

Summary

The inability of multiple financial institutions to roll over or obtain new short-term funding was one of the defining characteristics of the crisis. Systemic liquidity risks were underrecognized by both the private and public sectors and required unprecedented intervention by governments and central banks during the crisis. This chapter aims to better understand the vulnerabilities that led to the systemic liquidity crunch and, in doing so, begin to provide a holistic framework for dealing with them, with central banks expected to step in only in dire emergencies.

A key aspect of the crisis was the increased use by banks of short-term wholesale funding and the risks that it posed when these short-term markets dried up. Perhaps insufficiently recognized was that the wholesale providers of funds had also changed—instead of interbank markets acting to move unsecured funds where needed, other intermediaries, such as money market mutual funds, were growing suppliers of funds while traditional, more stable depositors were not. Secured lending through repurchase operations also grew immensely, greasing the funding markets.

The chapter shows that going forward a comprehensive approach is needed to better mitigate systemic liquidity risks. Higher liquidity buffers and lower asset/liability maturity mismatches in banks will help reduce the chance that an individual institution will run into liquidity difficulties. The proposals from the Basel Committee on Banking Supervision in this direction are likely to be a good starting point if designed and calibrated appropriately. To address the externality that some firms impose on the system as a whole, a measure of systemic liquidity risks attributable to them needs to be devised and perhaps a surcharge or insurance premia imposed. The chapter outlines some early proposals; a chapter in a subsequent GFSR will take up this topic more concretely.

The approach must also address how funding markets and nonbank institutions interact and, more specifically, how to correct infrastructure and practices that generate simultaneous and widespread dislocation in the funding markets. A well-functioning repurchase market is now a cornerstone of the wholesale funding market. In the run-up to the crisis, however, the market—in particular the triparty repo market—had features that increased systemic risks: poor collateral valuation and margining policies, a lack of due diligence about the counterparties' credit risk, and fragmented or nontransparent methods of clearing and settlement. Hence part of the solution will be requiring better internal controls on collateral valuation and margining policies, more transparency about counterparties, including through triparty relationships, and greater use of central counterparties for clearing and collateral management.

While still of less significance in Europe, U.S. money market mutual funds as a means of channeling institutional and retail funds to banks (both in the United States and abroad) are also now a systemically important component of funding markets. Ensuring that investments in such funds are regularly valued at market prices, and clearly differentiated from bank deposits, is another important method of mitigating systemic liquidity risk.

This chapter explores the causes of the system-wide breakdown in funding markets in the recent crisis and potential steps to ensure they are not repeated. The freezing up of the interbank, foreign currency swap, and secured money markets necessitated massive crisis intervention, cross-border coordination, and adjustments to central bank liquidity operations to stabilize the financial system and restore orderly market conditions. Central banks had to step in and take over the role of money markets in distributing liquidity in the system as banks and other lenders shunned transacting, particularly beyond very short-term maturities, due to rising counterparty risk concerns. In some places, central banks are still actively supporting money markets. Central banks also have become buyers of last resort of distressed assets, and governments have needed to guarantee bank debt.

To avoid a repeat of such breakdowns in the future, the Group of 20 (G-20) has called for strong liquidity buffers in the global financial system. A number of reforms and initiatives are under way to address shortcomings in financial institutions' liquidity practices, although policymakers have yet to put in place a framework that mitigates and manages the systemic aspect of liquidity risk—that is, the inability of markets to sustain liquid conditions so that financial institutions can fund maturity transformation and intermediation.

The crisis exposed shortcomings in liquidity risk management, with market and funding liquidity risks lightly managed even compared to other risks in banks and other financial intermediaries. The wider use of short-term wholesale funding markets, and hence greater maturity mismatch between assets and liabilities, was not fully appreciated. Secured funding markets were believed to be an effective and efficient source of funding, but the crisis proved these to be highly risk sensitive, unstable, and unreliable. Financial institutions did not factor in the possibility of a sudden, large-scale disruption in funding sources as investors withdrew owing to

uncertainty over asset valuations, counterparty risks, and availability of liquidity.

The crisis exposed a bank-centric rather than a systemic approach to liquidity risk management by supervisors. Supervisors were not aware of the systemic implications of institutional funding and liquidity management, and how idiosyncratic risk (e.g., subprime credit risk) could quickly morph into a systemic liquidity risk for the financial system as a whole. Nor did they fully appreciate the adverse implications of cross-border and currency funding and flows, and of different infrastructures for trading, clearing, and settlement in important secured funding markets.

This crisis also exposed the systemic importance of nonbank funding sources. Decisions taken by key money market investors proved to be highly disruptive, not only for the United States, but also, in terms of the availability of U.S. dollar funding, for non-U.S.-based financial institutions. As these investors were not covered under the formal financial safety net, when systemic vulnerabilities materialized, governments and central banks had to provide guarantees and liquidity support to funding markets and also nonbank money market participants.¹

This chapter aims to identify the failings that caused the systemic liquidity disruption in order to begin to identify policies to address these issues. It will examine how liquidity shocks contributed to systemic risk, with a focus on the role of the wholesale funding markets, and potential channels through which liquidity shocks propagate and are amplified, while exploring overall trends in the maturity structure of bank liabilities. The chapter puts into context recent reforms to strengthen liquidity risk management of banks. Finally, it suggests how regulatory policies may need to change to mitigate and manage systemic liquidity risk, and highlights elements absent from the current regulatory debate. It should be noted up front that information gaps in authorities' collection of funding and market data, reflecting also the over-the-counter (OTC) nature of many funding transactions, hamper the ability to perform adequate systemic liquidity risk analysis.

Note: This chapter was written by a team led by Jeanne Gobat and consisting of Alexandre Chailloux, Simon Gray, Andreas Jobst, Kazuhiro Masaki, Hiroko Oura, and Mark Stone. Excellent research support was provided by Oksana Khadarina and Dmytro Sharaievskyi.

¹The safety net typically involves regulation and supervision (both capital adequacy and appropriate liquidity management), access to central bank lending, and a deposit protection scheme.

Review of the Systemic Liquidity Shock through Various Short-term Funding Markets

The financial crisis that began in 2007 generated unprecedented disruptions in key funding markets (Box 2.1). The asset-backed commercial paper (ABCP) funding market was hit first in August 2007 and played a critical role in spreading the subprime crisis to other funding markets (Covitz, Liang, and Suarez, 2009). Securitized products, primarily made up of the failing subprime mortgages, were widely used as collateral in the ABCP market. The complex and opaque nature of securitized products made valuation extremely difficult.² In some cases there was no market to provide an objective valuation of the claims in question.³ In other cases, where prices were realized, other market participants used them to mark to market their positions, crystallizing their losses. This widespread absence of valuation information—the inability to identify precisely where losses lie and quantify them—made it difficult for market participants to discriminate among counterparties. This triggered a run by investors and rating downgrades of structured mortgage-backed securities. Yields on new ABCP issues soared and the outstanding amount of ABCP fell by almost 35 percent by end-2007 alongside a collapse of securitized products (Figures 2.1 and 2.2).⁴ The shutdown of this market primarily hurt banks' off-balance-sheet vehicles and forced many to tap contingency liquidity lines they had with their sponsor parent banks.

The steep contraction in the ABCP, in turn, sparked concerns over banks' exposures to their off-balance-sheet vehicles (the risks of which had not been captured by disclosures or regulations).⁵ Several U.S. and

²See IMF (2008) and Brunnermeier (2009) for a detailed discussion of market and funding problems in the early stages of the financial crisis.

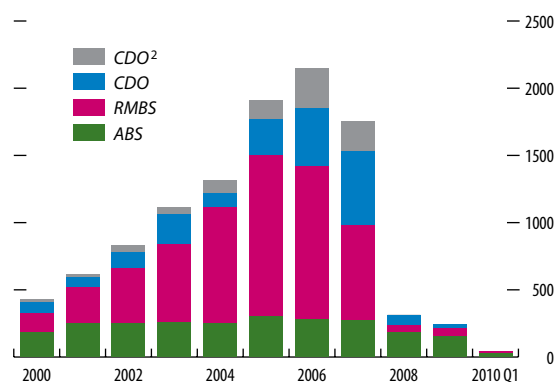
³Indeed, some securities had been priced by model rather than on the basis of market trading; when the models clearly failed to perform, there was in many cases no underlying market information on which to fall back.

⁴The total ABCP market was estimated to be about \$1.4 trillion at end-March 2007, with about 80 percent of that located in the United States. This market shrunk to \$410 billion at end-July 2010. The underlying assets now consist mainly of credit cards, trade receivables, commercial and auto loans, and securities.

⁵Citibank, JPMorgan Chase, Bank of America, State Street Bank, and Wachovia Bank were the top five commercial bank sponsors of ABCP programs by outstanding amount in the United States. In Europe, the top five sponsors were HBOS,

Figure 2.1. U.S. Private-Label Term Securitization Issuance by Type

(In billions of U.S. dollars)

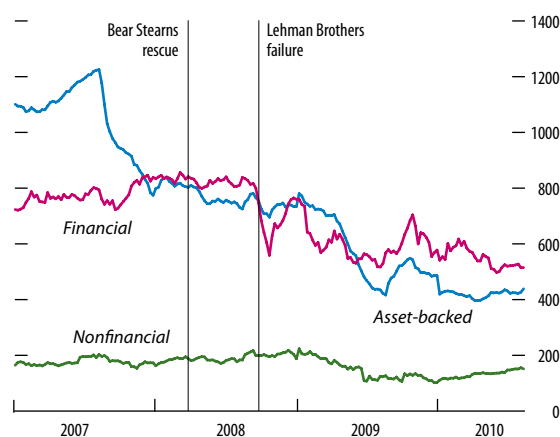


Sources: IMF staff estimates based on data from JPMorgan Chase & Co.; Board of Governors of the Federal Reserve System; and *Inside Mortgage Finance*.

Note: CDO = collateralized debt obligation; CDO² = collateralized debt obligation-squared and CDOs backed by asset-backed securities (ABS) and residential mortgage-backed securities (RMBS).

Figure 2.2. United States: Outstanding Amount of Commercial Paper

(In billions of U.S. dollars; seasonally adjusted)



Source: Board of Governors of the Federal Reserve System.

Note: The commercial paper market consists of financial, nonfinancial, and asset-backed commercial paper.

Box 2.1. Role of Money Markets

This box describes key components of the money markets used by banks, nonbank financial companies, and nonfinancial firms for short-term secured and unsecured borrowing. Short-term secured funding grew rapidly prior to the crisis.

In general, money markets are integral to the transmission of monetary policy and help support price formation in longer-dated debt markets. Money markets consist of unsecured interbank trading, short-term debt issuance, short-term secured lending, and the derivatives market:

- The interbank unsecured market is the most prominent and longest existing component of the money markets. Banks use this over-the-counter market to lend and borrow funds from their peers. Banks tend to open credit lines only to creditworthy and well-established counterparties. Money market indices like the LIBOR were initially established to provide benchmark rates to the unsecured interbank market, but started to be used increasingly for the indexation of short-term derivatives and securities (like floating rate notes). Although this market has remained decentralized, it is often supported by electronic trading platforms that offer matching and settlement services to their participants.
- The short-term securities markets are normally dominated by treasury bills, but also include bank certificates of deposit and commercial paper. Banks issue certificates of deposit and sell them to their customers, predominantly money market funds or other nonbank financial institutions. Commercial paper is issued by nonbank financial firms (e.g.,

Note: This box was prepared by Alexandre Chailloux and Andreas Jobst.

broker-dealers) and nonfinancial firms. These are purchased by a broader array of market participants, and in most cases, are held to maturity.

