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Special Issue

Lessons from
the Financial Crisis

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Cover

Bank Note, Îles de la Madeleine

Paul Berry, Chief Curator, Currency Museum

The hook-shaped archipelago of about a dozen islands that make up the Îles de la Madeleine (Magdalen Islands) is situated in the Gulf of St. Lawrence. Now a popular tourist destination, the Islands have a colourful history and may have been the site of one of the earliest attempts to establish a private bank in Canada.

Visited by Jacques Cartier in 1534, they were home to abundant schools of mackerel and cod and herds of walrus. In 1755, the Islands became a refuge for a group of Acadian families fleeing from the great deportation. There, they worked in the fishery, competing with French and American vessels. In 1798, the Islands were ceded to Admiral Sir Isaac Coffin, in return for services rendered to the British during the American Revolution. Coffin installed an agent who charged the 100 or so resident families rent for their land and for the use of the fishery. Sir Isaac's descendants maintained control of the Islands until 1903 when they were purchased by a maritime consortium.

Period documents suggest that Sir Isaac tried to improve the condition of his holdings by arranging for a circulating medium of exchange for use on the Islands, consisting of one-penny copper tokens. Dated 1815, they bear images of a harp seal and split cod fish and the appropriate legend "Success to the Fishery." A recent find suggests that he also had plates prepared with which to print private notes under the name of the Magdalen Island Bank.

No documentary evidence has been found to support the establishment of such a bank. Evidence of its existence rests solely upon the note pictured on the cover. The note was sold at a London auction in 2002 as part of a collection formed in the early nineteenth century by James Watt Junior, partner in the prominent Birmingham company Boulton, Watt & Sons which, operating under the name of the Soho Mint, struck tokens and coins under government and private contract. The note was packaged with two examples of the Coffin tokens and was identified in the handwriting of James Watt Junior.

The note is unique. It appears to be a plate proof rather than an unissued note, since it carries no serial number or authorizing signature. It is printed on wove paper that bears the partial watermark of the paper mill Ruse & Turners of Upper Tovil Mill, Maidstone, Kent, which appears to have operated from 1800 to 1840. The watermark includes a partial date that corresponds to the period when the tokens were manufactured. The image of a walrus in front of a craggy rock was engraved by William Radclyffe (1783–1855) a prominent Birmingham landscape engraver. The mammal's pose is identical to, and was probably modelled after, that of a walrus engraved by J. Scott and published in 1809. There is no indication of who printed the note.

If it had been established, Coffin's bank would represent the second bank formed in Canada, preceded only by the Canada Banking Company established in 1792. The tradition of private banking in England may have encouraged Coffin to establish a bank for his Canadian possessions. The Bank of England, established in 1694, and a myriad of private banks, in operation since the end of the eighteenth century, catered to British needs at the time. In comparison, formal banking in Canada was limited and began to develop only after 1817 when the Montreal Bank was formed.

Given the sparse population of Îles de la Madeleine, it is unclear what role Coffin saw for his bank. Did he intend it to provide capital to the local fishing industry, or was it an altruistic venture to encourage commerce? Further investigation may shed light on these questions.

The note on the cover is part of the National Currency Collection of the Bank of Canada. It measures about 20 cm x 11 cm.

Imaging by Lisa Craig

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Lessons from the Financial Crisis

Carolyn Wilkins, Guest Editor

The financial crisis of 2007–09, triggered by losses in American subprime-mortgage loans, was marked by a significant decline in the market liquidity of assets and in the ability of financial institutions to obtain funding in wholesale markets.[1] The deterioration in funding conditions for financial institutions led them to stop redistributing liquidity to the broader financial system, contributing to widespread disruptions and losses in financial markets and to a sharp downturn in many economies. It is important to try to draw lessons from any crisis, particularly given the magnitude and global scope of the crisis. This special edition of the *Review* examines the most recent research on liquidity and on public policy responses to restore stability to the financial system and to foster the economic recovery.

Céline Gauthier and Hajime Tomura, in "Understanding and Measuring Liquidity Risk: A Selection of Recent Research," summarize recent research on the role of liquidity in the financial system and examine the implications of this research for financial system reform. The authors highlight work which shows that uncertainty about fundamentals, fluctuations in margin requirements and spillover effects between institutions that are interconnected are important sources of destabilizing declines in market and funding liquidity. They maintain that this research generally supports the recently announced package of financial system reforms, including new capital and liquidity rules for the banking sector under Basel III, and increased use of central clearing counterparties for over-the-counter derivative transactions.

As part of the public policy response to the financial crisis and the subsequent collapse in real economic activity, central banks introduced numerous unprecedented monetary policy measures, including widespread purchases of both government and private sector debt instruments.[2] In "Unconventional Monetary Policy: The International Experience with Central Bank Asset Purchases," Sharon Kozicki, Eric Santor and Lena Suchanek review the evidence on the effectiveness of these policies and explore possible exit strategies. The authors find that these unconventional monetary policy actions were largely successful at reducing credit spreads and bond yields. They also conclude that the appropriate timing of the withdrawal of monetary stimulus in the countries that engaged in these policies is complicated by the fact that fiscal retrenchment will affect the economic outlook.

Central banks also introduced extraordinary liquidity facilities in order to ease pressures in funding markets. In "Lessons from the Use of Extraordinary Central Bank Liquidity Facilities," Stéphane Lavoie, Alex Sebastian and Virginie Traclet examine the provision of extraordinary liquidity by central banks during the crisis and its contribution to alleviating pressures in funding markets. The authors find that the liquidity facilities were effective in reducing funding pressures, in part because of considerable co-operation among central banks. The authors also find that clear guiding principles, combined with a flexible operating framework, were helpful in designing the appropriate policy response.

Central bank liquidity policies generally involve lending on a collateralized basis. Because of this, the collateral policies of central banks played a critical role during the crisis, as they were an integral part of the measures undertaken to alleviate the funding pressures facing financial institutions. In "Central Bank Collateral Policy: Insights from Recent Experience,"

1 Wholesale funding refers to borrowing from other financial institutions and non-financial corporations.

2 The Bank of Canada outlined a framework for quantitative and credit easing in the April 2009 *Monetary Policy Report*. Measures under this framework were not required.

Lorie Zorn and Alejandro García examine changes to the Bank of Canada's collateral policy during the crisis. They also discuss the use of central bank collateral policy to constructively influence financial market practices in three areas: transparency for securitized products, practices related to credit risk, and the reduction of procyclicality in the management of market risk.

Please note: Supplementary article

The Bank is launching a new series of polymer bank notes this year. A special supplement, "Paying with Polymer: Canada's New Bank Notes," will be published on the Bank's website when the new series is unveiled and will be sent to subscribers as a stand-alone article. In this article, author Charles Spencer reviews the complex process of developing the new series, which represents a dramatic change for Canada. The leading-edge security features made possible by the new substrate, the cost savings of the move to a polymer base and the environmental advantages of the new notes are also examined.

Understanding and Measuring Liquidity Risk: A Selection of Recent Research

Céline Gauthier, Financial Stability Department and Hajime Tomura, Funds Management and Banking

- *During the financial crisis, many financial institutions saw significant declines in the liquidity of their assets and in their ability to fund themselves in wholesale funding markets.*
- *Recent research suggests that important causes behind declines in liquidity include uncertainty about fundamentals, fluctuations in margin requirements, and spillover effects between interconnected institutions.*
- *The recently announced new capital and liquidity rules for the banking sector, Basel III, should reduce the occurrence of financial crises. Higher capital requirements should lessen the need to raise margins, as well as decreasing the extent of network externalities. More stringent liquidity standards will promote the resilience of banks during stressed periods.*

The recent global financial crisis exposed major weaknesses in the functioning of the global financial system. Those weaknesses allowed a relatively small shock—the losses on U.S. subprime mortgages—to set in motion a chain of events that led to a major crisis in global financial markets. Significant declines in the market liquidity of assets and in the ability of financial institutions to fund themselves in wholesale funding markets were important channels for the transmission and, indeed, the magnification of this shock. A better understanding of the risks surrounding funding and market liquidity is therefore crucial for improving the stability of the financial system.

In this article, we review a selection of recent research on liquidity risk, including work by Bank of Canada staff. We also examine how financial market reforms, together with the new global regulatory reform package recently announced by the Basel Committee on Banking Supervision—Basel III—support the need to better manage liquidity risk.

We first present the findings of recent empirical studies that illustrate the important role that the decline in wholesale funding played during the financial crisis.[1] We then review two mechanisms behind the interaction of the wholesale funding available to financial institutions and the market liquidity of financial assets. This is followed by an examination of state-of-the-art quantitative models that help us better understand the impacts of the market liquidity of assets and the availability of wholesale funding on the stability of the financial system. We then summarize the implications of this recent research for financial system reforms, including Basel III, and present some conclusions.

1 Wholesale funding is defined as borrowing from other financial institutions and non-financial corporations.

Growth of Assets and Leverage at Financial Institutions

The losses on U.S. subprime mortgages that triggered the recent global financial crisis were much smaller than the losses associated with the subsequent declines in the prices of financial assets and the write-downs experienced by financial institutions. **Chart 1** illustrates that even investment-grade financial issuers had to pay historically high yields over the period. This increase in funding costs contributed to the failure of many notable financial institutions, including Bear Stearns and Lehman Brothers.

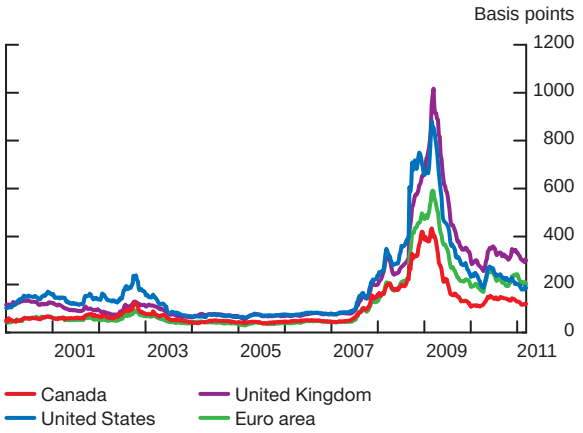
Recent empirical research suggests that one of the reasons behind the devastating effect of subprime losses was the high degree of leverage of certain U.S. and European financial institutions.[2] In particular, Adrian and Shin (2010) document a significantly positive correlation between asset growth and the growth of leverage at U.S. investment banks. Prior to the crisis, as asset prices rose, the balance sheets of investment banks expanded relative to their capital bases, meaning that they increased their leverage. But leverage quickly fell when the initial subprime-loan losses reduced the capital of U.S. investment banks: banks sold a higher proportion of assets than warranted by the decline in their capital. This behaviour is consistent with a vicious cycle, whereby a decline in asset prices (resulting from asset sales) reduces bank capital, causing more asset sales, which place more pressure on asset prices and further undermine bank capital. **Chart 2** shows that a positive correlation between asset growth and leverage growth also existed at Canadian banks over this period, but to a lesser extent than for U.S. investment banks.

Empirical analysis by Damar, Meh and Terajima (2010), using Canadian data, finds that a bank's access to the markets for wholesale funding, which was severely impaired during the crisis (see **Chart 3**), contributed importantly to this positive correlation.

The findings of Damar, Meh and Terajima are consistent with the nature of wholesale funding, which allows banks to take on wholesale debt more quickly than deposits from households in normal times, but also allows the sources of wholesale funding to disappear more rapidly when a decline in asset prices impairs the capital of the borrowing financial institutions. Thus, when asset prices drop, financial institutions that rely heavily on wholesale funding need to be

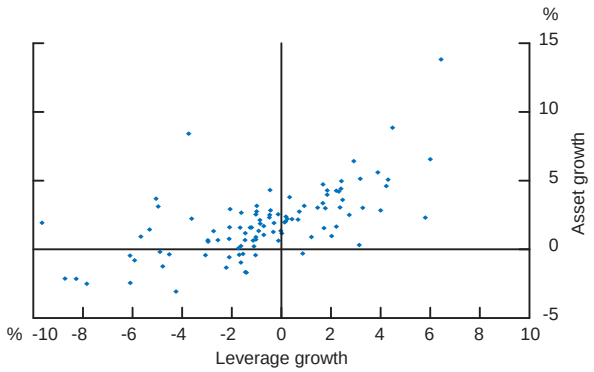
2 Leverage is the value of the assets held by a financial institution relative to its capital.

Chart 1: Yield spreads for investment-grade financial issuers



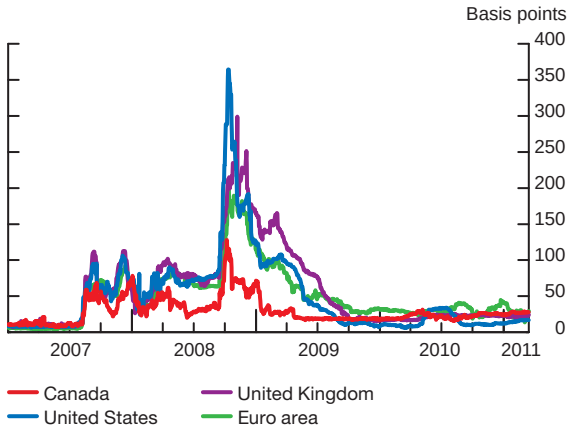
Sources: Bloomberg and Merrill Lynch Last observation: 23 March 2011

Chart 2: Growth in assets and leverage of major Canadian banks
1983—2009



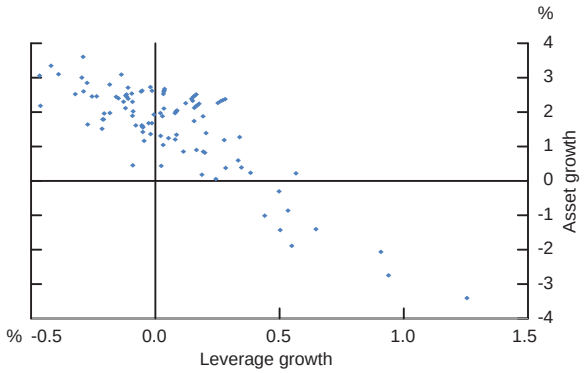
Sources: Office of the Superintendent of Financial Institutions and Bank of Canada calculations

Chart 3: Conditions in short-term funding markets[a]
Difference between 3-month interbank offered rates and their respective overnight index swaps



a. U.S. and U.K. LIBOR; EU EURIBOR; Canada CDOR
Source: Bloomberg Last observation: 15 March 2011

Chart 4: Growth in assets and leverage of Canadian households
1983—2009



Sources: Statistics Canada and Bank of Canada calculations

able to sell assets more quickly to reduce their liabilities (i.e., deleverage), generating a positive correlation between asset growth and leverage growth.[3] **Chart 4** supports Damar, Meh and Terajima, showing that the growth in leverage of Canadian households, who do not have access to wholesale funding, was negatively correlated with their asset growth over the same period.

In addition, **Charts 1** and **3** show that Canada experienced a smaller rise in funding costs during the financial crisis than other developed countries. This results partly from the fact that while the correlation between asset growth and leverage growth at Canadian banks is positive, the *level* of leverage taken by Canadian banks prior to the onset of the crisis was substantially lower than that taken by U.S. investment banks and major European banks. In fact, Canadian banks were subject to leverage limits (the asset-capital multiple limit imposed by the Office of the Superintendent of Financial Institutions), while U.S. investment banks and most European banks were not. As a result, the leverage carried by Canadian banks prior to the crisis was significantly lower than that of U.S. investment banks, as well as that of major European banks.[4] This feature of Canadian banks likely contributed to the relative stability of the Canadian banking system during a crisis that rocked banking systems in the United States and Europe.[5]

Mechanisms behind Declines in Wholesale Funding

The previous section provided evidence which suggested that during the crisis, the banks most dependent on wholesale funding were required to undertake relatively more deleveraging. We now present various factors that help to explain the decline in bank's access to wholesale funding during the crisis. We focus on the roles of uncertainty about fundamentals, fluctuations in margin requirements, and network externalities.[6]

Uncertainty about fundamentals

Part of the decline in wholesale funding reflected the flight of institutional investors, who were no longer willing to supply funds to particular financial institutions. This flight of wholesale funds was an important contributor to the collapse of Bear Stearns, Lehman Brothers, Northern Rock and other institutions. Morris and Shin (2009) model the causes behind the disappearance of an institution's wholesale funding. They suggest a combination of investor concerns about the risk that an institution may become insolvent (i.e., uncertainty about its fundamental value), a decline in the market liquidity of the institution's assets, and the extent to which it relies on wholesale funding markets.

