (AUM), and overnight repo volume outstanding. To identify MMFs at the fund level, we merge the transaction-level data with three N-MFP filings from October 31, 2014; November

¹³Prior to August 22, 2014, BONY used to provide a Tuesday snapshot of all outstanding open trades, for which it acts as custodian. After this date, BONY started providing daily transaction-level data. We merge Tuesday snapshots with the daily transaction data by multiplying the reported volume on Tuesdays by the number of business days in that week, and obtain an approximate weekly volume for each lender borrower pair. After August 22, 2014, we sum all transactions for a given lender-borrower pair at the weekly level.

30, 2014; and December 31, 2014. A fund is considered matched if we match overnight repo volumes within a 1% error given collateral type.

Overall, we document that MMF lending corresponds to about 50% of the volume in the triparty repo market. We are able to match 245 MMFs and 16 dealers, which account for 82% of the transaction volume in this data set. We identify a total of 851 unique MMF-dealer relationships, and 46,220 transactions. As reported in Table 2, eligible and ineligible MMFs account for 42% and 58% of these transactions, respectively. European dealers participate in 55% of transactions while the U.S. dealers account for the remaining volume.

4 Basel III Capital Regulations and Cash Demand

One cannot easily separate potential window-dressing activity from typical demand-supply dynamics in the repo market in the absence of an exogenous shock. The implementation of the Basel III capital reforms was an exogenous demand shock to repo borrowing that allows us to identify the specific dealer response on certain days, given the regional differences in the implementation of leverage ratio. Since the leverage ratio calculations of European dealers are not affected by their repo activity on other days, European dealers have the flexibility to expand borrowing on non-quarter-ends days unlike their U.S. counterparts. Therefore, U.S. and European dealers make up our control and treatment groups, respectively.

We consider several important dates in the Basel III regulation timeline to measure the extent of dealer response. Basel III capital rules that required repo positions to be included in the leverage exposure calculations were announced in the United States in June/July 2013. Leverage ratio requirements were transposed to local rules in Europe also by mid-2013. Therefore, we consider June 2013 as the announcement date of the leverage requirements in

both regions. Although full compliance with the new regulations was not mandated until January 2018, banks start adjusting their strategies earlier in order to signal that they are well positioned to meet regulatory targets by the compliance deadlines. On January 1, 2015, dealers began reporting the new leverage ratios to the public. This first public reporting with the new requirements included three quarters of historical data, making 2014:Q2 the first quarter-end entering into the calculations, which is when we expect to see a significant response to the new regulations.¹⁴

To quantify the extent of dealer window-dressing and its response to Basel III capital regulations, we estimate time-series regressions of aggregate daily repo borrowing by European and U.S. dealers from July 1, 2008, to August 1, 2016:

$$\begin{aligned}
 RB_t = & \beta_0 + \beta_1 D_{1t} + \beta_2 D_{2t} + \phi_1 RB_{t-1} + \theta_1 (\textit{Quarter} - \textit{end} \times \textit{Announced})_t \\
 & + \theta_2 (\textit{Quarter} - \textit{end} \times \textit{Implemented})_t + \theta_3 (\textit{Month} - \textit{end} \times \textit{Implemented})_t + \epsilon_t
 \end{aligned} \tag{1}$$

where RB_t is the log of aggregate repo borrowing by dealers in the triparty market at time t . *Announced* equals 1 after the details of Basel III regulations were announced on June 15, 2013 and turns 0 when the implementation of the new rules takes place. *Implemented* takes the value 0 before June 15, 2014, and 1 after this date.¹⁵ *Quarter – end* and *Month – end* are the indicator variables that take the value 1 on those calendar days and 0 otherwise. *Month – end* refers to those month-ends that are not also quarter-ends. D_{1t} is a 12×1 vector that includes calendar day indicators of five days prior to a quarter-end, the quarter-

¹⁴We also conducted a sensitivity analysis across alternative quarter-end dates within this timeline, and confirmed that 2014:Q2 is associated with the largest statistically significant dealer response on a quarter-end.

¹⁵Since these models are estimated at the daily frequency, we switch on the indicator variables in the middle of the month in order to accurately capture dynamics of the first quarter-end that follows.

end, five days after the quarter-end, and month-ends that are not quarter-ends. D_{2t} is a 2×1 vector that includes the *Announced* and *Implemented* indicator variables.

Our specification has three interaction terms to measure the change in repo borrowing with respect to the dates of interest. θ_1 measures the change in borrowing on quarter-ends after the announcement date, while θ_2 captures the change on quarter-ends after the implementation date. Since quarterly reported ratios were calculated as the averages of month-end values for European dealers until October 2014—when the rule was amended to require only end-of-quarter reporting—we also include an interaction term to measure potential month-end window-dressing. θ_3 measures the change in borrowing on month-ends that are not quarter-ends after the implementation date. If European dealers were further incentivized to contract their balance sheet on financial reporting days because of Basel III regulations, we expect θ_1 , θ_2 , and θ_3 to be negative and significant for European dealers and insignificant for U.S. dealers since their calculations are based on daily average values. Given that the repo borrowing exhibits substantial persistence, we include its first lag in the model to account for autocorrelation dynamics. We calculate robust standard errors and winsorize all continuous variables at the 1% level to avoid outliers that might bias the results.

Table 3 reports the estimation results from July 1, 2008, to August 1, 2016, for European and U.S. dealers in columns (1) and (2), respectively. First, we find that European dealers have been reducing their borrowing by about 12% five days leading up to quarter-ends, and an additional 9.8% on quarter-ends. The reduction in repo borrowing intensifies two days before the quarter-end. Following the financial reporting date, European dealers have been reversing this strategy, with a 11% increase in their total borrowing immediately on the two days following the quarter-end. While these dynamics are strongly pronounced for European dealers, we do not see any significant pattern for U.S. dealers at or around quarter-ends.

Second, we show that although balance sheet compression on financial reporting days was pronounced, the contraction became particularly substantial starting from June 2014 quarter-end which was the first to be included in the new leverage ratio disclosures in January 2015. We find that window-dressing by European dealers further intensified with an additional reduction in repo borrowing by 7.6% on the quarter end day, implying a total of \$130 billion drop in European dealer borrowing. Total decline in European dealer repo borrowing around quarter-ends has been around 30% in the post-Basel III period.

Third, after Basel III European dealers have been reducing their repo activity by 3.3 percentage points on month-ends that are not quarter-ends. Although, European dealers have been window-dressing their balance sheets on quarter-ends before the Basel III, they were not adjusting their repo activity on month-ends, as implied by the insignificance of the coefficient on month-end indicator. They also started contracting their balance sheets on month-ends after the implementation of Basel III since the reported ratios were based on the averages of the last three month-end values, with the exception of U.K. dealers which continued reporting based on quarter-end snapshots of their balance sheets. Finally, we find some evidence that after the Basel III implementation, U.S. dealers started stepping into the market while European dealers were withdrawing for reporting purposes. The average increase in U.S. dealer repo borrowing on month-ends is estimated to be 4.2 percent.

