2-21-2012

How Effective Were the Federal Reserve Emergency Liquidity Facilities?

Burcu Duygan-Bump

Patrick M. Parkinson

Eric Rosengren

Gustavo A. Suarez

Paul Willen

How Effective Were the Federal Reserve Emergency Liquidity Facilities? Evidence from the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility

BURCU DUYGAN-BUMP, PATRICK PARKINSON, ERIC ROSENGREN,
GUSTAVO A. SUAREZ, and PAUL WILLEN*

Journal of Finance, forthcoming
February 21, 2012

ABSTRACT

The events following Lehman's failure in 2008 and the current turmoil emanating from Europe highlight the structural vulnerabilities of short-term credit markets and the role of central banks as back-stop liquidity providers to financial markets. The Federal Reserve's response to financial disruptions in the United States importantly included creating liquidity facilities. Using unique micro datasets and a differences-in-differences approach, we evaluate one of the most unusual of these interventions—the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility. Our findings indicate that this facility helped stabilize asset outflows from money market funds and reduced asset-backed commercial paper yields significantly.

J.E.L Classification: E58, G01, G20
Keywords: Federal Reserve, Financial Crisis, Discount Window, Money Market Mutual Funds, Commercial Paper, Asset-Backed Commercial Paper

* Duygan-Bump, Parkinson, and Suarez are at the Federal Reserve Board, and Rosengren and Willen are at the Federal Reserve Bank of Boston. Parkinson played a key role in the design of the AMLF, and Duygan-Bump and Rosengren were actively engaged in policies related to its implementation. We are indebted to an anonymous referee, Cam Harvey (the editor), and an associate editor for detailed comments that greatly improved the paper. For valuable comments, we also thank Steffanie Brady, Ricardo Correa, Dan Covitz, Giovanni Dell'Ariccia, Refet Gürkaynak, Luc Laeven, Patrick McCabe, Bill Nelson, Andy Powell, Steve Sharpe, Bart Simon, and seminar and conference participants at the Federal Reserve Banks of Atlanta and Boston, the Federal Reserve Board, LACEA, IBEFA, and the International Monetary Fund. Neil Goodson, Jonathan Larson, Jonathan Morse, Landon Stroebel, and Isaac Weingram provided excellent research assistance. The views expressed here are those of the authors and not necessarily represent those of the Federal Reserve Bank of Boston or the Federal Reserve Board.

The events that followed the bankruptcy of Lehman Brothers in September 2008 helped define the financial crisis of 2007-2009 as the most severe since the Great Depression. Spreads between Libor and overnight index swap (OIS) rates rose to unprecedented levels as short-term credit markets came under pressure, and credit default swap (CDS) spreads for many large financial institutions soared (Brunnermeier (2009), Taylor and Williams (2009)). As institutions became unwilling to lend to each other, the flow of credit in financial markets was severely disrupted. The current European sovereign debt crisis has renewed the pressures on short-term credit markets, and CDS spreads on many large financial institutions have risen to similar or higher levels than those in the fall of 2008.

These events highlight how the global financial system and especially short-term credit markets remain vulnerable to liquidity shocks. One example that remains highly relevant is the U.S. money market mutual fund (MMMF) industry, which is the main investor in many money market instruments, including short-term debt issued by financial institutions in Europe and the United States. MMMFs are promoted to institutional and retail investors as stable investments that provide cash on demand at a constant net asset value (NAV) of $1 per share, very much like bank deposits.[1] However, without deposit insurance, these funds are prone to runs, as investors have an incentive to exit a fund at $1 per share if they suspect that its NAV is heading below $1 (i.e., they expect the fund to "break the buck"). The tidal wave of redemptions from MMMFs after one fund broke the buck in September 2008 because of its Lehman exposures is a clear example of such a modern "bank-run." Similarly, investors withdrew a significant amount of

funds from MMMFs in a "slow-motion run" in 2011, due to concerns that these funds were heavily exposed to European sovereign debt through their lending to European banks (The Economist (2011), Chernenko and Sunderam (2011)).

In response to the financial crisis and the global economic downturn, the Federal Reserve and other major central banks have aggressively used a mix of traditional as well as less traditional policy actions. For example, in addition to cutting interest rates to practically zero, the Federal Reserve substantially increased the size of its balance sheet, expanded the types of assets in its portfolio, and created emergency liquidity facilities to preserve market functioning in response to the freezing of short-term credit markets after Lehman's bankruptcy. Given the novelty and size of the interventions, studying the effectiveness of these policies is important not just for the theory and practice of monetary policy, but also more broadly for our understanding of the role of central banks and governments in financial markets during a crisis.

In this paper, we evaluate a major unconventional intervention by the Federal Reserve, the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (henceforth AMLF). The AMLF was created with two objectives: first, increasing the liquidity of the asset-backed commercial paper (ABCP) market; and, second, providing a means for money market mutual funds to liquefy assets without having to suffer fire sale costs to meet the wave of redemptions that followed the failure of Lehman Brothers, thus preventing many MMMFs from "breaking the buck."

The AMLF is especially interesting as it was the primary tool developed to provide a liquidity back-stop to MMMFs, which still remain susceptible to runs. Moreover, the AMLF

was one of the most unusual facilities when viewed against traditional lender-of-last-resort operations by a central bank (i.e., discount window lending). For example, in a substantial departure from its "traditional"—recourse and over-collateralized—loans, the Federal Reserve accepted some credit risk under the AMLF by issuing non-recourse loans to banks that purchased ABCP directly from money market funds and imposing no haircut on the collateral of these loans.

There is a growing literature evaluating the impact of various policy interventions during the crisis. However, most of these studies rely on aggregate data (e.g., Christensen, Lopez, and Rudebusch (2009), Stroebel and Taylor (2009), Taylor and Williams (2009), and Wu (2011)) and are subject to important identification problems. As discussed by Hamilton (2009), it is an econometric challenge to isolate the effects of numerous interventions that were introduced simultaneously using aggregate time series data alone. In addition, it is also a challenge to resolve the endogeneity of the Federal Reserve's response to market conditions.

In this paper we exploit two unique micro datasets to evaluate the effectiveness of the AMLF. First, we use the Federal Reserve's complete micro-dataset of all loans extended under the facility, which identifies the bank receiving the loan, the MMMF from which the ABCP was purchased, and the ABCP that collateralized the loan. These data, combined with information on MMMF portfolios, allow us to evaluate the extent to which this intervention stabilized net flows into money market funds. Second, using data for all U.S. commercial paper transactions from the Depository Trust and Clearing Corporation, we evaluate the extent to which the AMLF

stabilized the ABCP market by comparing how AMLF-eligible commercial paper behaved relative to non-AMLF eligible commercial paper.

The micro nature of these data is essential in our econometric identification of the impact of the AMLF. This feature essentially enables us to exploit not just time-series, but also cross-sectional variation to evaluate the AMLF separately from other roughly contemporaneous government initiatives, such as the temporary insurance offered by the Treasury Department to money market funds. Our identification strategy builds on the fact that the AMLF targeted a single asset, ABCP, while the Treasury Department's temporary insurance to MMMF balances effectively covered all money market fund assets. Accordingly, to isolate the impact of the AMLF, we exploit cross-sectional variation across MMMFs and within the commercial paper market to better understand the effects more directly attributable to the AMLF. Our empirical analysis is also aided by the fact that the AMLF was the first emergency liquidity facility created after the bankruptcy of Lehman Brothers and, unlike most policy interventions in the fall of 2008, involved no practical lag between announcement and implementation.

We document that the AMLF was quickly used by MMMFs as a sizeable source of liquidity. Our regression results suggest that the AMLF helped stabilize asset outflows from money market mutual funds. We also show that the AMLF helped to restore liquidity to the ABCP market and drive down ABCP spreads. In particular, we show that after the AMLF was implemented, yields on ABCP that could be pledged to the AMLF decreased significantly relative to those on similarly rated financial unsecured commercial paper, which could not be pledged to the AMLF. Comparing the overnight yield on an ABCP conduit sponsored by a financial institution with the

same financial institution's unsecured commercial paper yields, we find that the AMLF reduced ABCP yields by about 100 basis points, on average.

The rest of the paper is organized as follows. Section I provides institutional background on MMMFs and ABCP and reviews the events in money markets that followed the bankruptcy of Lehman Brothers. Section II summarizes the design and operation of the AMLF. Section III describes our datasets. Section IV presents the econometric design and the results from evaluating the AMLF's impact on short-term credit markets. Finally, section V concludes with some policy implications.

I. Money Market Mutual Funds and Commercial Paper during the 2008 Crisis

Money market mutual funds (MMMFs) are large financial intermediaries that operate outside the traditional banking system and are promoted as investments with stable values that provide cash on demand. Funds that register with the SEC and adhere to the portfolio restrictions of rule 2a-7 are allowed to market themselves widely to the public.[2]

There are three types of MMMFs: (i) Prime funds, which invest mainly in short-term debt instruments issued by financial and nonfinancial firms, such as commercial paper, bank certificates of deposit (CDs), and floating-rate notes; (ii) taxable government-only funds, which invest exclusively in U.S. Treasury and agency securities; and (iii) tax-exempt funds, which invest in tax-exempt securities issued by state and local governments. As of September 10, 2008, assets under management in these three types of U.S. MMMFs totaled $3.5 trillion. Of

this total, prime MMMFs managed $2.1 trillion in assets, taxable government-only funds managed $0.9 trillion, and tax-exempt funds managed $0.5 trillion.[3]

MMMFs offer immediate redemptions of shares at a constant net asset value (NAV) of $1 per share. If shareholders suspect that the NAV is heading below $1 (i.e., if they expect the fund to "break the buck"), they have an incentive to exit the fund at the price of $1 before other investors. Moreover, since funds do not generally have enough cash on hand to meet massive redemptions, they may have to sell some of their assets, which tends to be costly due to limited secondary market liquidity. In other words, MMMFs are susceptible to runs, making these funds similar to commercial banks but without the benefit of deposit insurance or a lender of last resort. MMMFs instead typically rely on implicit guarantees from their sponsoring financial institutions (Kacperczyk and Schnabl (2011)).

The tidal wave of redemptions from money market funds in the wake of Lehman's bankruptcy is a very good example of such a modern "bank-run." Figure 1 shows total assets under management for prime and taxable government-only MMMFs in September and October 2008. As shown by the dotted line, prime MMMFs marketed to institutional investors experienced massive outflows that depleted their assets under management starting around September 15, the day Lehman Brothers filed for bankruptcy. The outflows intensified after one of the oldest prime funds, the Reserve Primary Fund, "broke the buck" on September 16, due to its exposure to commercial paper issued by Lehman. As a consequence of these outflows, total assets managed by institutional prime funds, which were nearly $1.3 trillion dollars, fell by $400 billion in just a few days. In contrast, assets under management for retail prime funds, the solid

line, remained stable, and assets under management for government-only funds, the dashed line, increased substantially.