Their work shows that an otherwise solvent financial institution can be pushed into default if it is too dependent on short-term funding markets or if it is difficult to sell the institution's assets at fair prices; i.e., the market liquidity of the assets is low. For example, if the market liquidity of the assets falls, each lender becomes wary about the risk that the institution may have to sell assets at fire-sale prices as other lenders withdraw funding, and therefore pre-emptively cuts funding to that institution.

3 Adrian and Shin (2010) found no significant correlation between asset growth and leverage growth at U.S. commercial banks. The behaviour of Canadian banks lies between that of U.S. investment banks and that of U.S. commercial banks. This may partly reflect the fact that Canadian banks are more actively engaged in investment banking activities than U.S. commercial banks.

4 For example, the average leverage ratio for the Big Six Canadian banks, which incorporate investment-banking arms, was 20.8 in the first quarter of 2007, while that for U.S. investment banks was 25. The actual difference between Canadian and U.S. banks with large derivative activities was much larger than these numbers suggest, since the U.S. accounting standard (GAAP) allows derivatives to be netted. For example, Bordeleau and Graham (2010) show that the netting of derivatives by Deutsche Bank, which reports its balance sheet using both IFRS and U.S. GAAP for the period ending 31 December 2008, reduces its total assets by 50 per cent.

5 Some off-balance-sheet activities (such as liquidity facilities for securitization) are not included in the Canadian leverage ratio. However, Canadian banks were more restricted in these activities than banks in other countries since they were part of risk-weighted assets, and the floor on the Tier 1 capital ratio was higher in Canada than elsewhere. See, Crawford, Graham and Bordeleau (2009) for more details on the history of leverage regulation in Canada.

6 See Kirabaeva (2010–2011) for the role of serious information problems, such as adverse selection, during financial crises.

The findings of Morris and Shin are consistent with the complex securitization of subprime-mortgage loans as a cause of the decline in wholesale funding during the crisis. While the initial increase in delinquent subprime-mortgage loans raised concern about the solvency of some financial institutions, the securitization that distributed that delinquency risk to various asset-backed securities (ABS) made it difficult to identify the actual locations of the risk. This led to a significant decline in the liquidity of the ABS market and in wholesale funding for the financial institutions holding those assets.[7]

Margin spirals and wholesale funding

When buyers purchase securities they can use their assets as collateral for the purchase. The difference between the collateral value of the asset and the purchase price is the margin—the portion paid for with the buyer's own capital. The margin required is thus akin to the buyer's leverage capacity. The margin requirements for various securities increased sharply during the crisis, as shown by **Table 1** from the report of the Committee on the Global Financial System (CGFS 2010).[8]

Margin requirements for various securities increased sharply during the crisis

Regarding the effect of increased margin requirements, Brunnermeier and Pedersen (2009) illustrate that a small negative shock to asset prices can trigger a large decline in wholesale funding through the tightening of margin requirements for investment banks. Their work shows that an increase in asset sales that lowers asset prices can make investors wary about the risk of further price declines. To cover this risk, the suppliers of wholesale funds to investment banks require them to hold more capital in support of their asset positions (i.e., they raise the margin requirements), resulting in a decline in the banks' wholesale funding. This reduces the capacity of investment banks to absorb an excess supply of assets and increases their need to deleverage, leading to further asset sales, a further decline in asset prices, and even larger increases in margin requirements, again reducing the banks' wholesale funding.[9] This margin spiral likely contributed to the substantial increase in margin requirements along with the large depreciation in asset prices observed during the crisis.[10]

Credit risk, liquidity risk and network effects

The amount of risk in the financial system as a whole (system-wide risk) can be thought of as the combined impact of the different types of financial and economic risks. Recent Bank of Canada research (Gauthier, He and Souissi 2010; Gauthier, Lehar and Souissi 2010) builds on some of the theoretical literature described above to develop quantitative models for measuring system-wide risk.[11] Different types of risks are integrated into a network of bilateral exposures between banks, through which one bank's default can cause otherwise solvent banks to default as well.

Gauthier, He and Souissi (2010) incorporate the possibility of the disappearance of wholesale funding (à la Morris and Shin) into a stress-testing framework for Canadian banks. They find this channel to be a potentially important contributor to system-wide risk as illustrated by **Chart 5**: The likelihood of important losses in a stylized banking system increases substantially when network effects and liquidity risk are considered relative to consideration of only credit risk.

Their framework can also be used for policy analysis. To evaluate the trade-offs between the regulatory standards for capital and liquidity proposed in Basel III, the authors conduct simulations under a severe, but plausible, macroeconomic scenario for different combinations of banks' liquid asset holdings, capital, and short-term funding. One of their findings is that increasing capital alone is more effective at reducing solvency risk than liquidity risk.

7 See Gorton (2009) for more details on the complexity of the securitization process and Krishnamurthy (2010) for a review of the developments in debt markets during the crisis. Also, see Tomura (2010) for a model illustrating that the inability of outsiders to evaluate the quality of an asset leads to undervaluation of the asset in the market, and Fontaine and Garcia (2009) for a measurement framework of the effect of funding-liquidity conditions on bond prices.

8 The data were gathered through bilateral interviews with various market participants, including banks, prime brokers, custodians, asset managers, pension funds and hedge funds.

9 Shleifer and Vishny (1997) use a simple model to illustrate that margin requirements for arbitragers prevent corrections of mispricing in asset markets. Their model illustrates how a decline in asset prices because of random trading by uninformed traders is amplified through withdrawal of funding by investors and fire sales of assets by arbitragers. Allen and Gale (2005) show how a small shock causes a large change in asset prices when the prices are determined by the amount of cash held by arbitragers.

10 See Brunnermeier (2009) and CGFS (2010) for more details on margining practices during the crisis.

11 A *Bank of Canada Review* article providing more details on this work is planned for later this year.

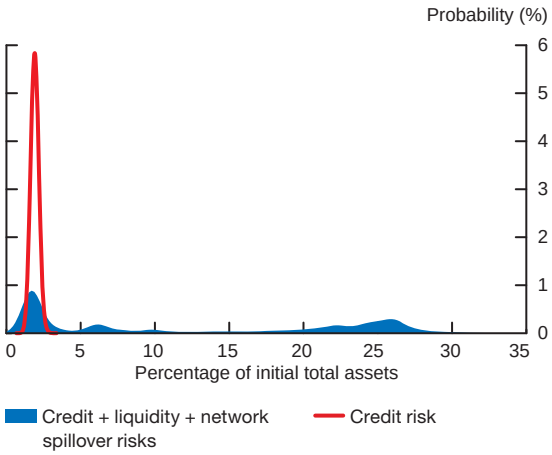
Table 1: Typical margins on term securities financing transactions (per cent)

	June 2007			June 2009		
	Prime counterparty	Non-prime counterparty	Unrated[a]	Prime counterparty	Non-prime counterparty	Unrated[a]
G-7 government bonds						
Short-term	0	0	0.5	0.5	1	2
Medium-term	0	0	0.5	1	2	3
U.S. agencies						
Short-term	1	2	3	1	2	3
Medium-term	1	2	3	2	5	7
Pfandbrief[b]	0	0	1	1	2	8
Prime MBS						
AAA-rated	4	6	10	10	20	30–100
AA- and A-rated	8	12	25	100	100	100
Asset-backed securities	10	20	20	25	50	100
Structured products (AAA)	10	15	20	100	100	100
Investment-grade bonds						
AAA- and AA-rated	1	2	5	8	12	15
A- and BBB-rated	4	7	10	10	15	20
High-yield bonds	8	12	20	15	20	40
Equity						
G-7 countries	10	12	20	15	20	25
Emerging economies	15	20	35	20	25	40

a. Hedge funds and other unrated counterparties
b. Pfandbrief is covered interest-bearing bonds issued by German banks under the Pfandbrief Act.
Source: CGFS (2010, 2)

A different version of the same stress-testing framework (Gauthier, Lehar and Souissi 2010) focuses on the market-liquidity risk arising from endogenous fire sales of assets (i.e., the sale of assets at a price below their fundamental value) by troubled financial institutions. The authors find that such a channel of contagion can also have important system-wide effects.[12] This framework was one of those used by the Financial Stability Board and the Basel Committee in their recent international study to assess the longer-run macroeconomic benefits and costs of higher capital and liquidity standards (Basel Committee on Banking Supervision 2010a).[13]

Chart 5: Distribution of total system loss



Source: Bank of Canada calculations

12 The integration of the asset-fire-sale component into the network model is an extension of the work by Cifuentes, Ferrucci and Shin (2005) in which banks are assumed to be equally risky. In contrast to that work, Gauthier, Lehar and Souissi (2010) assume a more realistic world in which banks have various risk profiles, and calibrate the model so that the equilibrium price of a bank's illiquid assets is a decreasing function of its riskiness. This reflects the fact that riskier assets are less liquid in a crisis period.

13 Both studies also show that limiting analysis to traditional interbank lending may seriously underestimate spillover risks, since the size of off-balance-sheet exposures has increased steadily over the past decade, and other types of on-balance-sheet exposures may also be important.

Implications of Financial System Reform

Banking sector regulation

In December 2010, in response to the weaknesses revealed by the 2007–09 financial crisis, the Basel Committee announced new capital and liquidity rules for the banking sector—Basel III.[14] Here, we discuss some of the measures in Basel III in light of the research described previously, as well as other recent Bank of Canada research, highlighting the importance of capital and liquidity standards in reducing the extent of liquidity risk.

Capital standards

A higher and better-quality capital base: Basel III requires banks to hold higher capital than the previous framework, Basel II. The new regulatory capital must also be of better quality, since its predominant form is common equity, which is tangible, loss-bearing capital.[15] Higher and better-quality regulatory capital under Basel III will reduce the scope for amplification of shocks through the various mechanisms described above: more capital and, hence, less leverage reduces the extent of deleveraging needed in times of stress, the likelihood of runs by creditors, the need to increase margin requirements, and the extent of negative spillover of a bank's fragility to other banks through interbank financial obligations. This expectation is consistent with the experience in Canada, where, as summarized by Carney (2010b), banks were already required to hold higher and better-quality capital than Basel II and remained remarkably stable during the financial crisis.

More capital and, hence, less leverage reduces the extent of deleveraging needed in times of stress

A countercyclical capital buffer: Beyond making the global system look more Canadian, Basel III introduces an important innovation for flexible capital standards. While Basel II set a constant minimum requirement for the risk-weighted capital-asset ratio of each bank, under Basel III national authorities can increase the minimum capital requirements for banks in their jurisdiction if they judge that aggregate credit growth is excessive and associated with a buildup of system-wide risk in their jurisdiction. This "countercyclical capital buffer" will require banks to increase their capital base during economic booms—when risk from the perspective of an individual bank is perceived to be low and risk at the system level is likely to be increasing—and allow them to draw down this capital buffer when conditions are weak (Arjani 2009; Chen and Christensen 2010). Such a buffer should help to counteract a buildup of leverage at financial institutions and resulting rises in asset prices during excessive asset-market booms, and should consequently reduce the likelihood of a financial crisis caused by the subsequent deleveraging and its negative externality to asset prices and bank capital. This hypothesis is supported by the model developed by Tomura (2010), which indicates that the dynamics of such a minimum bank capital requirement will prevent the disappearance of wholesale funding over the regular business cycle, where there is no disruption in the market liquidity of assets.[16]

Tomura's model also suggests an additional linkage between the market liquidity of assets and the countercyclical capital buffer. The model indicates that a decline in the market liquidity of assets because of difficulty in evaluating asset quality increases the minimum bank capital required to prevent bank runs. This result suggests that, even though banks may not be able to draw down a capital buffer in such a situation, a prior buildup of bank capital under the countercyclical capital buffer should reduce the occurrence of bank runs.

Leverage ratio: Along with the risk-based minimum capital requirement, banks will be required to satisfy a leverage limit based on the ratio of Tier-1 regulatory capital to their total assets, including selected off-balance-sheet commitments.[17] This leverage ratio is

14 See Basel Committee on Banking Supervision (2010b) for more details.

15 Under the new framework, regulatory capital at a bank consists of two Tiers: Tier 1 and Tier 2. Common Equity Tier 1 must be at least 4.5 per cent risk-weighted assets (RWAs), Tier 1 Capital (Common Equity Tier 1 + Additional Tier 1) must be at least 6 per cent RWAs, and Total Capital (Tier 1 + Tier 2) must be at least 8 per cent RWAs, at all times. In addition, each bank is restricted from paying out dividends when the difference between its Common Equity Tier 1 capital and the regulatory requirement (4.5 per cent) falls below 2.5 per cent RWAs, so that its retained earnings increase its Common Equity Tier 1 capital. See Basel Committee on Banking Supervision (2010b) for more details.

16 Meh and Moran (2010) analyze a different reason for a countercyclical capital buffer because of volatile bank-asset values. In their model, banks are essential to the economy since they monitor borrowers on behalf of depositors. But since their monitoring effort is not observable, banks must finance part of their lending to borrowers through their own capital to commit to efficient monitoring services. The authors show that when banks suffer unexpected loan losses, their capital-adequacy ratios decrease, since the scarcity of bank capital gives banks a greater incentive to monitor borrowers during such an episode.

17 The Basel Committee on Banking Supervision will test a minimum Tier-1 leverage ratio of 3 per cent during the parallel-run period from1 January 2013 to 1 January 2017.

intended to prevent an excessive buildup of leverage in the banking sector by introducing a safeguard against model risk and measurement error in the risk-based capital framework. A simple, transparent indicator of leverage will thus provide a useful backstop to such frameworks. This measure will also help contain the impact on the financial cycle of the interactions between leverage and asset growth that amplifies asset-market booms and subsequent financial crises, as described above. As already mentioned, a regulatory limit on leverage is already in place in Canada, and Canadian banks carried significantly lower leverage ratios than U.S. investment banks and major European banks before the recent financial crisis. This feature of Canadian banks likely contributed to the relative stability of the risk-averse Canadian banking system.

Liquidity standards

To reduce liquidity risk along with solvency risk, Basel III will supplement the capital standards with two new liquidity standards. One is a measure of whether banks have enough unencumbered liquid assets to cover cumulative net outflows over a 30-day horizon (the Liquidity Coverage Ratio). The second is a more structural measure requiring banks to maintain a certain level of stable funding that depends on the liquidity of their assets and the size of their off-balance-sheet exposures over a one-year horizon (the Net Stable Funding Ratio).[18] These new standards aim to promote the resilience of banks during stressed periods when the market liquidity of assets and wholesale funding for financial institutions decline.[19] The research summarized previously makes it clear that such measures should help to reduce the likelihood of institutions finding themselves caught short in terms of liquidity and thus the occurrence of financial crises.

These new standards aim to promote the resilience of banks during stressed periods

Financial market reforms

To maintain the stability of the whole financial system, it is important to ensure continuous operations of key financial markets, so that banks and other firms can have access to funding when necessary. Here, we discuss some of the recent proposals for financial market reform to increase the robustness of financial market infrastructure.

Central counterparties

The network effects measured by Gauthier, He and Souissi (2010) and Gauthier, Lehar and Souissi (2010) demonstrate the potential importance of bilateral exposures among banks in the transmission and amplification of risks. The benefits traditionally associated with central counterparties (CCPs)[20] include reduced counterparty credit risk and reduced potential for the transmission of stress through the financial system (Chande, Labelle and Tuer 2010). For example, in the case of a default by one system participant, the standardized procedures of a CCP can contribute to the orderly closing out of that participant's positions, thus eliminating the chance of a fire sale and reducing spillovers to other markets (Carney 2010a). The development of CCPs should therefore improve the resilience of the financial system, given that CCPs are designed to be risk proofed and thus robust in the presence of financial stress. For this reason, the Bank of Canada is supporting the development of a domestic CCP for Canadian-dollar repos, which will be provided by the Canadian Derivatives Clearing Corporation. The Bank is also working with its domestic partners to develop similar infrastructure for over-the-counter (OTC) derivatives markets.[21]

Through-the-cycle margins

As described earlier, a spiral of tightening margin requirements and declining asset prices destabilized the financial system during the 2007–09 crisis. In response, the Committee on the Global Financial System (2010) published a set of recommendations for preventing such a spiral in the future. One of these recommendations is to make the supervisory margin requirements on securities-financing transactions (such as repos, securities lending and OTC derivatives) relatively stable through the cycle (i.e.,

18 The Liquidity Coverage Ratio (LCR) and Net Stable Funding Ratio (NSFR) will be implemented following an observation period during which the Basel Committee on Banking Supervision will monitor implications of these standards for financial markets, credit extension and economic growth, addressing unintended consequences as necessary. The LCR, including any revisions, will be introduced on 1 January 2015. The NSFR, including any revisions, will move to a minimum standard by 1 January 2018 (see Basel Committee on Banking Supervision 2010b for more details).