Our data set also includes information on the maturity of trades starting from January 2011. To provide further insight into how dealers manage their balance sheets on quarter-ends we also estimate Equation 1 for overnight and term repo volumes of two dealer groups separately. Tables 4 and 5 summarize the results for overnight and term repo borrowing, respectively. European dealers, on average, have been reducing their repo borrowing by 11 percent on quarter-ends through overnight transactions (Table 4), and by 8.4% through term

transactions (Table 5). In response to Basel III implementation of leverage ratio regulations European dealers further reduced their overnight repo borrowing by 20% on financial reporting days, for a total of 28.4% in one day. We also find evidence that European dealers' response to Basel III has mainly been through adjustments to overnight rather than term repo activity. The reduction in overnight month-end repo activity after Basel III implementation is about 9%. For U.S. dealers, there is no pronounced pattern neither in overnight nor in term repo borrowing. The net effect after the implementation of Basel III is near zero, consistent with the results reported in Table 3.

5 The RRP Facility and Cash Supply

When the Fed started test operations at the overnight RRP facility, it released a list of eligible counterparties including MMFs. Eligible MMFs compare the offering rate at the facility with other market rates and determine whether to bid in the RRP operation offered each day. In addition, when dealers, the major repo borrowers, contract their balance sheets on financial reporting days, eligible MMFs have the option to go to the RRP facility, while ineligible MMFs try to invest their cash in the private market.

We examine how the inception of the RRP facility affected repo supply in the triparty market provided by eligible and ineligible MMFs. Measuring the effects of RRP on repo supply is a challenging task, mainly because in our first data set of daily transaction summaries, it is not possible to accurately identify MMFs at the fund level among all mutual funds, let alone determine their eligibility to participate in RRP operations. Therefore, for this exercise, we turn to our second transaction data set, which is available weekly from January 2, 2013, prior to the inception of the RRP facility. Although we cannot capture potentially

different dynamics on specific calendar days using weekly data, we can quantify the overall effect of RRP operations on repo supply available to dealers.

To measure potential differences in MMF lending resulting from the RRP facility on calendar days, we also estimate daily regressions from August 22, 2014 onwards. The RRP facility was well in place—about a year after its inception—with average daily takeup around \$100 billion and the number of participants around 50 for the daily sample period. Focusing on this period when daily data are available allows us to accurately measure the effects of RRP on eligible MMF lending on specific calendar days.

Figure 7 shows the log weekly lending by eligible and ineligible MMF from January 2, 2013 to August 1, 2016. Both series are trending down during the first half of the sample, reflecting factors such as the low rate environment and the implementation of more conservative risk measures. In addition, third round of LSAPs by the Fed reduced the supply of Treasury collateral and led to a decline in repo activity. To quantify the MMF response to the RRP, we first check for potential unit roots. Using Elliott et al. (1996) and Ng and Perron (2001) tests that are powerful against persistent alternatives we fail to reject the null of unit root, but there appears to be breaks in the data.¹⁶ Indeed, we find evidence of breaks in both series using Quandt-Andrews unknown breakpoint tests.¹⁷ Once we allow for breaks, we confirm that the series do not exhibit unit root behavior. To prevent the breaks from distorting the results, we regress the series on indicator variables corresponding to their respective break dates and retrieve the residuals, which are stationary. We then estimate the following regression:

¹⁶Perron (1989) points out that conventional unit root tests are biased towards a false unit root null when the data is stationary and include a structural break. Hansen (2001) provides a comprehensive review of the literature on structural breaks.

¹⁷For eligible MMF lending, the break date is 2014:W28, and for ineligible lending it is 2014:W17. For brevity, we do not report the unit root and structural break test statistics.

$$RL_t = \beta_0 + \beta_1 RL_{t-1} + \psi_1 RRP1 + \psi_2 RRP2 + \epsilon_t \quad (2)$$

We consider two RRP indicators: RRP1 takes the value 1 from September 23, 2013, to December 23, 2013 and 0 otherwise, to represent the initial period of testing. During this period, takeup at the facility was very low amid small individual bid limits which were then increased gradually. The individual bid size reached \$5 billion on December 23, 2013, and takeup increased to levels consistent with the sample average. Our second indicator variable, RRP2, marks the beginning of this period of increased capacity during which the facility started to be perceived as a viable investment option by market participants. We also account for autocorrelation by including the first lag of lending by MMFs.

Table 6 shows the results for the two groups of MMFs. We do not find a significant response of MMFs to the inception date of the facility as captured by RRP1, although we find evidence of a shift in eligible MMF in response to RRP2. Once the RRP facility became a significant factor in the triparty repo market with the increase in caps, eligible MMF lending declined by 16%. While we find a significant effect of RRP facility on eligible MMF lending, we do not find any effect on ineligible MMF lending.

Having showed that the RRP facility was a shock to the overall cash supply in the repo market, we now zoom into calendar days using daily data to identify potentially different dynamics for eligible and ineligible MMFs. The behaviors of eligible and ineligible MMFs are expected to differ mainly on specific calendar days when investing in the private market becomes difficult. To quantify potential changes in repo lending by MMFs on certain calendar days, we focus on the sample available from August 22, 2014 to August 1, 2016. We run a regression of the log of daily repo lending by the two groups of MMFs on indicator variables that represent quarter-ends, and month-ends that are not quarter-ends.

$$RL_t = \beta_0 + \beta_1 RL_{t-1} + \psi_1(Quarter - end)_t + \psi_2(Month - end)_t + \epsilon_t \quad (3)$$

where ψ_1 measures the change in MMF repo lending on quarter-ends, and ψ_2 on month-ends that are not quarter-ends.

Table 7 reports the results for daily lending by eligible and ineligible MMFs to dealers in columns (1) and (2), respectively. On quarter-ends, eligible MMF lending to dealers declines by almost half, as indicated by the coefficient estimate significant at the 1% confidence level. In contrast, there is no significant reaction by ineligible MMFs on these days, as implied by the near-zero coefficient in column (2). This is because eligible funds have the RRP as an investment option while ineligible funds do not have this option. An additional observation in support of this finding is that the time series for ineligible lending is much more persistent than that for eligible lending, with autoregressive coefficients of 0.94 and 0.44, respectively, indicating that ineligible funds, unlike eligible funds, do not have the flexibility to allocate their funds between RRP and private triparty repo.

Finally, we do not find any significant response on month-ends by either of these two groups, which we anticipated for this sample starting on August 22, 2014. When Basel III regulations were announced in June 2013, European banks were required to calculate their leverage ratios as the simple average of three month-end values over a quarter. We indeed find evidence of window-dressing on month-ends for the overall sample, as discussed in Section 4. However, in October 2014, this rule was amended to require reporting at the end of the quarter rather than on a three-month average basis. This change in the rule eliminated the incentive for European dealers to shrink their balance sheets on month-ends, as reflected in our results for the sample starting from August 22, 2014.

6 Trading Relationships in the Triparty Repo Market

6.1 Identification Strategy

Having provided evidence of intensified window-dressing by European dealers in response to Basel III regulations, and the reduced supply of cash by MMFs after RRP which is more pronounced on calendar days, we now turn to exploring the effects of these regulatory (demand-side) and monetary policy (supply-side) shocks on MMF-dealer relationships.

The DID setting allows us to measure the effects of implementation differences as well as the overnight RRP facility on trading relationships while controlling for other factors that might affect repo activity. We use the regional differences in implementation of the Basel III leverage ratio requirements to define our treatment and control groups: European and U.S. dealers, respectively. We also showed that the Fed’s RRP facility affected cash supply in the repo market by providing an alternative investment option to eligible funds as opposed to ineligible funds. These two exogenous shocks provide a clean DID setup to study potential changes to MMF-dealer relationships that are unrelated to their risk profiles.

