

LESSONS FROM THE FINANCIAL TURMOIL OF 2007 AND 2008



Reserve Bank of Australia

Proceedings of a Conference

held at the H.C. Coombs Centre
for Financial Studies, Kirribilli
on 14–15 July 2008

LESSONS FROM THE FINANCIAL TURMOIL OF 2007 AND 2008

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Reserve Bank of Australia

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Website: <http://www.rba.gov.au>

ISBN 978-0-9804751-0-4 (Print)
Sydney, October 2008

Printed in Australia by Pegasus Print Group
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Blacktown NSW 2148
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Introduction

Paul Bloxham and Christopher Kent

Global financial markets have now been in turmoil for over a year. The crisis began to unfold around the time of last year's Conference¹, with adverse news about the US sub-prime mortgage market gaining prominence in June and July 2007. By August, problems in credit markets had become widespread and spreads in interbank markets had increased significantly. While it was recognised towards the end of last year that these events may still have a while to play out, it was thought that it would be useful to make an early assessment of the nature of the crisis, consider its possible causes and discuss the merits of various policy responses.

To this end, the Bank commissioned papers for this year's Conference to examine three related issues. The first is how the crisis unfolded, with a view to understanding the causal factors and considering the effects of the turmoil on the financial system and the real economy. The second issue is financial innovation, focusing on the rise of disintermediation and the role of capital regulations in the lead-up to the crisis. The third issue is the response of central banks to the recent financial turmoil, particularly in their roles as providers of liquidity and lenders of last resort.

1. Overview – The Unfolding Turmoil

The Conference began with Ben Cohen and Eli Remolona's paper, which describes how the recent financial turmoil has unfolded and compares it to previous episodes. The authors argue that the origins of the turmoil are manifold, with low interest rates and the global 'savings glut', a greater reliance on the originate-to-distribute model, and some deterioration in risk management practices all contributing. They also suggest that while some features of this episode are unique, others are common to earlier financial crises. One common feature is the apparent procyclicality of the financial system, with a build-up of leverage in good times, when investors tend to underestimate risk, and the subsequent unwinding of this leverage when conditions deteriorate. Some of the more unique features are the long duration of the current crisis, the key role of assets that are held off banks' balance sheets, and the extent to which significant credit problems have affected the liquidity of the financial system.

These developments have prompted many central banks to adapt their policy arrangements. In particular, a number of central banks have widened the range of collateral accepted in market operations, lengthened the term of their operations and broadened the range of counterparties with which they deal. These policy initiatives reflect pro-active efforts by these central banks to ensure that liquidity can be accessed by sound institutions that have the need for it. And, as Cohen and Remolona suggest, central banks have sought to strike a balance between restoring

1. See Kent and Lawson (2007).

market liquidity and avoiding moral hazard. The full implications of these policy changes are, however, yet to play out, and it is not clear whether they will be permanent or temporary features of the financial landscape.

Beyond these short-term adjustments, Cohen and Remolona suggest that authorities need to deal with deeper issues in the financial system in order to restore stability. In their view, the two key areas that require improvement are credit ratings and the response of regulators to perceived risks. They suggest that credit rating agencies need to deal better with conflicts of interest and more clearly differentiate structured products from more standard financial instruments in their assessment of risks. They also suggest that authorities should consider the scope for the use of supervisory instruments that are explicitly countercyclical. This furthers a long-running debate that was also a key part of last year's Conference, with Claudio Borio, in particular, arguing that more should be done to limit the excessive build-up of risk by applying prudential 'speed limits' (Borio 2007).

2. Innovation, Disintermediation and Capital Regulation

Financial markets have evolved rapidly over the past decade or so. Part of this process has involved the increased use of financial products that have allowed banks to shift assets off their balance sheets, a process referred to as disintermediation. Much of the recent financial turmoil has been centred on these off-balance sheet assets, and many banks have been forced to 'reintermediate' assets as the crisis has unfolded. These developments raise questions about the role of disintermediation in financial crises and the extent to which the recent turmoil may have been fostered by the regulatory structure.

These themes were addressed by Nigel Jenkinson, Adrian Penalver and Nicholas Vause in a paper discussing the costs and benefits of financial innovation and ways to mitigate the costs. The main challenge is that as the number of links in the chain that connects the borrower and end-investor increases, information about the creditworthiness of the investment is lost. In addition, agents further up the chain often have more information about the principal's investment and may have an incentive to understate risk to those investors further down the chain. A key feature in the lead-up to the recent financial turmoil was the lengthening of this chain as structured financial products and the originate-to-distribute model allowed a large degree of disintermediation. This problem was exacerbated by an over-reliance on credit ratings. While innovative financial products have generally improved the capacity of markets to allocate risk efficiently, the authors argue that the amount of risk-taking went too far. As a result, there is likely to be a move towards simpler and more standard financial products in the future, which would improve the transparency of the financial system. They suggest that part of this move will be an endogenous response by financial market participants to the recent turmoil, although they also cite recommendations from the Financial Stability Forum, particularly regarding credit rating agencies, which could lead to greater standardisation.

While agreeing with both Jenkinson *et al* and Cohen and Remolona on a number of points, the paper by Adrian Blundell-Wignall and Paul Atkinson focuses on

changes in the regulatory regime as one of the main causes of the financial crisis. Specifically, they highlight changes to capital regulations that were part of the Basel II Framework and changes made by the US Government to capital requirements for the government-sponsored enterprises, Fannie Mae and Freddie Mac. They posit that these policy shifts drove the rise in sub-prime mortgage lending, from which the financial crisis stemmed. In response, the authors argue that further work is needed to simplify and generally improve the regulatory framework, including placing restrictions on the degree of concentration in any particular asset class and on the ability of banks to take assets off their balance sheets.

3. The Role of Central Banks as Liquidity Providers

A key feature of the recent crisis has been the extent to which liquidity has dried up in a number of financial markets. The appropriate role of central banks in the provision of liquidity was the focus of three papers at the Conference.

In his paper reviewing the evolution of the role of lender of last resort, Philip Davis argues that traditional models of bank liquidity risk, bank runs and the role of the lender of last resort are outdated. He suggests that recent financial innovations have meant that funding and market liquidity risk now interact more vigorously, and that this is a key reason why interbank markets have played a pivotal role during this crisis. While traditional models focus on ‘bank runs’, he suggests that the primary concern is now the possibility of ‘financial market runs’ which, via mark-to-market accounting, can threaten the solvency of financial institutions. These developments clearly pose new challenges for central banks, since it is clear that they should not lend to insolvent institutions, but financial innovation has made it far more difficult to distinguish illiquidity from insolvency.

The paper by Jonathan Kearns and Philip Lowe further discusses the extent to which there is a role for the public sector in the provision of liquidity in the financial system. They argue that while financial institutions should be required to deal with idiosyncratic liquidity problems (and that improvements here are needed), central banks should play a part in smoothing market liquidity. The authors contend that the case for public-sector involvement arises because a lack of liquidity can, in some respects, be considered a market failure, and requiring private financial institutions to be fully self-insured would be very costly (for a similar argument put forth at last year’s Conference, see Allen and Carletti 2007). Kearns and Lowe also suggest that while the provision of liquidity services by the public sector will change the behaviour of private-sector agents, it can in fact be socially optimal.

Nonetheless, as incomplete markets are the cause of this market failure, Kearns and Lowe suggest that actions to improve market infrastructure would be beneficial. In particular, they would welcome the migration of many over-the-counter (OTC) products to exchanges, as well as enhancements in settlement procedures for OTC products, and see a need to improve bank disclosure and the credit ratings process. They also argue that to address better the inherent procyclical nature of the financial system there is a case to tighten supervisory requirements during good times, when liquidity is judged to be ample and credit risk appears low. In a way, this could

be thought of as a cost that regulated institutions pay in order to access liquidity provided by the central bank during difficult times.

In his paper, Spence Hilton provides a review of the initiatives that the Federal Reserve System had undertaken up to mid 2008 to alleviate strains in financial markets, and some of the operational challenges involved. In particular, the Fed enhanced and introduced some new facilities for liquidity provision to financial institutions, with these initiatives driving substantial shifts in the composition of the Fed's balance sheet. Given these policy changes, his paper also identifies a number of issues concerning the new arrangements. In particular, Hilton suggests that if the Fed was required to provide further liquidity support, beyond its current balance sheet, the alternative means it would consider may include debt issuance by the fiscal authority, issuance by the central bank and/or investigating options regarding remunerating reserves. The new facilities also raise questions about their permanency and how an exit strategy would be orchestrated, if required. The paper singles out the term auction facility as a likely candidate for permanency and suggests that, more generally, it would be difficult to assess when market strains had been alleviated enough to justify removing any of the new facilities, and that any attempt to do so would be likely to be a gradual process.

4. Conclusions

The financial turmoil that began around the middle of 2007 has passed its first anniversary. The crisis continues to play out, and its causes and the required policy responses will no doubt be the subject of ongoing debate for years to come. So while it is too early to draw strong conclusions, the Conference papers and discussions reached broad consensus on a number of important issues.

The first is that the central bank responses to the drying-up of liquidity – particularly broadening the range of acceptable collateral and the option of longer terms – appear in large part to have been warranted. The willingness of central banks to assist the smooth functioning of financial markets was widely thought to have forestalled an even more pronounced crisis. However, it was acknowledged that this may alter the future behaviour of financial institutions, and that care was needed to help ensure that the provision of liquidity did not unduly lead to problems of moral hazard. In this regard, some participants emphasised that direct access to liquidity provided by central banks should be restricted to regulated institutions. At the same time, it was recognised that there is ample scope for such institutions to enhance their own liquidity arrangements.

The second area of general agreement relates to the need for changes in the regulatory framework, although there was considerable debate about the details. The need for these changes stems in large part from a recognition of the unique features of this crisis. Foremost perhaps is the role of disintermediation. While this development was in part a response to the regulatory structure and was envisaged as a way to spread risks more widely, it appears that in some ways risk became more concentrated, and that the nature of the disintermediation that occurred had added an extra dimension of opacity to the financial system. Hence, there was strong

support for changes that would enhance transparency and disclosure. Some pointed to the need to review the role and operation of credit rating agencies. Others argued for the need to avoid incentives for regulatory arbitrage – associated, for example, with off-balance sheet activities – and for changes to the regulatory framework to encourage better assessment of risks when determining capital allocations. One area of debate was the extent to which the market, left to its own devices, might respond to these recent failings without much, if any, regulatory adjustment.

While there was a consensus that the shortcomings of the financial system that had underpinned the current crisis needed to be addressed, many participants argued that there was a risk that policy adjustments become overly focused on ‘fighting the last war’. This prompted the more general question of what can be done about the procyclicality of the financial system, a common cause of financial crises. It was agreed that policy-makers are unlikely to ever entirely overcome this problem, but many accepted that something should be done to limit it. One option that received considerable attention was countercyclical prudential policy, whereby regulated institutions are required to set aside funds (capital) in excess of minimum requirements during good times and are allowed to draw on these during downturns. Many practical challenges associated with designing and implementing such policies were noted, not the least of which is that they may encourage much of the financing of economic activity to move outside of the regulatory net. Another approach that was discussed was the possibility of using monetary policy to ‘lean against the wind’, suggesting a greater role for asset prices and credit growth in monetary policy setting. This has been a topic of considerable debate in the past – including at a Reserve Bank conference a few years ago (see Richards and Robinson 2003) – and seems likely to receive renewed attention.

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The Unfolding Turmoil of 2007–2008: Lessons and Responses

Ben Cohen and Eli Remolona¹

Abstract

While the unfolding financial turmoil has involved new elements, more fundamental elements have remained the same. New elements include structured credit, the originate-to-distribute business model and expanded markets for repurchase agreements (repos). The recurrence of crises reflects a basic procyclicality in the system, which is characterised by a build-up of risk-taking and leverage in good times and an abrupt withdrawal from risk and an unwinding of leverage in bad times. To deal with the adverse liquidity spiral that has characterised the current crisis, central banks have tried to strike a balance between the importance of the continued availability of market liquidity as a public good and the moral hazard that any market intervention may induce. In proposing long-term responses to the crisis, the Financial Stability Forum has focused on areas where incentives for risk-taking may be aligned more properly and areas where risk management may be made more robust. Nonetheless, a recognition that the procyclicality of the system lies at the root of the crisis would suggest more aggressive countercyclical measures are needed.

1. Introduction

We are now well into the eleventh month of a financial crisis that has been extraordinary in its persistence, its global reach and the questions it has raised about the workings of the financial system. In past episodes of systemic stress, such as the Asian financial crisis of 1997 or the Long-Term Capital Management episode of 1998, which have occurred from time to time in all of our economies over the years, the policy questions in the aftermath have tended to centre around such issues as how to encourage more responsible behaviour among borrowers and how to resolve bad debt problems more effectively. While these questions have rightly been asked in the context of the current crisis, we have also had to grapple with more fundamental questions about the financial system itself.

To understand the crisis, we have had to look very closely at such questions as how credit has been intermediated, how losses are propagated and how market liquidity is generated and lost. To address the problems, we have had to ask what information should be available about borrowers and instruments, how regulation

1. The views expressed are solely our own and do not necessarily reflect those of the Bank for International Settlements or the Financial Stability Forum. For helpful comments, we thank Grant Spencer, Richard Portes and other participants at the Reserve Bank of Australia Conference in Sydney on 14–15 July 2008.

can most effectively prevent unnecessary disruptions to the functioning of the system without stifling innovation, and how central banks should act in their capacity as lenders of last resort.

In this paper, we focus on the turmoil itself and the short-term and medium-term policy responses it has elicited. First, we describe the chain of events that constituted the crisis, discuss the underlying causes and draw lessons from the events. In characterising the crisis, we distinguish among the elements that are new, those that have remained the same and those that we do not understand. Second, we examine the policy responses thus far, both in terms of efforts by central banks to stabilise markets in the short term and efforts by financial authorities to strengthen the underpinnings of the system over the longer term. We will end by emphasising the importance of recognising the issue of procyclicality.

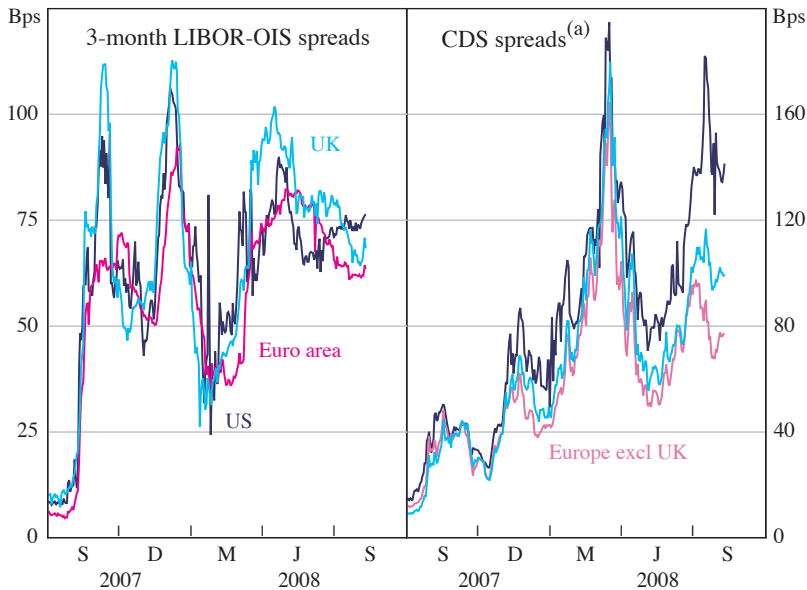
2. Origins of the Crisis: What's New, What's the Same and What We Don't Understand

Most commentaries about the crisis have focused on the unusual structures of the financial system and the role of excessively complex financial innovations. It is true that an important factor in the run-up to the turmoil was the reckless use of recent financial innovations, especially in markets for credit risk transfer. However, as Borio (2008) argues, these are but idiosyncratic elements that represent 'more fundamental common causes'. Indeed the current turmoil displays a number of important features that it shares with previous crises. At the same time, it is important to acknowledge that there are critical characteristics of the current crisis that we do not fully understand.

2.1 The chain of events

To understand what triggered the crisis and how it spread, it helps to follow the chain of events. Two types of interest rate spreads are especially helpful in tracking events as they have unfolded: the spreads of 3-month London Interbank Offered Rate (LIBOR) over the overnight index swap (OIS) and spreads on credit default swaps (CDS). The former is a good indicator of liquidity in interbank markets and the latter of credit risk premia. As shown in Figure 1, LIBOR-OIS spreads in the United States, the euro area and the United Kingdom rose sharply in August and September 2007, rose again in November and December 2007 and yet again in March and April 2008, in each case indicating a lack of liquidity. For their part, average CDS spreads in the same three regions followed roughly the same pattern, except that the widening of these spreads became more pronounced in each successive episode, especially in February and March 2008. There was also a jump in CDS spreads in July 2008 that was not echoed in LIBOR-OIS markets. What led these spreads to behave in this way?

Although US sub-prime mortgage default rates, and the spreads on associated securities, had been rising since late 2006, the first significant event in the broader financial market turmoil seems to have been the emergence of rumours during

Figure 1: Interbank Term and CDS Spreads

Note: (a) 5-year CDS spreads; simple average of major banks

Sources: Bloomberg; JPMorgan Chase

the third week of June 2007 about heavy losses in two hedge funds managed by Bear Stearns.² The losses were later confirmed, and they turned out to be related to positions in US sub-prime-backed structured securities. By July, major credit rating agencies had either downgraded or placed on review a large number of collateralised debt obligations (CDOs) that relied on mortgages as collateral. In August, the troubles spread to asset-backed commercial paper (ABCP) issued by entities that had invested in CDOs of mortgage-backed securities, and interbank markets around the world began to experience shortages of liquidity. On 9 August, the markets were jolted by the news that BNP Paribas, France's largest bank, halted withdrawals from three of its investment funds because it could not 'fairly' value their holdings. All these events culminated in September with a run on Northern Rock, a UK mortgage lender, when its liquidity problems became known. During this phase, the LIBOR-OIS spread rose to close to 100 basis points in the US interbank market and even higher in the UK market.

The second major event occurred in October 2007, as participants in the interbank and credit markets were again caught by surprise when large monoline bond insurers revealed losses related to credit enhancements they had provided to structured securities; not many observers knew the insurers had even been involved in this business. The losses were large enough to threaten the AAA/Aaa ratings that the monolines needed to operate. In December, mounting concerns by various lenders,

2. For a good narrative of these events, see Chapter VI of BIS (2008).

waves of margin calls in the repo markets and the anticipation of increased liquidity demands over the year-end led to widening CDS spreads and a second liquidity crisis in the money markets, prompting five major central banks to announce concerted actions to make more funding liquidity available. The LIBOR-OIS spread in the US and euro area interbank markets reached unprecedented levels, while in the United Kingdom these spreads rescaled the peaks they had reached in September.

The third and perhaps most alarming period of the turmoil is also the most difficult to explain. In late February and early March 2008, a new wave of deleveraging suddenly engulfed the fixed-income markets. There seems to have been no significant event that could have precipitated this episode, although mounting concerns about monoline insurers, the continued worsening in the US economic outlook, and associated valuation and liquidity problems in high-yield corporate debt, as well as in both prime and non-prime US housing-related paper, certainly were part of the background (see Rappaport, Mollenkamp and Richardson 2008; Shellock 2008). What is evident is that concerns about counterparty risk became extraordinarily intense. Dealers in mortgage-backed securities and in over-the-counter (OTC) derivatives started asking for more collateral from their counterparties. In repo markets, lenders sharply increased their margin calls and refused to accept as collateral anything but US Treasury securities or German bunds. Since bond dealers finance themselves in the repo markets, they abruptly withdrew from making markets in the broader fixed-income markets. Liquidity in US and European fixed-income markets seemed to vanish overnight.

In early March, the news headlines began to report what has become known as an adverse liquidity spiral, in which the US investment bank, Bear Stearns, was rumoured to be caught. On 16 March, after several days of customer outflows, shrinking capital, and fevered activity on Wall Street and at the Federal Reserve, the troubled investment bank was taken over by a US commercial bank, JPMorgan Chase, with the help of an arrangement by which the Fed would lend up to US\$30 billion (later reduced to US\$29 billion) to finance Bear's portfolio of troubled securities.

Markets appeared to stabilise in the aftermath of the Bear Stearns episode, but remained subject to episodes of turbulence. Equity and debt markets were buffeted by concerns about the prospects for various segments of the US financial system, as losses spread to the government-sponsored enterprises and to smaller and medium-sized banks. As of mid 2008, the impact of the financial system's troubles on the real economy remains a major source of uncertainty worldwide.

2.2 What's new

The blame for the turmoil has been linked to a wide variety of financial innovations. In particular, many observers have argued that, while these financial innovations have been fundamentally beneficial for the financial system, a reckless use of them has led to the crisis. Borio (2008), for example, has identified the two most salient innovations as structured credit and the originate-to-distribute business model. We would suggest that, while these have been the source of substantial losses and

uncertain valuations over the past 12 months, a little-noticed innovation in the repo market – the tri-party repo – also contributed significantly to the crisis.

The innovation of structured credit includes both CDOs and CDS. CDOs use the device of subordination to transform instruments with high credit risk into instruments that receive high credit ratings. The introduction of CDS contracts in turn allowed CDOs to be created more easily by serving as the underlying instruments for what are called ‘synthetic CDOs’. The pricing of these instruments relies critically on assumptions about default correlations, which have been intractably difficult to model or to measure.³

These instruments had been developed in the 1990s and had proven to be fundamentally important in improving the pricing and distribution of credit risks. But in the environment of the past few years, their use became quite widespread and complex variations on the instruments proliferated rapidly, aided by advances in modelling techniques. These variations included CDOs based on asset-backed securities (ABS), as well as ABCP issued by structured investment vehicles (SIVs) that held highly-rated credit instruments including CDO tranches. The sheer scale and variety of the use of these innovations outstripped the capacity of even the most sophisticated dealers and investors to understand and manage the risks associated with them.

The proliferation of CDOs owed much to the originate-to-distribute business model pursued by many of the world’s largest commercial and investment banks. The model itself is not new, having been used in the syndicated loan market for years. Nonetheless, it achieved new prominence in banks’ business strategies with the securitisation of mortgages. Under this model, a mortgage lender would routinely package its loans into mortgage-backed securities, which it would sell to investors, thereby providing funding for the loans. In the period leading up to the turmoil, the originate-to-distribute model contributed to the rapid growth of the US mortgage market (as Frankel (2006) has emphasised), but also evidently weakened the incentives of mortgage originators to properly screen loans. Once the first sub-prime mortgage defaults materialised, standard covenants of the securitisations forced the originators to take back newly minted loans. However, these types of securities had become so widely dispersed that a generalised crisis of confidence ensued. Banks were stuck with ‘warehouses’ of unpackaged loans that could not be sold and rapidly lost value as markets fell. They also discovered that the ‘super-senior’ CDO tranches, which the banks typically retained in order to facilitate the sale of other parts of the structure, were far riskier and less liquid than they had expected.

3. For the most part, price discovery in credit markets now takes place in the trading of CDS indices and of component parts called ‘loss tranches’. The spreads on these indices and their loss tranches in turn drive spreads on single-name CDS contracts as well as prices of CDO tranches. The most common pricing models in these markets attempt to account for default correlations in an ad hoc way, typically through a ‘Gaussian copula’. See, for example, Duffie and Singleton (2003), pp 237–242.

While the problems in CDS and CDO markets have been much commented upon during the crisis, the role of the tri-party repo has attracted less attention. This innovation has become the standard way of transacting in repo markets. In a tri-party repo, the third party is a clearing bank, which knows both the lender and borrower of a repo transaction and takes custody of the collateral. The arrangement has the advantages of avoiding delivery of collateral, facilitating substitution of collateral and reducing clearing costs. In recent years, the tri-party repo has allowed the repo market to accept a wide range of collateral, including mortgage-backed securities and CDOs and almost any asset that the clearing banks could hold in custody. Hence, it has allowed investors in various securities to more easily secure financing in the repo market by simply putting up their positions as collateral. However, an important factor contributing to the loss of liquidity in fixed-income markets in February and March 2008 was the sudden refusal of lenders in the repo market to accept as collateral the same wide range of assets as before. This made it difficult or impossible for holders to value the instruments, and also led to a sharp worsening of the liquidity profile of institutions, such as Bear Stearns, that had a large quantity of these assets on their balance sheets.

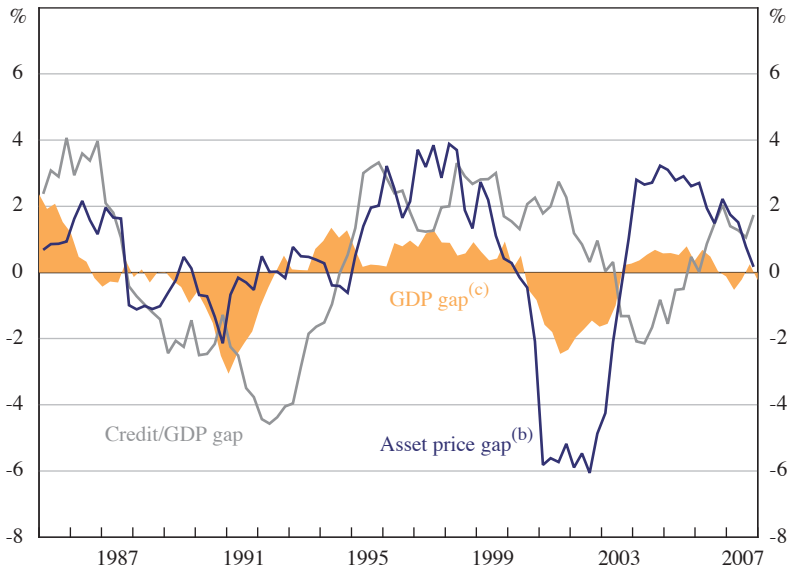
2.3 What has remained the same

The focus on what is new suggests that episodes such as the unfolding turmoil are ‘black swans’ or events so rare and unexpected that there is little that can be done about them. The truth, however, is that (just like black swans) the underlying causes of the turmoil are in many ways familiar.

The early part of this decade saw a long period of unusually easy macroeconomic conditions, with low or negative real interest rates in the major economies and a glut of savings centred in east Asia and the Middle East. In this environment, the global weight of excess savings and excess liquidity fed a steady run-up in asset prices, especially in credit instruments and housing markets, which in turn encouraged a build-up in leverage and risk-taking, among both regulated and unregulated entities. When the environment turned bad, the overextension of risk resulted in heavy losses and a rush to unwind leverage. As shown in Figure 2, this risk-taking behaviour has resulted in a correlation between credit growth, asset prices and the real economy in what Goodhart (2004) has termed the ‘excessive procyclicality’ of the financial system.

An environment that was increasingly tolerant of risk was evident in the tendency of banks to take on more risk and in a decline in risk premia to low levels, especially in the case of credit instruments. As shown in Figure 3, the value-at-risk (VAR) estimates that banks themselves reported show that they took on more risk. This is especially striking given that the realised and implied volatilities of most major asset classes, which form a central input to VAR calculations, were falling steadily throughout this period (see BIS 2006). Even more striking was the steady decline in credit spreads as reflected, for example, in such traded CDS indices as the iTraxx in Europe or the CDX in North America.

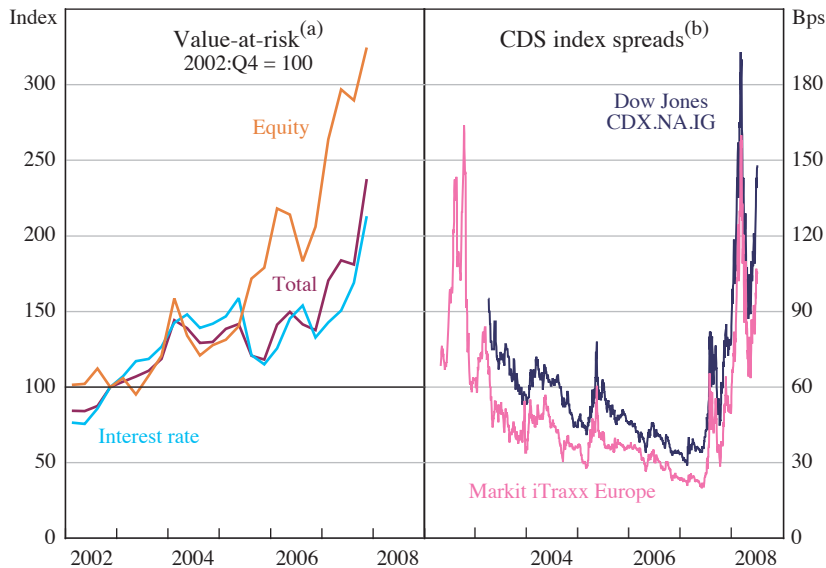
Figure 2: US Financial Markets and the Real Economy^(a)



Notes: (a) Deviations from trend – each trend is derived on the basis of data available in real time
 (b) Based on an index of real equity and residential & commercial property prices; scaled down by a factor of 3
 (c) Based on the logarithm of real GDP

Sources: Bloomberg; IMF; Thomson Reuters; national data

Figure 3: Banks' Value-at-risk and CDS Index Spreads



Notes: (a) Market capitalisation-weighted average of value-at-risk data of Citigroup, Crédit Suisse, Deutsche Bank, Goldman Sachs, JPMorgan Chase, Morgan Stanley, Société Générale and UBS
 (b) 5-year on-the-run CDS spreads

Sources: BIS; JPMorgan Chase

But as the upswing in markets gathered pace, there were also important *qualitative* shifts in financial market participants' attitude towards risk-taking. At many large financial institutions, forward-looking risk assessments were poor, reflecting inadequate risk measurement and lax governance of risk-taking within those institutions. Misaligned incentives cropped up throughout the financial system, as the penalties for poor decisions were ignored. Disclosure weakened, in part because investors slackened in their demand for it. Reviews by supervisors have also made it clear that some banks managed these risks substantially better than others, thanks to closer engagement by senior management and more effective internal controls (see Senior Supervisors' Group 2008). This suggests that at least a portion of the subsequent losses suffered by many banks were by no means inevitable.

In this world of ravenous appetites for risk, market participants became increasingly willing to hold rather complex instruments of unproven liquidity, and increasingly reluctant to apply sound risk management practices to them. In the end, mistakes in the valuation and risk management of these instruments turned out to be the critical errors that triggered the crisis. Risk management errors with respect to the super-senior tranches of CDOs of sub-prime mortgage-backed securities evidently had especially significant systemic effects, thanks in part to maturity and liquidity mismatches involving these instruments. When investors lost faith in ABCP that had been issued by conduits and SIVs holding these instruments, a credit risk event turned into a liquidity event.

2.4 What we don't understand

The combination of a credit risk event and a liquidity event seems to have led to the unique depth and duration of the current crisis. Over the past decade or two, financial markets in the developed economies have become pretty good at absorbing large losses, resolving them, and moving on, albeit usually with an altered set of players and altered judgments about risks. In the current turmoil, by contrast, the underlying functioning of the system has come into question. Whole classes of previously abundant assets can no longer find buyers – notably CDOs of ABS, and the instruments based on them, but also seemingly unrelated products such as municipal auction-rate securities.

While stories explaining the turmoil abound, these remain 'Just So Stories'. There are many fundamental things we just do not (yet) understand. How, for example, could defaults in a relatively small corner of the US mortgage market lead to such massive losses in broader credit markets and turn into a global turmoil of such proportions and such long duration? Greenlaw *et al* (2008) argue that leverage was a major contributing factor. While it is clear that leverage did play a role in the magnification of losses, it is still puzzling how instruments that were designed to spread and diversify risks ended up concentrating the risks.

The sudden evaporation of market liquidity has been even more surprising. Three-month spreads in the international interbank lending markets widened in August 2007 and have remained wide ever since. By late February and early March 2008, investors had seen the near cessation of trading activity in all but the most liquid

government securities. Repo markets, supposedly the most robust source of funding liquidity, experienced what can only be described as a run on all ‘eligible’ collateral except for the highest-rated government bonds. How could liquidity disappear so suddenly from markets that had not seen any sign of defaults or even credit rating downgrades? Brunnermeier and Pedersen (2007) demonstrate that the interaction of market liquidity and funding liquidity can generate what they describe as a liquidity spiral. Nonetheless, an explanation of the sudden disappearance of funding liquidity during February and March 2008 remains beyond the scope of their paper.