19 See Northcott and Zelmer (2009) for further discussion on the system-wide effects of liquidity standards.

20 A CCP is a financial market infrastructure that interposes itself between two parties in a trade.

21 See Wilkins and Woodman (2010) for more detail on how to strengthen the resilience of OTC derivatives markets.

introducing so-called through-the-cycle margins).[22] These margin requirements would take into account the volatility of asset prices over a long historical period that includes stressed market conditions, thereby avoiding a substantial decline in margins during economic expansions and a significant increase during stressed periods, such as that observed in the crisis.[23]

Conclusions

One of the forces set in motion by the initial losses on subprime-mortgage loans was a significant decline in the market liquidity of assets and in wholesale funding for financial institutions. This article has summarized selected examples of recent research that clarify the role of liquidity in destabilizing the financial system and has shown how the implications of this work support the recently announced package of reforms to the rules governing bank capital and liquidity.

Although recent research has greatly advanced our understanding of liquidity and its role in the financial system, such efforts should continue. Further research would provide insights for the ongoing improvement of policies and would help to improve the Bank's capacity to contain the emergence of serious system-wide risks.

In particular, we need to keep improving our ability to measure incipient risks to market liquidity and bank funding. The research summarized in this article will be an important building block for further progress in this area.

22 The report also recommends the introduction of CCPs; timely updates of margin requirements in order to avoid large, discrete margin calls; the development of best practices for securities lending; and the collection of information on credit terms.

23 For details, see Longworth (2010) and Kahmi (2009).

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Unconventional Monetary Policy: The International Experience with Central Bank Asset Purchases

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- *Evidence suggests that the implementation of unconventional monetary policy during the recent financial crisis, via credit easing and asset purchases, succeeded in reducing credit spreads and yields, thereby providing further easing of financial and monetary conditions and fostering aggregate demand.*
- *These policy measures are most effective when targeted to specific market failures, sufficiently large relative to the targeted market, and clearly communicated.*
- *The evidence must be treated with appropriate caution, since the evaluation of the effectiveness of unconventional monetary policy is subject to problems of identification.*
- *The ongoing fiscal retrenchment will affect the outlook and therefore the timing of the withdrawal of monetary stimulus.*
- *Central banks should account for the potential negative externalities of unconventional monetary policies, which are often neglected in the analysis of their effectiveness.*

The financial and economic crisis of 2007–09 witnessed unprecedented policy responses from central banks. As the first responders, central banks acted aggressively, lowering policy interest rates and introducing extraordinary measures to provide liquidity to short-term funding markets. The intensification of the crisis in the autumn of 2008 and the collapse of real economic activity prompted many central banks to further lower policy rates, although their ability to continue to do so became constrained as short-term interest rates approached zero.[1] Consequently, numerous unconventional monetary policy tools were introduced to provide additional monetary easing.[2] These included new or expanded credit facilities, as well as large-scale purchases of government securities (often referred to as quantitative easing, QE).[3]

The unconventional monetary policy actions were, by definition, unusual in both size and scope, and there was little guidance from previous experience that could be used to judge their expected impact.[4] Initial assessments and subsequent research have led to an emerging consensus that many of these policies were effective—but a vigorous debate continues.

This article examines the effectiveness of unconventional monetary policies implemented during the

1 The effective lower bound (ELB) for monetary policy rates is typically a small positive number because of institutional characteristics and financial market frictions.

2 Some of these tools—particularly those that focused on restoring market functioning—may also be referred to as financial stability policies.

3 Concurrently, fiscal and supervisory authorities enacted measures to stabilize the financial system, including injecting capital into the banking system, guaranteeing deposits and bank debt, and implementing fiscal stimulus.

4 The literature has found that the Japanese experience with QE from 2001–06 was rather unsuccessful. However, the circumstances under which QE was implemented, as well as the modalities and implementation of the program, were quite different from those of the current episode.

crisis, focusing on asset purchases.[5] The existing literature concludes that, on average, asset purchases were effective, since they improved market functioning, lowered interest rates, and helped to spur economic activity. These policies were most effective when they were targeted to address specific market failures, were sufficiently large relative to the targeted market, and were clearly communicated with respect to their purpose (i.e., as part of the effort to achieve the central bank's policy objective).

Nevertheless, gauging the impact of these measures is not straightforward: views differ with respect to the appropriate metrics of success, and the evaluation of program effects is subject to several identification problems. Moreover, most studies tend not to discuss the possible negative externalities arising from these measures, including potential financial market distortions, issues related to balance sheet management and, ultimately, concerns with respect to central bank credibility and independence. Thus, conclusions drawn from studying the effects of unconventional monetary policies must be treated with appropriate caution.

This article first defines and documents these unconventional measures, focusing on central bank asset purchases and the impact of these purchases on central bank balance sheets. It then discusses the challenges in identifying the effects of central bank asset purchases. Given these caveats, the existing evidence of the effectiveness of central bank asset purchases on financial and economic outcomes is examined. Strategies for exiting from the measures are then explored, followed by an analysis of the potential costs of these measures and the broader implications for monetary policy frameworks.

Types of Central Bank Asset Purchases

Central banks in major countries typically conduct monetary policy by setting a target for the overnight interest rate in the interbank money market. During the recent crisis, however, as financial instability intensified and policy rates approached their ELBs, central banks turned to asset purchases as an additional means to ease financial and monetary conditions. For the purposes of this article, asset purchases are separated into *credit facilities*—purchases of private sector assets designed primarily to ease financial stress—and *quantitative easing*—measures by which the central bank holdings of government debt were expanded to provide additional monetary ease.[6] This section reviews such policies as conducted by major central banks, including the U.S. Federal Reserve, the European Central Bank (ECB), the Bank of England and the Bank of Japan.[7]

Credit facilities

With the intensification of the financial crisis in 2008, central banks implemented various types of credit facilities to ease credit conditions and, in some cases, directly acted as an intermediary in dysfunctional markets.[8] Under these programs, central banks purchased private sector assets in certain credit markets that were impaired. The goals of these facilities were to i) improve market liquidity in important segments of the market for private debt securities; ii) further reduce market interest rates; and iii) ease funding conditions for firms and financial institutions, with banks then expanding their lending to the private sector (Beirne et al. 2011).

The Federal Reserve purchased private sector assets directly and provided financing to financial institutions to facilitate their purchase of private sector assets.[9] The Bank of England and the Bank of Japan introduced outright purchases of private sector instruments, such as commercial paper and corporate bonds, while the ECB purchased a limited amount of covered bonds.[10] Importantly, the various credit facilities were typically introduced when the policy rate was above the ELB.

5 Note that the term "unconventional monetary policy" encompasses other types of unconventional policies, such as conditional statements, which are not covered here.

6 Purchases of Government-Sponsored-Enterprise (GSE) debt and GSE-backed mortgage-backed securities by the U.S. Federal Reserve are included with government debt.

7 This article does not address unconventional policy measures implemented by the Bank of Canada. For the Canadian experience, please refer to Lavoie, Sebastian and Traclet 2011; Zorn, Wilkins and Engert 2009; Selody and Wilkins 2010; and Longworth 2010.

8 Such policies are often referred to as credit easing (Bank of Canada 2009).

9 The U.S. Federal Reserve purchased commercial paper under the Commercial Paper Funding Facility (CPFF), set up two facilities to facilitate funding of money market mutual funds, and implemented the Term Asset-Backed Securities Loan Facility (TALF), a lending facility to support the market for asset-backed securities.

10 In the case of the Bank of England, such purchases were initially funded by the issuance of Treasury Bills, rather than by central bank money, and thus did not increase the central bank's balance sheet. But since quantitative easing began in the United Kingdom, these purchases have been financed by central bank reserves and have expanded the monetary base.

Quantitative easing

In late 2008, as the financial crisis spilled over into the real economy, major central banks found themselves constrained by the ELB. To further ease monetary conditions, they turned to large-scale purchases of government debt. The idea behind such large-scale asset purchases (LSAPs) is that they would put direct upward pressure on the price of the targeted assets (typically longer-dated government debt instruments), thereby lowering their yields. Purchases could affect the economy through a variety of channels:

i. Encouraging investors to rebalance their portfolios in the direction of riskier higher-return assets (by reducing yields on government debt), thus exerting upward pressure on their prices and resulting in lower interest rates;

ii. Creating positive wealth effects through higher asset prices, which supports consumption;

iii. Stimulating consumption and investment by lowering debt-service costs on existing debt;

iv. Exerting downward pressure on the exchange rate (although central banks did not officially mention this channel as their objective) in order to favour domestic demand;

v. Placing upward pressure on inflation by raising domestic demand and increasing the domestic price of imports (through the exchange rate channel);

vi. Supporting confidence by demonstrating that the central bank would do whatever necessary to meet its economic objectives;

vii. Anchoring inflation expectations, thereby holding down real interest rates; and

viii. Increasing the effectiveness of fiscal expansion, by reducing long-term interest rates and thus mitigating the crowding out of investment and consumption (Kohn 2009).

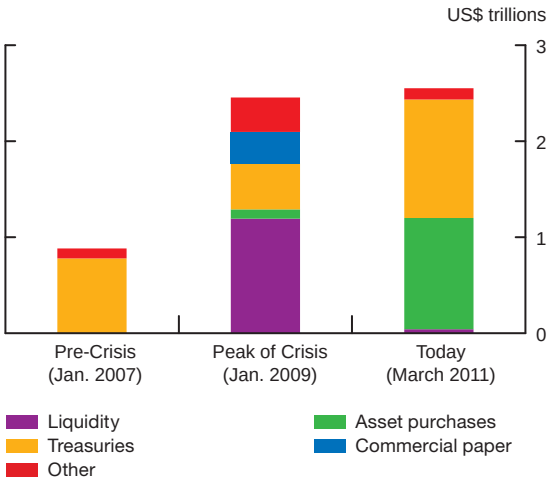
LSAPs put direct upward pressure on the price of the targeted assets, thereby lowering their yields

Several central banks purchased government debt in their efforts to provide further monetary ease. In addition to purchases of U.S. Treasury securities, the Federal Reserve also acquired large amounts of mortgage-backed securities (MBS) backed by the government-sponsored enterprises (GSEs) Fannie Mae, Freddie Mac and Ginnie Mae. These purchases were critical for reinvigorating the market for MBS, helping to increase the availability of credit for the purchase of houses, lowering mortgage rates and supporting the housing market and financial markets more generally.

The size of the purchases varied according to circumstances. The Federal Reserve and the Bank of England conducted sizable asset purchases, totalling close to 18 and 12 per cent of GDP, respectively, and leading to a dramatic expansion of their balance sheets (**Chart 1**).[11] The Bank of Japan and the ECB implemented more modest purchase programs, with the ECB's Securities Markets Programme focused more narrowly on stabilizing securities markets, as opposed to quantitative easing.[12] Except for the ECB, the purchases of financial assets through the creation of central bank reserves were unsterilized.[13] Interestingly, the Bank of England chose to explicitly refer to its purchase program as quantitative easing, since it sought to influence the quantity of money in the economy more broadly.

Chart 1: Central bank balance sheets (assets)

a. U.S. Federal Reserve



Note: Liquidity is the sum of currency swaps, TAF, MMIFF, primary dealer and other broker-dealer credit, AMLF, other credit extensions and loans, credit extended to AIG, and TALF.

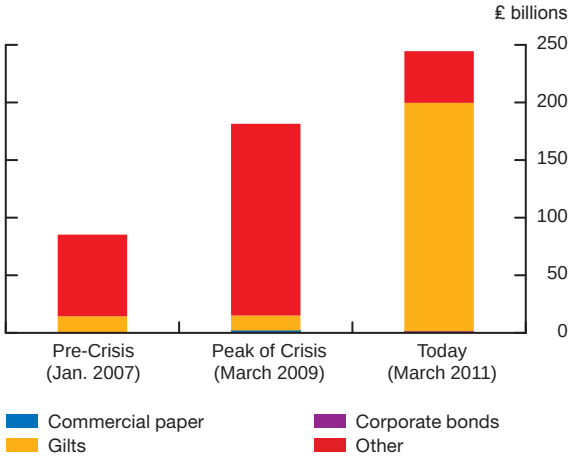
11 Overall, the U.S. Federal Reserve will have purchased a total of about US$2.265 trillion of long-term assets by the end of the second quarter of 2011. The Bank of England decided to purchase a total of £200 billion under its Asset Purchase Facility, mainly concentrating on government securities, i.e., gilts.

12 The program was launched in May 2010 at the start of the sovereign debt crisis which first emerged in Greece.

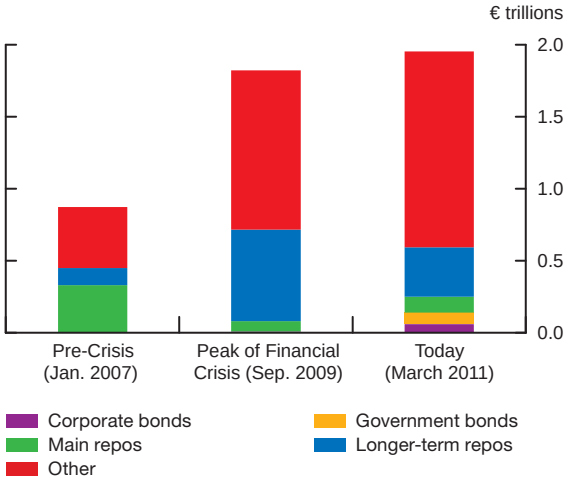
13 This means that purchases were financed through an expansion of settlement balances.

Chart 1 (cont'd): Central bank balance sheets (assets)

b. Bank of England

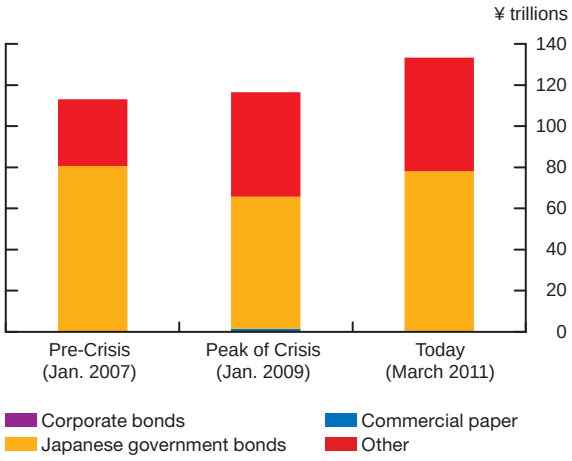


c. European Central Bank



Note: Corporate bonds refer to the Covered Bond Purchase Programme. Government Bonds refer to the Securities Market Programme.

d. Bank of Japan



Source: Individual central banks

The Evaluation Problem

Assessing the effectiveness of the various central bank measures is complicated by many conceptual and empirical hurdles. The primary objectives of the various initiatives differed greatly: credit facilities were often aimed at resolving a specific market failure, while LSAPs were motivated by a desire to lower interest rates, boost asset prices, and stimulate real economic activity. In addition, many of the initiatives had benefits beyond their primary objectives. Consequently, the metrics of success are open to debate. But this is not the only concern: gauging the effectiveness of individual measures is complicated by numerous identification issues.

Gauging the effectiveness of individual measures is complicated by numerous identification issues

Contemporaneous measures and effects

Given the nature of the crisis, central banks and fiscal authorities in many countries were simultaneously announcing and undertaking various new policy initiatives. The impact of asset purchases on interest rates, for example, would be difficult to estimate, since rates would be simultaneously influenced by other central bank initiatives, macroeconomic developments (including dramatic increases in government deficits and debt, new information on recent economic activity and the outlook for growth), changes in inflation expectations, and evolving risk appetite. The simultaneity issue is further complicated when examining the ultimate effects of asset purchases on economic activity and inflation, since measures of macroeconomic activity are infrequent and lumpy (monthly or quarterly), published with a lag, and often revised.

Policy lags

Potentially long and variable lags between financial developments, macroeconomic activity and inflation complicate the assessment. In the case of unconventional monetary policies during crisis periods, this challenge is exacerbated because, by reducing uncertainty and increasing confidence, these policies may have more immediate effects through the expectations channels in addition to effects through the standard channels of transmission.

