

CASE STUDIES ON DISRUPTIONS DURING THE CRISIS

- The 2007-09 financial crisis saw many funding mechanisms experiencing disruptions, with borrowing rates and haircuts reaching record highs and some funding markets freezing entirely.
- Yorulmazer presents case studies of several major financial markets and intermediaries that experienced significant distress during the crisis.
- The author discusses the size and evolution of each market, the sources of disruption, and the policy responses aimed at mitigating distress and restoring market liquidity.
- The review's broad focus includes auction-rate securities, commercial paper, money market mutual funds, and repo markets.
- The article serves as a reference on key episodes of financial market stress, and is useful for policymakers contemplating the scope and design of future market stabilization efforts.

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1. INTRODUCTION

During the crisis of 2007-09, many funding mechanisms experienced disruptions, when borrowing rates and haircuts reached record-high levels and some funding markets completely froze. This paper discusses several funding mechanisms that experienced significant distress during the crisis. For each case, we provide a discussion of the size and the evolution of the mechanism, the sources of the disruptions, and the policy responses aimed at mitigating distress and making markets more liquid.¹ In particular, we consider auction rate securities, commercial paper, asset-backed commercial paper, money market mutual funds, the bilateral and tri-party repo markets, credit commitments by banks, dollar funding of non-U.S. banks, and the fragility associated with wholesale funding, using a discussion of the Northern Rock episode.

¹ See Fleming (2012) for a discussion of the measures taken by the Federal Reserve for liquidity provision during the crisis of 2007-09.

Individual cases have been prepared by a group of colleagues at the Federal Reserve Bank of New York (at the time this article was prepared), including Tobias Adrian, Nicola Cetorelli, Linda Goldberg, Michael Holscher, Todd Keister, Antoine Martin, Joao Santos, and Asani Sarkar. The author thanks Morgan Lewis, Susan McLaughlin, Patricia Mosser, Jainaryan Sooklal, and Katheryn van der Celen for helpful discussions. The views expressed are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

2. AUCTION-RATE SECURITIES

2.1 Background

An auction-rate security (ARS) is a long-term debt security whose interest rate is reset regularly via an auction process. On each auction date, current investors decide how many shares they wish to redeem, bidders place bids for these shares, and a stop-out rate is determined. This interest rate is then paid by the issuer on all shares until the next auction date. An auction fails if there are fewer bids than investors seeking to redeem shares. In this case, the interest rate on the securities is reset to a maximum “penalty” rate to compensate investors for the inability to redeem their shares and to provide the issuer with an incentive to restructure the obligation.

Leading into the crisis, ARS were mostly issued by municipalities or their authorities in the form of tax-exempt or taxable bonds (municipal ARS, or MARS), by corporations or by closed-end mutual funds in the form of preferred stocks (ARPS), or by student loan authorities (student loan ARS, or SLARS).

Investors were typically corporate treasurers and high-net-worth individuals looking for liquid securities yielding more than money market funds or other cash accounts. In terms of size, the ARS market was substantial: ARS outstanding totaled about \$330 billion at the end of 2007, roughly half of which was accounted for by MARS (Han and Li 2010).

2.2 Source of Fragility

The ARS was a form of maturity transformation. The underlying asset was a long-term debt security, but holders of the security—in normal times—could withdraw their funds by redeeming shares in the next auction. Importantly, there was little to no market for these securities outside of the regularly scheduled auctions. A holder of the security who expects future auctions to fail may want to sell in the current auction to avoid being locked into the security. Similarly, new investors may be unwilling to bid in the current auction if they expect that future auctions may fail. In this way, a fear of failed auctions may become self-fulfilling.

Two features served to limit fragility in this market in the pre-crisis period. One was the penalty rate imposed after a failed auction, which made the security attractive to some investors even in the event that future auctions failed. The other was the possibility that a market maker would step in and submit sufficient bids to prevent an auction from failing (Han

and Li 2010). While this type of support was not guaranteed, it was provided by dealers on occasion prior to the crisis and many investors may have anticipated that it would be present in periods of market stress.²

2.3 Crisis

Some signs of stress appeared in the ARS market in August 2007 due to investor concern about the credit quality of the underlying instruments. Auction failures became much more widespread in February 2008, with a majority of auctions failing for all types of assets. Gradually, two distinct types of outcomes emerged. For those securities with a relatively low penalty rate, the auctions largely continued to fail and investors were, for the most part, unable to redeem shares. For those securities with a relatively high penalty rate, many auctions remained successful although the clearing rates increased substantially. In this latter case, investors were able to exit the market without experiencing losses, but issuers paid substantially higher rates.