Deleveraging and the hoarding of liquid securities by market-makers who also happened to be investors in a broad range of markets played some role in these phenomena. Indeed there were bouts of deleveraging in August 2007, December 2007, and February and March 2008. The first two episodes may have been triggered by disconcerting news about losses in hedge funds or banks. But it is hard to identify a specific trigger for the February–March episode. Market participants say they just had a ‘bad feeling about things’. The fact that many market participants seemed to get that bad feeling at about the same time suggests that a common factor was at work. But what that common factor was remains a mystery.

In trying to resolve the liquidity issues, monetary authorities have been mystified by the persistent stigma associated with borrowing from the central bank and the fact that this gets worse at the very time when such borrowing becomes most critical. As discussed below, it is also surprising how the simple mechanism of an auction can make such stigma go away.

3. The Challenges for Policy-makers: Short-term and Long-term Responses

The challenges that this episode of financial market turmoil has posed for public authorities can be divided into those meriting short-term responses and those meriting long-term responses. In what follows, we focus on the short-term efforts of central banks to provide liquidity and on the longer-term recommendations of the recent report of the Financial Stability Forum (FSF) to the Group of Seven (G7) finance ministers and central bank governors (FSF 2008).

3.1 Short-term responses: what central banks did

The short-term responses of central banks to the unprecedented and fast-changing situation have been creative, energetic and, in terms of the specific goal of keeping the system from grinding to a halt, effective. As Kearns and Lowe (this volume) point out, market liquidity has a large public good component, and a sudden loss of such liquidity is often the result of a market failure. At the same time, Davis (this volume) emphasises the moral hazard that accompanies any form of central bank emergency lending. In their efforts to restore market liquidity, central banks have clearly been seeking to strike the right balance between providing a public good and avoiding moral hazard.

With respect to operations in short-term money markets, central banks have initiated a wide variety of actions. One set of responses may be characterised as a broadening of the scope of their operations.⁴ This broadening took place along four dimensions:

- first, there has been a widening of the collateral accepted, which means that central banks have taken a *de facto* interest in the liquidity of a wider range of asset markets;
- second, there has been a widening of the set of counterparties, notably with the introduction of the primary dealer credit facility (PDCF) by the US Federal Reserve;
- third, central banks have done more to funnel liquidity in their own currencies to entities in other economies, through instruments such as swap agreements; and
- finally, central banks have increased their operations at terms longer than overnight, in order to satisfy the market's increased demand for term liquidity.

A second set of responses by central banks is designed to deal with the stigma associated with borrowing from them. Perhaps the most interesting efforts have been those by the Bank of England and the US Federal Reserve, because they address issues of transparency and the appropriate pricing mechanism for liquidity support.

The Bank of England had in past episodes provided liquidity support to an ailing bank in secret, generally with good results. In September 2007, however, the central bank planned to depart from past practice by announcing liquidity support for Northern Rock. As Davis (this volume) tells it, this plan was pre-empted by a leak to the British Broadcasting Corporation, which led to a run on the troubled bank. This was a forceful reminder of the stigma of borrowing from the Bank of England, and other banks then refused to access the central bank's lending facilities. It remains an open issue whether the Bank of England would have been well advised to keep to its practice of covert financing, or indeed whether such financing would have been feasible in the modern-day environment of more transparent financial markets.

In the case of the US Federal Reserve, banks had been reluctant to make use of the discount window because of the stigma associated with borrowing from it. Various efforts to mitigate the stigma during the early phases of the crisis had failed, and the discount window had remained inactive. For example, the Federal Reserve had reduced from 100 basis points to 50 basis points the interest premium over the target federal funds rate for borrowing from the discount window and had allowed banks to borrow funds for up to 30 days.⁵

What finally succeeded was an auction mechanism. The term auction facility (TAF) was announced on 12 December 2007, and the first auction conducted five days later. It was a single-price auction with a predetermined total amount of US\$20 billion and a fixed 28-day term. The Federal Reserve was no doubt pleased

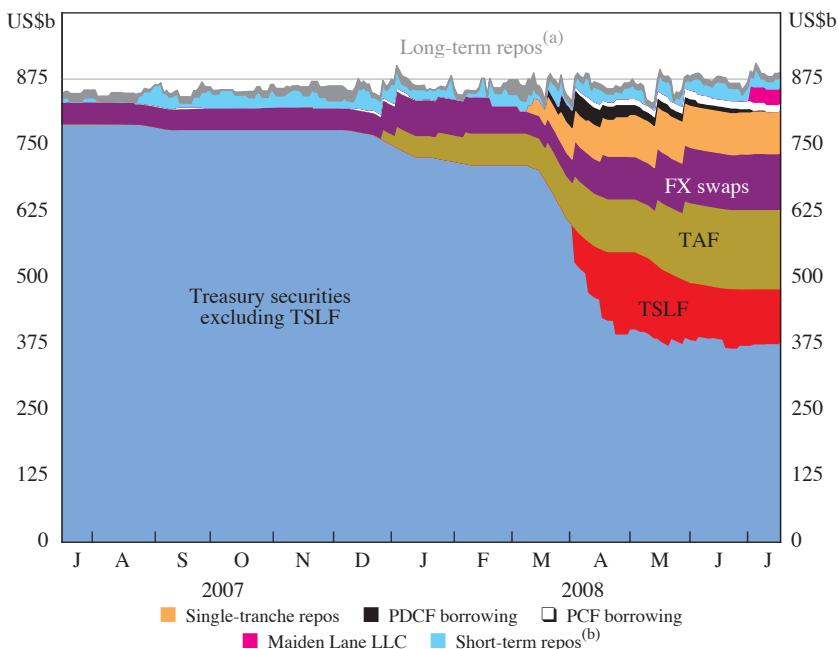
4. CGFS (2008) provides a comprehensive review of these operations by the major central banks. Hilton (this volume) provides a similarly comprehensive review of monetary operations by the Federal Reserve.

5. See Almantier, Krieger and McAndrews (2008) for a more comprehensive discussion.

when 93 banks showed for the auction and took up the entire amount. The question this episode raises is why did such an auction work while Bagehot’s dictum to lend freely at a penalty rate, which underlays the operation of the discount window, did not? Is it because there appeared to be ‘safety in numbers’ associated with the auction process? This may well be so. However, by relying on safety in numbers, such auctions may not ensure that liquidity goes to the institutions that need it most, as Goodhart (2004) has pointed out.

One result of the central banks’ liquidity operations was to change the *composition* of their balance sheets. As Cecchetti (2008) explains, this is conceptually different from the usual operations related to monetary policy, which change the size of the central bank’s balance sheet rather than its composition. Indeed, in the case of the Federal Reserve, the change in the composition of the balance sheet has been quite dramatic. As shown in Figure 4, the Federal Reserve started out in July 2007 with a balance sheet of US\$850 billion (excluding ‘other’ assets), with outright holdings of largely Treasury securities accounting for 93 per cent of the assets shown. A year later, the size of the balance sheet had risen to US\$890 billion but uncommitted outright holdings of Treasury securities now accounted for only 42 per cent of the balance sheet, with the rest presumably consisting of less liquid securities obtained through the various operations. In effect, the Federal Reserve has used its balance sheet to supply the repo market with the assets that market participants now prefer; in turn it has taken from the market those assets that were no longer desired.

Figure 4: Evolution of the Federal Reserve’s Balance Sheet



Notes: (a) Repos with an original maturity of 10–19 days

(b) Repos with an original maturity of 2–9 days

Sources: Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release: H.4.1; Federal Reserve Bank of New York

Taken together, these types of liquidity operations by central banks more generally have helped to stabilise short-term money markets. Nevertheless, these markets remain plagued by wide spreads and, from time to time, volatile rates, reflecting the underlying balance sheet problems which still need to be resolved. Moreover, in several cases, central banks will sooner or later have to decide whether these actions are temporary measures responding to unusual circumstances, or whether they should retain a more permanent place in their operational toolbox.

At the same time, there are some worrying signs that policy-makers may be sowing the seeds for future liquidity and credit problems, and that market participants' expectations of inflation may already be on the rise as a result. Thanks to higher inflation expectations and falling or stable policy rates, global real monetary policy interest rates, which had already been at low levels for some years, have recently dropped to negative levels in many key jurisdictions. In addition, many countries, particularly emerging market economies, have been reluctant to allow their currencies to appreciate against the dollar and other major currencies, consequently continuing their massive foreign exchange intervention purchases. This combination of a rapid and very large decline in real policy interest rates in key jurisdictions and massive foreign exchange interventions by emerging markets has been contributing to a large expansion in liquidity at the global level.

3.2 Long-term responses: the FSF Report

None of these short-term responses by central banks will be sufficient to stabilise the financial system unless market participants can be reassured that the more fundamental issues that led to this turmoil are being addressed. In this section, we focus on the actions set out by the FSF (2008) in their April report to the G7 Finance Ministers and central bank governors. The report draws on an extensive body of work by national authorities and the main international regulatory, supervisory and central bank bodies.

Speaking broadly, the goal is a financial system where risks are more accurately identified and managed, where perverse incentives are reduced and where build-ups of leverage pose less of a threat. There is no silver bullet that will accomplish all of these goals at once, but concerted action in a few key areas can accomplish a lot.

In the area of *strengthened prudential oversight*, the key steps recommended by the FSF report involve the capital and liquidity frameworks. Implementing Basel II will, by itself, eliminate several of the perverse incentives that were created by the existing regulatory framework. The Basel Committee is also looking actively at ways to strengthen Basel II, and in particular has proposed increasing capital charges for complex structured credit products, for credit exposures in banks' trading books, and for liquidity facilities provided to off-balance sheet vehicles. They have also issued guidance for strengthening liquidity risk management at regulated firms.

With respect to *transparency*, the FSF report sets out leading practices for disclosures based on a survey of large banks and securities firms, with an emphasis on exposures, such as US sub-prime products, that the marketplace considers to

be especially risky. Supervisors in a number of countries have actively encouraged their banks to follow these practices for their 2008 mid-year accounts.

Current discussions about *valuation* are also important. Better disclosure means nothing if markets are not confident that the numbers are meaningful. The report makes clear that completely suspending fair value accounting would be a mistake, because such a step would do more to reduce confidence in the system than any short-term relief it might bring to holders of problem assets. But there are legitimate questions regarding how to value assets when markets are illiquid. In response to concerns expressed by the FSF, the International Accounting Standards Board has established an expert panel – drawn from financial institutions, supervisors, investors and auditors – to assist it in developing enhanced guidance in this respect. The objective will be to reinforce sound valuation practices and transparency, not to undermine confidence in accounting standards or valuations.

Beyond the issue of valuing assets when markets are illiquid, it is evident that, at least in the short term, asset prices tend to be driven by changes in investors' risk appetites rather than by what may be characterised as fundamentals. For example, Amato and Remolona (2005) show that CDS spreads are largely accounted for not by any measure of default risk, but rather by what can only be described as the general appetite for risk. This calls into question the value of marking to market on a daily basis when, at this horizon, risk appetites rather than fundamentals drive market prices. Nonetheless, in the absence of reliable alternative measures of fundamental inputs such as correlation or expected volatility, market values are likely to be the most consistent, if imperfect, way to generate useful asset valuations. The challenge then becomes how to make effective use of the information they contain without ignoring their limitations as guides to fundamental values.

This brings us to the issue of the role and use of *credit ratings*. Credit ratings clearly play an important role in financial markets by helping investors to filter information critical to their portfolio decisions. But the crisis revealed shortcomings regarding how the ratings are generated and how investors use ratings. The FSF has called on the rating agencies to:

- improve the quality of the rating process, including by better managing conflicts of interest in line with the revised International Organization of Securities Commissions Code of Conduct (see IOSCO 2008);
- differentiate ratings on structured finance from those on bonds, as a signal of the critical differences in their risk characteristics under stress; and
- enhance the information they provide on the risk characteristics of structured products.

Others also have a role to play so as to improve the use of credit ratings. Investors will need to better exercise due diligence and use their own independent judgment of risks, while regulators have begun to investigate the ways in which ratings are sometimes 'hard-wired' into regulatory and supervisory frameworks.

Finally, the FSF has outlined a number of ways in which *public authorities*, both at the national and international levels, need to do a better job in assessing and responding to risks. In particular, they need to:

- better translate risk analysis into action, by upgrading their expertise and communicating more directly with the management and boards of regulated institutions about the risks they see;
- improve information exchange and cooperation, for example through broader use of supervisory colleges for banks that are active in several national markets;
- enhance the effectiveness of international bodies, such as those that meet under the auspices of the BIS, by improving prioritisation and conducting joint strategic reviews; and
- clarify and strengthen national and cross-border arrangements for managing crises and dealing with weak banks.

4. Living with Procyclicality

This paper began by discussing the broad rise in risk-taking and leverage that took place in the years preceding the crisis. The recent recommendations of the FSF and the subsequent work program deal with the various ways that regulators, firms, investors and rating agencies can improve the system's ability to measure, assess and manage risk, which are important steps. But whether there is anything more fundamental that we can do to prevent financial crises remains an open question. This crisis shares many characteristics with past crises in terms of underlying causes, most notably the inherent procyclicality of the financial system. It seems reasonable, therefore, to suggest that more could be done to reduce this tendency of the financial system to accumulate too much risk in good times and to shed it rapidly in bad times. But how can this be achieved?

In the foreword to its April 2008 report to the G7, the FSF stated its intention to examine the drivers of procyclical behaviour and possible options to mitigate it. This process has now begun. Among the issues that are being considered are capital requirements, fair value accounting, compensation systems and funding liquidity. In each case, the idea is to investigate the procyclical drivers involved and potential policy responses. This is not always easy, in view of ongoing structural changes in financial systems. Many more recent structures are only now being fully tested in a downturn. But the authorities can seek to ensure that regulatory systems, such as the capital regime, do not reinforce the natural cycles of the financial system. They can also seek to ensure that the incentives are well aligned, which points policy-makers towards taking a closer look at private-sector compensation systems and counterparty risk management to ensure that they do not foster excessive risk-taking behaviour.

In a widely cited paper, Borio, Furfine and Lowe (2001) call for the use of supervisory instruments in an 'explicitly *countercyclical* fashion'. The object of this policy is '... [to] *encourage the building-up of a protective cushion in good times that can be drawn down in bad times*' (p 2). In principle, the cushion could take

the form of loan-loss provisions as well as capital. It may also involve the lowering of regulatory loan-to-value ratios at times when the prices of the underlying assets have been rising at an especially rapid pace. Recent events suggest that a further cushion could take the form of robustly liquid securities – for example, highly rated and actively traded government bonds – which the repo markets will always accept as collateral, to guard against the runs we have recently seen on most other forms of repo collateral.

Finally, an unusual buoyancy of markets should serve to remind the financial stability departments of central banks and supervisory authorities to monitor especially closely any related innovative financial instruments. This is because excesses in risk-taking tend to involve the use of such instruments. The object of these monitoring efforts would be to understand the various ways in which these instruments are used and track the channels through which they proliferate. The development of such market intelligence would then help alert the authorities to times when it would be appropriate to apply countercyclical supervisory instruments to particular segments of the financial markets.

5. Conclusion

In this paper, we have emphasised that certain elements are new to the current episode of financial turmoil, while many elements have remained the same. The new elements include structured credit, the broader use of the originate-to-distribute business model and new arrangements in repo markets that allow the use of almost any financial asset as collateral. These are fundamentally good innovations but their reckless use has helped to underpin the crisis. The elements that have remained the same are those processes that underpin the basic procyclicality in the system, that is, the tendency for a build-up of risk-taking and leverage to occur in benign economic environments and the abrupt withdrawal from risk and an unwinding of leverage that typically happens once the environment turns bad.

In their short-term response to the dramatic loss of liquidity, central banks have had to trade off the importance of ensuring the continued availability of market liquidity as a public good against the moral hazard that any market intervention is likely to induce. Overall, central banks have acted to broaden the scope of their liquidity operations. At the same time, however, they have had to deal with the stigma often associated with borrowing from them, which seems to get worse at the very time when liquidity from the central bank is needed the most.

In proposing long-term responses to the crisis, the FSF has focused on areas where incentives for risk-taking may be aligned more properly, for example through strengthened capital requirements and more judicious use of credit ratings, and areas where risk management may be made more robust, such as through better disclosure rules and valuation standards. Nonetheless, recognising that the procyclicality of the financial system lies at the root of this and other financial crises before it would suggest that more extensive policy responses may be required. The use of supervisory instruments in an explicitly countercyclical way is one avenue requiring further investigation. Policies here would be designed to build adequate buffers in the system to prevent shocks from propagating too far.

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Discussion

1. Richard Portes

1.1 Origins and the extent of the crisis

The paper by Ben Cohen and Eli Remolona provides an excellent summary of the origins of the crisis. I agree with their emphasis on three key factors. There was: (a) financial innovation – with exceptional opacity of new instruments; (b) low interest rates globally, which prompted a search for yield; and (c) an environment of ‘ravenous’ risk appetites driven by problematic incentives in various guises. The authors state that as credit risk problems became apparent, they transformed into a liquidity event, leading to what they claim to be the unique depth and duration of this crisis. The key to this is the interaction between market liquidity and funding liquidity in the context of maturity mismatch, with the potential for multiple adverse liquidity spirals as laid out by Brunnermeier (forthcoming).

With this as background it is worth asking: what policy options might have worked to prevent or mitigate the effects of the crisis this time around, if they had been applied? There is some evidence that better regulation could have stopped some excesses. One case is the Bank of Spain, which did not permit abusive off-balance sheet exposures, the use of structured investment vehicles, and the like. As a result, Spanish banks are in relatively good shape, despite the bursting of the Spanish real estate bubble.

History teaches that the next crisis will not have the same origins. Because it will come from somewhere else, policy-makers must avoid the mistake of ‘fighting the last war’. Great examples of this kind include the portfolio insurance problems of 1987, derivatives disasters in the 1990s, and exceptionally high hedge-fund leverage associated with the LTCM crisis of 1998. All these evoked ‘suitable’ policy responses, so none was a source of the current turmoil – which came nevertheless.

The main puzzle in my mind is the extent to which the current episode really constitutes a financial crisis, rather than only a crisis for the financial sector. So far, the effects on the non-financial sector and the aggregate real economy, even in the United States, are far short of what one might expect from the ‘biggest financial crisis since the Great Depression’. It could, in fact, be argued that commodity and food price inflation have been much more important factors in driving the fall in growth rates – which still, almost a year after the onset of the turmoil, does not amount to a recession.

In some respects the problems are similar to those faced in the latter part of 1998 – during which there was a major sovereign default and a spike in market volatility that was just as great – even though the financial market turmoil then was not as deep nor as long as the current episode. So we have more puzzles: deleveraging has so far been much less than in previous episodes; volatilities and indicators of risk aversion do not appear unusual in historical perspective (even the peak of credit default swap

(CDS) spreads in February–March is not much higher than the 2002 peak); TED and LIBOR-OIS spreads are stubbornly high despite exceptional liquidity interventions; and long rates have not risen *pari passu* with inflation expectations.

1.2 Policy responses

Part of the answer to these puzzles may be that policy has actively responded to the financial turmoil. In particular, there have been cuts in monetary policy rates; not by the European Central Bank, but they might otherwise have raised rates in August 2007. There have also been major changes in the market operations of central banks, a widening of the range of collateral accepted (though not in the euro area, where it was already extensive), the creation of new facilities (again not in the euro area), and swap agreements across countries. In addition, there have been efforts to repair bank balance sheets. Policy-makers have acted aggressively in their own domains. In many respects, however, there has been a lamentable lack of policy coordination among the major central banks, sometimes even vocal discord.

On the issue of write-downs and recapitalisation many questions remain. Why did the banks not cut dividends quickly and substantially? Was there any pressure from regulators to do so? To the extent that there has been action, the approach has been piecemeal. Repeated write-downs have been largely perceived as lacking transparency and have in many cases led to further falls in bank share prices. Sovereign wealth funds, hedge funds and others who have invested new funds have been burnt, so not surprisingly, there is a reluctance to invest further in bank recapitalisation. All this has been partly caused, or at least exacerbated, by mark-to-market accounting.

1.3 Capital market dysfunctionalities

I now want to turn to three types of problems in capital markets that have exacerbated the turmoil. These are problems that policy-makers did not fully or properly understand, so it is only now that they are attracting attention – but perhaps not yet enough. The first of these is in the CDS market, which faces considerable distortion. In particular, if current levels of CDS spreads were accurate indicators of the probability of default, then many banks should be pronounced dead. The problem is that this market started out with a view to buying and selling credit protection, but it has now also become a vehicle for speculation – the size of the market is an order of magnitude greater than the underlying credit risks being hedged. The market now has also become one-sided. Everyone wants to bet against the banks, but no-one wants to write protection. And with limited supply and rumours fuelling demand, prices have gone way up on thin and volatile trading. It seems clear that this is a highly speculative market, and it is subject to some manipulation.

The abnormally high CDS spreads have become a major problem for the banks because new bond issues have to be priced by reference to (and hence above) CDS spreads. Given the current high spreads, these markets are effectively closed. It also appears that hedge funds are ‘playing rough’, trying to make things look worse than

they actually are, thereby helping to drive spreads up even further. Such a strategy can be combined profitably with going short in bank stocks.

There is a vicious circle operating in this market. CDS spreads widen, investors demand higher yields, the cost of capital rises and its availability falls, balance sheets deteriorate, and CDS spreads widen further. What could be done to fix this? Often discussed – including by Ben and Eli – is the value of organising centralised clearing, thereby significantly lowering counterparty risks. This falls far short, however, of the transparency and normalisation of the markets that would come from requiring that they go onto organised exchanges. If the specificity of many of these instruments precludes exchange trading, then we should simply accept the cost of greater uniformity. Unfortunately, any such initiative will be resisted by the investment banks, which generate large profits precisely from the specificity and opacity of the current arrangements. They are enthusiastically pushing for centralised clearing in order to circumvent pressure for exchange trading.

The second problem plaguing capital markets is the application of marking to market. Valuing assets at ‘market value’ in period of financial distress (when the market is not functioning) amplifies balance sheet problems. It also inhibits reliquefaction of markets, because asset holders will not want to sell at distressed prices if they then have to mark down their entire portfolios to those prices. Another vicious circle can arise here, because as hedge funds and others sell at distressed prices, banks are forced to mark their books lower, requiring them to tighten credit and leading to a further round of selling. Meanwhile, long-term investors do not enter the market because they believe prices will fall still further. These problems are compounded by the fact that many assets are valued with respect to credit derivative prices (for example, the ABX index), which are highly volatile and appear to overestimate probabilities of default.

It is less than 15 years ago that the Securities and Exchange Commission began to require ‘fair value’ accounting. Fortunately, that was well after the debt crisis of the early 1980s, when the nine New York money centre banks found themselves with aggregate exposure to developing country sovereign debt of about 250 per cent of their equity capital. If these assets had been marked to market when Brazil, Mexico and others stopped paying, the banks would have been ‘under water’ (assuming a market valuation of less than 60 cents on the dollar – which is not much below where they settled in the Brady Plan, almost a decade later). The world financial system faced a serious danger of collapse. What was the solution? Jacques de Larosière and Paul Volcker saw the threat clearly and successfully pressed for forbearance, that is, classifying this debt as being ‘held to maturity’. This cannot be done nowadays.

Ben and Eli argue that ‘... suspending fair value accounting ... would do more to reduce confidence ... than any short-term relief it might bring ... But there are legitimate questions regarding how to value assets when markets are illiquid. In response ... the International Accounting Standards Board has established an expert panel ...’. It will report in due course. Meanwhile, I think it would be wise and not confidence-impairing to limit the application of fair value accounting to assets on trading books, while excluding assets which are bought to hold till maturity.

The third dysfunctionality I want to highlight is that of the (dis)credit(ed) rating agencies (CRAs). The natural monopoly characteristics of this industry have been enhanced by the dependence of regulators on ratings – that is, the CRAs have been granted a ‘regulatory licence’. Pension funds, insurance companies and others may invest only in securities given ‘investment-grade’ ratings by a small number of agencies specifically designated by the regulators. But they are subject to considerable conflicts of interest, use models which are suspect, produce ratings that are lagging indicators and add little, if any value (Levich, Majnoni and Reinhart 2002). Ben and Eli tell us that ‘regulators have begun to investigate the ways in which ratings are sometimes “hard-wired” into regulatory and supervisory frameworks’. They also propose better management of conflicts of interest ‘in line with the revised International Organisation of Securities Commissions Code of Conduct’. The 2005 version of the Code was fully implemented, however, with zero effect (see AMF 2008); I would suggest that self-regulation is unlikely to accomplish anything.

So how else can the CRAs be dealt with? The heart of the problem lies in designing a system with the right incentives. Normally public goods should have public funding, but not here – there are obvious problems that would arise with public involvement in ratings. I would argue that subscription (the pre-1975 model) should be revived, perhaps via a levy on users. We should also require the agencies to provide more information regarding their judgments, including an assessment of the liquidity characteristics of an instrument and the likely volatility of its market price. Moreover, rating ranges should be provided in many instances, in preference to point estimates. The business of providing ratings should be separated from the advisory/consultative side of the business. Most important, the ‘regulatory licence’ should be eliminated.

Let me conclude by commending Ben and Eli on their summary of the nature of this crisis and the manner in which it has unfolded. I think that more work needs to be done to address problems in the capital markets, which this crisis has exposed. At the same time, we need to avoid merely ‘fighting the last war’ by remembering that while all ‘... crises are the same ... All crises are different’ (Portes 1999, pp 471–472).

There is an alternative. That this conference session is being held on Bastille Day brings to mind an admittedly radical policy – to ‘shoot the speculators’ (the guillotine being an outdated technology). The then French Finance Minister, Michel Sapin, cited this historical precedent in his parliamentary intervention on the crisis of the EU Exchange Rate Mechanism in autumn 1992. One can easily imagine that it would be a popular policy now.

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2. Grant Spencer

The paper by Ben Cohen and Eli Remolona provides a good overview of the current episode of financial turmoil and is a useful introduction to what will no doubt be an interesting conference. In my comments I would like to briefly discuss the effects that the financial turmoil has had on New Zealand so far, and its implications for the Reserve Bank of New Zealand (RBNZ, which is also the prudential regulator). I think that this is likely to be of some interest given that New Zealand's very open capital markets and relatively high debt levels have presented some very specific issues in the current adverse global credit environment.

Overall, New Zealand's financial system has so far withstood the global financial turmoil well. This is partly because it has little direct exposure to the mortgage market in the United States, and NZ banks have not developed the complex structured financial instruments which have been a key contributor to the recent turmoil. New Zealand has, however, been affected by the global tightening of credit markets. So while the banking sector has not suffered any shortage of equity, it has been affected by the tighter cost and availability of debt. As defaults on US sub-prime mortgages have risen, liquidity in global capital markets has become scarce. NZ (as well as Australian) banks source a significant degree of funding from international capital markets (around 40 per cent of bank liabilities in New Zealand are external) and often at short maturities. In both Australia and New Zealand, the spread to overnight indexed swaps increased in mid 2007 and has remained well above its long-run average, although it is worth noting that these spreads are not as large as those in the United States and Europe.

The significant external exposure of the NZ economy is manifest in its sizeable current account deficit, with a large share of the nation's external liabilities held on NZ banks' balance sheets. Clearly, any disruption in the flow of funds to NZ banks will be potentially disruptive for the macroeconomy. In other words, a further tightening of global credit markets could have significant implications for macrofinancial stability as well as the prudential soundness of the banking system. Related to this, there is concern about liquidity shortages in the foreign exchange market. Although the NZ currency is presently above its long-run average, it has been below the level suggested by the historical relationship between the exchange rate and the yield differential with the United States. The declining appetite for risk in global financial markets and the international economic slowdown may put downward pressure on the NZ currency, which could pose risks to markets and the economy if the adjustment is sharp.

The immediate policy response in New Zealand to the global financial market turmoil has been to adopt a quite accommodating liquidity stance for banks. The RBNZ implemented changes to its domestic market operations to ensure that banks would be able to access liquidity should the credit squeeze become more acute. The RBNZ increased settlement cash levels, narrowed the discount margin and lengthened the discount window to 30 days. We also expanded the range of securities we would accept as collateral to encompass NZ dollar, NZ-registered, AAA-rated residential mortgage-backed securities.

The RBNZ is also currently undertaking a review of its prudential regulation, specifically focusing on liquidity management by banks. It is likely that this review will produce recommendations aimed at ensuring that banks lengthen the maturity of their wholesale funding as well as diversify their sources of liquidity. Given the reliance of the major NZ banks on short-term wholesale funding from the international markets, I would expect that the new policy will require more conservative liquidity profiles than we see at present. In implementing the new Basel II regime, the RBNZ has focused on ensuring that bank holdings of capital are adequate to withstand credit losses from a significant downturn in the domestic housing market. In the current environment, this is a very real risk over the coming year or two. The RBNZ will soon also have responsibility for the regulation of non-bank deposit-takers and the insurance sector. The relevant legislation is currently in the House of Representatives. An important role of these regulatory frameworks is to provide buffers against the sort of international financial shocks that we are now experiencing.

Finally, I would note that the credit creation process has been very procyclical in New Zealand over recent years. Aggressive credit expansion by the banks through 2003–07 contributed to the biggest housing boom seen in decades. Subsequently, since mid 2007, credit standards have tightened sharply as the housing market has turned down – particularly with the overlay of tight global credit markets. Factors contributing to this procyclicality, in my view, include asymmetric incentives facing bank management, mark-to-market accounting, the new International Financial Reporting Standards provisioning requirements, and point-in-time capital models. A potential response to this could be a countercyclical prudential policy, which could operate by means of the Pillar 2 supervisory overlay. Such an approach has been discussed at earlier RBA conferences, along the lines of the work of Claudio Borio and Philip Lowe. However, our own simulations suggest that the required moves in capital ratios would be too large for practical implementation. The cyclical component would swamp the prudential component, thereby undermining the original rationale for the capital adequacy policy. An alternative could be a more countercyclical monetary policy. However, as we have found in New Zealand in recent years, this can also be very difficult if the domestic cycle is out of sync with the global economic cycle.

3. General Discussion

The paper and discussants' comments provoked debate about the magnitude of the 2007 and 2008 financial market turmoil to date, and its likely impact on the real economy. This was partly in response to Richard Portes's suggestion that, on a range of metrics, financial conditions did not look as bad as they had been during recent financial crises. Some participants thought this view was too sanguine, suggesting that the decline in the US housing market, according to some measures, had been greater than during the Great Depression. In line with this, a number of participants suggested that – notwithstanding the positive effect of recent policy responses – a substantial part of the effect of the financial turmoil on the real economy was yet to materialise, and that weaker economic outcomes (assuming they did occur) would lead to further losses for financial institutions.

The discussion moved on to a debate about the causes of the recent financial turmoil. Some participants suggested that low global interest rates early in the decade and the extent of financial market innovation were both potentially factors which led to and/or exacerbated the crisis. In particular, the creation of some complex financial instruments had made risk exposures more difficult to assess and added 'opacity' to some parts of the financial system. One participant suggested that risk had become more concentrated, not less, in part because the largest dozen banks in the world now handle the bulk of the transactions, hold a large part of this risk, and operate with similar business models. Consequently a problem at one major institution can have global ramifications. More generally, participants argued that the model of banking had changed in recent years, with many commercial banks now operating in similar ways to investment banks, particularly in their use of high-leverage strategies. This raised the general question of whether it was appropriate for all banks to operate in this way. Other participants argued that systems of executive compensation had also evolved such that there were conflicts of interest in the private sector. This met with some debate, as some suggested that private-sector agents needed to have more 'skin in the game', while others thought that recent large declines in bank share prices and the loss of managements' reputation, by association with any bank failures, were incentive enough to promote prudent risk management. In response to the question of how problems in one part of the financial markets could lead to the global turmoil, one participant suggested that the underlying problem had been the house price bubble in the United States, and the sub-prime mortgage problems were just one symptom of this much bigger concern.