[Figure 1 about here]

Although MMMFs rely on their relatively short-term asset portfolio to meet expected redemption requests, they had to sell some assets to meet the extraordinary redemption requests that followed Lehman's bankruptcy. As of September 16, 2008, the most likely source of such sales was unsecured commercial paper and asset-backed commercial paper (or ABCP), which accounted for about 45% of total assets, according to data from iMoneyNet.

Commercial paper is a short-term credit instrument traditionally used by financial and nonfinancial corporations for financing operating expenses. Since the early 1990s, banks and other financial institutions have also structured ABCP programs or conduits to finance the purchase of pools of assets off their balance sheets by issuing and rolling over commercial paper, which is collateralized by the assets. These ABCP conduits expanded from financing of short-term receivables collateral to a broad range of loans, including auto loans, credit cards, student loans and commercial mortgage loans (Covitz, Liang, and Suarez (2009)). To obtain high short-term credit ratings, the bank or financial institution that sponsors or structures the ABCP program typically commits to provide liquidity or credit support that covers all the liabilities of the conduit. As of September 10, 2008, the week before Lehman's bankruptcy, the total outstanding U.S. unsecured commercial paper was about $760 billion and U.S. ABCP outstanding amounted to about $740 billion.[4]

The primary buyers of commercial paper are MMMFs, which hold it to maturity. Accordingly, secondary market trades of commercial paper are mostly bid-backs by dealers, and so, even in typical times, are fairly thin.[5] When MMMFs began to experience large redemptions after Lehman's bankruptcy, dealers were reluctant to buy back commercial paper because of pressures on their own capital and liquidity. Secondary markets for the remaining asset classes other than government securities were also impaired.

As a result, MMMFs pulled back from purchasing new issues in a variety of short-term funding markets. As shown in Figure 2, at-issue spreads of overnight ABCP rates over the target federal funds rate soared to about 450 basis points in the week ending September 19. Spreads also rose notably for highly rated unsecured commercial paper issued by financial institutions. Similarly, unsecured commercial paper of financial firms dropped about $70 billion and ABCP outstanding fell roughly $40 billion the week Lehman Brothers failed.

[Figure 2 about here]

In response to the extraordinary outflows from prime MMMFs and the severe disruptions in money markets that followed the bankruptcy of Lehman Brothers, the Treasury Department and the Federal Reserve intervened on September 19. The Treasury Department announced it would offer insurance to existing balances on registered 2a-7 MMMFs using the Exchange Stabilization Fund. In addition, the Federal Reserve announced its ABCP Money Market Mutual Fund Liquidity Facility (AMLF). After the Treasury and Federal Reserve announcements, the outflows from prime funds slowed notably.[6]

II. Design and structure of the AMLF

The decision by the Federal Reserve to provide a liquidity backstop for MMMFs was made relatively quickly, given the "bank-run" environment faced by the money market mutual fund industry. Internal discussions among Federal Reserve officials about the AMLF started on Tuesday, September 16, 2008, after the Reserve Primary Fund broke the buck. The AMLF was approved by the Federal Reserve Board on Friday, September 19, and became operational the following Monday, September 22 with the operational details worked out over the interim weekend. Unlike other emergency lending facilities created by the Federal Reserve after the bankruptcy of Lehman Brothers, the AMLF had no significant lead time between its announcement and implementation. By contrast, for example, the Term Asset-Backed Securities Loan Facility (TALF), created to support various securitization markets, was announced on November 25, 2008, but launched operations on March 3, 2009 (Campbell et al. (2011)).

The AMLF was designed with the dual objectives of increasing liquidity in the ABCP market and providing a means for MMMFs to liquefy assets to meet the wave of redemptions that followed the failure of Lehman Brothers, thus preventing many MMMFs from "breaking the buck." The Federal Reserve had three primary reasons to intervene and support MMMFs, an industry that had grown from $500 billion in total assets in 1990 to $3.5 trillion by the beginning of September 2008.[7] First, the Federal Reserve intervened to prevent a series of failures of solvent but illiquid institutions. Second, the potential widespread failures of MMMFs threatened systemic financial stability, as these funds were the main investors in many money market instruments. For example, according to Flow of Funds data from the Federal Reserve, at the

beginning of September 2008, MMMFs held about 45% of all commercial paper outstanding in the United States. Accordingly, a failure of the money market mutual fund industry was feared to have serious repercussions on other institutions and overall credit market conditions, as many businesses and investment vehicles would have had difficulty rolling over their liabilities and potentially been unable to finance their operations. Third, the AMLF was created to alleviate severe disruptions in the ABCP market, which had already experienced a run in the summer of 2007. Stabilizing the ABCP market was considered important to prevent additional strains on the balance sheets of banks that were committed to support the ABCP market (Covitz, Liang, and Suarez (2009)). In sum, widespread failures of MMMFs would have further constrained the credit flow to households and firms and, thus, economic activity.[8]

The Federal Reserve's decision to provide liquidity to MMMFs faced two major challenges. First, the Federal Reserve could only extend collateralized loans; it could not buy MMMF assets, such as asset-backed commercial paper. Second, MMMFs were reluctant to borrow from the Federal Reserve, fearing that investors would recognize that leverage would amplify the effects of any losses on the remaining shareholders, increasing their incentive to run from MMMFs.[9]

The AMLF was designed to address these two challenges. Instead of directly lending to MMMFs, the Federal Reserve extended loans to U.S. depository institutions, bank holding companies, and branches of foreign banks (henceforth "banks") that used AMLF loans to purchase highly rated ABCP from MMMFs that qualify under SEC rule 2a-7. In effective terms, the AMLF relied on banks to serve as intermediaries between the Federal Reserve and the MMMF industry.

To facilitate their intermediary role, the borrowing banks received from the AMLF non-recourse loans that were collateralized by the ABCP purchased from MMMFs, thus minimizing their credit risk of holding ABCP. In addition, the AMLF extended loans at the primary credit rate of the Federal Reserve, while the borrowing banks purchased ABCP from MMMFs at amortized cost. Hence, as long as money markets were disrupted and ABCP holdings of MMMFs paid rates in excess of the primary credit rate, the participating banks gained a positive spread for borrowing from the AMLF. This feature helped the facility to automatically wind down as market conditions improved. Finally, the Federal Reserve provided a temporal exemption from leverage and risk-based capital rules for the ABCP held by banks as a result of their involvement in the AMLF. The Internet Appendix graphically summarizes a stylized AMLF transaction and provides additional details on eligibility requirements for the facility.

Shortly after its implementation, the AMLF was widely used by MMMFs to obtain some of the liquidity required to meet redemptions. In fact, lending under the AMLF grew very rapidly, reaching about $150 billion after just 10 days of operation (Figure 3). At its peak of activity, the ABCP pledged as collateral for AMLF loans amounted to roughly 22% of all ABCP outstanding in the U.S. market. The lending activity of the AMLF was concentrated in the first weeks of operation and became sporadic in 2009 until its expiration in February 2010.

[Figure 3 about here]

The AMLF was utilized by 105 MMMFs, comprising 42% of eligible prime MMMFs. The AMLF extended loans to 11 banks and bank holding companies that purchased ABCP from participating MMMFs. Overall, 90 out of the 170 active ABCP issuers and 47 out of the 71

active ABCP sponsors were represented amongst the collateral pledged to the AMLF. The average loan size was $68 million with an average maturity of 47 days (and a maximum of 168 days).[10]

Unlike typical discount window loans, the Federal Reserve did not charge a penalty rate for AMLF loans or impose a haircut on the ABCP pledged as collateral, due to the already weakened net asset values of MMMFs. This departure from more traditional discount window lending assumed that the market value of ABCP reflected primarily liquidity risk and not credit risk. Consistent with that assumption, the Federal Reserve did not suffer any losses in its operation of the AMLF.

The main criticism of the AMLF is that its unconventional no-haircut loans likely created incentives for MMMFs to first use their riskier eligible ABCP at the facility.[11] An examination of the characteristics of the collateral pledged at the facility presented in the Internet Appendix partially supports this argument. During the first few weeks that followed the bankruptcy of Lehman Brothers, when liquidity problems were at their peak and the bulk of the activity of the facility was concentrated, the ABCP pledged as collateral at the AMLF was largely unrelated to perceptions of credit risk of the sponsors of the ABCP held by MMMFs. However, once the worst phase of the financial crisis eased in 2009, ABCP issued by programs sponsored by institutions with high CDS spreads was more likely to be used as collateral.

III. Data

Our study of the AMLF relies primarily on two unique micro-level datasets, which we combine with publicly available data on money market mutual funds. First, we use the Federal Reserve's complete dataset of loans extended through the AMLF. These data contain information on the bank receiving the loan, the MMMF from which the bank purchased the ABCP collateralizing the loan, and the characteristics of the ABCP collateral, including its size and maturity. Second, we compile issuance-level data from the Depository Trust and Clearing Corporation (DTCC), the agent that electronically clears and settles all U.S. commercial paper transactions. We collect data for 170 ABCP programs that issued paper in the primary market from September 2008 to September 2009. Using data from Moody's Investors Service, we identify the financial institution that sponsors each ABCP program. We obtain data on the unsecured commercial paper issued by the sponsors from DTCC and credit default swap (CDS) spreads for the sponsors from Markit. The AMLF dataset is essential for analyzing the impact of the AMLF on MMMFs and the DTCC data are essential for analyzing the impact on the commercial paper market.

We combine the AMLF data with MMMF characteristics taken from iMoneyNet. iMoneyNet tracks over 1,600 money market funds—including the vast majority of the 2a-7 funds that were eligible for the AMLF. Based on voluntary information provided by MMMFs, iMoneyNet reports for each fund weekly portfolio composition by asset class, as well as daily total assets under management, gross and net fund yields, and weighted average maturity.

Unless otherwise stated, our sample is limited to prime MMMFs, which account for most of the money market mutual fund assets and primarily invest in short-term private-sector debt instruments. Since ABCP was the only form of collateral accepted at the facility, only prime MMMFs could effectively use the AMLF. This leaves us with a sample of 250 MMMFs, 105 of which utilized the AMLF.

Table I summarizes the mean characteristics and portfolio composition of all prime funds, as of September 16, 2008 (the day Reserve Primary Fund broke the buck), and compares funds that participated in the AMLF with funds that did not participate. Funds that market themselves to institutional investors, which suffered the largest redemptions after Lehman's bankruptcy, accounted for 64% of the funds that used the facility and for 52% of the non-participating funds. In addition, compared to prime funds that did not participate in the facility, those funds that used the AMLF were significantly larger, and held more ABCP (18% versus 7%) and fewer liquid assets, defined as the sum of repos, Treasury securities, and other U.S. agency notes (14% versus 26%). Participating and nonparticipating funds held similar fractions of assets in U.S. Treasury securities.[12]

[Table I about here]

Since the characteristics of the funds that participated in the AMLF differ from those that did not, our specifications control for fund characteristics and portfolio composition to alleviate concerns about selection bias in our estimates of the effect of the AMLF. We also check the robustness of our results using a matching methodology that explicitly corrects for selection based on observable characteristics.