6.2 Measuring Trading Relationship Strength

We construct two measures of trading relationship strength (TRS) between MMF i and dealer j that capture the concentration of lending by MMF i to a specific dealer j from two perspectives: (1) the transaction volume (TRV), and (2) the transaction frequency (TRF). The two measures are based on the transactions of each lender-borrower pair over week t and defined from the perspective of the lender. These statistics can be written as follows:

$$TRV_{ij,t} = \frac{\text{Lending by MMF } i \text{ to dealer } j \text{ over week } t}{\text{Total lending by MMF } i \text{ over week } t} \quad (4)$$

$$TRF_{ij,t} = \frac{\text{Number of transactions between MMF } i \text{ and dealer } j \text{ over week } t}{\text{Total number of transactions by MMF } i \text{ over week } t} \quad (5)$$

$TRV_{ij,t}$ focuses on the amount transacted by the specific trading pair, while $TRF_{ij,t}$ measures the frequency of trading between the two parties at week t . Both the TRV and TRF measures take a value between 0 and 1, with higher values indicating stronger relationships.

6.3 The Model

We estimate, for eligible and ineligible MMFs, the following weekly DID regression at the relationship level using the two TRS measures described in equations 4 and 5:

$$\begin{aligned} TRS_{ij,t} = & \beta_0 + \beta_1 TRS_{ij,t-1} + \theta_1 (EUD_j \times Implemented_t) \\ & + \phi_t + \delta_{ij} + \theta_2 (X_i \times Implemented_t) + \epsilon_{ij,t} \end{aligned} \quad (6)$$

where $TRS_{ij,t} = \{TRV_{ij,t}, TRF_{ij,t}\}$ is the outcome of interest for MMF i and dealer j in week t . EUD is an indicator variable that equals 1 if dealer i is a European dealer. $Implemented$ is an indicator variable that equals 1 after Basel III was implemented, i.e. after June 15, 2014.¹⁸ The main coefficient of interest is θ_1 , which reflects the change in TRS for European dealers in comparison with U.S. dealers after the implementation of Basel III.

We also consider the possibility that relationships between (in)eligible MMFs and European and U.S. dealers may differ in ways that are correlated with the TRS , and hence bias the estimates. Thus, we control for initial characteristics of MMFs as well as their interaction

¹⁸We do not separately include *Implemented* or *EUD* indicators in the model since they are absorbed by time and relationship fixed effects.

with the *Implemented* indicator variable. This way, we ensure that the results are driven not by the typical repo trading dynamics of European versus U.S. dealers but instead by the regional implementation differences of Basel III (Barrot (2016)). The measures of MMF initial characteristics we consider are the monthly averages of their AUM, flows, and their average overnight repo outstanding from January 1, 2013, to July 1, 2013.

We include relationship fixed effects, δ_{ij} , to avoid potential bias that could result from time-invariant relationship characteristics. For example, δ_{ij} allows us to control for unobservable differences between eligible and ineligible MMFs. Additionally, we include week fixed effects, ϕ_t , to account for time trends in the outcome variable, alleviating the concern that the implementation of Basel III may have occurred around the same time with other changes that may affect relationship strength.¹⁹ We also include lagged *TRS* to account for autocorrelation. Standard errors are clustered at the relationship level to account for cross-sectional correlation, following Petersen (2009) and Bertrand et al. (2004).

The assumption of parallel trends between the control and treatment groups in the absence of different regulatory requirements is crucial for the validity of the DID estimation. Figures 8 and 9 plot weekly average values of the two relationship strength measures, TRV and TRF, calculated separately for U.S. and domestic dealers. Before the implementation of Basel III leverage ratio requirements, trends in TRV and TRF are parallel for the two types of dealers, consistent with the main DID assumption for the pre-treatment period. After the Basel III implementation date, both measures for European dealers decline substantially, moving away from the common trend with the U.S. dealers up to that point. Overall, these figures provide evidence of the parallel trends assumption for the two groups of dealers.

¹⁹The effective implementation of Basel III coincides with some monetary policy actions by the European Central Bank, such as the introduction of negative deposit rate, and launching of its asset purchase program for a range of investment-grade securities. These actions are not likely to affect European dealer repo activity in the U.S. market for general collateral.

6.4 Empirical Results

6.4.1 Ineligible MMFs lend less to European dealers after Basel III

Table 8 reports the results from the DID estimation of the effect of Basel III leverage ratio implementation on TRV . We find that eligible MMFs lend 3.1 percentage points more to European dealers in comparison with U.S. dealers after the Basel III implementation took place (7.5% increase in total MMF lending). From column (3), we see that ineligible MMFs lend 2.8 percentage points less to European dealers, in comparison with U.S. dealers, which accounts for about 7% of total MMF lending. As shown in columns (2) and (4), the coefficient estimates on $EUD \times Implemented$ remain almost the same after adding MMF control variables, implying that potential differences in MMF characteristics are not driving the results. Overall, these results imply that lending by ineligible MMFs to European dealers decreased by nearly 15%, compared with eligible MMFs.

We also consider two additional interaction terms of EUD and indicator variables representing the introduction of the overnight RRP facility. The first indicator is equal to 0 prior to the inception of the facility on September 23, 2013, and then equal to 1 until December 23, 2013, when the takeup increased significantly following the increase in individual bid size to \$5 billion. The second indicator variable is equal to 1 from December 23, 2013 onwards, and zero prior to that.

Using our other relationship strength measure, TRF, that is based on the frequency of transactions between the counterparties, we do not find a significant change for eligible MMFs and European dealers, as shown in Table 9, columns (1) and (2). However, we find that ineligible MMFs reduced their lending to dealers by 1.4 percentage points, which is robust to an inclusion of various control variables (columns (3) and (4) of Table 9).

The coefficients associated with the interaction terms of our treatment group, *EUD*, and the RRP indicator variables are insignificant and near zero in all considered cases, implying no differential behavior between the treated and the control groups prior to the Basel III implementation. Although operations at the RRP facility started in September 2013, we do not observe any change in trading relationship dynamics until mid-2014, when the new rules started to affect reported leverage ratios. This result provides further evidence for the parallel trends assumption, which is crucial for the DID estimation to be valid.

Overall, our results suggest that ineligible MMFs found it inconvenient to continue trading with European dealers in the post Basel III period. Meanwhile, eligible MMFs considered the RRP facility as a convenient alternative when European dealers withdrew for financial reporting purposes. Although we do not find any significant increase in terms of transaction frequency, eligible MMFs increased the amount of their lending to European dealers, perhaps because the RRP facility served as a backstop on financial reporting days. The fact that ineligible MMFs reduced their exposure to European dealers after Basel III implies that relationships likely became more important for ineligible funds relative to eligible funds.

In our estimations, we do not condition on existing relationships of MMFs and dealers prior to Basel III, so estimates also incorporate new relationship formation over time. Being agnostic as to why the relationship was created in the first place, we also perform a robustness check where we focus only on counterparties that have prior relationships. We obtain slightly different estimates under this condition, but our findings remain robust.

6.4.2 European dealers do not face higher funding costs post Basel-III

Having presented results based on transaction volume and frequency for MMFs and dealers, we now turn to potential pricing effects of Basel III implementation and the overnight RRP

facility. Specifically, we examine whether the RRP facility affected rates of return on repo transactions of eligible versus ineligible MMFs and funding costs of European and U.S. dealers in the post-Basel III period. Given that window-dressing by European dealers intensified post-Basel III, one may expect their funding costs to go up if their withdrawal from the market on calendar days is inconvenient for their counterparties. On the supply side, MMFs that have access to the RRP may have more bargaining power compared to ineligible MMFs.