Much of the rest of the discussion was focused on the role of policy-makers in managing risk in the financial system. One participant argued that a key goal for macro-prudential regulators is to determine how to predict crises by identifying events which might indicate the advent of a crisis. In this regard, a few participants highlighted the importance of large increases in the prices of assets, particularly those that form the basis of collateral and accompany rapid increases in credit. With regards to potentially adverse structural change, the institutionalising of mark-to-market accounting was raised as a possible policy concern on a number of fronts. First, it was suggested that accounting has become quite liberal and in some ways more art than science. Second, there was some question about whether

it should be the role of the authorities to create markets where they do not exist, so that mark-to-market accounting could work effectively. Related to this, there was a debate about the role of central banks in becoming market-makers of last resort, with the attendant moral hazard concerns. Some thought the moral hazard issues were significant, while others were of the view that it had not been a major problem in previous episodes.

There was a brief discussion about procyclical prudential regulation. Some participants agreed with Grant Spencer's comments, suggesting that it was unlikely that loan-to-valuation ratios (LVRs), or procyclical liquidity and capital requirements could be implemented in a way that had a substantial effect on reducing credit cycles. In response, Eli Remolona suggested an alternate view, citing developments in Hong Kong in the early 1990s as an example of the successful use of procyclical LVRs. Hong Kong's LVR was lowered significantly during the run-up in house prices, which helped limit the extent of large systemic problems and bank failures when house prices subsequently declined.

Financial Innovation: What Have We Learnt?

Nigel Jenkinson, Adrian Penalver and Nicholas Vause

1. Introduction

At last year's conference, we presented a paper highlighting the profound impact of rapid financial innovation, deregulation and capital market integration on the performance, risk and management of the global financial system (Hamilton, Jenkinson and Penalver 2007). We particularly noted the benefits of financial innovation. We argued that the development of new financial instruments has created opportunities for households and companies to improve their management of financial risks, and has facilitated the smoothing of consumption and investment over time and across different states of the world. But we also emphasised that the breakdown of barriers to the supply of financial products and the large volume of risk pooling and shifting within and across borders has increased the network interconnections within the global financial system. That has added to the system's complexity. And we underlined that understanding and addressing the corresponding evolution of financial system risks poses major challenges for financial institutions and for authorities charged with maintaining financial stability.

The past year has seen these potential major challenges turn into real practical problems. We are now almost a year into a credit crisis centred around a sudden evaporation of market liquidity for many structured credit products that rapidly spilled over into wholesale bank funding markets and beyond, given a complex web of interconnections (see, for example, BoE 2007 and BoE 2008). So it is an opportune moment to review whether the financial innovation of recent years that created such structured products has indeed been a positive force, as argued by Alan Greenspan¹ for example, or whether financial innovation has been a malign development, producing 'financial weapons of mass destruction' in the words of Warren Buffett.²

There is clearly some force in both arguments. On balance, we continue to see considerable benefits to households and companies from the broadening of choice in financial products and from improvements in the completeness of financial markets. But equally, the severe pressures and strains of the past year have highlighted the pervasiveness of some market frictions that have a major bearing on system-wide behaviour and dynamics, amplifying and transmitting shocks. Action to lower these frictions is consequently important to capture the full benefits of innovation and to ensure that these are durable.

1. See, for example, Greenspan (2002).

2. Referring to derivatives in Berkshire Hathaway (2002).

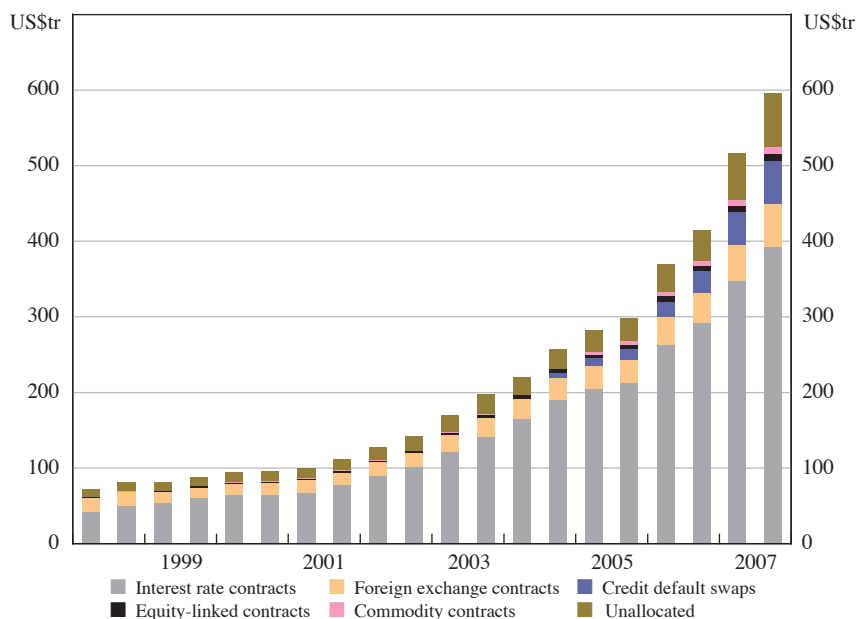
This paper explores these issues further. Section 2 provides a short reminder of the staggering extent of financial innovation in recent decades. Section 3 sets out the theoretical vision of how financial innovation offers the potential for substantial improvements in the capability of companies and households to manage financial risks. Section 4 highlights the obstacles to the fulfilment of that vision given the imperfections in financial markets. Lessons for the future and possible policy responses are discussed in Section 5, while Section 6 concludes.

2. Trends in Financial Innovation

The pace of change in financial markets in recent years is truly remarkable. A few statistics help to illustrate this point and set the scene.

- The outstanding value of interest rate swaps and other derivatives reached almost US\$600 trillion or some 11 times annual global GDP by the end of 2007, according to the Bank for International Settlements (BIS). Ten years ago the value was around US\$75 trillion (2 ½ times global GDP; Figure 1). The global derivatives market expanded almost 50 per cent during 2007.

Figure 1: Outstanding Notional Amounts of Derivatives



Source: BIS

- The credit default swaps (CDS) market has experienced explosive growth. The outstanding value of CDS contracts has surged to more than five times the outstanding principal of global corporate bonds by the end of 2007. Yet only three years ago, at the end of 2004, the CDS market was only some 85 per cent of the size of the corporate bond market. The CDS market is now by far the more liquid market for trading credit risk.

- The outstanding value of commodity derivatives has risen from around US\$400 billion in 1998 to US\$9 trillion at the end of 2007.
- Options markets have also grown very strongly. For example, the outstanding principal of interest rate options has increased from US\$8 trillion to US\$57 trillion in the past decade.
- Innovation and the removal of barriers to cross-border activity has spurred global capital market integration. For example, turnover in foreign exchange markets has tripled since the BIS survey in 2001 (BIS 2002). And the increase in cross-border asset holdings has outpaced the strong growth in the global stock of financial assets.
- Markets offering investors ready-made portfolios rose very rapidly in advance of the credit crisis. Issuance of asset-backed securities (ABS) globally was US\$1460 billion in the first half of 2007, up from US\$425 billion nine years previously. There was rapid expansion in the market for collateralised debt obligations (CDOs) from US\$75 billion in the first half of 2005 to US\$200 billion in the first half of 2007. And innovation spawned greater complexity. Investment banks launched a series of highly complex products such as constant proportion debt obligations and resecuritisations of CDOs and ABS (so-called CDO-squared and CDOs of ABS).

Demand for such tailor-made products has plummeted over the past year, while other markets such as the corporate CDS market have continued to expand rapidly. A possible explanation and assessment of the implications is set out in the remainder of the paper.

3. Financial Innovation: A Broadening of Choice

A crucial function of the financial system is to help companies and households to manage risks. The discharge of this function depends on the type of financial products or contracts available to companies and households to hedge and take on exposures in close alignment with their individual risk preference and tolerance, as well as the capability of the institutions that make up the financial system to manage the risk inherent in these products. The focus of this section is on how innovation in financial instruments extends the choice of risk management products available to companies and households, moving us closer towards a vision of liquid markets in state-contingent securities. But it must also be borne in mind that imperfections within financial markets will affect the performance of these innovative financial products, which may in turn limit their availability. Such frictions may thus affect the ability of the financial system to support corporate and household risk management. This issue is covered in Section 4.

As an illustration of the potential benefits of innovation in contract design and broadening choice, consider the market for corporate credit risk. In previous decades, the only securities available to investors wishing to invest in corporate debt were corporate bonds. One might call such assets 'natural assets', as the same instrument that is issued by the borrower is also held by the investor. In this

example, the role of the financial system is simply to facilitate the intermediation between end-borrowers and end-investors, and, in some cases, to provide a secondary market in the asset, intermediating between alternate end-investors. There is no transformation of the asset.

Financial engineering can, however, decompose the returns on a corporate bond into different fundamental components of risk.

- For example, CDS can be used to separate the return on a corporate bond into the compensation for default risk and the compensation earned on a risk-free security. An investor wanting to make an intertemporal transfer without taking on any credit risk, for example, could buy a bond and purchase CDS protection, thus retaining exposure to the cash flows on the risk-free component of the underlying instrument. Synthetically, this expands the volume of low-risk investment portfolios. On the other side, a market is created for those who specifically want to trade default risk which allows cleaner pricing of this dimension of risk. Efficient markets for each element should raise the efficiency of the corporate bond market as a whole, with attendant benefits for both borrowers and investors.
- Furthermore, because CDS have different maturities, investors could, for example, buy the corporate bond and retain the resulting exposure to default risk in the near term. But they could also buy protection against default risk at longer horizons, about which they may be more uncertain.
- Moreover, nominal corporate bonds can also be separated into a nominal and inflation-linked risk component if the company also issues inflation-indexed bonds. Investors can utilise these instruments to buy or sell protection against exposure to inflation risk.

As noted above, the markets for single-name corporate CDS have become more liquid than the underlying bonds due to the flexibility and specificity they provide to end-investors.

The underlying components of risk can, of course, also be recombined by financial engineering to create new financial products with different risk characteristics. Extending the above example, single-name CDS have been pooled together into standardised indices. This creates a synthetic market in generalised corporate credit risk, enabling investors wishing to hedge or establish a new position linked to macroeconomic risk to do so. And there are many parallel developments, such as products tracking equity indices, commodity prices and emerging market debt to name but a few.

The value of standardised indices to financial intermediaries can be illustrated by considering a CDS dealer, who may find at the end of a day's trading that they have been a net seller of default protection on numerous companies. The dealer could hedge such a position by buying protection on the standardised indices. The hedge would of course not be perfect, as in all likelihood the firms in the standardised indices would not be an exact match for those to whom the dealer had sold protection. But because indices are relatively liquid and thus cheaper to trade, the dealer may decide that the resulting saving in transaction costs may outweigh the residual 'basis' risk that results from the hedge being imperfect. And

through competition, the benefit would tend to be shared by corporate borrowers and investors in corporate credit risk.

Taking the example further, investors who wish to take exposure to generalised corporate credit risk but who wish to limit their potential losses can do so through trading options contracts on the standardised indices. The array of options with different 'strike prices' – which represent the thresholds beyond which the options do or do not pay out – allows market participants to express opinions about the distribution of possible future aggregate corporate conditions.

CDS are not the only way an investor can engineer a targeted exposure to credit risk. Alternatively, an investor can take a position on corporate credit risk by purchasing a securitised product such as a CDO. In this case, a pool of assets such as corporate bonds is created and the payment streams produced by these are allocated to different classes or tranches depending on the default experience. This allows investors to take positions on the scale of default losses in the underlying asset pool.

Stepping back, the extended example above highlights how financial engineering has facilitated the decomposition of corporate credit risk into different subcomponents and the recombination of these subcomponents into new financial products with different risk characteristics. There are many other examples across the financial system. The consequent broadening of the range of financial products has improved choice and the matching and tailoring of products to customer needs. For instance, the ability of non-financial companies to manage their risks has been transformed by their increasing use of derivatives to hedge interest rate and currency risks as well as their exposures to commodity prices. And notwithstanding the current squeeze on the availability of credit (and the withdrawal of many products), households have also benefited from a significant expansion in the range of saving and borrowing products over the past 20 years or so.

The practical examples described above clearly demonstrate the benefits of financial innovation. Enhancing the capability to transform and transfer risk, and thus improving the matching of the supply of risk products to the demands of end-investors, offers the prospect of lower risk premia and greater financial efficiency. This in turn should lower the cost of capital for firms and improve the ability of households to smooth their lifetime consumption and insure against unexpected outcomes.

Taking an even further step, there is a beguiling vision of financial innovation taking us closer towards a world of more complete and efficient markets for state-contingent contracts. The potential to decompose and trade the distribution of many dimensions of fundamental risks would create a matrix of efficient prices for risk which can then, by arbitrage, be used to price efficiently the combinations of these risks embedded in 'natural assets' and in 'synthetic assets' structured to meet investor demand.

4. Frictions and Market Imperfections

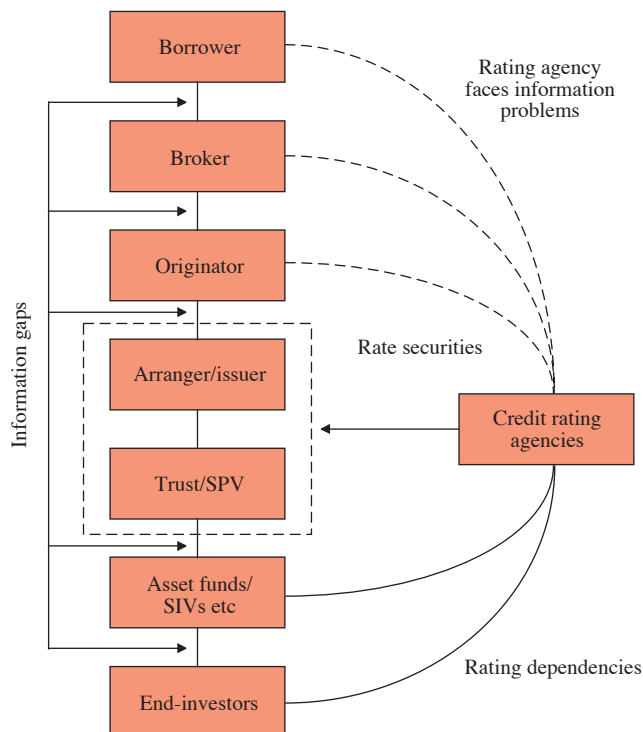
The previous section described how financial innovation has widened the range and choice of financial products available to companies and households to facilitate improved risk management. But it also noted the potential importance of market imperfections and frictions in the provision of such contracts. One year on from the onset of the current credit crisis, what have we learned about the performance of the financial system and such market imperfections?

In broad terms, an important lesson from the past year is that these frictions appear more powerful than market participants and financial authorities previously judged. They pose substantial barriers and practical limitations to the achievement of a stylised vision of full, complete and efficient markets in fundamental components of risk. Five areas of potential weakness are highlighted in turn: incomplete information; alignment of incentives; liquidity in financial markets; robustness of financial market infrastructure; and system dynamics.

4.1 Incomplete information

The vision of a world of complete and efficient markets for risk depends on full information. This full-information requirement sounds deceptively simple but is actually extremely onerous. An investor needs to know the mapping between states of the world and the pay-offs they would receive in each state as well as the likelihood of these states of the world materialising. This means not only understanding the details of highly complex contracts but also the effects of the interplay between exposures and contracts of all the other agents in the economy. Not surprisingly, many of the problems that have occurred over the past year or so have arisen as a result of incomplete and asymmetric information. There are a number of dimensions to consider.

First, it is very difficult to ascertain the distribution of pay-offs for many instruments. For example, a mezzanine tranche of a CDO might have attachment and detachment points of say 7 per cent and 10 per cent, meaning that for losses on the underlying collateral of less than 7 per cent they continue to pay out at par, but become worthless when losses reach 10 per cent. The pay-offs to such instruments are therefore highly sensitive to quite minor changes in expected credit conditions. In a full-information world with known probability distributions, instruments with such highly sensitive pay-offs are no more difficult to price than any others. But when incomplete information makes the future uncertain, in a Knightian sense, contracts with pay-offs that are highly sensitive to slight changes in credit conditions become increasingly risky. Moreover, innovative instruments inherently will not have a long run of performance data. Those seeking to summarise their likely performance using statistical metrics based on limited data, and drawn from very benign circumstances, have a very difficult task. Many investors in residential mortgage-backed securities (RMBS) and CDOs of ABS linked to US sub-prime mortgages have been surprised by the extent to which the performance of these instruments has fallen short of even their worst expectations. Securities with complex pay-offs have clearly been shown to be highly vulnerable to increased macroeconomic uncertainty.

Figure 2: Information Loss

Source: BIS, Committee on the Global Financial System

Second, information loss is built into the securitisation process because of the separation between the originator of the loan and the end-investor. Figure 2 illustrates how information is lost at every step in the chain of risk transfer. To some extent, holding a diversified pool of underlying loans acts as protection against a lack of information about idiosyncratic risk. But the experience of the past year has shown that diversified pools and seniority in the tranche structure may not provide adequate protection against highly correlated or ‘systemic’ risk.

Many investors had, of course, also delegated their monitoring responsibility to credit rating agencies. This offered, potentially, a very significant efficiency gain. Rather than many investors paying privately to be moderately informed – with corresponding substantial replication of investment analysis – credit rating agencies were paid to be well-informed and to make this information public. But we now know that rating agencies were also unable to overcome many of these same underlying information problems, and have been forced to make multiple downgrades to many of their ratings of structured credit products and to modify the models they use for ratings. A major problem for the market as a whole has been that once investors collectively lost trust in rating agencies, the next most informed participants in the market were a long way behind. As a result, there was a step-

change down in the level of confidence in the likely performance of these assets and a consequent system-wide increase in the risk premia required to hold such assets. With hindsight, information generation and processing was too reliant on a limited number of rating agencies, and there was too much confidence in the ability of individual rating agencies to solve the highly complex information problems underlying some securities.

Third, it is very hard to determine counterparty credit risk for state-contingent securities. In a world of full information, the state-contingent survival of counterparties would be known and nobody would accept contracts from those who could not honour them – at least not without a substantial price discount by way of compensation. But when investors cannot know the full network of exposures in the financial system, it is extremely hard to estimate where the ultimate incidence of losses from an extreme shock will occur. The failure of your counterparty's counterparty can shift you up the queue of potential losers quite quickly. Moreover, the fear of potential counterparty risk itself quickly affects the behaviour of individual firms and thus leads to a collective lowering of the appetite for risk.

These problems are potentially the most acute for what might be called tail-risk products. During the boom, tail-risk products, like deeply out-of-the-money options, seemed an easy way to make money. The protection seller could collect a steady stream of premia with the extremely unlikely prospect of having to make a very large payment. Since these sorts of contracts offer 'deep' insurance, it is important to the system as a whole that they are held by the most robust institutions. Here, the theory of risk transfer was that risk would be re-allocated to those most able to bear it. In practice, though, those most willing to take these risks have in some cases turned out to be those who understood the risks the least and thus were prepared to take them on at too low a price. This problem is extremely hard to guard against because of the difficulty in determining whether a counterparty who is insuring you against risk (or a chain of counterparties) fully understands what they have taken on and have the capacity to make good on their commitment in adverse states of the world. In recent months, banks have been forced to write down the value of contracts that they had bought from monoline insurers to guarantee the payments promised by their holdings of highly-rated CDOs linked to US sub-prime mortgages. With the likelihood of such guarantees being called upon appearing very small, the monolines wrote a large volume of such guarantees. But more recently, this prospect has become a distinct possibility, and one that threatens the viability of some of the monoline insurers, and thus their perceived ability to pay.

4.2 Incentives

These information problems are difficult enough when risk is treated as exogenous. And in a world of full information, 'nature' can be the only source of uncertainty. But in practice, when there is a lack of information and uncertainty about actions, the incentives facing individual agents become very important and can lead to endogenous risk creation within the financial system.

These incentive problems have been clearly apparent in risk transfer markets. As has been widely described elsewhere, if loan originators do not have sufficient capital at stake, they will not screen potential borrowers adequately (see, for example, BoE 2007). In the US sub-prime mortgage market, rewarding loan originators by volume of issuance was a recipe for lax credit assessment standards. But even when originators seem to have an economic stake in performance, for example by holding some of the ‘first loss’ or equity tranche of a securitisation, this is not sufficient to guarantee incentive compatibility, as it is possible to hedge the exposure to the equity tranche through a separate market transaction.

There is, though, a more subtle problem. As mentioned above, holding a diversified pool provides protection against idiosyncratic risk. But the absence of a concentrated exposure can also limit the incentive to monitor individual loans, and thus the pooling of risk may lead to a reduction in the overall level of risk screening *ex ante* and monitoring *ex post*. It was the combination of these misaligned incentives that proved such a problem in the US sub-prime mortgage market. Individual end-investors had little incentive to monitor the performance of loan originators, perhaps presuming that originators had sufficient stake in the securitisation to provide market discipline. Issuers, though, transferred much of the risk and did so comprehensively, as they needed to demonstrate that they had transferred risk irrevocably before they could get capital relief. But in the absence of adequate monitoring, originators could chase volume at the expense of lending standards.

Therefore, two elements at the heart of the benefits of financial innovation – the ability to pool and transfer risk – contributed to an endogenous increase in the level of underlying credit risk.

There is also an incentive problem arising from the separation of legal ownership from economic exposure, and while this is not so apparent at the moment, it could become more of a problem in the future. CDS transfer the risk of economic loss to the seller of protection, but the right to trigger covenants or put a firm into administration remains with the underlying asset holder. However, a protected asset holder has little incentive to monitor a company closely and trigger covenants or force it into administration at the first signs that its business may have become unsustainable. Meanwhile, the seller of protection lacks an alternative legal remedy. Companies may therefore continue to operate for longer than they have in the past once they get into trouble. In this way, the use of CDS may reduce the probability of default but increase loss given eventual default.

4.3 Liquidity

These problems of incomplete information and misaligned incentives have had a major impact on the market liquidity of innovative financial instruments.

As described above, misaligned incentives in origination and distribution allowed the provision of sub-prime mortgages to households with very little prospect of repayment and significant vulnerability to modest changes in economic circumstances. So any investor trying to estimate the distribution of likely future delinquency rates

amongst sub-prime borrowers, for example, would not only have to consider the range of macroeconomic outcomes but also how much this effect would be amplified by poor credit risk screening. This would be an extremely difficult variable to quantify. However, because of the sensitivity of complex securities to small changes in loss rates, differing judgments about the quality of risk screening could make a material difference to the value of the instrument. Early on in the current crisis, risk screening and the availability and quality of information on the performance of complex products was recognised as being significantly weaker than previously anticipated. This became obvious when, for example, investors lost confidence in the quality of credit ratings, which led to a substantial increase in the risk premium required to hold such assets. These effects made the valuation of assets extremely uncertain and contributed to the rapid evaporation of secondary market liquidity.

There is also an important and fundamental tension between the capability of financial engineering to tailor financial products to meet individual investor demand more effectively and secondary market liquidity. The more closely a specific financial instrument is matched to the risk preferences of an individual investor, the harder it is to find another investor willing to trade that exact instrument in the event of a shock to those risk preferences.

In other words, the improved matching of risk to an individual's risk profile has given rise to an increase in basis risk within the system. As an example, any investor wishing to hedge any exposure to the US sub-prime mortgage market over the past year or so would have little alternative but to trade in the standardised ABX indices (which themselves have often been relatively illiquid) rather than in the specific instrument they held. The developments over the past year have illustrated that hedges have often proved less effective than envisaged, and that there was a significant under-pricing of the inherent basis risk of many innovative structured instruments at the point of origination, given the lack of secondary market liquidity for such specific risk. Looking forward, it is quite likely that there will be greater unbundling of complex instruments into standardised components that are likely to be liquid and readily traded with low transactions costs, and bespoke elements that will command a higher risk premium given their inherent illiquidity.

4.4 Strengthening financial market infrastructure

Because of the specificity of the risk, innovative financial products are rarely exchange-traded. Non-standardised products require the services of a broker-dealer to trade. But over-the-counter (OTC) trading is vulnerable to many operational risks. In particular, investors are exposed to the default of the major broker-dealer counterparties. This was a significant concern to counterparties of Bear Stearns when it was in distress before being taken over by JPMorgan. To moderate such concerns in the future, private-sector initiatives are being developed to introduce a central clearer to the CDS market. Such initiatives are very welcome. Although the net positions of CDS dealers generally represent only a very small fraction of their gross positions – because these gross positions have grown so rapidly in recent years – inter-dealer positions can sometimes be very significant, even after

netting. A central clearer that would offset any long bilateral positions that one bank had with another with any short positions that the same bank had with a third bank, could significantly reduce counterparty risk in the CDS market. A leading proposal at present is centred on the Clearing Corporation, which is jointly owned by 11 major banks and other trading platforms.

Counterparty risk, as described above, is particularly corrosive for liquidity in financial markets. Investors become concerned not only with the soundness of their immediate counterparties but their counterparties' counterparties, and so on. When risk crystallises it can be unclear which financial institutions have been adversely affected. As a result of limited disclosure and transparency, investors may limit the supply of funds to a much broader array of counterparties than necessary. This helps to explain why all banks found it more difficult to raise funding when the deterioration in the performance of sub-prime assets became apparent, even though it would later be revealed that some banks were more exposed than others.

A further challenge is that the markets for innovative financial instruments can grow very rapidly, outstripping the capacity of back-offices to keep up with trading. Towards the end of 2005, CDS trading had run ahead of the processing of trades to the extent that the major CDS dealers, on average, had unconfirmed trades outstanding that were equivalent to a couple of weeks of trading volume. If the reference entities underlying these CDS trades had defaulted, it would not have been clear – at least for some time – who was owed money by whom. The international authorities then set the major CDS dealers targets to reduce volumes of unconfirmed trades, which subsequently fell significantly. But a backlog of unconfirmed trades did start to accumulate again during the early months of the recent financial turmoil, although this has also diminished over the past six months. Furthermore, the proportion of new CDS trades that are confirmed electronically, and hence immediately, has increased sharply from around 50 per cent when concerns were raised in 2005 to over 90 per cent at present.

It is also important that innovative financial products are documented sufficiently carefully and that their risks are accurately communicated to potential investors. The more complex the instrument, the greater the scope for misunderstandings. Investors have recently incurred significant losses on complex securities like CDOs and a number are expected to sue for mis-selling. HSH Nordbank is already suing UBS for the mis-selling of CDOs, for example, and Banca Popolare di Intra has a lawsuit against Bank of America for the same reason. Wingecarribee Shire Council (in Australia) is also suing Lehman Brothers for the mis-selling of CDOs.

4.5 System dynamics and the amplification of shocks

The frictions of incomplete information, imperfect incentives and inherent illiquidity of bespoke financial instruments may also be amplified by adverse dynamics within the financial system itself. For example, poorly-designed remuneration structures and short-term performance targets may encourage 'herding' behaviour within the financial system that raises the costs of taking a contrarian view. There

are also well-documented concerns that regulatory design pays insufficient attention to the risk of procyclicality (see Borio, Furfine and Lowe 2001; BIS 2008).

It also appears to be the case that many firms failed to take sufficient account of the likely behaviour of other firms, and thus of system properties, when designing stress tests and contingency plans. They were far too confident in their ability to exit or hedge positions in high-risk instruments, where trades were highly crowded, and were consequently under-prepared for the evaporation of market liquidity.

Moreover, there are some financial instruments (such as mortgage-backed securities where the mortgages have prepayment options) where the dynamic hedging behaviour of holders can amplify price movements, as dynamic hedging can lead to additional short hedging positions being required after a price fall. With individual institutions being small relative to the market, each individual institution may think that their new short position will have little or no impact on market prices. But collectively, the aggregate demand for new short positions is likely to drag prices down further and amplify the original shock, generating additional losses for those who were slower to update their dynamic hedging (see BoE 2005).

5. Some Lessons and Policy Responses

We are now around a year into a severe credit crisis centred on many of the complex structured instruments described earlier. An immediate behavioural response of risk managers in major financial institutions has been to pull out of these markets entirely. This has dramatically reduced primary and secondary market liquidity and increased price volatility, further reducing incentives to invest in these instruments. The short-term outlook for many of these innovative instruments is poor. And as described in Section 4, the past year has revealed that market imperfections and frictions are more potent than was previously thought. It is clear that the capacity of the financial system to deliver all of the benefits of financial innovation spelled out in Section 3 is limited. But equally, it would be wrong to jump to the opposite extreme, given that there are clearly major welfare gains from improved choice of financial products and better matching of risks.

So what are some of the lessons for financial innovation? What will the landscape look like in five to ten years' time, once the dust has settled and institutional changes can be implemented to address the frictions identified? What, if anything, can policy do to facilitate or expedite this process of adjustment?

A first observation is that it is important to distinguish between different financial products. As shown in Table 1, there has been a huge dispersion in activity in different innovative products over the past year. For example, the corporate CDS market grew by 36 per cent in the second half of 2007 and appears to be underpinned by strong demand. Other derivative and options markets have also continued to grow very rapidly. But on the other hand, new issues of corporate CDOs, collateralised loan obligations (CLO) and CDOs of ABS have stopped almost completely. Complex structured products with a high premium on information requirements and with a high bespoke element have thus fared much worse than simpler innovative instruments where there is more natural two-way trading and liquidity. Moreover, it is important

Table 1: Growth of Selected Financial Markets
Per cent

	1998:H1– 2007:H1 ^(a)	2005:H1– 2007:H1 ^(a)	2007:H1– 2007:H2	2007:H2– 2008:Q1 ^(b)
OTC derivatives (notional principal outstanding)				
FX forwards and swaps	8.1		18.8	
FX options	11.0		8.0	
Interest rate swaps	28.1		13.7	
Interest rate options	23.4		8.9	
CDS		17.2	36.0	
ABS (issuance)				
Non-agency RMBS	15.7		–67.4	–67.5
Commercial mortgage-backed securities	25.0		–40.9	–93.8
Auto loans	7.8		–32.5	–17.1
Credit cards	6.7		–9.8	19.0
Student loans	12.0		–56.9	–34.2
CDOs (issuance)				
Corporate CDOs		121.0	–46.0	–92.1
CLOs		42.5	–56.9	–74.4
CDOs of ABS		38.7	–68.2	–85.2

(a) Annual growth rate

(b) Growth of annualised issuance

Sources: BIS; Dealogic; Securities Industry and Financial Markets Association

not to lose sight of the fact that the success of some products and failure of others is a standard feature of the innovation process and of a competitive economy.

It is vital that market forces should be decisive in determining which instruments live or die. Regulators and supervisors should try to make the playing field as level as possible, and certainly be on the lookout for regulatory distortions which unduly favour the creation of particular products or limit the creation of other welfare-improving innovative instruments. But the market place should decide which products match issuer and investor desires once all risks are correctly priced.

What are some of our expectations for future financial market developments? We will put forward seven suggestions:

- First, there will be additional focus on simpler, more standardised products. For example, it would be a surprise, and probably undesirable, if mezzanine resecuritisations were to reappear. Simpler products should be easier to understand and therefore less prone to radical changes in expectations of their likely performance. Improved stability of expectations should help sustain market liquidity during periods of stress. Standardised products also economise on information requirements and therefore also improve liquidity in secondary markets.

- Second, products will be more transparent in design and content, to improve the ease of monitoring and hence lower information costs. Increased transparency should not be confused with reams of data. The issuance documentation for many securitisations often contained a barrage of statistics. For CDOs of ABS, these documents could run to thousands of pages given that the documentation for each underlying ABS could already comprise hundreds of pages. Any investor with the appetite to conduct due diligence would have found this volume of information completely indigestible. Products are likely to come with a broader range of standard expected performance statistics.
- Third, as already recommended by the Financial Stability Forum and the Committee on the Global Financial System (FSF 2008; CGFS 2008), rating agencies will supply additional information on the risk characteristics of rated securities and the sensitivity and uncertainty attached to their ratings. But there will also be increased recognition of the limitations and costs of any monitoring function for highly complex products. That, too, will support greater standardisation and transparency.
- Fourth, and relatedly, end-investors will demand more explicit rules governing acceptable collateral for securitisation and greater due diligence and risk-sharing by originators and issuers. For example, strict definitions of prime/Alt-A/sub-prime mortgages will be required based on FICO scores, loan-to-value ratios and other characteristics. Also, originators will be required to report their exposure to the securities they issue. Contracts, for example, may require issuers to declare and maintain a significant stake in securitisations to align their incentives to screen and monitor loans.
- Fifth, investment banks will continue to offer tailored products to match specific risks. But there will be much greater recognition of the illiquidity and hence cost of the bespoke component. Equilibrium liquidity premia will be higher (than they had been prior to the credit crisis). That is likely to lower demand for such products, perhaps substantially.
- Sixth, banks and other financial institutions will provide more information on their exposures as pressures to improve market disclosure and transparency continue. Already regulators are assembling best-practice accounting disclosures which should become standard.
- Seventh, greater emphasis on standardisation of products may facilitate improvements in market infrastructure. Pressure will continue for more products to be traded on exchanges rather than OTC. That should also help control counterparty and other operational risks.