IV. Evaluating the Impact of the AMLF

In this section, using a differences-in-differences-type approach, we evaluate the impact of the AMLF by focusing on the markets directly related to the objectives of the facility. First, we analyze the impact on net flows from MMMFs, the institutions that effectively could obtain loans from the AMLF. Second, we study the impact on the pricing of ABCP, the only form of collateral accepted at the facility.[13]

A. The Impact of the AMLF on Net Flows into Money Market Mutual Funds

Our basic approach consists of comparing net flows into individual MMMFs that were more likely to benefit from the AMLF with the flows into funds that were less likely to benefit from the AMLF. We identify the former funds as those with relatively large holdings of ABCP prior to the implementation of the AMLF on September 19, 2008, as ABCP was the only asset accepted as collateral for loans extended by the Federal Reserve under the facility.

More formally, using a panel of daily observations encompassing one week before and one week after the announcement of the AMLF (September 12-26, 2008), we estimate:

$$\Delta A_{it} = \beta_0 + \beta_1 After_t + \beta_2 S_i^{ABCP} + \beta_3 After_t \times S_i^{ABCP} + \delta X_i + \varepsilon_{it}, \quad (1)$$

where ΔA_{it} represents the percentage change in total assets under management for fund *i* between days *t* -1 and *t* (the inverse of fund redemptions); $After_t$ is an indicator that equals 1 after September 19, 2008, the day the AMLF was announced; and S_i^{ABCP} represents the share of ABCP holdings in fund *i*'s portfolio on September 16, 2008, prior to the implementation of the AMLF. Finally, X_i is a vector of fund characteristics, also measured as of September 16, 2008,

which includes: (i) the share of liquid assets in the fund portfolio, defined as the sum of repos, Treasury securities, and other U.S. agency notes; (ii) an indicator variable that equals 1 for MMMFs that market themselves to institutional investors; and (iii) the percent of assets in the fund portfolio that are scheduled to mature within 7 days, as a measure of portfolio liquidity. As a robustness check, we also estimate regressions including the average annualized 7-day gross yield of the fund, computed from weekly data for the year preceding the collapse of Lehman Brothers (September 4, 2007 to August 29, 2008). To account for serial correlation of errors over time, in all specifications we cluster standard errors at the fund level.[14]

The identification of the impact of the AMLF relies not just on the time-series variation (captured by the $After_t$ dummy), but also on the cross-sectional variation across MMMFs with respect to their ABCP holdings, the interaction between $After_t$ and S_i^{ABCP}. We expect funds with larger holdings of ABCP to benefit more from the AMLF. An implicit assumption in equation (1) is that all MMMFs benefit to the same extent from other government initiatives that were announced around the same time, in particular the Treasury guarantee covering the existing balances on MMMFs as of September 19, 2008. More formally, under the hypothesis that the AMLF helped to reduce outflows from MMMFs beyond other government interventions, the coefficient on the interaction term in equation (1), β_3, should be positive and significant, indicating more inflows (or lower redemptions) after the AMLF is implemented for funds with larger portfolio shares allocated to ABCP.

Table II shows the results of estimating equation (1). The regression in column 1 excludes the fund-level controls represented by vector X_i. The regressions in columns 2 and 3 expand the regression in column 1 to include day-fixed effects, and day- and fund-fixed effects, respectively. The regression in column 4 includes the fund-level controls in vector X_i, and the regression in column 5 includes the annualized gross yield of the fund as a measure of the fund's portfolio riskiness.[15]

[Table II about here]

Consistent with the hypothesis that the AMLF helped to stabilize net asset flows to MMMFs, we find that the coefficient on the interaction term between the intervention dummy and the share of ABCP in the fund portfolio is positive and highly statistically significant across specifications. While the AMLF dummy itself is not significant, this result suggests that the reduction in net outflows that followed the implementation of the AMLF was significantly more pronounced for funds that held ABCP in their portfolio and therefore could participate in the facility using their ABCP as collateral. These coefficients also indicate that the impact of the AMLF was economically significant as well. For the average prime fund that participated in the facility, with about 18% in ABCP holdings (Table I), the implementation of the AMLF was associated with a reduction in asset outflows of about 1.5 percentage points. This is an economically significant impact compared with the 3% average decrease in daily assets during the week before the AMLF.

The regressions in columns 4 and 5 show that these results are robust to the inclusion of other control variables, such as the fraction of liquid assets or gross fund yields. They also show that funds that marketed themselves to institutional investors, funds that had higher pre-Lehman holdings of ABCP, and funds that had higher risk, as proxied by higher yields, experienced heavier outflows (smaller net inflows) during the weeks that followed the bankruptcy of Lehman Brothers.[16]

In Table III, we check the robustness of our estimates of the effect of the AMLF on net flows into MMMFs to common problems of differences-in-differences estimators.[17] OLS standard errors of traditional differences-in-differences estimates of treatment effects typically understate the true standard errors due to serial correlation (Betrand, Duflo, and Mullainathan (2004)). To alleviate concerns about serial correlation, we cluster the standard errors in Table II at the fund level. However, to further test the robustness of our results to this problem, we follow Bertrand, Duflo, and Mullainathan (2004) in Table III and collapse our dataset into a 2-period panel: we average the observations in dates prior to the AMLF into a single pre-intervention period and average the observations in the dates following the AMLF into a single post-intervention period. Column 1 in Table III reports the estimate of the interaction coefficient of the intervention dummy and the pre-Lehman fund holdings of ABCP in this 2-period panel. The estimated effect is very similar to the estimate derived from Table II and remains statistically significant, which confirms that the baseline results are robust to using estimators that very conservatively adjust standard errors for serial correlation.

[Table III about here]

Traditional differences-in-differences estimators rely on linear regressions, like equation (1), to evaluate the impact of a policy intervention. The linearity assumption in equation (1) implies that the effects of time and of the policy intervention are invariant across funds. Athey and Imbens (2006) propose a nonparametric changes-in-changes estimator that relaxes these assumptions and generalizes the differences-in-differences estimator. Column 2 in Table III reports the changes-in-changes estimate of the average effect of the AMLF on net flows into MMMFs.[18] The estimate in column 2 splits the sample into funds with ABCP holdings on September 16, 2008 (the "treatment" group) and funds with no ABCP holdings (the "control" group). Consistent with the results in Table II, the changes-in-changes estimate in column 2 of Table III indicates that the average effect of the AMLF on net inflows into MMMFs was positive and statistically significant, even when we consider nonlinear effects of the policy intervention.

Equation (1) implicitly assumes that all money market mutual funds benefit equally from other government interventions contemporary to the AMLF, like the Treasury guarantee. To relax this assumption, we consider the case in which the Treasury guarantee disproportionally benefits funds with riskier portfolios. Similarly, funds with ABCP holdings before the collapse of Lehman Brothers may be different from funds with no ABCP holdings. While our baseline results includes controls for some of these observable characteristics as reported in Table I, we also estimate the effect of the AMLF using a matching procedure to compare the net flows into funds with similar portfolio risk (as measured by the variables in vector X_i) around the

implementation of the AMLF. Using the Coarsened Exact Matching (CEM) method (Iacus, King, and Porro (2011a, 2011b)), we match funds that hold ABCP in their portfolios with funds that hold no ABCP but are comparable in terms of their portfolio risk.[19] We next compare the difference between treatment and control funds around the implementation of the AMLF. The average effect of the AMLF on net inflows for funds with ABCP holdings compared with net inflows for funds with no ABCP holdings is shown in column 3 of Table III. These results suggest that matching funds based on observable risk characteristics does not change the conclusions from the analysis in Table II.[20]

B. The Impact of the AMLF on ABCP yields

Our basic approach to evaluate the effect of the AMLF on ABCP yields consists of constructing an appropriate control group for each ABCP issuer. The only eligible collateral for the AMLF was dollar-denominated ABCP with top short-term credit ratings (A-1 by S&P, P-1 by Moody's , and F1 by Fitch). Top-rated, dollar-denominated unsecured commercial paper issued by financial institutions, also held by MMMFs, was ineligible as collateral. As reported by Moody's (2003), an ABCP conduit obtains high ratings largely because the sponsoring financial institution responsible for its operation is willing to support the conduit. The most typical form of support is a credit line that commonly absorbs losses from the assets in the conduit. The close connection between securitized products and sponsoring financial institutions is highlighted by Gorton and Souleles (2007) and, more recently, by Acharya, Schnabl, and

Suarez (2010) in the ABCP market. Therefore, the unsecured commercial paper issued by the sponsor is a plausible control group for the ABCP issued by the conduit.

Using data on ABCP transactions from DTCC, we compute overnight yields on ABCP eligible as collateral for AMLF loans. Using reports from Moody's Investors Service, we match each ABCP conduit eligible as collateral to its sponsoring financial institution. Typically, a single sponsor is matched to multiple conduits. In our baseline regression, we compare the yield of ABCP with the overnight yield on commercial paper issued by its sponsor.

After matching sponsors and conduits, we use a panel of daily observations of ABCP conduits that issued paper from September 12 to September 26, 2008, to estimate:

$$r_{i,t}^{ABCP} - r_{s(i),t}^{CP} = \beta_0 + \beta_1 After_t + \beta_2 AMLF_i + \beta_3 After_t \times AMLF_i + \delta X_{it} + \varepsilon_{it}, \quad (2)$$

where $r_{i,t}^{ABCP}$ is the overnight yield on ABCP issued by conduit *i* on day *t*; $r_{s(i),t}^{CP}$ is the overnight yield on unsecured commercial paper issued by the financial institution that sponsors conduit *i*; $After_t$ is an indicator variable that equals 1 after September 19, 2008, when the AMLF was announced; and $AMLF_i$ is a dummy that equals 1 for ABCP programs pledged as collateral to the AMLF over its first month of operation. Finally, X_{it} is a vector of conduit-level characteristics, including: the premium on the 5-year CDS of the sponsor of the ABCP program; and dummies for program type as classified by Moody's (the categories included are multi-seller, single-seller, securities arbitrage, and structured investment vehicle), which capture the investment strategy of the conduit (Covitz, Liang, and Suarez (2009)). To control for possible correlation across different conduits sponsored by the same financial institution, we cluster standard errors at the sponsor level.

Note that, similar to the case of Libor-OIS spreads, the widening of ABCP spreads during the crisis was driven by both increases in credit risk and illiquidity. While it is not straightforward to decompose the spreads into these two categories, we try to focus on the impact of the AMLF on liquidity premiums by explicitly controlling for credit risk. In particular, we analyze the impact of the AMLF on ABCP yields *relative* to unsecured commercial paper yields of the ABCP sponsor, controlling for the sponsor CDS spread in equation (2). This measure primarily captures changes in liquidity premiums and is analogous to the specifications used by Taylor and Williams (2009) and Wu (2011) to study the impact of TAF on Libor-OIS spreads.

Columns 1 to 3 in Table IV show the results of estimating equation (2) imposing the restriction that β_2 and β_3 are equal to 0. The estimated treatment effect in these regressions is the dummy that equals 1 after the policy intervention. The estimates in columns 1 to 3 suggest that the impact of the AMLF was significant in reducing ABCP yields. These estimates suggest that the facility led to a decrease of around 100 basis points in the ABCP yields of the average conduit, compared with the yields of the unsecured commercial paper issued by its sponsor. These magnitudes are economically significant, considering that ABCP yields averaged about 4.8% in this period. The findings are similar after controlling for conduit-specific variables (X_{it}) and sponsor-fixed effects.