We calculate the volume-weighted mean repo rate for MMF i and dealer j based on their transactions that take place in week t . To investigate potential pricing effects of changing repo dynamics we estimate the regression in equation 6 using the calculated weekly repo rate from our transaction-level dataset. We also include an indicator variable to account for the level shift due to the federal funds rate hike in December 2015.

Table 10 reports the estimation results from these pricing regressions. We find that coefficient estimates of all three interaction terms are statistically insignificant in all considered specifications regardless of the inclusion of control variables. These results imply that European dealers did not face higher funding costs although their window-dressing intensified after the Basel III implementation. In addition, the introduction of the RRP did not affect rates offered by eligible or ineligible funds.

The absence of a differential pricing effect for eligible and ineligible funds suggests that the RRP offering rate is an anchor for market repo rates. This result is consistent with the findings of Klee et al. (2016) who show that the RRP facility limited rate movements below the offering rate and thus set a soft floor for the average market rate.

7 Concluding Remarks

We analyze changing dynamics in the repo market in the wake of Basel III regulations and the Fed's monetary policy implementation framework. First, we document that European dealers were reducing their repo borrowing in the triparty market by 10% on quarter-ends for financial reporting purposes before the Basel III regulations took effect. We find that the Basel III implementation intensified their window-dressing by 80%. Total decline in European dealer repo borrowing around quarter-ends has been around 30% since Basel III.

We then show that the RRP facility led to a 15% decline in eligible MMF lending in the triparty market. The behaviors of eligible and ineligible funds particularly differ on financial reporting days when investing in the private market becomes difficult due to the withdrawal of European dealers. Since eligible MMFs have the RRP option, they cut their lending to dealers almost by half on those days and lend to the Fed instead.

We examine the implications of these exogenous regulatory and monetary policy shocks on trading relationships in a DID setting. We show that these independent shocks inadvertently interacted in the repo market, and the RRP facility helped market functioning as participants were adjusting to the new regulations in the wake of Basel III. Especially on financial reporting days when certain dealers reduce the size of their balance sheets, the RRP facility served as a backstop for money funds looking for alternative investment options. We find that MMFs that cannot trade with the Fed lent 15% less to European dealers that withdrew from the market for reporting purposes, compared with ineligible MMFs. While intermediation through the RRP led to quantity adjustment in the market which is especially pronounced on financial reporting days, we do not find any evidence of pricing effects which is consistent with the RRP offering rate anchoring market rates.

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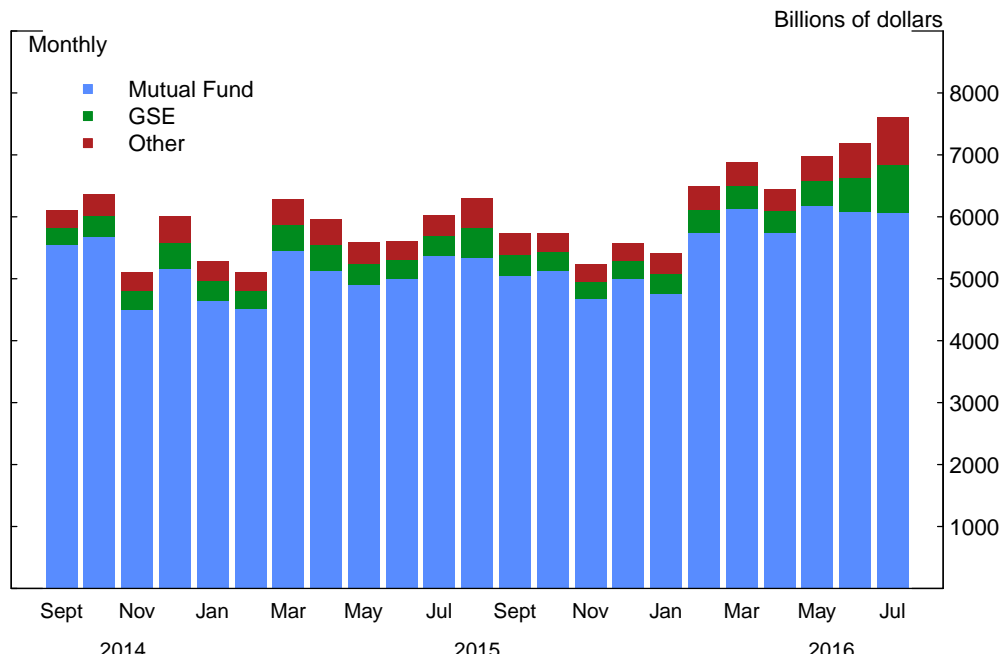
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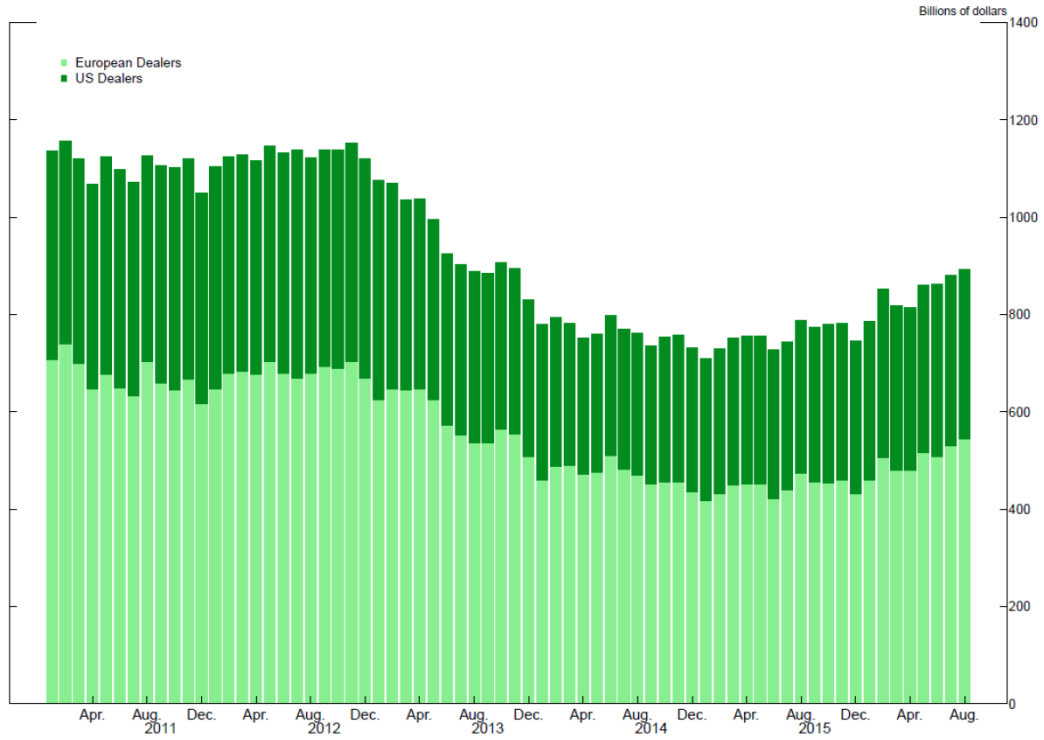
Figures and Tables