2.4 Policy Response

There was no formal policy response to the disruptions in the ARS market during the crisis. In subsequent months and years, many investors in ARS sued their brokers, claiming they were misled about the liquidity risks involved.

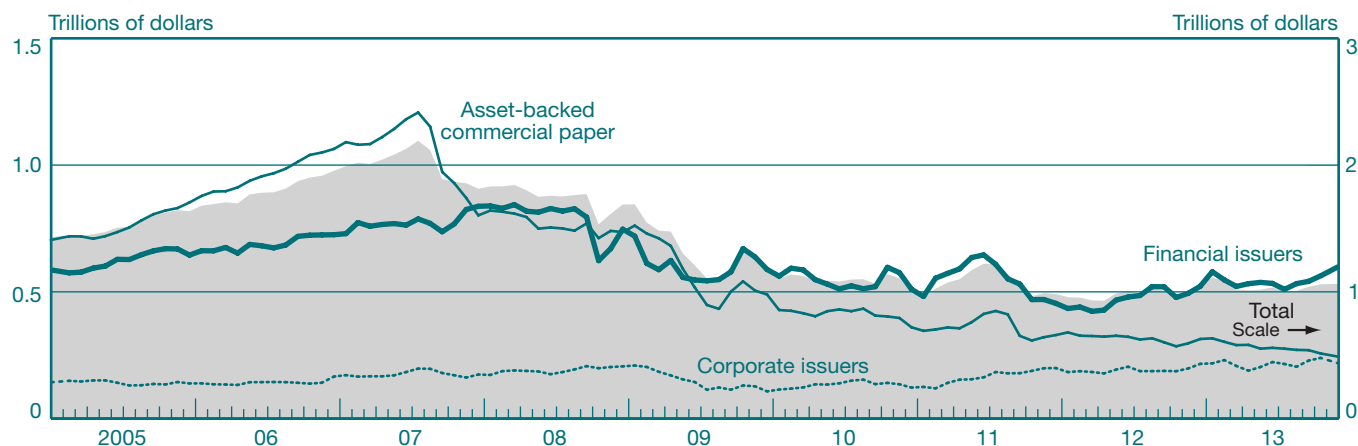
3. COMMERCIAL PAPER

3.1 Background

Commercial paper (CP) is a key source of short-term financing for U.S. corporations and financial institutions. Disruptions to the CP market may result in higher funding costs, forced asset sales to raise cash, and pressure on credit lines extended by commercial banks. CP outstanding peaked at \$2.2 trillion in July 2007 (see chart). At that time, asset-backed commercial paper (ABCP) accounted for 55 percent of the market, financial CP for 36 percent and corporate (nonfinan-

² See Han and Li (2010) for a discussion.

Commercial Paper Outstanding



Sources: Federal Reserve Board; Haver Analytics.

Note: Trend lines for asset-backed, financial, and corporate commercial paper outstanding track to the scale on the left-side Y-axis; shaded gray area representing total commercial paper outstanding tracks to the scale on the right-side Y-axis.

cial) CP for 9 percent.³ As of November 2013, commercial paper outstanding stood at \$1.06 trillion, with ABCP accounting for 23 percent of the market, financial CP for 57 percent, and corporate CP for 20 percent.

Unsecured financial CP is typically issued by U.S. subsidiaries of foreign banking organizations, bank-related finance companies (such as funding subsidiaries of large bank holding companies), and captive finance companies (like subsidiaries of auto or other manufacturing companies). Corporate CP is typically issued by large, highly rated, publicly traded non-financial corporates. Issuers typically use CP to finance current business transactions, such as the funding of operating expenses or current assets. CP is attractive to investors given its short duration; the maturity of CP is limited to 270 days, but averages close to thirty days.

3.2 Crisis

The vulnerability of CP markets is attributable to the type of investors who purchase CP, the short-term nature of the market, and the rollover risk faced by institutions reliant on it, which became evident during the recent crisis. The ABCP market was hit particularly hard after the summer of 2007, yet financial and corporate unsecured issuance remained stable.

³ A separate case study on the ABCP market is provided in the next section.

The unsecured CP market came under pressure following Lehman Brothers' bankruptcy in September 2008 and the Reserve Primary Fund's announcement that it had "broken the buck" due to its exposure to Lehman. These events triggered massive redemptions from prime money market funds, which subsequently reduced their holdings of CP as investors became increasingly skeptical, especially of ABCP (given its complexity and opaque nature) and of unsecured CP with longer-dated maturities (Kacperczyk and Schnabl 2010). Total outstanding CP fell 15 percent between August and October 2008, and financial CP outstanding fell 32 percent. Securities firms, banks, and insurance firms found their ability to issue mostly limited to the overnight market, and the weakest institutions found themselves excluded altogether.