6. Conclusions

Financial engineering facilitates the transformation and reshaping of risk. It thus supports the development of new products that decompose, transfer and pool risks to match the needs of users. Innovation thus delivers a broadening of financial choice that enables companies and households to improve their management of risk, with attendant gains in economic welfare.

There are, however, a number of frictions and market imperfections that lower the effectiveness of financial innovation. There may be insufficient information to gauge the risk in new financial instruments. Indeed, information can get lost when a chain of parties are involved in the creation of new financial instruments. If these parties do not retain an economic interest in the performance of the instrument, its inherent risk can grow as incentives to screen and monitor weaken. In addition, the benefits of tailoring the risk profile to meet the demands of specific investors can be offset by the poor liquidity that might apply to a bespoke component. These frictions have become much more apparent during the credit crisis of the past year, during which time primary market issuance and secondary market trading of some innovative financial instruments have fallen sharply.

Looking ahead, however, ideas are being developed to lower some of the frictions from which innovative structured credit instruments in particular have suffered during recent months. Removal of these frictions will, in some cases, necessitate recognition of additional costs, for example in the screening of information and in the provision and cost of liquidity, that were severely underplayed in the earlier boom in financial markets. Recognition of these costs will, however, strengthen the resilience of the financial system and underpin the durability of the manifold benefits from financial innovation.

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Discussion

1. Gerard Caprio¹

Messrs Jenkinson, Penalver and Vause have furnished the reader with a very good review of the benefits of financial innovation and some of the barriers to the fulfillment of the ‘complete markets’ vision of finance. In the midst of a crisis that is shaking the financial sector to its foundations, it is useful and refreshing to be reminded of what the sector is supposed to do and why innovation can play a positive role.

That said, I found myself getting impatient with a review of the ‘complete markets’ story for two reasons: first, we are enmeshed in a crisis in which markets have been operating far from this standard, and second, as there is no mention of the history of crises in finance, it is a bit limiting in a paper dedicated to ‘What Have We Learnt’ to consider lessons from the current crisis alone, as if it were an aberration. Combined with the terminology referring to the barriers to more complete markets as mere frictions (yes, the proper textbook terminology), the paper comes across as a bit unrealistic. The complete markets’ view assumes that individuals are fully rational in their choices, and yet we hear no mention of recent advances in behavioural economics and neuroeconomics, the latter showing that the emotional centres of the brain dominate in financial and risk decisions.² As a result, rationality seems less useful as a standard. Moreover, financial history, replete with numerous episodes of bubbles and crashes, suggests that this orientation, while understandable in a basic treatment as might be found in a textbook discussion, falls considerably short of what we encounter in markets. What about the rush to invest in transition countries and the subsequent Long-Term Capital Management (LTCM) crisis, the dot.com bubble, and before that the debt crisis of less developed economies, the Savings and Loan crisis of the United States, the 130 or so financial crises in developing countries in the World Bank’s database since the late 1970s, and the centuries of crises so well conveyed in Kindleberger (1996)’s *Manias, Panics, and Crashes*? I understand that central bankers might emphasise the positive and stable aspects of financial markets, and the authors do include some of the ‘warts’ associated with these markets, but in a paper intended to draw lessons, I would have expected a bit more balance.

Rather than being new or unprecedented, the ‘turmoil’ besetting industrialised country financial markets for the past year, and the focus of this Conference, has all the hallmarks of the developing country crises that marked the 1980s and 1990s: excessive risk-taking, even looting in the financial system; exorbitant compensation

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1. The author wishes to thank the Reserve Bank of Australia for the opportunity to attend and speak at their Annual Conference, ‘Lessons from the Financial Turmoil of 2007 and 2008’, and Paul Bloxham and Christopher Kent for comments on this note. The author retains full responsibility for the views expressed here.
 2. See Camerer, Loewenstein and Prelec (2005) for a discussion of what neuroeconomics offers. For a sceptical view, see Bernheim (2008).

of financial market participants relative to average incomes; extreme information asymmetries and faulty accounting and auditing, to the point that much information is suspect; collapsing asset prices; and sharp questioning of regulatory officials. In short, these were a number of the hallmarks of what was labeled as ‘crony capitalism’ during the east Asian crisis. Ironically, developing country officials have been moving in recent years to adopt industrialised country best practice, and now must be asking themselves about the appropriate standard.

To be sure, the authors do discuss some of the problems that may have caused the recent crisis, notably the loss of information that was part of the securitisation process. The explanation is accurate, clear, and nicely portrayed in Figure 2 of their paper on information loss, but deserves further elaboration. For example, how much diversification was achieved by omitting market risk – which in this case was mostly the risk, and even likelihood, that market interest rates could rise, increasing the defaults across the pool of securities? Was this incompetence or should it have been another issue taken up in their section on incentives? Rajan (2005) presciently noted several years ago the downside of financial innovation, and the authors might recognise this earlier on in their discussion: rather than being praised as a source of potential efficiency, the key downside, namely that the originate-to-distribute model would leave banks as agents rather than the principals in mortgage transactions, deserves more emphasis.

If one views crises as endemic to finance, then one might want to think in more radical terms as to what might be done to change the way in which it is regulated. The recommendations, or suggestions, in Section 5 of the paper include some predictions (for example, ‘... products will be more transparent in design and content ... end-investors will demand more explicit rules ... [e]quilibrium liquidity premia will be higher ... banks and other financial institutions will provide more information ...’). Unfortunately, it is not clear how we will get to such eventualities. Might not one have offered the same predictions after the crash of 1987, LTCM, or the Enron/WorldCom debacle? As has been seen in financial history, markets have short memories, and the debate therefore is how we might steer the system to a different outcome. For example, can the industry reform compensation on its own and develop more robust disclosure standards (including compensation itself!), or is regulatory intervention necessary?

As a model for the future, I would note that it is important to look at what works and what does not in financial regulation in practice. While certainly not immune to criticism, cross-country databases offer some lessons and a different perspective on reform. James Barth, Ross Levine and I (Barth, Caprio and Levine 2006), using a large cross-country database on bank regulation and supervision, assembled under the auspices of the World Bank, found the following in our 2006 study:

- *no* evidence that capital regulation works to improve financial development, efficiency in financial markets, financial stability, or corruption in the financial system;
- *no* evidence that supervision helps in any of these regards, and in fact some evidence that increasing supervisory power in a weak institutional setting can do harm;

- *clear* evidence that market discipline helps improve along the dimensions above except not in increasing financial stability; and
- evidence that increasing diversification – allowing banks to engage in a broader array of financial activities – and limiting moral hazard in banking are linked to more stable banking systems.

Clearly the Barth *et al* (2006) study does not constitute an evaluation of Basel II, which was not in effect during the late 1990s when the data in the study were collected.³ Still, in addition to the failure of models and rating agencies (linchpins of Pillar 1 of Basel II) these conclusions suggest that relying on capital and supervision Pillars 1 and 2 of the new Basel system is not likely to succeed. Barth *et al* suggest a new model for regulation, in which market discipline is not an afterthought, but rather plays a central role. In this model, supervisors would not be devising complex formulas for risk management (Pillar 1) or applying their judgment in regulating banks (Pillar 2), but rather would be concentrating on compelling banks to disclose information on an accurate and timely basis and handing out penalties for shortcomings in this area. In this respect, supervision would work to complement market discipline, rather than to regard market discipline as an afterthought. Moreover, there is clear evidence that a well-functioning financial system contributes to growth, and that an approach stressing market discipline supports the development of the financial sector. Requiring mandatory subordinated debt, which would confront supervisors with the markets' views on intermediaries on a timely basis, is consistent with this approach and worthy of discussion, and certainly the current crisis suggests that much more thought is needed on the extent of disclosure and how non-banks are to be regulated. With more information, large uninsured creditors might have done more to limit the scale of risk-taking prior to the recent crisis.

Although suggestions for market discipline are out of favour since the crisis started, why would one think that the current approach of increasing reliance on official supervision can be perfected? Given the resources devoted to supervision in the United States and the United Kingdom in recent years, will more resources work? In other words, rather than suggesting a *laissez-faire* approach, reform should recognise both market failure *and* government failure. Yet the latter seems far from the focus, indeed it does not appear on the radar screen of the Basel Committee on Banking Supervision. It is high time that the incentives of markets and officials receive due attention, and that the Committee returns to the drawing board. By its silence on Basel II, and by endorsing some of the recommendations of the Financial Stability Forum, the authors create the impression that modest reforms around the current regulatory model will succeed. It is more likely that finance is in for a regulatory upheaval not seen since the Depression. The current crisis, the history of crises in finance, and an examination of regulation in practice all support the utility and timeliness of such a re-examination.

3. See the World Bank website at <<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/0,,contentMDK:20345037~pagePK:64214825~piPK:64214943~theSite:PK469382,00.html>> for updates on that database ('Bank Regulation and Supervision').

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2. Paul Bide

The paper by Nigel Jenkinson, Adrian Penalver and Nicholas Vause very capably logs many features of the financial system that have contributed to the recent financial turmoil. I therefore do not want to provide a critique, but rather to discuss these issues from my own perspective: that of a financial market participant and observer.

I might commence my comments by observing that in my view, it needs to be said that, in a sense that is relevant to financial markets, *guns don't kill people, people kill people*. I think this line is relevant in a couple of ways. First, not every participant in the finance industry was engaged in the financially innovative segment of that industry and, second, not every participant that did engage 'shot' themselves. Some of the systemic and idiosyncratic issues with respect to liquidity and bank capitalisation occurred because some very old-fashioned ways of losing money were newly discovered.

I also note that the financial sector is ultimately about providing financial products and services to end-users, a lot of them retail-level borrowers and lenders. Any examination of the issues needs to incorporate the products and practices of the whole system. Moreover, it is the behavioural features of that system which determine how free will manifests itself in markets. If there has been unwanted excess in markets then by definition, people – regulators, legislators, policy-makers, bankers and financial markets professionals, and financial 'civilians' – have all been part of those excesses. For instance, with respect to the United States, the right kind of regulations, awareness and practices would have prevented the wrong sort of mortgage being offered to, and being taken by, the 'wrong' kind of borrower, which would have lessened the negative impact the US mortgage industry has had in this episode.

A key feature of this recent episode of financial turmoil has been the rapid pace of innovation and the increasing complexity of financial products. As pointed out by the authors, there has been an increasing distance between the borrower and lender, as the process of disintermediation has played out. This was exacerbated by globalisation. It is clear – with hindsight – that financial participants did not know

enough about the risks they were taking, and with whom they were taking them. The pace of innovation added to the problem as it helped to facilitate the degree to which the market could execute ‘bullish’ transactions.

Market participants, more often than not, act in highly correlated ways. It is human nature to ‘go with the flow’, and it is often very hard to stand apart from the crowd. Doing so in a long market trend can be very hard to defend. Risk capital might be taken from such ‘mavericks’, which would mean that their contrarian view stands no chance of ultimately being a successful one. Whether markets overshoot or undershoot fundamental prices can only ever be determined with certainty in hindsight. While ‘short termism’ is a culprit here, it can only be judged as right or wrong in the fullness of time. The global financial markets’ culture reflects a free-market view of the risk-reward trade-off. It is neither good nor bad – it just exists, and it needs to be taken into account and understood in that context before broad conclusions as to what is ‘right’ are made.

Nevertheless, in the recent bull market for credit and liquidity, risk ‘antenna’ were certainly not picking up the right signals and a correctly functioning free market needs to acknowledge that. Where lessons can be learnt, they should be.

We are always operating in an environment where there is a great deal of uncertainty. One important aspect of this is model uncertainty. The models that have been used to understand risk relied on assumptions as to how markets worked *mechanically*, but these did not work well in all the conditions it was assumed that they would. Some of the modelling work on default analysis and correlation between underlying assets and different trading instruments, for example, proved to be well short of the mark in stressful situations. It will be helpful to identify exactly where these models broke down, and improve these models where possible. However, it is worth remembering that models will always be incomplete and an informed view of markets needs to look at the system as a whole; something which is difficult to do with even the most sophisticated models.

Compounding the technical difficulties of the model-based approach that the structured credit, and other, markets used was a basic failure of discovery and awareness. These are not technical shortcomings but reflect the traits of people that operate in these markets. To go back to the original analogy, guns don’t work unless people pick them up and pull the trigger.

Faced with these issues, we must question whether the regulatory environment can be modified to reduce the likelihood of, and damage caused by, financial crises in the future. At the same time, when thinking about regulatory change, we must find the optimal balance between the benefits of a system which encourages financial innovation and efficient risk-sharing (which are well understood by all of the participants in this Conference) and the costs of financial crises. How can we avoid or temper the worst of what the crisis has delivered?

During the past decade the pace of financial innovation, disintermediation and globalisation was very fast. The ability for regulators and other controllers (both inside and outside financial institutions) with finite resources to keep pace with and assess the implications of all innovations and how they might interact is limited

at best and most likely not possible. They too, only truly know with the benefit of hindsight what caused problems. For this reason, I think we need to acknowledge that micro-management of specific risks using regulation in a free market system is unlikely to prevent systemic problems from arising.

Rating agencies have been given a special place in discussions regarding this episode. Looking back, it is now clear that in the lead-up to the crisis there was an over-reliance on the rating agencies. In determining what constituted an 'authorised' investment, investors took great comfort in the agencies' assessments of the likelihood of defaults. When the investors eventually saw defaults and credit/spread stress not commensurate with strong ratings, their trust in ratings diminished. This led to a sharp and sizeable loss in the appetite for structured paper. This, in turn, led to a breakdown in the asset-backed commercial paper and term structured securities markets, with adverse effects on the liquidity, capital and profits of the banking sector and funds managers. The effect on the non-banking sector funds managers (the capital markets' investor base) was significant. The disintermediation away from banks so prevalent for the previous 10–15 years (and facilitated by the capital markets developments) turned around very quickly, with most of the liquidity demands flowing straight back to the banks (a problem of reintermediation).

Most discussions regarding the agencies and their ratings are with respect to the proper 'alignment of interests', specifically, that the agencies had a bias towards favourable ratings for those who paid the fees for the ratings (and not for the investors who used the ratings). It may be appropriate for conflicts of interest within those businesses to be regulated, just as conflict issues are managed elsewhere in the system.

However, this part of the crisis can hardly be wholly sheeted home to the agencies – investors and financiers did not have to outsource their credit assessment to such a degree. The degree of outsourcing clashed with the *through the cycle* risk-reward process to which most participants would say they aspire. In theory, risk 'antenna' could have picked up these risks and limited how much outsourcing had been given to the agencies. In practice, it did not work out this way.

Other factors that may have contributed to the financial turmoil are some of the regulations themselves. In particular, I am thinking of accounting standards such as the post-International Financial Reporting Standards mark-to-market environment, the US Generally Accepted Accounting Principles and the more rigid, post-Enron, reporting environment more generally. At face value, the high standards for transparency and disclosure of the value of assets on the balance sheet should be thought of as beneficial and this should become apparent in the long run. However, when combined with illiquidity, disappearing markets and reintermediation, these changes increased the pressure on the banking system.

Hard to observe prices for illiquid securities meant 'fair value' for a security was often determined by the last observable trade on another security, or a derivative, taken as a proxy for it. Some participants, those who stood to gain from a credit crisis, had a vested interest in adding fuel to the already apparent volatility. Marking to market large parts of balance sheets across the globe (in accordance with these

methods) most certainly contributed to the crisis. I suspect that the system-wide, short-term impacts of these rules, interacting with the volatility, would only be seen as a virtuous thing by the most ardent purist. ‘Blaming’ transparency may fall into the category of ‘shooting the messenger’, and perhaps we should all relax in the knowledge that the lesson learnt will set us up well for the future. In response to that, I think we would all agree that right now, textbook logic is not very comforting.

Other things that may have had unintended consequences were associated with some of the Basel I regulations that helped to drive the development of the large ‘shadow banking’ or ‘thin capital’ sector. This contributed to what we can now see as a systemic under-pricing of liquidity. Again, on their own these regulations had merit and a legitimate place in financial innovation’s best intentions but, coupled with the scale and pace at which the shadow banking sector developed in conjunction with the structured credit market and other features of the pre-crisis period, it proved less than beneficial to the system overall, as events transpired.

Ultimately, we have to ask how much of the sort of behaviour we observed in financial markets can be modified by regulation? The global financial crisis of 2007 and 2008 (and perhaps beyond) is in some ways just the current manifestation of the longstanding but occasional problems incurred by those who borrow short and lend long.

While this crisis involves structured credit products, it is not innovation *per se* that is the cause. Uncertain asset values, high gearing ratios, large exposure concentrations to particular sectors, regions, industries and entities have been part of the banking risk management landscape for centuries.

In light of these issues, we must also ask ourselves what kind of regulation is optimal and take care not to make policy in a ‘knee-jerk fashion’, which may add to the problems rather than fix them.

At the same time, we would be remiss as an industry if we did not try to learn something from this episode and improve the landscape. I think a correct approach to this would include efforts at both the wholesale ‘financial markets’ level, as well as the retail ‘product, end-user’ level.

Fundamentally though, financial literacy and risk management is most important for all sectors of the economy, including the regulators. Ultimately, the best managers of the risk-and-reward balancing act are those that have the risk and can correctly assess it. This is our best defence.

3. General Discussion

The discussion started with comments about the extent to which the benefits of financial innovation outweighed the costs. One participant disagreed with the assumption in most standard economic analysis that risk-sharing via international financial markets enhanced social welfare and suggested that there is little empirical evidence that this occurs, particularly in the sovereign debt literature.

While textbook economic models assume there is a single equilibrium elicited by a competitive market, and that this would maximise social welfare, it was argued that in the real world there are multiple equilibria. As a result, optimal risk-sharing, which improves social welfare, is not necessarily achieved. A number of participants disagreed with the general argument, suggesting that there had been significant benefits associated with less regulated, more open, and more competitive and innovative financial markets; one participant thought that the Australian experience over the past two decades or so was an obvious case in point.

There was some discussion on the efficiency of the pricing of complex financial instruments, particularly OTC instruments. One participant suggested that some of the smaller markets, such as the ABX markets, were inefficient and thus did not price appropriately. Another participant suggested that this was partly because some of the indicators from these markets were not designed to be used for pricing risk in the way that they were currently being applied. In response to concerns about the efficiency of pricing OTC securities, it was suggested that exchange-traded securities should perhaps be preferred. It was pointed out, however, that forcing financial instruments to be traded on exchanges would not, on its own, make the instruments simpler. Rather, if instruments become simpler in the future, this may increase the likelihood that they are traded on exchanges.

The discussion moved on to the role that regulators could play in dealing with the costs and benefits associated with financial innovation. One discussant noted that a difficulty for regulators was determining which financial products were welfare-enhancing, and that recent experience with financial instrument design had been decidedly mixed. It was suggested that a lot of the financial instruments that had been created to transfer risk, and were designed to be held by pension funds, had actually ended up largely on banks' balance sheets, which could partly reflect the Basel II rules.

There was some scepticism about the paper's suggestion that the financial system of the future is likely to involve simpler financial products and that achieving this may require intervention by authorities. One participant pointed out that a lot of the discussion had been about the sell-side of the transactions (that is, the supply of financial instruments) but that the buy-side of these transactions was also important. It seems likely that during the recent episode some part of the problem had been that strong demand for high-grade securities meant there was a profitable business converting low-grade securities into high-grade ones. By way of extension, another participant argued that, unfortunately, there will always be imprudent investors willing to pay excessive prices for products they do not fully understand, and that heightened requirements regarding disclosure are likely to be of little help in this regard.

The Sub-prime Crisis: Causal Distortions and Regulatory Reform

Adrian Blundell-Wignall and Paul Atkinson¹

1. Introduction

Financial bubbles associated with leverage and the crises to which they give rise are always a consequence of distortions somewhere in the world economy. To be sure, there is usually more than one factor at work in the timing, location and size of a crisis. But the reform process will need to consider causality, if sensible principles are to be developed.

The economic consequences of the bursting of the sub-prime bubble are only in their early stages. The banking system is short of capital – both in the United States and in Europe (where people seem, perhaps wrongly, to be very sanguine about the likely fallout).

The crisis took policy-makers by surprise. In the second quarter of 2007, there was only mild concern about the risk of a financial storm.² The IMF *Global Financial Stability Report*, a good touchstone for official consensus at the time, ranked credit risk as the lowest in their Global Financial Stability Map, and wrote:

... weakness has been contained to certain portions of the subprime market (and to a lesser extent, the Alt-A market), and is not likely to pose a serious systemic threat. Stress tests conducted by investment banks show that, even under scenarios of nationwide house price declines that are historically unprecedented, most investors with exposure to subprime mortgages through securitized structures will not face losses. (IMF 2007, p 7)

The United Kingdom's Financial Services Authority (FSA) signed off on Northern Rock becoming an early Basel II 'internal ratings-based' obligor, knowing full well that this would dramatically reduce their capital, only shortly before the crisis began.

There was also a general tone amongst policy-makers of a greater willingness to rely on the private sector's own assessments of risk and capital requirements, consistent with the push towards Basel II in its sophisticated version.

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 2. Certain 'mavericks' in the official family voiced concerns, but they had been doing so for a long time in some cases, apparently 'wrongly', and did not affect the policy process in any pre-emptive way.

Notwithstanding the surprise factor in the crisis, views are divided concerning the broad paradigm in which financial policy-making is carried out. The Financial Stability Forum (FSF 2008) recommendations look to iron out various anomalies and oversights. The move to Basel II, the blueprint for which was published in June 2004, is endorsed (with some yet-to-be announced modifications). As the chairman of the Basel Committee on Banking Supervision recently pointed out, 'there is a strong consensus that the implementation of Basel II will put capital regulation on a sounder footing' (Wellink 2008). Mr Paulson, of the US Treasury, is focused on the United States, and is advocating major consolidation of the overlapping regulatory structure there.

Academic research is more critical, and points to possible major flaws in the capital regulation paradigm, not just the ineffectual Basel I system, but the evolution towards Basel II, which will be both procyclical in its current proposed form and will not systematically penalise concentration and regional risk factors, except insofar that supervisors under Pillar II choose to focus upon such concerns (see Goodhart 2007, for example). Banks, credit rating agencies and monoline insurers are ducking for cover on their past 'mistakes', but are finding a voice to argue against regulatory over-reaction.

The main risk is, with all of these cross-currents, that the US and other economies 'muddle through' again this time, and necessary reform is not put in place. Indeed, if current policy responses increase moral hazard in the banking system, then future crises may not only be likely, but possibly larger than the current one.

Understanding causality is a precondition for correct policy-making. Causality in economics usually carries the connotation of 'exogeneity': a policy distortion, a change or a shock not caused by events, but setting them in motion. Endogenous variables respond to the shock, subject to certain parameters or conditioning factors that may restrain or exacerbate outcomes – themselves often drifting and stretching over time. The reform process needs to consider the conditioning factors, and improve them. But bubbles and crises will still occur if the causal distortions are not addressed directly. Think of the analogy of a flood of running water from a badly-made and bursting dam: the gullies, rocks and branches in its way are conditioning factors that influence the speed and direction of the flow – but the excess water will always find its way around these obstacles. They only influence precisely where the inevitable damage to the landscape will occur. A bad dam is causal. The obstacles (levies etc) may moderate or exacerbate the situation, but most fundamentally we need to understand what constitutes good and bad infrastructure. So it is with liquidity, financial bubbles, crises due to excess leverage and regulation.

This paper examines the process of disintermediation that led to the current crisis, the extent to which it was an unintended consequence of capital regulation, and what the turmoil means for prospects for the financial system and how it should be regulated. The plan of the paper is as follows.

Section 2 looks at the global macroeconomic causes of the current crisis. Section 3 explores the securitisation process: the main players, trends, the nature and size of the crisis, and the case for serious regulatory reform. The Financial Stability Forum

summary of key weaknesses and recommendations is summarised in Section 4 and causal versus conditioning factors are discussed. Key elements of the Basel capital regulation framework are set out in Section 5, and Basel I is compared with the revised Basel II Framework. Problems with capital regulation under Pillar 1, the extent to which Pillars 2 and 3 might be expected to help and the problems of ‘anticipation’ affecting what banks did in respect to mortgage concentration in the run-up to Basel II are discussed in this section. Section 6 looks at the problem of regulatory competition and illustrates it with the controls placed on Fannie Mae and Freddie Mac, which in the view of this paper played a role in causing the crisis. Econometric techniques are used to illustrate the likely magnitude of the contribution of regulation to the sub-prime crisis in Section 7. To support the views in all the preceding analysis from a microeconomic perspective, the cases of Citi (Section 8) and UBS (Section 9) are looked at in some detail.³ Capital regulation in the United States is compared to the situation in Europe in Section 10. Europe is shown to be very under-capitalised compared to the United States and less able to absorb financial turmoil. A summary of the key findings of the paper is set out in Section 11 and finally some observations on the key required elements of reform are set out in Section 12.

2. The Global Liquidity Bubble

Liquidity-driven bubbles have their roots in distortions somewhere in the world economy. To think about causality it helps to look at the exogenous drivers. The starting point for the sub-prime crisis in this broad context focuses on three (inter-related) distortions:

- i. Low US interest rates (the federal funds rate was 1 per cent in 2003/04) following the tech bust, and the associated weakening in the US dollar from 2002.
- ii. Chinese industrialisation, foreign reserve accumulation and sovereign wealth fund (SWF) growth. These are associated with: high saving and current account surpluses; a strongly managed exchange rate in the face of foreign direct investment inflows, resulting in huge foreign exchange intervention; low administered energy prices that do not permit the rising oil price to have a demand-slowng effect, and result in even higher global oil prices and unprecedented revenue to oil-producing countries and their SWFs; and the recycling of Asian and OPEC current account surpluses and reserves back into western financial markets, affecting interest rates and the cost of capital (while at the same time disguising inflation pressure as a current account deficit, with cheap manufactures causing import competition, etc).
- iii. Japan’s near-zero interest rate and (low) exchange rate policy, as it tries to adjust to new competitive challenges from China and other industrialising countries. This reinforces the low global cost of capital in financial markets via carry trades.

The *ex ante* excess of saving over investment and nominal flows to which these trends gave rise resulted in price responses in financial markets to equate *ex post*

3. Citi was formerly known as Citigroup.

savings and investment. The search for yield contributed to financial bubbles and excess leverage (Blundell-Wignall 2007a, 2007b). Liquidity-driven bubbles and a global cost of capital that was too low led to excess risk-taking and asset prices getting driven out of line with fundamentals based on realistic future cash flows. Excess leverage resulted from the reduction of nominal constraints on borrowers (as lower servicing burdens supported cash flows) and because collateral values, as measured at a point in time, are directly linked to loan size.

Sensible reform of the global financial system must go hand-in-hand with wider regulatory reform if periods of financial turbulence are to be avoided (exchange rate arrangements, energy price controls, and low interest rate beggar-my-neighbour policies). Regulation cannot, and should not have to, compensate for serious macroeconomic distortions that drive rolling liquidity bubbles. At the more micro level of financial markets, it has to be asked: why did this flood of liquidity, like the water analogy above, find its way into the sub-prime market in such an extreme and damaging way, in spite of the financial regulations in place to stop it? Even more puzzling, why was it so extremely concentrated in private-label residential mortgage-backed securities (RMBS) after 2004?

3. Intermediation and Securitisation

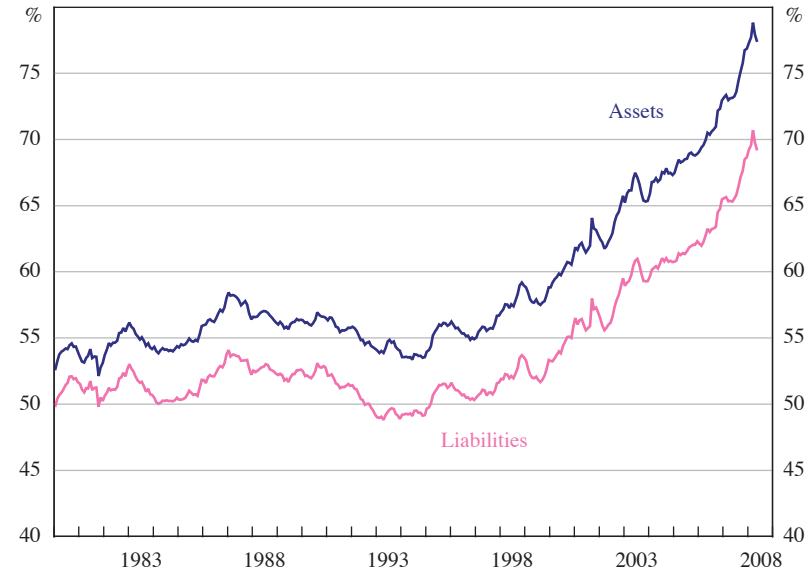
Banking is a highly-leveraged activity – it consists of borrowing from the public through deposits or via commercial paper in the wholesale markets (bank liabilities) and lending to households and businesses (bank assets). Between these two large items of the balance sheet sits a thin sliver of capital or equity (on the liabilities side of the bank balance sheet) which can disappear quickly. The gap between assets and borrowed liabilities of US commercial banks is shown in Figure 1. In the decade from January 1994 (the end of a previous major banking crisis) to January 2004, US bank assets rose from 54 per cent of GDP to 66 per cent, some 12 percentage points of GDP. From January 2004 to March 2008 (just over four years) assets rose again by 13 percentage points of GDP to a record 79 per cent of GDP.

3.1 The exponential ‘take-off’ in mortgages and securitisation of mortgages

The surge in assets post 2004 was driven almost exclusively by residential and commercial mortgages (Figure 2). From the end of 2004, the process of securitisation of mortgages from private-label issuers of asset-backed securities (ABS) also took off, but in a more extreme and almost exponential fashion – notwithstanding the fact that securitisation has been around for about two decades, and the conduits used to create leveraged demand for RMBS, for example, collateralised debt obligations (CDOs), have existed for at least a decade. Figure 3 shows RMBS alongside other securitised loans.