Ongoing nature of the crisis

An important aspect of the financial and economic crisis has been its protracted nature. Given the impaired state of the global banking system, and the critical interrelationships between the financial sector and real economic activity (which led to a negative feedback loop), determining what the evolution of economic and financial conditions would have been in the absence of policy responses becomes particularly difficult.

Spillovers

While each policy initiative may have been designed primarily to mitigate a specific challenge, they would all have had broader spillover effects across markets. For example, large-scale purchases of MBS by the Federal Reserve might not only improve the functioning of that market, but could also affect the pricing of other securities through changes in perceived risk, which could lead to reallocations of private sector portfolios that raise the demand for other assets. Similarly, policies enacted in one country could have spillover effects in other countries.[14]

Fiscal policy

In addition to the simultaneity of the announcements and the implementation of fiscal stimulus with unconventional monetary policy measures, the response of financial markets to fiscal action varied over time, further clouding any assessment. In particular, in the early stages of the crisis, fiscal stimulus was seen as a stabilizing force, because it helped provide reassurance that policy-makers were doing what they could to avoid an even worse recession. At that stage, fiscal stimulus (and the associated increase in debt and deficits) helped stabilize financial markets. As the crisis faded, however, concerns related to sovereign indebtedness in some regions caused country risk premiums to rise, complicating the assessment of policy effectiveness.

Prices versus quantities

Expectations and confidence can respond very quickly to announcements of policy initiatives, leading to swift reactions in asset prices. On the one hand, such observations might be taken as evidence of policy effectiveness. On the other hand, if credit conditions remained sufficiently tight that essentially no new borrowing was occurring, then the repricing of existing assets could provide a misleading signal of overall policy effectiveness with respect to financial conditions and economic activity.

Macrofinancial and macroeconomic environment (crisis versus non-crisis)

The effectiveness of policies is influenced by the broader economic environment. For instance, policies that are seen as particularly effective in crisis periods, owing to their ability to reduce uncertainty and improve confidence, may not be very effective in more typical non-crisis periods. Similarly, policies that prove to be effective at stimulating demand and production by reducing borrowing costs may be ineffective in periods of extremely tight credit. Such non-linearities can make it difficult to determine a baseline for evaluating or estimating the effectiveness of various initiatives.

Selection bias

The countries that undertook asset purchases were generally those that were the most adversely affected by the crisis. The impact of the measures taken may therefore have been affected by the degree of impairment of the financial markets in these countries.

Taken together, these concerns present a significant hurdle when trying to assess the effectiveness of the respective policy measures. These evaluation exercises should therefore be approached with an appropriate degree of caution.

The Evidence

The effectiveness of unconventional policy measures is, not surprisingly, the subject of ongoing debate and research interest. Keeping in mind the caveats mentioned above, the overall evidence to date suggests that unconventional monetary policy initiatives contributed to the functioning of financial markets and were successful in providing additional stimulus through easier monetary and financial conditions.[15]

Evidence on the effectiveness of credit facilities

Overall, the credit facilities implemented by major central banks appear to have made a positive

14 Studies of the effects of fiscal stimulus suggest important international spillovers (de Resende, Lalonde and Snudden 2010).

15 The literature has evaluated the impact of asset purchases by analyzing their effect on prices (spreads and yields), quantities (i.e., turnover in specific markets and/or the supply of credit) and, ultimately, their impact on the real economy. Methodologies include event studies, reduced-form models and theoretically founded models.

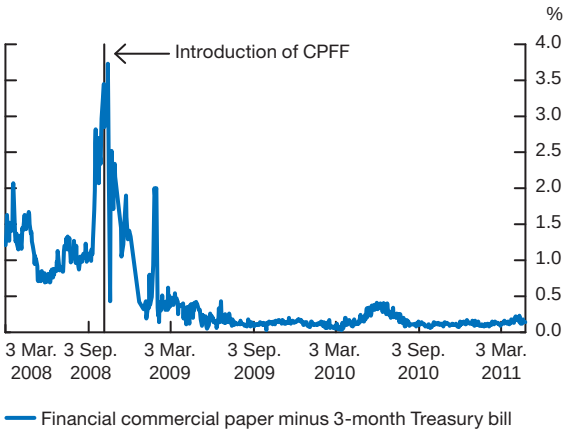
contribution to the functioning of the targeted markets (**Table 1**). Both the Federal Reserve's Commercial Paper Funding Facility (CPFF) and the Bank of England's Commercial Paper Facility seem to have reduced market illiquidity, lowered spreads, and increased issuance (**Chart 2**) (Dale 2009). Such facilities may also have had important confidence effects in signalling that the central bank would be willing to act as a backstop purchaser/seller.[16] In turn, although the amount of funds provided by the TALF was relatively small, it also appeared to revive the issuance of asset-backed securities, and their spreads narrowed considerably.

The ECB's Covered Bond Purchase Programme seems to have stabilized the covered bond market and contributed to a tightening of spreads on covered bonds of different maturities and in different jurisdictions (IMF 2010). Moreover, the program may have led to an increase in the issuance of bonds and facilitated the issuance of longer-dated bonds, thereby easing funding conditions for banks (Beirne et al. 2011). The Bank of Japan's credit-easing facilities appear to have been partially successful in reducing stress in targeted markets. On the one hand, initial outright purchases of commercial paper triggered a fall in the yields for these instruments, with some estimating a cumulative effect on the commercial paper issue rate of 39 basis points (Hirose and Ohyama 2009). On the other hand, the Bank of Japan's outright purchases of corporate bonds may have had a lesser impact, since the rounds of purchases were substantially undersubscribed, perhaps reflecting a mismatch between the types of bonds that banks and brokerages wanted to sell and the instruments that the central bank was willing to buy.[17]

Evidence on the effectiveness of LSAPs

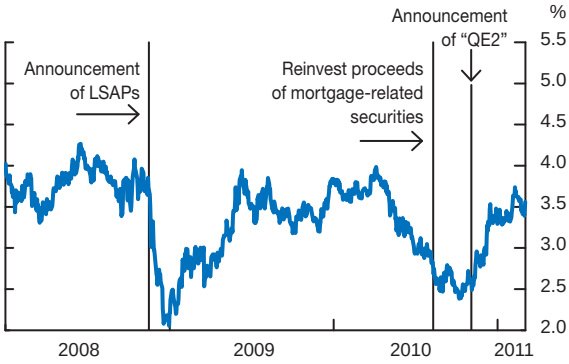
Several recent studies have attempted to estimate the quantitative effect of LSAPs, with most studies focusing on the Federal Reserve's programs (often referred to as QE1 and QE2) (**Table 1**). Overall, these studies suggest that LSAPs had a significant impact on financial markets and likely provided stimulus to the overall economy. In particular, a consensus has emerged that the first phase of the Federal Reserve's LSAPs probably lowered the yield on the 10-year

Chart 2: Daily spreads in the U.S. commercial paper market



Source: DataStream

Chart 3: Yield on 10-year U.S. Treasury bills



Source: Bloomberg

Treasury note, as well as on high-grade corporate bonds, by about 50 basis points. This is consistent with the observed drop in yields that occurred on the announcement of the purchases (**Chart 3**). Nevertheless, considerable uncertainty surrounds these estimates.

Studies estimating the impact of LSAPs on the macroeconomy have generally concluded that they seem to have had sizable impacts on GDP growth (**Table 2**). The most important caveat to such studies is that they employ models tuned to non-crisis periods to assess the macro implications of the financial responses to policy actions. As discussed earlier, traditional real-financial transmission channels may not have been functioning normally during the financial crisis.

The Federal Reserve's purchases of GSE-guaranteed MBS appear to have eased mortgage-market conditions. The 30-year conforming mortgage rate declined by more than one percentage point following the

16 Bean (2011) argues that a credible statement in this respect may have been enough to restore normal market functioning.

17 The Bank of Japan (2009) nevertheless argues that the compression in spreads on corporate bonds in fiscal year 2009 may be attributed partly to the measures taken by the central bank and the government to facilitate corporate financing.

Table 1: Impact of credit easing and LSAPs on financial markets

Authors	Policy	Financial market impact
Adrian et al. (2010)	CPFF	Expansion of the CPFF was accompanied by the narrowing of the spreads on commercial paper
Agarwal et al. (2010)	TALF	Program offered a liquidity backstop, helped to reduce spreads in core ABS classes, and funding new issuance
D'Amico and King (2010)	QE1	Reduction by 30 to 50 bps across the yield curve
Doh (2010)	QE1	Regression analysis: 39 bps
Gagnon et al. (2010)	QE1	Purchases reduced 10-year term premium by 30 to 100 bps, with most estimates in the lower and middle thirds of this range.
Neely (2010)	QE1	Portfolio model: 88 bps for U.S. Treasuries, 57 to 76 bps for other countries. Event study: 107 bps (U.S. Treasuries)
Krishnamurthy and Vissing-Jorgensen (2011)	QE1	Event Study: Treasuries fall by a cumulative 107 bps. Regression analysis: Baa-Aaa spread reduced by 4 to 61 bps
	QE2	Event Study: Treasuries fall by a cumulative 30 bps. Regression analysis: Baa-Aaa spread reduced by 7 to 21 bps
Macroeconomic Advisers (2010)	QE1	Initial impact: 100 bps, lasting impact: 50-60 bps
Hamilton (2010)	QE2	About 11 bps at the 10-year yield, effect not significant
Swanson (2011)	Operation Twist and QE2	Operation Twist and QE2 are roughly similar in size, so that the predicted effect for QE2 is 15 bps
Joyce et al. (2010)	QE (U.K.)	Event study: 100 bps. Econometric analysis: 30 to 85 bps
Fuster and Willen (2010)	MBS purchases	Wide dispersion in the rate changes, reductions of up to 40 bps
Hancock and Passmore (2011)	MBS purchases	Announcement effect: reduced mortgage rates by about 85 bps. Actual purchasing of MBS decreased abnormal risk premiums by roughly 50 bps.
Stroebel and Taylor (2009)	MBS purchases	MBS program has no significant effect (movements in prepayment risk and default risk explain movements in mortgage spreads)
Kozicki, Santor and Suchanek (forthcoming)	QE1	Increase in Treasury holdings was associated with a decrease of 1.08 percentage points in long-term forward rates

Note: bps stands for basis points

Table 2: Evidence on the macroeconomic impact of LSAPs

Authors	Policy	Treasury yield	GDP	Unemployment	Inflation
Baumeister and Benati (2010)	QE (U.S.)	Rely on estimates of Gagnon et al. and Bean	Without QE, real growth would have been 4 pps lower in 2009Q1	-	Without QE, inflation would have been 0.4 pp lower in 2009Q2
	QE (U.K.)		Without QE, real growth would have been 4 pps lower in 2009Q1	-	Without QE, inflation would have been 4 pps lower in 2009Q1
Chung et al. (2011)	QE1	Term premium 50 bps lower	Without QE, level of real GDP almost 2% lower by early 2012	Without QE, unemployment would be 1 pp higher by 2012	Without QE, inflation would be 0.7 pp lower by 2011
	QE2	Additional 20 bps	Without QE, level of GDP would be lower by an additional 1%	Without QE, unemployment would be higher by an additional 0.5 pp by 2012	Without QE, inflation would be lower by an additional 0.3 pp
Deutsche Bank (2010)	QE2	Assumption: QE2 = $1 tr leads to 50 bps fall	Level of real GDP 0.7% higher over 2 years	0.2% lower after one year and 0.5% lower after 2 years	0.1-0.2 pp higher
Macroeconomic Advisers (2011)	QE2	Assumption: QE2 lowers 10-year yield by 20 bps	Level of real GDP after eight quarters increases by 0.4%	Unemployment falls by 0.1 pp in year 1 and 0.2 pp in year 2	0.1 pp higher over next 2 years

Notes: bps stands for basis points, pp[s] for percentage point[s]

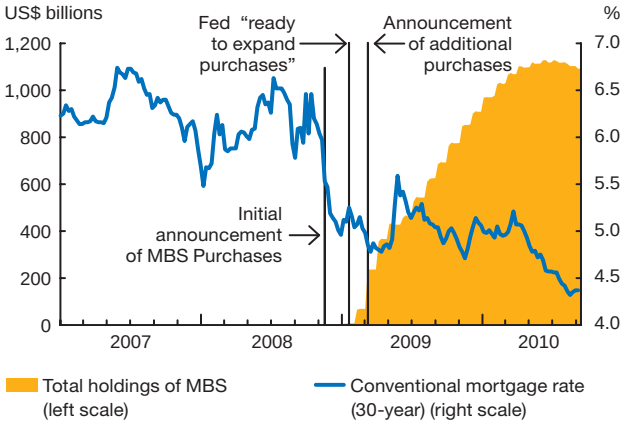
announcement of this program and continued to decline after its expansion (**Chart 4**). The purchases also assured a steady demand for these securities at a time of strained market conditions. The purchases reduced abnormal risk premiums embedded in mortgage rates by roughly 50 basis points (Hancock and Passmore 2011; Gagnon et al. 2010).[18]

The effectiveness of LSAPs appears to depend crucially on underlying financial and economic conditions

The effectiveness of LSAPs appears to depend crucially on underlying financial and economic conditions. The magnitude of the effects of the Federal Reserve's second round of purchases (dubbed QE2) seems to have been more modest than the first round of purchases (**Tables 1** and **2**).[19] Importantly, the first round of LSAPs was implemented at a time of considerable strain in financial markets, severely weakened macroeconomic conditions, and low confidence. The overall financial and economic environment subsequently improved, implying that there were fewer distortions for the interventions to mitigate.

Purchases of government debt by the Bank of England (QE) also appear to have had a significant effect: on the announcement of quantitative easing, yields on gilts of maturities ranging from 5 to 25 years that were eligible for purchase fell by about 40 to 90 basis points. Joyce et al. (2010) estimate that the overall impact on gilt yields was roughly 100 basis points. Moreover, QE appears to have had wider effects, such as lowering corporate yields, helping to restore market liquidity and confidence, and stimulating nominal spending (Dale 2009). The ECB's purchases of government bonds, although small and sterilized, appeared to temporarily calm markets and reduce spreads on the sovereign debt of peripheral European economies. But these spreads have widened again and remain elevated, indicating renewed stress. Finally, the market reaction to the Bank of Japan's announcements to increase the size of its government bond purchases has been relatively muted, perhaps because

Chart 4: MBS holdings and mortgage rate



Source: Bloomberg

purchases have been too small compared with the size of the market to have a measureable impact.

Under what circumstances were policies effective?

The effectiveness of unconventional monetary policy measures depends on several factors. Measures appear to have been effective (i) when targeted to address a specific market failure, focusing on market segments that were important to the overall economy; (ii) when they were large in terms of total stock purchased relative to the size of the target market; and (iii) when enhanced by clear communication regarding the objectives of the facility. More broadly, unconventional measures also appear to have been effective because of acute financial market stress, low confidence and a weak economic environment. Indeed, recent evidence suggests that the benefits of asset purchases are substantial only at times of unusual financial distress (Curdia and Woodford 2010).

Given these observations, it follows that unconventional monetary policies that were appropriate in one country may not necessarily be effective in other countries. The effectiveness of the policies depends on country-specific characteristics, including institutional features.[20] Consequently, overall evidence of effectiveness may not be generalized across countries, or even across time as the economic environment changes.

18 The effect may have been partly temporary because, even in the absence of action by the U.S. Federal Reserve, spreads would have come down eventually as the financial crisis passed and the economy began to recover. The simultaneous decline in prepayment risk and default risk may also account for the reduction in mortgage spreads (Strobel and Taylor 2009).

19 Nevertheless, several Federal Reserve officials judge that QE2 has been effective (Bernanke 2011; Bullard 2011; Rosengren 2010; and Yellen 2011).

20 Bini Smaghi (2009) argues that because euro area countries primarily rely on bank-based financial systems, whereas the financial system in the United States is market based, different policy responses are required.

Exiting from Unconventional Monetary Policies

The implementation of extraordinary polices is only one challenge—the eventual exit from such measures must also be considered. The decision of when and how fast to exit from unconventional monetary policies must balance the risk of an overly aggressive exit, particularly in the face of fiscal retrenchment, against the risk of an excessively delayed exit. In the former case, aggressive tightening could risk pushing economies back into recession, while in the latter case, the failure to unwind programs could lead to excess liquidity and contribute to rising inflationary pressures.

