

October 8, 2019

Recent Money Market Developments¹

Introduction and key takeaways

This memo discusses the stress that emerged in short-term funding markets during the week beginning September 16, when repo rates soared and the effective federal funds rate (EFFR) rose outside the FOMC’s target range. We review the Federal Reserve’s response, examine the factors that contributed to the stress, and draw the following preliminary conclusions:

- **Long-term trends in Treasury issuance have made short-term funding markets more vulnerable to shocks.** Historically high levels of Treasury issuance have increased dealers’ repo financing needs, and Treasury security settlements on September 16 boosted demand further.
- **The outsized effects of anticipated and relatively modest shocks on money market rates highlights the fragility of systemically important short-term funding markets.** Demand for overnight funding appears to be highly inelastic at times, as borrowers roll over funding even when costs rise substantially. Supply of funds, particularly in repo markets, depends largely on money market funds (MMFs) and other risk-averse participants, who may shun apparently profitable lending opportunities when uncertainty rises. The enormous volume of overnight funding that must be rolled over each day raises the costs of even brief interruptions in market functioning.
- **Funding flows across the system proved to be relatively unresponsive to price signals.** Broad uncertainty about liquidity conditions may have made lenders reluctant to step forward in size. Declining reserve balances could have dampened the willingness of domestic banks to step in and lend funds that would have helped to alleviate pricing pressures. Firms’ risk management practices, which have been shaped directly and indirectly by bank regulations and

¹ Sriya Anbil, Alyssa Anderson, Stephanie Curcuru, Dianne Dobbeck, Burcu Duygan-Bump, Erik Heitfield, Michael Hsu, Stefan Gissler, Josh Frost, Dan Li, Yi Li, Gordon Liao, Laura Lipscomb, Matthew Malloy, Patrick McCabe, Rebecca McCaughrin, John McGowan, Borghan Narajabad, Julie Remache, Christine Repper, William Riordan, Sean Savage, Sam Schulhofer-Wohl, Zeynep Senyuz, Steven Spurry, and Francesca Zucchi. We thank James Clouse, Dan Covitz, Rochelle Edge, Josh Gallin, Beth Klee, Thomas Laubach, Andreas Lehnert, Lorie Logan, Beth Anne Wilson, Nathaniel Wuerffel, and Patricia Zobel for their help and comments on the memo.

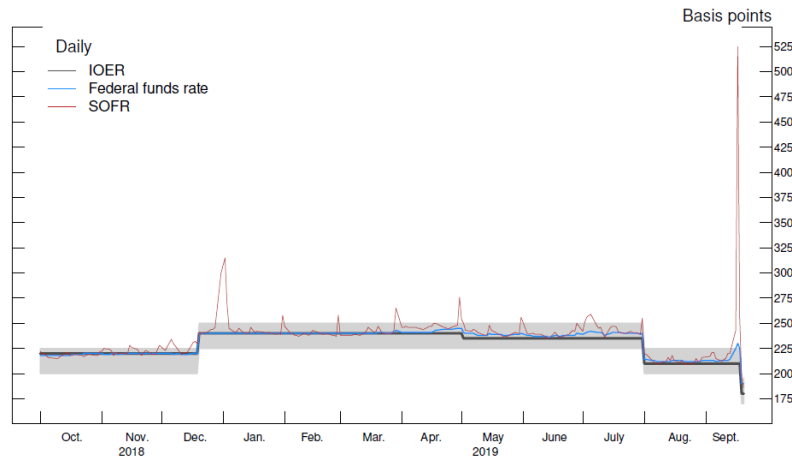
supervision, appear to have played a role. In addition, counterparty relationships in short-term funding markets take some time to establish.

- **Even with \$1.34 trillion in aggregate reserves, the share of banks with reserves near their lowest reported comfortable level of reserves (LCLoRs) was unusually high on September 16.** Those same institutions were actively bidding in the fed funds markets, where some banks even borrowed above the primary credit rate.
- **Clarity about future Federal Reserve open market operations helped calm markets.** These interventions ultimately proved successful in softening pressure on rates, but their reach may have been constrained because of the limited set of counterparties with which the Desk can currently transact.
- **Looking forward, some of the factors that contributed to the mid-September funding stress will likely affect money markets again.** The Treasury is expected to continue its heavy issuance of debt into the foreseeable future, and, absent Federal Reserve action, reserves would be projected to decline further through year end.

What happened during the week beginning September 16?

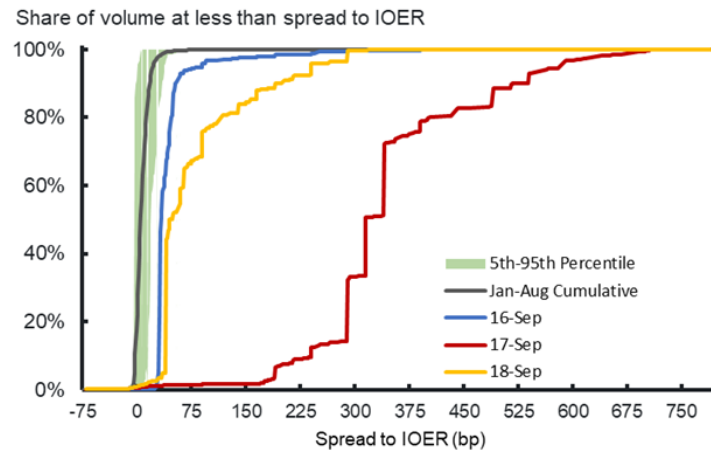
Interest rates in overnight money markets rose dramatically and exhibited significant volatility in mid-September, with Treasury general collateral repo rates rising as high as 10 percent and the EFFR printing above the target range (Figure 1). The moves in both secured and unsecured rates on Monday, September 16 and Tuesday, September 17 were exceptionally large by historical standards (Figures 2 and 3).

Figure 1: SOFR and EFR



On Friday, September 13, rates on forward trades in the repo market and the effective fed funds rate were modestly elevated, but not out of line with expectations. On Monday, secured rates moved significantly, and carried over to unsecured rates.² Fed funds volumes declined, while the overall distribution of rates moved notably higher. The Secured Overnight Financing Rate (SOFR), a broad measure of the cost of borrowing cash overnight secured by Treasury collateral, printed at 2.43 on Monday, 13 basis points higher than the previous Friday. The EFR printed at 2.25, 11 basis points above the Friday print and at the top of the FOMC’s target range.

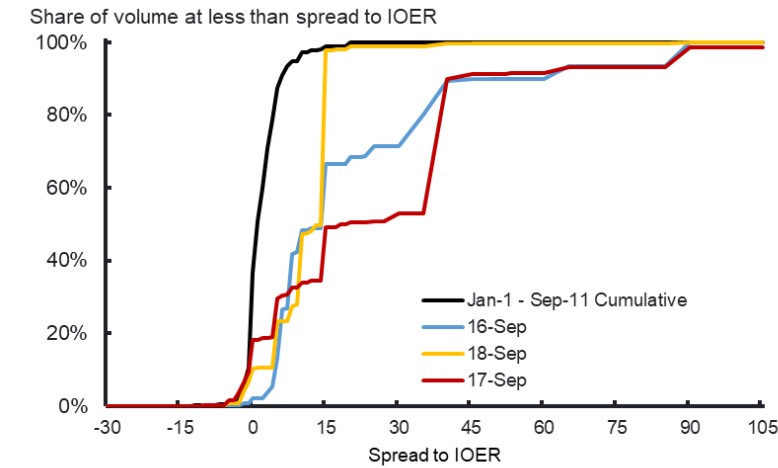
Figure 2: Distribution of SOFR Volumes by Spread to IOER



Source: FICC, BNYM, Desk Analysis

² The vast majority of repo trading occurs early in the morning by 9 a.m., while fed funds trading occurs later in the session. As fed funds trading activity became increasingly strained later in the session, contacts attributed the increased volatility to dislocations in repo spilling over into fed funds.