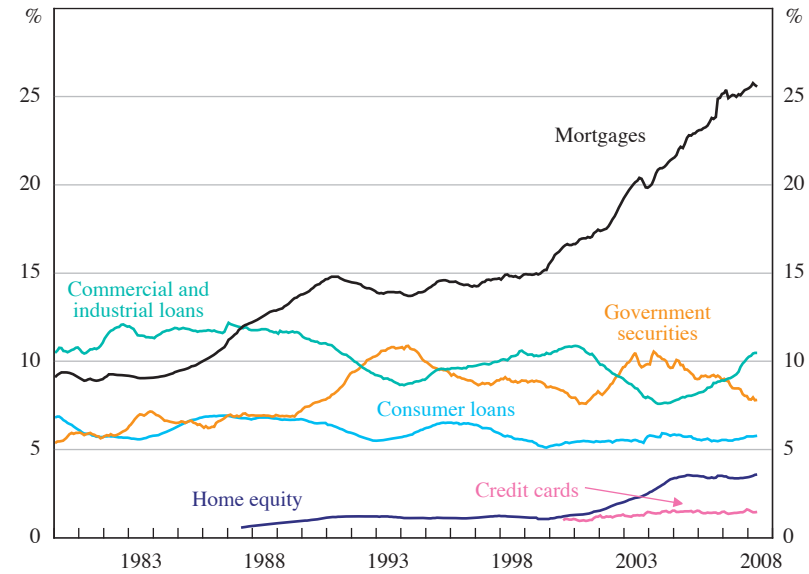
On-balance sheet bank mortgages rose by 6 percentage points of GDP from 20 per cent in January 2004 to 26 per cent in March 2008 – but RMBS from ABS issuers rose much more dramatically. RMBS and home equity loans rose from

Figure 1: US Commercial Banks – Assets and Liabilities
As a per cent of GDP



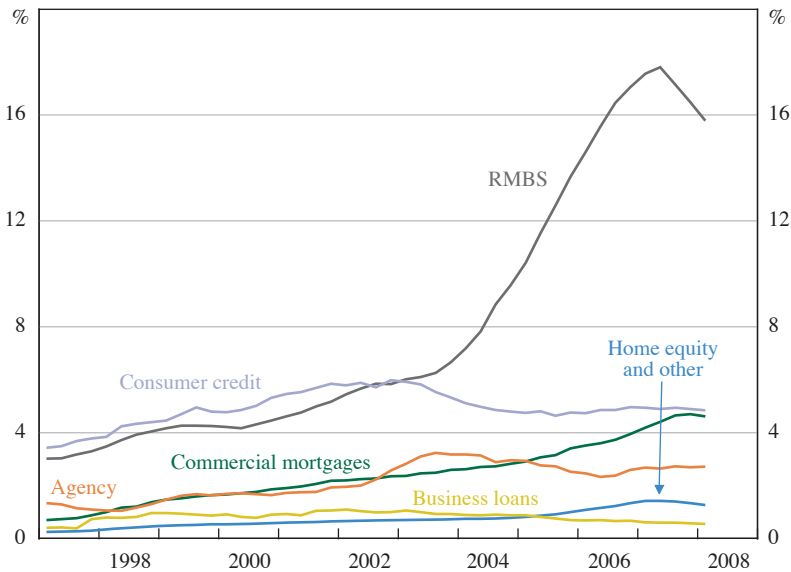
Sources: Board of Governors of the Federal Reserve System; Thomson Reuters

Figure 2: US Commercial Banks – Asset Composition
As a per cent of GDP



Sources: Board of Governors of the Federal Reserve System; Thomson Reuters

Figure 3: RMBS versus Other Securitised Assets
As a per cent of GDP



Sources: Board of Governors of the Federal Reserve System; Thomson Reuters

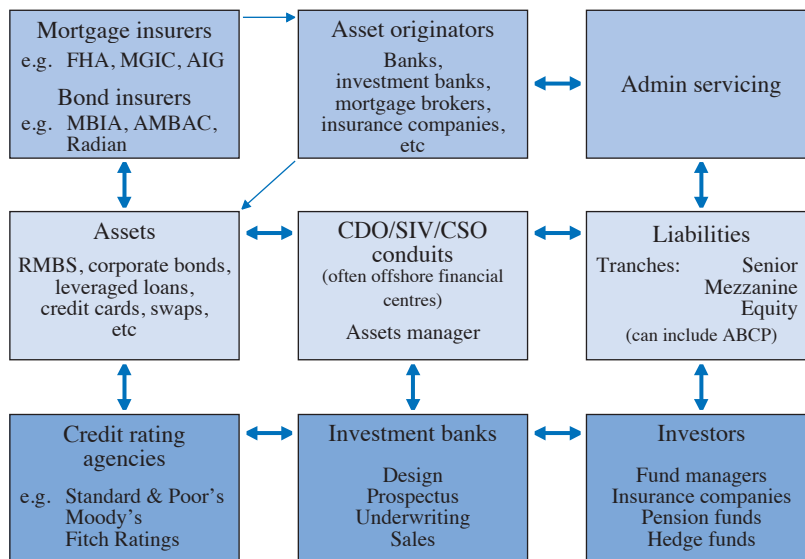
7 per cent of GDP in the March quarter 2004 to a peak of 18 per cent in the June quarter 2007, some 11 percentage points, before dropping back to 16 per cent by the end of 2007, as the crisis in these instruments began to emerge. This is quite extraordinary: from the end of 2004, RMBS accelerated more in three years than it had in the prior twenty years. This sudden and extreme move in private-label RMBS was to become the vortex of the sub-prime crisis.

Any causal understanding of the sub-prime crisis not only has to describe general contributing factors to securitisation and off-balance sheet activity; it must also explain the magnitude of change in such a compressed period of time (post 2004). What were the catalysts?

3.2 The securitisation players

The main players in the securitisation and structured products process are shown schematically in Figure 4. Loans are originated and then securitised by an ABS issuer – often the originator if it owns an investment bank. Mortgages are also bought from third-party issuers for this purpose. The pooled loans securitised in this way are sold to investors for a fee, thereby transferring the assets off the balance sheet. Pipelines of loans and ABS are then warehoused by the investment bank until securitised and sold. To ensure investor demand keeps up with the fee-driven securitisation process, the use of off-balance sheet special-purpose vehicles (SPV) using CDOs, asset-backed commercial paper (ABCP) conduits, and structured investment vehicles (SIVs) accelerated sharply from 2004. The conduits are not actual

Figure 4: Collateralised Debt Obligations – Market Structure and Main Players



Source: OECD

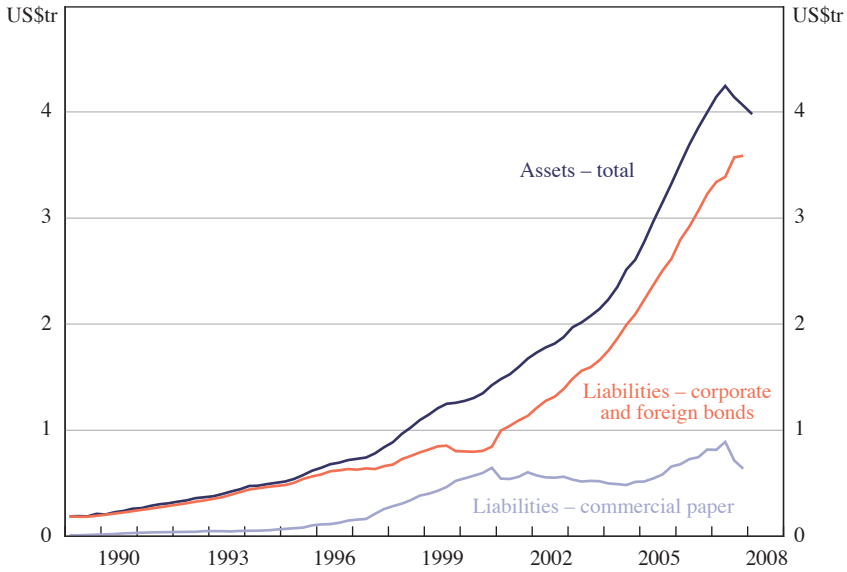
institutions in most cases, but are entities created for bookkeeping purposes – their assets and liabilities are shown schematically in the central row of Figure 4.

Other key players include the credit rating agencies (CRA) (bottom left in Figure 4) and ‘monoline’ bond insurers (top left in Figure 4). Both were critical to the securitisation process to ensure comfort levels for investors buying CDO tranches – because super senior tranches would have AAA ratings attached, and interest payments would be insured (see the discussion below). The whole edifice also requires servicing (usually a fee channel kept by the originator to continue to look after the loan servicing; top right in Figure 4) and investment banks to do the underwriting (middle of the bottom row).

Total assets of ABS issuers in the United States are shown in Figure 5, alongside the commercial paper and bond funding liabilities. Fortunately the lion’s share of the funding is of longer duration, but there was US\$890 billion in short-term commercial paper funding at its peak in June 2007, just prior to the crisis. Short-term notes are rolled over at the discretion of the holder and as the crisis unfolded such funding dried up. This meant that banks had to bring conduit assets back onto the balance sheet of the originator or extend credit (via pre-arranged credit lines). Reputational considerations sometimes came into play when arm’s-length relationships were supposed to be in effect between the bank and the conduit.

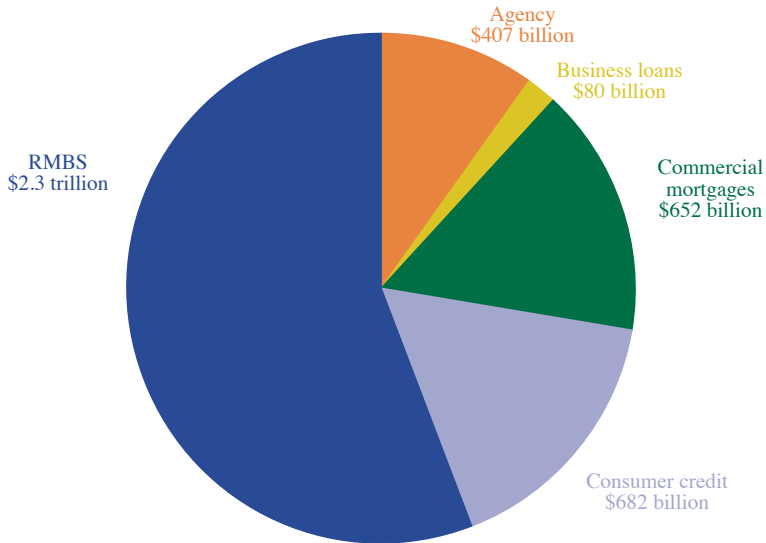
The breakdown of the assets of private ABS issuers is shown in Figure 6. Of the US\$4 trillion, more than half is accounted for by mortgages and home equity loans

Figure 5: Issuers of Asset-backed Securities – Assets and Liabilities



Sources: Board of Governors of the Federal Reserve System; Thomson Reuters

Figure 6: Issuers of Asset-backed Securities – Asset Composition 2007:Q4



Sources: Board of Governors of the Federal Reserve System; Thomson Reuters

(US\$2.3 trillion), followed by consumer and commercial real estate mortgages at nearly US\$0.7 trillion each.

3.3 Securitisation and the capital market: sub-prime and the ‘lemons’ issue

The central idea of financial intermediation is that banks produce information about borrowers that is not known to outsiders in the wider capital market; they allocate credit and then monitor borrowers. If problems arise, banks can restructure loans to try to control borrower behaviour prior to delinquency, default and foreclosure action. If they do this well, with appropriate diversification, then with lender-of-last-resort central banking and the presence of deposit insurance in most jurisdictions (and certainly in the United States), they produce securities that should be almost riskless on the liabilities side of the bank balance sheet (at least where depositors or buyers of notes are concerned). Bank loans should not be saleable to capital markets because of the information asymmetry implicit in this form of intermediation – ‘if a bank wants to sell me this loan, then there must be something wrong with it’ (Akerlof 1970). Yet this is exactly what happened in the genesis of the sub-prime crisis – indeed it happened on a scale that proved that it was quite easy to sell ‘lemons’ into the capital markets.

This transformation was made possible by the role of bond insurance and CRAs. The CRAs worked with the issuer to provide a credit default rating on the bond (an assessment of its underlying assets), essentially taking over the role of the bank in assessing credits. As the CRA would receive a fee for this task, so that its own corporate revenue would benefit, a natural moral hazard existed: top-rated securities give comfort to investors, and the more generous the rating the more sales volume would go through.

The average rating of a CDOs underlying bond pool is BBB – this is needed to make the spread profitable, as returns have to be paid to investors – the bulk of which is typically rated as AAA in the super senior tranche. This seemed sensible on the basis of past mortgage history, because the non-investment grade and equity tranches of the CDO should absorb ‘normal’ losses, and because the interest payments could be insured by the bond insurers (often referred to as ‘monolines’, such as MBIA, AMBAC, etc). The AAA ratings obviously helped to sell the super senior tranches to investors. Risks, being based on past price history, were massively mispriced in the new edifice. A 10-standard-deviation price event before the sub-prime crisis is very different to what it would be measured at today. This is a sobering point that bears on the likely effectiveness of the revised Basel II approach (discussed below). The ultimate losses are likely to be large, and bank capital is small in comparison.

3.4 The crisis

Delinquencies in sub-prime mortgages underlying RMBS and leveraged off-balance sheet conduits began to rise in early 2007, causing their prices to fall and generating losses on securities. With mark-to-market accounting rules in

place these losses had to be recognised under corporate reporting requirements. This was followed by downgrades to the securities by the CRAs, and there was a general loss of confidence. Money market investors in ABCP refused to roll over their investments in bank conduits and SIVs. By August 2007, sponsoring banks with liquidity commitments to their off-balance sheet vehicles sought to raise cash and refused to provide loans to others in the interbank markets. As these markets dried up, central banks became the major providers of ‘crisis liquidity’, and price discovery in illiquid markets became a major problem. No-one was sure what these assets were worth, and hence how large losses and potential bankruptcies might be, so the liquidity crisis extended.

The root of the problem should be thought of as a solvency crisis of underlying mortgages and of banks without sufficient capital to absorb the losses. Where banks had been warehousing mortgages and bonds in the securitisation process, this was a direct hit on their assets. Where they were forced to bring conduit assets back onto their balance sheets, at mark-to-market prices, there was a further hit. These hits led to write-offs and the destruction of bank capital. As the sliver of capital is so thin, some institutions failed, while others became desperately short of equity – if not falling below regulatory minima, certainly impacting their ‘well-capitalised’ status and credit ratings, which led to problems associated with banks’ dealings with each other. Loss of bank capital is precisely the situation that leads to ‘deleveraging’ (a ‘credit crunch’) by banks, and capital markets also dry up as a source of funds. These are the key channels that generate recessionary pressures. Mark-to-market accounting and the liquidity crisis should be thought of as exacerbating factors.

Financial institutions across the globe, most notably Europe, were drawn into the crisis for the simple reasons that: first, their global banks operate in the United States; second, about one-third of the securitised sub-prime-related products were sold to offshore investors; third, the business model used all over the globe that saw longer-run assets financed out of the commercial paper market came under extreme pressure as the liquidity crisis unfolded; and fourth, because asset price ‘beta effects’ across the globe affected the value of assets under mark-to market accounting rules (under conditions of extreme volatility, the correlations of all risky assets rise).

The worst moment of the crisis to early July has been the collapse and rescue of an investment bank, Bear Stearns, with significant amounts of public money put at risk. Overall, the likely deleveraging process that will accompany the sub-prime and related mortgage losses will cause major headwinds to the economy and will take time to work through – the risk to inflation, if liquidity policies go too far for too long, also raises the spectre of stagflation.

3.5 Size of losses, deleveraging and the economy

When a bank loses that thin sliver of capital, or goes below the regulatory minimum, it has three basic choices. It can:

- i. raise capital, which dilutes shareholdings with new equity or subordinated debt issuance. These are often taken up in a crisis situation by risk-takers such as SWFs and hedge funds;

- ii. retain earnings and cut the dividend, so that capital is built internally – but this takes more time; or
- iii. cut back on lending and reduce its balance sheet, so that the smaller capital base is consistent with asset size and capital requirements. This latter route can give rise to a ‘credit crunch’. If banks do not lend and call in loans, there will be a recession – which is exactly what happened in the 1991 crisis.

In 2007, the OECD was the first to put out a big estimate of the likely ultimate losses (after collateral is sold) on the assets underlying RMBS (mainly US sub-prime, Alt-A and jumbo loans) – US\$300 billion, based on prices derived from ABX indices.⁴ International organisations and private firms have since used these techniques to come up with some truly alarmist numbers.⁵ There is a massive problem of distortion and exaggeration when ABX prices are used to estimate losses, precisely because of the illiquidity problems discussed above. For this reason, in 2008 the OECD built a credit default model, which works independently of market prices (Blundell-Wignall 2008).⁶ This requires modelling delinquency and default rates, and combining these with scenarios about the economy (GDP, employment and, most importantly, house prices). It also requires assumptions to be made about recovery rates as property collateral is repossessed and sold. The latest number for ultimate losses calculated this way is between US\$370 billion and US\$440 billion; the mid point of around US\$400 billion is a bit up on last year, but not by too much.

A US\$400 billion loss is a significant problem because those ‘thin slivers of capital’ are so ‘thin’. Of this, about US\$90 billion is estimated to accrue as ultimate losses (not mark-to-market writedowns) to the US banks and investment banks (about US\$130 billion is in Europe and US\$180 billion is split between non-bank US investors – insurance, hedge funds and fund managers).⁷ This US\$90 billion of losses will be difficult to raise as new capital – about half this amount was raised on a recent count – but initial SWF investors were so burned they will not be back for a while. More importantly, US\$90 billion is not enough, as covering the ultimate losses only allows banks to maintain a flat balance sheet, which is exactly what happened in 1991.⁸ This would still give rise to a credit crunch, as the economy needs rising intermediation in order to grow. To grow by the average balance sheet growth rate of 7 per cent per annum would require more than double this amount of capital to be raised over a full year. If banks attempt to respond via retained earnings alone,

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- 4. The prices of credit default swaps used to insure the risk of default in the underlying sub-prime mortgages.
 - 5. The IMF (2008) has an estimate of US\$1 trillion, but this includes losses on all loans in the global economy and is not comparable to our modelling of the component of key policy interest.
 - 6. See Greenlaw *et al* (2008) for a detailed look at alternative approaches.
 - 7. Ultimate losses are what bond markets should price, that is, after foreclosure and sale of collateral. It is highly unlikely that this is happening, so ultimate losses are likely to be smaller than initial write-downs.
 - 8. Implicit here is the assumption of some regulatory forbearance if mark-to market write-downs are greater than ultimate losses. Alternatively, banks would have to raise more capital in the near term than they would ultimately need, intensifying the credit crunch.

with no lending, Blundell-Wignall (2008) estimates that it will take five quarters to adjust fully – and certainly through all of 2008.

These numbers are ‘first-round’ estimates, and there is a risk that the credit crunch could lead to a worse economic scenario than assumed.⁹ If this proves to be so, not only will the sub-prime losses be larger, but there will be a greater risk of flow-on effects to other sectors and assets (for example, with corporate defaults adversely affecting corporate bonds, equities and their investors).

3.6 Moral hazard and the urgent need for better regulation

This is the third major banking system crisis since the early 1990s, and maybe the biggest. The risk of a credit crunch is large. Europe is lagging behind the United States, but similar forces are in play. In the case of Bear Stearns, taxpayers’ money has been used to guarantee the Bear Stearns portfolio beyond a certain amount of loss – and it can by no means be assumed that this is the end of it for Bear Stearns’ or any other firm’s toxic assets. Few people realise that had the Federal Reserve and JPMorgan Chase weekend rescue not happened in mid March 2008, then during the following week at least two more investment banks would have been at grave risk: and the world would have been on the verge of an even less manageable crisis. At that point there was no choice. Similarly, the rescues of IKB and WestLB in Germany have large implications for German taxpayers, as does the nationalisation of Northern Rock for taxpayers in the UK (following the first bank run in the UK in over 140 years). In principle, taxpayers’ money should not be used in this way.

After such a crisis, with public money on the line, it is reasonable to ask: can the effectiveness of markets as an allocator of capital amongst competing ends be relied upon in the future, when the trade-off between risk and return is now so asymmetric, and banks know they are too big to fail? As the memory of this current crisis fades, we will be straight back into a process that leads to the next one.

It is like the space traveller about to pass into a black hole, asking a Martian the way back to Earth – he replies: ‘if you want to get to Earth, you shouldn’t be starting from here’. But the regulatory debate is starting from here! There needs to be some new thinking about reform of the regulatory and policy-making paradigms for the longer run.

It is important to ask: what went wrong? Is the problem one where a combination of better short-term liquidity management and some improvements to the existing rules and regulations will be sufficient to right the situation and put the global economy on an even keel for the next few decades? Or is there something more fundamentally wrong with the structure of the market and the current paradigm of thinking about how to regulate it?

9. That is, a small recession, like the 2001 period, and house price falls of no more than 4 per cent using the Office of Federal Housing Enterprise Oversight (OFHEO) measure.

4. The Financial Stability Forum (FSF) Analysis of the Crisis and the Issue of Causality

At the global level the body charged with analysing the crisis and recommending reform is the FSF. It brings together top-level central bankers and supervisors as well as representatives of international organisations (IOSCO, IMF, World Bank, OECD, etc). This group can draw on all of the resources of institutions around the world to do some thorough analysis. The FSF published their findings in April 2008. A summary of the findings is presented in Table 1 (FSF 2008). There are nine key underlying weaknesses on the left-hand side and five sets of key recommendations shown on the right-hand side of the table. The weaknesses taken together presumably should explain the sudden explosion of RMBS after 2004 – in other words, there should be causal factors amongst them. Effective reform, as argued earlier, should attach more weight to causal as opposed to conditioning factors.

Taking the nine weaknesses as hypotheses about causality, in turn:

1. Poor underwriting standards. Their presence is indisputable. But does this factor cause the explosion in RMBS and levered conduits? It is equally arguable that it is a facilitating aspect of the process and not a cause. Loan officers did not decide exogenously to become lax after 2004. Rather, the pressure to securitise may have forced them in that direction.
2. Poor risk management. Again, this is tautologically correct for the institutions that made bad loans. But did risk management models switch to inferior types from 2004? Did management deliberately or inadvertently decide to downgrade/ignore the role of risk management after 2004? It is argued below (in the discussion of UBS) that cultural factors embedded in bank strategy – and driven by revenue pressures from other causes – led some boards to give a lower weight to risk before the crisis.
3. Poor investor due diligence. Again a tautology. Investors are always likely on average to take excessive risks in a boom when liquidity is ample and interest rates are low. This is a part of the procyclicality debate. No one is going to disagree with a recommendation that they should try to do better. But will human nature, given the evidence of all past cycles, really be likely to change in an effective way in future decades? This is highly unlikely.
4. Credit rating agencies. It is indisputable that they did a poor job, as has been evidenced by the extent of recent downgrades. What is less clear is whether they independently decided to reduce the quality of their analysis after 2004. As with risk control, ratings become procyclical and that will always be a feature of the financial landscape. Of course improvements in practices are desirable, and this will at minimum avoid future exacerbating behaviour. But it is not going to remove procyclicality. What is very important, and not a focus of the FSF report, is the competitive structure of the market. The oligopoly of the ‘issuer-pays’ model, with only a few ratings firms, is likely to be a causal factor through the fee incentives and moral hazard issues that arose. If institutional investors in securities on the ‘buy side’ were required to obtain an independent

Table 1: Report of the Financial Stability Forum on Enhancing Market and Institutional Resilience

Underlying weaknesses	Solutions
<p>(1) Poor underwriting standards (high LVRs, verification income, etc) Due to risk transfer/weak oversight/the house price boom and low rates</p> <p>(2) Poor risk management practices in firms: couldn't estimate 'tail-risks' for CDOs etc (default, concentration and liquidity risk). Due to lack of history on returns and correlations.</p> <p>(3) Poor investor due diligence/excess reliance on CRAs</p> <p>(4) Poor CRA performance Due to: (i) inadequate models; (ii) lack of due diligence on collateral pools; (iii) insufficient transparency; (iv) insufficient education on meaning of a rating (credit only); (v) conflict of interest (especially where consulting and rating businesses are mixed)</p> <p>(5) Incentive distortions (i) Originate-to-distribute → no ongoing information on quality/performance of assets (ii) Basel I encourages securitisation via off-balance sheet conduits with low capital charges (iii) Compensation schemes in financial firms that encourage excess risk taking</p> <p>(6) Weaknesses in disclosure (unclear risks), especially off-balance sheet/inaccessible presentation</p> <p>(7) Thin market feedback loop with sharp price falls → losses/capital falls/more selling There is a major 'price discovery' issue with absent markets</p> <p>(8) Weaknesses in regulatory frameworks pre-Basel II (unregulated exposures and liquidity risk)</p> <p>(9) Originate-to-distribute model itself (i) Leveraged off-balance sheet conduits with liquidity risk (ii) Bank still 'connected' via credit lines/reputational issues/counterparty credit exposure (iii) Conduit liquidity assumptions wrong (iv) Warehousing pipeline assumptions wrong (large ongoing demand did not eventuate)</p>	<p>Improve transparency and valuation on CDOs etc</p> <ul style="list-style-type: none"> Require reporting of exposures: total; before and after hedging and writedowns Pillar 3 guidance on all this to be improved after consultation IASB to lead a convergence push on accounting standards on all this Focus on valuation at fair value in illiquid markets; strengthen models and procedures for marking to market on trading books IAASB and national standard setters to enhance audit guidance Regulators to look at scope for post-trade transparency (prices/volumes) <p>Change the role and use of credit ratings</p> <ul style="list-style-type: none"> Separate rating from other business and strengthen internal oversight and methods IOSCO will strengthen codes on conflict and methods Separate rating scale for structured products encouraged CRAs must insist on better data from underwriters/publish performance of ratings Investors and regulators to be less reliant on CRAs (own assessments) <p>Move quickly to a (strengthened) Basel II where capital is required for:</p> <ul style="list-style-type: none"> Market risk on trading book (stop regulatory arbitrage with banking book) Credit risk on banking book Liquidity for off-balance sheet conduits (to be proposed in 2008) <p>and where supervisors will:</p> <ul style="list-style-type: none"> Update risk parameters and study Basel II cyclicity issues in 2008 Encourage insurance supervisors (especially monolines) to follow <p>Dealing with stress in the financial system (FSF liquidity management guidelines to be released by July 2008)</p> <ul style="list-style-type: none"> Focus on risks/stress tests/intraday/cross-border <p>Improve supervisory oversight of risk management including off-balance sheet</p> <ul style="list-style-type: none"> BCBS Pillar 2 guidance in 2008–2009 to ensure capital 'buffers', including for: <ul style="list-style-type: none"> concentration risk (individuals/sectors/regions/economy); stress testing of capital cushions; guidance on managing securitisation (including warehousing/trading/syndication); issue guidance on exposure to leverage of counterparties; and encourage company boards and investors to do better <p>Improve infrastructure for OTC derivatives</p> <ul style="list-style-type: none"> Standard documentation and cash settlement obligation Automate trade to remove crisis spike backlogs Dealer/investor standards for netting, reconciliation and valuation of trades <p>Responsiveness of authorities/international bodies to be strengthened</p> <ul style="list-style-type: none"> Improve responsiveness, techniques, coordination domestically; and coordination across borders and currencies <p>For crisis management and dealing with weak banks (including deposit insurance)</p>

Source: authors' summary of FSF (2008)

appraisal, for example, then a competitive market would develop. Groups like Morningstar, with the right in-house expertise, could move into debt rating for the buy side, putting pressure on fees, reducing moral hazards and improving the rating process itself.

5. Incentive distortions via Basel I regulatory arbitrage and financial market compensation schemes – the former had been in play since 1992, and the latter for much longer. Basel weights are exogenous, and more causal in the sense of this paper. The more interesting question is what caused these mechanisms to be taken advantage of from 2004 onwards.
6. Disclosure (valuation, fair value accounting, audit, etc) – did it deteriorate in 2004, or did pre-existing weaknesses come to light as other causal factors accelerated the securitisation process? The FSF focuses on strengthening models and procedures. This has to be supported as an important ‘conditioning factor’. A more structural concern is the audit market itself. There are only four audit firms (post Arthur Anderson) who work closely with complex financial institutions, for substantial fees. This closeness is a concern and creates the risk of reduced independence. These firms are protected by a legal restriction in key jurisdictions: that only audit partners can own shares in audit firms. This precludes someone like Warren Buffett setting up competitor firms by raising funds on the stock exchange. This issue is surely worthy of further consideration in the reform process.
7. Thin markets and price discovery – this liquidity issue was exposed by the solvency crisis in mortgages and under-capitalised banks. It is unlikely to have been a cause of the crisis, but clearly exacerbated it. The FSF intends to issue guidance on dealing with leveraged counterparties (like hedge funds), warehousing and the like. What remains unclear, at least to the authors of this paper, is a set of clear definitions for those institutions that should fall with the regulatory framework for ‘safe-and-sound banking’ and those that should not.
8. Weaknesses in the regulatory structure pre-Basel II – this area is a key focus of this paper because regulatory changes were signalled and some changes did occur at the critical time that needs explanation. The ‘mid-year’ Basel II text for the revised framework for capital standards was released in June 2004 (BCBS 2004), and the Quantitative Impact Study 4 (QIS-4) Basel II simulations revealed the extremely favourable likely weighting for mortgages, and the freeing up of capital that would arise for banks. At the same time, the OFHEO, which was the Fannie Mae and Freddie Mac regulator, began a series of strong measures that constrained the balance sheets of these institutions. These events fit with the timing of the surge in RMBS issuance and are exogenous events. They have to be considered as potentially causal factors.
9. The originate-to-distribute model – was this a causal factor? Or was its increased use quite logical, flowing from the incentives set up by other distortions after 2004?

As noted in the introduction, causality carries with it some notion of exogeneity in economics and econometrics, while other factors condition the outcome of the causal influences and may even restrain them. Regulatory factors are causal in this sense and deserve special attention. Private-sector practices need to be improved, to be sure, but if regulators set distortions, then problems will follow just as surely as if a poorly made dam were to burst.

5. Capital Regulation and the Basel System¹⁰

Sudden changes in asset quality and value can quickly wipe out bank capital. Where short-term wholesale liabilities fund longer-term assets, failure to roll over short-term financial paper, or a ‘run’ on deposits, can force deleveraging and asset sales. Banking crises associated with such changes are often systemic in nature, arising from the interconnectedness of financial arrangements: banks between themselves, with derivative counterparties, and with direct links to consumption and investment spending decisions. In history, banking crises have been associated with major economic disruption and recessions. It is for this reason that policy-makers regulate the amount of capital that banks are required to hold, and require high standards of corporate governance, accounting, audit and lending practices.

Capital regulations under Basel I came into effect in December 1992 (after development and consultations since 1988). The aims were: first, to require banks to maintain enough capital to absorb losses without causing systemic problems; and second, to level the playing field internationally (to avoid competitiveness conflicts). A minimum ratio of 4 per cent for Tier 1 capital (essentially, equity less goodwill) to risk-weighted assets (RWA) and 8 per cent for Tier 1 and Tier 2 capital (certain subordinated debt etc).¹¹ The Basel I risk weights for different loans are shown on the left side of Table 2.

A ‘revised framework’ known as Basel II was released in June 2004 (see BCBS 2004) after many issues with Basel I, most notably that regulatory arbitrage was rampant (Jackson 1999). Basel I gave banks the ability to control the amount of capital they required by shifting between on-balance sheet assets with different weights, and by securitising assets and shifting them off balance sheet – a form of disintermediation. Banks quickly accumulated capital well in excess of the regulatory minimum and capital requirements, in effect, had no constraining impact on bank risk-taking. The evolution of US commercial bank capital (goodwill included) versus a calculation of the regulatory minimum under Basel I is shown in Figure 8.¹²

The revised framework is based on three pillars, which we will now examine and discuss in turn.

10. Both Basel I and II are only frameworks for capital regulation. Actual regulations reflect national modifications to Basel in different countries.

11. A third tier of capital is defined in the Market Risk Amendment to the original accord.

12. This is calculated by weighting all of the assets of the banking system by their corresponding weight shown in Table 2.

Table 2: Basel and Basel II Risk Weights and Commentary
Selected risk weights under Basel I and Basel II (Pillar 1); per cent

Security	Basel I		Basel II		Basel II advanced : internal ratings-based (IRB) for the United States		Commentary
	Simplified, standardised	Standardised based on external ratings	Average percentage change in portfolio MRC	2004-05 QIS-4 Median percentage change in portfolio MRC	2004-05 QIS-4		
Most government/central banks	0	0	0	0	0		Comes close to letting banks set their own Pillar 1 capital, with supervisory oversight. Risk weights depend on internal estimates of a loan's probability of default; loss given default; and exposure to loss. These are based on the banks' own complex risk models, relying on subjective inputs and often on unobservable (e.g. OTC illiquid securities) prices. Pillar 2 provides for supervisory oversight. With stress testing, and guidance from supervisors, banks can be made to hold capital for risks not adequately captured under Pillar 1. Pillar 3 is disclosure and market discipline which relies on some notion of market efficiency. Rational markets punish poor risk managers.
AAA to AA-		0					
A+ to A-		20					
BBB+ to BBB-		50					
BB+ to B- (& unrated)		100					
Below B-		150					
Other public (supervisors' discretion)	0-50	0	0	0	0		
Claims on MDBs	20	0	-21.9	-29.7			
Most OECD banks & securities firms	20	20	-21.9	-29.7			
AAA to AA-		<90 days					
A+ to A-		20					
BBB+ to BBB- (& unrated)		20					
BB+ to B-		50					
Below B-		150					
Residential mortgages - fully secured	50	35	-61.5	-72.7			
Retail lending (consumer)	100	75	(-6.5 to -74.3)	(-35.2 to -78.6)			
Corporate & commercial real estate	100	100	(-21.9 to -41.4)	(-29.7 to -52.5)			
AAA to AA-		20					
A+ to A-		50					
BBB+ to BB- (& unrated)		100					
Below BB-		150					

Notes: QIS-4 – Fourth Quantitative Impact Study; MRC – minimum capital requirement; MDBs – multilateral development banks
Sources: BCBS (1988, 2004, 2006); FDIC (2005); author commentary

5.1 Basel II Pillar 1

Pillar 1 defines minimum capital to buffer unexpected losses. Total RWA are based on a complex system of risk weighting that applies to ‘credit’, ‘market’ (MR) and ‘operational’ risk (OR), which are calculated separately and then added:

$$RWA = \{ 12.5(OR + MR) + 1.06 \text{SUM}[w(i)A(i)] \}$$

where: $w(i)$ is the risk weight for asset I ; and $A(i)$ is asset I ; OR and MR are directly measured and grossed up by 12.5 for 8 per cent equivalence; and credit risk is the sum of the various asset classes, each weighted by its appropriate risk weight. A scaling factor applied to this latter term, estimated to be 1.06 on the basis of QIS-3 data (but subject to change), was envisaged for the transition period, which was supposed to start for most countries in January 2008. Banks were to be able to choose between: first, a simplified approach (for smaller institutions without the capacity to model their business in risk terms) by using the fixed weights shown in Table 2; second, an approach based on external ratings (shown in Table 2); and third, an internal ratings-based (IRB) approach for sophisticated banks, driven by their own internal rating models (see Table 2).