[Table IV about here]

Columns 4 and 5 report estimates for the effect of AMLF by estimating equation (2) allowing β_2 and β_3 to be different from 0. This specification defines treatment and control groups more narrowly, by identifying conduits that were more likely to be affected by the AMLF. Under the

hypothesis that the AMLF helped to reduce ABCP yields because it was perceived as potential collateral for the facility, the interaction coefficient in equation (2), β_4, should be negative. A negative coefficient on the interaction term indicates that ABCP programs perceived as potential collateral for the facility experienced larger reductions in yields after the facility was announced. In column 6, we estimate equation (2) replacing $AMLF_i$ with a dummy variable that equals 1 if at least 25% of the largest 40 MMMFs by assets held paper issued by the conduit in the most recent SEC filing prior to the second quarter of 2008.

The estimates reported in columns 4 to 6 suggest that ABCP yields relative to the yields paid by unsecured paper issued by their sponsors decreased significantly more for ABCP conduits that were perceived as potential collateral for the facility. These results are robust to controlling for time- and conduit-fixed effects.

[Table V about here]

As in the previous section, we check the robustness of our results to two common limitations of differences-in-differences estimators in Table V. Column 1 reports the results of estimating the interaction coefficient in equation (2), collapsing the sample into a 2-period panel with a single pre-AMLF period and a single post-AMLF period to adjust standard errors for serial correlation. Column 2 reports the results of estimating the treatment effect of the AMLF on ABCP yields using the changes-in-changes estimator of Athey and Imbens (2006), which is robust to estimating treatment effects that vary across treatment and control groups. The estimator in column 2 defines paper issued by ABCP conduits as the treatment group and paper issued by their corresponding sponsors as the control group. The results in Tables IV and V are

very similar (in magnitude and statistical significance) and suggest that the AMLF substantially decreased ABCP yields relative to the yields paid by their sponsoring financial institutions.

V. Conclusions

Both the 2007-2009 financial crisis and the current financial disruptions associated with the sovereign debt crisis in Europe highlight the vulnerability of short-term credit markets. This paper evaluates one of the emergency lending facilities implemented by the Federal Reserve to alleviate the severe financial disruptions that followed the bankruptcy of Lehman Brothers—the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF). The AMLF is an interesting case to study the effectiveness of government or central bank interventions to support financial markets during times of crisis and minimize spillovers to the rest of the economy.

Using a carefully constructed quasi-experimental design and two unique data sets, we show that the AMLF was effective, as measured against its two objectives: Our results suggest that the AMLF provided an important source of liquidity to MMMFs and the ABCP market, as it helped to stabilize MMMF asset flows and to reduce ABCP yields.

Although the AMLF and many of the Federal Reserve's emergency liquidity interventions were instrumental in restoring stability in the short term, it is also important for the long term to address the financial system's weaknesses as exposed by the crisis. For example, the events of September 2008 highlighted the inherent susceptibility of MMMFs to runs. Unfortunately, this structural weakness remains a real threat as highlighted recently by the media, academics,

investors, and policy makers due to increased attention to the exposures of MMMFs to debt issued by European financial institutions.

In the case of MMMFs, this weakness arises due to a maturity mismatch between their assets and liabilities, NAVs rounded to $1 per share, portfolios with credit and interest-rate risk, and discretionary sponsor support instead of formal capital buffers or insurance. Runs on MMMFs may threaten the broader economy, as firms and financial institutions depend on money markets for funding. Given the temporary nature of the AMLF, regulators need to consider ways to reduce systemic risks posed by money market funds. In 2010, the SEC changed rule 2a-7, which governs money market mutual funds, by imposing more stringent requirements on liquidity, credit risk, asset maturities, and disclosures. However, many questions remain open, such as whether or not to keep a fixed NAV, and whether to implement deposit insurance or some form of capital buffers, as discussed in the Squam Lake Group proposal (2011).

References

Acharya, Viral V., Philipp Schnabl, and Gustavo Suarez, 2010, Securitization without risk transfer, NBER Working paper 15730.

Athey, Susan, and Guido W. Imbens, 2006, Identification and inference in nonlinear difference-in-difference models, *Econometrica* 74, 431–497.

Baba, Naohiko, Robert N McCauley, and Srichander Ramaswamy, 2009, US dollar money market funds and non-US banks, *BIS Quarterly Review*, March, 65–81.

Bertrand, Marianne, Esther Duflo, and Sendhil Mullainathan, 2004, How much should we trust differences-in-differences estimates? *Quarterly Journal of Economics* 119, 249–275.

Besley, Tim, and Anne Case, 2000, Unnatural experiments? Estimating the incidence of endogenous policies, *Economic Journal* 110, F672-F694.

Brunnermeier, Markus, 2009, Deciphering the liquidity and credit crunch 2007-2008, *Journal of Economic Perspectives* 23, 77-110.

Campbell, Sean D., Daniel Covitz, William Nelson, and Karen Pence, Securitization markets and central banking, *Journal of Monetary Economics* 58, 518-531.

Chernenko, Sergey, and Adi Sunderam, 2011, The quiet run of 2011: Money market funds and the European debt crisis, Working paper, Harvard University.

Christensen, Jens, Jose Lopez, and Glenn Rudebusch, 2009, Do central bank liquidity facilities affect interbank lending rates? Working paper, Federal Reserve Bank of San Francisco.

Covitz, Dan, and Chris Downing, 2007, Liquidity or credit risk? The determinants of very short-term corporate yield spreads, *Journal of Finance* 62, 2303–2328.

Covitz, Daniel, Nellie Liang, and Gustavo Suarez, 2009, The evolution of a financial crisis: Panic in the asset-backed commercial paper market, Finance and Economics Discussion Series 2009-36, Board of Governors of the Federal Reserve System.

Gorton, Gary, and Nicholas S. Souleles, 2007, Special purpose vehicles and securitization, in Mark Carey, and Rene M. Stulz, eds.: *The Risks of Financial Institutions* (University of Chicago Press).

Hamilton, James D., 2009, Evaluating targeted liquidity operations, Remarks prepared for the Federal Reserve Bank of Boston Annual Conference, October 16.

Iacus, Stefano M., Gary King, and Giuseppe Porro, 2011a, Multivariate matching methods that are monotonic imbalance bounding, *Journal of the American Statistical Association* 106, 345–361.

Iacus, Stefano M., Gary King, and Giuseppe Porro, 2011b, Causal inference without balance checking: Coarsened Exact Matching, *Political Analysis* 19, 1–24.

Kacperczyk, Marcin, and Philipp Schnabl, 2010, When safe proved risky: Commercial paper during the financial crisis of 2007-2009, *Journal of Economic Perspectives* 24, 29–50.

Kacperczyk, Marcin, and Philipp Schnabl, 2011, Implicit guarantees and risk-taking: Evidence from money market funds, Working paper, NYU.

Madigan, Brian, 2009, Formulating and implementing policies to combat the financial crisis, Prepared for the Federal Reserve Bank of Kansas City's Annual Economic Symposium.

McCabe, Patrick, 2010, The cross section of money market fund risks and financial crises, Finance and Economics Discussion Series 2010-51, Board of Governors of the Federal Reserve System.

Minutes of the Federal Reserve Board Meetings, July 13 to December 16, 2008, Available at: http://www.federalreserve.gov/newsevents/press/monetary/monetary20090311a1.pdf

Moody's Investors Service, 2003, The fundamentals of asset-backed commercial paper, February.

Squam Lake Group, 2011, Reforming money market funds: A proposal by the Squam Lake Group. Available at: http://www.sec.gov/comments/4-619/4619-57.pdf.

Stroebel, Johannes C., and John B. Taylor, 2009, Estimated impact of the Fed's mortgage-backed securities purchase program, NBER Working paper 15626.

Taylor, John B., and John C. Williams, 2009, A black swan in the money market, *American Economic Journal: Macroeconomics* 1, 58–83.

The Economist, 2011, European banks: Chest pains, August 27.

Wu, Tao, 2011, The U.S. money market and the Term Auction Facility in the financial crisis of 2007-2009, *Review of Economics and Statistics* 93, 617–631.

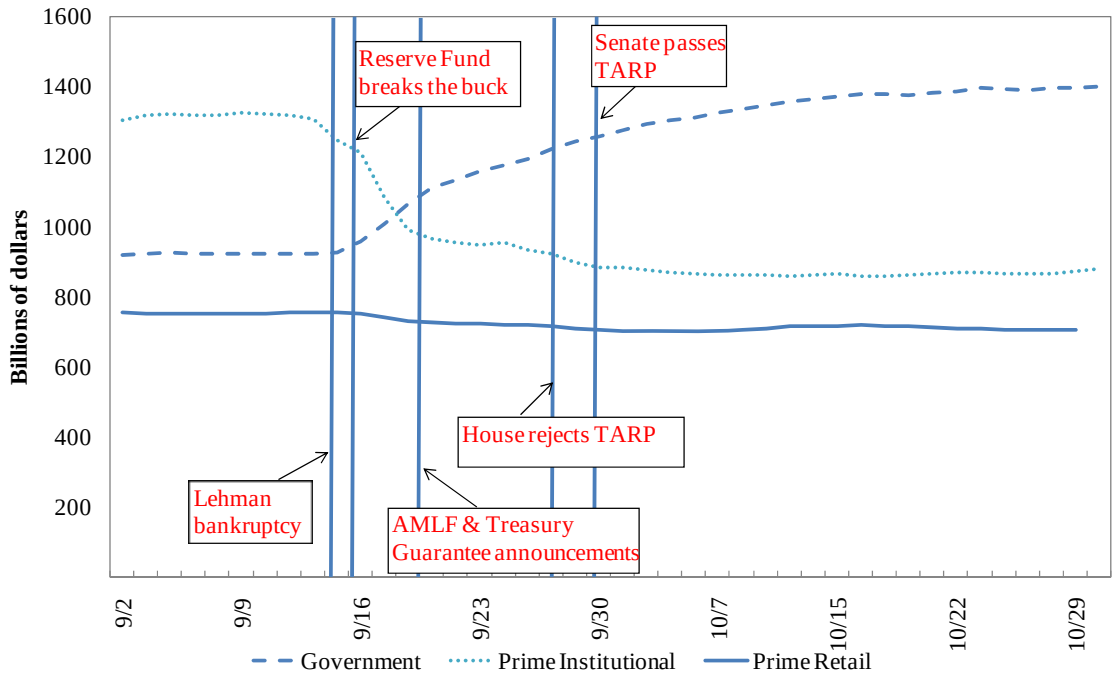

Figure 1. Total assets under management, prime and government-only money market mutual funds, September-October 2008.