Exit strategies should be specified, even if not needed immediately

To keep inflation expectations well anchored, central bank exit strategies should be specified, even if not needed immediately. Given the wide range of policy interventions that have been implemented by central banks, exit strategies will necessarily depend on facility- and country-specific circumstances. Nevertheless, the following principles should help guide the exit from unconventional monetary policies:

1. Monetary policy should be guided by objectives for inflation or price stability.
2. Monetary policy should be conditioned on information regarding the economic outlook, including fiscal paths. In this context, fiscal authorities need to plan and communicate their intentions to the public. This would allow central banks to condition monetary policy on the fiscal outlook and help reinforce central bank credibility.
3. Policy authorities need to understand how the monetary transmission mechanism may have changed.
4. Policy credibility and central bank independence must be maintained to ensure the effectiveness of future policy.
5. Communication regarding exit strategies should be clear and should include timely reporting of balance sheet developments.

Whereas the use of credit facilities naturally declines as they become less attractive, QE will require a more "active" exit approach, since it represents a more permanent addition to the central bank's balance sheet (often because of the longer duration of the assets acquired). An active exit from asset-purchase programs involves decisions related to the total value of purchases. Central banks may simply allow these assets to mature or, in the case of MBS, not replace decreased holdings resulting from prepayments. Central banks will also want to consider decreasing their holdings through explicit sales, although other options to drain reserves are possible, such as conducting reverse repos with financial market participants, offering term deposits to banks, or issuing central bank marketable securities.

The ability of central banks to pay interest on reserves is a key element of any exit strategy, since it allows them to raise policy rates despite having large balance sheets and thus provides additional flexibility in formulating exit strategies.[21] The basic intuition is that raising the rate paid on reserve balances reduces the opportunity cost of excess reserves, and as such, banks will not want to lend out their reserves at rates below what they can earn at the central bank. Thus, the interest rate paid by the central bank should tend to put a floor under the target for the overnight policy rate. Central banks can thus tighten monetary policy by raising the target for the overnight policy rate at the same time that they raise the rate paid on reserve balances. This allows central banks to raise interest rates before, or at the same time as, reserves are drained, and before all LSAPs made during the crisis are reversed. Additional flexibility may be available through policy decisions related to the corridor.[22]

Several concerns arise when considering the exit from unconventional monetary policy. First, policy-makers need to allow for the possibility that concurrently raising policy rates and draining reserves might alter the usual transmission mechanism. For example, a typical policy-rate increase could prove less contractionary than usual in the presence of substantial excess liquidity. Second, in the current environment, it is crucial to understand whether the standard transmission mechanism of accommodative policy in the form of a low policy rate is different from that related to the creation of reserves and the size of the central bank balance sheet. Finally,

21 This flexibility is important in the current environment. The presidents of some Federal Reserve Banks have hinted that leaving rates "too low for too long" may create an environment conducive to the emergence of asset bubbles (Hoenig 2010; Dudley 2010; Fisher 2010; and Plosser 2010).

22 The upper limit of the corridor usually represents the level of the standing liquidity facility at which banks can obtain base money from central banks, whereas the lower limit represents the interest rate that banks can obtain on deposits at the central bank. Goodhart (2009) has recently suggested that in the early state of the recovery, margins may be allowed to be biased "downwards," i.e., a relatively low deposit rate, with lending rates relatively inexpensive (close to the official rate), penalizing reserve buildup and encouraging borrowing from the central bank. Once the recovery has become firmly established, central banks may, as part of their exit strategy, want to tilt the margins "upwards," i.e., holding banks' deposit rates close to the official rate, while at the same time making additional borrowing from the central bank expensive.

an important headwind for consideration in the current environment is the end of the fiscal stimulus enacted in response to the crisis, as well as the additional fiscal restraint necessitated by the high levels of debt in many countries. There is heightened uncertainty in the fiscal outlook relative to historical experience. The need for considerable fiscal consolidation in many countries means that central banks will not only need to take account of uncertain fiscal paths domestically, but will also need to be mindful of the spillover effects of fiscal consolidation elsewhere.[23]

Policy Considerations

The use of unconventional monetary policy has sparked discussion of how such measures could affect the conduct of monetary policy, and their potential costs. In this section, we discuss some of these issues.

Unconventional monetary policy and the ELB

An ongoing subject of debate regarding monetary policy, in the context of inflation targeting, is the appropriate target rate of inflation. When the inflation target is relatively low, the probability that the target for the policy rate will approach or hit the ELB will be higher. This concern has prompted some observers to note that inflation targets should not be lower than the current convention of 2 per cent.[24] But if unconventional tools are effective, this concern may be alleviated, thus reassuring those who would advocate lower inflation targets. The current evidence with respect to the effectiveness of unconventional monetary policy, however, is drawn primarily from the use of these measures during crisis periods. Thus, the effectiveness of such measures under more "normal" circumstances remains an open question, and the ELB could be a binding constraint.

Potential costs of unconventional monetary policy

The use of unconventional monetary policy, both in crises and as part of an established monetary policy toolkit, may also have unintended consequences that should be considered when such measures are undertaken. In fact, studies of the effectiveness of unconventional measures seldom (if at all) attempt to quantify any potential negative externalities. Potential costs include:

Financial market distortion

Unconventional monetary policy measures could distort financial markets. Asset purchases, particularly those of longer-dated government securities, may suppress long-term interest rates, affecting investors, such as pension funds, that need to match long-term liabilities to long-term assets and potentially encouraging excessive leverage and risk taking, posing financial stability concerns (Carney 2010). On a different note, in countries where the stock of debt is relatively small, asset purchases may also distort the yield curve, since such purchases would reduce the supply of liquid securities (i.e., government debt). Moreover, if asset purchases account for a large portion of the outstanding stock of government debt, the central bank could become a dominant market player, affecting the behaviour of other market participants. Lastly, purchases of private sector assets (such as commercial paper or asset-backed securities) may involve picking "winners" and "losers," which raises issues of political economy.

Additional challenges of balance sheet management

Asset purchases can lead to a large expansion, as well as a change in the composition, of the central bank's balance sheet. Exiting from an expanded balance sheet may complicate the conduct of monetary policy. For example, failure to adequately manage the balance sheet could lead to monetary conditions that are not consistent with the central banks' policy objectives. In addition, the purchase of risky assets may expose the central bank to credit risk, market risk and, thus, capital losses. The management of balance sheet risk also raises issues of the extent to which, and the means by which, the central bank should be held accountable. These issues underline the importance of ensuring that proper accountability and governance mechanisms are in place when considering the use of unconventional policy measures.

Potential loss of central bank independence and credibility

Some observers have raised the concern that LSAPs could undermine the independence and credibility of the central bank, particularly if purchases of sovereign debt are viewed primarily as a means of facilitating fiscal deficits or if purchases of risky assets lead to capital losses. In such circumstances, unconventional policy could undermine the central bank's goals, since

23 See also Clinton and Zelmer (1997) on the challenges of conducting monetary policy in an environment where there are concerns about rising government debt.

24 In light of the recent constraints of the ELB on monetary policy, Blanchard, Dell'Ariccia and Mauro (2010) have suggested consideration of higher inflation targets.

a perceived loss of independence and credibility can lead to a de-anchoring of inflation expectations. Central banks need to be mindful of such concerns and must be sure to "firewall" their monetary policy actions from the fiscal authority.

Conflict with financial stability responsibilities

Asset purchases could potentially conflict with the central bank's responsibilities for financial stability. Should lower long-term interest rates caused by LSAPs encourage excessive leverage and risk taking, central banks may find that their monetary policy objectives are in conflict with their financial stability objectives. As central banks expand their mandates in this regard, due attention should be paid to ensuring that proper accountability and governance mechanisms are in place.

Delay of necessary macroeconomic adjustments

Lower long-term interest rates may have broader unintended macroeconomic consequences (Carney 2010). First, by suppressing debt-service payments, low interest rates may allow sovereigns to delay necessary fiscal consolidation. Second, low rates for an extended period may induce banks to roll over non-viable loans; thereby delaying necessary restructuring of industry, such as happened in Japan in the 1990s. Last, low long-term interest rates may encourage households to take on excessive debt or to delay adjustments necessary to reduce their indebtedness.

Conclusion

As part of the policy response to the financial crisis of 2007–09, central banks embarked upon a series of unprecedented policy interventions. The evidence to date suggests that these measures were effective, helping to mitigate the worst aspects of the crisis and to strengthen the recovery. Nevertheless, the evaluation of unconventional monetary policy has not yet adequately assessed the costs of such measures and how they "fit" into the overall monetary policy framework of the central bank. As time allows for a more thorough and seasoned assessment, further research on these issues should be duly considered, including:

- How is the transmission mechanism affected by unconventional monetary policy?
- How do investors reallocate portfolios in crisis versus non-crisis times?
- How is the formation of expectations affected by the use of unconventional policy measures?
- What are the implications of implementing asset purchases and managing associated risks for central bank governance and accountability?

More broadly, future research should address the question of how unconventional monetary policy contributes to the respective monetary policy and financial stability functions of the central bank. Whereas the existing literature has measured the financial market impact of unconventional policies, a more thorough analysis is warranted to understand to what extent such policies have helped the central bank achieve its monetary policy objective. Moreover, while unconventional monetary policies to restore financial market functioning appear to have been successful in their immediate objective, their broader implications for financial stability have yet to be assessed.

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Lessons from the Use of Extraordinary Central Bank Liquidity Facilities

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- *During the financial crisis, central banks took extraordinary measures to inject liquidity into the global financial system in response to widespread deterioration in funding conditions.*
- *The traditional liquidity facilities available to central banks prior to the crisis were not designed to deal with severe disruptions in funding markets.*
- *Central banks adapted their facilities and introduced new ones. Overall, the evidence suggests that the policy response helped to reduce funding pressures.*
- *Important lessons can be drawn from this experience: extraordinary actions should be anchored by clear principles; a flexible operating framework facilitates an appropriate policy response; central bank co-operation maximizes effectiveness; and financial institutions and core funding markets are interdependent.*

Financial institutions rely to varying degrees on capital markets, including short-term funding markets, for their financing needs. In normal times, central banks provide routine short-term financing (hereafter referred to as liquidity) to financial institutions to support the smooth operation of the payments system, promote well-functioning funding markets and support the monetary policy stance. During the recent crisis, however, widespread deterioration in funding conditions for financial institutions led them to stop redistributing liquidity to the broader financial system, as they normally do, causing a seizing-up of important funding markets and requiring unprecedented measures from central banks. They responded by expanding their traditional provision of liquidity along the following dimensions: volume, term, eligible counterparties and acceptable collateral.[1] These extraordinary actions helped funding markets to gradually return to more proper functioning.

In this article, we examine the provision of central bank liquidity during the crisis and its contribution to alleviating pressures in short-term funding markets.[2] Central banks were flexible in providing extraordinary liquidity, and their actions were also designed to encourage a return to financing in private funding markets and to limit moral hazard.[3] A review of this experience illustrates the importance of well-articulated intervention principles, a flexible operating framework, and clear communication by—and coordination among—central banks, regarding their

1 See Zorn, Wilkins and Engert (2009) for more on the Bank of Canada's liquidity actions during the crisis and Zorn and García in this issue for more on collateral policies.

2 Although we focus on measures taken by the Bank of Canada, the Bank of England, the European Central Bank and the U.S. Federal Reserve, other central banks took similar measures.

3 Moral hazard arises when central bank actions reduce the incentive for financial entities to protect themselves against risky outcomes. The concern with providing extraordinary central bank liquidity is that banks would improperly manage their funding risk, assuming that the central bank would provide liquidity support in times of stress.

liquidity policies. It also exposes the degree of interdependence of financial institutions and markets, making it essential to adopt reforms aimed at improving the infrastructure supporting core funding markets and the liquidity positions of individual institutions.

Liquidity Facilities: From Traditional to Extraordinary

Most central banks play the role of lender-of-last resort to the financial system of their respective countries.[4] This involves providing routine liquidity to support the payments systems and the monetary policy stance, as well as providing emergency liquidity to eligible financial institutions affected by idiosyncratic liquidity shocks.[5]

Traditional liquidity facilities

To manage the aggregate level of liquidity available in the financial system, central banks typically use open market operations and/or a standing liquidity facility, whereby the central bank provides routine short-term liquidity to individual financial institutions. Liquidity is then efficiently allocated by these institutions to the financial system more generally. The Bank of Canada's framework for implementing monetary policy comprises the following key features: the target for the overnight rate, the operating band, the ability to conduct buyback operations at the target rate, and the management of settlement balances.[6] Although deficit and excess settlement positions are typically resolved in the market, the Bank—through its Standing Liquidity Facility—provides collateralized routine overnight loans at the Bank Rate (the upper limit of the 50-basis-point operating band) to direct participants in the Large Value and Transfer System (LVTS), Canada's main payments system, if they are in a deficit settlement position. Conversely, the Bank of Canada pays interest (at the lower limit of the operating band) on deposits from institutions that are in a surplus position. The target overnight rate is the midpoint of the operating band, and the Bank can adjust the level of settlement balances and undertake overnight special purchase and resale agreements (SPRAs) or sale and repurchase agreements (SRAs) to reinforce its target for the overnight rate if required.[7]

To manage the aggregate level of liquidity available in the financial system, central banks typically use open market operations and/or a standing liquidity facility. Liquidity is then efficiently allocated to the financial system generally

As the ultimate source of liquid funds to the financial system, central banks can also extend emergency liquidity to solvent individual financial institutions that face liquidity difficulties. Thornton (1802) and Bagehot (1873) established the principles that govern the extension of central bank liquidity: central banks should lend early and freely to solvent institutions against good collateral at a penalty rate.[8] Since idiosyncratic liquidity shocks can lead to contagion and affect the financial system as a whole, the provision of emergency liquidity to individual banks contributes to financial stability. But central banks will lend only to solvent institutions; the solvency assessment is made by the bank regulator, which can be the central bank itself or, as is the case in Canada, a separate entity (with whom the central bank is typically in close collaboration).[9]

Extraordinary liquidity support

When the crisis began in the summer of 2007, central banks initially relied on their traditional tools, with marginal modifications in some cases, to support the orderly functioning of short-term funding markets and to support liquidity in the system through their traditional counterparties. In the summer and autumn of 2007, the European Central Bank (ECB) conducted a

4 For a review of the theory governing this role, see Freixas, Giannini, Hoggarth and Soussa (1999) and Cecchetti and Disyatat (2010).
5 Idiosyncratic liquidity shocks affect the liquidity position of individual financial institutions but not the overall financial system.
6 The framework for implementing monetary policy and the LVTS are closely linked because the final positions of LVTS participants settle on the books of the Bank. The penalty rate for participants that are short of settlement balances (i.e., require advances) provides them with incentives to obtain the liquidity they need from the market rather than from the Bank. Thus, end-of-day advances from the Bank are relatively small. For details, see Engert, Gravelle and Howard (2008) and <http://www.bankofcanada.ca/monetary-policy-introduction/framework>.
7 For more details on SRAs and SPRAs see Bank of Canada (2010).
8 For example, the Bank of Canada has an Emergency Liquidity Assistance facility whereby it can provide funds to a member of the Canadian Payments Association for a maximum of 6 months (renewable) at a minimum lending rate of Bank Rate (Bank of Canada 2004).
9 In Canada, the Office of the Superintendent of Financial Institutions has primary responsibility for regulating and supervising federally regulated deposit-taking institutions, and the Bank of Canada is a member of the Financial Institutions Supervisory Committee, which facilitates the exchange of information among federal entities.

number of supplementary long-term refinancing operations (LTROs) in addition to its regular monthly LTROs to help restore the normal functioning of the euro money market. The Bank of Canada conducted several overnight SPRA operations and increased the level of settlement balances in the system. In the United States, the stigma associated with the Federal Reserve's Discount Window Facility (DWF) led deposit-taking institutions to refrain from using this facility in the early phase of the crisis, despite increasing funding pressures (Bernanke 2009).[10] To promote DWF borrowing, the Federal Reserve modified its terms in August 2007, lowering the penalty interest rate charged, extending the terms of the loans, and communicating that using the DWF was appropriate.

Going into year-end, pressures in global funding markets increased, leading to a significant shortening of the terms (i.e., not beyond year-end) at which funding was available. Central banks responded by adopting additional measures for injecting longer-tem liquidity into the system through their traditional counterparties. Specific measures depended on the features of existing facilities: some central banks modified their existing open market operations (the Bank of England and the ECB),[11] while others introduced term liquidity facilities. For example, the Federal Reserve introduced the Term Auction Facility (TAF), and the Bank of Canada introduced the Term Purchase and Resale Agreement (PRA) Facility.[12] Central banks also adjusted the amounts offered, the term and frequency of the operations, and the eligible collateral, as required.