The simplified approach is more ‘granular’ than Basel I, but retains its basic features. It is striking in light of the sub-prime crisis that the simplified approach shows the Basel Committee cutting the risk weight to mortgages by some 30 per cent (from 50 per cent to 35 per cent).

The IRB approach requires banks to specify the probability of default for each individual credit, its loss given default, and the expected exposure at default. This requires highly complex modelling and aggregation, and offers banks with the necessary expertise the possibility of deriving more risk-sensitive weights. This approach requires the approval of the bank’s supervisor.

5.2 Problems with Basel capital regulation and Pillar 1

5.2.1 Portfolio invariance and linear weights

The risk-weighting formulas in the Basel capital regulations are based on a specific mathematical model, developed by the Basel Committee, which is subject to the restriction that it be ‘portfolio invariant’; that is, the capital required to back loans should depend only on the risk of that loan, not on the portfolio to which it is added (Gordy 2003). This is convenient for additivity and application across countries. But it has an important disadvantage: it does not reflect the importance of diversification as an influence on portfolio risk. Thus the minimum capital requirements associated with any type of loan due to credit risk simply rise linearly with the holding of that asset type, regardless of the size of the exposure (that is, appropriate diversification is simply assumed). This means, in simple terms, that it does not do the most basic risk management function of penalising portfolio concentration (as might occur, for example, under a quadratic rule).

Furthermore, the problems of regulatory arbitrage under Basel I are not solved within Pillar 1 of Basel II, and the new rules may even introduce new problems. For example, the problem of moral hazard is stronger with the IRB approach, as risk inputs are subjective. Some prices are of the over-the-counter variety and are not observable, nor do they have appropriate histories for modelling purposes. Banks can manipulate inputs to reduce required capital. Sheila Bair, Chair of the FDIC, puts it this way:

... the key risk inputs that drive the advanced approaches are subjective ... unreliable and unproven ... Regulators have taken appropriate care not to micro-manage internal rating systems. But the resulting wide latitude in capital requirements could lead to inconsistency across banks. And it could lead regulators to accept capital requirements that are too low. (Bair 2007)

For these sorts of reasons, the Basel Committee envisaged that Pillar 2 would deal with risks not appropriately covered in Pillar 1.¹³

5.2.2 *Regional and sector risk factors*

For the mathematical model underlying the Basel approach (I or II), each exposure's contribution to value-at-risk (VAR) is portfolio invariant only if: (a) dependence across exposures is driven by a single systemic risk factor – a global risk factor, since it is supposed to apply to global banks operating across countries; and (b) each exposure is small (Gordy 2003). What we know of the sub-prime crisis is that it originated in the US housing market (regional sector risk in this framework) and exposures were quite large.

Of the two conditions for invariance, by far the most important is the requirement of a single risk factor that applies to all participants. Almost prophetically, Gordy says:

A single-factor model cannot capture any clustering of firm defaults due to common sensitivity to these smaller-scale components of the global business cycle. Holding fixed the state of the global economy, local events in, for example, France are permitted to contribute nothing to the default rate of French obligors. If there are indeed pockets of risk, then calibrating a single-factor model to a broadly diversified international credit index may significantly understate the capital needed to support a regional or specialized lender. (Gordy 2003, p 222)

If 'France' was replaced by 'the United States' and 'sub-prime' was mentioned as the pocket of risk, the story of the current turmoil was pretty much told in a rather technical paper four years before the crisis.

The Chair of the FDIC commented on US mortgages versus global banking risk after the US QIS-4 that showed banks reducing their weights for mortgages by up to 90 per cent, in the following way:

13. Kane (2006) points out that the whole process of negotiating Basel II in the United States has been made especially difficult due to disagreements between complex financial institutions and the various regulatory groups. In this process, the banks are always going to seek the least burdensome system where any choice is involved.

To me, one of the most troubling aspects of Basel II is that a purely historical look at mortgage data might have justified such numbers ... These kinds of results are simply unacceptable. Redefining capital requirements sharply downward in this way under the advanced approaches, risks increasing the fragility of the global banking system. (Bair 2007)

5.2.3 The procyclicality of the Basel system

The Basel system is known to be procyclical. There are many reasons for this. The most basic reason is that judgments tend to underestimate risks in good times and overestimate them in bad times. More specific factors include:¹⁴

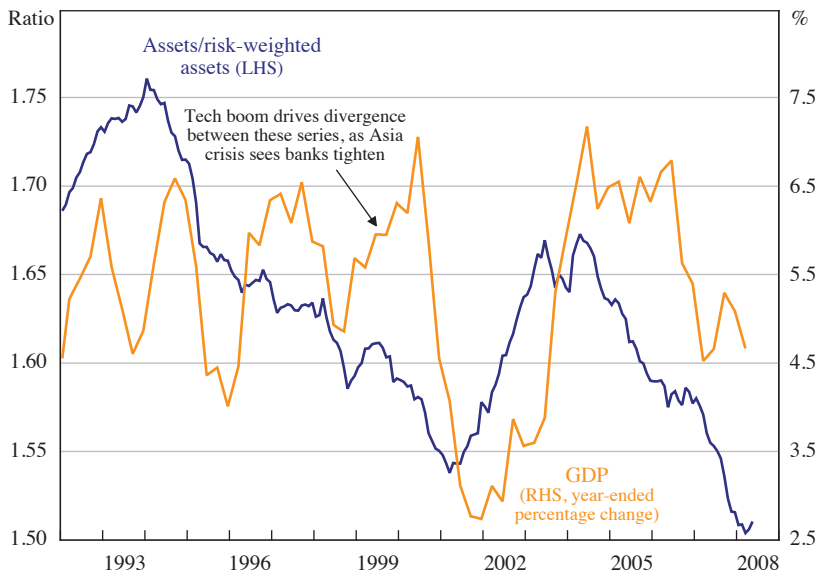
- i. leverage ratios that depend on current market values (and are therefore high in good times and low in bad times). If asset values do not accurately reflect future cash flows, procyclicality results. This, of course, would be amplified by the distortions of excess liquidity and low interest rates discussed above;
- ii. banks' risk measurements tend to be point-in-time and not holistic measures over the whole cycle (see Section 8 below, for discussion of this point relating to UBS);
- iii. counterparty credit policies are easy in good times and tough in bad; and
- iv. profit recognition and compensation schemes encourage short-term risk-taking, but are not adjusted for risk over the business cycle.

Capital regulation under Basel does nothing to counter this procyclicality. Banks can control their RWA via regulatory arbitrage and by varying bank capital more directly via dividend and share buyback policies (high dividends and buybacks in the good times and vice versa).

Figure 7 shows US GDP growth and a constructed series of aggregate total assets as a ratio to RWA, over the Basel era. This simple variable leads the broad trend in the nominal business cycle.

The IRB approach of the revised framework actually institutionalises this procyclicality by making banks themselves responsible for estimating probability of default, loss given default and exposure at default, which are all a function of the cycle, and are led by the stock market, asset values and other financial variables. Private bankers cannot predict future asset prices and future volatility events. The simplified system would change nothing, relative to Basel I, and the external ratings-based approach uses credit ratings, which are notoriously procyclical.

14. See Bernanke, Gertler and Gilchrist (1999).

Figure 7: US GDP and Total Assets/Risk-weighted Assets

Sources: OECD; Thomson Reuters

5.3 Basel II Pillars 2 and 3

Pillar 2 relates to the supervisory review process. With stress testing and guidance from supervisors, banks can be made to hold capital for risks not appropriately captured under Pillar 1. Building buffers in this way requires supervisors to be forward-looking, that is, to keep up with changes in market structure, practices and complexity. This is inherently difficult. Supervisors are even less likely to be able to predict future asset prices and volatility than private bankers. Furthermore, supervisors have smaller staff (per regulated entity) and are less well paid. If supervisory practices lag (as in the sub-prime crisis) the policy-makers will be ineffective in countering defects in Pillar 1.¹⁵ Pillar 2 is not likely to be effective in a forward-looking way.

The Chair of the FDIC is highly sceptical about the ability of supervisors to play the role asked of them in compensating for all the deficiencies in the basic capital rules:

In response to such criticisms, many argue that supervisory diligence under Pillar 2 will somehow protect against inadequate capital under Pillar 1. More specifically, they say required stress testing by banks will take care of any shortages under Pillar 1 ... Despite the best of intentions ... banks and supervisors may be ill-equipped to mitigate deficiencies in the advanced approaches. If the basic capital standards are unreliable, how can we have confidence that supervisory add-ons will be sufficient or consistent? (Bair 2007)

15. A former very senior member of the Basel Committee mentioned several times in discussions that banks are very effective at driving their agenda and influencing outcomes.

In this respect it is worth noting (see below) that the United Kingdom's FSA, which is one of the best staffed and most sophisticated of supervisors, signed off on Northern Rock to be one of the first banks to go to the Basel II IRB approach, understanding fully that this would reduce their capital massively, immediately prior to the sub-prime crisis.

Pillar 3 relies on disclosure and market discipline to help enforce sound risk management practices by punishing bad banks. Underlying this is an efficient markets notion that markets will act in a fully rational way.

At the level of markets, the bubble at the root of the sub-prime crisis, and those before it, suggest the systematic absence of informational efficiency. The whole procyclicality debate concerning the Basel system is premised on the idea that asset prices do not reflect future cash flows accurately.

At the reporting level there is room for even greater scepticism. In March 2008, KPMG conducted research amongst 1 080 audit committee members of public companies (150 from the United Kingdom and the rest globally). Of the respondents, 46 per cent were satisfied that their company had an effective process to identify the potentially significant business risks facing the company; and only 38 per cent were very satisfied with the risk reports they received from management (KPMG's Audit Committee Institute 2008).

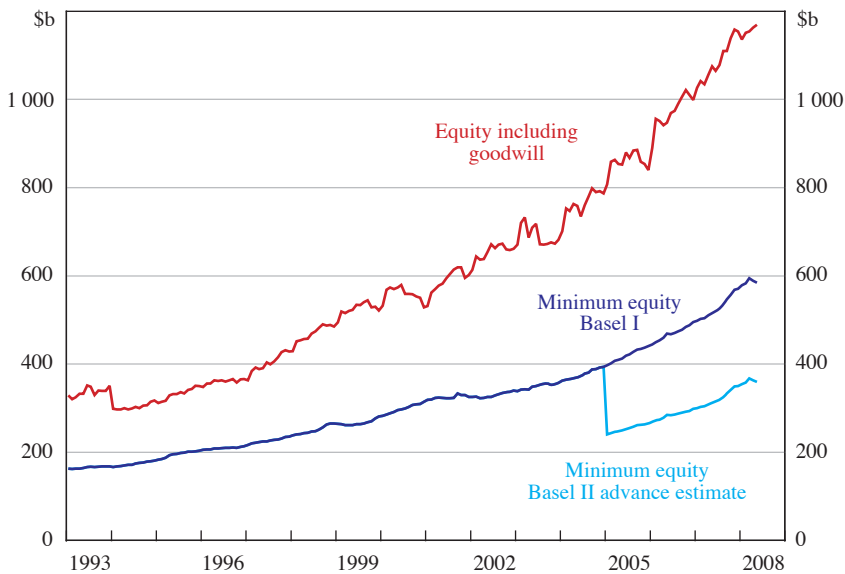
The reality is that even insiders have difficulty in measuring and reporting risk to themselves. For banking, in a mark-to-market reporting world (particularly in a universal bank that incorporates an investment bank alongside a commercial bank), risk management and reporting systems are extremely complex and require enormous resources. The ability of supervisors to follow any of this in anything other than a superficial way and to act pre-emptively is a daunting task.

5.4 The sub-prime crisis and the role of regulation

The revised framework was published in June 2004, after years of consultations and negotiations with financial institutions. In 2004 the QIS-4 was conducted in a number of countries to see how risk weights would change in practice. These studies were completed by the start of 2005. The results were surprising, and some of the average and median changes in minimum regulatory capital are shown in Table 2 for the United States. Of telling importance, for the purposes of this paper, is that the average minimum risk weight for fully-secured mortgages would fall by 61.5 per cent and the median weight by 72.7 per cent (for some individual institutions the fall was closer to 90 per cent).

As a simple illustration, the Basel II advance estimate line in Figure 8 shows the implied changes to the minimum regulatory capital where the 'average' percentage changes from the QIS-4 results are applied to the Basel I weights (using the more granular categories of Basel II) in the US commercial banking system. By the end of 2007, just prior to the supposed introduction of the revised framework, this would amount to a reduction in minimum regulatory capital of around

Figure 8: US Commercial Bank Equity, Basel I Minimum Capital, Basel II Advance Estimate



Sources: Board of Governors of the Federal Reserve System; OECD

US\$220 billion. Of course supervisors in many jurisdictions recognised this effect and provided for various transition arrangements to avoid such an immediate large drop – the argument here, however, is that banks would nevertheless anticipate the freeing-up of capital and take advantage of changing weights to optimise their future position.

From 2005 to 2007, a frequent theme in broking research notes was the question of what banks would do with the excess capital to which the revised framework would give rise. Banks could either expand their portfolios and take more risk, or return the money to shareholders via dividends and buybacks. Banks could not assume with certainty what the final risk weights would be, or the overall fall in total capital that might be permitted by supervisors, particularly during the first few years of transition. The United States, for example, flagged in September 2005 that there would be a three-year transition period with: no cuts in minimum capital in 2008, a floor of 95 per cent in 2009, falling to 90 per cent in 2010 and 85 per cent in 2011, before a possible full removal thereafter. Nevertheless, bank strategy would inevitably have to take into account the changes that had been clarified, and the extremely favourable cut in the risk weights that would in any case apply to mortgages.¹⁶

16. See 'Banking Agencies Announce Revised Plan for Implementation of Basel II Framework', joint press release of Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation, Office of the Comptroller of the Currency, and Office of Thrift Supervision, PR-98-2005, 30 September 2005.

5.5 Off-balance sheet treatment

Under Basel II, off-balance sheet exposures are converted to balance sheet equivalents by ‘credit conversion factors’ (CCF) which vary depending on the type of exposure (as with Pillar 1 weights). Exposures unconditionally cancellable by the bank without prior notice carry a CCF of 0, while others range up to 100 per cent. Risk weights are applied to the converted amounts.

Under the standardised approach, structured products are treated like corporate exposures as long as they carry an investment grade rating of BBB- or above. The better end of the junk ratings carry a 350 per cent risk weight and exposures that rate B+ or below and unrated securitisations must be fully deducted from capital. Where banks use the IRB approach, the risk weights depend on external ratings, with weights ranging from as low as 7 per cent to very high weights and, in the limit, are full deductibility from capital. Originating banks can exclude certain securitised product exposures where risk is fully transferred – but otherwise they generally require a CCF (usually 100 per cent). This is undoubtedly the most positive and important aspect of the revised framework.

Given that Basel II would deal explicitly with off-balance sheet exposures in this way, and that the time line for its introduction was clear, a rational financial organisation would not take advantage of the anomalies under Basel I by rapidly growing its off-balance sheet exposures, only to find that it had to deleverage massively or to raise capital as Basel II came into force – unless, of course, Basel II was to free up capital anyway, and off-balance sheet exposure could be concentrated in products with weights much lower than Basel I. This, of course, was exactly the situation that banks became aware of by 2005, and fits with the explosion of private-label RMBS at that time. Basel II implied:

- i. mortgages risk weights would be cut to 35 per cent under the simplified system, and much less than 35 per cent under the IRB approach, encouraging the expansion of on-balance sheet mortgages from 2004 onwards (see Figure 2);
- ii. increased scope for banks originating securitisations to reduce their exposures, or exclude them altogether, as well as the low risk weights (7 per cent to 35 per cent under IRB) for senior tranches rated BBB+ or above; and
- iii. banks would be fully encouraged to arbitrage differences in risk weights by shifting to real estate and securitised assets due to the additive nature of required capital without penalty for concentration – other than Pillar 2 requirements being imposed after the fact (see the RMBS acceleration after 2004 in Figure 3).¹⁷

It would be very naïve to believe that banks did not begin to incorporate these changes into their growth strategies. The following quote from a senior investment banker not wishing to be named, sums up the situation:

17. Under Basel I, credit lines to off-balance sheet identities required capital to be held for credits of duration of one year or more. In effect, this required no capital at all, as credit lines could simply be structured to be 364-day loans or contingent credit lines.

We started looking at the implications of Basel II from the day it was published back in 2004. Changes like these have huge implications for our business, so you can't just leave it to one side until the system is up and running. Internal seminars and meetings began even before the 2004 publication. We have been looking at this and adopting anticipatory strategies for at least four or five years. What you have to understand about complex regulations that affect our business is that we work intensively to minimise the impact they have on our bottom line. It is exactly the same as with taxation. The more complex the structure the more scope there is for finding ways around it! It amazes me that regulators asked us to set our capital regulation weights, given the way the incentives are. Of course our managers want to participate in the process, for all the obvious reasons. But good luck to any supervisors who want to find out what is going on inside businesses – that is difficult for insiders to know fully and impossible for outsiders. In our country the supervisors are thought of as excellent on a global comparison, and we think they are very smart. It is just that the scope to choose how you report and measure things is so huge. Our internal processes and resources are enormous, and we work only on our own bank. The supervisors can never match this with the best will in the world.

5.6 Northern Rock and the 'anticipating Basel II' factor

Northern Rock is another good on-the-record example of the anticipation of Basel II affecting the structure of the portfolio. They were one of the first banks to get up and running under the Basel II IRB approach. The collapse of Northern Rock was preceded by a few years of aggressive expansion (with assets rising at a rate of over 25 per cent per annum) funded by borrowing heavily in wholesale markets (requiring rollovers and refinancing). They also concentrated their assets in mortgage products (75 per cent of assets) which reduced their capital requirement as they progressed.

Here is the response of the CEO in the UK Treasury Committee Evidence:¹⁸

Mr Fallon: Mr Applegarth, why was it decided a month after the first profits warning, as late as the end of July, to increase the dividend at the expense of the balance sheet?

Mr Applegarth: Because we had just completed our Basel II two and a half year process and under that, and in consultation with the FSA, it meant that we had surplus capital and therefore that could be repatriated to shareholders through increasing the dividend.

In this two-and-a-half year preparation period, the balance sheet of Northern Rock grew rapidly (in the year to June 2007 by a very fast 28.3 per cent) using funds from the wholesale market. It is implicit here that the well-resourced FSA became critical of Northern Rock only after the crisis; they had approved the Basel II IRB approach for Northern Rock in June 2007, knowing full well that it would reduce their required capital.

By June 2007, just as the crisis was to break and liquidity was to dry up, Northern Rock had total assets of £113 billion and shareholders equity of £2.2 billion. Their RWA under Basel II was a mere £19 billion (16.7 per cent of total assets), compared to £34 billion under Basel I (30 per cent of assets). Under Basel II they had Tier 1

18. House of Commons Treasury Committee (2008), Ev 48.

capital of a healthy 11.3 per cent of RWA, but only 2 per cent of total assets. When the crisis started, and liquidity dried up, they suffered the first run on a British bank since 1866, and their regulatory capital was less than 10 per cent of the £23 billion that the authorities used to support it.

The mechanisms involved in preparing for Basel II and concentrating in mortgages played a key role in some of the banks that suffered huge losses. The Basel II transition was a necessary if not sufficient condition to explain the sudden nature of the acceleration of RMBS after 2004.

In the United States a second factor, or catalyst, also played a role and curiously enough was also a result of actions within the complex US regulatory structure.

6. The Regulation of Fannie and Freddie (The Dominant RMBS Enterprises)

The main regulatory players in US banking are the: Board of Governors of the Federal Reserve (for federally-chartered banks), Federal Deposit Insurance Corporation (FDIC, deposit insurance banks and thrifts), Office of the Comptroller of the Currency (national and foreign bank branch regulation and supervision), and Office of Thrift Supervision. Another important regulator which deals with the largest mortgage players, Fannie Mae (Federal National Mortgage Association) and Freddie Mac (Federal Home Loan Mortgage Corporation) is the Office of Federal Housing Enterprise Oversight (OFHEO).

The complex and overlapping regulatory structure in the United States is another key part of the puzzle for the behaviour of RMBS post 2004. Two specific factors were at play.

First, from early 2004 OFHEO imposed an ongoing requirement on each enterprise to maintain a capital level at least 30 per cent above the statutory minimum requirement. This was implemented because of the financial and operational uncertainties regarding Fannie Mae and Freddie Mac's past problems, which had been associated with operational control and audited financial statements. When capital has to be raised like this, deleveraging mechanisms lead to balance sheet contraction and constraint.

Second, balance sheet caps were subsequently imposed (post the capital-induced deleveraging effect). For Fannie Mae the cap was the end of the 2005 balance sheet level, with any increase above this to be approved by the OFHEO. For Freddie Mac, the cap was set at $\frac{1}{2}$ per cent per quarter growth above the mid-2006 level. These were to remain in place until the Generally Accepted Accounting Principles (GAAP) audit issues were solved. Removal occurred on 1 March 2008 (partly to help alleviate pressures from the sub-prime crisis).

Fannie Mae and Freddie Mac were dominant in the mortgage securitisation business in large measure because they benefited from an implicit government guarantee and insurance. After the Savings and Loan (S&L) crisis, Fannie Mae and Freddie Mac expanded their balance sheets rapidly, filling the gap left by the

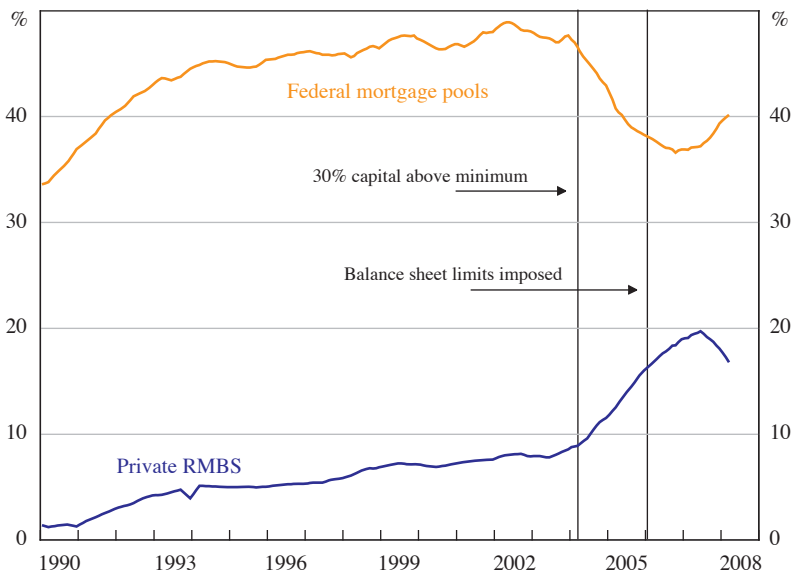
S&L associations that were shut down. Private-label securitisation also proceeded, but at a much slower pace. Banks and mortgage lenders, however, sell mortgages to Fannie Mae and Freddie Mac, and this was a significant revenue generator. When the constraints were imposed, this did two things:

- i. the potential for a large *revenue gap* opened up, with no sales to Fannie Mae and Freddie Mac, hurting bank share prices if it was not filled; and
- ii. it caused the contraction and subsequent ‘hobbling’ of the major players in securitised mortgages, which had previously had the unfair advantage of competing with perceived government guarantees. This had the effect of opening a new market for banks, helping them to move more quickly into the RMBS business, which they had always thought should have been theirs in the first place.

For an analogy, think of a patchwork balloon. If you apply inflexible strips to it, then the hot air just forces its way into the flexible parts. At the micro level, bonus remuneration and the profit motive set in train incentives to focus hard on the new growth areas. As there were no government guaranteed competitors, and the flexible conditioning factors like credit ratings, bond insurance, lending standards, corporate governance, risk control, etc could adjust, RMBS exploded (encouraged by the prospect of even more favourable weights for mortgages under Basel II).

Figure 9 shows Federal mortgage pools as a share of total mortgages, with the periods of regulatory activity shown by the vertical lines, alongside the private-label RMBS as a share of total mortgages. The inverse pattern is clear.

Figure 9: Federal Mortgage Pools versus RMBS
As a per cent of total mortgages



Sources: Board of Governors of the Federal Reserve System; OECD; Thomson Reuters

7. An Illustrative Econometric Analysis of RMBS Structural Change: Basel and OFHEO

Table 3 sets out an econometric analysis of the various influences on private-label RMBS based on a simple co-integration model, where major structural change is expected as a consequence of changes in Basel I rules and the OFHEO constraints imposed on Fannie and Freddie.

In the model's simplest form, mortgage securitisation is related to GDP, the spread between the mortgage rate and money market rates (the federal funds rate) – which is a proxy for the profit margin to be split between the various players – the level of the mortgage rate as a nominal demand constraint on the mortgage borrower, excess capital over the Basel I minimum, and the rate of growth of house prices as a speculative demand variable. A dummy variable is included for the massive disruption caused by the S&L crisis of the early 1990s (calculated as the dollar value of write-offs of the assets of S&L associations that were formally closed down between January 1989 and December 1993, scaled by total assets of the banking system, and zero elsewhere).

The monthly model is first estimated for the period 1990–2003, prior to the structural change. The model has the expected signs and appears to be co-integrated (see the bottom rows of Table 3). Over the full sample, through the period of structural change to 2007, the model breaks down (with wrong-signed coefficients on house prices and an implausible jump in the Basel I excess capital variable). The Durban-Watson statistic of 0.06 and the wrong sign and insignificance for the restricted error correction coefficient both indicate that the first model is not co-integrated over the full sample period. Including a simple dummy variable for the Fannie and Freddie balance sheet constraints period (Table 3) has the expected effect on the coefficient; it is positive and highly significant. All the correct signs for the other coefficients are restored, and the model again becomes consistent with weak co-integration. If structural change is allowed to shift the Basel I coefficients in the direction of the QIS-4 changes (greatly favouring mortgages and reducing expected required capital) from the beginning of 2005 (refer to Table 2 and Figure 8), then most of the old pre-structural change coefficients are restored to be similar to their old values. The dummy variable for Fannie Mae and Freddie Mac and the redefined excess capital (Basel I prior to 2005 and QIS-4 adjusted after) are both highly significant. The model is again consistent with strong co-integration.

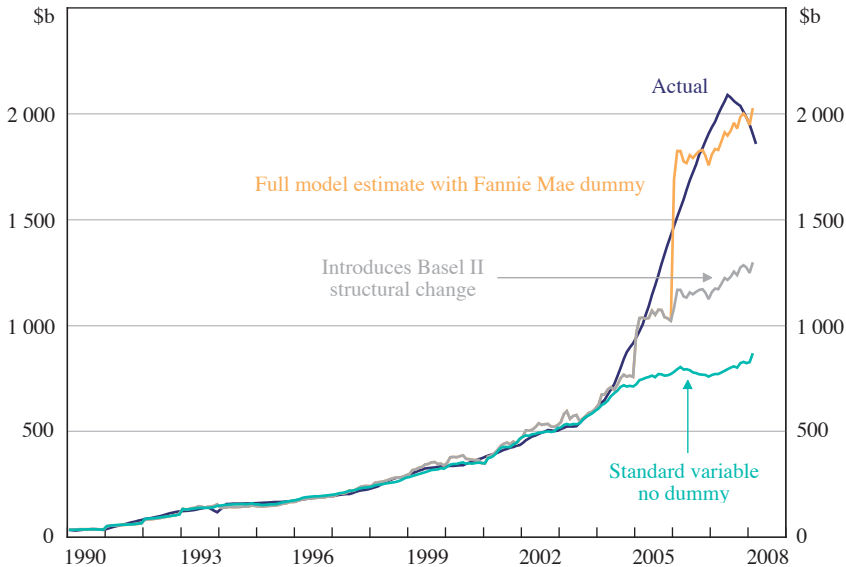
Figure 10 sets out the results of the econometric dissection of the various influences on private-label RMBS.

In February 2008, off-balance sheet private-label RMBS totals around \$US2 trillion. Of this, about US\$0.8 trillion is explained by the standard variables from the old model prior to 2004 (GDP, the interest rate terms, house price inflation and excess Basel I capital). Allowing for the Basel I coefficients to change following QIS-4, and assuming this leads to anticipatory behaviour as discussed earlier (for example, Northern Rock etc), adds US\$0.5 trillion, taking the total to US\$1.25 trillion. The rest, some US\$0.8 trillion, is estimated to have been due to the regulations placed on the balance sheets of Fannie Mae and Freddie Mac.

Table 3: RMBS (Monthly) Model and Major Regulatory Structural Change

Dependant variable is the log of RMBS	1990–2003		1990–2007			
	Coeff	t-value	Coeff	t-value		
Constant <i>c</i>	-16.94	-27.62	-18.47	-23.24	-18.26	-27.82
Log GDP	2.46	35.92	2.65	31.18	2.58	37.16
Fixed mortgage rate	-0.024	-2.55	-0.027	-1.21	-0.044	-1.75
Spread to federal funds rate	0.046	9.91	-0.014	-1.38	0.032	5.07
12-months-ended house price inflation	1.81	3.09	-2.45	-3.92	2.21	2.87
S&L crisis dummy 1989–1993	-0.24	-22.81	-0.079	-3.89	-0.184	-15.11
Basel I excess capital/total assets	2.65	2.32	14.01	5.37	4.58	na
Basel II adjusted excess capital/total assets	na	na	na	na	na	10.91
Fannie/Freddie balance sheet constraint dummy	na	na	na	na	0.675	16.02
Durban-Watson statistic		0.37		0.06		0.36
Restricted error correlation test for co-integration	-0.096	-3.87	0.011	0.99	-0.022	-1.77
						-2.58

Source: OECD

Figure 10: Model-based Contributions to the RMBS Explosion

Source: OECD

8. Citi: Illustrations of Capital Regulation and Off-balance Sheet Activity

Too often macroeconomic policy-makers focus on broad aggregates and analyses including econometrics that may or may not be consistent with *firm-specific* developments. Two institutions with the highest profile write-offs in the sub-prime crisis are Citi and UBS. Both combine investment and commercial banking. This section looks at developments in Citi in light of the above aggregate analysis. Table 4 shows Citi's balance sheet and capital management and Table 5 summarises its use of securitisation vehicles, most of whose assets are off-balance sheet. These are used to answer some key questions.

- i. Is there evidence of capital arbitrage and absence of constraints on the Citi balance sheet? From the beginning of 2003 to June 2007 (just before the crisis), after distribution of US\$39 billion in cash dividends, gross additions to equity in the form of retained earnings and new stock issues amounted to US\$54 billion (Table 4). At the same time Citi returned US\$23 billion to shareholders with share buybacks, for a net addition to equity from these sources of US\$30 billion. This is approximately equal to the increase in Tier 1 capital, which rose by 57 per cent. Notwithstanding the large return of cash to shareholders, total assets on the balance sheet more than doubled (Table 4), implying only 2.7 per cent equity backing for the total asset increase of US\$1.1 trillion, as excess regulatory capital was absorbed. This understates the degree of evident comfort in terms of capital adequacy, because the analysis up to this point ignores off-balance sheet transactions.