Figure 1: Tri-Party Repo Lending by type



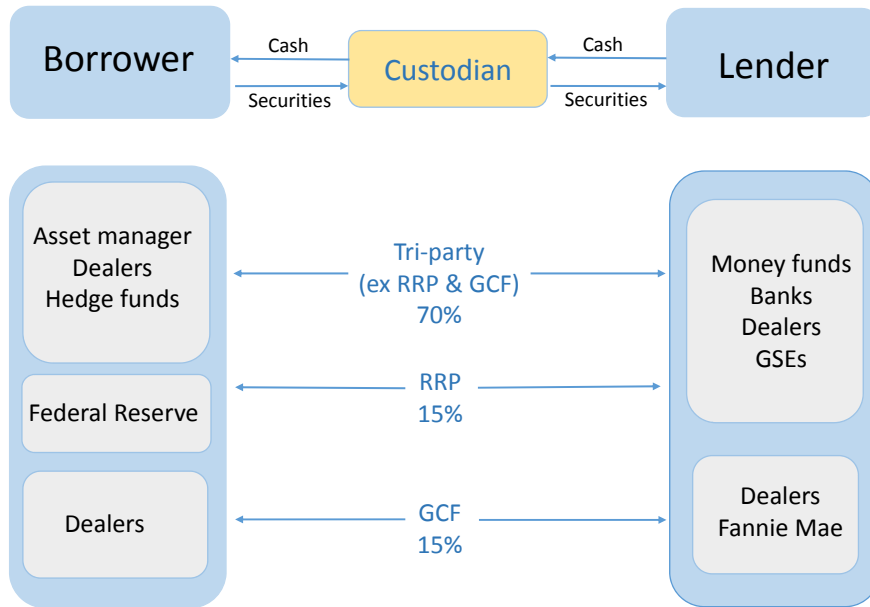
Note: Data on daily summaries of triparty repo transactions are obtained from the FRBNY, and aggregated monthly. The sample shown here is from August 2014 to August 2016.

Figure 2: TriParty Repo Borrowing by Dealers



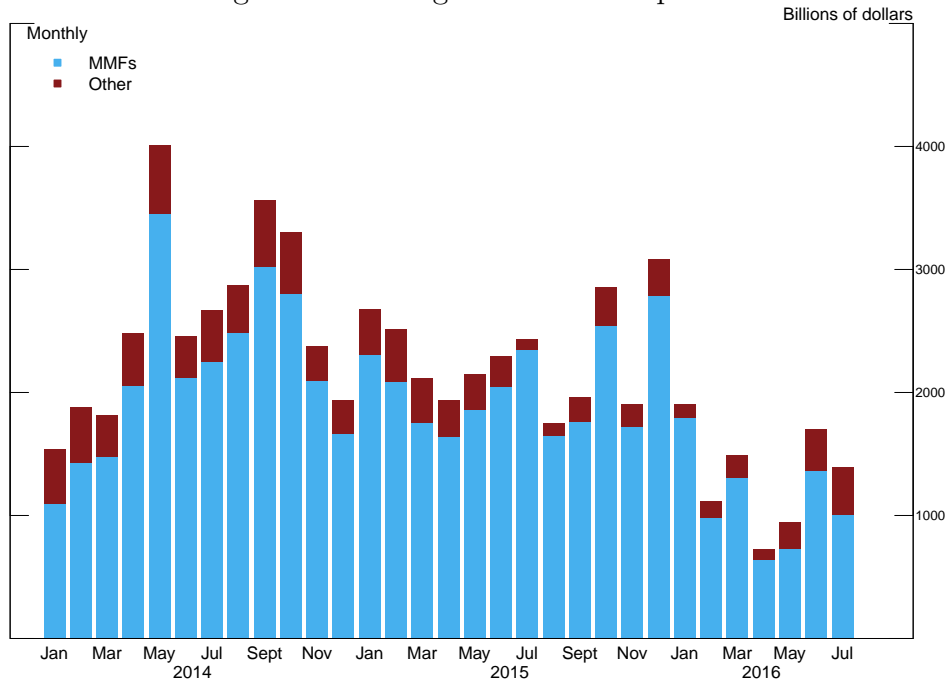
Note: Data on daily summaries of triparty repo transactions are obtained from the FRBNY, and aggregated monthly. The sample shown here is from January 2011 to August 2016.

Figure 3: TriParty Repo Market Mapping



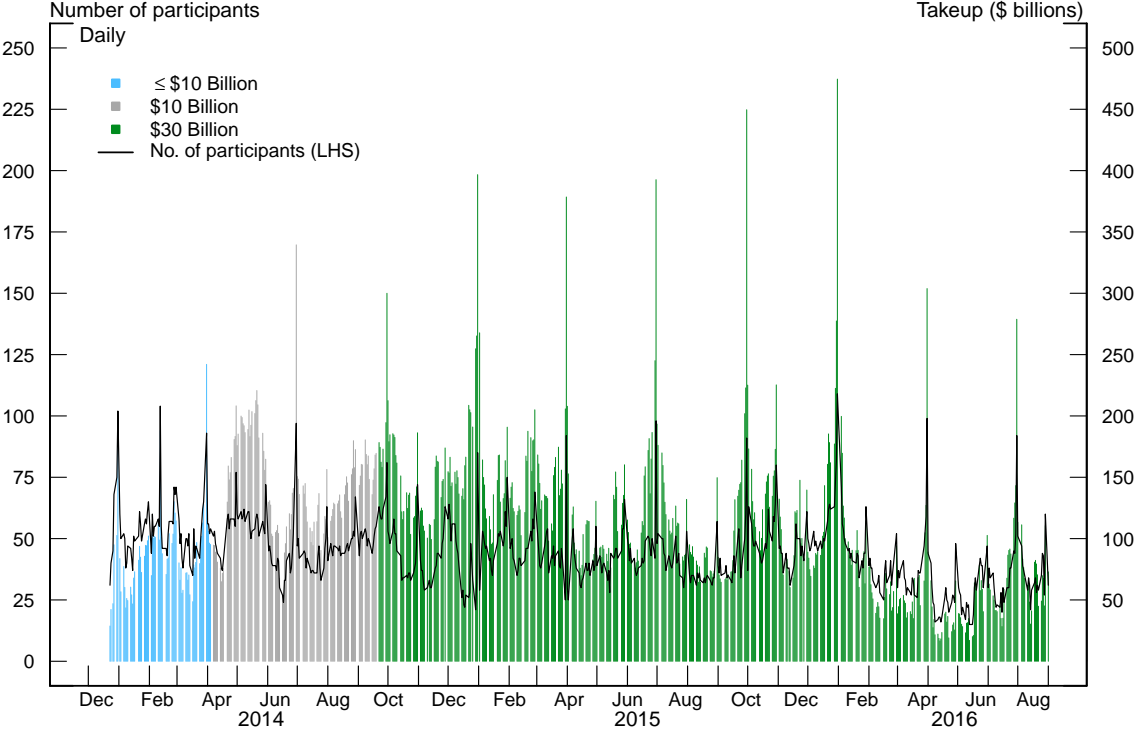
Note: The triparty GC repo platform consists of repo transactions for which Bank of New York Mellon and JP Morgan are the custodian banks, interdealer transactions that take place in the GCF segment, and transactions with the Fed via the RRP. Average shares of each segment shown above fluctuates on certain calendar days, such as quarter-ends.