3.2 Policy Response

In response to the dislocation in the CP market following the Lehman bankruptcy, and to shield the real economy from liquidity distortions created by the run on money market instruments, the Federal Reserve created on October 7, 2008, the Commercial Paper Funding Facility (CPFF).⁴ The CPFF was designed to provide temporary support to all CP issuer types through the provision of a liquidity backstop. Through

⁴ See Adrian, Kimbrough, and Marchioni (2011) for details on the CPFF.

the CPFF, the Fed would purchase three-month commercial paper directly from eligible issuers to provide assurance to both issuers and investors that firms would be able to roll over their maturing CP. At the peak, the Fed owned 22.4 percent of the CP market. By the expiration of the CPFF on February 1, 2010, the Fed had purchased up to \$370 billion in CP, making it the single largest buyer (Kacperczyk and Schnabl 2010).

4. ASSET-BACKED COMMERCIAL PAPER

4.1 Background

ABCP is a form of secured, short-term borrowing. ABCP programs first appeared in the mid-1980s. While they were primarily sponsored by commercial banks to provide trade receivable financing to their corporate customers, they grew to serve a wide variety of needs, in particular warehousing of assets prior to term securities issuance, investment in rated securities for arbitrage profit, provision of leverage to mutual funds, and off-balance-sheet funding of selected assets.⁵

ABCP was only about 6 percent of the total commercial paper market in 1990, but it accounted for about 55 percent of the total market in mid-2007, or approximately \$1.2 trillion. From its peak in July 2007, and after the first collapse in the second half of 2007, where the outstanding total dropped to about \$800 billion, the market has regressed steadily and it is currently at about \$290 billion.⁶

ABCP was issued by off-balance-sheet conduits of large financial institutions. As their role evolved over time, they increasingly held long-term assets, thus becoming significant vehicles of maturity transformation. In order to enhance their attractiveness to prospective investors, their rating status was boosted with guarantees, typically provided by the sponsoring institutions. Since most sponsors were large banks with the highest credit ratings, the provision of such guarantees effectively transferred the rating status of the sponsor to the conduit. In 2003, the Financial Accounting Standards Board issued a guideline that would have required sponsoring banks to consolidate ABCP conduits on their balance sheets. However, the following year, the U.S. bank regulatory agencies issued a ruling that allowed banks to exclude sponsored conduits from

⁵ “The Fundamentals of Asset-Backed Commercial Paper.” Moody’s Special Report, February 2003.

⁶ Source: Federal Reserve Board.

consolidation requirements. Moreover, the sponsoring banks were granted a favorable capitalization rule for the provision of their guarantees. Namely, while credit enhancements required full capitalization, liquidity enhancements required banks to hold capital only at a 10 percent conversion rate. Because of the high rating status and the short-term characteristics of their liability notes, ABCP conduits were considered especially attractive to money market funds, which are restricted in their investment opportunities.

4.2 Crisis

Recall that the ABCP market collapse began in August 2007 as a result of increasing uncertainty about the quality of the assets backing commercial paper issuance. This enhanced uncertainty, coupled with the pronounced maturity mismatch of conduits’ balance sheets, triggered what has been characterized as a run on their liabilities (Covitz, Liang, and Suarez 2013). The market was further hit in the aftermath of Lehman’s bankruptcy, as a result of the run on one of the largest money market funds, the Reserve Primary Fund.

4.3 Policy Response

Following August 2007 and prior to Lehman’s default, policy action mainly focused on providing liquidity to banks by reducing the discount window rates and extending the loan terms, followed by the institution of the Term Auction Facility (TAF) in late December 2007.⁷ However, it was only after Lehman’s failure that policy actions were specifically aimed at the commercial paper market. On September 19, 2008, the Federal Reserve announced the institution of the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF). The AMLF provided nonrecourse loans to commercial banks to purchase eligible ABCP from money market mutual funds (MMFs).⁸ Moreover, on October 7 of that year, the Federal

⁷ The maximum term on discount window loans was extended to thirty days in August 2007 and then to ninety days in March 2008. The spread between the primary credit rate and the target fed funds rate was reduced from 100 basis points to 50 basis points in August 2007 and to 25 basis points in March 2008. More information can be found at <http://www.newyorkfed.org/aboutthefed/fedpoint/fed18.html>.