This figure represents assets under management (in billions of dollars) for all taxable 2a-7 money market funds according to data from iMoneyNet. The dashed line represents assets of government-only funds, which invest exclusively in U.S. Treasury and agency securities. Prime money market funds invest mostly in short-term instruments other than U.S. Treasury and agency securities. The dotted line represents assets of prime money market funds marketed to institutional investors. The solid line represents assets of prime money market funds marketed to retail investors.

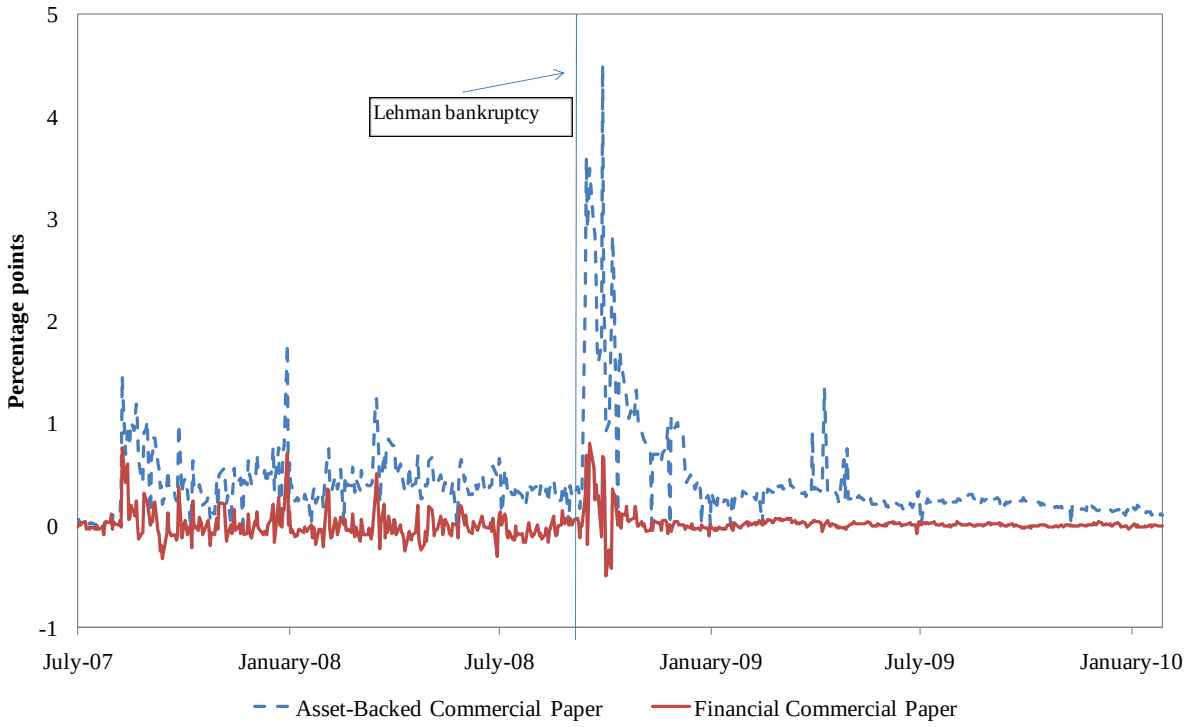

Figure 2. Spreads on overnight commercial paper over the effective fed funds rate.

This figure shows daily overnight commercial paper spreads over the target federal funds rate from July 2007 to January 2010, according to the Commercial Paper Statistical Release from the Federal Reserve Board. The dashed line is the spread of top-rated asset-backed commercial paper, and the solid line is the spread of top-rated commercial paper issued by financial corporations. Spreads are based on at issue yields expressed in percentage points.

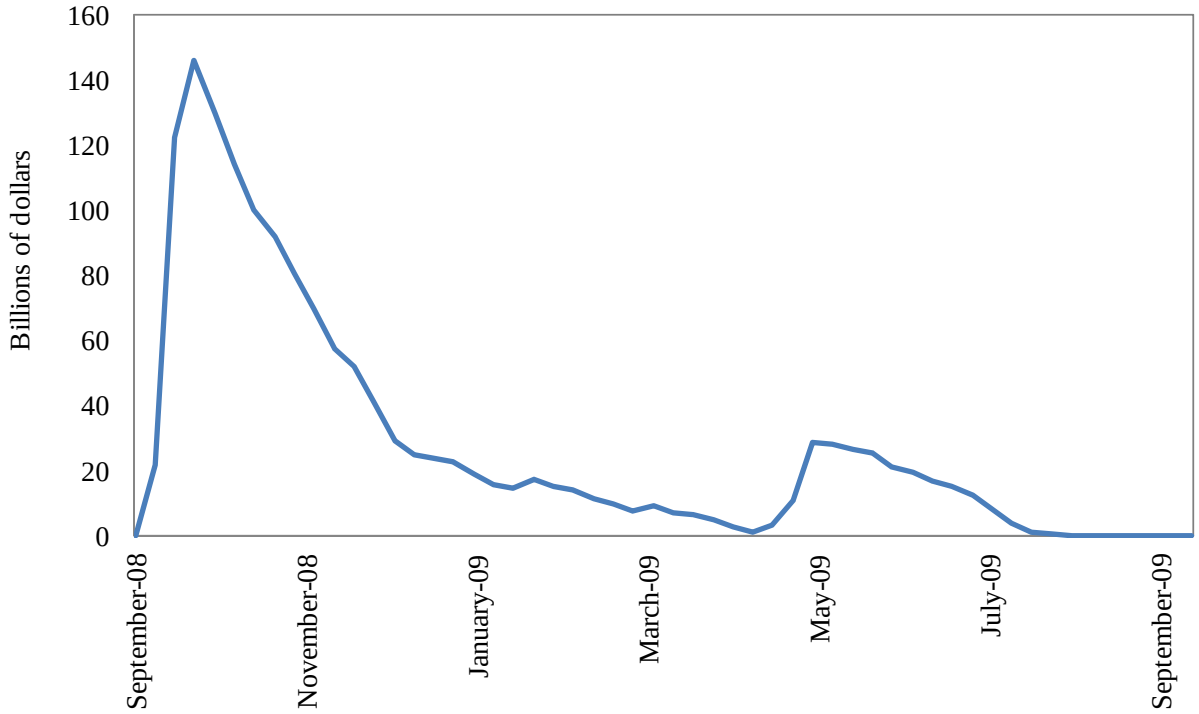

Figure 3. Loans extended through the Asset-Backed Commercial Paper Money Market Liquidity Facility (AMLF), September 2008 to September 2009.

The figure plots the volume of loans outstanding at the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) in billions of dollars. Data are reported as weekly averages from September 2008 to September 2009, based on the H.4.1 statistical release (Factors Affecting Reserve Balances) by the Federal Reserve Board.

Table I

Prime Money Market Mutual Fund Characteristics, September 16, 2008

This table reports money market fund characteristics as of September 16, 2008, based on data from iMoneyNet, revealing a snapshot of the industry around the collapse of Lehman Brothers. AMLF Participant denotes participation in the AMLF program at any date when the facility operated. Funds are defined at the Master Class portfolio level. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	All Prime Funds Average (1)	AMLF Participant Average (2)	Non-AMLF Participant Average (3)	Difference (2)-(3) (4)
Assets (millions of dollars)	8,173	11,624	5,553	6,071***
Weighted average maturity (days)	43.9	46.7	41.7	5.1***
Fraction of assets maturing in 7 days	27.5%	24.0%	30.0%	-6.0%***
Fraction of ABCP	11.5%	18.0%	6.8%	11.2%***
Fraction of U.S. Treasury securities	0.5%	0.2%	0.7%	-0.5%
Fraction of other U.S. government agency securities	9.8%	5.4%	12.9%	-7.5%***
Fraction of repos	11.0%	8.7%	12.6%	-3.9%**
Fraction of liquid assets	21.3%	14.3%	26.3%	-12.0%***
Change in daily assets (Fraction of assets)	-0.8%	-1.2%	-0.5%	-0.7%
Institutional (first) indicator	0.572	0.638	0.524	0.114*
Retail (first or second) indicator	0.428	0.362	0.476	-0.114*
Funds	250	105	145	
Fund complex (count)	114	41	94	

Table II
Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Money Market Mutual Fund Asset Flows

This table reports the estimated effect of the AMLF on money market mutual fund (MMMF) assets. The dependent variable is the percentage change in assets under management for a given MMMF. The sample is a panel of daily observations for prime money market mutual funds from September 12 to September 26, 2008. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008, when the AMLF was implemented. Fraction of ABCP, fraction of assets maturing in 7 days, and fraction of liquid assets are all computed as of September 16, 2008. Average annualized gross 7-day yield is computed from weekly MMMF yield data from September 4, 2007, to August 29, 2008. Data on MMMF portfolios and yields are from iMoneyNet. Robust standard errors clustered by fund are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)
Post-AMLF indicator	-0.002	0.006	-0.001	0.006	-0.003
	(0.005)	(0.013)	(0.014)	(0.013)	(0.006)
Post-AMLF indicator × Fraction of ABCP	0.083*	0.083*	0.081*	0.083*	0.084*
	(0.044)	(0.044)	(0.044)	(0.044)	(0.049)
Fraction of ABCP	-0.087**	-0.087**		-0.074**	-0.074*
	(0.037)	(0.037)		(0.036)	(0.040)
Fraction of assets maturing in 7 days				-0.003	
				(0.011)	
Fraction of liquid assets				0.023**	
				(0.011)	
Institutional fund indicator				-0.014***	
				(0.002)	
Average annualized gross 7-day yield					-0.018*
					(0.010)
Day-fixed effects	No	Yes	Yes	Yes	No
Fund-fixed effects	No	No	Yes	No	No
Observations	2,644	2,644	2,644	2,644	2,325
R^2	0.015	0.025	0.020	0.036	0.017

Table III
Robustness Tests on the Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Money Market Mutual Fund Asset Flows

This table reports the estimated effect of the AMLF on the percentage change in assets under management (AUM) for money market mutual funds (MMMF) using three methods: a sample averaging differences-in-differences estimator, a changes-in-changes estimator, and a matching-based estimator. Column (1) reports a differences-in-differences estimator based on a panel of pre-AMLF and post-AMLF averages of percentage changes in AUM of daily observations from September 12 to September 26, 2008. The coefficient from the differences-in-differences estimator is multiplied by 0.214—the average fraction of ABCP held by funds with ABCP in their portfolios. The treatment effect is the coefficient on the interaction between a post-AMLF indicator and the fraction of ABCP held by a fund on September 16, 2008. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008. Robust standard errors clustered by fund are reported in parentheses. Column (2) reports the changes-in-changes estimator of Athey and Imbens (2006) using pre-AMLF and post-AMLF averages of the component of percentage change in AUM that is not explained by day-fixed effects, the fraction of liquid assets, the fraction of assets maturing in 7 days, and an institutional fund indicator. Bootstrapped standard errors based on 1,000 repetitions are reported in parentheses. Column (3) reports the differences-in-differences estimator based on a panel of pre-AMLF and post-AMLF averages of percentage change in AUM of daily observations from September 12 to September 26, 2008, after using coarsened exact matching. Funds are matched based on the fraction of liquid assets, the fraction of assets maturing in 7 days, and an institutional fund indicator. Robust standard errors clustered by fund are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Sample Averaging Differences-in-Differences Estimator	Changes-in-Changes Estimator (Athey and Imbens (2006))	Differences-in-Differences Estimator after CEM
	(1)	(2)	(3)
Estimated effect of the AMLF	0.018*	0.012*	0.011**
	(0.044)	(0.006)	(0.005)
Observations	481	470	390
R^2	0.073	-	0.044