Figure 4: Overnight RRP Participation



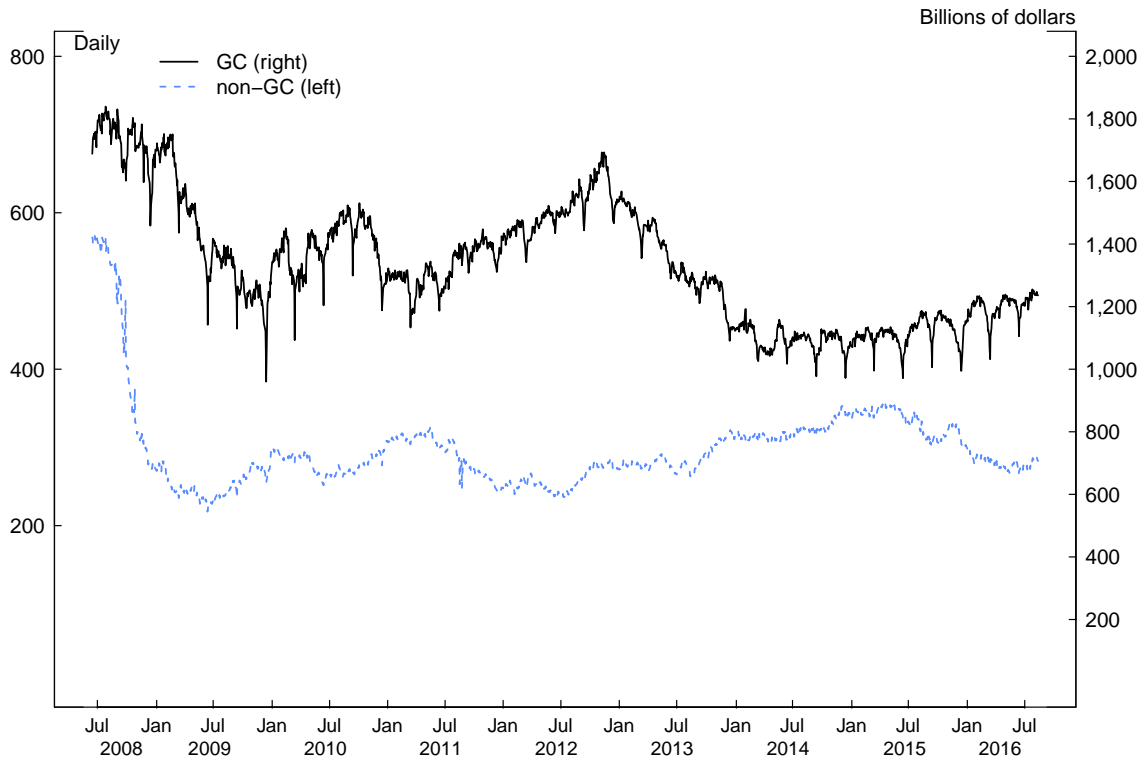
Note: Data on overnight RRP take-up by counterparty type are available from the FRBNY. The monthly sample shown here is from January 2014 to August 2016.

Figure 5: RRP Facility Usage



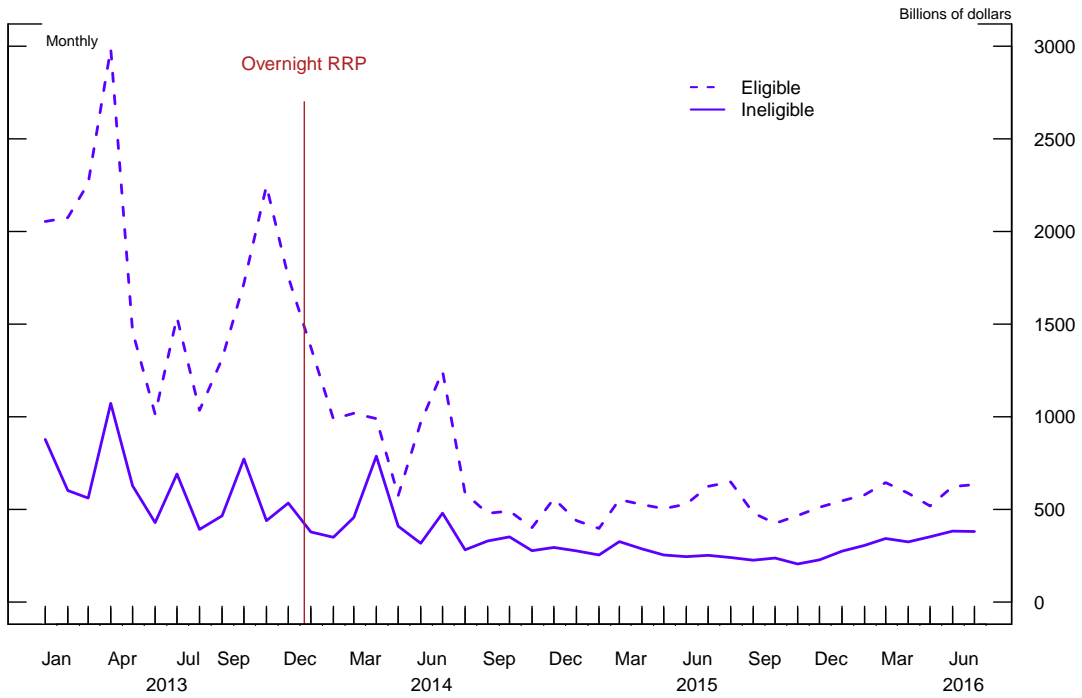
Note: RRP takeup includes both overnight and term RRP operations. Data on overnight and term RRP takeup are available from the FRBNY. The daily sample shown here is from December 23, 2013, to August 1, 2016.

Figure 6: Daily Triparty Repo Outstanding



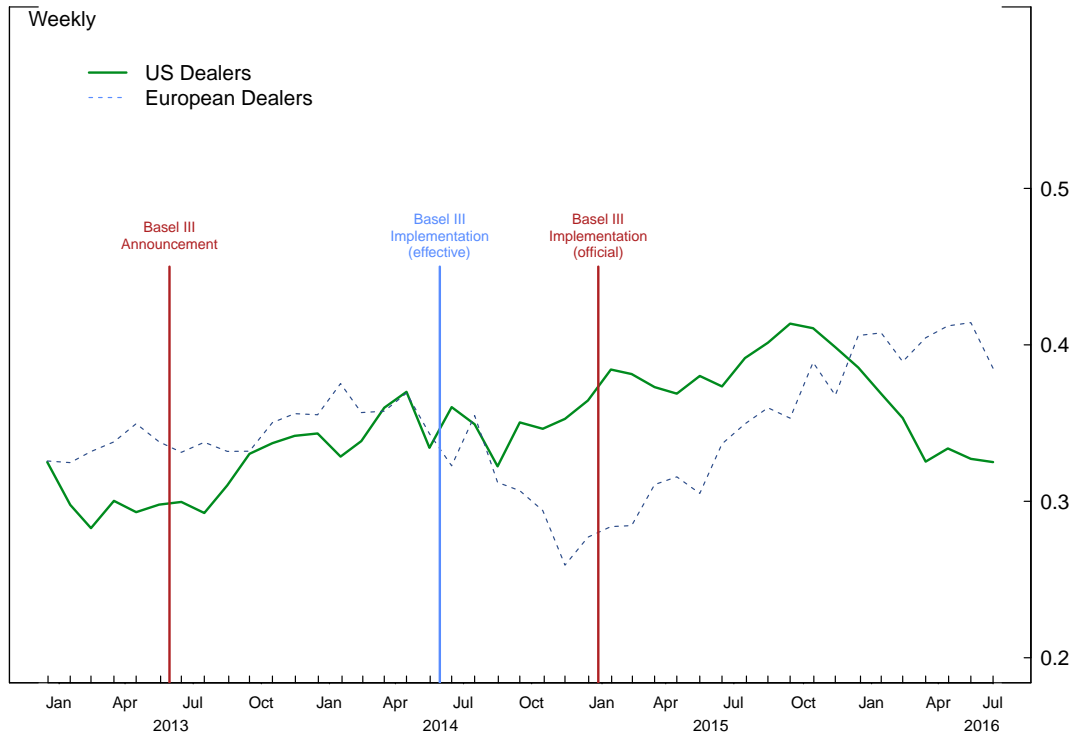
Note: Data on daily summaries of triparty repo transactions are obtained from the FRBNY. The daily sample is from from July 1, 2008 to August 1, 2016

Figure 7: MMF Lending



Note: Data on daily summaries of triparty repo transactions are obtained from the FRBNY. The weekly sample is from January 1, 2013, to August 1, 2016

Figure 8: Trends in Trading Relationship Strength: TRV



Note: TRV is based on the weekly average amount of transactions of MMFs with U.S. and European dealers, from January 2, 2013 to August 1, 2016.