- The short-term secured funding market consists of collateralized lending, with the underlying collateral including commercial paper, treasury bills, other government securities, credit default obligations, other structured credit and credit products, and equity. The market is dominated by the repo market (see separate discussion in Box 2.3).
- The short-term asset-backed securities market has been hit hard during the crisis, following a relatively rapid expansion. The issuance of short-term securities backed by claims on longer-term assets initially focused on trade receivables. More recently, off-balance-sheet vehicles have issued asset-backed commercial paper to fund various stages of the securitization process, including to securitize real estate loans, car loans, or credit card receivables.
- The short-term derivatives market, while not a funding market, is generally seen as a full subsegment of the money markets, and is the largest in terms of notional exposure and turnover. Interest rate swaps and short-term interest rate futures contracts are used by banks for interest rate risk management purposes. They also serve to optimize bank funding costs and arbitrage interest differentials across currencies, along with foreign exchange swaps. Foreign exchange swaps allow banks to raise funding in one currency and to expand assets in another currency, without taking on any foreign exchange risk. However, this can entail foreign currency liquidity risk, given potential maturity mismatch between foreign currency assets and liabilities.

non-U.S. banks were forced to bring their ABCP conduit assets on balance sheet, creating a significant drain on their liquidity. This general uncertainty further

reduced banks' funding access to the capital markets, which fell sharply in the latter part of 2007 (Figure 2.3). Institutions that relied primarily on wholesale funding were most vulnerable to the rapidly deteriorating conditions in wholesale funding markets.⁶

ABN AMRO, HSBC, ING, and Fortis. For a number of banks, their liquidity exposure to off-balance-sheet vehicles accounted for about 30 percent of total funding. ABCP programs in Australia and Canada were also affected (Moody's, 2007; and Fitch Ratings 2007).

⁶Wholesale funding accounted for 68 percent of Northern Rock's liabilities in 2007 (Yorulmazer and Goldsmith-Pinkham, 2010).

This widespread uncertainty over valuation and counterparty risk began affecting the global money markets, including the unsecured and secured markets (Figure 2.4). Banks began conserving liquidity, drawing down liquidity overseas, cutting back credit lines to counterparties to overnight, or ceasing to trade altogether. Yields on government securities across countries declined sharply, while short-term unsecured funding rates for banks, visible in the three-month U.S. dollar LIBOR-overnight index swap (OIS) spread, shot up.⁷

The interbank market strains exacerbated a shortage of U.S. dollars in the global markets, in particular for internationally active banks.⁸ U.S. dollar funding was required especially by banks in Europe (e.g., Dutch, German, Swiss, and U.K. banks), but also by banks in Korea, to roll over short-term funding of longer-term U.S. dollar assets (Box 2.2). The shortage in U.S. dollars also affected the foreign exchange swap market, with the U.S. dollar being used as the main swap currency for cross-currency funding (Figure 2.5). This reflected the growing use of foreign exchange swaps to obtain foreign currency funding, including in emerging European countries. In response, several central banks established foreign exchange swap lines with the U.S. Federal Reserve at end-2007, and these then were expanded to include more central banks as the crisis spread into 2008.

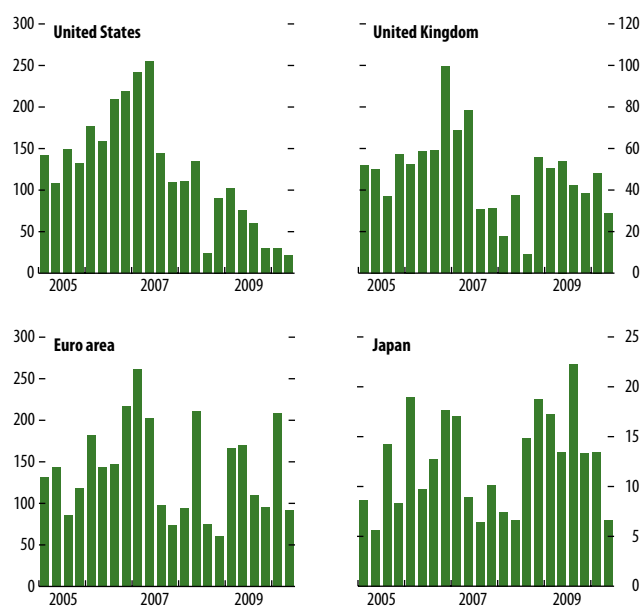
By this time, the repo market, in particular in the United States, showed signs of strains amidst heightened concerns about credit and counterparty risk (Figure 2.6).⁹ This put at risk the funding model of investment banks that relied heavily on overnight repo operations for funding, with the share of overnight repos as a percent of total assets doubling between

⁷The spread is a proxy measure for counterparty and liquidity risk premia (Aït-Sahalia and others, 2009).

⁸McGuire and von Peter (2009) document the rapid expansion of cross-border borrowing and net foreign positions denominated in U.S. dollars by European banks over the past decade. European banks sharply increased their U.S. dollar assets between 2000 and 2009, and funded this by borrowing short term in the U.S. money market. See also McGuire and von Peter for a discussion on the U.S. dollar shortage in global banking, and CGFS (2010) for a detailed discussion of the functioning of cross-border markets during the crisis.

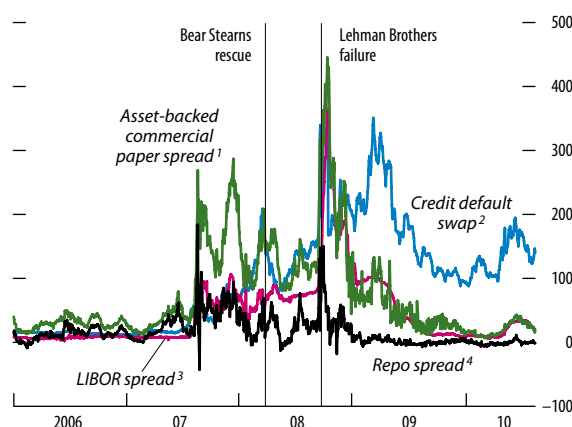
⁹Bear Stearns fell victim in March 2008 to deteriorating conditions in the repo market, given its heavy reliance on overnight repos for funding, but avoided bankruptcy due to the takeover by JPMorgan Chase.

Figure 2.3. Bank Bond Issuance
(In billions of U.S. dollars)



Source: DCM Analytics.

Figure 2.4. Aggregate Bank Credit Default Swap Rate and Selected Spreads
(In basis points)



Sources: Bloomberg L.P.; and IMF staff estimates.

¹Spread between yields on 90-day U.S. asset-backed commercial paper and on three-month U.S. Treasury bill.

²The unweighted daily average of five-year credit default swaps for the following institutions: Morgan Stanley, Merrill Lynch, Goldman Sachs, JPMorgan Chase, Deutsche Bank, Bank of America, Citigroup, Barclays, Credit Suisse, and UBS.

³Spread between yields on three-month U.S. LIBOR and on three-month U.S. overnight index swap.

⁴Spread between yields on three-month U.S. Treasury repo and on three-month U.S. Treasury bill.

Box 2.2. Disruptions to Cross-Border Funding and Foreign Exchange Swaps

In several countries affected by the financial crisis, financial institutions were confronted with major difficulties accessing cross-border wholesale funding and foreign exchange swap markets. This box summarizes how the crisis affected countries such as Australia, Korea, and Hungary.

Although financial institutions in Australia and Korea had very little direct exposure to troubled U.S. credit instruments such as subprime mortgage loans, asset-backed securities, or collateralized debt obligations, and had healthy capital ratios going into the crisis, they are characterized by greater reliance on wholesale funding than their peers in the region.¹ Wholesale funding accounts for about 50 percent of total funding at Australian banks and a bit less for Korean banks. It is sourced in both the domestic and international financial markets. This increased their vulnerability to the major dislocations in the cross-border funding markets:

- The largest Australian banks source about one-third of their funding in the offshore markets. Although they continued to have access to the offshore money and capital markets but at higher cost, there was some concern that they could face difficulties rolling over their U.S. dollar short-term obligations. Australian banks subsequently prefunded their obligations and diversified their currency and funding base, and also lengthened their maturity structure through strong growth in deposits and issuance of long-term bonds. As a consequence of these actions, the short-term component of total liabilities declined to 25.6 percent at end-2009 (of which 12.3 percent was foreign), down from 32.2 percent at mid-2007 (of which 13.8 percent was foreign).
- In Korea, foreign bank branches rely on lending by their foreign parent bank. During the peak of the crisis, investments in securities and lending by the foreign bank branches fell dramatically as their global parent banks (in particular U.K. and euro area banks) retreated and deleveraged. This affected liquidity conditions in the local foreign currency market, and led

to a dislocation of the foreign currency swap market and affected local Korean banks' foreign currency liquidity management, as most found themselves at the same time shut out from the international market for U.S. dollar funding. Lack of a deep liquid foreign exchange market exacerbated the problem.

The authorities in both countries took several measures to stabilize their financial system and foreign currency funding market. The establishment of deposit and wholesale funding guarantees by the Australian government in October 2008 (expired at the end of March 2010) and considerable central bank actions to provide sufficient liquidity helped maintain confidence in the financial sector. Both the Reserve Bank of Australia and the Bank of Korea established foreign exchange swap lines with the U.S. Federal Reserve (these lines expired in February 2010). The Bank of Korea also expanded its collateral facilities to include U.S. dollar instruments and provided foreign currency liquidity to the private sector. The Australian and Korean financial systems coped better than others in part because of their stronger macroeconomic and overall banking fundamentals.

In late 2008, turbulence in global money markets spread to European emerging economies, reflecting also the use of foreign exchange swaps to fund domestic foreign currency lending. There was significant Swiss franc lending in a number of these countries. The most acute tensions were felt in Hungary, where the drying up of dollar funding and the sharp depreciation of the domestic currency—reflecting market concerns about fiscal sustainability—resulted in a sharp tightening of liquidity conditions and higher funding costs. The central bank created several new facilities to inject both forint and foreign currency liquidity. Tension in the foreign exchange swap market receded after the U.S. Federal Reserve and the Swiss National Bank swaps provided significant support.

Still, implicit rate spreads have remained significantly above pre-crisis level; even the implied spreads for the Czech koruna, which was relatively stable in the crisis, have switched from persistently negative to persistently positive. This can be attributed to more conservative risk pricing, some segmentation between swap and domestic money markets, and reliance on cross-border funding and swap operations that had fueled rapid credit expansion.

Note: This box was prepared by Pierluigi Bologna, Erlend Nier, Alessandro Giustiniani, and Jeanne Gobat.

¹New Zealand banks were also affected. They are similarly dependent on wholesale funding, with most being subsidiaries of Australian banks. To improve banks' liquidity and lower reliance on short-term offshore funding, the authorities introduced new quantitative liquidity requirements, effective as of April 2010.

2000 and 2007.¹⁰ Following the bankruptcy of Lehman Brothers in September 2008, conditions in the repo market deteriorated sharply as key cash lenders pulled back from the market or scaled down their nongovernment repo holdings.¹¹

Moreover, the events related to Bear Stearns and Lehman Brothers greatly increased the realization that repo markets were not immune to counterparty risk. Indeed, realizing that credit risks had been priced too low, cash providers drastically adjusted their conditions, including higher repo rates, accepting only top-quality collateral, at significantly higher haircuts (Table 2.1). Mark-to-market conventions forced lower valuations, which in turn led to fire sales of assets and a self-fulfilling vicious circle of lower valuations, higher volatilities, and larger haircuts.