Figure 3: Distribution of Fed Funds Volume by Spread to IOER



Source: FR2420, Desk Analysis

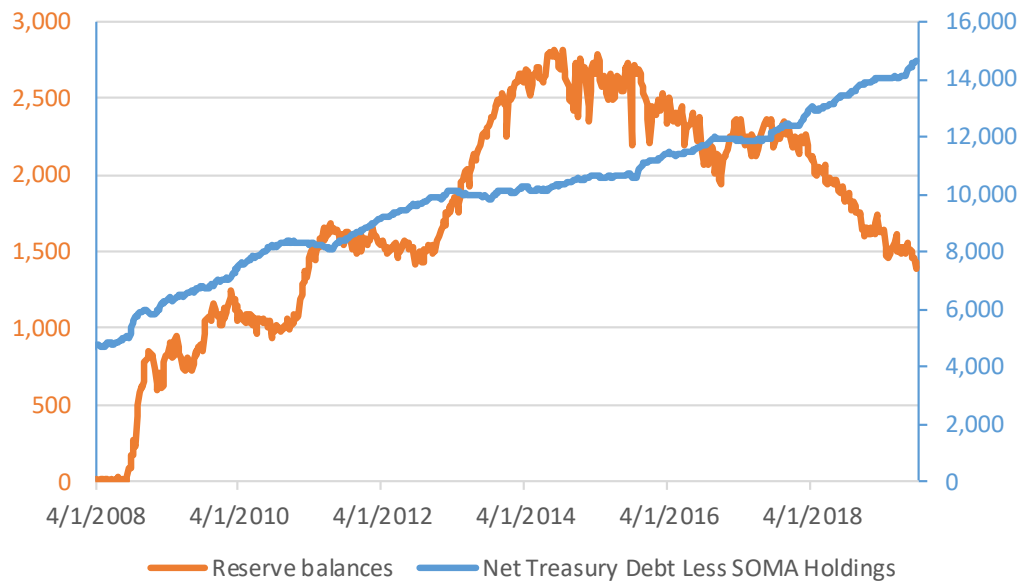
On Tuesday, SOFR spiked 282 basis points to 5.25 percent amid acute volatility and limited liquidity, while the EFFR rose to 2.30 percent, five basis points above the target range. Market contacts cited elevated repo rates as driving upward pressure on fed funds and related rates.

Ahead of this episode, quarterly corporate tax payments and the settlement of Treasury auctions were expected to exert upward pressure on money market rates. Primary dealers accommodate Treasury auction settlements in part by expanding balance sheets, increasing their need for repo funding. Tax payments generally result in a reduction in reserves in the banking system and outflows from money markets funds, which diminish their funds available for lending. Indeed, reserves fell \$120 billion in just two business days, between Friday, September 13 and Tuesday, September 17, because of an increase in GSE deposits with the Fed, tax payments that boosted the Treasury General Account, and the Treasury security settlements.

In recent years, similar dynamics have led to smaller spikes in repo rates. The sensitivity of the federal funds rate to the repo market dynamics has historically been muted but has increased in recent months, coinciding with ongoing declines in reserve balances. Thus, going into mid-September, some upward pressure on repo rates and some pass-through to the federal funds market were expected. However, the realized upward pressure on secured and unsecured rates was significantly greater than both staff and market participants had anticipated.³

³ A range of models suggest that movements in repo rates passes through to EFFR less than one-for-one when spreads of repo rates to IOER are modest. Staff analysis had suggested that repo markets

Figure 4: Treasury Net Debt Outstanding and Aggregate Reserves (\$Trillions)



These developments occurred against a backdrop of heavy issuance of Treasury securities (Figure 4). Hence, primary dealers' inventories were already elevated by historical standards. At the same time, reserves had been declining since 2014 amid balance-sheet normalization. Aggregate reserves reached a multi-year low of \$1.34 trillion on September 16.

How did the Fed Respond?

On Monday, September 16, market intelligence suggested that repo rates were more elevated than anticipated and that dispersion in trading was wide in both secured and unsecured markets. The Desk developed an implementation plan in case it needed to conduct open market operations on Tuesday to keep the EFFR in the target range.

On Tuesday morning, after observing that overnight money market rates were even more elevated and funding conditions more stressed than on Monday, the Desk announced plans to conduct an overnight repo operation at 9:30 a.m.⁴ Following the completion of the operation, which provided \$53 billion in additional reserves, rates

would likely firm by a few basis points, in line with rate movements around the April and June tax payment periods in 2019, and that this could put modest pressure on the EFFR. In addition to pass-through from repo rates, declining level of reserves may have put pressure on the EFFR. Models of the relationship between overnight interest rates and aggregate reserve balances generally predict that rates become more responsive to changes in reserves as reserve levels decline. Summary of these analytical models are in the technical addendum to the Report on Reserve Conditions, September 2019.

⁴ Due to technical difficulties, the operation was canceled and reopened at 9:55 a.m. The operation was completed at 10:10 a.m.

declined immediately and conditions generally improved. Despite the impact the first operation had in improving money market conditions, forward settling trades indicated that upward pressure on rates was likely to persist for several days. Contacts noted uncertainty over whether the Desk would continue to conduct repo operations as contributing to the upward pressure on rates. Overnight repo operations were announced each day that week and overnight markets generally stabilized over the remainder of the week, with the federal funds rate returning to the target range. The Desk offered up to \$75 billion in overnight repo each morning from Wednesday through Friday, with all three operations fully subscribed.

While overnight markets stabilized, trading volumes in term repo markets remained low, and rates were elevated and dispersed. To address potential stress around the September quarter end, on Friday, September 20 the Desk announced a schedule of term and overnight repo operations through October 10. The Desk injected just over \$200 billion in additional reserves over quarter end. Against the backdrop of the Desk's repo operations, overnight secured and unsecured markets traded in a more orderly fashion on September 30, though rates were slightly more elevated compared to prior quarter ends. In addition, rates continued to exhibit greater-than-typical dispersion. To support continued orderly trading in repo markets and address potential stress, including around the settlement of Treasury security auctions in October, on Friday, October 4 the Desk announced a schedule of term and overnight repo operations through early November. The operations will offer more than \$200 billion in liquidity each day through end-October.

Repo operations have been effective, but they have limitations. In particular, for the operations spanning the quarter-end, balance sheet constraints for Desk counterparties, the primary dealers, may have limited their participation. In particular, market rates remained above those offered in the repo operation and take-up was not for the full amount offered, likely reflecting some friction on the part of counterparties to intermediate with others who did not have direct access to the Fed operations. This constraint is related to the balance sheet impact of borrowing via triparty operations with the Fed and then lending to clients or other market participants. Because these operations cause dealer balance sheet to increase, dealers report some reluctance to borrow to the fullest extent possible. While this was not a substantial constraint around the September quarter-end, it could be more so around year-end when there is additional focus on balance sheets.

What was behind these extraordinary rate moves?

During the week beginning September 16, both demand for and supply of overnight funding appeared to be relatively inelastic, that is, unresponsive to price signals. Thus, reductions in funding supply caused by tax payments and increases in demand related to Treasury settlement led to sharp increases in money market rates. The

outsized moves were probably exacerbated by distributional frictions that impeded rapid adjustments to flows of funding from market participants with surplus cash to those who needed financing.