Figure 9: Trends in Trading Relationship Strength: TRF



Note: TRF is calculated as the weekly average number of transactions of MMFs with U.S. and European dealers, from January 2, 2013 to August 1, 2016.

Table 1: Summary Statistics for Tri-Party Repo Outstanding

Asset Class	Overnight		Term	
	Avg. Volume	Std. Dev.	Avg. Volume	Std. Dev.
Agency CMOs	45	18	46	12
Agency Debentures	66	28	21	12
Agency MBS	282	79	241	65
U.S. Treasuries	480	81	140	71
Total GC Collateral	874	140	449	129
Total non-GC Collateral	86	29	209	46
All Collateral	960	160	658	144

Note: Data on the daily summaries of triparty repo transactions are obtained from the FRBNY. The figures are in billion dollars and show the size and composition of assets pledged as collateral in the triparty repo market from January 2, 2011 to August 1, 2016, with the maturity breakdown of trades into overnight and term.

Table 2: Summary Statistics for Tri-Party Transaction-level Data

Items	No. of Transactions
Eligible MMFs	19.183 (42%)
Ineligible MMFs	27.037 (58%)
European Dealers	25.282 (55%)
U.S. Dealers	20.938 (45%)
Transactions	46.220

Note: Tri-party repo transaction-level data are obtained from the FRBNY. The data are reported by Bank of New York Mellon to FRBNY, and available from January 2, 2013, to August 1, 2016.

Table 3: Total Repo Borrowing by Dealers on Calendar Days and Effects of Regulations

	(1) European Total Repo Borrowing	(2) U.S. Total Repo Borrowing
Quarter-end x Announced	0.025 (1.21)	0.028* (1.86)
Quarter-end x Implemented	-0.076*** (-3.74)	0.042*** (3.13)
Month-end (not Quarter-end) x Implemented	-0.033*** (-4.36)	-0.006 (-1.01)
Quarter-end (-5)	-0.011** (-2.52)	-0.004 (-1.27)
Quarter-end (-4)	-0.018*** (-3.47)	0.001 (0.31)
Quarter-end (-3)	-0.016*** (-2.98)	-0.001 (-0.19)
Quarter-end (-2)	-0.031*** (-5.45)	0.000 (0.14)
Quarter-end (-1)	-0.045*** (-4.72)	-0.009** (-2.48)
Quarter-end	-0.098*** (-6.35)	0.003 (0.30)
Quarter-end (+1)	0.099*** (4.70)	-0.005 (-0.42)
Quarter-end (+2)	0.015** (2.04)	-0.001 (-0.35)
Quarter-end (+3)	0.004 (0.66)	-0.003 (-0.91)
Quarter-end (+4)	0.006 (0.88)	-0.001 (-0.17)
Quarter-end (+5)	0.001 (0.13)	0.007* (1.78)
Month-end (not Quarter-end)	-0.006 (-1.44)	0.011*** (2.99)
Total Borrowing (-1)	0.916*** (16.97)	0.948*** (32.77)
Observations	1585	1585
R^2	0.965	0.957

Note: This table presents the results of time series regressions for the log of total repo borrowing by European and U.S. dealers, in columns 2 and 3, respectively. *Announced* equals 1 after the details of Basel III regulations were announced on June 15, 2013 and turns 0 when the implementation of the new rules takes place. *Implemented* takes the value 0 before June 15, 2014, and 1 after this date. Daily sample runs from July 1, 2008, to August 1, 2016. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. *t*-ratios are reported in parentheses and are calculated using robust standard errors.

Table 4: Overnight Repo Borrowing by Dealers on Calendar Days and Effects of Regulations

	(1) European Overnight Borrowing	(2) U.S. Overnight Borrowing
Quarter-end x Announced	-0.021 (-0.59)	0.030 (1.14)
Quarter-end x Implemented	-0.195*** (-5.93)	0.066 (1.62)
Month-end (not Quarter-end) x Implemented	-0.085*** (-4.68)	0.003 (0.17)
Quarter-end (-5)	-0.006 (-0.97)	0.016 (1.53)
Quarter-end (-4)	-0.035*** (-2.59)	-0.014 (-1.01)
Quarter-end (-3)	-0.014 (-1.07)	-0.003 (-0.32)
Quarter-end (-2)	-0.052*** (-5.82)	-0.008 (-1.30)
Quarter-end (-1)	-0.045*** (-4.19)	0.032*** (4.09)
Quarter-end	-0.107*** (-4.48)	0.037 (1.47)
Quarter-end (+1)	0.152*** (5.42)	-0.047*** (-3.31)
Quarter-end (+2)	0.020*** (2.70)	0.004 (0.35)
Quarter-end (+3)	-0.010 (-0.98)	-0.010 (-1.21)
Quarter-end (+4)	-0.002 (-0.23)	-0.010 (-0.83)
Quarter-end (+5)	0.017* (1.74)	0.015 (1.64)
Month-end (not Quarter-end)	-0.010 (-1.39)	0.006 (0.58)
Overnight Borrowing (-1)	0.885*** (55.55)	0.957*** (98.95)
Observations	1056	1056
R^2	0.978	0.981

Note: This table presents the results of time series regressions for the log of overnight repo borrowing by European and U.S. dealers, in columns 2 and 3, respectively. *Announced* equals 1 after the details of Basel III regulations were announced on June 15, 2013 and turns 0 when the implementation of the new rules takes place. *Implemented* takes the value 0 before June 15, 2014, and 1 after this date. Daily sample runs from January 2, 2011, to August 1, 2016.***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. *t*-ratios are reported in parentheses and are calculated using robust standard errors.