⁸ The U.S. Treasury also provided a temporary guarantee on the share price of MMFs through the Temporary Guarantee Program for Money Market Funds and the Federal Reserve announced another lending program, the Money Market Investor Funding Facility (MMIFF), as a complement to the AMLF intended to provide nonrecourse loans to money market funds. However, no loans were made under the MMIFF. The facility was closed on October 30, 2009.

Reserve announced the purchase of commercial paper through the CPFF, aimed directly at issuers of commercial paper. These facilities closed on February 1, 2010. In 2010, new accounting rules were introduced (Financial Accounting Standards 166 and 167) requiring consolidation for accounting purposes of most ABCP conduits on the balance sheet of the sponsoring institution, thus reducing the scope for ABCP market growth based on regulatory arbitrage motives.

5. MONEY MARKET MUTUAL FUNDS

5.1 Background

MMFs are key intermediators of short-term debt, particularly for financial issuers, with total assets under management of \$2.6 trillion as of April 2013. All MMFs that are regulated under Rule 2a-7 of the Investment Company Act of 1940 maintain a stable share price of \$1. In part because of their record in maintaining a stable share price, MMFs serve as an important cash management tool for individuals, firms, institutions, and governments.⁹

The historical success of the funds in maintaining principal stability attracted a large, highly risk-averse shareholder base that included institutional investors that were not reluctant to pull away at any sign of trouble.¹⁰

5.2 Source of Fragility and the Crisis

Investors have a strong incentive to run from a distressed MMF because redemptions can shift risks and costs to remaining shareholders. Most importantly, because MMFs round their share price to the nearest cent, an investor who redeems shares from a fund that has incurred a loss of less than 0.5 percent may still be able to obtain \$1 per share. In effect, the fund transfers a redeeming shareholder's pro-rata share of the loss to the fund's nonredeeming shareholders. In addition, MMFs meet redemptions by disposing of their highly liquid assets, rather than selling a cross-section of all of their holdings, which typically

⁹ MMFs keep their net asset value (NAV) between 99.5 cents and 100.5 cents per share and rely on penny rounding to keep the share price at \$1 per share.

¹⁰ Cipriani, Martin, and Parigi (2013) build a model where MMFs are subject to runs and show that a banking system intermediated through MMFs can be more unstable than one in which investors interact directly with banks.

include some less liquid securities. This, in turn, can help the funds avoid losses from sale of less liquid securities. However, during periods of market strain, the investors that redeem pose a negative externality on nonredeeming investors by leaving them with a less liquid pool of assets.

Given the size of the money fund industry and its importance in allocating short-term funding to financial institutions, this vulnerability posed a considerable risk to the U.S. financial system. The potential consequences of a run on MMFs became evident in September 2008, when the Lehman bankruptcy caused the Reserve Primary Fund to "break the buck" (stating a share price lower than \$1, which, in turn, triggered significant redemptions from MMFs).¹¹ These outflows contributed to a freezing of short-term funding markets and a broader curtailment of credit supply.

5.3 Policy Response

Policymakers responded with both emergency and longer-term reform measures. Emergency measures included the Treasury's Temporary Guarantee Program, which temporarily provided a guarantee against loss for shareholders in participating MMFs. Also, the Federal Reserve's AMLF supported MMF liquidity by providing nonrecourse financing for bank purchases of ABCP from MMFs. In the wake of the crisis, the Securities and Exchange Commission (SEC) modified rule 2a-7 to further limit the liquidity, credit, and market risks of MMFs. The revisions also enhanced fund transparency, and made it easier for boards of directors to close troubled MMFs.¹²

6. REPO MARKETS

A repurchase agreement, known as "repo," is the sale of a security coupled with the promise to repurchase the security at a specific price at a prespecified future date. The difference between the repurchase price and the original sale price represents interest, which may be expressed as a "repo rate." The market value of the securities purchased typically exceeds the value of the cash the borrower receives. This difference, which is normally expressed as a percentage, is called the "margin" and measures the extent to which the implicit cash loan is overcollateralized.

¹¹ Prior to 2008, only one money fund had "broken the buck" since 1983, when the SEC adopted rule 2a-7 to govern MMFs.

¹² See McCabe et al. (2012) for a proposal for money market reform, which requires that a small fraction of each MMF investor's recent balances, called the "minimum balance at risk," be demarcated to absorb losses if the fund is liquidated.