Table IV
Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Asset-Backed Commercial Paper Yields

This table reports differences-in-differences-type estimators of the effect of the AMLF on asset-backed commercial paper (ABCP) yields. The dependent variable is the overnight yield on ABCP issued by a conduit minus the overnight yield on unsecured commercial paper issued by the financial institution sponsoring the ABCP conduit, measured in percentage points. The sample is a panel of daily observations for conduits that issue AMLF-eligible paper in the U.S. market (non-extendible issues rated at least A-1/P-1) from September 12 to September 26, 2008. Data on yields are from DTCC and data on money market mutual fund (MMMF) portfolios are based on SEC filings. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008, when the AMLF was implemented. AMLF participant indicator is a dummy variable that equals 1 for ABCP programs pledged as collateral at the AMLF over its first month of operation, based on data from the Federal Reserve. MMMF portfolio intensity indicator is a dummy variable that equals 1 if at least 25% of the largest 40 MMMFs held some of the conduit in its portfolio in the most recent SEC filing prior to 2008:Q2. Conduit controls are the 5-year credit default swap (CDS) spread of the ABCP program sponsor measured in percent and dummy variables for program type (multi-seller, single-seller, securities arbitrage, structured investment vehicle, and other). Robust standard errors clustered by sponsor are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)
Post-AMLF indicator	-1.005***	-1.147***	-1.186***	-0.131		
	(0.250)	(0.288)	(0.263)	(0.428)		
AMLF participant indicator				-0.271	-0.785	
				(0.468)	(0.676)	
Post-AMLF indicator × AMLF participant indicator				-1.215**	-1.860***	
				(0.389)	(0.222)	
MMMF portfolio intensity indicator						0.048
						(0.065)
Post-AMLF indicator × MMMF portfolio intensity indicator						-1.141**
						(0.368)
Conduit controls	No	Yes	Yes	Yes	Yes	Yes
Sponsor-fixed effects	No	No	Yes	Yes	No	No
Conduit-fixed effects	No	No	No	No	Yes	Yes
Day-fixed effects	No	No	No	No	Yes	Yes
Observations	262	262	262	262	262	262
R^2	0.186	0.311	0.435	0.518	0.794	0.612

Table V
Robustness Tests on the Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Asset-Backed Commercial Paper Yields

This table reports the estimated effect of the AMLF on overnight yields on asset-backed commercial paper (ABCP) using sample averaging differences-in-differences estimator and a changes-in-changes estimator. Column (1) reports a differences-in-differences estimator based on a panel of pre-AMLF and post-AMLF averages for conduits that issue AMLF-eligible paper in the U.S. market (non-extendible issues rated at least A-1/P-1), based on daily observations from September 12 to September 26, 2008. The dependent variable is the difference between the ABCP yield and the sponsor yield in percentage points. The treatment effect is the coefficient on the interaction between a Post-AMLF indicator and an AMLF participant indicator. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008, and AMLF participant indicator is a dummy variable that equals 1 for ABCP programs pledged as collateral at the AMLF over its first month of operation. The regression controls for conduit- and time-fixed effects and the average 5-year CDS spread of the sponsor. Robust standard errors clustered by sponsor are reported in parentheses. Column (2) reports the changes-in-changes estimator of Athey and Imbens (2006) defining ABCP paper as the treatment group and paper issued by its sponsor and the control group and using pre-AMLF and post-AMLF averages of the component of yields that is not explained by conduit- and time-fixed effects, and the CDS spread of the sponsor. Bootstrapped standard errors based on 1,000 repetitions are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Sample Averaging Differences-in-Differences Estimator	Changes-in-Changes Estimator (Athey and Imbens (2006))
	(1)	(2)
Estimated effect of the AMLF	-2.694***	-1.257*
	(0.514)	(0.215)
Observations	71	71
R^2	0.652	-

Appendix: Timeline of Events and Policy Actions by the Federal Reserve and Other Government Agencies, September 12-26, 2008

This table lists the main events and policy actions around the announcement of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF). The list is based on the financial crisis timeline compiled by the Federal Reserve Bank of St. Louis (http://timeline.stlouisfed.org/index.cfm?p=timeline).

Date	Event
September 14	The Federal Reserve Board (FRB) expands the list of eligible collateral for the Primary Dealer Credit Facility (PDCF) and the Term Securities Lending Facility (TSLF). The FRB also increases the frequency of Schedule 2 TSLF auctions and total offering to $150 billion. The FRB also adopts an interim final rule that provides temporary exceptions to Section 23A of the Federal Reserve Act to allow insured depository institutions to provide liquidity to their affiliates for assets typically funded in the tri-party repo market.
September 15	Bank of America announces its intent to purchase Merrill Lynch & Co. Lehman Brothers Holdings files for Chapter 11 bankruptcy protection.
September 16	The FRB authorizes the Federal Reserve Bank of New York to lend up to $85 billion to the American International Group (AIG) under Section 13(3) of the Federal Reserve Act. The Federal Open Market Committee (FOMC) votes to maintain the target federal funds rate at 2%. The net asset value of shares in the Reserve Primary Money Fund falls below $1, due to losses on Lehman Brothers commercial paper and medium-term notes.
September 17	The U.S. Treasury Department announces a Supplementary Financing Program consisting of a series of Treasury bill issues that will provide cash for use in Federal Reserve initiatives. The SEC announces a temporary ban on short selling in the stocks of all financial sector companies.
September 18	The FOMC expands existing swap lines by $180 billion and authorizes new swap lines with the Bank of Japan, Bank of England, and Bank of Canada.
September 19	The FRB announces the creation of the AMLF. The FRB also announces plans to purchase federal agency discount notes issued by Fannie Mae, Freddie Mac, and Federal Home Loan Banks from primary dealers. The U.S. Treasury Department announces a temporary guarantee program that will make available up to $50 billion from the Exchange Stabilization Fund to guarantee investments in participating money market mutual funds.
September 20	The U.S. Treasury Department submits draft legislation to Congress for authority to purchase troubled assets.
September 21	The FRB approves applications of investment banking companies Goldman Sachs and Morgan Stanley to become bank holding companies.
September 24	The FOMC establishes new swap lines with the Reserve Bank of Australia, the Sveriges Riksbank, the Danmarks Nationalbank, and the Norges Bank.
September 25	The Office of Thrift Supervision closes Washington Mutual Bank. JPMorgan Chase acquires the banking operations of Washington Mutual.
September 26	The FOMC increases existing swap lines with the ECB and the Swiss National Bank.

Footnotes

[1] Throughout the paper, we use money market mutual funds (MMMFs) and money market funds interchangeably.

[2] SEC rule 2a-7 (17 CFR 270.2a-7) pursuant to the Investment Company Act of 1940 regulates MMMFs and was most recently revised on May 5, 2010. These rules restrict MMMF investments in terms of the maturity, quality, and the diversification of their portfolio assets. See the Internet Appendix for a summary of the rule.

[3] Source: iMoneyNet.

[4] Source: Commercial Paper statistical release, Federal Reserve Board.

[5] See Covitz and Downing (2007) for a review of institutional details of the market for commercial paper. In a typical bid-back, the dealer, acting as intermediary between issuers and investors, buys previously issued paper from an investor, because the dealer expects to re-sell it to other investors. According to Federal Reserve data (http://www.federalreserve.gov/releases/cp/), dealers intermediate the vast majority of U.S. commercial paper.

[6] Shortly after the Treasury and Federal Reserve announcements, Treasury Secretary Henry Paulson unveiled a plan to buy $700 billion in toxic assets through the Troubled Asset Relief Program (TARP). See the Appendix for a summary of the most relevant events in financial markets in September 2008.

[7] See Madigan (2009) for a detailed discussion of the design and implementation of the Federal Reserve emergency liquidity facilities, including the AMLF.

[8] In addition, Baba, McCauley, and Ramaswamy (2009) discuss the role of MMMFs as the largest supplier of dollar funding to non-U.S. banks, and the associated stress created in the global interbank and foreign exchange markets following the bankruptcy of Lehman Brothers.

[9] In fact, on October 3, 2008, the Federal Reserve Board approved a facility designed to directly lend to MMMFs. However, after consulting with market participants about operational details of the program, the Federal Reserve Board rescinded its approval before the facility became operational (Minutes of the Federal Reserve Board Meetings, July 13 to December 16, 2008).

[10] Source: Federal Reserve and iMoneyNet data. The maturity of the AMLF loans matched the remaining maturity of the ABCP used as collateral.

[11] As with other government interventions, another major criticism relates to moral hazard. In particular, if funds believe that the government will intervene when needed, they are less likely to manage their portfolio risk prudently. Unfortunately, the moral hazard effect is very hard to quantify.

[12] The Internet Appendix presents the results of regressions of the probability that an eligible fund with ABCP holdings participated in the AMLF. We find that larger MMMFs, MMMFs with larger redemptions, and MMMFs with lower holdings of U.S. Treasury and U.S. agency securities after the bankruptcy of Lehman Brothers were more likely to participate in the AMLF. After controlling for other observable characteristics, the fraction of ABCP is not significantly correlated with the probability of using the facility.

[13] An interesting question we do not study in this paper is the response of MMMF portfolios to the facility. In particular, whether or not MMMFs continued to invest exclusively in safe havens, like Treasury securities, once redemptions subsided. Unfortunately, data on asset shares are only available weekly, and thus, we are unable to reproduce the differences-in-differences-type of analysis described in this section.

[14] Our results are robust to clustering at the fund-family level.

[15] We follow McCabe (2010) in using average annualized gross 7-day yields (computed using weekly data from September 4, 2007 to August 29, 2008) as a proxy for the riskiness of the funds.

[16] The Internet Appendix presents two additional tests confirming the robustness of these findings. On the cross-section side, we use the interaction of the share of liquid assets with the AMLF dummy, instead of the interaction with the ABCP share. On the time-series side, we use September 26, instead of September 19, as the "intervention date." In both cases, the coefficients on the variable of interest are insignificant, suggesting that the effects identified in Table II are indeed likely associated with the AMLF. We repeat the second test for our yield regressions and find similar results.

[17] Besley and Case (2000) point out that many policy interventions may be endogenous to economic conditions and may not necessarily be pure experiments. Addressing this issue typically requires data on multiple interventions, which is not the case with the AMLF. This data limitation prevents us from exploring the exact implications of the endogeneity of the AMLF implementation on our results. However, we are more likely to underestimate the impact of the AMLF on ABCP yields and overestimate its impact on MMMF asset flows, as the intervention is likely positively correlated with increases in ABCP spreads and negatively correlated with asset flows.