Table 5: Citi Off-balance Sheet Activity
Securitisation and special-purpose entities, US\$ billion

	2002	2003	2004	2005	2006	2007
Balance sheet (end Dec)						
Assets in consolidated VIEs ^(a)		36.9	35.6	50.4	42.1	121.8
Assets in unconsolidated VIEs (<i>significant involvement</i>)		116.6	135.8	191.4	388.3	356.3
Sub-prime in securities and banking						37.3
<i>of which</i> – CDOs of ABS						29.3
– direct exposure						8.0
Maximum loss exposure to unconsolidated VIEs		50.0	78.0	91.0	109.0	
<i>As reported and revised in 2007 financials</i>					147.9	152.2
<i>of which</i> – funded						38.5
– unfunded						113.7
Assets in QSPEs: all involvement ^(a)		653.9	971.9	1 203.5	1 505.7	
<i>QSPEs (Citi acting as 'principal')</i>					541.2	766.0
<i>of which</i> – retained interests in mortgages					8.8	18.4
– other retained interests					10.4	13.9
– transferred mortgage exposures					394.4	582.5
– other transferred interests					127.6	151.2
Cash flows during the year						
Proceeds from new mortgage securitisation	40.1	70.9	66.4	85.2	99.4	147.3
<i>of which</i> – US consumer				58.9	67.5	107.2
– markets and banking				26.3	31.9	40.1
Commissions and fees		15.7	16.0	16.9	19.2	21.1
<i>of which</i> – investment banking		3.5	3.5	3.5	4.1	5.2
– credit cards and bank cards		4.2	4.5	4.5	5.2	5.1
– Smith Barney (GWM)		2.1	2.2	2.3	3.0	3.3
– markets and banking trading-related		1.6	2.0	2.3	2.5	2.7
Principal transactions	4.5	4.9	3.7	6.7	8.0	-12.1
<i>of which markets and banking</i>				5.6	6.9	-15.0
<i>of which</i> – fixed income	2.3	2.4	1.8	3.9	5.6	4.1
– credit products ^(b)	0.0	-0.1	0.1	0.0	-0.8	-21.8
– equities	0.2	0.2	-0.3	0.3	0.9	0.8
– foreign exchange	1.9	2.2	1.8	0.6	0.7	1.2
– commodities	0.1	0.1	0.4	0.8	0.5	0.7

(a) Securitisation vehicles used by Citi are generally accounted for as 'variable interest entities' (VIEs) or 'qualifying special purpose entities' (QSPEs). VIEs are vehicles that either must supplement their equity with additional subordinated financial support, or whose equity investors lack the characteristics of a controlling financial interest. Under FIN 46-R the primary beneficiary of a VIE is obliged to consolidate it. Maximum exposure to loss where a 'significant involvement' in an unconsolidated VIE exists must also be disclosed. QSPEs are passive entities generally exempt from consolidation by the transferor, here Citi.

(b) Includes structured products, including sub-prime related.

Source: Citi, Form 10-K filings with Securities and Exchange Commission

- ii. Was the off-balance sheet activity substantial? Yes. Citi's securitisation activities are largely carried out using two types of special purpose entities (SPEs), most of whose assets are *not consolidated* onto Citi's balance sheet. Variable interest entities (VIEs, see Table 5 for a definition) amounted to US\$478 billion at the end of 2007, US\$356 billion of which was not consolidated. This figure, which represents a tripling from the end of 2003, is nevertheless a decline from the previous year, due to the large consolidation of previously off-balance sheet assets due to the sub-prime crisis. In Table 4, assets of qualifying special purpose entities (QSPEs, see Table 5 for a definition) – predominantly mortgages – add a further US\$766 billion, only US\$32 billion of which reflects 'retained interests'. A continuous series for QSPEs is not available, but expansion of these assets seems to have proceeded in line with those in VIEs. Altogether, assets in unconsolidated SPEs are equivalent to an additional 52 per cent of the balance sheet. In principle, the risk associated with these assets has been largely transferred, justifying non-consolidation, even though exposure to losses in the unconsolidated VIEs could be as high as 43 per cent, or US\$152 billion (see Table 5). Some commentators continue to argue that Pillar 2 of the revised framework can be relied upon to save the flaws in Pillar 1. This episode suggests that pre-emptive supervisory intervention is at best very difficult.
- iii. Is the Citi evidence consistent with procyclicality of the Basel capital regulation process? During the four and a half years from the end of 2002 to mid 2007 – essentially the upswing that followed the tech bust – Tier 1 capital rose by 57 per cent. At the same time, risk weight adjustments, that is, assets not requiring capital backing, rose from 35 per cent to 46.5 per cent of total assets, allowing an overall balance sheet expansion of more than 100 per cent. Securitised off-balance sheet assets – mostly real estate related – rose even faster. During this period, OFHEO house prices rose by 41 per cent. As the crisis emerged, Tier 1 capital and the risk weight adjustments both declined, resulting in a small balance sheet contraction during the second half of 2007, even as off-balance sheet assets were repatriated to the balance sheet, reinforcing the cyclical slowdown that was under way.
- iv. How long will it take Citi to recapitalise via earnings? So far Citi has announced US\$42 billion of write-offs related to sub-prime and off-balance sheet exposures. The fiscal authorities will necessarily absorb a significant part of this, but retained earnings and external capital will be required to restore Citi's capital base, and resumption of normal operations involving balance sheet expansion will require further capital backing. On the basis of analysis similar to the aggregate work on the size of losses and time required to rebuild in Blundell-Wignall (2008), summarised earlier, it would take until mid 2010 for Citi to rebuild the equity backing for its balance sheet to 2003 levels while supporting balance sheet expansion of 6 per cent (in line with nominal GDP growth in the United States). This assumes an underlying earnings rate 'norm' somewhat over 1 per cent of assets, elimination of the dividend and no external capital injections. In fact Citi has already raised US\$7.5 billion from the Abu Dhabi Investment Authority and

US\$6.9 billion from the Government of Singapore Investment Corporation, so recovery could come somewhat earlier.

- v. Is there evidence that accounting is an ‘art’ not a ‘science’, that is, that firms have scope to recognise and model potential losses and risks in different ways that can lead to massive revisions? The maximum loss exposure for Citi’s unconsolidated VIEs was reported as US\$109 billion for 2006, in the 2006 filings. In the 2007 filings, Citi revised its definition of ‘significant’ involvement in VIEs and restated its 2006 disclosure data to be consistent with this. The number was raised to US\$148 billion for the 2006 accounts, a 35 per cent increase (see Table 5). In 2007, the maximum loss exposure rises only modestly to US\$152 billion. Similarly, the assets in QSPEs reported in 2006 covered ‘all’ involvement and amounted to US\$1.5 trillion. In 2007, coverage of mortgage securitisations was more restricted and the number reported was cut to US\$541 billion for the 2006 year (see Table 5). The ability of internal audit committees, external auditors and bank supervisors to keep track of consistency with accounting standards and to avoid such arbitrary outcomes – presumably at least one of the many key requirements for the success of Basel II – seems questionable.
- vi. Is Citi’s off-balance sheet activity consistent with the view that an unintended consequence of the likely reduction in weightings for mortgages in Basel II, and the balance sheet caps on Fannie Mae and Freddie Mac, was to stimulate private-label securitisation? Table 5 shows proceeds from new mortgage securitisations. The Basel II framework was published and QIS-4 testing conducted in 2004, and it was then that Fannie Mae and Freddie Mac had to raise 30 per cent more capital and stopped buying mortgages. In 2003, Citi’s proceeds from mortgage securitisations were US\$71 billion. In 2004 they actually fell. Subsequently, however, these proceeds accelerated sharply; from US\$66 billion in 2004, they rose 122 per cent to US\$147 billion by 2007. A revenue gap opened up in 2004 and was subsequently closed via off-balance sheet VIE and QSPE securitisations (or private-label RMBS as these activities have been referred to throughout this paper). While these numbers are not operating revenues, they incorporate fees and contribute importantly to the commissions and fees reported in Table 5. As with Northern Rock, increasing concentration of mortgages was also a feature. Citi’s on-balance sheet mortgages were 34 per cent of total loans in 2003, and rose to 41 per cent by the end of 2006 (see Table 4). The share of mortgage-backed assets in unconsolidated VIEs is not available, but the far larger and rapidly increasing QSPE assets are dominated by mortgages.

9. UBS Report to Shareholders

It is difficult to understand the complexity, the incentives for revenue generation, the influence of personalities, and the culture for growth and beating the competition that the factors discussed above breed in an investment bank. Containing those forces is difficult for management, and their willingness to do so is also cyclical. The history of UBS in the lead-up to the crisis (which for them can be dated as

when a write-down was forced on them by the Swiss regulator) gives a rare insight into some of this.

9.1 Corporate governance, risk control and funding

On paper UBS looks to be ‘state of the art’ in corporate governance and risk control. Overarching principles include: managerial responsibility; independent checks and controls; the requirement for transparent risk disclosure internally; earnings protection for shareholders; and the protection of UBS’s reputation. There is a specialist risk sub-committee of the board, an audit committee and internal and external audit reviews. There is also an internal funding process run by a centralised Group Treasury, with group-level governance oversight.

Risk control included explicit frameworks for ‘market’ and ‘credit’ risk, and all new business initiatives and significant transactions required prior approval by management. The ‘market risk framework’ explicitly favours VAR and stress-loss analysis (as favoured by the Basel Committee). These cover concentration issues, exposure to related parties and operational limits. Credit risk covers limits and monitoring (country, sector and products). In 2006 and 2007, UBS chose to allocate the bulk of their VAR limit and group stress loss limit to the investment bank, around which the growth strategy was centred.

UBS Group Senior Management identified the sub-prime issue as a major risk in September 2006, but the investment bank management did not act until July 2007, when it was too late. What is striking about the UBS story is that the complexity and the very nature of investment bank culture make it difficult to manage capital and risk even for highly-sophisticated organisations. No internal rules appear to have been broken, but the losses piled up quickly to around 50 per cent of stockholders equity.

9.2 The damage

At the time of writing, UBS has taken US\$19 billion in write-downs. In December 2007, total balance sheet assets were US\$1 828 billion (versus Citi’s US\$42 billion write-down with assets of a similar size at US\$2 146 billion, net of goodwill). These losses were heavily linked to the investment bank and Dillon Read Capital Management (DRCM). These losses came from businesses within the investment bank (84 per cent of write-downs, or about US\$16 billion), or from DRCM (16 per cent of the losses and about US\$3 billion). At December 2007, UBS had US\$38 billion in capital compared to Citi’s \$114 billion in stockholders equity.

The main contributor to UBS write-downs within the investment bank was the CDO trading desk in the Securitised Products Group (66 per cent of write-downs, or US\$12.7 billion). This business grew rapidly through 2006. The rest of the losses in the investment bank came from foreign currency and cash collateral trading (10 per cent, US\$1.9 billion) and the Proprietary Trading and Credit Fixed Income businesses (8 per cent, US\$1.5 billion).

With good governance, new business and transaction approval rules in place, Basel capital requirements being met, and oversight from supervisors all over the world, it interesting to see just what went wrong.

9.3 Primary causation: the revenue gap/growth catch-up factor

As discussed earlier, by June 2005 the financial boom and liquidity bubble underpinned by global carry trades was in full swing, and it was argued that US mortgage originator/investment banks were developing new strategies for private-label RMBS and leveraged conduits for structured products to meet demand. UBS is not a major US sub-prime loan originator, and could not have been impacted much by the new regulations on Fannie Mae and Freddie Mac. However, UBS saw the rapid growth of these new businesses, and perceived that it was falling behind. At this time UBS management launched DRCM, with the precise aim of establishing a new alternative investment business.

An external consulting firm (Mercer Oliver Wyman) was also appointed to recommend strategy. This consultant pointed out that of all the businesses, fixed income was the area where the investment bank lagged the three leading competitors the most. The investment bank had its biggest gaps in the credit, securitised products and commodities businesses – product gaps in credit, high yield, mortgage-backed securities, sub-prime and adjustable-rate mortgages were singled out. In March 2006, the investment bank presented its conclusions and key initiatives to close revenue gaps. These included expanding its: securitised products via a new Securitised Products Group; global structured finance and high-yield loan business; structured credit; and the development of trading strategies for these products.

The three biggest players in fixed income revenue in 2005 and 2006 were Goldman Sachs (about US\$8¾ billion and rising to US\$10.4 billion in 2006), Citi (about US\$9¼ billion and rising to US\$10½ billion in 2006); and Deutsche Bank (about US\$9 billion and rising to US\$11½ billion in 2006). These numbers were presented by the UBS Head of Fixed Income in March 2007 as the ‘gap’ that had to be closed – UBS was a mere ninth at around US\$6 billion in 2005 and about US\$6¼ billion in 2006.¹⁹ UBS developed a ‘me too’ revenue gaps strategy – a ‘growth at any cost’ mentality – at exactly the wrong time from a macroeconomic prudential risk perspective. This is classic investment banking (from the Latin American Debt crisis to the sub-prime crisis, modern bankers continue a long tradition). Market share, revenue gaps and beating the key competition is the topic of every morning meeting at all levels in the bank, and for senior management it can be a question of holding your job.

The corporate governance and risk control functions in many firms will adjust (this is as much a cultural issue within the firm) but it is very hard for these functions

19. Simon Bunce, UBS Fixed Income Businesses Investor Day, 28 March 2007. He identifies a US\$4.6 billion revenue gap to the top three competitors as the most significant opportunity to increase revenue.

to stand in the way of growth. The idea of a ‘crisis’ is not on the ‘sell team’s’ mind before a crisis breaks, and all the incentives are aligned to make money for the company and for the key personalities to be seen to be driving this. This certainly appears to have been the case in UBS, where departing top managers were replaced by people from a sales background (consistent with growth), not a risk management background. Key internal risk controllers do *not* hold sway at this point, and they simply have to adjust, or risk their own jobs – this is how it works. Only once a crisis hits does the relative power begin to shift in favour of the risk controllers.

9.4 Funding, hard limits and staff remuneration incentives

UBS has a centralised treasury able to raise funds efficiently in the open market, and it chose to distribute funds internally within the normal external spread:

... i.e. internal bid prices were always higher than the relevant London Inter-Bank Bid Rate (LIBID) and internal offer prices were always lower than relevant London Inter-Bank Offered Rate (LIBOR). (UBS 2008, p 25)

The businesses were able to fund themselves at prices better than in the market. No attempt was made to take account of liquidity in this process (to match term funding to liquidity). A stricter funding model was seen as a ‘constraint on the growth strategy’. There was strong resistance from the investment management to hard limits on the balance sheet and RWAs. Such limits were quickly installed only in the second half of 2007, once the crisis was under way.

Staff compensation incentives did not differentiate between the creation of genuine ‘alpha’ versus the creation of returns based on low-cost funding, nor the quality (risk attributes) of staff earnings for the company. The relatively high yield from sub-prime assets made this an attractive candidate for long-position carry trades, (even with thin margins) via leverage (and the use of derivatives). This encouraged concentration in the higher carry mezzanine tranches of CDOs. It also encouraged minimal hedging of super senior positions (in order to be more profitable).

9.5 Corporate governance stretching

Notwithstanding the fact that UBS Group Senior Management (GSM) identified the sub-prime issue as a major risk in September 2006, the investment bank management did not adjust until July 2007 (the way this works internally is that GSM and the Board would not have felt strongly enough about the possibility of a crisis). Growth and revenue are in the interests of the shareholders and the Board would not have been able to act forcefully: in complete contrast to their actions once the crisis became clear. Investment bank management held sway and GSM and the Board went along with it. The report states that GSM took comfort from the main exposures being AAA CDOs, and that they were prepared to rely on investment bank assurances that the risk was well managed. Revenue growth and catching up to competitors was the dominant culture. All of the focus of the management within the investment bank on ‘processes’ for new business initiatives and prior approval of transactions was:

... on speeding up approvals as opposed to ensuring that the process achieved the goal of delivering substantive and holistic risk assessment of the proposals presented. (UBS 2008, p 41)

The report also states that internal reporting of risk positions was complex, even across the ‘silos’ within a business line. A holistic picture of the risk situation within investment bank business lines was not presented to management or the Board, and there was no serious internal challenge to the overall strategy.

9.6 How the losses occurred in DRCM

DRCM (16 per cent of losses) implemented their strategy late, just as the market turmoil was beginning. This ‘bad luck’ led to reviews of the reporting line and control issues; but the shareholder report states quite clearly that no internal rules were broken (UBS 2008). The report suggests that problems arose because of:

- i. staff changes – leadership and technical ‘key person’ risk played a role and is not captured in regulations;
- ii. the relative autonomy of the team, with cross-reporting lines.²⁰ This contributed to a doubling-up of fixed income strategies in the investment bank and DRCM – when DRCM was closed in 2007 the exposures still existed in the investment bank; and
- iii. the inability of management to focus on all aspects of the complex growth in their business.

9.7 The investment bank

The investment bank was anointed as the key driver of the growth strategy. This strategy, together with the cheap funding and lack of hard limits on RWA, ensured that the investment bank would play a key role in the losses. The investment bank did not have the incentive to assess and prioritise between businesses, from the perspective of allocating resources, when setting strategy.

The CDO desk within the investment bank was responsible for 66 per cent of write-downs. UBS-sourced RMBS were held in a CDO warehouse (on UBS’s books, thus exposing the investment bank to market risk). Once securitised, the RMBS were transferred to a CDO SPV and structured into tranches. Higher fees caused the desk to focus on mezzanine tranches (the structuring fee was 125 to 150 basis points on the notional value of the deal, whereas super senior was only 30 to 40 basis points). The report also states clearly that the growth in the structuring business was hugely accelerated by the development of the CDS market, because this avoided cash ABS being sourced for inclusion (the cash plus synthetic ‘hybrid’ CDOs became 75 per cent of the total CDO exposure). The warehouse was responsible for one-quarter of the CDO desk losses.

20. DRCM reported to Global Asset Management, but the investment bank was exposed to the risk and returns of DRCM managing its proprietary capital via UBS finance companies.

In 2006 and 2007 there were no notional limits on the warehouse pipeline and retained pipeline positions, but they were subject to VAR limits and stress testing and were identified by Market Risk Control, as early as late 2005, as the main source of market risk in the investment bank. That there were no notional limits and all deals were approved is very consistent with the growth culture dominating the risk control culture until mid 2007. This relative ‘cultural sway’ within an organisation is the most basic source of ‘procyclicality’, and is almost impossible to regulate against.

UBS at first sold the super senior AAA CDO tranches to third-party investors, but then began to retain them for their own book (and buy them from third parties). This (with cheap funding) was seen as an easy source of profit. Some of these were fully hedged (via CDS) with monoline insurers as counterparties. There was no breakdown in risk controls or the setting and monitoring of counterparty limits. The losses here simply came from the widening of margins in anticipation of expected severe downgrades. They simply ‘got it wrong’.

The amplified mortgage portfolio also became a part of this business. Here the super senior tranches were only partially hedged to improve their expected profitability: a few per cent of the notional value was believed to be sufficient to hedge even a major negative event, based on historical statistical analysis. There were no notional limits on the size of these positions. The partial hedges were quickly exhausted as the crisis unfolded, leaving UBS fully exposed, with the actual volatility well outside of historical experience. When decisions were taken to exit positions from mid 2007, it was too late as liquidity had disappeared.

Of the US\$50 billion super senior tranches held by UBS at December 2007, US\$21 billion was bought from third parties, of which US\$15 billion was fully hedged and the remaining US\$6 billion was only partially hedged. Super senior tranches contributed three-quarters of the CDO desk losses and 50 per cent of the total write-downs.

Because of illiquidity, the crisis dramatically changed what a 10 standard deviation event looks like – 2–4 per cent hedging looked adequate before the crisis, but for some AAA tranches we now know that 50 per cent losses or worse are possible. This of course highlights one of the great weaknesses of the Basel II IRB approach, which relies on internal bank modelling. The VAR methodologies also rely on the AAA ratings of the super senior tranches. There was no attempt to look through these to analyse the underlying collateral; there was a belief that the sub-prime crisis would not impact on AAA assets. (Once again this calls attention to the role of CRAs.)

10. The Situation in Europe versus the United States and the Leverage Ratio

US banks are much better capitalised than their European counterparts. It has been argued above that the US sub-prime crisis is a regional/sectoral crisis that the Basel RWA approach is ill-suited to deal with. It was also argued that the problems in the United States were compounded by proposed changes to the Basel weights.

The crisis was centred in the United States and not elsewhere, because: first, at the macroeconomic level the US growth cycle was not synchronised with other countries; the Federal Reserve had 1 per cent interest rates (following the bursting of the tech bubble) and international reserves from Asia were mainly pouring into the United States, flattening the yield curve, both of which helped generate a housing boom; and, second, a regulatory catalyst stimulated the private mortgage securitisation and sale process, where the crisis was to become focused. Were US banks not as well capitalised as they are, the impact of the crisis would have been much worse than it is currently.

Table 6 shows the leverage ratios for a selection of major European and US banks – measured here as Tier 1 capital divided by the bank's total assets. The average leverage ratio for the European banks shown is 2.68 per cent, while that for US banks is 5.15 per cent, and 5.88 per cent if investment banks are excluded. European banks, in other words, typically have around half the capital of US banks as a share of assets.

The main reasons for this are the explicit use of the leverage ratio in requirements set by the Federal Reserve (a minimum of Tier 1 capital to adjusted total assets of 4 per cent is required for most banks regardless of RWA) and the *Federal Deposit Insurance Corporation Improvement Act (FDICIA) of 1991*, enshrining 'prompt corrective action' in law. The aim of the latter is to minimise the exposure of the deposit insurance fund to losses. Five categories have been established:

- i. 'well-capitalised', meaning 'significantly exceeds' the Federal Reserve's minimum and, more precisely, by 25 per cent or more (that is, a leverage ratio of 5 per cent or more);
- ii. 'adequately capitalised' means meeting the minimum;
- iii. 'undercapitalised' means failing to meet the minimum;
- iv. 'significantly undercapitalised' means failing by a significant amount in view of FDIC; and
- v. 'critically undercapitalised' means failing to meet any of the capital requirements, and this is specified as no less than 2 per cent. At 'significantly undercapitalised' levels, banks are forced by law to raise capital or resolve the issue in other ways (for example, merge, etc), whereas the worst category makes it mandatory for the relevant regulator to appoint a receiver.

On the basis of the US FDIC Act, none of the European banks shown in Table 6 would be 'well capitalised', two would be adequately capitalised, eight would have to adjust and three would be closed down. In the US case, only the investment banks (Goldman Sachs, Lehman Brothers, Merrill Lynch and Morgan Stanley) would not meet the minimum requirement. This is because investment banks were not supervised as banks, but fell under the supervision (voluntarily) of the Securities and Exchange Commission. It is interesting in this regard that Bear Stearns, an investment bank, has been the main casualty of the sub-prime crisis thus far.

The FDIC has analysed the implications of the US QIS-4 results (some of which are reported in Table 2) for prompt corrective action. All 26 institutions in the

Table 6: Bank and Investment Capitalisation
Europe versus United States

	Currency	Assets (A)	Tier 1 capital (B)	Leverage ratio (B/A) %
Europe				
Deutsche Bank	EUR	2 020 349	28 320	1.40
Crédit Agricole	EUR	1 414 223	28 000	1.98
Commerzbank	EUR	616 474	16 333	2.65
Barclays	GBP	1 227 361	27 408	2.23
BNP Paribas	EUR	1 694 454	37 601	2.22
UBS	CHF	2 272 579	32 811	1.44
Société Générale	EUR	1 071 762	21 616	2.02
Crédit Suisse	CHF	1 360 680	34 737	2.55
HBOS	GBP	666 947	24 388	3.66
Lloyds TSB	GBP	353 346	13 952	3.95
BBVA	EUR	502 204	20 659	4.11
Banco Santander	EUR	912 915	39 725	4.35
Royal Bank of Scotland	GBP	1 900 519	44 364	2.33
Total	EUR	15 673 605	351 950	2.68
United States				
<i>Banks</i>				
Citi	USD	2 187 631	89 226	4.08
U.S. Bancorp	USD	237 615	17 539	7.38
Wells Fargo	USD	575 442	36 674	6.37
Bank of America	USD	1 715 746	83 372	4.86
JPMorgan Chase & Co	USD	1 562 147	88 746	5.68
SunTrust	USD	179 574	11 425	6.36
Washington Mutual	USD	327 913	22 406	6.83
BB&T	USD	132 618	9 085	6.85
National City	USD	150 374	9 367	6.23
Countrywide Financial	USD	211 730	8 754	4.13
<i>Investment banks</i>				
Goldman Sachs	USD	1 119 796	42 728	3.82
Lehman Brothers	USD	691 063	23 103	3.34
Merrill Lynch	USD	1 020 050	31 566	3.09
Morgan Stanley	USD	1 045 409	32 074	3.07
Total		11 157 108	506 065	5.15
<i>US banks</i>		7 280 790	376 594	5.88
<i>US investment banks</i>		3 876 318	129 471	3.33

Source: annual reports

study experienced a drop in capital based on RWA, and nine became significantly undercapitalised – three critically so, if capital were determined under the revised IRB approach. In effect, the results imply that the leverage ratio would become the binding constraint in capital regulation.²¹

Because of these issues the debate is shifting. Countries that rely relatively more heavily on RWA and the Basel system, as in Europe, have relatively weak capital positions. A financial crisis in the European Union, along the lines of the US crisis, would have much more devastating economic consequences through the deleveraging mechanisms referred to earlier. If banks were asked to double their capital in Europe pre-emptively this too would be disruptive (extremely so for rapid adjustment). This argues in favour of changes and reform.

Given compliance costs, abandoning the RWA would be the natural outcome if a leverage ratio was always to be the binding constraint (that is, requiring more capital than the RWA approach), particularly if the IRB approach were not altered to address concentration issues.²²

If some reformulation of RWA was thought necessary – one that avoided all of the above criticisms – then combining it with a leverage ratio would have the advantages of: first, supervisors and banks focusing on broader metrics which reduces the scope for regulatory arbitrage (banks could no longer arbitrage to maximise profits against a single metric); and second, increasing the scope for dealing with regional/sectoral risk factors, as opposed to the global risk factor upon which the RWA approach is based.

11. Summary and Overview of Some of the Key Issues

11.1 Causal versus conditioning factors

Mixing causal and conditioning factors risks coming up with an impressive list of reforms without weighting them – that is, it risks giving insufficient attention to causal structural factors. To continue the earlier water analogy, better levies, building location restrictions and warning signs should be encouraged, but are not a substitute for sound dam infrastructure.

The key causal (more exogenous) factors identified in this report include:

- i. Global interest and exchange rate distortions: leading to rolling excess liquidity-driven bubbles.
- ii. A sub-optimal Basel II (Pillar 1) capital regulation framework: that can lead to undercapitalisation of banks via regulatory arbitrage and by handing the setting of capital standards to private banks via their modelling and other assumptions. Sophistication and complexity increases the scope for reducing capital

21. See Powell (2005), former chair of the FDIC.

22. There is no point in imposing compliance costs, which can be very high, if they have no binding influence.

requirements. This distorts asset allocation decisions, leads to procyclicality and fails to address regional/sectoral risks. Anticipatory behaviour has already influenced mortgage concentration and wholesale financing in some institutions and contributed to the sub-prime crisis. Sheila Bair puts it very well:

Risk number one: The advanced approaches come uncomfortably close to letting banks set their own capital requirements. That would be like a football match where each player has his own set of rules. There are strong reasons for believing that banks left to their own devices would maintain **less** capital – **not** more – than would be prudent. (Bair 2007)

- iii. Problems with multiple independent regulatory authorities for interdependent financial firms – with changes by one regulator leading to problems for others. The controls on Fannie Mae and Freddie Mac, for example, caused revenue gaps and created incentives for a rapid expansion of private-label RMBS.
- iv. Regulating investment banks differently to banks and bank holding companies that include investment bank subsidiaries. In the US, this has left investment banks with capital ratios that are half those of the commercial banks, yet many of the sub-prime problems (and the need for capital) have involved the activities of investment banks. ‘Consolidated’ capital rules are unlikely to resolve this issue. The ‘revised framework’ of Basel II states that capital requirements should be ‘applied on a consolidated basis to internationally active banks ... to ensure that it captures the risk of the whole banking group’ (BCBS 2006, p 7). However, wide scope exists for parent groups to meet capital requirements simply by shifting funds within the group. Balance sheets can expand without requiring subsidiaries to add capital for the group as a whole.²³
- v. Procyclical incentive structures. The ‘revenue gap’ and ‘market share’ focus of bank strategy are both inherently procyclical. They lead to ‘copycat’ behaviour with respect to new innovations in competitor banks and compensation incentives that are geared to short-term return recognition, and are not risk-adjusted (see the UBS discussion above). Tools that measure risk at a point in time, rather than through-the-cycle and counterparty credit policies that vary with the cycle are also procyclical. Reliance on credit ratings, which in practice tend to be cyclical variables, and leverage linked to asset values which vary with the investment cycle and do not necessarily reflect future cash flows accurately are another key cause of procyclicality.
- vi. The competitive structure of rating agency and audit markets. Both of these markets have oligopolistic structures, at least as it applies to dealings with complex financial institutions, leading to high fees and the potential for reduced independence (see the discussion of the FSF conclusions above).
- vii. Bailouts that create moral hazard: associated with ‘too-big-to-fail’ risk-taking by lenders and borrowers (see the Bear Stearns, Northern Rock and IKB discussions above).

23. See Atkinson (forthcoming) for an exposition of this and examples from Citi, Merrill Lynch, E-Trade and Northern Rock.

In sum, if these problems are not addressed, they will push the job of supervisors to the limits of difficulty and occasionally beyond it.

11.2 Conditioning factors for which little or no improvement is likely

It is impossible for financial firms and supervisors to predict the future level and volatility of asset prices, nor their correlations at different points in time. This means that business strategies for the future, and the ability to control risk in the face of unexpected shocks, are always going to pose major challenges. Risk models fail, not because firms are not sophisticated enough, but because the inputs cannot be predicted, and the past is a guide only for situations where extreme market breaks, panic and liquidity problems are absent. Internal systems can be improved, but it is a case of 'garbage in, garbage out'. If you do not anticipate a crisis in risk analysis, the best model in the world will not help much in the presence of an 'a-historic' risk event that is not normally distributed.²⁴ The United States has the deepest and most active financial markets, and it still experiences major risk events. There is no 'magic pudding'. At the board level, corporate governance will always have a procyclical element to it because directors are no better at predicting the future than anyone else.

It is impossible to change human nature as it operates in a broker-dealer or investment bank. Job tenure is limited and remuneration depends on how well you do while you are in the position. It is possible to change remuneration formulae to encourage longer-run thinking and risk-adjusted rewards. But this is only likely to have limited results. Job tenure cannot be guaranteed in the face of adverse outcomes. Key employees understand this, and will still seek and achieve rewards for successful rapid moves up the risk curve in apparent good times, and *vice versa* in bad times. Employers adjust because key people will go to other employers or (even more likely these days) leave to set up their own boutique or hedge fund (note the discussion of key person risk in the case of DRCM).

12. Ten Elements for a Sound Global Regulatory System

The observations and analysis in this paper suggest at least 10 elements that need to be thought about in the context of regulatory reform.

- i. Recognition that regulatory policy needs to proceed hand-in-hand with reform to the international monetary system. Systems of fixed/managed exchange rates (especially in the presence of price controls on energy) across the major developing economies, particularly in Asia and the Middle East, have contributed to excess demand and worked to destabilise the global financial system. Without progress on this front, the task of financial regulation in individual countries is made more difficult, and regulatory policies themselves will always be subject to more lobbying from domestic financial firms with respect to their competitiveness.