It is useful to distinguish different market segments by the way repos settle. In the bilateral market, the settlement of the repo is handled by the two counterparties, while in the tri-party repo market a third-party clearing bank provides settlement and collateral management services.

Lack of data makes it difficult to estimate the size of the U.S. repo market. Data have been available for the tri-party repo market since 2008. At its peak in April 2008, this market reached a volume of around \$2.8 trillion. The volume shrank to about \$1.6 trillion in late 2009 and has been steady around that level since then (Copeland, Martin, and Walker 2010). The largest borrowers in the tri-party repo market are securities dealers. Money market mutual funds and securities lenders are the two largest groups of cash investors, representing together over half of the cash invested in that market. JPMorgan Chase and Bank of New York Mellon are the two tri-party clearing banks. We have very little information on the size of the bilateral repo market.¹³

6.1 Source of Fragility and the Crisis

Risk associated with repo arises from many factors, such as the term of the security, the quality of the collateral, and the strength of the counterparties involved. Short maturities and the risk of fire sales are two factors that exacerbate fragility for repo financing. Short maturities can create rollover risk when the buyers get concerned and pull out, similar to a run. Repos are exempt from the automatic stay of bankruptcy, meaning that if a borrower defaults and fails to repurchase its securities, the buyer can liquidate them.¹⁴ If the market for the securities is not very liquid, or if the amount of securities being sold is very large, the lender may be forced to sell its assets at fire-sale prices and could suffer losses.¹⁵

Disruptions in repo markets contributed to the failure or near-failure of major financial institutions during the crisis of 2007-09. Gorton and Metrick (2010, 2012) analyze haircuts in

¹³ Copeland et al. (2012) provide estimates for the bilateral and the aggregate repo market. Gorton and Metrick (2012) estimate the size of the aggregate repo market to be around \$10 trillion.

¹⁴ A defaulting dealer is likely to be liquidated by the Securities Investor Protection Corporation (SIPC), which obtains from the bankruptcy court an order that imposes a stay preventing its repo investors from taking certain actions, including disposing of repo collateral, without SIPC consent. While SIPC has issued letters in the past suggesting that it will act promptly on requests to liquidate collateral, consent might take several days.

¹⁵ See Acharya, Gale, and Yorulmazer (2011) for a model of fire sales and rollover risk, and Begalle et al. (2013) for a discussion of the risk of fire sales in the tri-party repo market.

an interdealer market for less liquid collateral and show that during 2007-08, the repo haircuts on a variety of assets rose on average from zero in early 2007 to nearly 50 percent in late 2008. They also report that some collateralized debt obligations could not be financed at all (100 percent haircut) during the crisis. In contrast, the level of haircuts and the amount of funding were stable in the tri-party repo market from July 2008 to early 2010 (Copeland, Martin, and Walker 2010). However, Bear Stearns and Lehman Brothers experienced problems borrowing in the tri-party repo market in the period leading up to their collapse.¹⁶ The evidence suggests that runs in the tri-party repo market may occur precipitously, more like traditional bank runs, rather than manifest themselves in the form of large increases in margins.¹⁷

6.2 Policy Response

The Federal Reserve established several funding programs to backstop the tri-party repo market, provide emergency liquidity to dealers, and strengthen investor confidence in dealers' ability to repay funds borrowed under repo agreements. The Term Securities Lending Facility (TSLF) was announced on March 11, 2008. The TSLF periodically auctioned loans of Treasury securities to primary dealers against eligible collateral for twenty-eight days. The Primary Dealer Credit Facility (PDCF) was created on March 16, 2008, as an overnight loan facility that provided funding to primary dealers in exchange for a specific range of eligible collateral.¹⁸ Six months later, the Federal Reserve expanded the facility to accept a broader range of collateral. Prior to the creation of these facilities,

¹⁶ The Tri-Party Repo Infrastructure Task Force's 2010 report notes that, "At several points during the financial crisis of 2007-2009, the tri-party repo market took on particular importance in relation to the failures and near-failures of Countrywide Securities, Bear Stearns, and Lehman Brothers. The potential for the tri-party repo market to cease functioning, with impacts to securities firms, money market mutual funds, major banks involved in payment and settlements globally, and even to the liquidity of the U.S. Treasury and Agency securities, has been cited by policymakers as a key concern behind aggressive interventions to contain the financial crisis."