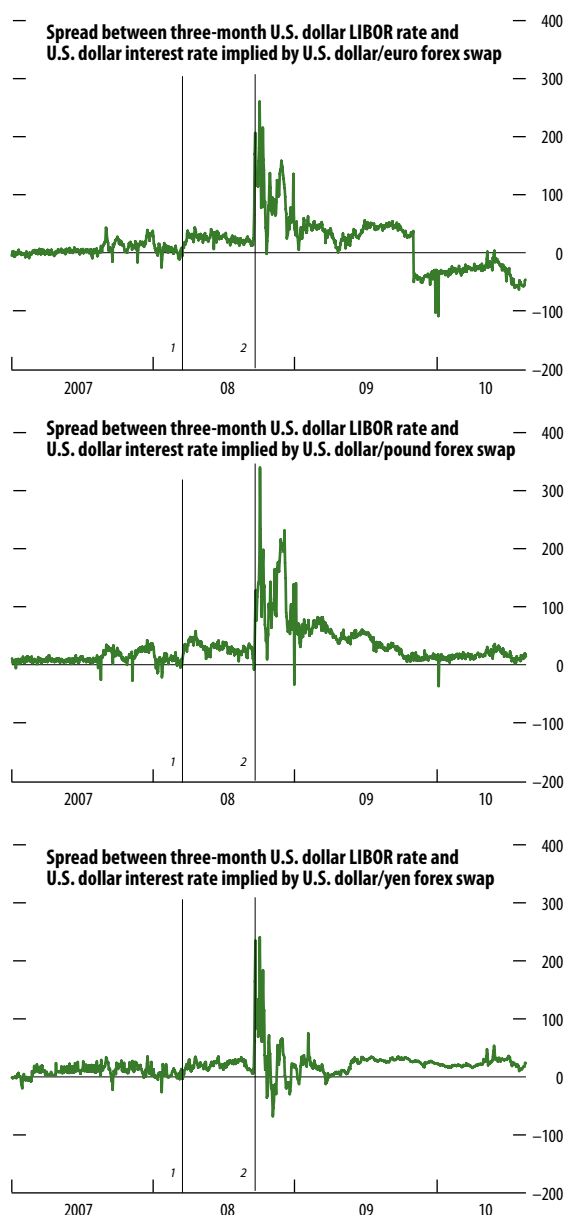
Developments since late 2008 indicate that key funding markets remain shut down despite significant intervention by central banks. The commercial paper market has not picked up in the United States. Money market funds are placing a greater amount of their funds in government-backed repos and short-term certificates of deposit, including those of European banks. In Europe, the greater issuance of securitized products largely reflects the European Central Bank's (ECB) expanded open market operations, in which asset-backed securities and covered bonds can be used as collateral. While overall unsecured borrowing rates have come down since their peaks in September 2008, turnover and the number of active participants in the unsecured market have fallen, with most transactions overnight (Figure 2.7) (ECB, 2009a). Nongovernment repo operations also remain sharply lower or inactive for the United States and Europe, with shorter-term duration (Figure 2.8). Greater risk aversion and ongoing concerns over counterparty risk can also be seen in a growing shift to electronic trading backed by central counterparties (CCPs) in the euro area.

Generally, since the start of the crisis, central banks have assumed a bigger role in intermediating between institutions both to provide short-term

¹⁰Term repos with a maturity of up to three months stayed roughly constant as a percent of total assets during this period (Brunnermeier, 2009).

¹¹Money market funds came under wholesale redemption pressures after Reserve Fund's Primary Fund "broke the buck" when its share price fell below par.

Figure 2.5. U.S. Dollar Currency Spread Implied by Three-Month Forex Swap Contracts
(In basis points)

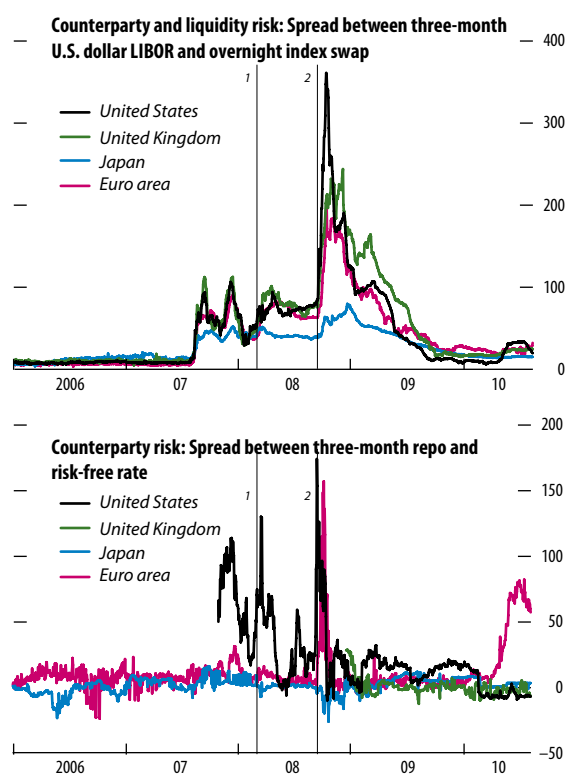


Sources: Bloomberg L.P.; and IMF staff estimates.

1. March 14, 2008: Bear Stearns rescue.

2. September 14, 2008: Lehman Brothers failure.

Figure 2.6. Selected Indicators of Short-Term Funding Rates
(In basis points)



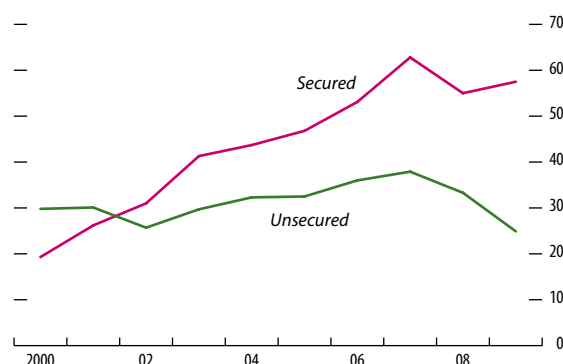
Source: Bloomberg L.P.

Note: Risk-free rate refers to a three-month government bond rate.

1. March 14, 2008: Bears Stearns rescue.

2. September 14, 2008: Lehman Brothers failure.

Figure 2.7. Share of Average Daily Turnover of Secured and Unsecured Lending and Borrowing for Euro Area Banks
(Total aggregated average daily turnover volume in 2002 = 100)



Source: European Central Bank, *Euro Money Market Survey 2009*.

Note: The total turnover includes unsecured lending and borrowing, secured lending and borrowing, derivatives, and short-term securities.

liquidity through repo-based activity and as a buyer of last resort of short-term distressed assets (Figure 2.9). Moreover, sustained adverse funding and market liquidity conditions as well as the push to increase longer-term funding have started to erode banks' margins and earnings, since long-term funding is more expensive (see Chapter 1 for more details on current funding conditions).

Funding Markets as Propagation Channels of Systemic Liquidity Risk

Secular Shift in Banks' Funding Markets

While banks have always specialized in maturity transformation from short-term liabilities, primarily in the form of deposits to long-term loan assets, a noticeable development of the pre-crisis period has been greater reliance on short-term wholesale funding. Banks in Korea, the United Kingdom, and the euro area have made greater use of short-term wholesale funding to expand their balance sheets, although there is considerable variation within countries and across banks in the euro area (Figure 2.10) (ECB, 2009b). In the United States, commercial banks have made less direct use of short-term wholesale funding, although the balance sheet data do not account for the largest banks' exposures to their off-balance-sheet vehicles. Focusing on U.S. banking data also ignores the significant increase in maturity transformation by investment banks that relied extensively on very short-term wholesale funding (Figure 2.11).

In most of these countries, global financial integration, along with deregulation and innovation (such as securitization), has permitted banks to diversify funding sources, including across currencies and markets. In the United States, key participants in the "shadow banking" system, such as money market mutual funds (MMMFs), have been central to this trend (Figure 2.12). Banks and other institutions such as broker dealers, finance companies, and off-balance-sheet vehicles and conduits, have tapped these for short-term funding.

Repo as a Driver of Wholesale Funding Growth

The repo market has represented the fastest growing component of the wholesale funding markets, and hence it is useful to understand its genesis (Box 2.3).

Table 2.1. Typical Haircut on Term Securities Financing Transactions*(In percent)*

	BBB+/A Corporates	AA-AAA Corporates	A-AAA ABS- Auto/CC/SL	AA-AAA- RMBS/CMBS	< AA ABS- RMBS/CMBS	Unpriced ABS/MBS/All Subprime	AA-AAA CLO	AA-AAA CDO	Unpriced CLO/CDO
2007:Q1	0	0	0	0	0	0	0	0	0
2007:Q2	0	0	0	0	0	0	0	0	0
2007:Q3	0	0	0	0	0	0	0	0	0
2007:Q4	0	0	0	0	0	0–5	0	5–10	5–10
2008:Q1	0	0	0–5	0–10	5–15	10–20	0–10	15–25	20–30
2008:Q2	0	0	0–5	5–10	10–15	15–20	10–15	20–30	30–35
2008:Q3	0	0	5–15	0	15–25	n.a.	0	25–30+	30–40
2008:Q4	0–5	0–5	10–20	20–30+	20–30+	n.a.	0	n.a.	n.a.
2009:Q1	0–5	0–5	15–20	20–30+	20–30+	n.a.	25–35	n.a.	n.a.
2009:Q2	0–5	0–5	15–20	20–30+	20–30+	n.a.	25–35	n.a.	n.a.

Source: Gorton and Metrick (2009).

Note: BBB+/A Corporates = corporate bonds rated between BBB+ and A, inclusive; AA-AAA Corporates = corporate bonds rated between AA and AAA, inclusive; A-AAA ABS Auto/CC/SL = asset-backed securities (ABS) comprised of auto loans, credit-card receivables, or student loans, with ratings between A and AAA, inclusive; AA-AAA ABS RMBS/CMBS = residential mortgage-backed security (RMBS) or commercial mortgage-backed security (CMBS) with ratings between AA and AAA, inclusive; < AA ABS RMBS-CMBS = RMBS or CMBS with ratings AA and lower, inclusive; Unpriced ABS/MBS/All Subprime = all tranches of ABS and MBS and all subprime securitized bonds that do not have public pricing posted on Bloomberg or Reuters; AA-AAA CLO = collateralized loan obligations (CLO) with ratings between AA and AAA, inclusive; AA-AAA CDO = collateralized debt obligations (CDOs) with ratings between AA and AAA, inclusive; Unpriced CDO/CLO = all tranches of CDO and CLO securitized bonds that do not have public pricing posted on Bloomberg or Reuters.

Repo markets have doubled in size since 2002, with gross outstanding amounts for the United States and euro area repo markets at year-end 2007 amounting to \$10 trillion, and another \$1 trillion for the U.K. repo market (Hördahl and King, 2008). However, these numbers are estimates given that almost all of the repo transactions are conducted over the counter.

The legal security afforded by repo operations has made them attractive and accessible to a broad class of investors and was a major reason for their rapid expansion. Unlike unsecured money market lending, the security offered by the irrevocable transfer of legal ownership of the collateral gave repo cash lenders a sense of protection against counterparty risk. It thereby created a larger potential set of counterparties for banks, as well as funding alternatives and short-term investments for other market participants, such as money market mutual funds, corporate treasurers, and investment banks.