It became increasingly evident that the usual mechanism for redistributing liquidity within the financial system was impaired

As the crisis unfolded, it became increasingly evident that the usual mechanism for redistributing liquidity within the financial system via markets and financial intermediaries was impaired and that the injection of liquidity through traditional counterparties was insufficient. Institutions that were eligible to participate in the central banks' facilities did not always redistribute liquidity across funding markets because of concerns about their counterparties and/or the preservation of precautionary liquidity for their own needs. This prompted central banks to take new measures along four broad lines.

First, some central banks introduced mechanisms that allowed firms to exchange less-liquid assets for very liquid assets. This was done to increase the volume of high-quality collateral available for funding in private markets, since liquidity in funding markets for other forms of collateral was seriously curtailed. The Federal Reserve created the Term Securities Lending Facility (TSLF) through which it lent Treasury securities to primary dealers for 28 days against less-liquid securities. Similarly, the Bank of England's Special Liquidity Scheme allowed banks and building societies to swap high-quality but relatively illiquid mortgage-backed securities for U.K. Treasury Bills. In Canada, the Government of Canada's Insured Mortgage Purchase Program (IMPP), through which the government purchased insured residential mortgage pools from regulated financial institutions, performed a similar function.[13] Moreover, the Bank of Canada temporarily allowed LVTS participants to substitute their non-mortgage loan portfolio (NMLP) for marketable securities pledged as collateral in the LVTS, thus permitting participants to use these marketable securities elsewhere, notably in private funding markets.[14]

Second, since some key providers of liquidity in funding markets experienced serious liquidity shortages and did not always have access to the central banks' traditional liquidity facilities, some central banks created new facilities to provide liquidity to targeted groups of institutions. This was the case in the United States, where the Federal Reserve created two liquidity facilities for primary dealers.[15] In addition to the TSLF mentioned above, the Primary Dealer Credit Facility (PDCF) provided primary dealers with

10 Armantier, Ghysels, Sarkar and Shrader (2011) provide empirical evidence of the stigma associated with the DWF. They show that banks were willing to pay a premium to borrow from the Term Auction Facility (TAF), a new facility created during the crisis, rather than from the DWF.

11 In addition to raising the amount of liquidity offered through its longer-term open market operations, the Bank of England expanded the range of collateral eligible for these operations, notably to include asset-backed securities and residential mortgage-backed securities.

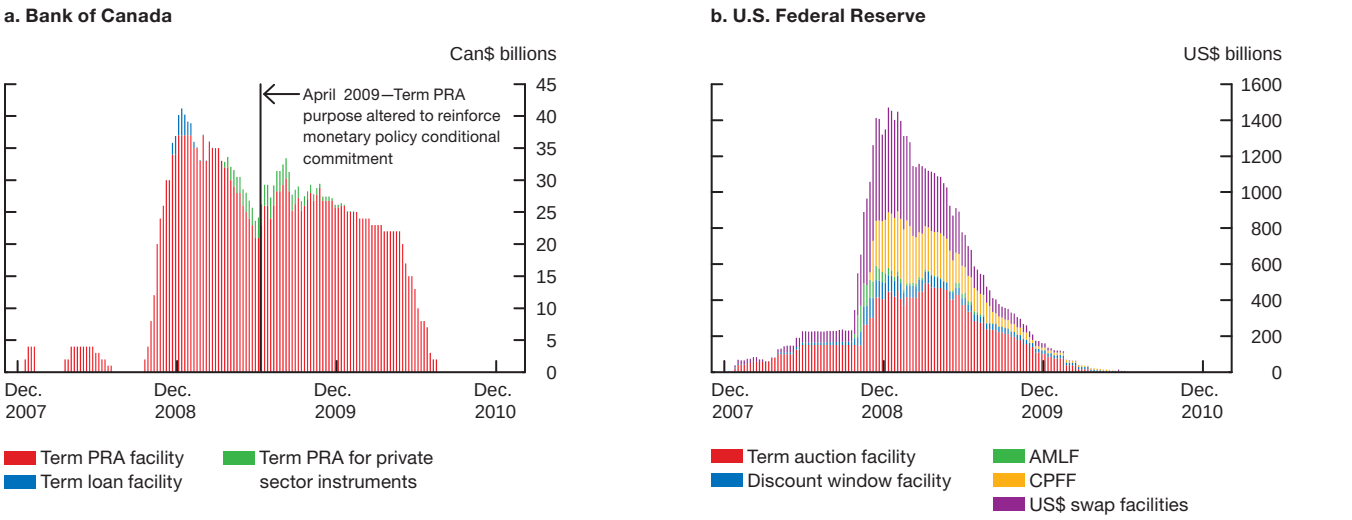
12 Eligible counterparties in the TAF were deposit-taking institutions, the Fed's traditional counterparties in the DWF, while eligible counterparties in the Bank of Canada's Term PRA Facility were primary dealers, the Bank's traditional counterparties in repo operations.

13 For details about the IMPP see Government of Canada (2008). While the mortgages were purchased for cash, the purchases were financed via the issuance of additional government debt securities. So for the financial system as a whole, these operations essentially represented a swap of more-liquid for less-liquid assets.

14 The Bank of Canada also created the Term Loan Facility (TLF) whereby direct participants in the LVTS could secure term loans against their NMLP.

15 Although primary dealers are counterparties in the Federal Reserve's open market operations, they are not eligible for the DWF and the TAF.

Chart 1: Use of central bank liquidity facilities



Sources: Bank of Canada and U.S. Federal Reserve

overnight liquidity, thereby easing liquidity pressures in the repo market and helping to stop the liquidity-price spiral (Adrian, Burke and McAndrews 2009).

Third, as liquidity deteriorated in markets that play a crucial role in the provision of credit in some countries, some central banks provided liquidity directly to participants in these markets. To help restore liquidity in the markets for commercial paper and asset-backed commercial paper, the Federal Reserve introduced three complementary facilities: the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF), the Commercial Paper Funding Facility (CPFF) and the Money Market Investor Funding Facility (MMIFF).[16] Similarly, the Bank of Canada's Term PRA Facility for private sector money market instruments was intended to enhance the functioning of money markets by providing the major participants in these markets with a liquidity backstop.[17] Likewise, the Bank of England introduced an Asset Purchase Facility (APF) through which it purchased eligible commercial paper and corporate bonds to improve liquidity in these markets. The APF was later turned into a tool for easing monetary policy (Kozicki, Santor and Suchanek 2011).[18]

Finally, pressures on U.S.-dollar funding were experienced across jurisdictions. European financial institutions had difficulty securing sufficient U.S.-dollar funding early in the crisis, leading the ECB and the Swiss National Bank to establish reciprocal U.S.-dollar swap facilities with the Federal Reserve that permitted them to provide their counterparties with significant term funding in U.S. dollars. In the autumn of 2008, U.S.-dollar funding pressures became more acute, prompting coordinated measures, and many central banks entered into similar reciprocal swap agreements with the Federal Reserve to provide U.S.-dollar funding to financial institutions in their respective jurisdictions.[19]

As illustrated in **Chart 1**, the liquidity facilities of central banks were used intensively during the crisis, although to a different extent across facilities.

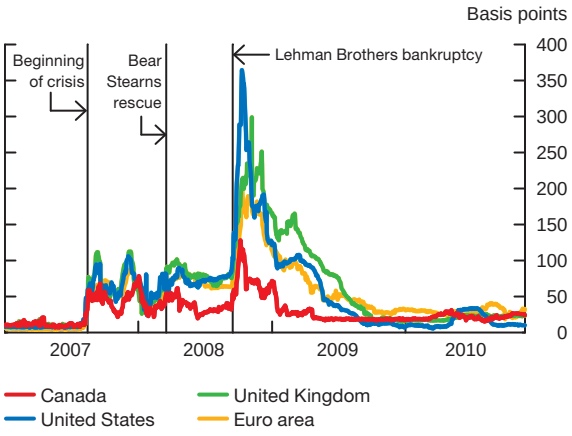
16 The AMLF assisted money market mutual funds facing redemptions; the CPFF offered term funding for commercial paper, providing greater assurance to issuers and investors that firms could roll over maturing debt; and the MMIFF facilitated the sales of money market instruments in the secondary market.

17 In February 2009, the Bank of Canada replaced this facility with a broader Term PRA Facility for private sector instruments designed to support the functioning of the money market and the corporate bond market.

18 When the APF served as a liquidity facility, asset purchases were financed by the issuance of Treasury Bills, whereas when the decision was made to use the APF for monetary policy purposes (i.e., to boost the supply of money and credit to meet the Bank of England's inflation target), asset purchases were financed by the creation of money.

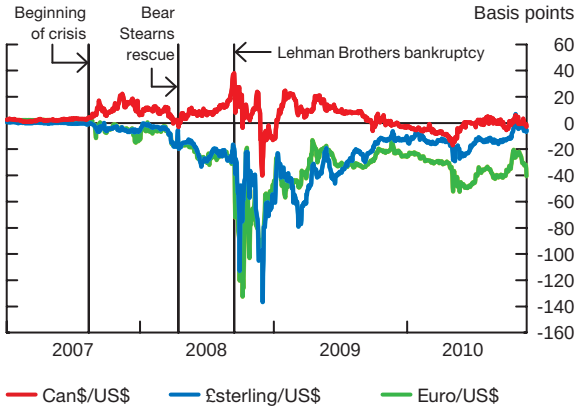
19 The Federal Reserve entered into reciprocal swap agreements with 14 central banks, including the Bank of Canada (http://www.federalreserve.gov/newsevents/press/monetary/20081029b.htm). The Bank of Canada did not draw on this facility but judged that it was prudent to have the agreement in place. Swap lines have the advantage of respecting the principle that the home central bank should be the provider of funds to institutions in its jurisdiction, because it has better information about the borrower's needs and financial conditions (CGFS 2008).

Chart 2: Funding pressures in local funding markets[a]
3-month LIBOR-OIS Spread



a. The spread between the London interbank offered rate (LIBOR) and the overnight indexed swap (OIS) rate is used to capture funding liquidity risk and credit risk for banks (or a combination of the two). The Canadian Dealer Offered Rate (CDOR) is the Canadian equivalent of the LIBOR.
Source: Bloomberg Last observation: 31 December 2010

Chart 3: Funding pressures in U.S.-dollar funding markets
One-year cross currency basis swap



Source: Bloomberg Last observation: 31 December 2010

How Effective Were Liquidity Facilities?

To date, the evidence suggests that the provision of liquidity by central banks during the crisis helped to reduce funding pressures. The provision of extraordinary central bank liquidity directly improved the funding position of participating institutions (usually key financial intermediaries) by providing funding for a range of assets (or exchanging them for more liquid ones) that had become more difficult to finance in private markets in times of stress. It contributed indirectly to improving the liquidity position of the institutions with which these firms interact. Overall, this supported the private provision of liquidity in markets more broadly. As illustrated in **Charts 2** and **3**, funding conditions deteriorated markedly during the crisis, leading to the extraordinary measures described previously. The subsequent narrowing of funding spreads suggests that these facilities have had the intended effect. However, the possibility that other factors contributed to this improvement motivated a number of empirical studies that attempt to isolate the effect of central bank liquidity facilities.[20]

Several studies of the Federal Reserve's TAF suggest that it was effective in reducing funding pressures for banks. McAndrews, Sarkar and Wang (2008) use an event-study approach and show that TAF announcements contributed to a reduction in the liquidity component of the LIBOR-OIS spread.[21] Sarkar and Shrader (2010) also conclude that the TAF operations were associated with a reduction in that spread at the beginning of the crisis, when funding pressures were driven mainly by liquidity concerns, but that the impact moderated over time as the widening spread reflected rising credit risk.[22] Christensen, Lopez and Rudebusch (2009) generate the path that the 3-month LIBOR-Treasury spread would likely have followed without the TAF and conclude that interbank-market spreads would have been even higher than those observed during the crisis. Enenajor, Sebastian and Witmer (2010) also use an event-study approach to assess the impact of the Bank of Canada's Term PRA facility on CDOR-OIS spreads. After controlling for other factors, notably changes in the U.S. LIBOR-OIS spread, they show that the Term PRA announcements did have a statistically and economically significant impact.[23] Overall, these findings tend to suggest that the announcement of liquidity provision by the central

20 Although the impact of other facilities has been studied, we focus on the assessment of term liquidity and swap facilities.

21 An OIS is a short-term swap in which two parties agree to exchange, for an agreed period, a fixed interest rate determined at the time of the trade for a floating rate that will vary over time.

22 The increase in market indicators of funding costs, such as the LIBOR-OIS spread, conceals significant disparities in the experiences of individual banks. For example, using a model of bidding with data from the ECB's one-week auctions, Cassola, Hortacsu and Kastl (2009) find considerable heterogeneity across banks. While two-thirds of participating banks suffered a dramatic increase in the cost of obtaining funds in the interbank market, the remaining third did not.

23 Using individual bank data, Allen, Hortacsu and Kastl (forthcoming) show that banks' willingness to pay for central bank liquidity in Canada rose for only a limited time (the two months following Lehman's bankruptcy). This contrasts with the situation in Europe and the United States where funding pressures persisted for a longer period.

bank, together with other measures, contributed to alleviating funding pressures.[24]

Studies also suggest that U.S.-dollar swap facilities were effective in reducing pressures in U.S.-dollar funding markets. Baba and Packer (2009) show that deviations from short-term covered interest parity for three currency pairs in the foreign exchange swap market were explained by different factors during the crisis. At first, counterparty risk seemed to be driving the dislocations, and U.S.-dollar auctions do not appear to have had an effect. Following the failure of Lehman Brothers, however, there was a global shortage of U.S.-dollar funding, and auctions of U.S.-dollar funds had a significant impact, suggesting that swap facilities were effective in reducing funding pressures when they became systemic. Similarly, Coffey, Hrung, Nguyen and Sarkar (2009) and Fleming and Klagge (2010) find that the introduction of central bank swap lines contributed to easing the U.S.-dollar funding pressures experienced by overseas financial institutions.

Guiding Principles and Facility Design

By providing extraordinary liquidity in times of severe market dislocations, central banks were supplementing—and in some cases effectively replacing—private funding markets. Although this was necessary to secure financial stability, the provision of significant central bank liquidity for an extended period may discourage financial institutions from dealing with each other (Cecchetti and Disyatat 2010). Therefore, central banks had two objectives: (i) to provide sufficient funding liquidity to the targeted institutions and affected funding markets, while (ii) ultimately encouraging a return to functioning private funding markets as conditions improved. The design of central bank liquidity facilities played a central role in achieving these objectives.

Throughout the crisis, five principles guided the Bank of Canada's decisions with regard to the form and quantity of liquidity to provide (Engert, Selody and Wilkins 2008). Intervention should:

(i) target market failures that are of system-wide importance;

(ii) be well suited to the problem;

(iii) be graduated, commensurate with the severity of the problem;

(iv) be designed to be efficient and non-distortionary; and

(v) mitigate moral hazard.

To maintain adequate liquidity throughout the system, central bank facilities targeted the institutions (and their funding markets) that experienced the most severe liquidity distortions. Differences in market structure and in the process of funding intermediation across jurisdictions meant that central banks adopted different approaches. In the United States, liquidity strains expanded beyond interbank markets into other markets that are key sources of funding for the economy (e.g., repo and commercial paper markets); therefore, the Federal Reserve expanded liquidity beyond banks. In Europe, since banks are the main providers of credit to the economy, they were the focus of the ECB's liquidity facilities throughout the crisis (Trichet 2009).

Pricing incentives

Underlying the pricing of many extraordinary liquidity facilities was the principle that the cost of central bank funding should be higher than the cost prevailing in private markets in normal times, but lower than the cost that existed during times of acute stress.[25] Such pricing mechanisms were designed to ensure that market participants accessed the facilities during periods of liquidity shortages, but had an incentive to return to private funding markets as conditions normalized. This pricing principle was implemented in two ways. For some facilities, such as the Federal Reserve's CPFF and the Bank of England's APF, the cost of funding was set as a fixed spread over the rates on overnight indexed swaps (OIS), whereas facilities that allocated funding via competitive auctions employed a minimum bid rate (which could be set as a spread over the OIS rate). Examples of facilities that used this latter structure include the Bank of Canada's Private Sector Term PRA and Term Loan Facilities, the Federal Reserve's TAF, and the ECB's LTROs before October 2008. Central banks also encouraged a return to private market financing by charging fees for the use of some facilities. For

24 Government initiatives aimed at improving the solvency of financial institutions in a number of jurisdictions, e.g., capital injections and/or asset purchases, also likely contributed to the overall improvement in global funding conditions by alleviating counterparty concerns and thus restoring banks' willingness to transact with each other.