Below, we note that this episode is a reminder that short-term funding markets are vulnerable to shocks. Then, we turn to a discussion of the roles of inelastic demand for funding, inelastic supply, and distribution frictions that likely contributed to the spikes in money market rates.

Fragility of short-term funding markets

An enormous volume of overnight lending (more than \$2 trillion in repo alone) is transacted daily among systemically important institutions and highly risk-averse investors, some of whom – for example, MMFs – are themselves vulnerable to runs. Uncertainty can cause participants to pull back from lending, consistent with standard theoretical models in which coordination failures lead to bank runs. To be sure, in mid-September, lenders did not pull back in aggregate, although uncertainty about anticipated deposit outflows and redemptions likely tempered opportunistic investing by banks and MMFs, respectively. Moreover, outcomes might have been more problematic in the absence of Federal Reserve intervention.

Fragility in short-term funding markets also reflects some borrowers' apparent dependence on, and inelastic demand for, overnight funding. Because such funding must be raised in relatively narrow time frames, strains can spread very quickly. Furthermore, the highly concentrated nature of some segments of the funding markets, such as FHLB lenders in the federal funds market, can make the markets sensitive to idiosyncratic behavior by a relatively small number of participants.

Borrowers' inelastic demand and distributional frictions

Within the repo market, we observe detailed, transactions-level data on the triparty market and FICC bilateral market, where much of the secured borrowing by dealers and depository institutions (DIs) take place.⁵ In both of these markets, borrowing by dealers and DIs were stable from September 16 to September 17, even as rates shot up. As shown in Figures 5 and 6, these institutions borrowed nearly the same amounts in triparty and FICC bilateral repo on September 17 as they did the day before. Notably,

⁵ The repo market consists of two broad segments: the bilateral market and the triparty market. In the bilateral market, lenders (typically large dealers) and borrowers (typically hedge funds and small dealers) interact directly to negotiate the terms and settle the trade. The FICC bilateral repo segment is a subset of the bilateral market where FICC stands as a central counterparty to each side of the trade. In the triparty market, lenders (typically MMFs) and borrowers (high-credit-quality dealers) use the services of Bank of New York Mellon to act as a custodian, providing operational efficiencies over the course of the transaction.

higher-credit-quality dealers borrowed the same amounts in the triparty market, despite the higher rates, and did not lend more in the FICC bilateral repo market. At the same time, small dealers did not have to pay up as much for funding relative to borrowers in the sponsored repo market, where levered investors, such as hedge funds, borrow directly from MMFs. In addition, there is a large uncleared bilateral repo market, where levered investors borrow from dealers. We do not observe micro-data for this segment of the market.

Figure 5: 552 U.S.C. (b)(4)
552 U.S.C. (b)(4)

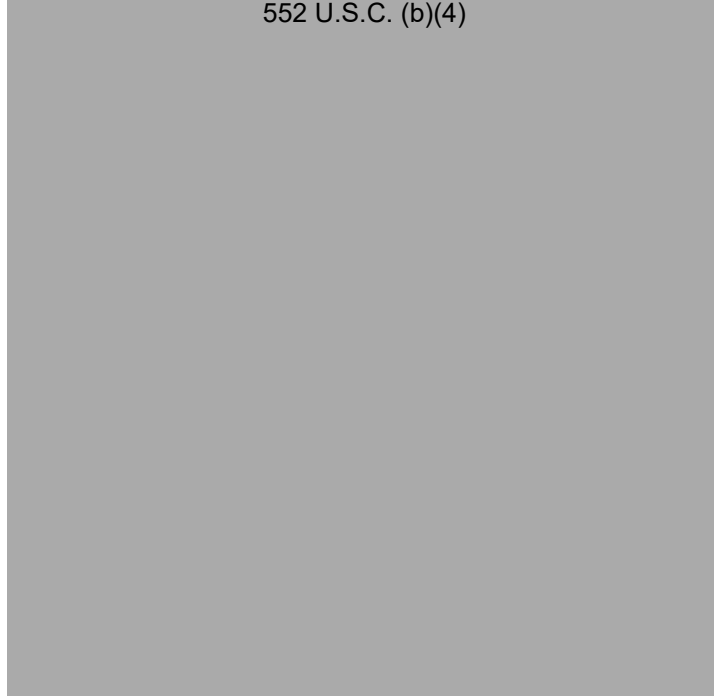
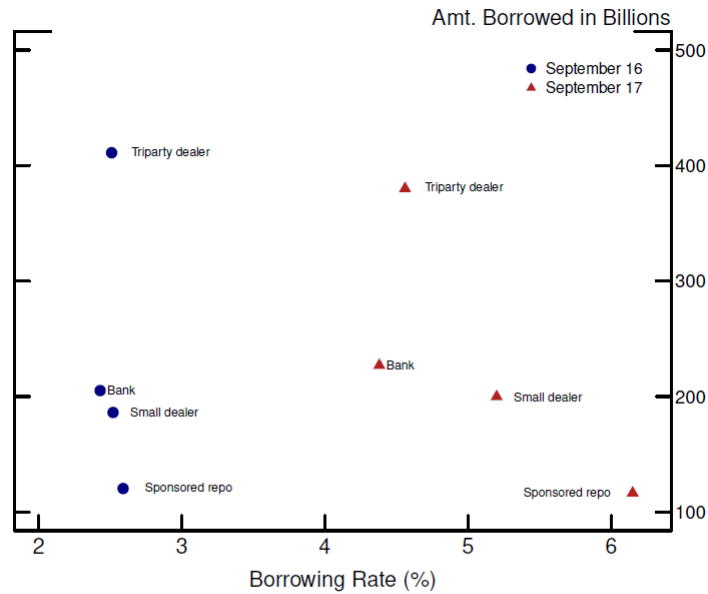


Figure 6: Borrowing in FICC Bilateral Repo

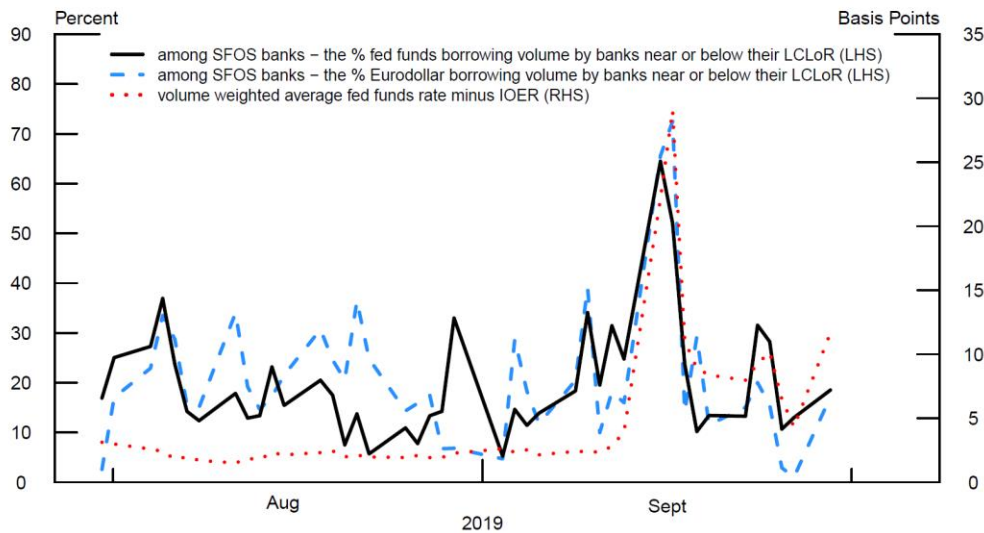


Source: FICC Bilateral DVP Supervisory Data.
Note: Data presented are overnight Treasury GC repo market positions.
Triparty dealers are eligible to borrow in the triparty market.
Sponsored repo refers to FICC's sponsored repo service (borrowing and lending).
Small dealers are ineligible to trade in the triparty market. Rates shown are volume-weighted average rates.