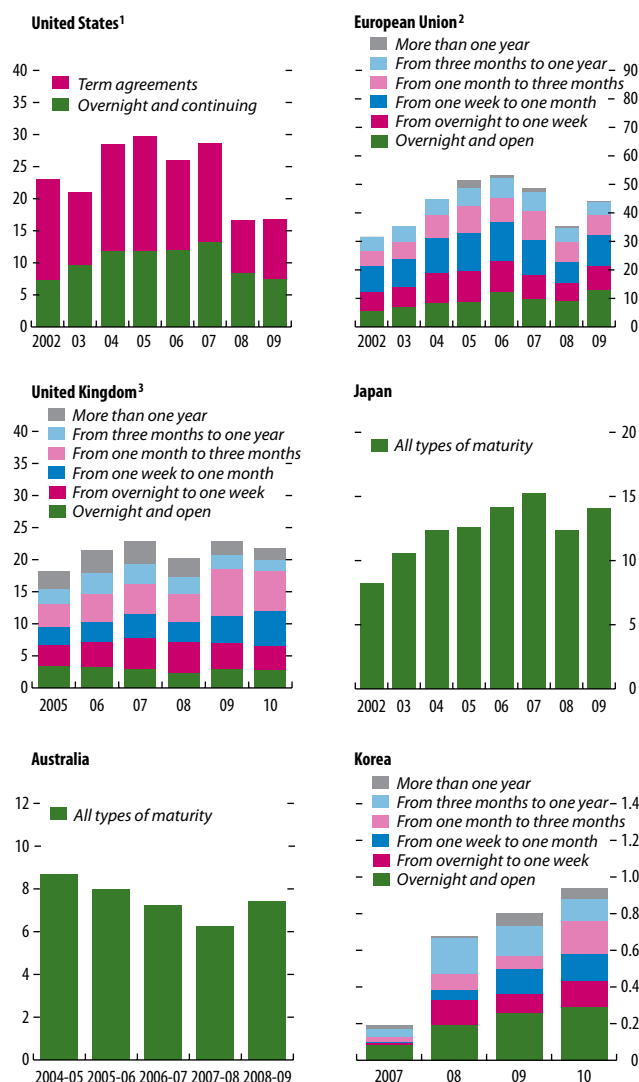
In recent years, repo operations have benefited from other developments. The greater use of CCPs in Europe and triparty arrangements in the United States allow for

the centralization of some administrative functions such as collateral management. Rapid securitization allowed for wider use of securitized products as collateral. Regulations under Basel I and II also favored repos as a funding instrument. Banks sought alternatives to lower capital charges associated with unsecured transactions and used repo operations to do this. This in turn freed up capital and allowed them to add leverage to grow more rapidly, while it also spurred demand for lower-rated collateral (Chailloux and Jobst, forthcoming).

Growing Role of Money Market Mutual Funds

MMMFs have played a central role in of the wholesale money market, and in the run-up to the crisis, with their outright purchases of mortgage-backed ABCP.¹² MMMFs have also been critical

¹²The U.S. MMMFs' total holdings of financial assets at end-2009 amounted to about \$3.3 trillion, equivalent to 22 percent of GDP, and they also account for a significant share of the triparty repo market. See Senior Supervisory Group (2009) and Investment Company Institute (2009).

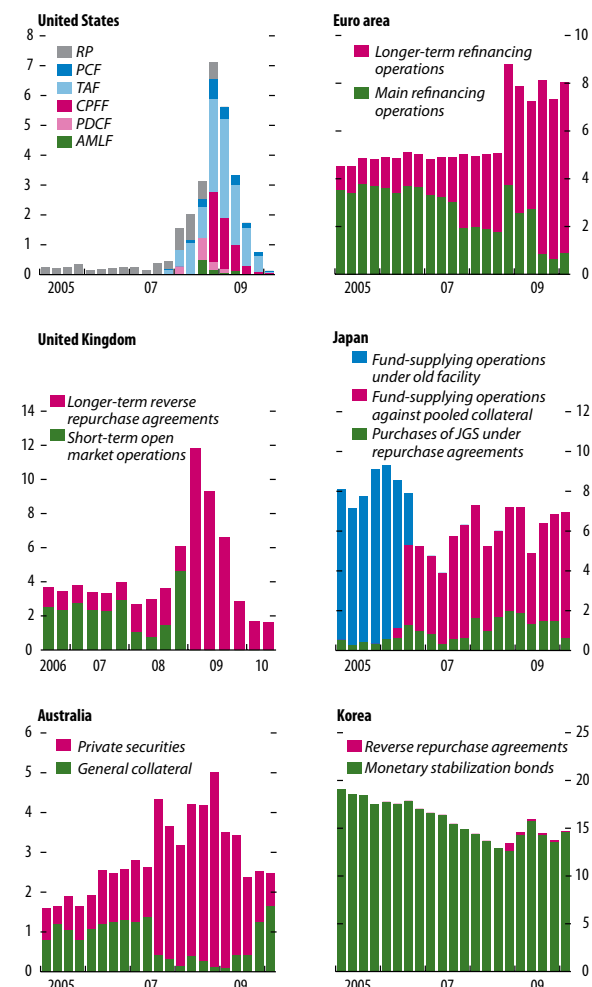
Figure 2.8. Outstanding Amounts of Private Market Repo Operations
(In percent of GDP)

Sources: European Repo Council; International Capital Market Association; Australian Financial Markets Association; Association for Financial Markets in Europe; Asia Securities Industry and Financial Markets Association; Korea Securities Depository; Federal Reserve Bank of New York; Bank of Japan; and Bank of England.

¹Data based on the primary dealer statistics published by the Federal Reserve Bank of New York, reflecting the general trend of repo market operations. These statistics exclude transactions between counterparties that are not primary dealers, such as mutual funds.

²Data based on ERC-ICMA European Repo Survey, excluding forward-start repo operations. The survey also includes repo operations of non-European banks within Europe.

³Data include only transactions based on government collateral (U.K. gilts).

Figure 2.9. Central Bank Temporary Reserve-Providing Operations
(In percent of GDP; outstanding amounts unless noted otherwise)

Sources: U.S. Federal Reserve; European Central Bank; Bank of England; Bank of Japan; Reserve Bank of Australia; CEIC database; and IMF, World Economic Outlook database.

Note: The panels show central bank operations that add reserves to the system, excluding outright asset purchases (sometimes described as permanent reserve-providing operations) and foreign exchange swap operations. Changes from pre-crisis levels in these temporary reserve-providing operations reflect additional central bank support of the market, which allows for uniform treatment of different central bank balance sheets. Other operations are not considered as differing practices in the outright purchases, and in the level of remuneration of excess reserves, complicate comparisons across central banks. TAF = Term Auction Credit Facility; CPFF = Commercial Paper Funding Facility; PDCF = Primary Dealer and Other Broker-Dealer Credit Facility; AMLF = Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility; PCF = Primary Credit Facility; RP = repurchase agreement; JGS = Japanese government securities. The TAF, CPFF, PDCF, AMLF, and PCF were introduced by the United States in 2008.

in financing foreign banks' short-term U.S. dollar funding needs. Financial reports of prime money market mutual funds show that they placed about half of their assets in securities (such as certificates of deposit) issued by non-U.S. banks (Baba, McCauley, and Ramaswamy, 2009).

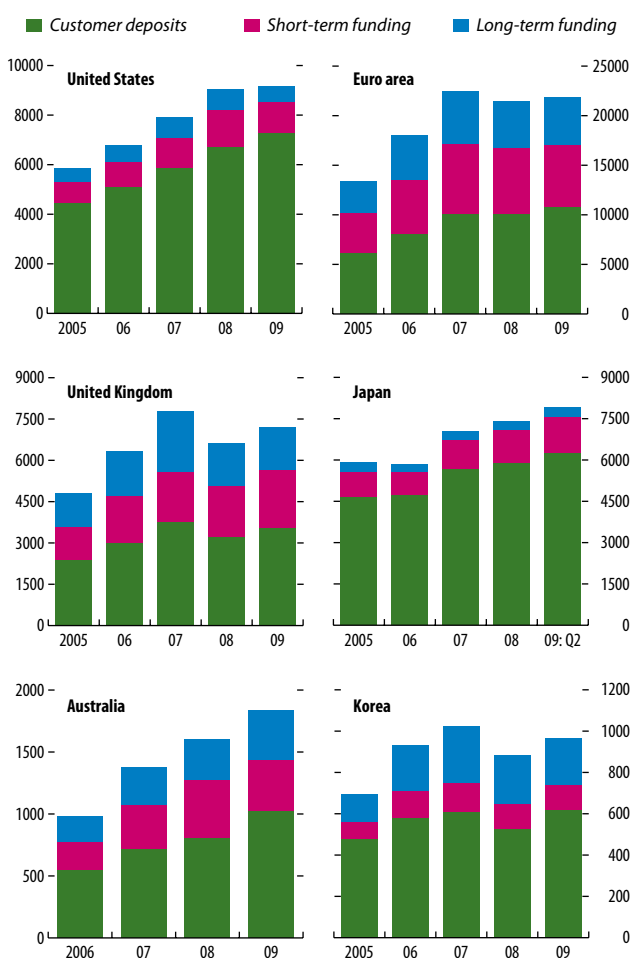
MMMFs in the United States originated in the 1970s from a desire by investors to escape Regulation Q, which set a ceiling on interest rates offered by deposit-taking institutions on demand deposits, and to avoid the reserve requirements imposed on depository institutions. MMMFs have also flourished due to two key regulatory features: (1) "hold to maturity" accounting conventions that allowed them to use stable net asset values (NAVs) for reporting and redemptions; and (2) the right to take on some credit, market, and maturity risk without being subject to stringent regulations. In the past, sponsoring banks made (and on a number of occasions had to fulfill) an explicit commitment to support the losses of their MMMFs with their own resources if the share values were to fall below par ("breaking the buck").

By contrast, MMMFs in Europe have not taken such a central role in maturity transformation.¹³ MMMFs in Europe are predominantly used by institutional investors, and many operate with both variable and stable NAVs. ECB monetary data show that MMMF holdings for the area as a whole remain small relative to banks' retail deposits (around 8 percent).¹⁴ This evidence is further corroborated by industry data that highlight the limited development of MMMFs in Europe: the European Fund and Asset Management Association shows that MMMF holdings in the United States represent 2.5 times the outstanding amount in the European Union (EU). This is in part because some of the incentives to move from deposits to MMMF investments that are present in the United States (such as higher reserve requirements and no interest payable on demand deposits) are absent in the European financial system.

¹³The term MMMF covers a range of different assets in the European Union, mostly falling under Undertakings for Collective Investments in Transferable Securities Regulations; steps are being taken to harmonize definitions and regulation.

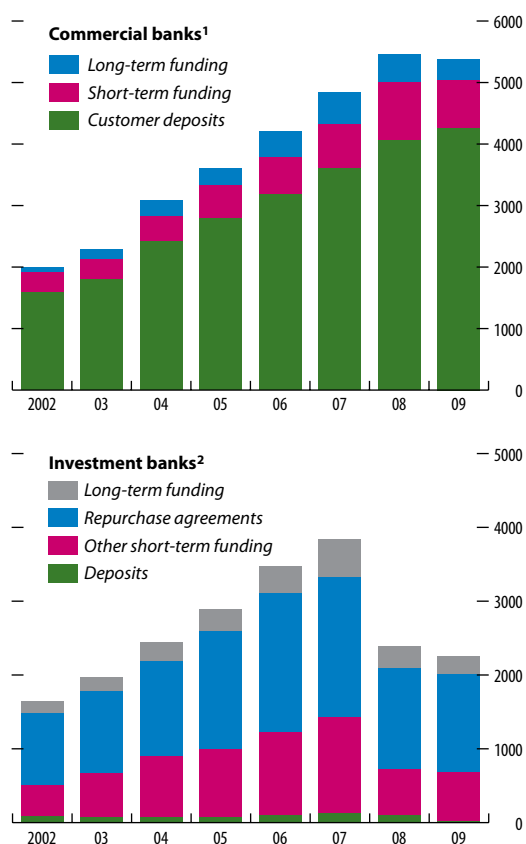
¹⁴This includes demand deposits and time deposits.