¹⁷ Krishnamurthy, Nagel, and Orlov (forthcoming) measure the repo funding extended by MMFs and securities lenders to the shadow banking system. They show that the contraction in repo with private sector collateral is relatively insignificant compared with the contraction in ABCP during the crisis. However, the contraction in repo particularly affected key dealer banks with large exposures to private sector securities and the dealers to take defensive actions, given their own capital and liquidity problems, raising credit terms to their borrowers. The authors argue that their findings look less like a traditional bank run and more like a credit crunch among dealer banks.

¹⁸ See Fleming, Hrungr, and Keane (2009) for details on the TSLF and Adrian, Burke, and McAndrews (2009) for details on the PDCF.

dealers had no lender-of-last-resort access. These facilities were effective in stabilizing repo markets; however, both were temporary and were closed on February 1, 2010.

7. CREDIT COMMITMENTS

7.1 Background

Historically, banks have been the main source of credit to corporations, but they have also provided corporations liquidity insurance by extending them lines of credit and loan commitments. Firms value credit lines because they protect them against changes in interest rates, help them signal their true quality, or reduce instances of credit rationing. Also, it is believed that banks' access to deposit funding gives them an advantage in providing credit commitments to firms—as long as the drivers of deposit withdrawals and firms' drawdowns are not correlated, banks can save on the amount of liquidity they need to meet the demands from both firms and depositors. With the advent of the originate-to-distribute model, where lenders originate loans with the intention of selling them to other investors as opposed to holding until maturity, banks increasingly moved pools of loans into structured investment vehicles financed with short-term commercial paper. To make these vehicles more attractive to investors, banks offered credit enhancements to reduce the risk to investors in the event of unexpected losses and provided liquidity backstops to insure against refinancing risk. Virtually all banks offer credit lines to firms. As for the credit commitments to ABCP programs, these were predominantly extended by the banks (mostly larger banks) that embraced the originate-to-distribute model.

7.2 Source of Fragility

There are two major sources of fragility. First, deposit withdrawals and firms' drawdowns will likely come together in instances when there is uncertainty about the financial condition of the bank—on those occasions, depositors will have an incentive to withdraw their deposits and firms will have an incentive to draw down their credit lines, putting liquidity pressure on banks. Second, when banks provide credit commitments to ABCP programs or to back up CP programs, they create a liquidity exposure to a new factor—the CP market.

Anything that disrupts this market will translate into a liquidity shock to the banks.

7.3 Crisis

There is evidence that banks that had larger losses, as measured by their charge-offs, experienced both an increase in the drawdown rates on their credit lines and a runoff in uninsured deposits (Santos 2011). This combination is bound to have put liquidity pressure on these banks. Also, as structured investment vehicles accumulated losses and investors lost confidence in them, these vehicles increasingly became unable to fund themselves in the CP market, and calls on banks' liquidity started to mount. Lastly, the run on the money market fund industry that followed the events at the Reserve Primary Fund raised concerns about the ability of commercial paper issuers to renew their debt and the demand for liquidity from banks via drawdowns on back-up credit lines.

7.4 Policy Response

The increase in the deposit limit covered by deposit insurance from \$100,000 to \$250,000 and the guarantee in full of non-interest-bearing transaction accounts appear to have helped stabilize the exodus of deposits from the banking industry.¹⁹ The Temporary Guarantee Program for Money Market Funds by the U.S. Treasury Department also helped the stability of this business and, by extension, the commercial paper market, reducing the pressure on banks' liquidity demands. Lastly, all of the liquidity made available to banks, via the discount window, or the other facilities that were put in place, also likely helped banks defray the liquidity pressure they were under during these "freezes" of the commercial paper market.

¹⁹ The temporary increase from \$100,000 to \$250,000 was effective from October 3, 2008, through December 31, 2010. On May 20, 2009, the temporary increase was extended through December 31, 2013. On July 21, 2010, the insurance coverage was permanently raised to \$250,000. See the Federal Deposit Insurance Corporation (FDIC) press release at <http://www.fdic.gov/news/news/press/2010/pr10161.html>. On October 14, 2008, the FDIC implemented the Temporary Liquidity Guarantee Program (TLGP). One of the two components of the TLGP was the Transaction Account Guarantee Program, which introduced a guarantee in full of noninterest-bearing transaction accounts through December 31, 2009. The deadline was extended twice and the program expired on December 31, 2010. See the FDIC press release at <http://www.fdic.gov/regulations/resources/TLGP/>.