Inelastic demand in repo markets may have affected the federal funds market, where distributional frictions also could have increased rates. Some of the borrowing in this market was likely driven by the large drop in reserves on September 13 and 16, to \$1.34 trillion, the lowest level since normalization of the Fed's balance sheet began. This level of reserves is substantially higher than the upper end of staff estimates of aggregate demand for reserves (about \$1 trillion) derived from the Senior Financial Officer Survey (SFOS). However, aggregate estimates of reserve demand from the SFOS do not provide information about the additional amount of reserves that may be needed to overcome distributional frictions and thus may be needed to ensure ample supply.

As reserves dropped, the number of banks near or below their LCLoRs increased substantially. On September 16-17, over 50 percent of federal funds borrowing by SFOS banks was by banks that had fallen to near or below their LCLoRs. As seen in Figure 7, this spike was about double typical levels of around 25 percent.

Figure 7: SFOS Bank Activity in Unsecured Markets⁶



Note: Lowest Comfortable Level of Reserves (LCLoR) data from August 2019 Senior Financial Officers’ Survey (SFOS). “Near or below” means that a bank’s reserves are below 130 percent of its LCLoR. The above data only encompasses banks that replied to the SFOS. In fed funds, SFOS banks make up about 70 percent of borrowers on average, and in Eurodollar markets they make up about 85 percent of borrowers on average.

Stigma associated with the Federal Reserve’s Discount Window and a reluctance to use daylight credit also appear to have contributed to banks’ demand for reserves and their inelasticity of demand for overnight funding. In the overnight unsecured markets (federal funds, Eurodollars, and selected deposits) from September 16 to 18, fifteen banks paid rates that exceeded the primary credit rate, that is, the rate charged to creditworthy borrowers at the Discount Window. Banks also have expressed a reluctance to use daylight credit, due in part to concerns about an ability to “cure” the overdraft by the end of the day.

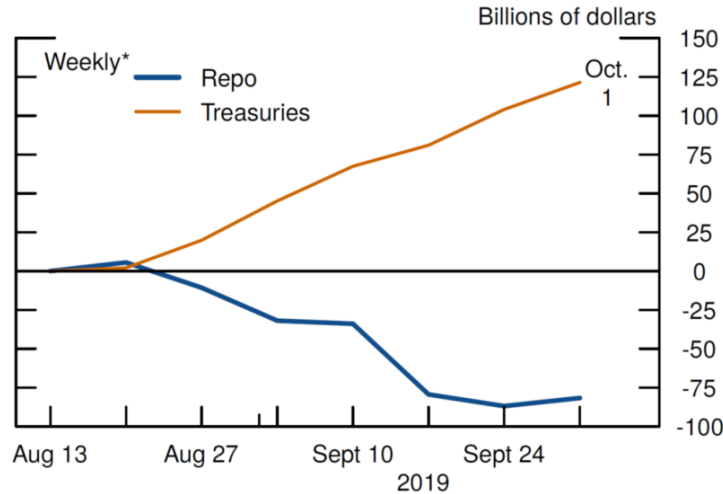
Money market funds’ pull-back in repo lending leading into mid-September

MMFs are very large lenders in short-term funding markets and the main cash lenders in repo markets, where they provide \$1.3 trillion in financing. However, government MMFs, which provide most of this financing, reduced their repo lending by about \$80 billion from mid-August to mid-September as they shifted into Treasury bills (Figure 8). This portfolio reallocation was likely intended to extend portfolio maturities ahead of an expected FOMC policy easing and to take advantage of rising spreads of

⁶ “SFOS banks” refer to banks that participated in the Senior Financial Officers’ Survey, a Federal Reserve administered survey that asks banks about their demand for reserves. One question asks banks to identify the LCLoR that they feel comfortable holding before taking action to retain or increase their reserve balances. SFOS banks from the latest survey in August 2019 include 43 domestic banks – including all 8 GSIBs – and 34 FBOs, which together make up about three-fourths of total system reserve balance holdings.

Treasury bill rates to OIS amid heavy Treasury bill issuance. The reduction was particularly sharp in the week ending September 17, when government MMFs' repo investments dropped \$45 billion (about 4 percent of their repo holdings).

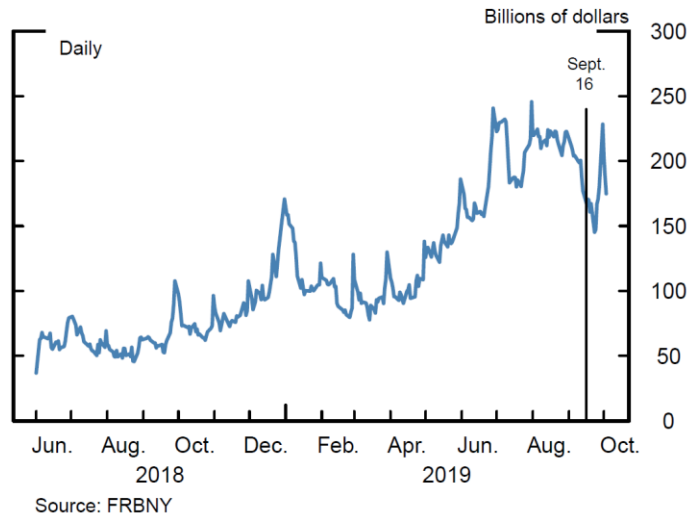
Figure 8: Cumulative Changes in Holdings by Government MMFs



*Data are for holdings as of Tuesday of each week.
Source: iMoneyNet.

The decline in MMF repo lending – and, at the time, uncertainty about how far it would go – likely added to pressures in repo markets going into the week of September 16, particularly in the FICC-sponsored segment. FICC-sponsored repo is a rapidly growing segment of the repo market, where MMFs lend through FICC without dealer intermediation. As shown in Figure 9, the total amount of FICC-sponsored repo peaked in August at over \$200 billion. However, volumes fell substantially, by roughly \$50 billion, leading into mid-September, as MMFs disproportionately reduced FICC-sponsored repo (the funds maintained more stable levels of triparty repo, probably because they prioritize maintenance of relationships with triparty dealers).

Figure 9: Lending Volumes in the Sponsored Repo Market



On September 16 and 17, MMFs appear to have been relatively unresponsive to the higher repo rates, particularly in the FICC-sponsored segment. Figures 10 and 11 show the distribution of triparty and FICC-sponsored lending activity on those two days. Some funds modestly increased their triparty lending when rates jumped on September 17, but overall lending in the market was little changed. Rates on FICC-sponsored repo rose sharply, but quantities moved little from the day before. MMF contacts mentioned that they shifted some investments from unsecured instruments, such as time deposits and commercial paper, into repo on these days to take advantage of higher repo rates. However, uncertainty about possible tax-payment related outflows reportedly dampened MMFs' willingness to boost repo investments to take advantage of higher repo rates.