Figure 2.10. Commercial Bank Funding Structure
(In billions of U.S. dollars)



Source: ©2003 Bureau van Dijk Electronic Publishing-Bankscope.
Note: The selected banks account for more than 80 percent of each country's total bank assets.

Figure 2.11. United States: Funding Structure of Selected Largest Commercial and Investment Banks
(In billions of U.S. dollars)



Source: ©2003 Bureau van Dijk Electronic Publishing-Bankscope.

Note: Short-term funding is funding with maturity less than one year.
¹Top 10 commercial banks in terms of total assets.

²Data for investment banks capture 60 percent of total investment bank assets as reported by Bankscope. For 2008 and 2009, data exclude Lehman Brothers and Bear Stearns.

In Japan, MMMFs witnessed strong growth in the 1990s as investors sought higher yields to offset close to zero interest rates on bank deposits—a result of the Bank of Japan’s monetary easing. However, in the fall of 2001, several MMMFs’ net asset values fell, due mainly to defaults of bonds issued by Enron, and investors incurred financial losses.¹⁵ As a result, investors shifted their funds back to bank deposits (deposits at the time were protected by the government’s blanket guarantee), and MMMF investments have remained low since then.

The Buildup of Vulnerabilities

The greater use of short-term wholesale funding was key to the buildup of vulnerabilities in the system, including excess leverage and maturity mismatch. A number of studies have shown that financial systems that relied more on wholesale funding were more vulnerable to the global financial crisis.¹⁶ The greater use of wholesale funding exposed them to new types of liquidity-related risks that were fully accounted for neither in the risk management practices of financial institutions nor in the systemic oversight framework of regulators (Box 2.4). The risks include those delineated below.

New Counterparty Risks

- The broadening circle of repo users to less regulated institutions that are either outside of the purview of supervisors, or subject to a different supervisory regime, or not regulated at all made it difficult to monitor exposures. The critical role played by MMMFs in the short-term funding

¹⁵In Japan, MMMFs are valued on a daily basis at market value.

¹⁶Ratnovski (2009) explores the factors behind the unusual resilience of Canadian banks and finds that they relied less on wholesale funding than their peers in other advanced countries. Rajan (2006) notes that banks’ greater reliance on market liquidity makes their balance sheets more suspect in times of crisis. Demirgüç-Kunt and Huizinga (2009) found that banks’ reliance on nondeposit sources of funds increases their risk. Other studies show that banks that relied more heavily on wholesale funds were more affected by the liquidity crunch, experienced a larger abnormal decline in their share prices, and cut back more on lending activity (Raddatz, 2010). See also Brunnermeier (2009), Adrian and Shin (2009), and Ratnovski and Huang (2010).

market was not well understood. This increased the vulnerability of funding markets to a sudden withdrawal of liquidity by the MMMFs as their investors made redemption requests.

Credit Risks of the New Collateral

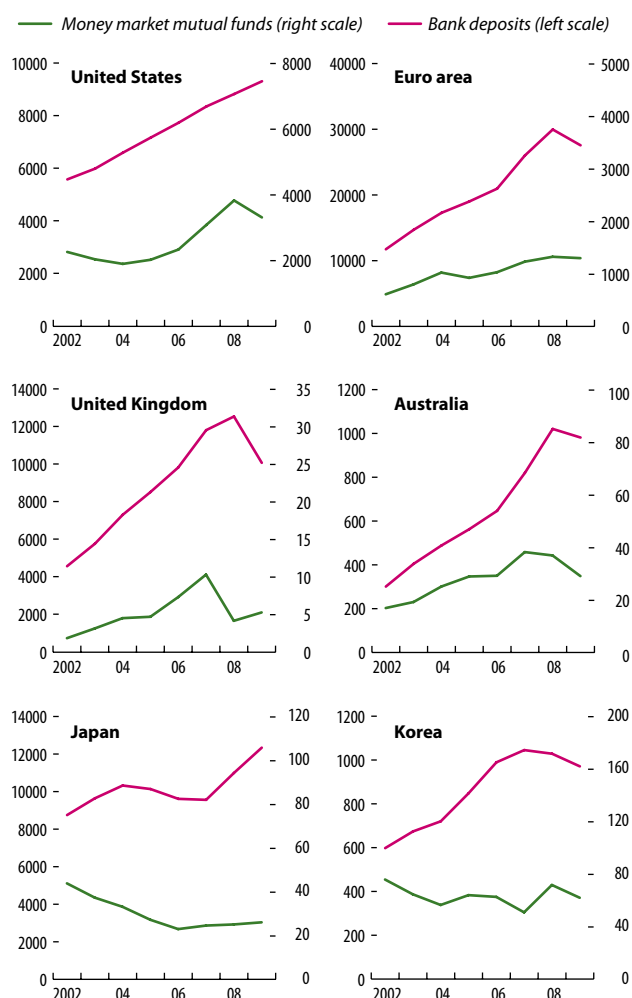
- As risks were increasingly underestimated in the run-up to the crisis, lower-quality securities began to be used as collateral in secured funding markets. This use was encouraged by a change to the U.S. bankruptcy code in 2005 that allowed a safe harbor for mortgage-backed and related securities in repo transactions, implying that these securities would not be pooled with other assets for distribution to other creditors.¹⁷
- At the same time, the generalized use of models to assign values for infrequently traded, exotic structured credit products supported their growing use as collateral in part because the models did not reflect the discount that fire sales would generate and the likelihood of longer liquidation periods. Hence, these securities were inappropriately being valued around par on an ongoing basis, generating haircuts close to zero.

Underestimation of Market Risks

- The prolonged low nominal interest and unusual low risk premia environment led to an underestimation of market risk, overestimation of asset valuations, and compressed margins. This in turn allowed for faster asset expansion that banks in turn could use to access credit markets. In this environment of rising values of collateral assets, repo providers also opted for small haircuts to maximize the potential for higher collateral turnover of their repo operations. Such procyclicality-induced feedback effects resulted in excessive leverage and risk taking in the upswing, and as a consequence, excessive deleveraging in falling asset markets, both with consequences for financial stability and the real economy.

¹⁷This provision was previously restricted to treasury and agency securities, certificates of deposit, and bankers' acceptance (Sissoko, 2010).

Figure 2.12. Bank Deposits versus Money Market Mutual Funds
(In billions of U.S. dollars)



Sources: Investment Company Institute; CEIC database; Haver Analytics; Australian Bureau of Statistics; Investment Trusts Association, Japan; and IMF, International Financial Statistics database.

Note: Total net assets of money market mutual funds; and amounts outstanding of bank deposits.

Complex and Poorly Understood Infrastructure

- Although to a lesser extent, some of the vulnerabilities were exacerbated by poorly understood incentives in the repo market infrastructure and uncertainties about how it might function during a period of stress. For instance, the growing use by institutions (notably in the United States) of triparty agents for repo operations contributed to the watering down of margin maintenance as due diligence was essentially transferred from the original counterparties to these agents.
- The fragmented structure of repo service providers in Europe (Box 2.5), with multiple trading venues and competing collateral management venues, including three CCPs, a large number of national central security depositories (CSDs), and two established international central security depositories (ICSDs)—Clearstream and Euroclear—has repeatedly contributed recently to difficulties in the European repo market.¹⁸
- In the United States, the concentration of a key element of the repo market infrastructure in two banks, Bank of New York Mellon and JPMorgan Chase, providing triparty repo agent services, has been considered a vulnerability of liquidity risk management in the United States.¹⁹

In sum, the buildup of vulnerabilities to systemic liquidity risk occurred through shortcomings in liquidity risk management at individual institutions, poor market practices, the complexity of the infrastructures of funding markets, and regulatory gaps. Hence, policymakers will need to develop solutions that address all these shortcomings. This will help mitigate systemic liquidity risk and lower the probability of liquidity crises occurring. These solutions are addressed in the next two sections.

¹⁸Some of the cross-border settlement difficulties reflect the fact that most of these national systems were created before the establishment of the euro. See also the recent report by the Committee on Payment and Settlement Systems (CPSS, 2010) for further details on the fragmented nature and associated risks of repo markets.

¹⁹The U.S. Financial Sector Assessment Program also identified the inadequacy of risk management practices of cash lenders and clearing banks and the lack of effective plans for managing the triparty collateral of a large securities dealer in the case of its default as vulnerabilities (IMF, 2010a).

Policies to Strengthen the Resilience of Funding Markets

A striking feature of the financial crisis has been the breakdown of the short term secured funding markets. It is not unusual to find the unsecured interbank markets shut down during times of financial stress, as institutions ration liquidity and credit, but what was more puzzling about the crisis was the inability of financial institutions to borrow short-term against assets that had relatively low risks (Acharya, Gale, and Yorulmazer, 2008). While unsecured markets are vulnerable to changes in perceived counterparties, such concerns should be mitigated in collateralized transactions. Going forward, reforms should be aimed at improving the functioning of both the secured and unsecured markets, acknowledging that such reforms may be less effective in the unsecured market, as the reason for its breakdown during times of distress and heightened counterparty risk is harder to fix. Nonetheless, policymakers should strive to ensure that both markets provide for a more reliable source of funding during good and bad times.

Fixing the Unsecured Interbank Market

Determining how best to repair the unsecured market is difficult because the underlying reason for the dislocation in times of systemic crisis is the widespread uncertainty regarding counterparty risk that occurs when perceived credit differentiation closes the market to some participants.

Hence, better information available to participants so that they can accurately assess counterparty risks would be necessary to keep unsecured interbank markets open at such times. It should be recognized that information available to market participants may not entirely address counterparty concerns, particularly when disruption in unsecured markets remains protracted. In these cases, supervisors may ultimately need to address the uncertainty by identifying insolvent institutions in the system and using bank resolution tools to restore confidence.

Fixing the Secured Funding Market

As noted above, two main vulnerabilities deserve special attention to fix the functioning of secured markets: (1) collateral valuation and margin policies; and

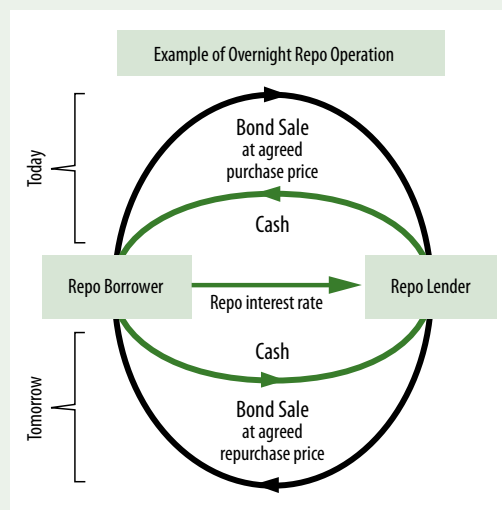
Box 2.3. The Repo Markets: A Primer

The repo market is used by large institutional investors to lend short-term cash, while banks and broker-dealers and others use it to borrow by offering collateral in return for cash. The market was at the epicenter of the global funding crisis, as cash lenders began asking for larger haircuts and safer securities as collateral. This box explains key features underpinning a repo transaction.

A repurchase agreement (or “repo”) is a sale of securities coupled with an agreement to repurchase the same securities at an agreed price at a future date, typically at a higher price. Functionally, it is similar to a collateralized loan, where the borrower pledges securities as collateral. The transfer of ownership for the duration of the transaction offers a high degree of security by limiting the credit risk to that of the underlying assets. The most commonly used collateral is government bonds, though corporate bonds, municipal bonds, asset-backed securities, and equities may also be used. Since the cash provider is in possession of the security, the provider can sell the asset to recover the cash if the cash borrower defaults on its obligation. Most repo operations are overnight, but “term agreements” are struck for several months or longer. On maturity, the borrower pays back the loan principal with interest and the lender returns the collateral.