Table 5: Term Repo Borrowing by Dealers on Calendar Days and Effects of Regulations

	(1) European Term Borrowing	(2) U.S. Term Borrowing
Quarter-end x Announced	0.059** (2.52)	-0.111*** (-4.14)
Quarter-end x Implemented	0.041 (1.50)	-0.085*** (-3.80)
Month-end (not Quarter-end) x Implemented	-0.010 (-0.61)	-0.043** (-2.44)
Quarter-end (-5)	-0.020 (-1.49)	-0.012 (-1.23)
Quarter-end (-4)	-0.000 (-0.03)	0.016** (2.28)
Quarter-end (-3)	-0.025** (-2.37)	-0.003 (-0.32)
Quarter-end (-2)	-0.014* (-1.67)	0.022*** (3.16)
Quarter-end (-1)	-0.042*** (-4.67)	-0.060*** (-3.66)
Quarter-end	-0.084*** (-3.62)	0.075*** (6.96)
Quarter-end (+1)	0.056** (2.36)	0.013** (2.50)
Quarter-end (+2)	0.016 (1.58)	0.002 (0.16)
Quarter-end (+3)	0.026*** (3.80)	0.011 (0.79)
Quarter-end (+4)	0.014* (1.93)	0.015 (1.44)
Quarter-end (+5)	-0.017* (-1.80)	-0.007 (-0.74)
Month-end (not Quarter-end)	0.017 (1.52)	0.045*** (3.15)
Term Borrowing (-1)	0.949*** (91.84)	0.956*** (106.76)
Observations	1056	1056
R^2	0.927	0.930

Note: This table presents the results of time series regressions for the log of term repo borrowing by European and U.S. dealers, in columns 2 and 3, respectively. *Announced* equals 1 after the details of Basel III regulations were announced on June 15, 2013 and turns 0 when the implementation of the new rules takes place. *Implemented* takes the value 0 before June 15, 2014, and 1 after this date. Daily sample runs from January 2, 2011, to August 1, 2016.***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. *t*-ratios are reported in parentheses and are calculated using robust standard errors.

Table 6: Effects of RRP on Repo Lending to Dealers

	(1) Eligible MMF	(2) Ineligible MMF
RRP1	0.03 (0.25)	-0.08 (-0.8)
RRP2	-0.16*** (-2.32)	-0.10 (-1.56)
Repo Lending (-1)	0.45*** (6.31)	0.30*** (4.01)
Observations	180	180
R^2	0.27	0.11

Note: This table presents the results of time series regressions for the log of weekly repo lending by MMFs to dealers. Weekly sample runs from January 2, 2013, to August 1, 2016, and is obtained from the FRBNY. Dealers comprise of all European and U.S. dealers in our sample. RRP1 takes the value 1 from September 23, 2013, to December 23, 2013 and 0 otherwise. RRP2 is equal to 0 until December 23, 2013, and 1 thereafter. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. t -ratios are reported in parentheses and are calculated using robust standard errors.

Table 7: RRP and Calendar Day Effects on Repo Lending to Dealers

	(1) Eligible MMF	(2) Ineligible MMF
Quarter-end	-0.458*** (-6.84)	-0.002 (-0.05)
Month-end	-0.296 (-1.25)	-0.248 (-1.22)
Repo Lending (-1)	0.435** (2.31)	0.935*** (14.71)
Observations	369	363
R^2	0.0968	0.2932

Note: This table presents the results of time series regressions for the log of daily repo lending by eligible and ineligible MMFs to dealers. Daily sample runs from August 22, 2014, to August 1, 2016, and is obtained from FRBNY. Dealers comprise of all European and U.S. dealers in our sample. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. t -ratios are reported in parentheses and are calculated using robust standard errors.

Table 8: Effects of Regulations on TRV

	(1) Eligible MMF	(2) Eligible MMF	(3) Ineligible MMF	(4) Ineligible MMF
EUD x RRP1	0.005 (0.45)	0.006 (0.56)	-0.010 (-1.46)	-0.010 (-1.47)
EUD x RRP2	0.009 (0.52)	0.011 (0.62)	-0.004 (-0.40)	-0.004 (-0.40)
EUD x Implemented	0.030** (2.21)	0.035** (2.55)	-0.028** (-2.54)	-0.028*** (-2.59)
TRV (-1)	0.538*** (18.65)	0.534*** (18.73)	0.632*** (28.85)	0.630*** (29.83)
Time FE	Yes	Yes	Yes	Yes
Relationship FE	Yes	Yes	Yes	Yes
Controls x Implemented	No	Yes	No	Yes
Observations	18857	18857	26512	26512
R^2	0.7050	0.7058	0.8187	0.8190

Note: This table presents the results of the DID estimates of the effect of Basel III regulations and the overnight RRP facility on trading relationship strength of MMFs and dealers, as measured by the TRV. TRV is calculated based on the dollar amount of transactions between the two parties. RRP1 takes the value 1 from September 23, 2013, to December 23, 2013 and 0 otherwise. RRP2 is equal to 0 until December 23, 2013, and 1 thereafter. Controls for initial MMF characteristics are the monthly averages of their AUM, flows, and overnight repo outstanding from January to July 2013. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. t -ratios reported in parentheses are calculated using standard errors clustered at the relationship level.

Table 9: Effects of Regulations on TRF

	(1) Eligible MMF	(2) Eligible MMF	(3) Ineligible MMF	(4) Ineligible MMF
EUD x RRP1	0.000 (0.07)	0.001 (0.19)	-0.006 (-1.51)	-0.006 (-1.53)
EUD x RRP2	0.005 (0.42)	0.006 (0.54)	-0.005 (-0.74)	-0.005 (-0.77)
EUD x Implemented	0.011 (1.08)	0.014 (1.32)	-0.012* (-1.68)	-0.012* (-1.74)
TRF (-1)	0.628*** (17.76)	0.623*** (17.83)	0.740*** (34.30)	0.737*** (35.29)
Time FE	Yes	Yes	Yes	Yes
Relationship FE	Yes	Yes	Yes	Yes
Controls x Implemented	No	Yes	No	Yes
Observations	18857	18857	26512	26512
R^2	0.8070	0.8076	0.8965	0.8966

Note: This table presents the results of the DID estimates of the effect of Basel III regulations and the overnight RRP facility on trading relationship strength MMFs and dealers, as measured by the TRF. TRF is calculated based on the frequency of transactions between the two parties. RRP1 takes the value 1 from September 23, 2013, to December 23, 2013 and 0 otherwise. RRP2 is equal to 0 until December 23, 2013, and 1 thereafter. Controls for initial MMF characteristics are the monthly averages of their AUM, flows, and overnight repo outstanding from January to July 2013. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. t -ratios reported in parentheses are calculated using standard errors clustered at the relationship level.

Table 10: Pricing Effects in the Repo Market

	(1) Eligible MMF	(2) Eligible MMF	(3) Ineligible MMF	(4) Ineligible MMF
EUD x RRP1	-0.000 (-0.11)	-0.000 (-0.10)	0.000 (0.26)	0.000 (0.25)
EUD x RRP2	-0.003 (-1.29)	-0.003 (-1.38)	-0.001 (-0.86)	-0.001 (-0.97)
EUD x Implemented	-0.002 (-0.71)	-0.002 (-0.70)	-0.001 (-0.73)	-0.001 (-0.73)
Price (-1)	0.229*** (2.74)	0.229*** (2.73)	0.266*** (4.65)	0.265*** (4.64)
Time FE	Yes	Yes	Yes	Yes
Relationship FE	Yes	Yes	Yes	Yes
Controls x RRP2	No	Yes	No	Yes
Observations	18857	18857	26512	26512
R^2	0.9822	0.9822	0.9889	0.9889

Note: This table presents the results of the DID estimates of the effects of Basel III implementation of capital rules and the overnight RRP facility on rate of transactions between MMFs and dealers. The price is the volume-weighted mean repo rate for MMF i and dealer j based on all the transactions between them that take place in week t . RRP1 takes the value 1 from September 23, 2013, to December 23, 2013 and 0 otherwise. RRP2 is equal to 0 until December 23, 2013, and 1 thereafter. Controls for initial MMF characteristics are the monthly averages of their AUM, flows, and overnight repo outstanding from January to July 2013. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively. t -ratios reported in parentheses are calculated using standard errors clustered at the relationship level.