8. DOLLAR FUNDING OF NON-U.S. BANKS

8.1 Background

Non-U.S. banks accumulated sizable U.S. dollar assets in the past decade. For example, European banks had assets equal to \$3.2 trillion at the end of 2010:Q4, according to European Central Bank (ECB) estimates,²⁰ amounting to slightly more than one-quarter of the total assets of FDIC-insured commercial banks. Various explanations are provided for the rapid expansion. One basic argument is that the growth in dollar assets was associated with increased investment opportunities during this period. For example, non-U.S. banks made loans to U.S. companies and invested in AAA-rated tranches of U.S. structured financial products. Other arguments focus on European banking regulations that was primarily concerned with the amount of capital relative to a bank's risk-weighted assets. Finally, the international role of the dollar as a medium of exchange in global trade also contributed to the dollar exposures of non-U.S. banks.

These same banks had substantial dollar liabilities on the other side of their balance sheets. Available data suggest that, even when the net dollar imbalance was small, the system-wide bank funding risk associated with gross positions could be large (Fender and McGuire 2010b). Due to the costs and restrictions associated with establishing a U.S. commercial bank and qualifying for federal deposit insurance, as well as limitations on internal capital market transfers between related organizations under the Federal Reserve Act,²¹ most non-U.S. banks meet their dollar funding needs by issuing dollar-denominated wholesale debt, such as certificates of deposits (CDs) and commercial paper, out of U.S. bank branches and other corporate entities. U.S. investors such as MMFs buy these debt instruments and constitute the main source of dollar funding of European banks.

8.2 Crisis

The fragility of the dollar funding model of non-U.S. banks during times of crisis arises from its dependence on the wholesale funding markets. U.S. wholesale investors, in par-

²⁰ ECB *Financial Stability Review*, June 2011.

²¹ See the Federal Reserve Act, Section 23A, at <http://www.federalreserve.gov/aboutthefed/section23a.htm>.

ticular the MMFs that are sensitive to risk, tend to pull back and reduce lending when investment risks intensify. Such a pullback occurred during the subprime crisis and has recurred during the European debt crisis. For example, estimates from Fitch Ratings indicate that, since the end of May 2011, the ten largest U.S. MMFs have reduced their exposure to European banks by 45 percent.

Non-U.S. banks can fill the dollar funding gap by “deleveraging,” or shrinking dollar assets so as to reduce their need for dollars. They can also transfer dollars intrafirm (that is, U.S. branches of non-U.S. banks receive dollars from their foreign parents). The most widely used alternative is to convert domestic currency liabilities into dollars for a fixed period through foreign exchange swaps (Fender and McGuire 2010a). Finally, non-U.S. banks may borrow dollars from central bank dollar liquidity facilities.

8.3 Policy Response

The Federal Reserve provided dollar loans to U.S. branches of foreign banks through the discount window (DW) and the Term Auction Facility, which operated from December 2007 to March 2010.²² Of 411 banks that were awarded funds in the TAF during this period, seventy-three (or almost 18 percent) were non-U.S. banks. TAF loans reached almost \$500 billion on March 4, 2009, of which almost 40 percent were outstanding to non-U.S. banks. Non-U.S. bank participation in the DW was smaller, and constituted about 3 percent of the total between 2008 and 2011.

In addition, the Federal Reserve, in coordination with other central banks, put in place temporary reciprocal currency arrangements, or central bank liquidity swaps, in December 2007.²³ Under these arrangements, the Federal Reserve provides U.S. dollars in exchange for an equivalent amount of foreign currency based on prevailing market exchange rates for a predetermined period. The foreign central bank makes loans to banks in its jurisdiction, and bears the credit risk associated with those loans. The dollar loans were provided at a rate that made it attractive for banks to borrow in times of crisis, but not during more normal market conditions. Consequently, banks borrowed from their own central banks that used the dollar swap facilities. The amount outstanding in central bank liquidity swaps reached a peak of more than \$550 billion during the last quarter of 2008.

²² See Armantier, Krieger, and McAndrews (2008) for a discussion of the TAF.

²³ The swap arrangements expired in February 2010, but were renewed in May 2010, when the lack of dollar liquidity once more became pronounced. See Fleming and Klagge (2010) and Goldberg, Kennedy, and Miu (2011) for details on the dollar swap lines.

Faced with market concerns about stigma associated with using the central bank liquidity swaps in November 2011, the ECB, the Bank of England, the Swiss National Bank, the Bank of Canada, and the Bank of Japan further facilitated access to dollars by lowering the cost of dollars borrowed. Moreover, in December 2011, the ECB eased access to dollar liquidity (as well as euro liquidity) by expanding the set of eligible collateral at its facilities.