Cash borrowers pay a repo rate, tied to general market interest rates, which is typically lower than unsecured money market rates because a repo is less risky. The repo lender determines the collateral eligibility and the haircut that caps the maximum loan amount. Historical price variability of the security may cause the cash lender to insist on asking for more collateral value than the amount of the loan. The difference is the initial margin (or haircut). The initial margin protects the buyer against a decline in collateral value and against counterparty risk.

The safety of a repo ultimately relies on the adequacy of the collateral (and the legal contract). Lenders accept illiquid collateral only subject to appropriate initial margins and limits. Collateral is regularly revalued and, if its value falls, extra col-



lateral is quickly requested (a process called margin maintenance). Due to relatively intense operational requirements, some repo participants outsource the management of their collateral to so-called triparty repo agents. This is most common in the United States because of the administrative burden of handling a large number of nongovernment securities. More generally, the effectiveness of repo markets is a function of the market liquidity in which the collateral trades and the soundness of clearing and settlement frameworks.

The cash lender can re-use the collateral during the term of the repo, whether via an outright sale, an onward repo, or a pledge to a third party. If the lender sells the asset outright, it is taking a short position. When the lender is willing to accept a wide range of securities as collateral (mostly high-grade government and perhaps corporate bonds), the repo is against general collateral. Most repos are based on general collateral. A special repo is where the cash lender specifies the securities (which may include equities) needed in the context of its operations (for example, to make delivery in a separate transaction). Special repos are commonly used by securities dealers. In order to deliver the promised security the dealer will arrange to borrow it through a special repo transaction with a client or another dealer, or alternatively purchase the security outright.

Note: This box was prepared by Andreas Jobst.

Box 2.4. What Went Wrong in Financial Firms' Liquidity Risk Management Practices?

The recent global crisis revealed regulatory and institutional shortcomings in liquidity risk management at individual institutions. This box discusses the main shortcomings in liquidity risk management, drawing from industry surveys, including Deloitte (2009), ECB (2007, 2008), and Senior Supervisory Group (2009).

Prior to the crisis, liquidity risk generally took a backseat in importance to credit and market risk management. There was no regulatory capital charge against liquidity risk under the Basel framework, unlike credit and market risks, with the regulatory focus on solvency. Liquidity risk was mostly considered a short-lived funding problem and not a threat to a financial institution's profitability and solvency. Central bank operations and deposit insurance schemes were considered sufficient to handle liquidity problems at a bank and system-wide level. Money markets were viewed as efficient, with repo markets, in particular, believed to buffer cash lenders against counterparty and credit risks, and deeply liquid, as evidenced by their treatment under the Basel II capital regime.

Although banks did have a liquidity risk management system, including liquidity stress testing and a contingency funding plan, they were unprepared for a long-lasting liquidity shock and the systemic nature of the crisis, and failed to account for the following:

- The possibility of a severe or complete shutdown of secured funding markets owing to concerns about the liquidity of markets for assets used as collateral. While some tested for increased haircuts and margin calls, they were usually meant to reflect increased counterparty risk specific to the borrowing bank, rather than the generalized precipitous price decline across a wide class of underlying collateral assets.

Note: This box was prepared by Hiroko Oura.

- The possibility of second-round market effects and other amplification mechanisms causing liquidity spirals and nonlinear effects, including rising counterparty risk concerns. The close interaction between market and funding liquidity and counterparty risk—whereby small initial shocks could be transmitted to a wider range of markets and participants—was not appreciated.
- The possibility of a simultaneous and severe disruption in several key funding markets. While some banks tested for some funding market shutdown, the extent of affected funding markets was much wider than anticipated in stress tests and contingency plans.
- The possibility that potential contingent cash liabilities would materialize. Many banks were forced in the crisis to provide cash support to their sponsored off-balance-sheet vehicles because of credit guarantees, credit line commitments, or reputation-based support, although in some cases they had no legal obligation. Such operations expanded the need to find cash in distressed funding markets.
- The possibility of a long-lasting liquidity shock. Liquidity shocks are commonly viewed as short lived. In this crisis, liquidity stress is still ongoing, affecting funding options, net interest margins, and earnings, and could affect some institutions' solvency.
- Underestimation to an extent reflects the fact that these extreme market funding events had never occurred, and hence there was no historical event on which to rely for modeling and operational risk management purposes. This in part reflects the enormous structural changes that have occurred in the banking sector and global financial system, including the critical importance of nonbank financial institutions in maturity transformation.

(2) infrastructure issues, such as clearing and settlement, including the use of CCPs.

Both the U.S. Triparty Repo (TPR) Infrastructure Reform Task Force and a working group associated with the Committee on the Global Financial System have put forth sets of recommendations to address

shortcomings brought to the fore in collateral valuation and margin policies by financial institutions. Implementation of these recommendations would help minimize macro-prudential risks emanating from collateral management and risk management practices. They include:

Box 2.5. Repo Infrastructure: Trading, Clearing, and Settlement

Repo operations are supported by a complex trading and settlement infrastructure that involves various service providers and trading and clearing platforms as well as risk management systems. It tends to be also fragmented within and across countries, reflecting the fact that repo trades can take place at a bilateral level, through triparty agents, or through central counterparties. This box briefly describes the key functions that service providers offer.

Repo operations basically comprise six different functions: trading, matching, collateral management, clearing, custody, and settlement. Repo operations can be conducted bilaterally between two market participants, or using a third party to which collateral management is outsourced, i.e., using a triparty repo arrangement. The third party can be a custodian bank or any entity providing operational services, such as custody of securities, settlement of cash and securities, collateral valuation, and optimization tools to allocate collateral efficiently (like those provided by Euroclear Bank and Clearstream Banking, the two large international central security depositories).

Repo trading is carried out electronically (via trading platforms, such as BrokerTec or MTS, the electronic

platform for euro-dominated government securities trading) or through traditional over-the-counter channels. Electronic trading venues generally offer various clearing and settlement options, which allow trading counterparties to either channel their settlement instructions through clearinghouses, such as central counterparties (CCPs), or directly toward local central security depositories. Some trading platforms offer trading, matching services, and automated connection to a CCP that guarantees fulfillment of transactions and collateral management across different custodians (like Eurex Clearing general collateral repo pooling services).

Where a CCP is used, it acts as a clearinghouse between the trading counterparties and, after execution of a trade (confirmation), enforces the specific terms of the contract and guarantees their satisfaction until maturity. In this capacity, it undertakes the following functions: (1) daily valuation of the contract, including the determination/application of haircuts and the adjustment of margins according to day-to-day changes in replacement cost (variation or mark-to-market valuations); (2) the monitoring of counterparty risk to ensure the compliance of dealers with the terms of the contract; and (3) initiation of settlement to recover net final payments if default or termination occurs.

Note: This box was prepared by Alexandre Chailloux and Andreas Jobst.

Repo Market: Service Providers and their Functions

Service Providers	Institution Name	Functions					
		Trade	Match	Collateral Management	Clearing	Custody	Settlement
Electronic trading platforms	BrokerTec, MTS, Eurex Repo	✓	✓ ¹				
Trade matching and regulatory reporting systems	Trax and Trax II		✓				
Triparty agents	Euroclear Bank, Clearstream Banking, SIS SegalInterSettle, JPMorgan Chase, Bank of New York Mellon			✓	✓	✓ ¹	✓ ¹
	LCH.Clearnet, Cassa di Compensazione e Garanzia, Eurex Clearing, Fixed Income Clearing Corporation (FICC), Japan Government Bond and Clearing Corporation (JBCC)	✓	✓	✓	✓		
Central counterparty/ Clearinghouse							
Central security depositories (CSDs)	Euroclear Bank, Clearstream Banking, National CSDs					✓	✓

Note: This table is not meant to be comprehensive and does not include smaller service providers with limited geographic reach.

¹Not provided by all service providers in this category.

- *Enhance collateral valuation practices.* This can be achieved through (1) more frequent collateral valuation adjustments, (2) more realistic assumptions in terms of holding and liquidation periods, and (3) more rigorous valuation approaches (that restrict the eligibility of the most hard-to-price and illiquid assets as collateral). Sound valuation methodologies would also need to rely on “mean reversion” (through-the-cycle) assessments of volatility, spreads, and liquidity of the underlying market.
- *Strengthen margining standards.* This can be achieved through higher frequency changes to margin, with incremental margin adjustments more desirable than discrete, large-scale margin calls that can be destabilizing. This would require greater transparency about how margin policies are constructed and so-called “haircut grids” that assign differential haircuts to different types of collateral, maturities, and counterparties. The setting of initial margins should be calibrated to account for the likelihood of longer periods for liquidating the underlying collateral. In addition, supervisors should periodically validate the initial margins generated by banks’ in-house models.
- *Minimum haircuts/initial margins.* Some thought is being given to having regulators assign minimum haircuts that would be recalibrated for different collateral types. While such regulatory oversight is welcome, it would be important that such minimum margins respond over time to changes in risk, which, if ignored, could have unintended consequences for the flows of liquidity.
- *Transparency and independent pricing.* One way to minimize the risk of pricing disputes and sudden adjustments to collateral values (so-called “cliff effects”) is to have third parties provide on a continuous basis price estimates for collateral used in repo transactions that could be used by others. More generally, greater provision of data to the market would help enhance collateral risk management. To this end, in May 2010 the U.S. Federal Reserve began collecting and releasing data on types of repo collateral and on margin levels to the public.

While to date market regulators have been advocating the use of CCPs as a key tool to mitigate counterparty

risk in OTC markets, the use of CCPs for repo transactions, which can lower operational, counterparty, and liquidity risk in repo transactions, should be encouraged as well.²⁰ To facilitate the use of the growing number of CCPs in Europe, the Operations Group of the European Repo Council (ERC) recently reached an agreement with the two ICSDs to establish linkages so as to permit their collateral pools to serve as the basis for repos to be cleared by customers at their preferred CCP.²¹

The key benefits of using CCPs in repo transactions are:

- They lower operational risk by specifying and enforcing consistent collateral and margin agreements. Unlike bilaterally negotiated deals, CCPs maintain the same set of procedures and rules for all their clearing members.
- They mitigate counterparty risk for clearing members by guaranteeing the satisfaction of contractual agreements and can use collateral posted to them as part of the clearing member obligations to close out the position even if the repo borrower defaults. The underlying collateral for the repo transaction is automatically allocated to the owed clearing member in the CCP.
- They can reduce liquidity risk and improve collateral management through the process of multilateral netting. While bilateral repo counterparties can net standardized trades when supported by legal opinions, CCPs net exposures across multiple repo transactions of all clearing members, optimizing their use of collateral and better conserving economic capital. Netting helps lower the potential loss incurred by a repo cash lender to a specific defaulting repo borrower.²² Since more multilateral netting can be accomplished when trades are concentrated in a single CCP, too many CCPs would lessen this benefit. Here, policies could be considered that

²⁰See IMF (2010b) for a fuller discussion of CCPs in the context of OTC derivatives.

²¹The proposed model foresees enhanced trading in triparty repos, via a single CCP, with settlement neutrality (i.e., the CCP evaluates and allocates collateral for settlement requirements, but settlement can occur with any ICSD or CSD) pending final agreement on collateral transfers.

²²Contract netting occurs when identical cash flows within a contract are netted. In addition, payment netting occurs throughout the life of a transaction as all payment obligations are replaced with a single amount on each payment date.

would not discourage greater cross-border linkages across CCPs to accomplish this goal.

As with CCPs in the OTC derivatives markets, CCPs serving repo markets should be subject to minimum regulatory requirements ensuring their safety and soundness. This would help to assure a level playing field across CCPs, prevent unhealthy competition between CCPs, and enhance the transparency of how the infrastructure operates.