[18] In its general form, the changes-in-changes estimator of Athey and Imbens (2006) applies even to repeated cross-sections. We impose a panel structure to the changes-in-changes estimator to compute bootstrapped standard errors.

[19] In our context, the CEM method creates a grid from the coarsened support of each variable in X_i and then exactly matches funds with holdings of ABCP with funds with no ABCP holdings in the same cells and prunes unmatched funds. Iacus, King, and Porro (2011a) show that, compared to common matching methods (e.g., propensity score), CEM reduces the imbalance between comparison groups, is independent from the functional form of the matching metric (e.g., the logit score in propensity score matching), avoids extreme counterfactual comparisons for funds without close matches, and considers higher moments of the distribution of X_i to match control and treatment funds.

[20] Regressions presented in the Internet Appendix indicate that we obtain similar results if we match based on average annualized 7-day gross yield of the fund.

Internet Appendix to

"How Effective Were the Federal Reserve Emergency Liquidity Facilities? Evidence from the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility"*

* Citation format: Burcu Duygan-Bump, Patrick Parkinson, Eric Rosengren, Gustavo A. Suarez, and Paul Willen, [year], Internet Appendix to "How Effective Were the Federal Reserve Emergency Liquidity Facilities? Evidence from the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility," Journal of Finance [vol #], [pages], http://www.afajof.org/IA/[year].asp. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the authors of the article. The views expressed here do not necessarily reflect those of the Federal Reserve Bank of Boston or the Federal Reserve Board.

- IA.A summarizes SEC rule 2a-7, which restricts the portfolios of registered money market mutual funds.
- IA.B describes the eligibility requirements of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) and presents a graphic representation of a stylized transaction of the AMLF.
- IA.C reports the results from regressions analyzing the characteristics of the asset-backed commercial paper (ABCP) that was used as collateral at the AMLF. The explanatory variables are conduit and sponsor characteristics and time-fixed effects. These regressions indicate that during the first few weeks that followed the bankruptcy of Lehman Brothers, the ABCP pledged as collateral at the AMLF was largely unrelated to perceptions of credit risk of the sponsors of the ABCP held by MMMFs. However, once the worst phase of the financial crisis eased in 2009, ABCP issued by conduits sponsored by institutions with high CDS spreads was more likely to be used as collateral.
- IA.D presents the results of regressions of the probability that a given money market fund participated in the AMLF. We find that larger MMMFs, MMMFs with more sizeable redemptions, and MMMFs with lower holdings of Treasury and U.S. agency securities after the bankruptcy of Lehman Brothers were more likely to participate in the AMLF. After controlling for other observable characteristics, the fraction of ABCP is not significantly correlated with the probability of using the facility.
- IA.E presents two additional tests confirming the robustness of the findings in Table II of the paper. First, we use the interaction of the AMLF dummy with the share of liquid assets instead of the interaction of the AMLF dummy with the ABCP share. Second, we use September 26, instead of September 19, as the "intervention date." In both cases, the coefficients on the variable of interest are insignificant, suggesting that the effects identified in Table II are likely associated with the AMLF. We repeat the second test for the yield regressions in Table IV of the paper and find similar results.
- IA.F presents a robustness test of the findings in Table III. We reproduce the results of column (3) in Table III but matching funds based on their average annualized 7-day gross yields.

Appendix A: Rule 2a-7 of the Investment Company Act (1940)

Money market funds that register with the SEC must adhere to rule 2a-7, which, at the time of this writing, was last revised in 2010. This rule restricts the maturity, quality, and liquidity of assets in money market funds. In particular, from a maturity perspective, the average dollar-weighted portfolio maturity of investments held in a money market fund cannot exceed 60 days. From an asset quality perspective, money market funds must invest in "eligible" securities. Among rated securities, eligible securities are defined as assets that receive one of the two highest short-term ratings from the requisite nationally recognized statistical ratings organizations (NRSROs). To adhere to rule 2a-7, money market funds must invest no more than 3% of assets in eligible securities in the second highest short-term rating tier. From a liquidity perspective, a taxable fund must invest at least 10% of assets in securities that can be converted into cash within one day; a fund must invest at least 30% of assets in securities that can be converted into cash within five business days; and a fund must invest at most 5% of assets in securities that take more than seven calendar days to convert into cash. Finally, the last revision of the rule also requires funds to conduct stress tests to verify their ability to maintain a stable Net Asset Value (NAV) under adverse conditions. More details can be found, for example, at: http://taft.law.uc.edu/CCL/InvCoRls/rule2a-7.html.

Appendix B: Eligibility Requirements and Graphic Representation of a Stylized Transaction of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)

The AMLF was designed subject to institutional constraints from the Federal Reserve and market conditions of money market mutual funds (MMMFs) in September 2008. The Federal Reserve was restricted to extend collateralized loans, and money market funds did not have regular access to regular discount window borrowing from the Federal Reserve. Moreover, MMMFs were reluctant to borrow from the Federal Reserve directly, as they feared that investors would recognize that leverage would amplify the effects of any losses on remaining shareholders and increase investor incentives to run. Accordingly, instead of directly lending to MMMFs, the Federal Reserve extended loans to U.S. depository institutions, bank holding companies, and branches of foreign banks (henceforth "banks") that used AMLF loans to purchase highly rated asset-backed commercial paper (ABCP) from MMMFs at amortized cost. The ABCP purchased by participating banks was in turn used as collateral for the loans. The AMLF was operated by the Federal Reserve Bank of Boston, which extended nonrecourse loans to participating banks at the discount window rate without imposing a haircut on the collateral.

At the time the AMLF was implemented in September 2008, the Federal Reserve determined that only MMMFs that qualify under SEC rule 2a-7 were eligible to participate in the AMLF. To discourage excessive reliance on the facility, the Federal Reserve imposed additional restrictions

to the AMLF in June 2009 by requiring MMMFs to experience significant redemptions to qualify for the facility.

The only form of collateral eligible under the facility was highly rated ABCP denominated in U.S. dollars and issued by a U.S. conduit that was actively selling eligible paper to market investors as of September 18, 2008. At the time of pledge, the ABCP collateral was restricted to be rated no lower than A-1, P-1, or F1. The maturity of the loan extended to a participating bank was restricted to match the remaining maturity of the ABCP collateralizing the loan. The maximum maturity of the ABCP collateral allowed was 120 days for depository institutions and 270 days for non-depository institutions.

Figure IA.1 graphically summarizes a stylized AMLF transaction. In the transaction, an eligible participating bank is allowed to borrow $1,000 from the AMLF in order to fund the purchase of ABCP from an eligible money market mutual fund. The ABCP is pledged to the AMLF as collateral for the loan.

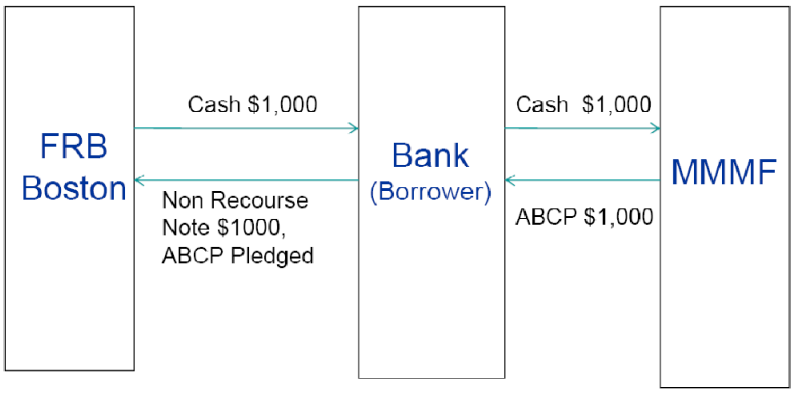

Figure IA.1. Structure of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF).

This figure represents the operation of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) using a stylized transaction, in which a money market mutual fund (MMMF) obtains $1,000 in funds. The first box from the left represents the Federal Reserve Bank of Boston, the middle box represents the eligible borrower (U.S. depository institutions, U.S. bank holding companies, and U.S. branches and agencies of foreign banks), and the last box represents an eligible MMMF (qualifying as a money market mutual fund under SEC rule 2a-7). In the stylized AMLF loan, an eligible borrower purchases asset-backed commercial paper (ABCP) from an eligible MMMF at its amortized cost of $1,000. The eligible borrower obtains a non-recourse loan for $1,000 from the Federal Reserve Bank of Boston with the same maturity as the remaining maturity of the ABCP at the primary credit rate and pledges the $1,000 ABCP as collateral. The Federal Reserve Bank of Boston does not impose a haircut on the collateral backing the $1,000 loan to the eligible borrower.

Appendix C: Analyzing the Characteristics of the Collateral Pledged to the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)

In this appendix, we study whether asset-backed commercial paper (ABCP) from conduits or programs with relatively higher credit risk was more likely to be pledged to the AMLF. To answer this question, we use a panel of daily observations of all conduits that issued AMLF-eligible paper to estimate a probit model for the probability that ABCP issued by a given conduit was pledged to the facility on a given day. The right-hand side variables are ABCP conduit type dummy variables; sponsor credit default swaps (CDS) spreads; and day-fixed effects.

The results in column (1) of Table IA.I indicate that conduit-level risks, captured by sponsor CDS spreads, were not significantly correlated with the probability that a given ABCP issue was pledged to the AMLF in the first few weeks of operation of the facility. This period marks the high point of funding and liquidity pressures on money market funds after the bankruptcy of Lehman Brothers. By contrast, in the regressions for subsequent months, columns (2) to (7), the marginal effect of sponsor CDS spreads becomes statistically significant. In other words, once the aggregate liquidity and funding pressures on money market funds subsided, the use of the facility was driven by changes in perceived credit risk of the sponsors of the ABCP conduits pledged as collateral.[1] Importantly for the AMLF functioning, the majority of its loans were extended in the period covered in column (1), when sponsor CDS spreads were not significantly related to probability that the collateral was pledged to the AMLF.

[1] Standard & Poor's placed on watch for a downgrade the ratings of some U.S. banks sponsoring ABCP conduits a few days before the U.S. government released results of bank stress tests (Wall Street Journal, May 4, 2009).