Figure 10: 552 U.S.C. (b)(4)

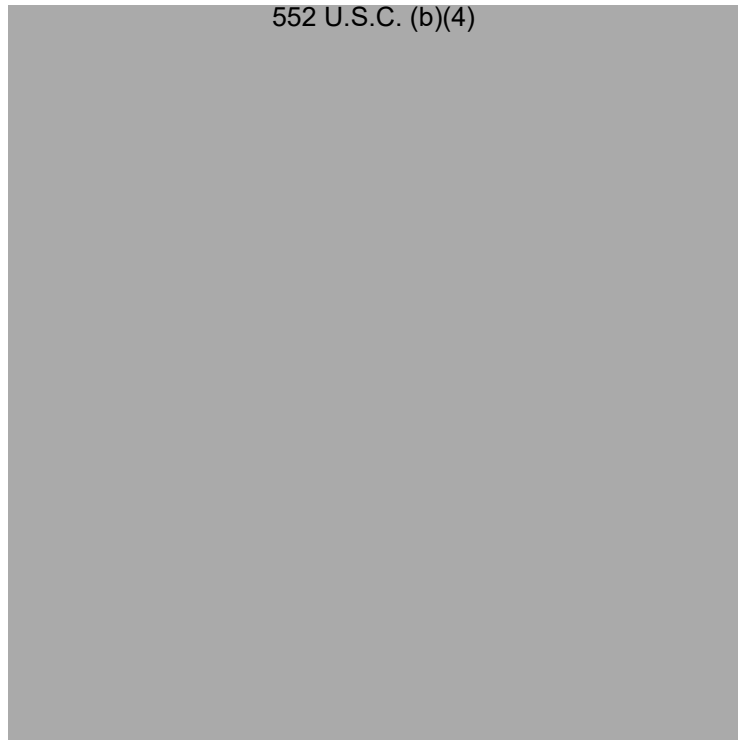
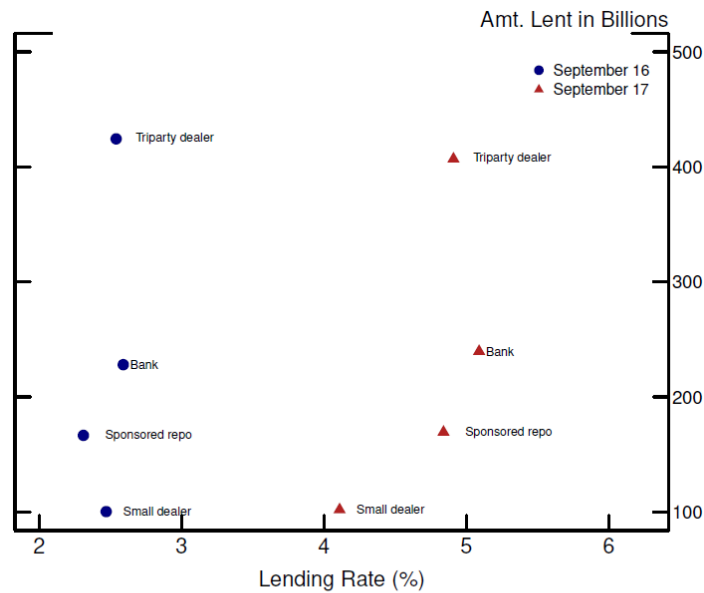


Figure 11: Lending in FICC Bilateral Repo



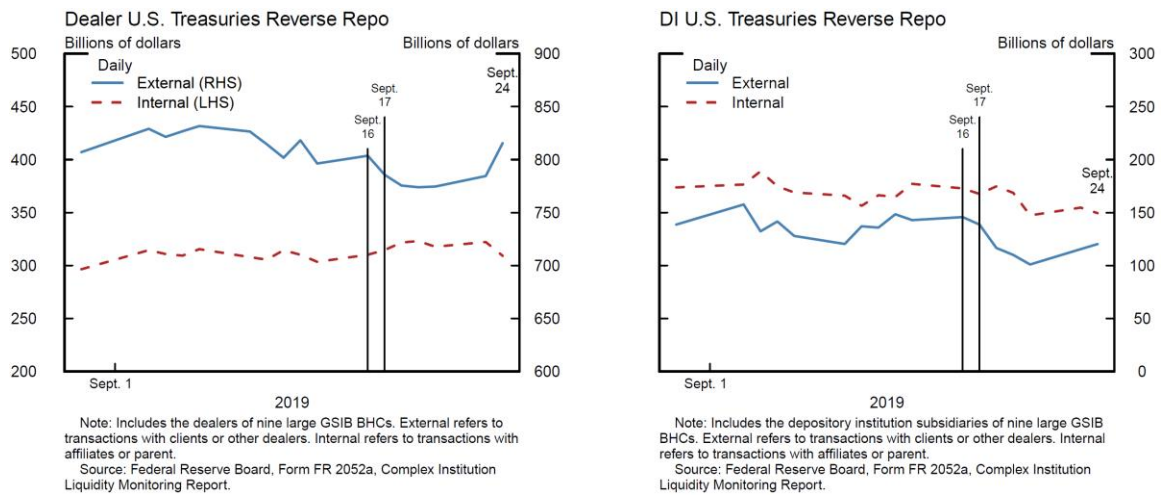
Source: FICC Bilateral DVP Supervisory Data.
Note: Data presented are overnight Treasury GC repo market positions.
Triparty dealers are eligible to borrow in the triparty market.
Sponsored repo refers to FICC's sponsored repo service (borrowing and lending).
Small dealers are ineligible to trade in the triparty market. Rates shown are volume-weighted average rates.

BHCs’ inability or unwillingness to step in and lend more

Dealer subsidiaries of large BHCs typically run a matched book business, which largely involves borrowing through repo in the triparty market and lending to clients through reverse repo in the bilateral market. Supervisory data suggest that, despite higher repo rates, primary dealer subsidiaries of GSIBs did not substantially change their aggregate repo lending on September 16 and 17 (Figure 12, Left).

Domestic DI subsidiaries of large BHCs, where reserves are typically located, are smaller players in the repo market. Despite their ample reserves, in aggregate, DIs of GSIBs did not substantially change their lending through reverse repo either. Moreover, they do not seem to have increased secured lending to their primary dealer affiliates through internal repo transactions on September 16 and 17 (Figure 12, Right). Increased uncertainty and the temporary nature of the rate spike appear to have contributed to a reluctance by some DIs to significantly increase their lending of surplus reserves to take advantage of attractive rates.

Figure 12: Treasury Reverse Repo by Dealer and DI Subs of GSIBs



Information on banks’ LCLoRs collected in the SFOS suggests that the concentration of surplus reserves (as measured by balances above banks’ reported LCLoRs) in the GSIB banks contributed to distributional frictions. In particular, the largest banks did not appear to significantly boost their lending of reserves. The eight U.S. GSIBs typically hold about \$200 billion in surplus reserves, about the same amount as the 34 foreign banking organizations (FBOs) that participate in the SFOS combined.

Meanwhile, the 30 large domestic SFOS banks, in aggregate, hold just \$80 billion in surplus reserves.⁷

Some market participants have suggested that post-crisis bank regulations may have limited the banks' ability and willingness to step in to take advantage of higher rates. Technically, liquidity and capital regulations applicable to U.S. GSIBs are not constructed in a way to directly constrain this type of bank lending. The substitution of reserves for reverse repo collateral would constitute an exchange of one high-quality liquid asset for another, with no change to a bank's overall asset size or liability composition. Given that, one would expect banks to opportunistically convert excess reserves into reverse repos backed by U.S. Treasuries to earn a higher return when overnight repo rates rise sharply. Banks' inertia may be indirectly related to the influence of supervision and regulations on banks' internal risk management practices, which may have made some banks reluctant to step in.⁸ [REDACTED] 552 U.S.C. (b)(4)

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Banks may also face additional balance sheet costs, and the largest banks often report high-hurdle rates for lending in unsecured overnight markets. For example, the GSIB banks reported in the SFOS that they would require spreads in unsecured overnight markets of between 50 and 100 basis points over IOER to lend reserves, and they reported that they would cumulatively lend out about \$70 billion at spreads in that range. Reported spreads to IOER required to lend in secured markets against Treasury securities and other Level 1 high-quality liquid assets ranged between 4 and 50 basis points across institutions, with the cumulative amount to be lent at these spreads close to \$100 billion.⁹

⁷ FBOs have much higher ratios of surplus reserves to assets than U.S. domestic banks. FBOs on average hold over 10 percent in surplus reserves relative to assets, while the median U.S. GSIB only holds 3 percent and large domestics hold over 1 percent.