However, moving repos to CCPs is not costless. Because the use of CCPs entails greater focus on collateral policies and the posting of particular types of collateral, there are implications for the market liquidity of eligible collateral—a particular concern for other repo participants. The concentration of some types of collateral within CCPs could become a source of systemic risk itself unless CCPs themselves are subject to very high-quality risk management processes that help avoid high correlation between collateral and counterparty risk. Moreover, the collateral posted at CCPs is not available for other uses, potentially lowering the liquidity of some types of collateral and earnings from reletting the collateral (called “rehypothecation”) that is taken out of circulation.

In the United States, discussions to strengthen the clearing and settlement process in repo transactions have mainly focused the triparty repo markets. The TPR Task Force has proposed reforms to the current operational arrangements, including the elimination of the intraday exposure of clearing banks created by the daily unwinding of all trades. It also emphasized the need for market participants to manage liquidity risk more conservatively, notably with respect to the risk posed by the reliance on the rollover of large overnight funding operations, and to the assumptions made on the liquidity of various types of collateral under stress.

Minimizing Investor Runs: Money Market Mutual Funds

A number of reforms have been put in place to address MMMFs’ critical role in the secured funding market, with the main focus on minimizing the risk of a run by investors. The U.S. Securities and Exchange Commission recently modified its “2a-7 Funds” rule governing mutual funds under the Investment Company Act. These funds will face

new constraints in terms of asset quality and new liquidity rules so that they can withstand increased redemption pressures. MMMFs will be required to hold 10 percent of their assets in liquid instruments that can be liquidated within one day and 30 percent of their assets in instruments that can be liquidated within one week.²³ They must maintain a maximum weighted average maturity of 60 days, down from 90 days at present, to lower maturity mismatch risks. They face more restrictive limits on collateral acceptable for their repo operations, a ban on the ability to hold illiquid securities, and additional financial disclosure. They also are now permitted to suspend redemptions if asset values fall below a certain level, to allow for an orderly liquidation of assets.

These measures are a significant step forward to lowering the risk profile of the industry, but may not be sufficient to mitigate the systemic liquidity risk this sector poses in the medium term. Ideally, institutions that contribute to systemic liquidity risk via maturity transformation and which offer banking services should be set up and regulated as banks. One option, then, for U.S. MMMFs would be to retain the bank-like nature of the business through relicensing as banks. This would clearly require a substantial change in structure, capitalization, and regulation.

The more favorable option, as it is a less fundamental change, would be to require that MMMFs, over time, move to a floating NAV. This could be too disruptive at the moment to implement given bank funding pressures, as it may result in investors shifting funds to banks and other markets, and thus its introduction would need to be carefully planned. (See Chapter 1 for a discussion of banks’ rollovers of liabilities over the next several years.) However, a floating NAV would enhance awareness that the market risks are borne by the investor, and that an MMMF investment is different from a bank deposit where there is a guaranteed return of the principal underpinned by public deposit insurance. This would also address level playing field concerns currently favoring MMMFs in the United States relative to commercial banks (Krug-

²³With some \$3 trillion of money market fund assets in 2009, the liquidity rules would require that the money market fund industry have \$290 billion in daily liquidity and \$870 billion in weekly liquidity (Investment Company Institute, 2009).

man, 2010; Tucker, 2010). Moving to a floating NAV would also eliminate the first-mover advantage, a contributor to destabilizing runs, whereby early redemption requests are paid at par, even if actual asset values are lower, leaving investors who redeem later to bear disproportionate losses.

One compromise, and an alternative idea floated by the industry to contain the risk of a run (while retaining a stable NAV), is to create a private liquidity “bank” that MMMFs could resort to in crisis times. The bank would augment the liquidity already required as a result of the recent rule changes. This, however, might not necessarily protect MMMFs against a systemic run, and in such circumstances the fund might need to close, and/or central bank intervention might be necessary to assure normal functioning in the money markets, as was the case in the current crisis.

More generally, there needs to be greater clarification as to the definition of money market mutual funds. In particular, there are a host of funds, so-called enhanced cash funds (ECFs) in the U.S. financial system, that, similar to MMMFs, aim to provide liquidity and capital (principal) preservation. ECFs are available only to institutional investors, not retail investors, and they are not regulated by the SEC 2a-7 rule.²⁴ However, the ambiguity over their status created some market confusion in 2007, as many ECFs were forced to shut down, and they were identified in the press incorrectly as money market mutual funds (Investment Company Institute, 2009). While not of systemic importance, they contribute to maturity transformation risk, and given their close resemblance to MMMFs, their role and regulatory status should be clarified. Similarly, the regulatory framework governing MMMFs in Europe also needs to be clarified and strengthened given their growing importance. As a first step in this direction, the Committee

for European Securities Regulators (CESR) published guidelines to harmonize the definition of MMMFs across Europe. These guidelines are approaching SEC’s Rule 2a-7, although differences remain, such as on minimum liquidity requirements. The proposed guidelines by CESR also retain the current choice whereby an MMMF can maintain either a floating or a constant NAV.

Policies to Strengthen Prudential Liquidity Regulations for Institutions

To help mitigate systemic liquidity risks by lowering the probability that an individual institution runs into liquidity difficulties, discussions are under way to impose prudential liquidity requirements on commercial banks. Several advanced countries have already upgraded their prudential liquidity regulations. These include New Zealand and the United Kingdom.²⁵ Switzerland finalized additional liquidity requirements based on the stress tests for its two big banks in June 2010.

The Basel Committee on Banking Supervision (BCBS, 2009) proposed in December 2009 two sets of standardized quantitative requirements to enhance liquidity buffers in the banking system: the liquidity coverage ratio (LCR), and net stable funding ratio (NSFR). These have subsequently been slightly modified.²⁶ The current plan is to phase in the LCR as of the end of 2012. The NSFR will be modified and final proposals will be issued later in 2010. The implementation of the NSFR is not expected before early 2018, after an observation period starting in 2012. The proposed regulations are to be applied to banks in a uniform manner, while national regulators may apply more stringent requirements to individual institutions based on their liquidity risk profile. The quantitative approach by the BCBS is the first instance of international consensus on liquidity requirements—a departure from the more qualitative recommendations that the Committee had previously endorsed—and

²⁴ECFs aim for a stable net asset value of \$1, but their NAV can fluctuate on a daily basis above and below that value. ECFs seek to deliver higher returns by including instruments with moderately longer maturities and by taking on somewhat more interest rate risk, credit risk, and liquidity risk than MMMFs. They emerged in the early 2000s due to low spreads in traditional cash equivalents (i.e., deposits and MMMFs) as investors began looking for short-term investment products that could provide better returns.

²⁵The United Kingdom’s liquidity requirements address some precursors to the systemic liquidity events witnessed during the crisis.

²⁶The December 2009 proposals were partially amended and reviewed in July 2010 and released in September 2010. See BCBS (2009, 2010a, 2010b).

represents a significant step forward (BCBS, 2008). The rules are as follows:

- *LCR*: The ratio is intended to ensure that banks can survive an acute stress situation lasting at least one month. The stress scenario includes specific assumptions on a combined idiosyncratic (institution-specific) and systemic shock (affecting the whole financial system).²⁷ Banks are required to maintain a level of unencumbered, high-quality assets that can be converted into cash to meet their liquidity needs for a 30-day time horizon in times of stress. The eligible assets include two tiers of liquid assets. Level 1 assets are cash, central bank reserves, and high-quality sovereign debt. Level 2 assets comprise high-quality corporate and covered bonds (with rating AA- or higher) and non-zero-risk-weighted sovereign debt (issued in foreign currency to the extent that this currency matches the currency needs of the banks' operations in that jurisdiction). Level 2 assets, however, will be subject to haircuts and limited to a cap of 40 percent of the overall stock of liquid assets.
- *NSFR*: This metric, as presented at end-2009, is still under review. Its purpose is to promote stable sources of funding in line with the liquidity profile of assets and contingent calls related to off-balance-sheet items. Available stable funding should be instruments that are expected to be reliable sources of funds over a one-year horizon under extended idiosyncratic stress.²⁸

The proposed regulations are a welcome addition to the solutions for systemic liquidity risk, as banks are encouraged to hold higher liquidity buffers and lower maturity risk. Liquidity risks are notoriously difficult

to measure and control, so the BCBS's proposal represents the first concrete attempt to address a consistent problem during the crisis. That said, there are a couple of areas that need to be further elaborated, and care needs to be given to the implications the rules may have on how banks fund themselves. This is why the BCBS recently decided to lengthen the phase-in period. The following outcomes should be accounted for in the final calibration of the regulations:

- Banks will likely compete more vigorously for deposits and other long-term funding sources, and those that rely more on secured short-term funding are likely to be more affected. Overall, funding costs are expected to rise given the limited pool of deposits, with a potential impact on net interest margins and profitability. This is already taking place in several countries where banks rely more heavily on short-term wholesale funding, partly due to bank management decisions and partly due to supervisory action. Also, deposits could become more interest rate sensitive and less stable, and hence less reliable. To the extent that these changes represent the true costs of safer and more stable funding they should be welcomed. Careful attention to whether they unduly constrain credit growth, however, is warranted.
- The regulations could also potentially push banks to take on more risks to maintain their profitability given the higher holdings of low-yielding liquid assets, and lower income from trading, while longer-term funding requirements could potentially reduce bank margins given higher funding costs.
- If liquid assets eligible for the regulation are defined too narrowly, market liquidity for government securities could potentially dry up as banks decide to hold on to these rather than manage their liquidity actively. This could change secondary market trading activity in government securities, and potentially undermine the price discovery and liquidity-generating function of certain assets. At the same time, excessive holdings of government securities could create unintended concentration risks for banks.
- Moreover, in certain jurisdictions, government securities may not be the most liquid securities market, given prudent fiscal policies and other factors, while other securities markets that are receiving less favorable regulatory treatment may be more liquid

²⁷Idiosyncratic shocks comprise credit rating downgrades, deposit runs, the disappearance of unsecured funding, surging haircuts for secured funding, or extra collateral for off-balance-sheet items (e.g., derivatives).

²⁸The NSFR is calculated as a ratio of available stable funding (ASF) sources to required stable funding (RSF) sources. This ratio should exceed 100 percent. The RSF is calculated by applying a factor to each category of assets according to their liquidity. Similarly, the ASF is calculated by applying a factor to each category of liabilities. Four categories of stable funding sources are proposed: Tier 1 and Tier 2 capital and liabilities with effective maturity of one year or longer, "stable" deposits of retail and small business customers, less stable deposits of retail and small business customers, and wholesale funding provided by nonfinancial corporate customers. All other liabilities are not considered sources of stable funding.

and play a significant role in financial institutions' liquidity management.²⁹ Ignoring the actual liquidity characteristics and usage of eligible assets may be counterproductive, and in some jurisdictions, it may lead to an increase in the liquidity risk profile of the banking system rather than to a reduction.

- The proposed rules will likely have varying implications for banks' business models and the markets and regions within which they operate (such as mortgage banks).³⁰ Some restructuring is desirable, but commercial banks with a large retail deposit base may have an advantage over banks that use a less stable source of funding. However, the rules could complicate group-wide liquidity risk management for institutions composed of different legal entities, potentially limiting some of these advantages.

The impact of the BCBS regulations would vary across jurisdictions based on the design of other aspects of systemic liquidity policy. These interactions should be considered so that they do not give rise to competitive distortions. For example:

- *Reserves held at central banks.* In the BCBS regulations, reserves held at central banks are classified as liquid assets "to the extent that they can be drawn down in times of stress." If that means that reserve balances exceeding mandatory requirements (i.e., excess reserves) are counted as liquid assets, banks that hold a large amount of excess reserves at the central bank on a regular basis will be better able to meet the requirements.
- *Definition of stable deposits.* In the BCBS regulations, deposits that are covered by an effective deposit

insurance scheme can be categorized as "stable deposits," for which lower run-off ratios would be applied than for other deposits. Different application of deposit insurance schemes across national jurisdictions could affect what are considered "stable" deposits. Further, the reliability of deposits as a stable funding base, as mentioned above, could change with the implementation of the rules, although a longer phasing-in period may help lower this risk.