25 Some market segments stopped functioning, so funding in those markets was effectively unavailable at any price.

example, the PDCF was subject to a fee dependent on usage over time, while the TSLF was subject to a fee that depended on the type of collateral posted.

Over the course of the crisis, variations of this pricing structure were used. When the pricing mechanism did not incorporate a penalty rate, the incentive to gradually return to private market funding sources was achieved in other ways. For example, prior to April 2009, the Bank of Canada's Term PRA facility employed a competitive auction without a minimum bid rate.[26] The Bank of Canada imposed counterparty limits and also used the bidding data at term PRA auctions as a measure to gauge the demand for funds and adjusted the size of the operations accordingly, scaling down the provision of liquidity as conditions improved. In the aftermath of October 2008, the ECB's liquidity facilities offered unlimited amounts at the ECB's policy rate to ensure that there would be enough liquidity to meet the high funding needs. As funding conditions for European institutions improved, the ECB began to gradually revert back to the facility design used in their standard operating framework, which includes multi-price competitive auctions with or without a minimum bid rate, depending on the type of operation. As funding conditions in Europe deteriorated again in mid-2010, however, the ECB reverted to providing unlimited amounts at a fixed rate.

Lessons Learned

During the financial crisis, not only did central banks inject an unprecedented volume of liquidity into the global financial system, but in some cases used measures that had never been employed before. A number of lessons can be drawn from this experience.

Extraordinary actions should be anchored by clear principles

The crisis demonstrated that idiosyncratic and systemic liquidity shocks require different policy responses. Traditional central bank liquidity facilities were designed to deal with liquidity problems faced by individual institutions and could not effectively respond to a system-wide liquidity shock that affected funding markets. Central banks therefore modified some of their facilities and created new ones. The scale, scope and diversity of central banks' interventions suggest that establishing clear principles to guide such actions prior to, or early in, a crisis can help anchor decisions and guide central banks' operations in rapidly evolving circumstances. For instance, the Bank of Canada's principle that intervention should be commensurate with the severity of the problem guided its decisions on the appropriate size of the liquidity injections over time, while the principle that interventions should be non-distortionary argued for pricing at backstop rates relative to normal funding conditions and that auction-based mechanisms should be used in the allocation of these funds.

Establishing clear principles prior to, or early in, a crisis can help anchor decisions and guide central banks' operations in rapidly evolving circumstances

Such principles also facilitate effective communication with financial markets and the general public, to explain why certain measures are taken and others are not (especially if those measures appear to pose increased credit or market risk to the central bank) and how those actions differ from regular operations. And because it is not possible to know ex-ante exactly what form of intervention might be required in a future crisis, guiding principles for intervention are preferable to precise rules. Although central banks' extraordinary liquidity facilities varied across countries and over time, the broad principles that underlined them were to maintain an appropriate level of liquidity in the financial system while minimizing distortions in the efficient allocation of credit and mitigating moral hazard.

A flexible operating framework facilitates an effective policy response

The rapid evolution of funding conditions during the crisis and the range of actions taken by central banks demonstrated the importance of having an operating framework that is flexible enough to accommodate the need to respond in an appropriate and timely

26 The Bank of Canada used the Term PRA facility for monetary policy purposes starting in April 2009. In order to reinforce its conditional commitment to leave the target for the overnight rate unchanged until the end of the second quarter of 2010, conditional on the inflation outlook, the Bank lengthened the term of the PRA transactions to up to 12 months and introduced minimum and maximum bid rates that matched the upper and lower limits of the operating band for the overnight rate, respectively.

manner.[27] Facilities designed to deal only with a previous crisis may not allow an appropriate response to future events, so central banks must be able to adapt. This includes having the ability to target segments of the financial system where disruptions can have important negative implications for the broader financial system and the economy.

In addition, a flexible policy response can help mitigate moral hazard. To the extent that there is uncertainty with regard to the central banks' actions, including whether or not it will intervene and if so when, how, and at what price, the ability of market participants to anticipate those actions and adjust their behaviour in anticipation of the central bank's response is reduced (Selody and Wilkins 2010). There is thus a trade-off between preserving flexibility to facilitate an appropriate response and to mitigate moral hazard while, at the same time, establishing clear principles to guide and explain the central bank's actions.

Effective central bank co-operation is important

The global scale of the recent crisis demonstrated the benefit of co-operation among central banks in times of acute stress. Throughout the crisis, central banks engaged in continuous close consultation and co-operated in unprecedented joint actions to reduce strains in financial markets. For example, in light of the global disruptions to funding markets, central banks entered into reciprocal swap agreements to facilitate the provision of U.S.-dollar funding to their respective banks.[28] This co-operation helped to reassure markets that policy-makers understood the severity and global nature of the crisis and were prepared to respond accordingly. This likely increased the overall effectiveness of the policy response.

Funding markets and financial institutions are interdependent

Finally, the crisis highlighted the important role that financial markets play in the provision of credit to the economy and exposed how interdependent financial institutions and financial markets have become; a fact that many did not fully appreciate prior to the crisis. Financial institutions rely to varying degrees on capital markets, including short-term funding markets, for their financing needs. It is therefore essential that the funding markets at the core of the financial system be continuously open, even in times of crisis.[29] For example, Fontaine and Garcia (2009) show that funding liquidity predicts risk premiums across a range of markets. The effect is large and pervasive through crises and normal times. Their findings show that funding markets have a first-order impact on other capital markets and suggest that, as the recent crisis unfolded, funding conditions became the hub for the amplification and propagation of financial shocks throughout the financial system and to the real economy. At the same time, most financial markets are dependent on the ability and willingness of a core set of institutions to transact, which reinforces the interdependence of markets and financial institutions.

The crisis exposed how interdependent financial institutions and financial markets have become

Policy initiatives designed to improve the infrastructure supporting core markets and to reduce the potential disruptions that can be caused by the failure of a single institution are therefore of utmost importance. One example is the increased use of central counterparties in repo and over-the-counter derivatives markets (Chande, Labelle and Tuer 2010; Wilkins and Woodman 2010). The crisis also revealed the unrealistically high degree of confidence of many financial institutions in their ability to access short-term funding markets and their insufficient planning for the possibility that funding might not always be available at a reasonable cost. The revised regulatory regime for banks, including the introduction of new liquidity standards, appropriately aims to increase their resilience in such circumstances (BCBS 2010).[30]

27 Amendments to the Bank of Canada Act came into effect in August 2008 to provide the Bank with greater flexibility to purchase and sell a wider range of securities.

28 Also, in an October 2008 press release, G-7 central banks announced coordinated interest rate reductions, recognizing that intensification of the financial crisis had increased the downside risks to economic growth and diminished the upside risks to inflation, warranting some easing of global monetary conditions. See <http://www.bankofcanada.ca/publications-research/press-releases>.

29 A core funding market is one that: (i) is an important source of funding for the institutions, market-makers, and governments at the centre of the financial system; (ii) constitutes a funding source for which there is no immediate substitute; and (iii) could channel significant contagion should it cease to function properly. See Fontaine, Selody and Wilkins (2009) and Carney (2008).

30 The Liquidity Coverage Ratio requires banks to hold enough unencumbered liquid assets to cover their cumulative net outflows for 30 days. The Net Stable Funding Ratio requires banks to maintain a certain level of stable funding dependent on the liquidity of their assets and the size of their exposures.

Conclusion

Two and a half years after the dramatic events of the autumn of 2008, central banks are taking stock of their experiences with extraordinary liquidity facilities during the crisis, and some central banks are adjusting their frameworks. For instance, the Bank of England has made permanent changes to its Sterling Monetary Framework, including the introduction of a DWF whereby banks can borrow U.K. Gilts for longer terms against a wide range of collateral (Fisher 2010). The Bank of Canada also decided to continue allowing the use of NMLP as collateral, but for only a portion of the collateral pledged by LVTS participants.

A lot has been learned from this difficult period. Clearly, idiosyncratic and systemic liquidity shocks require different policy responses, and the traditional facilities available to central banks prior to the crisis were not designed to deal with system-wide disruptions. Central banks adapted their facilities and introduced new ones. Overall, the evidence and research suggest that the response was effective. Still, events have shown that central banks need to be flexible enough to adapt their policy response. At the same time, extraordinary actions should be based on sound principles that can guide and help communicate policy-makers' decisions. Central banks will continue to review their experience during the worst crisis in decades, and to learn from this episode.

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Central Bank Collateral Policy: Insights from Recent Experience

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- *The collateral policy of central banks reflects two key objectives: to protect the central bank's balance sheet from financial losses arising from counterparty default, and to support the central bank's objectives for monetary policy and the financial system.*
- *Financial conditions may necessitate changes to central bank collateral policy. During the recent financial crisis, the temporary expansion of the range of acceptable collateral by central banks helped to support market and funding liquidity.*
- *The unique position of central banks in the financial system provides them with an opportunity to use their collateral policy to encourage better risk-management practices, including those related to the transparency of securitized products and the management of credit risk and market risk.*

One of the salient features of the recent financial crisis was the drastic reduction in market and funding liquidity in core markets.[1] The ability to trade financial asset positions of reasonable size with little price impact (market liquidity) and the ability of solvent institutions to readily obtain immediate means of payment to meet liabilities coming due (funding liquidity) are essential for a safe and efficient financial system. The reduction in liquidity therefore threatened the stability of the financial system and reduced the effectiveness of the instruments that central banks traditionally use to conduct monetary policy (Cecchetti 2008). Major central banks acted to bolster liquidity and alleviate funding pressures, and their collateral policy played a critical role.[2] Central banks not only increased the amount of liquidity offered to the financial system,[3] but also expanded the list of collateral that would be accepted in exchange for central bank liquidity. This helped to counter the effects of the aggregate liquidity shock and eventually helped money and credit markets to function more normally.

This article examines central bank collateral policy and draws insights from the experience gained during the recent crisis. In formulating its collateral policy, a central bank is motivated not only by the traditional objective of protecting its balance sheet from financial losses, but also by its goals for monetary policy and the financial system. Balancing these objectives depends on the external environment; i.e., collateral

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1 A core funding market is one that (i) is an important source of funding for the institutions, market-makers, and governments at the centre of the financial system; (ii) constitutes a funding source for which there is no immediate substitute; and (iii) could channel significant contagion should it cease to function properly. See Fontaine, Selody and Wilkins (2009) and Carney (2008).

2 See Zorn, Wilkins and Engert (2009) for a full description of the extraordinary measures taken by the Bank of Canada over 2007–09 in response to the financial crisis.

3 See the article by Lavoie, Sebastian and Traclet on page 27.

policy may need to differ in ordinary versus extraordinary times. Central banks can also use their collateral policy to positively influence financial market practices, thereby contributing to monetary stability and the efficiency and stability of the financial system. We discuss three important areas in which central banks can contribute to global initiatives aimed at improving the risk-management practices of financial system participants: promoting greater transparency for securitized products; improving the practices related to managing credit risk; and reducing procyclicality in the management of market risk.

What Is Collateral Policy?

Collateral generally refers to assets pledged as security against loans. For the Bank of Canada this includes liquidity loans provided under the Standing Liquidity Facility (SLF) to support intra-day payments in and settlement of the Large Value Transfer System (LVTS),[4] as well as extraordinary lending that might be conducted during crisis periods.[5]

A central bank designs its collateral policy not only to manage its own risks, but also in consideration of the broader impacts on the financial system

Collateral policy is the set of principles and rules governing the valuation, risk assessment, and acceptance of assets as security for lending transactions. It includes eligibility criteria for the types of assets that can be pledged, measures to control risk, and how the rules themselves may be changed in certain circumstances. Collateral policy affects individual transactions among financial institutions and, thus, can have an impact on the entire financial system: collateral helps to limit a lender's losses in the event of a counterparty default; at a macro level, the collective results of individual collateral arrangements can affect the degree of overall market and funding liquidity. Understanding this, a central bank designs its collateral policy not only to manage its own risks, but also in consideration of the broader impacts on the financial system.

Designing Collateral Policy

Central bank collateral policy can have more than one objective. First, as a public institution its collateral policy should preserve the value of the central bank's financial assets. Second, it should support the central bank's monetary policy and financial system responsibilities. Central bank collateral policy directly affects liquidity in core funding markets and can indirectly influence the relative pricing of credit risk and the level of credit intermediation in the economy. It can also affect money market dynamics and, therefore, the monetary policy transmission mechanism. Consequently, in setting its collateral policy, the central bank considers the requirements for well-functioning markets, which in turn, support financial system stability and efficiency and the implementation of monetary policy.

The first objective is supported by reducing the probability of losses on the central bank's collateral—minimizing the risk of counterparty default, as well as minimizing losses arising from the market risk associated with the collateral pledged. The central bank deals only with selected, creditworthy counterparties and accepts only high-quality collateral in which it obtains a valid first-priority security interest. To control the risks inherent in the collateral itself, terms and conditions for accepting collateral are established, including applicable limits and haircuts.[6]

In jurisdictions with well-developed financial markets, the central bank supports the second objective in accordance with the state of the financial system. In normal times, the central bank can promote financial system stability and efficiency in a market-neutral manner; i.e., there is no need or desire on the part of the central bank to interfere with market forces. But recent experience has demonstrated that the central bank may need to intervene during crisis periods, particularly those characterized by sharp, system-wide reductions in market and funding liquidity.[7] In such exceptional times, the central bank may use elements of its collateral policy to counteract the negative effects that arise when market participants act to protect their own financial interests without considering or realizing the impact of their actions on

4 The LVTS is Canada's large-value payments system.

5 This definition of collateral excludes securities that are eligible for repo operations, although the term is often used in this context.

6 Margins are the amount of collateral that must be deposited to cover the credit risk borne by the lender. The haircut determines the valuation of any asset pledged as collateral and is the discount applied to the current market value of the asset to reflect the uncertainty in its future value should the collateral need to be liquidated.

7 Central bank engagement may also be desirable when markets are developing and have not reached a level of maturity sufficient to allocate resources efficiently.

risk to the system as a whole.[8] This effect may be small and is especially difficult to identify in normal times, because there are many participants, each acting differently and each action having only a small impact on aggregate risk. Under extraordinary circumstances, such as systemic shocks, however, market participants act in a more homogeneous manner, and the combined negative impact of their individual actions may be significant.

A central bank's collateral policy and related practices should be set out in a clear, principles-based framework that allows some flexibility to address extraordinary circumstances

To facilitate the central bank's ability to intervene when needed, its collateral policy and related practices should be set out in a clear, principles-based framework that allows some flexibility to address extraordinary circumstances.[9] In particular, the operational framework supporting the collateral policy should include risk-management and valuation methods that can accommodate new and/or complex assets. By temporarily accepting riskier collateral under an appropriate risk-mitigation strategy, the central bank can address any shortage of highest-quality collateral and liquidity, thus helping to offset distortions in financial markets and re-establish market functioning.

Changes to Central Bank Collateral Policy during the Crisis

During the recent financial crisis, market participants tightened the terms and conditions attached to secured lending transactions by restricting eligible collateral and increasing haircuts. In aggregate, these actions reduced funding and market liquidity and intensified market volatility. One way in which central banks responded was by expanding the list of assets acceptable as collateral so that counterparties had greater flexibility in accessing central bank funds. In order to address heightened pressures in short-term funding markets, the Bank of Canada accelerated its decision-making process in the early stages of the crisis, so that U.S. Treasury securities and certain asset-backed commercial paper (ABCP) were added more quickly to the list of assets permanently eligible as collateral under the SLF.[10] As the risk aversion of investors towards securitized products increased during the crisis, sponsoring banks were forced to take these securities back onto their balance sheets.[11] To provide greater flexibility in managing collateral and to support efforts to generate liquidity, the Bank of Canada temporarily allowed sponsoring banks to pledge their own ABCP and applied a higher haircut.