9. WHOLESALE FUNDING AND NORTHERN ROCK

In September 2007, Northern Rock—the fifth largest mortgage lender in the United Kingdom—experienced an old-fashioned bank run, the first in the United Kingdom since the collapse of City of Glasgow Bank in 1878. The run could only be contained by the government’s announcement that it would guarantee all deposits in Northern Rock.

Since its conversion from a building society to a bank in 1997, Northern Rock grew rapidly to reach £113.5 billion in assets by June 2007. Northern Rock relied on securitization and funding from wholesale markets rather than “traditional” funding from retail deposits and holding loans until maturity. Northern Rock had only seventy-six branches in 2007 and retail deposits accounted for only 27 percent of its liabilities, whereas wholesale funding accounted for 68 percent of its liabilities and mortgage loans comprised 77 percent of its assets.

The drying-up of liquidity in wholesale markets in the summer of 2007 adversely affected Northern Rock. In August, Northern Rock informed authorities about its funding difficulties, and on September 13, the Bank of England agreed to provide emergency assistance, which was publicly announced on Friday, September 14. This news confirmed the extent of difficulties and resulted in a run on Northern Rock. On the evening of Monday, September 17, the government announced it would guarantee all existing deposits to contain the run.

Goldsmith-Pinkham and Yorulmazer (2010) provide an analysis of the run on Northern Rock and analyze the spillover effects on other banks from the difficulties of Northern Rock.²⁴ The table shows the balance-sheet data for the ten largest U.K. banks analyzed in that study.²⁵ The authors show that the main driver of the spillover effect on the other U.K. banks was the funding difficulty in wholesale markets, where

²⁴ See also Shin (2009) for a discussion of the Northern Rock case.

²⁵ The ten largest U.K.-owned banks accounted for around 90 percent of U.K.-owned bank assets.

Balance Sheet Data Percent

	Mortgage	Deposits	Wholesale	Equity
Abbey National	53	34	21	1.7
Alliance & Leicester	55	45	52	3.0
Barclays	6	26	19	2.5
Bradford & Bingley	62	51	44	3.2
Halifax Bank of Scotland	37	38	36	3.6
HSBC	4	48	17	6.2
Lloyds TSB	28	42	27	3.4
Northern Rock	77	27	68	3.1
Royal Bank of Scotland	8	43	24	4.8
Standard Chartered	17	58	20	7.1
Average	34.7	41.2	32.8	3.86

Source: Goldsmith-Pinkham and Yorulmazer (2010).

Notes: Mortgage represents mortgage loans (as a percentage of total assets). Deposits represent customer deposits. Wholesale is the sum of debt securities in issue and deposits from other banks, and represents funding from wholesale markets. Equity represents shareholders’ equity, all as a percentage of total liabilities. Data for mortgage loans are for the 2006 year-end and are collected from the website of Council of Mortgage Lenders (<http://www.cml.org.uk/cml/statistics>), except for Standard Chartered, which are from the interim results for June 30, 2007. All other data are from interim results for June 30, 2007, except for Bradford & Bingley, which are from the annual report for December 31, 2006.

banks that relied on wholesale markets were affected severely.^{26, 27} Furthermore, the institutions shown to have been affected experienced subsequent failures (or near failures). Examples include the takeover of Alliance & Leicester by Grupo Santander; the partial nationalization and the purchase of the savings business of Bradford & Bingley by Grupo Santander; Lloyds TSB’s acquisition of HBOS; and HBOS’ pre-tax loss of £10.8 billion in 2008 hitting Lloyds TSB, which had to be recapitalized by the U.K. government.

²⁶ To analyze the effect of bank characteristics on stock price returns, a series of regressions are run, where the dependent variable is the abnormal return during the period of interest and the explanatory variables are the bank balance sheet characteristics. Significant negative abnormal returns are regarded as evidence of spillover. The results show significant negative abnormal returns for Alliance & Leicester (-34.8 percent), Bradford & Bingley (-18.8 percent), and HBOS (-5.7 percent) during the event window of September 14-17.

²⁷ Furthermore, some banks that are dissimilar to Northern Rock, such as Abbey National (with a lower level of wholesale funding), actually experienced positive returns during this period. In other words, the spillover was confined to the set of banks that had a similar business model to Northern Rock and relied on wholesale markets for funding.

While Northern Rock's heavy reliance on wholesale funding markets played an important role in the run, some particular features of the deposit insurance scheme in the United Kingdom were another contributing factor. U.K. deposit

insurance at that time only covered 100 percent of the first £2,000 and 90 percent of the next £33,000. Furthermore, the deposit insurance fund was not ex-ante funded and it could take about six months for depositors to access their funds.

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