⁸ Separately, the largest banks also run internal liquidity stress tests, which are examined by supervisors. Supervisors focus on liquidity risk management, including managing buffers to be able to meet outflows as they occur in stress. Some market participants may have interpreted that focus as a supervisory preference for reserves. The heterogeneous approaches to buffer composition in evidence among the large banks, however, is consistent with supervisors taking a firm-specific approach to liquidity risk management practices.

⁹ In the February 2019 Senior Financial Officers' Survey (SFOS), staff asked respondents to identify the lowest spreads (to the IOER rate) and the volumes at which they would be willing to lend cash in overnight unsecured and secured markets. About three-quarters of respondent banks reported both a spread and an amount. Overall, the 75 banks that responded to the February 2019 SFOS held about 77 percent of aggregate reserves.

FHLBs' precautionary lending behavior

FHLBs play a critical role in the overnight fed funds market, where they supply more than 90 percent of the lending, and they are a key conduit through which stress in other short-term funding markets can spread to the fed funds market. Since FHLBs prioritize extending advances to their own members, when FHLBs face uncertainty about members' liquidity needs, they may reduce or delay fed funds lending in order to ensure that they have sufficient resources to meet their members' demand for advances.¹⁰ Moreover, because FHLBs actively lend in both repo and fed funds markets, higher repo rates tend to induce them to direct available liquidity toward the repo market, reducing their lending in the fed funds market.

In the week beginning September 16, many of the FHLBs reported considerable uncertainty as to the amount of overnight advances that their member banks would seek given pressures in funding markets. The FHLBs faced increased demand for advances from their members on Monday, September 16 and expected to face significant demand again on Tuesday. Hence, on Tuesday morning, FHLBs raised funds by issuing \$20.6 billion in overnight discount notes at the very steep rate of 4.5 percent. Later in the day, they issued another \$2.25 billion at 2.0 percent.^{11, 12}

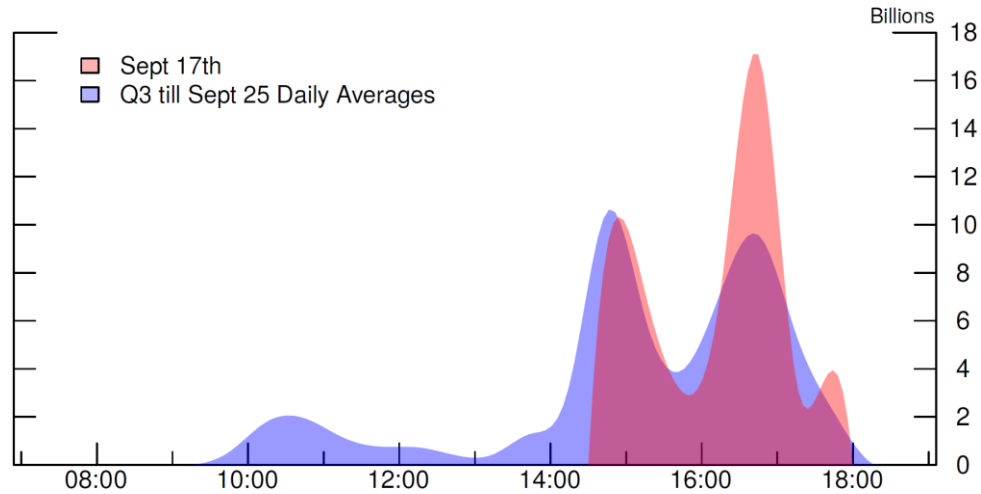
Fed funds transactions typically occur early in the morning over the phone, and cash settles throughout the day. As shown in Figure 13, on the morning of September 17, FHLBs appear to have held back cash in order to meet members' potential need for advances later in the day. One FHLB reported to the Desk that it executed a single early morning \$500 million fed funds trade at 5 percent with a Canadian bank. Aside from this one trade, none of the seven FHLBs the Desk contacted on Tuesday reported selling fed funds until after the Desk's repo operation was announced just after 9 am. Following the Desk's repo operation, the FHLBs resumed lending into the fed funds market.

¹⁰ Membership in FHLB is generally limited to federally-insured depository institutions and insurance companies who have at least 10 percent of their total assets in residential mortgage loans, and community development financial institutions. Foreign financial institutions operating in the United States and regulated by a U.S. regulatory agency are not eligible for FHLB membership, as members must be chartered by a U.S. federal or state regulatory agency, such as the Office of Thrift Supervision, the Office of the Comptroller of the Currency, the National Credit Union Administration, or a state Banking or Insurance Department. FHLBs lend fed funds to both members and non-members. However, currently foreign banking organizations account for the majority of fed funds borrowing—approximately 70 percent of daily fed funds borrowed on average in 2019, as reported on the Federal Reserve's Report of Selected Money Market Rates (FR 2420).

¹¹ The rise in their cost of borrowing followed outflows from money market funds combined with the fact that FHLB discount notes compete with repo as MMFs are significant investors in both.

¹² Elevated overnight discount rates were cited among the factors that drove FHLBs to increase the offer rates on fed funds at the start of the day on Tuesday. Even so, one FHLB acknowledged taking a loss on some fed funds trades Tuesday afternoon, having raised funds at 4.5 percent via overnight discount notes in the morning and selling fed funds at rates of 2.5 percent or less.

Figure 13: Intraday Fed Funds Lending by FHLBs



Source: FR2420 Filings and Fedwire Transactions

FHLBs shifted some of their lending from the fed funds market to the repo market on Monday, in line with their recent behavior, reducing their supply of fed funds to banks. However, on Tuesday, FHLB lending in the repo market was lower than on Monday despite the higher rates, as they sought to preserve liquidity for later in the day.¹³ This pullback might also have contributed to the pressures in the repo market.

Downstream costs and other repercussions

The market for US Treasury repo is one of the largest and most liquid funding markets, and stress in this market spilled over to other areas. While such downstream effects were significant at the time in some markets, they appear to have been short-lived.