Table IA.I

Characteristics of the Asset-Backed Commercial Paper (ABCP) Conduits Pledged as Collateral to the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)

This table reports estimates of the relationship between sponsor credit default swap (CDS) spreads and the probability that the sponsored asset-backed commercial paper (ABCP) is pledged to the AMLF. The dependent variable is the probability that ABCP issued by a given conduit is pledged to the AMLF on a given day. The sample is a panel of daily observations for all conduits that issue AMLF-eligible paper in the U.S. market (non-extendible issues rated at least A-1/P-1). The table reports marginal effects of a probit model. All regressions include dummies for ABCP program type (multi-seller, single-seller, securities arbitrage, and structured investment vehicle), as classified by Moody's. Sponsor CDS spread, taken from Markit, is the premium on the 5-year CDS of the program sponsor measured in percent. Robust standard errors clustered by sponsor are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Sept 19-Oct 31, 2008	Nov 1-30, 2008	Dec 1-31, 2008	Jan 1-31, 2009	Feb 1-28, 2009	Mar 1-31, 2009	Apr 1- May 5, 2009
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Sponsor CDS spread	0.000	0.014*	0.078*	-0.008	0.007*	0.043**	0.029*
	(0.001)	(0.007)	(0.044)	(0.006)	(0.004)	(0.021)	(0.017)
Program-type-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Day-fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,251	342	85	658	340	76	42
Pseudo-R^2	0.291	0.350	0.236	0.083	0.054	0.176	0.533

Appendix D: Regressions on the Fund Decision to Participate in the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)

Table IA.II shows the results of regressions of the probability that eligible money market mutual funds with asset-backed commercial paper (ABCP) holdings participated in the AMLF. The regression in column (1) estimates a probit model, the regression in column (2) estimates a linear probability model (OLS), and the regression in column (3) estimates a logit model. The explanatory variables are fund size; the change in assets under management; the fraction of ABCP in the fund portfolio; the fraction of liquid assets; a measure of, the maturity of the fund assets; an indicator variable for institutional funds; and day-fixed effects.

We find that larger funds, funds with larger redemptions, and funds with lower holdings of U.S. Treasury and U.S. agency securities after the bankruptcy of Lehman Brothers were more likely to participate in the AMLF. After controlling for other observables characteristics, we find that the fraction of ABCP in the fund portfolio was not significantly correlated with the probability that the fund participated in the facility.

Table IA.II
Regressions on the Fund Decision to Participate in the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF)

This table reports regressions on the fund decision to participate in the AMLF. The dependent variable is an indicator that equals 1 if a money market mutual fund (MMMF) used the AMLF on a given day. The sample is a panel of daily observations from September 22 to September 26, 2008—the first week that the AMLF was operational—of prime MMMFs that held asset-backed commercial paper (ABCP). Column (1) reports the results of a probit regression. Column (2) reports the results of a linear probability model. Column (3) reports the results of a logistic regression. Data on MMMF portfolios and characteristics are from iMoneyNet. Data on fund participation are from the Federal Reserve. Robust standard errors clustered by fund are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Probit	OLS	Logit
	(1)	(2)	(3)
Assets (log millions of dollars)	0.058***	0.053***	0.057***
	(0.015)	(0.013)	(0.014)
Change in daily assets (fraction of assets)	-1.741***	-1.074**	-1.647***
	(0.565)	(0.430)	(0.559)
Fraction of ABCP	0.050	0.095	0.064
	(0.159)	(0.182)	(0.147)
Fraction of liquid assets	-0.352**	-0.333**	-0.356**
	(0.179)	(0.159)	(0.166)
Fraction of assets maturing in 7 days	0.145	0.132	0.141
	(0.149)	(0.162)	(0.139)
Institutional fund indicator	0.015	0.030	0.013
	(0.046)	(0.045)	(0.044)
Day-fixed effects	Yes	Yes	Yes
Observations	650	650	650
R^2		0.101	
Pseudo R^2	0.117		0.118

Appendix E: Robustness Tests on the Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Money Market Fund Asset Flows and Asset-Backed Commercial Paper Yields

Because the indicator variable for periods after the AMLF was announced (defined as $After_t$ in equation (1) of the paper) might pick up the effects of other government interventions, when we analyze the regressions of money market asset flows reported in Table II, we focus on the interaction between $After_t$ and fund holdings of asset-backed commercial paper (ABCP). Similarly, to study the impact of the AMLF on ABCP yields, we look at the difference in yields between ABCP and unsecured commercial paper, exploiting the fact that while the AMLF accepted only ABCP as collateral, the overall effect of government interventions likely impacted both ABCP and unsecured commercial paper.

In this appendix, we report two "placebo" tests confirming the robustness of the findings in Tables II and IV in the paper. In the first robustness test, we use the interaction of $After_t$ with the fund portfolio share allocated to liquid assets, instead of the interaction of $After_t$ with the fund portfolio share allocated to ABCP. If the AMLF contributed to lowering redemptions from money market funds, we should expect to find a statistically significant coefficient on the interaction of $After_t$ with the portfolio share in ABCP and a statistically insignificant coefficient on the interaction of $After_t$ with the portfolio share in liquid assets. As shown in column (2) of Table IA.III, we find that the interaction between the dummy for periods after the AMLF, $After_t$, and the share in liquid assets is statistically insignificant, suggesting that the effects

identified in Table II are associated with the AMLF and not with other contemporaneous policy interventions. For comparison, column (1) of Table IA.III reproduces the results of Table II of the paper using the interaction between $After_t$ and the fund portfolio share in ABCP.

Table IA.III

Robustness Tests for Table II

This table reports robustness tests for the regressions reported in Table II of the paper. The dependent variable is the percentage change in assets under management for money market mutual funds (MMMFs). The sample in columns (1) and (2) is a panel of daily observations for prime MMMFs from September 12 to September 26, 2008. The sample in column (3) is a panel from September 19 to October 3, 2008. Data on MMMF portfolios and yields are from iMoneyNet. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008, when the AMLF was implemented. Post-September 26 is a dummy that equals 1 after September 26, 2008. Fraction of asset-backed commercial paper (ABCP), Fraction of assets maturing in 7 days, and Fraction of liquid assets are all computed as of September 16, 2008. Robust standard errors clustered by fund are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)
Post-AMLF indicator	-0.002	0.019***	
	(0.005)	(0.007)	
Post-AMLF indicator × Fraction of ABCP	0.083*		
	(0.044)		
Fraction of ABCP	-0.087**		-0.019*
	(0.037)		(0.010)
Post-AMLF indicator × Fraction of liquid assets		-0.055	
		(0.039)	
Fraction of liquid assets		0.056*	
		(0.029)	
Post- September 26 indicator			0.002
			(0.002)
Post-September26 indicator × Fraction of ABCP			-0.004
			(0.022)
Observations	2,644	2,644	2,644
R^2	0.015	0.016	0.004

In the second robustness test, we define September 26, 2008, instead of September 19, 2008, as the "intervention date." As shown in column (3) of Table IA.III, the interaction between the intervention dummy and the fund portfolio share allocated to ABCP is not statistically significant if we assign the AMLF intervention to a later date.

We repeat the second robustness test for the regressions on the difference between ABCP yields and the unsecured commercial paper yields of the sponsor. In Table IA.IV we define September 26, 2008, as the "intervention date" for the ABCP yield regressions. For comparison, columns (1) and (3) in Table IA.IV reproduce the baseline results reported in Table IV of the paper using September 19, 2008, as the intervention date. Columns (2) and (4) show the results of replacing the dummy for dates after the AMLF was implemented (September 19, 2008) with a dummy for dates after September 26, 2008.[2] We find that the coefficients of interest are statistically insignificant if we consider September 26, 2008, instead of September 19, 2008, as the intervention date.

[2] In the regressions reported in Table IA.IV, we use the same conduits as in Table IV of the paper, but there are more overnight issues per conduit in days after September 26, 2008.

Table IA.IV
Robustness Test for Table IV

This table reports robustness tests for the regressions reported in Table IV of the paper. The dependent variable is the overnight yield on asset-backed commercial paper (ABCP) issued by a conduit minus the overnight yield on unsecured commercial paper issued by the financial institution sponsoring the conduit. The sample in columns (1) and (3) is a panel of daily observations for conduits that issue AMLF-eligible paper in the U.S. market (non-extendible issues rated at least A-1/P-1) from September 12 to September 26, 2008. The sample in columns (2) and (4) is a panel of daily observations for conduits from September 19 to October 3, 2008. Data on yields are from DTCC. Post-AMLF indicator is a dummy variable that equals 1 after September 19, 2008, when the AMLF was implemented. Post-September 26 is a dummy that equals 1 after September 26, 2008. Conduit controls are the 5-year credit default swap (CDS) spread of the ABCP program sponsor measured in percent (based on Markit) and dummy variables for program type (multi-seller, single-seller, securities arbitrage, structured investment vehicle, and other) as classified by Moody's. Robust standard errors clustered by sponsor are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	(1)	(2)	(3)	(4)
Post-AMLF indicator	-1.005***		-1.186***	
	(0.250)		(0.263)	
Post-September 26 indicator		-0.212		-0.016
		(0.263)		(0.379)
Conduit controls	No	No	Yes	Yes
Sponsor-fixed effects	No	No	Yes	Yes
Observations	262	330	262	330
R^2	0.186	0.006	0.435	0.405

Appendix F: Robustness Tests on the Matching Estimator of the Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Money Market Fund Asset Flows

Selection bias in our estimates is a potential concern, as discussed in the paper. While our baseline results in Table II control for some of the observable differences between funds that participated in the AMLF and those that did not, we also estimate the effect of the AMLF using a matching procedure to compare the net flows into funds with similar portfolio risk around the implementation of the AMLF (Table III). Using the Coarsened Exact Matching (CEM) method (Iacus, King, and Porro (2011a, 2011b)), we match funds that hold ABCP in their portfolios with funds that hold no ABCP but are comparable in terms of their portfolio risk. In the regression reported in Table III (reproduced in column (1) of Table IA.V), funds are matched based on the fraction of liquid assets, the fraction of assets maturing in 7 days, and an institutional fund indicator. In column (2) of Table IA.V, we show that these results are robust to matching funds based on their average annualized 7-day gross yields. The average yield of a fund may be correlated with its riskiness, which could make the fund more likely to benefit from the Treasury guarantee on money market funds.

Table IA.V
Robustness Tests on the Matching Estimator of the Impact of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF) on Money Market Mutual Fund Asset Flows

The table reports the estimated effect of the AMLF on the percentage change in assets under management (AUM) for money market mutual funds (MMMFs) using an alternative matching criterion to that used in Table III of the paper. Column (1) reports the differences-in-differences estimator based on a panel of pre-AMLF and post-AMLF averages of percentage change in AUM of daily observations from September 12 to September 26, 2008, after using coarsened exact matching. Funds are matched based on the fraction of liquid assets, the fraction of assets maturing in 7 days, and an institutional fund indicator. Column (2) reports the differences-in-differences estimator based on a panel of pre-AMLF and post-AMLF averages of percentage change in AUM of daily observations from September 12 to September 26, 2008, after using coarsened exact matching. Funds are matched based on their average annualized 7-day gross yields between September 4, 2007, and August 29, 2008. Data on MMMF portfolios and yields are from iMoneyNet. Robust standard errors clustered by fund are reported in parentheses. *** indicates statistical significance at the 1% level, ** at the 5% level, and * at the 10% level.

	Differences-in-Differences Estimator after CEM	Differences-in-Differences Estimator after CEM
	(1)	(2)
Estimated effect of the AMLF	0.011**	0.011*
	(0.005)	(0.006)
Observations	390	410
R^2	0.044	0.045

References

Iacus, Stefano M., Gary King, and Giuseppe Porro, 2011a, Multivariate matching methods that are monotonic imbalance bounding, Journal of the American Statistical Association 106, 345–361.

Iacus, Stefano M., Gary King, and Giuseppe Porro, 2011b, Causal inference without balance checking: Coarsened Exact Matching, Political Analysis 19, 1–24.