- *The range of eligible liquid assets.* If eligibility for central bank collateral is used as the only criterion for liquid assets (the current BCBS proposal qualifies the definition of liquid assets with other criteria such as marketability and minimum rating), the competitive landscape for banking could be altered depending on how narrowly or broadly jurisdictions define which assets are eligible.

In sum, the proposed prudential liquidity requirements are to be welcomed as they address many of the basic issues that arise in the crisis. As recognized by the BCBS, this is a difficult area for which to devise internationally consistent quantitative regulations, and more work is required to calibrate them well. Care also needs to be given to designing the proposed rules so that they can be flexibly applied and broad enough to adjust to changes in the financial structure. In addition, the BCBS regulations currently apply only to depository institutions, and standard setters should consider extending their application, in some form, to nonbank financial institutions that, as the crisis demonstrated, can contribute to maturity transformation and systemic liquidity risk. This could mitigate the potential buildup of liquidity risks in the less regulated "shadow banking" system.

Outstanding Policy Issues in Addressing Systemic Liquidity Risk

Minimize Moral Hazard by Pricing the Systemic Externality

While the proposed BCBS liquidity rules address idiosyncratic risk, they only partially address the risks that arise from the inability of institutions to access markets to sustain sufficient market and funding liquidity under stress. There is a need to disentangle when

²⁹Denmark is a good example of this. Banks hold covered bonds for liquidity management purposes. The covered bond market is viewed as highly liquid even in times of stress. Banks' exposure to government securities is relatively small. Implementing the LCR would generate significant stresses as there may not be sufficient short-term government securities to meet the rule, and banks would have to be required to hold longer-term and less liquid government securities.

³⁰For instance, Danish mortgage banks fund each individual mortgage with fully maturity-matched mortgage bonds, but will be penalized for this approach under the proposed net stable funding ratio calculation. The BCBS is working on a general definition that can reflect such arrangements.

liquidity strains are driven by individual institutions, which optimally should self-insure and bear this cost through higher liquidity buffers, from when events affect multiple institutions simultaneously, requiring central bank liquidity support. Rapid withdrawals by participants in money markets contributed to the spread of financial losses and liquidity strains well beyond what subprime credit positions would have justified. Regulatory capital and liquidity requirements are not designed to deal with such extreme events. In cases when market funding freezes up, central bank support is warranted to assure that liquidity risks do not morph into solvency problems and undermine financial intermediation and the real economy.

While the deterioration of liquidity conditions in stressful times can be arrested by central banks' liquidity operations, any robust systemic liquidity framework would need to encourage appropriate pricing of liquidity risk in good times to limit its negative impact in times of market stress and minimize the moral hazard problem. Against this backdrop, a systemic liquidity risk regulatory framework should focus on ensuring that banks and others considered important to liquidity and maturity transformation are contributing in some form to systemic risk insurance in good times. To this end, a number of proposals are being floated, including those identified below.

- Gorton and Metrick (2009) advocate a systemic liquidity risk insurance guarantee fee that explicitly recognizes the public sector cost of bailing out repo counterparties. The primary objective would be to induce a change in behavior in order to promote the internalization of systemic risks.
- Brunnermeier and others (2009) call for explicit consideration of the risks associated with the liability structure of banks in the form of a risk premium associated with the relative importance of wholesale funding.
- Perotti and Suarez (2009) suggest introducing mandatory liquidity insurance. The charge would have to be paid in good times in exchange for emergency liquidity support during systemic stress. The tax would be imposed on the wholesale funding base and increase proportionately with the maturity mismatch in assets and liabilities. Retail deposits would

be excluded as they are covered by the deposit insurance scheme. The charge would be imposed on all institutions with access to a formal financial safety net and guarantees.

- Acharya and Oncu (2010) focus on the United States and propose excluding only very liquid and safe collateral, such as treasuries and agency debt, from "stays" in bankruptcy proceedings, whereby such assets would not be treated as part of the firm's assets for distribution in the bankruptcy proceedings.
- In a more extreme view, Roe (2009) argues that the internalization of such cost would ideally be achieved by exposing repo lenders to counterparty risk by disallowing unrestricted access to collateral even in case of default of the counterparty. This would likely reverse the current advantages investors and borrowers have to use the repo market.

A future GFSR will introduce a more holistic measure of systemic liquidity risk to directly take account of the connections between various participants in the wholesale funding markets. Aside from improving surveillance of funding markets, this could form the basis for a systemic liquidity risk insurance premium or surcharge.

Strengthen the Central Bank Liquidity Support Framework

Central bank liquidity support is an integral part of the overall systemic liquidity framework and acknowledges that large systemically driven liquidity shocks cannot always be effectively managed by individual firms. Central banks intervene in financial markets through various routes, including open market operations, standing facilities, and by use of emergency liquidity assistance. During the crisis several advanced-country central banks significantly adjusted their liquidity framework and available instruments. Some of these changes have been made permanent while others are viewed as temporary crisis measures. With the exception of the euro area, most of them have been scaled back significantly.

Looking ahead, central banks should have available instruments capable of providing necessary liquidity

to their financial system in order to ensure financial stability while conducting monetary policy effectively. Which measures should be used on a regular basis or be kept for temporary use for addressing systemic liquidity disruption depends on such factors as the structure of the financial system.

The design of macro-prudential policies should assess the implications they may have for central bank operations and financial stability. For instance, a central bank's eligibility criteria for collateral would influence banks' holdings of eligible assets and thereby change the market for those assets. At the same time, reserve balances that banks hold at the central bank (and collateral eligibility) should be taken into account in banks' prudential liquidity regulations, as they indeed are by the BCBS in its definition of liquid assets.

The scope of counterparties included in central bank liquidity support arrangements may need to be expanded in some countries. As financial intermediation outside the conventional banking sector has increased due to financial innovation, central banks in these countries need to be able to deal with a broad range of counterparties—both the number of counterparties and the types of financial firms—in systemically important funding markets to effectively support systemic liquidity under different market conditions.

In addition, a wider range of eligible collateral may be helpful for financial firms to access central bank liquidity in times of need. An excessively narrow definition of eligible assets could result in disruption of the markets depending on availability of those assets. As central banks face trade-offs between effective liquidity provision and risks to their balance sheet, the appropriateness of pricing and risk management measures (e.g., haircuts, margin calls) that take into account credit and liquidity risks of financial assets will need to be reviewed.

The parameters of reserve balances held at the central bank also warrant review. The appropriate level of reserves should take into account the implications for financial stability, as reserve balances may work as the first line of defense against liquidity shocks. In general, larger reserves could help better absorb liquidity shocks and thereby enhance resilience of the financial system, while an excessive amount of reserves could discourage banks from implementing effective internal risk management systems and could lock up more collateral with the central bank. The role that the central

bank expects to play in supporting the liquidity of money markets is a key consideration in choosing the appropriate level of reserves' supply and remuneration (the opportunity cost of holding reserves is important), as well as the design of a reserve maintenance period.

Consider the Cross-Border Dimension of Maturity Transformation

The crisis exposed the global dimension of managing systemic liquidity in stressed money market conditions. In response to the vulnerability of offshore dollar markets, especially in Europe and Asia, and the potential for feedback to U.S. markets given linkages via the inter-bank market, the U.S. Federal Reserve established foreign exchange swap agreements with 14 foreign central banks. These proved an effective means to provide dollar liquidity to strained offshore markets. Although first-round support for such markets has been wound down, some swap arrangements have been resurrected in the wake of the new market turbulence in Europe. The experience suggests merit in ensuring that such facilities are readily available in the future. Central banks should review the pricing and other terms of operations when lending foreign currencies to ensure that the incentive structure motivates market participants to enhance their own cross-border liquidity management, and to turn to such facilities only in times of stress.

Finally, greater consideration should be given to the cross-border dimension of maturity transformation. The crisis demonstrated that national authorities were not aware of the scale of the cross-border dimension of complex money markets within which their supervised institutions fund and manage liquidity. Close international cooperation should be sought to systematically collect information on relevant markets; ensure that new liquidity regulations adequately cover the additional vulnerabilities of cross-border, cross-currency positions; and ensure continued, timely, effective, and well-coordinated responses to systemic cross-border turmoil. Since banks adjust their funding structure in response to changing collateral and counterparty risk regardless of national borders, different domestic regulatory standards could segment liquidity within markets and specific jurisdictions. Indeed, anecdotal evidence suggests that domestic banks are more likely to charge lower haircuts and interest to domestic than foreign counterparties.

Conclusions and Policy Considerations

The chapter finds that systemic liquidity risk arises from weaknesses in market risk management practices and market infrastructure, and regulatory gaps. The chapter reviews how vulnerable funding and risk management strategies threatened to undermine the solvency of financial institutions and the stability of the overall system during the crisis. In particular, financial institutions failed to take into account the possibility of a sudden loss of access to secured financing, as investors withdrew from the market owing to uncertainty over asset valuations, counterparty risk, and availability of liquidity.

These liquidity risks were not fully accounted for in the risk management practices of financial institutions or in the systemic oversight framework of regulators. Policymakers are still struggling with how to adequately address the systemic component of liquidity risk.

To encourage progress in this difficult area, this chapter has analyzed factors contributing to market and funding illiquidity and potential channels through which liquidity shocks propagate and are amplified. In the United States, the maturity transformation took place in the large, unregulated shadow banking sector, while in Europe and elsewhere the banking system's overreliance on short-term wholesale funding, including through offshore markets, left it vulnerable when markets dried up. The lack of a systemic perspective in ongoing policy efforts primarily reflects the conceptual difficulties arising from the complex interactions between the banks and the nonbank financial institutions. These nonbank institutions may not be willing to provide funding during periods of market stress; nor can they access traditional lender-of-last-resort facilities at central banks.

The chapter suggests that policies to address systemic liquidity risk must deal both with institutions and the markets within which they interact.

For institutions, the chapter recommends:

- Higher liquidity buffers for all financial institutions (not just banks) that are reliant on short-term wholesale markets for funding and that engage in maturity transformation.
- New guidelines on how much maturity transformation by financial institutions is appropriate when they have access to the financial safety net. How-

ever, care needs to be given to ensure that these do not give rise to moral hazard so that eligible firms do not reduce their risk management practices.

- Consideration of a fee or surcharge on the externality produced by institutions when they do not take into account the effect of their behavior on funding markets.

In sum, market participants should be paying the full cost of their idiosyncratic liquidity risk. Policies to this end are in progress, including the liquidity rules as proposed by the BCBS. However, more needs to be done to ensure that the role of nonbank institutions in funding markets is adequately understood and the risks they pose are mitigated in some way.

For liquidity-providing markets, the chapter recommends:

- Better collateral valuation and margining practices for repo markets.
- Improving clearing and settlement infrastructure, including greater use of central counterparties in repo markets.
- Over time, removing the regulatory privileges given to money market mutual funds by letting them choose either to move toward floating net asset valuation, or else be overseen and regulated as banks, and as such their liabilities would be treated as deposits.

The regulatory framework should further ensure that core financial market infrastructures such as central counterparties, receive emergency liquidity support in times of systemic liquidity crisis. Central bank systemic liquidity policies should be periodically reevaluated in light of financial institutions' changing funding structure and markets. Finally, there are significant data gaps that need to be addressed in order to appropriately measure and monitor systemic liquidity risks.

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