Nonfinancial corporate short-term borrowing costs increased

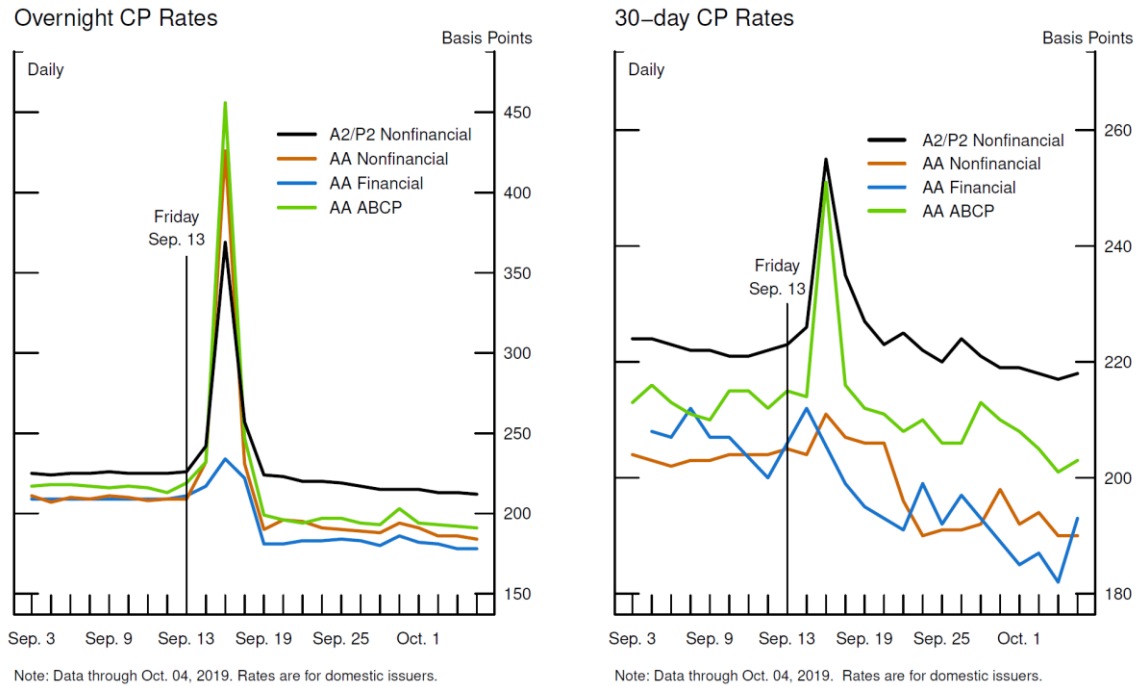
Rates on nonfinancial commercial paper (CP), which currently provides firms with about \$300 billion in short-term financing, soared on September 17, particularly for overnight tenors. The overnight AA-rated nonfinancial CP rate increased 194 basis points that day, its largest single-day increase ever in a series dating back to 2001 (Figure 14). Rates for lower-rated (A2/P2) CP and asset-backed CP (ABCP) also soared. Transmission of higher rates into the CP market likely reflected pressures from prime

¹³ This is consistent with data from the FHFA which show on September 16 FHLBs lent \$39 billion (at an average rate of 2.41 percent) in fed funds and \$51 billion (at an average rate of 2.43 percent) in reverse repo, and on September 17 lent \$51 billion (at an average rate of 2.45 percent) in fed funds and \$44 billion (at an average rate of 4.73 percent) in reverse repo.

MMFs and other investors that might have otherwise shifted away to higher-yielding repo.

Of note, effects on the CP market were not limited to overnight rates, as 30-day rates for A2/P2-rated firms and ABCP also jumped dramatically on September 17. Moreover, some of these pressures persisted well beyond September 17; for example, the spread of the overnight A2/P2 CP rate to the EFFR was still somewhat elevated as of October 4.

Figure 14: Nonfinancial Commercial Paper Rates

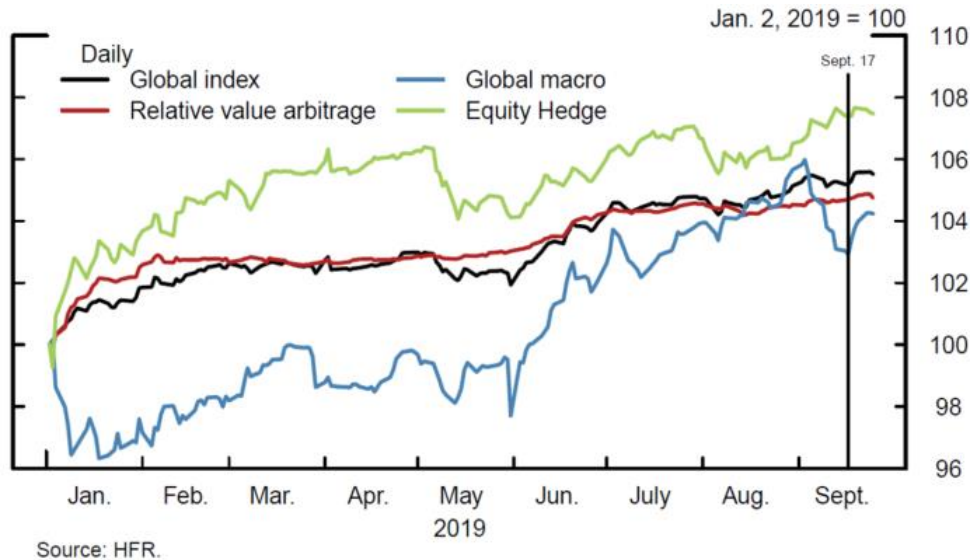


Hedge fund borrowing volumes from large dealers appear little changed

We have limited visibility on leveraged traders who rely on repo markets for funding. Data on borrowing terms paid by leveraged investors to their dealers are extremely limited. We can, however, partially observe the volumes of investor borrowing by examining dealer lending volumes. On both September 16 and 17, secured funding provided by large primary dealers to their clients, including hedge funds, was fairly stable.¹⁴ However, at an aggregate level, dealer-lending activities appear inelastic, similar to their borrowing activities. Any broader effects on hedge funds appear to have been limited, as average returns of hedge funds of various styles were mostly flat or slightly positive during the week, even for strategies that rely most on leverage from bilateral repo (Figure 15).

¹⁴ Available data are not granular enough to show whether primary dealers were prioritizing their favored clients.

Figure 15: Hedge Fund Return Indices



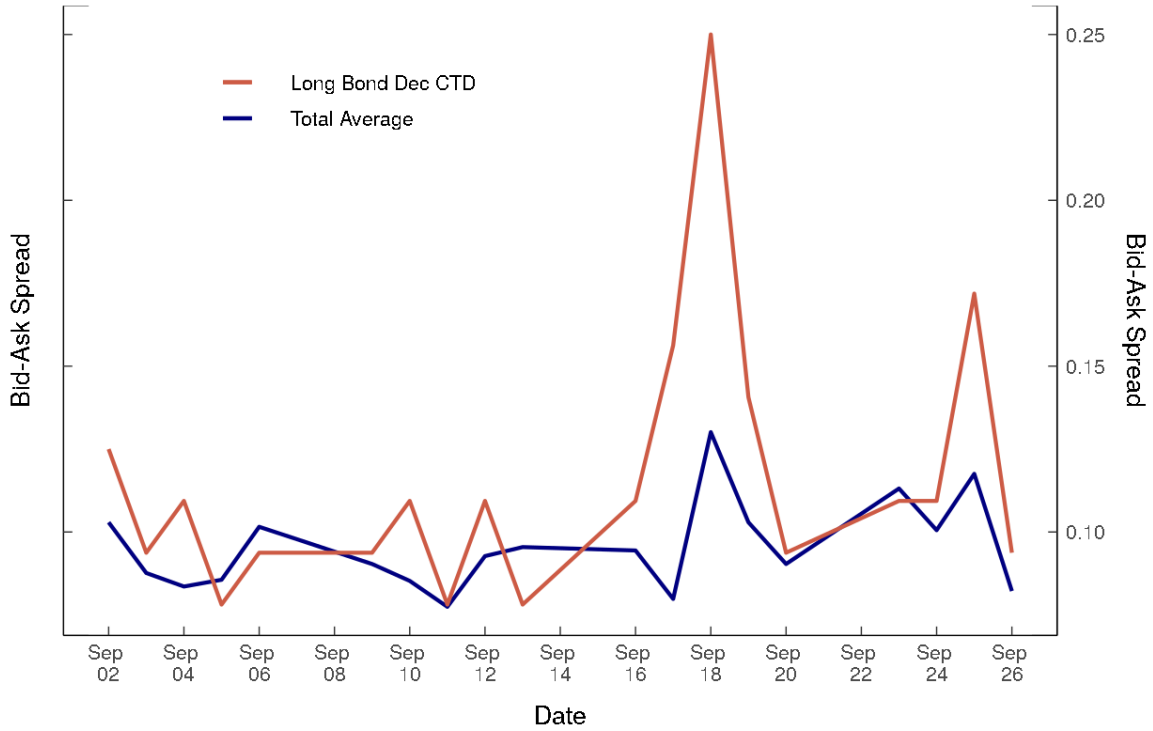
Treasury market functioning was affected as relative-value investors pulled back