During the crisis, the Bank of Canada also began to accept assignment of the non-mortgage loan portfolio (NMLP) of banks as collateral.[12] Direct participants in the LVTS were able to substitute their NMLP in place of securities to cover their collateral requirements for the LVTS, the SLF, and the Term Loan Facility.[13] The Bank was willing to accept a pool of non-marketable, illiquid assets as collateral on a temporary basis, so that LVTS participants could use their conventional, liquid collateral elsewhere.[14] As funding conditions normalized, the eligible amount of the NMLP was gradually reduced. To support efficiency, the Bank maintained limited, permanent use of the NMLP as collateral and allows temporary lifting of the limit in extraordinary circumstances in order to accommodate extremely large payment flows (Bank of Canada 2009).[15]

Although a flexible collateral policy can help the central bank to achieve its policy goals, this flexibility is accompanied by the risk of moral hazard; i.e., the expectation that the central bank will act in a similar fashion in the future may encourage more risk taking. More generally, the perception could prevail that

8 It is perfectly rational for a market participant to act in its own best interest, rather than contribute to the broader good at its own expense.

9 Engert, Selody and Wilkins (2008) outline principles for central bank intervention in response to financial market turmoil.

10 ABCP had previously been eligible as collateral under a temporary liquidity facility established to support potential challenges arising from the year-2000 rollover (Bank of Canada 1999). The Bank was aware that acceptance of these securities would send an important signal to the market and, in turn, help to support the longer-term viability of the Canadian ABCP market.

11 The sponsoring bank, while not the legal issuer, typically supports the promotion, marketing and distribution of the securities, in addition to providing administrative services, liquidity support and/or credit support.

12 The NMLP had also been eligible as collateral under the temporary year-2000 liquidity facility.

13 Details on the Term Loan Facility can be found on the Bank of Canada website at <http://www.bankofcanada.ca>.

14 Risk was mitigated by limiting the collateral value of the NMLP to 60 per cent of the loan portfolio's value, although, in practice, collateral needs were only a fraction of this amount. There was also a reasonable assurance of quality, given that pledging institutions were regulated by the Office of the Superintendent of Financial Institutions, with which the Bank of Canada has a close, formal relationship for the purposes of exchanging information relevant to the financial system.

15 As of 1 April 2010, LVTS participants may use their NMLP for up to 20 per cent of their total collateral value.

central bank liquidity is a readily available substitute for market funding. Central banks need to emphasize that extraordinary actions are temporary and situation specific. They must underscore the uncertainty surrounding such events and that the central bank's response to them is not guaranteed. Consequently, individual system participants should guard against the risk that they may suffer a loss if they inappropriately incorporate an implicit guarantee of central bank intervention (Selody and Wilkins 2010). Clear communication of the principles for intervention can help in this regard.

Central banks can also reduce the need to intervene in financial markets by encouraging individual actors in the financial system to be sufficiently resilient to shocks.[16] Encouraging the adoption of appropriate financial market practices is one way of achieving this.

Promoting Appropriate Market Practices

The Bank of Canada has always had an interest in the development of well-functioning financial markets that support the stability and efficiency of the financial system and, at various times, the Bank has taken an active role in improving market dynamics and practices.[17] Since the financial crisis, efforts have focused on behaviour that strengthens the financial system and prevents future crises. At the same time, the Bank of Canada and its peers have recognized that their unique role in the financial system provides them with the opportunity of using collateral policy to promote positive change.

Central bank liquidity is an important facet of the day-to-day functioning of the financial system, and private sector practices can be influenced by dealings with a central bank. Given the increasing importance of collateral-based financing, the central bank can shape its collateral policy so that its counterparties, and by extension the broader marketplace, are encouraged to adopt appropriate practices in investment and collateral management, thereby contributing to well-functioning financial markets and a more stable and efficient financial system. Although central banks generally rely on market forces to set market standards, the incentives of the private sector are not always geared to developing or adopting best practices in a timely manner for the benefit of all. At such times, it may be beneficial for central banks to model appropriate practices. This has become evident in three areas: transparency for securitized products, the management of credit risk, and the management of market risk.

The central bank can shape its collateral policy to encourage appropriate practices in investment and collateral management, thereby contributing to a more stable and efficient financial system

Transparency for securitized products

The availability of relevant and timely investment information should benefit the quality of investor decision making and make it easier for investors to enforce market discipline, thereby improving overall market stability and efficiency. One of the many factors contributing to the recent crisis was an inadequate understanding of risks, combined with too little due diligence by investors. This was particularly evident with respect to securitized products, for which sufficient information was not readily available (Hendry, Lavoie and Wilkins 2010). Recognizing this shortcoming, the G-20 committed to improving the transparency of these products, and regulators, as well as industry groups, have advanced a number of supporting initiatives.

In December 2007, the Bank of Canada announced that it would develop eligibility requirements for accepting ABCP as collateral for the SLF that would include higher standards for disclosure (Bank of Canada 2008). This announcement indicated the Bank's intention to contribute to a broader objective of greater transparency for securitized products. The announcement not only signalled the Bank of Canada's view that securitization is important because it supports the allocation of credit, but also that flaws in the structure of securitized products and deficiencies in the disclosure of information were of concern. The Canadian ABCP market was hit during

16 Many reforms currently under way are aimed at reducing the likelihood that central bank intervention will be required in the future. These include reforms aimed at increasing the amount and quality of capital and liquid assets held by financial institutions, as well as greater use of central counterparties in repo markets.

17 For example, during the 1950s and 1960s, the Bank of Canada's market operations were designed to encourage the development of a Canadian money market; in the 1990s, the Bank worked with the financial industry to develop a code of conduct for the Government of Canada securities market; the Bank continues to be an active member of the Canadian Foreign Exchange Committee (CFEC), which aims to establish practices and procedures for the foreign exchange market.

the first wave of the crisis, and a poor understanding of the risks associated with ABCP investments contributed to the situation. When the terms and conditions for acceptance of ABCP as collateral were finally announced in March 2008, a large component was related to information disclosure.[18] Other stakeholders in the Canadian ABCP market have endeavoured to improve the availability of relevant investment information.[19]

On an international basis, other central banks have contributed to enhanced transparency for securitized products through adjustments to their collateral policies. For example, in September 2008, the European Central Bank (ECB) refined its eligibility requirements for asset-backed securities (ABS) accepted as collateral in Eurosystem credit operations, specifying important investment details to be included in a publicly available credit-rating report.[20] More recently, in December 2010, the ECB announced its intention to introduce loan-by-loan information requirements and to actively encourage a data-handling infrastructure to ensure that data are made available to market participants (ECB 2010). In November 2010, the Bank of England also set out details and implementation timelines for new transparency criteria for ABS and covered bonds accepted as collateral for the central bank's liquidity facilities.[21]

Transparency initiatives for securitized products involve co-operation among market participants, industry groups, regulators and central banks and are ongoing as part of a broader set of initiatives geared towards strengthening this market.[22] Nevertheless, there is still a question as to how the transparency requirements of central banks should complement those of regulators. At the request of the Financial Stability Board (FSB) and the G-20, regulators are reviewing the need for rule changes related to disclosure for securitized products, but to date, there does not appear to be a common approach between central banks and regulators.[23]

Managing credit risk

Understanding and evaluating the credit (or default)-risk characteristics of assets accepted as collateral is an important component of risk management, and various tools are available. Credit-rating agencies (CRAs) provide an accessible, alternative source of opinion on credit risk, particularly if a market participant is unable to perform a complete, independent assessment. But lax credit-risk management and mechanistic reliance on CRA ratings can be problematic for individual market participants and for the financial system. The recent crisis demonstrated how unforeseen and abrupt credit-rating downgrades can inadvertently increase financial system instability by triggering large-scale sell-offs and knock-on effects that exaggerate negative market impacts.[24]

This experience confirmed the need for credit-risk-management practices to evolve so that the limitations of CRA ratings are understood and other information is used to form a full, independent assessment of credit risk. Action is required from both the public and private sector to reduce incentives for the mechanistic use of CRA ratings.

In October 2010, the FSB published a number of high-level principles to guide the public and private sectors in reducing their reliance on CRA ratings when making investment decisions and when developing standards, laws and regulations (FSB 2010). The principles make specific reference to central bank collateral requirements. Central banks are encouraged to make their own judgments related to the credit risk of the financial instruments that they accept and to avoid mechanistic use of CRA ratings in their collateral policies.[25] The principles do recognize that central banks can use CRA ratings as one of a set of tools used to make such judgments, however. Indeed, if the central bank relied solely on its own judgment of credit risk, private sector behaviour could be influenced by its decisions. By using a broad array

18 The Bank's transparency requirements for ABCP specify: a single, concise document provided by and validated by the sponsor, containing all relevant investment information; that is accessible to all investors; and timely notice of changes to the information contained in this document. Although the Bank provides guidelines on the information that it considers relevant, the onus is placed on the sponsor to determine what information is important for investors.

19 For example, Dominion Bond Rating Service (DBRS) now publishes enhanced "Structured Finance Surveillance Reports" that allow for more thorough analyses of certain asset classes.

20 The initial report must include a comprehensive analysis of structural and legal aspects, a detailed analysis of the collateral pool, analysis of transaction participants, and any other particulars relevant to the transaction. Key transaction data and performance data are to be included in quarterly publications of ratings reviews.

21 Although primarily aimed at improving the efficiency of its risk management of ABS, the Bank of England has indicated that increased disclosure requirements will advance progress in market-wide transparency (Bank of England 2010a and 2010b).

22 See Allan and Bergevin (2010), IMF (2009), Paligorova (2009), Selody and Woodman (2009) for more on the reform of securitization markets.

23 On 25 March 2011, the Canadian Securities Administrators (CSA) published for comment proposed enhancements to transparency and disclosure requirements for securitized products. The CSA indicated that the proposed requirements were designed to be consistent with international developments.

24 The IMF has discussed the inadvertent contribution of rating agencies to financial instability, both before and after the crisis; e.g., IMF (2008, 2009) and Kiff (2010).

25 As stated in its collateral policy, the Bank of Canada retains the right of refusal for any asset presented as collateral, allowing for other relevant factors, in addition to CRA ratings, to be included in its judgment of acceptability.

of information to establish creditworthiness, the central bank could prompt its counterparties to also look beyond CRA ratings in making investment and collateral decisions.

The Bank of Canada has made several adjustments to its collateral policy in order to better manage credit risk and to promote more prudent practices. When it first accepted ABCP as collateral in 2008, the Bank applied "stand-alone," versus official, credit ratings as part of its credit-risk assessment of the bank sponsors of ABCP.[26] The Bank also instituted the requirement of at least two credit ratings to establish creditworthiness. In September 2010, this requirement was extended to all non-sovereign securities. Having more than one CRA rating provides the Bank and its counterparties with greater assurance that all the factors contributing to credit risk have been identified and evaluated. In addition, the second-highest credit rating is now used to establish eligibility, as well as to determine applicable haircuts. This approach limits incentives for issuers to shop around for the best rating, and the Bank avoids being seen as overly conservative or overly lenient when interpreting conflicting ratings.

Other information may be employed when assessing credit risk, including market-based measures.[27] Research at the Bank of Canada is examining the value of indexes for credit default swaps and data on expected default frequency as supplementary information on credit risk.[28] Many central banks supplement the requirement of a minimum CRA rating with market information and/or engage in full internal assessments of credit risk. Practices have evolved since the crisis and will likely continue to evolve in the coming years.

Managing market risk

Fluctuations in asset prices present the risk that an asset held as collateral will decline in value and that losses will be incurred in the event that a counterparty default forces the sale of that collateral. The application of haircuts is an important element in managing this market risk.

The financial crisis exposed practices for managing market risk that negatively affected market dynamics and magnified the fluctuations in business cycles; i.e., procyclical practices. At the heart of these problems was the inherently procyclical nature of margining and haircut conventions.[29] In recognition of this phenomenon, policy-makers are considering measures to reduce the procyclicality caused by margining practices. These measures aim to dampen the buildup of leverage in good times and soften the systemic impact of subsequent deleveraging during downturns.[30]

The financial crisis exposed practices for managing market risk that negatively affected market dynamics and magnified the fluctuations in business cycles

Against this backdrop, the Bank of Canada continuously reviews its own approach to setting haircuts to ensure that its practices do not contribute to excessive procyclicality and to better identify the central bank's role in preventing and resolving liquidity-induced crises. As a starting point, during periods of extraordinary financial system stress the central bank should place greater emphasis on its financial stability objective, avoiding any actions that could negatively reinforce funding-liquidity dynamics. This implies maintaining haircuts such that they are constant "through-the-cycle" (TTC), rather than varying them in response to short-term changes in risk measures.

A TTC haircut would be based on a large sample of data that accounts for the risk-return characteristics of assets through a full price cycle that includes at least one crisis episode. Only periodic re-evaluation would be necessary to ensure that haircuts remain adequate in relation to the risk-tolerance level of the central bank. In a TTC approach, haircuts would not react to temporary spikes in liquidity premiums, but would reflect only fundamental credit and liquidity risks. However, decomposing a haircut into compensation for credit risk, liquidity risk and a liquidity premium is not an easy undertaking, and further study is

26 Stand-alone credit ratings are those that do not incorporate implicit third-party financial support from a government. See Harvey and Merkowsky (2008) for a discussion of stand-alone ratings.

27 For example, Moody's publishes Market-Implied Ratings that incorporate the market price of default risk over time.

28 See García and Prokopiw (2009) for discussion of credit-risk measures that may be useful for a central bank's assessment of aggregate credit conditions.

29 See Gorton and Metrick (2009), Kamhi (2009) and Krishnamurthy (2010) for a discussion of procyclical margining practices during the crisis.

30 See (CGFS 2010) for analysis of the linkages between margining and haircut practices and financial system procyclicality.

required.[31] The Bank of Canada has committed to a research agenda aimed at better understanding these issues.

As post-crisis analyses and reforms continue, central banks may be in a position to consider how they can contribute to better margining practices. As the ultimate providers of liquidity, there may be a need for central banks to adjust their own haircut frameworks in order to limit procyclical dynamics and to ensure that core funding markets remain continuously open during crisis periods.[32]

Lessons Learned

The financial system policy objectives of central banks gain attention during crisis periods, and central bank collateral policy can be used as part of the set of extraordinary measures taken by the public sector to stabilize the financial system. The central bank may need to accept riskier assets as collateral in the short term (applying appropriate risk controls), but the potential cost to the central bank is outweighed by the benefits to the financial system.

The preservation, on a limited scale, of certain collateral-specific measures introduced to address liquidity pressures during a crisis may also be justified. For example, the continued acceptance of a limited amount of non-conventional collateral during normal times can support the ability of market participants to manage their collateral, particularly in an environment where collateral-based financing is growing, and thus can promote well-functioning markets. It also supports the operational readiness of the central bank to address extraordinary events by increasing the eligible amount of non-conventional collateral.

This potential benefit must be balanced with consideration for limiting moral hazard, however. By clearly communicating the uncertainty surrounding any changes to its collateral policy as they are introduced during a crisis, and by reinforcing that extreme adjustments to that policy are specific to rare and temporary conditions, there is less likelihood that the central bank's counterparties will adversely change their behaviour.

At the same time, central bank collateral policy can help motivate positive changes to market behaviour, thus reducing the likelihood and intensity of a financial system shock in the future. Imposing transparency requirements for securitized products accepted as central bank collateral can encourage issuers to increase the quantity and quality of the information available to investors. Central banks can also help reduce mechanistic reliance on CRA ratings by ensuring that these are only part of a set of tools used to establish the creditworthiness of collateral for central bank facilities. To the extent that practices for managing market risk take their cue from central bank collateral policy, central banks may be able to reduce the extent of procyclical margining practices by adopting through-the-cycle haircuts.

Conclusions

The recent financial crisis was widespread and demanded a coordinated global response. As policies and practices evolve in the aftermath of the crisis, coordination on a global basis will also be important. The sharing of analysis and experience will be helpful as central banks consider how best to shape their collateral policies, and many issues could be explored. For example:

- The benefits of a flexible collateral policy were demonstrated during the crisis, but how flexible should collateral policies be? How much risk can or should a central bank take on? How can operational readiness to accommodate this flexibility be balanced with the costs, particularly when extraordinary events are, by definition, infrequent?
- To what extent should central bank collateral policy be used to motivate positive changes to market behaviour, and when should this be left to markets? Should central bank collateral policies be coordinated in order to limit the potential for arbitrage?

The Bank of Canada is open to engaging other central banks in examining these and other issues and will continue to review its collateral policy as one means of achieving its goals for monetary policy and the financial system.

31 Given these challenges, the approach to date has been to calculate haircuts using a long historical sample and to hold them constant over an extended period.

32 This idea was put forward by Governor Carney as one of many considerations for adjusting monetary policy implementation as a means of promoting financial stability (Carney 2009).

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