Leveraged investors specializing in relative-value strategies seek to profit by arbitraging the difference between the market prices of Treasury futures contracts upon delivery and the prices of the corresponding cheapest-to-deliver Treasury securities. Typically, such trading keeps the implied basis between Treasury securities and comparable Treasury futures quite narrow, which supports liquidity in both the cash Treasury market and the Treasury futures market.

The very high cost of financing investments in those Treasury securities that constitute the cash leg of cash-futures arbitrage transactions appears to have induced relative-value investors to curtail trading early in the week of September 16. This had two consequences for Treasury markets. First, as relative-value investors sought to liquidate their cash Treasury positions, bid-ask spreads for the relevant Treasury securities used in arbitrage trades spiked upward (Figure 16). Second, because less arbitrage activity was taking place, the basis between cash Treasuries and Treasury futures widened significantly (Figure 17).¹⁵ These dislocations were short-lived, and measures of the bid-ask spread on cheapest-to-deliver Treasuries and cash-futures basis returned to earlier levels by then end of the week.

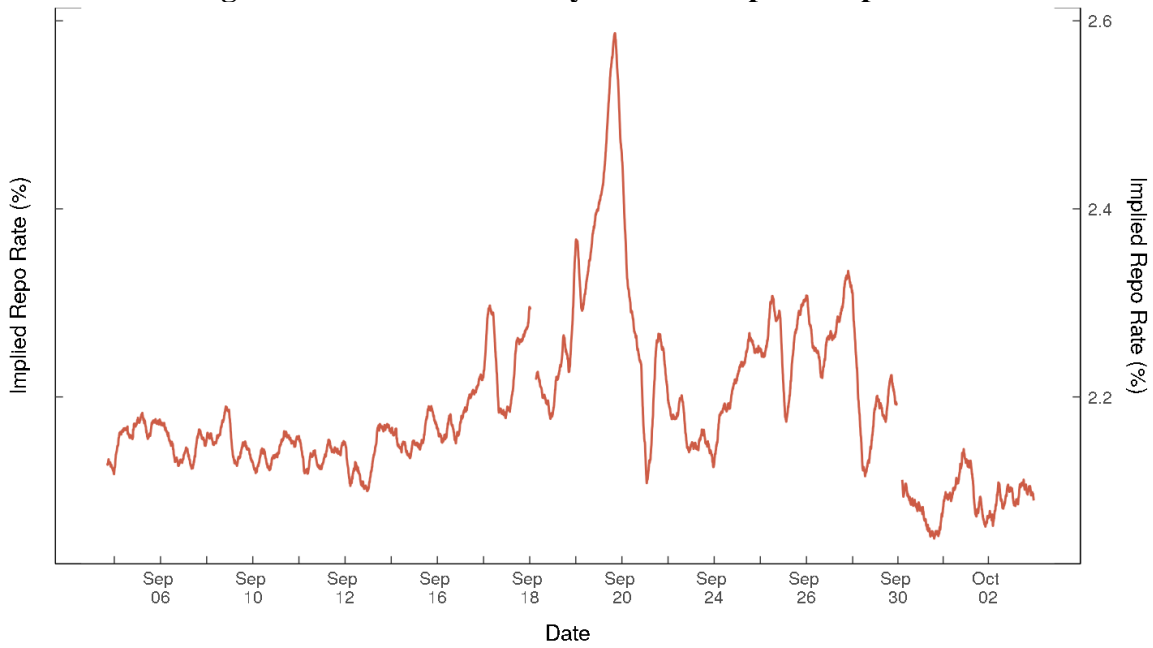
¹⁵ The futures implied repo rate is the rate of return needed to match the present value of Treasury futures settled at a future date with Treasury securities purchased on the “as of” date. A higher value implies that cash Treasuries are relatively cheap compared to Treasury futures.

Figure 16: Bid-Ask Spread on Cheapest-to-Deliver 10-Year Treasury



Source: Bloomberg

Figure 17: 10-Year Treasury Futures Implied Repo Rate



One-hour moving average of one-minute intervals
Source: Bloomberg

Interest costs of debt linked to SOFR increased little

The SOFR is increasingly being used as a reference rate for dollar-denominated floating-rate loans and securitization products. Since the rate was introduced in April 2018, \$297 billion in floating rate instruments linked to SOFR have been issued. Importantly, such instruments typically reference a compounded or simple average of daily rate over a period of weeks or months, most commonly three months. Despite the very large spike in SOFR on September 17, the three-month backward-looking compounded average of SOFR moved up only three basis points to 2.33 percent on that day.

SOFR futures trading was relatively orderly

SOFR futures trading on CME and ICE increased dramatically on September 17 but price changes for most contracts were modest. An estimated \$680 billion notional in futures contracts were sold, by far the largest daily volume since SOFR futures began trading in May 2018, as investors reportedly sought to hedge volatility in the spread between secured and unsecured funding rates. The market appeared able to accommodate the increased volume; though bid-ask spreads for shorter-dated contracts did widen, they were not significantly higher than usual. Aside from one-month contracts expiring in September 2019, whose prices reflect both realized and expected SOFR rates during the calendar month, SOFR futures contract prices did not change significantly on September 17. This suggests that, while the spike in overnight rates was much larger than anticipated, market participants expected it to be transitory.

Dollar funding costs for foreign investors spiked temporarily

Foreign investors commonly obtain dollar funding by purchasing U.S. dollars with foreign currency and simultaneously entering into a swap agreement to sell the same dollar amount at a future date at a specified exchange rate. The spike in the U.S. repo rates had a noticeable impact on the overnight borrowing cost for dollars in the FX swaps market. On September 17, the cost of borrowing dollars overnight collateralized by euro currency ended the day at around 4.5 percent, up from an already-elevated level of 3.7 percent on September 16, and well above the 2.3 percent September 13 level. Intraday FX swap-implied dollar funding rates were volatile during the episode, and bid-offer spreads for the overnight-implied rate were over 150 basis points. The funding pressures were short-lived, however, and there was very little demand at the ECB's dollar swap auction held on September 18.

Conclusion

Monetary policy implementation and financial stability depend on well-functioning short-term funding markets. The events of mid-September are a reminder

that short-term funding markets can also be brittle. A series of anticipated technical factors prompted an outsized increase in the price of overnight funding, underscoring that borrowers' demand is highly inelastic and that funding liquidity may not adjust quickly.

Ultimately, the stress in funding markets in mid-September proved to be short-lived and relatively benign. However, it is important to recognize that the problems could have been much worse. Many large financial institutions – including large, highly interconnected, financial market utilities – operate with the expectation that that they will be able to rapidly convert Treasury securities into cash in the repo market if they come under stress. Fortunately, no such institution was experiencing significant difficulties in mid-September, and this assumption was not tested.