24. All of the mathematics of VAR models depends on asymptotic normal distributions of volatility and error terms.

- ii. Recognition that monetary policy in advanced countries should take more account of the international global financial implications of their policies. Extremely low interest rate policies, pursued with domestic objectives in mind, cause carry trades and asset price effects that influence leverage.
- iii. Simple rules should be favoured over complex ones based on unrealistic models. The theoretical underpinning of the Basel framework, based on the assumption that only one global risk factor exists, is not a sound basis on which to base any binding model for capital requirements in each jurisdiction. Allowing banks to set their own capital standard, via complex internal modelling of risk outcomes, is likely to generate too little capital and concentration distortions. Complex weighting rules that discriminate between assets in terms of capital penalties create an industry of avoidance which is both costly in terms of productivity and likely to distort asset mixes. A simplified and more transparent system of *ex ante* requirements, like the leverage ratio with prompt triggers for corrective action, allows greater scope to take local and global factors into account and gives supervisors *ex ante* tools that do not rely on judgment and predicting the future.
- iv. Recognition of the need for a framework that is more sensitive to the concentration of risk and duration mismatch. Penalising or limiting deviations from a 'benchmark' is common in pension fund oversight and should also have a role in capital regulation with respect to the assets and liabilities of banks. At the consolidated portfolio level, penalties for concentration need built-in *ex ante* capital rules (which are not reliant on supervisory oversight in Pillar 2). A quadratic (as opposed to linear) capital rule penalising increasing portfolio concentration in Pillar 1 is worth considering. Asset and liability duration mismatch is linked to concentration risk. Northern Rock, for example, used wholesale funding to build rapid concentration in mortgages. The necessity to roll over short-term commercial paper also contributed to a liquidity crisis.
- v. Consolidation of on- and off-balance sheet bank exposure. This is an important advance under Basel II. But it will require very clear and uniform definitions for what constitutes an 'arm's-length' relationship or entity. This is critical for the effective operation of internal and external auditors. In this context, it is probably unwise to allow consolidation of investment bank and commercial bank capital requirements within a holding company context.
- vi. Recognition that competitive structures increase efficiency and independence in the role of rating and audit firms. There needs to be some thought about requiring the 'buy side' to obtain an independent ratings assessment (to increase the independence and quality of ratings, and reduce the monopoly element of the issuer-pays model). A removal of the legal restrictions that enhance audit firm monopoly is also worth considering, as a means to encourage the entry of new (and listed) capital.
- vii. A clear definition of what the bank/financial regulated sector is, rather than endless debates about how much hedge funds should or should not be regulated or self-regulated. There is interconnectedness between banks and hedge funds,

as there is between banks and corporate borrowers, and banks' dealings with corporate treasuries. The line between banking and certain other financial activities that warrant regulation for safety and soundness needs to be made clear. For example, if a hedge fund begins to issue notes in its own name to raise capital; begins to employ market-making traders in derivative markets; or begins to take on reinsurance activities, then it may have to come inside the regulatory net for banks, investment banks and/or insurance companies. This is quite different from a hedge fund that borrows from a bank or deals in derivatives with a bank, as most large corporate treasuries also do. According to this view, the line for prudential supervision turns on what the firm actually does. Of course, all firms fall within the market integrity and consumer protection regulations.

- viii. A single overarching regulator for prudential standards across all financial institutions; and a single overarching regulator for market integrity and consumer protection (the so-called 'twin peaks' model used in Australia is a good starting point). This should not be the central bank, where monetary policy should focus on inflation objectives and not risk conflicts in policy objectives in a solvency crisis.
- ix. A lender-of-last-resort facility and comprehensive market liquidity provisions for maintaining the stability of the financial system in the event of periods of turmoil (which can only be run out of the central bank).
- x. Recognition of the moral hazard effects of bailouts and government guarantees on assets. This creates asymmetry in risk-taking. The threat of bankruptcy and the loss of shareholders' equity and at least some non-deposit debt needs to be made more 'credible'. A resolution regime including protection for depositors (to avoid Northern Rock situations), and clear receivership processes for the closing down of banks (in jurisdictions where these elements are absent) would help in this respect.

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Discussion

1. John Laker

This is a thoughtful and provocative analysis of the US sub-prime crisis, which we now know to be another classic boom/bust event. It goes beyond ‘official’ analyses, such as the Report of the Financial Stability Forum in April, to try to identify factors that were causal to the sudden acceleration of the residential mortgage-backed securities (RMBS) market in the United States after 2004.

Alas, to a prudential regulator, the paper reads as an ‘ode to futility’! Prudential regulators, we are told, are unable to predict future asset prices and volatility, are underpaid and under-resourced, and are unable to understand the inner workings of complex financial institutions. The paper is also critical of regulatory approaches to capital adequacy, particularly the new Basel II Framework. And yet, the paper looks to regulatory solutions to the sub-prime crisis and even gives a plug to Australia’s ‘twin peaks’ regulatory arrangements.

The provocative part of the paper is the assertion that the transition to Basel II – in particular, the anticipation of much lower risk weights for mortgage lending – was a necessary if not sufficient condition for the sudden acceleration of the RMBS market after 2004. The catalyst was the regulatory limits imposed on the balance sheets of Fannie Mae and Freddie Mac, which it is claimed caused RMBS issuance by banks and other issuers in the United States to explode after 2004. Some basic econometric tests are provided to support this assertion. Certainly, it seems plausible that a pull-back by these agencies could have led to a rebalancing of activity in the US RMBS market toward less experienced players, contributing to the sub-prime crisis. But whether this would have happened absent the regulatory constraints on Fannie Mae and Freddie Mac is of course impossible to know.

More relevant for this audience (and the Australian Prudential Regulation Authority – APRA – in particular) is the causal role attributed to the impending introduction of Basel II in encouraging the market behaviour that we have witnessed. The authors go so far as to conclude, from their co-integration analysis, that over one-third of total off-balance sheet RMBS in February 2008 not explained by the standard variables can be attributed to banks anticipating the effect of Basel II on capital.

The authors back this assertion with logical analysis and anecdotal evidence. However, there are some remaining ‘puzzles’ to be resolved before this assertion can be fully convincing.

First, many of the originators and distributors in the private-label RMBS market in the United States were not subject to bank capital rules. This includes the mortgage finance companies and investment banks. The paper does not explain why bank capital rules would drive RMBS issuance by unregulated lenders and investment banks.

Second, the timing is problematic. Most of the fraudulent and sub-prime mortgages that were packaged into collateralised debt obligations were apparently of the 2006–07 vintage. The Basel II Framework was not in place in 2006 and there were

significant doubts, even then, about whether the Framework would be implemented in the United States. The objections of the Federal Deposit Insurance Corporation (FDIC), quoted at several points in the paper, were well-known. The assertion that US banks not only actively anticipated Basel II but actually adjusted their portfolios well in advance of obtaining any capital benefit (and thereby incurring a short-term capital penalty) does not seem consistent with our understanding of how banks manage their capital.

In addition, the capital impacts of Basel II have been subject to considerable uncertainty from the beginning, as illustrated by the divergence between the Quantitative Impact Study 4 (QIS-4) results cited by the authors and subsequent surveys. It will be some years before the full impacts on major US banks are clear.

Third, US banks were exceptionally well capitalised over the period in question (generally well above regulatory minima), due to strong economic conditions and profits. It is difficult to accept that regulatory capital requirements would have been a major driver of activity given that they were not binding. Even if capital requirements were a factor, the incentives with respect to securitisation activity should work in the opposite direction to what has been asserted. Basel II reduces housing capital risk weights in most cases. This should clearly discourage, not encourage, securitisation of mortgage loans by banks and encourage on-balance sheet origination.

Finally, if banks adjusted activity to anticipate Basel II, we would expect them to have reduced or repriced their asset-backed commercial paper liquidity lines, for which capital would have to be raised. There is no evidence they did this. Indeed, the Financial Stability Forum has argued that it was the pre-Baseel II Framework that encouraged banks to securitise assets through instruments with low capital charges (such as 364-day liquidity facilities).

The assertion of a powerful causal role for Basel II would, of course, be most convincing if it could also be shown that impacts were similar in jurisdictions outside the United States. If banks' actions in originating sub-prime mortgages and securitising them were a response to arbitrage of capital rules, why did this also not occur in Australia? True, there was a significant increase in securitisation activity over the same period (2004–2007), but little evidence of imprudent credit practices by regulated financial institutions. The growth of Australian RMBS in this period can be explained by the mutually reinforcing recovery in the local housing market and the global availability of low-cost funding to Australian financial institutions. However, the larger banks that were likely to be beneficiaries of the advanced Basel II approaches do not make substantial use of securitisation markets, while the smaller banking institutions that do so for funding or capital management purposes have maintained strong lending and servicing records.

There are answers to this puzzle in Australia's case, which address some of the FDIC's criticisms about Basel II. One is that expectations of substantial reductions in regulatory capital, prompted by the early QIS results, gave way during APRA's accreditation process to a greater recognition – particularly when boards and senior management became involved – that Basel II was much more about improved risk management systems and pricing for risk. Related to this, banks were not allowed to set

their own (low) capital requirements. The accreditation process led to a considerable uplift in banks' original risk estimates, which were generally developed using data from a benign part of the credit cycle; APRA also imposed a 20 per cent floor on loss given defaults (LGDs) in housing lending, which will remain until institutions develop higher-quality, more forward-looking estimates in this area.

In general, the jury may need to stay out longer on the causal role of the Basel II Framework. Much as I would like to think that prudential regulators do wield real influence, it is nonetheless difficult to accept that savings in regulatory capital (real or anticipated) in the United States outweighed fundamental business pricing and risk judgments. Regulatory capital arbitrage may save a few basis points on a transaction, whereas bad debt and fair value charges incurred to date have wiped out entire principal portfolios.

Let me turn to the paper's more general concerns about the Basel II Framework. The paper concludes that the Framework:

- fails to address concentration risk;
- is procyclical; and
- can lead to undercapitalisation of banks by allowing regulatory arbitrage and letting banks set their own capital requirements.

As a consequence, the authors favour simple over more complex regulation, such as a leverage ratio with prompt corrective action triggers.

A simplified capital framework, which is not subject to arbitrage, is not procyclical and deals appropriately with risk concentrations would indeed be the holy grail of capital regulation. A simple rule that effectively covers all risk situations and sets the right incentives! But, in the meantime ...

We need to remind ourselves that the move away from simple leverage ratio-type rules, initially to the 1998 Basel Accord, then to Basel II, was aimed at more accurate capital requirements that better reflect the risk profiles of institutions and, in comparison, lessen opportunities for regulatory arbitrage. After all, a leverage ratio penalises low-risk assets and may lead institutions to take on more risks. Basel II was also a response by supervisors to support improvements in risk measurement/management techniques being made by major international banks.

This is not to say that the Basel II Framework or for that matter any capital regime is perfect. Certainly we agree that more attention is needed to address concentration risks, as the Basel Committee has also recognised. This is not an issue that is, or can be, dealt with by simple leverage-type ratios. The authors offer some high-level suggestions, but the really tricky (and important) piece is the identification and proper measurement of risk concentration exposures.

Procyclicality is also a feature of Basel II as it is for banks' internal risk measurement systems; it exists even with the Basel Accord and other more simplistic capital regimes. The issue is a difficult one, although it is a matter of conjecture how much Basel II might in reality add to the already considerable procyclical forces operating more generally within the economy and financial sector. But again, Basel II recognises the issue and there are elements of the Framework intended to help deal with the possible effects.

I have already commented about the concern that Basel II will effectively allow banks to set their own capital requirements and exploit the complexity of their risk estimates to lower these requirements. Ask any of the larger Australian banks if this is so! Nonetheless, we would acknowledge that the setting of capital requirements under the advanced Basel II approaches is challenging for supervisors but there is an issue of materiality here and there is no need to chase all rabbits down their burrows. In any event, the Framework does not simply take whatever estimates banks decide to put forward for regulatory purposes. Within the credit risk area, for example, the Framework does not accept banks' full portfolio credit models (only certain inputs to those models), introduces the concept of downturn LGDs and sets criteria for acceptable risk estimates.

Any assessment of the Basel II Framework at this early stage in its implementation should bear in mind the warning of the previous Chairman of the Basel Committee '... to not let the best be the enemy of the good' (Le Pan 2008). Capital requirements are just one tool (though an important one) for prudential oversight, not a replacement for sound risk management and a deep understanding of the regulated institutions' business and risk profile.

Perhaps what the paper is really arguing, deep down, is that more capital is better than less capital. This might be music to a prudential regulator's ears, and well-capitalised banks are certainly better placed to weather current global market turmoil. But is a regulator's job simply and always to require more capital? Over time, if capital requirements are set too high (and too bluntly, for example, via a leverage ratio) regulated institutions will have strong incentives to take on more risky business and arbitrage the regulations – that is, to appear safer than they are. The unregulated sector might also expand at the expense of regulated institutions. None of these outcomes can be considered conducive to financial system stability.

If I can express one disappointment with this otherwise engaging paper, it is that it has given market participants something of a free pass. The paper concedes, *en passant*, that '[p]rivate-sector practices need to be improved, to be sure ...' but later claims that it is impossible to change certain human behaviour. The implication is that the reaction of market participants to increase their risk appetite and vastly misprice risk was somehow 'to be expected'. 'Boys will be boys' when the global liquidity tap is turned on appears to be the authors' assessment and real blame is instead saved for regulators in setting rules that encourage this risk-taking behaviour.

Any comprehensive analysis of the sub-prime crisis would surely acknowledge that through poor risk management oversight and an inability to think beyond the then buoyant economic cycle, many institutions and investors were lulled into thinking that their liquidity and credit exposures were very low. It is interesting that, of the eight underlying weaknesses identified in the Report of the Financial Stability Forum, poor underwriting standards and shortcomings in firms' risk management practices ranked one and two. Weaknesses in regulatory frameworks, such as those related to the pre-Basel II Framework, ranked eight. This view from Paris could not be more different!

Understanding the failure of market disciplines during the sub-prime crisis would require a rich vein of issues to be analysed. What roles were played by boards of

financial institutions scarred by the crisis? Has the discipline of shareholders as owners been diluted by the involvement of institutional funds managers, owning shares on behalf of pension funds? Did executive compensation provide sufficient, if any, penalties for failure? How did the incentives in the RMBS market in the United States for recovering sub-prime loans compare with the incentives to package and distribute these loans? I could go on, but I hope that I have said enough to tempt the authors of this paper to embark on a second round of research.

Reference

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2. Brian Cahill

Adrian Blundell-Wignall and Paul Atkinson's paper provides a detailed overview of the sub-prime crisis and analysis of likely causes of the crisis. In particular, it outlines regulatory influences in the creation of the crisis and concludes by listing a number of factors that the authors believe are likely to have caused the crisis. It also suggests 10 elements that need to be thought about in the context of regulatory reform.

The paper, at least from my perspective, mostly focuses on the regulatory framework – especially Basel I and II – and the way in which such a framework encouraged the explosion in RMBS issuance and off-balance sheet vehicles post 2004. This is not my area of expertise and – given John Laker is sitting next to me – I thought it wise to perhaps leave that major theme of the paper to others to discuss.

The paper also touches on the role of the credit rating agencies (CRAs) in the crisis and – if I might paraphrase some of the authors' comments in this area – suggests that the agencies were a key enabler in allowing lemons to be sold into the capital markets. It also highlights an issue that has been the subject of intense debate now for almost a year: that moral hazard and conflict of interest issues arise from the issuer-pays model, or more succinctly, problems can arise when the person whose debt you rate, pays your fees.

Given my role at one of the CRAs, I thought it might be a useful contribution to the discussion if I provided some of my thoughts on these comments.

- First, it is obviously correct that any analysis of the sub-prime crisis must look at the role of the CRAs. Indeed multiple organisations are – the Financial Stability Forum, the US Securities and Exchange Commission, the Committee of European Securities Regulators in Europe and the International Organisation of Securities Commissions – to name some international organisations, and closer to home the Australian Treasury and the Australian Securities and Investment Commission.
- Second, I think the key concern in the paper with respect to CRAs could be summarised as anxiety concerning our independence. Are the CRAs truly independent given the issuer-pays model? We would argue that we are, and

that the checks and balances, which were in place before the crisis and which have been subsequently strengthened, prevent the issuer-pays model affecting the independence of our ratings. We are engaging on many fronts to seek to demonstrate this and – where appropriate – make further changes to provide further reassurance. This is a hugely important issue for us, as it massively reduces our credibility and value if people believe we give ratings that are influenced by those who pay us. We do not. We are doing our absolute best to demonstrate this and to reassure people about this.

- Third, in this context it is worth asking: which CRA fee model would be more independent? For example, an investor-pays model? That is not independent, it simply changes the pressures. I would suggest to the authors – and many others that comment on the business model of the CRAs – that the focus should be on the checks and balances, not the model itself. This is essentially what many regulatory initiatives are focused on.
- Finally, I thought I might add a suggestion as to what else might have been covered by the paper in more detail. A keen area of debate surrounding the crisis has not only been the role of rating agencies in providing AAA ratings to some structured finance products, but what context allowed such paper to be sold. If these products were indeed lemons – as the authors argue – why did people buy them? To my mind this is an area that might have been further explored in the paper. A recent paper from the Committee on the Global Financial System (CGFS 2008) – on ratings in structured finance during the sub-prime crisis and what went wrong – highlights a number of analytical shortcomings at the CRAs that they believe need addressing. It also highlights perhaps a too heavy reliance on ratings by investors and the need for investors to strengthen their own risk assessment going forward. The paper also suggests the need for greater information transparency. We would support this and are actively taking steps to improve the information flow around how we arrive at ratings and what they mean. We would support greater *market* transparency, in respect to information disclosed about structured finance products. That ratings should support, not replace, investor due diligence is a key conclusion from that paper which we would heavily support.

In conclusion, Adrian and Paul's paper gives an illuminating overview of the background and likely causes of the sub-prime crisis, with a key focus on regulatory frameworks. In particular, it focuses on the enablers or motivators that drove the creation of sub-prime products from the sell-side. If I might say so, it lets the non-bank buy-side off a little lightly to my mind, by not further exploring their role as large buyers of sub-prime products. What lessons can be learnt from this? Part of the answer involves looking at the credit rating agency industry, but this is clearly not the whole story.

Reference

CGFS (2008), 'Ratings in Structured Finance: What Went Wrong and What Can Be Done to Address Shortcomings?', CGFS Papers No 32.

3. General Discussion

In their paper, Adrian Blundell-Wignall and Paul Atkinson argue that two key causes of the recent financial turmoil were changes in the capital adequacy and balance sheet restrictions of the government-sponsored entities and the release of Basel II. They argue that these were primary drivers of the large pick-up in sub-prime lending in the United States after 2004. Much of the general discussion was associated with these particular results.

One participant suggested that although the timing of these events matched the run-up in sub-prime lending, the change in incentives as a result of the regulatory adjustments were actually likely to have worked in the opposite direction to that argued in the paper. In particular, the Basel II rules reduced the capital charges for on-balance sheet assets, so it would seem peculiar that this change would cause a large move of assets to off-balance sheet vehicles, such as structured investment vehicles. In response, Adrian Blundell-Wignall suggested that the capital charge for off-balance sheet assets did not apply at the time these changes were taking place, and that the financial institutions planned to bring these assets back onto bank balance sheets when Basel II came into effect. Other participants offered alternative explanations for the timing of the run-up in sub-prime lending. It was suggested that given an expectation in 2003–04 that real US interest rates would rise quite rapidly, financial institutions chose to lower underwriting standards, rather than accept slower rates of growth in lending. It was argued that part of the reason for this was that bank staff were compensated for their near-term performance relative to other banks. There was some debate about whether sub-prime lending was even the right place to look for causal factors of the financial turmoil at all, with some participants indicating that the large decrease in interest rates globally (the global ‘savings glut’) and the widespread decline in the volatility of output and inflation were more important.

Following on from this debate there was some discussion about the design of Basel II. One participant pointed out that Basel II was a response to pressures by financial institutions and it was the private-sector institutions that had encouraged greater weight to be placed on internal capital modelling. Many private-sector institutions reportedly viewed previous guidelines as inadequate in a number of respects. For example, they treated a loan to a small business as having the same risk as a loan to a large conglomerate. Nevertheless, it was suggested that there was still much debate about what constitutes an acceptable capital modelling framework for the purposes of determining minimum capital requirements. One participant suggested that a positive feature of Basel II was that it had been developed in consultation with the banks and was based on a framework that had developed gradually, in an iterative way. Another participant disagreed, suggesting that the regulators had been bullied into the Basel II arrangements.

There was also consideration of the role of credit rating agencies. In particular, some participants raised concerns about the independence of the rating agencies, pointing to the adverse impact on their clients’ profitability that could come from a poor rating. In line with the paper, there was support for the idea that authorities

should act to help increase competition in the ratings industry. It was suggested that reducing the reliance of the regulatory system on ratings could force purchasers of securities to obtain information by other means and encourage greater transparency by the issuers themselves. In response to these comments, Brian Cahill noted that Moody's welcomes competition and pointed out that it was the regulators who embedded ratings in the system, not the credit rating agencies.

Liquidity, Financial Crises and the Lender of Last Resort – How Much of a Departure is the Sub-prime Crisis?

E Philip Davis¹

Abstract

Liquidity risks are endemic to banks, given the maturity transformation they undertake. This gives rise to risk of bank runs, the first line of defence against which should be appropriate liquidity policy of banks. Nonetheless, solvent banks can face liquidity difficulties at times of stress, necessitating liquidity support. The traditional role of the lender of last resort (LOLR) is to avoid unnecessary failures that could threaten systemic stability, while ensuring that there are suitable safeguards for central bank balance sheets and that moral hazard is minimised. The sub-prime crisis has shown that traditional models of bank liquidity risk and of LOLR require revision, as was already apparent to a lesser extent in the Long-Term Capital Management (LTCM) episode. Funding risk now interacts with market liquidity risk to create difficult challenges for central banks. The LOLR has had to adapt radically, for example, in terms of lending to investment banks, taking lower-quality collateral and lending at longer maturities. Central banks have also been challenged by difficulties in maintaining confidentiality of support and by the interaction of these problems with low levels of deposit insurance.

1. Introduction

This paper seeks to assess the importance of liquidity in financial crises and how the authorities may deal with it. It starts from the concept of bank runs – whereby the nature of banking means that solvent banks may at times be subject to panic runs and consequent illiquidity – and their ubiquity in most crises to date. Contagion may arise via credit risk linkages to other banks. This is a problem of ‘funding liquidity’. It then considers the authorities’ response to crises in terms of LOLR – illustrated by historical examples – and the evolving ‘doctrine’ of LOLR.

The paper then goes on to assess how liquidity problems during the current crisis have differed from the past. During this crisis the authorities have had to adapt their LOLR policy to a crisis which is not merely one of ‘funding liquidity’ but also of ‘market liquidity’ (Davis 1994; IMF 2008), while contagion has occurred more via

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market prices and less via credit risk (Adrian and Shin 2008) and new ‘amplifiers’ of financial instability have become apparent (Brunnermeier, forthcoming). The LOLR has had to adapt radically, for example, in terms of lending to investment banks, taking lower-quality collateral and lending at longer maturities. It has also been challenged by difficulties in maintaining confidentiality of support and the interaction of these problems with low levels of deposit insurance.

2. Liquidity in Financial Crises

Liquidity risk, in general, is the risk that an asset owner is unable to recover the full value of their asset when sale is desired. One type of liquidity risk is funding risk, which relates to the ease with which one can raise money by borrowing using an asset as collateral. Liquidity risk of this type has always played a key role in banking crises. This section provides a benchmark against which to compare previous episodes to the sub-prime crisis.

Bank assets – particularly loans – are by their nature illiquid and long-term, and subject to imperfect information, while liabilities are mostly liquid and short-term. These short-term liabilities are conceptually a means of disciplining bank managers via the threat of bank runs, as they help to ensure that bank managers take depositors’ interests into account by not taking excessive risks in their choice of asset holdings (Kaufman 1988). But depositors’ monitoring of projects is likely to be prone to error, making banks vulnerable to ‘overdiscipline’ (and possibly runs on solvent banks), leading to socially wasteful liquidation of projects. Owing to the fire sale problem – that is, the inability to realise assets at full value owing to asymmetric information – illiquid banks can rapidly become insolvent.

Once one bank has experienced a run, there is the possibility of contagion, with runs on other banks. Depositors may react either to balance sheet similarities with the failed institution under uncertainty and asymmetric information (Morgan 2002), or to perceived counterparty exposures with the failed bank. Contagion could, in turn, impact on the wider economy via monetary contraction, or credit contraction owing to the difficulty individual borrowers may have in establishing new credit relations with a different financial institution when their bank fails (Freixas, Giannini *et al* 2000). Note, however, that widespread bank runs need not imply contagion. An alternative possibility, as was arguably the case with the banking crises in Scandinavia in the early 1990s, is that there is a macroeconomic shock of such magnitude that many banks become simultaneously insolvent.

There are various models of bank runs. The best known is the Diamond and Dybvig (1983) model, in which banks provide liquidity insurance to risk-averse depositors. Normally, the demand for repayment by depositors is predictable and can be catered for by a low level of liquid assets; however, if the bank is forced to sell its illiquid assets in a ‘fire sale’, then it may not realise sufficient cash to cover all of its deposits. Then some depositors may run, if they suspect other depositors will also do so, as they fear being last in the queue for cash (that is, there is a coordination problem). This pattern may lead to the insolvency of a potentially sound institution.

The Diamond-Dybvig model assumes that bank runs are purely random events. Alternatively, Chari and Jagannathan (1988) suggest that adverse information leads to panics – that is, systematic risks are inferred from what may be idiosyncratic. Jacklin and Bhattacharya (1988) focus on the role that information of depositors may have on the quality of bank assets. Gorton (1988) saw panics occurring mainly in recessions, which confirms the adverse information hypothesis, since panics occur close to the period when business failures are most widespread.

Runs are traditionally assumed to take place among retail depositors, but large wholesale depositors are increasingly important. Wholesale depositors are generally better informed and less likely to be covered by deposit insurance and (as discussed below) banks are increasingly dependent on wholesale funding. The interbank market is a key locus of runs in recent years, including, for example, the failures in the United States of Franklin National in 1974 and Continental Illinois in 1984.

Of course, the systemic importance of interbank markets has increased because of recent trends in financial innovation. For example, there is a growing need for liquidity owing to growth in international trading and transactions – notably, over-the-counter (OTC) derivatives can give rise to unexpected liquidity demands – and also of large-value interbank payment systems using real-time gross settlement (RTGS). Nevertheless, although there have been individual bank failures, the domestic interbank markets of the advanced countries have historically been fairly robust.

The international interbank market has been a major focus of liquidity crises, as in the Asian crisis of 1997. Bernard and Bisignano (2000) highlight a number of features of the international interbank market that contribute to this. They include, first, the typical lack of security (collateral) and low levels of information gathering. These may in turn be linked to moral hazard via implicit guarantees by central banks for the interbank market's functioning. The existence of the interbank market may also lead banks to underinvest in liquidity. A range of banks with low credit quality (as in east Asia up to the crisis of 1997) may operate in it so long as lenders believe the implicit guarantees. The international interbank market is typically subject to quantity and not price rationing of credit, due to low levels of information on credit risk. The short maturity makes withdrawal easy and, more generally, the market is vulnerable to sudden increases in credit rationing during periods of stress, as a result of adverse selection and moral hazard problems. These shortcomings give rise to a potential for contagion and global transmission of shocks.

Theory has begun to catch up with this shift in importance from retail to wholesale runs.² For example, Allen and Gale (2000) highlight the possibility that systemic risks in the interbank market can vary with the structure of creditor relations. Most risky is a structure with unilateral exposure chains among banks, while there is less risk of contagion when all banks lend to each other, as the effects of shocks are less concentrated. In between these two types of structures is a tiered structure of money centre banks on which other banks rely (Freixas, Parigi and Rochet 2000).

2. For a survey of the theory, see De Bandt and Hartmann (2002).

3. Liquidity Policy of Banks

Banks can protect against liquidity risk. Most obviously this can be done by holding a significant proportion of liquid assets (a so-called net defensive position). Cash is then available to be used immediately to answer liquidity needs, while government securities can be used readily as collateral. However, banks seek to avoid holding liquid assets given the cost in terms of lower profitability, the low frequency of crises, limited liability of shareholders, and the safety net, as discussed below. There have been major declines in asset liquidity over recent decades; for example, in the United Kingdom, banks' liquid assets were 30 per cent of the total in the 1950s, but today are only 1 per cent (Goodhart 2007).

Banks can dissipate withdrawal risk by diversifying funding sources. This is liability management, which aims to ensure the continuity and cost effectiveness of funding (Greenbaum and Thakor 2007). There are three key issues. The first is to ensure enough diversification to reduce liquidity risk among, for example, certificates of deposit, eurodollars, repurchase agreements (repos), subordinated debt and contingent credit facilities from other banks as well as interbank, time and demand deposits. Securitisation is a further instrument for liability management.³ The second is to ensure the appropriate mix of traditional deposits and investment products. Deposits typically incorporate services, have pay-offs that are insensitive to the fortunes of the intermediary, and are for small/uninformed users who are insured, so their demand for such deposits is usually stable. Investment products are typically risk-sensitive, have pay-offs that vary with the intermediary's performance, involve monitoring, and are for large/informed users, so their demand for these products may be more volatile. The third is the choice of maturity structure – duration matching affects the degree of liquidity risk, but may also reduce flexibility.

A further backup is holding adequate capital to ensure that creditworthiness is maintained in the face of adverse shocks. However, experience has shown that adequate capital according to current rules is not always sufficient to ensure liquidity problems are avoided, as solvent banks can suffer runs due to illiquidity. Regulation of bank liquidity is less developed than for capital, and not subject to international agreement.⁴ Compulsory reserve requirements are one policy for ensuring that banks hold liquidity, although their main purpose is for collateral in central bank monetary operations, overall monetary control and payments system functioning. Reserves are not readily available to meet a liquidity spike, especially if there is a mandatory minimum ratio. There is also typically qualitative oversight of liquidity policy in the context of prudential supervision (Pillar 2 of Basel II).

Goodhart (2007) argues that generous provision of liquidity by central banks, in normal times and times of crisis, has made banks careless in liquidity risk management, with low liquid assets and reckless liability management. The banks are seen as taking a liquidity 'put' with the downside risk of liquidity crises covered

3. For some discussion of contingent credit facilities see Gatev, Schuermann and Strahan (2006).

4. Rochet and Vives (2004) show that a combination of liquidity requirements, capital requirements and the lender of last resort can prevent coordination failure in interbank markets.

by the central bank. It is to the LOLR, that is, liquidity policy in times of emergency, that I now turn.

4. The Lender of Last Resort (LOLR)

I now go on to outline the doctrine of the LOLR, citing examples from history which are relevant to each point. These are the ‘accepted wisdom’ which, I argue, is called into question by the sub-prime crisis.

4.1 The nature and history of LOLR

The LOLR is generally described as an institution, such as the central bank, which has the ability to produce, at its discretion, currency or ‘high-powered money’ to support institutions facing liquidity difficulties and to create enough base money to offset public desire to switch into money during a crisis. This delays the legal insolvency of an institution and prevents fire sales and calling of loans.

The LOLR operation is by discretionary provision of liquidity (against collateral) to an institution or market to offset an adverse shock that creates an abnormal increase in demand for liquidity. The aim of the LOLR is to prevent illiquidity at an individual bank from leading to insolvency (owing to the fire sale problem, as defined above). Thereby it may avoid runs that spill over from bank to bank (contagion, as defined above), which may in turn lead to an impact on real wealth and GDP that would not occur in the absence of the panic. LOLR needs to act rapidly before illiquidity becomes insolvency and before such a panic begins to take hold.

I first briefly note historical developments before World War II. Although Thornton wrote first about the concept in 1802, the genesis of LOLR in practice is often thought to be the aftermath of the Overend Gurney crisis of 1866, when the Bank of England failed to prevent a crisis, which was subsequently reflected upon by Bagehot (1873). Put simply, he argued that the central bank should lend freely at a penalty rate against good collateral. Furthermore, the central bank has to act in the public interest and not solely its private interests, as the Bank may have done in 1866. The classic operation of LOLR was reflected, for example, in the rescue of Barings Bank by the Bank of England in 1890, as well as in panics during 1878 and 1914 (Bordo 1990). As noted by Goodhart (1988), these events took place during the period of the Gold Standard when the central bank was the institution maintaining convertibility of the currency with gold, which made it a natural LOLR, albeit generally also involving other banks in rescues given the limitation of its own capital base.⁵ Combined with uncertainty regarding rescues, the ‘club’ of banks in a national market would protect against moral hazard by policing behaviour of counterparties, even in the absence of modern banking regulation.

Even after the demise of the Gold Standard, the key role of the LOLR has often been considered to offset the risk of a monetary contraction, as in 1932 in the United

5. As noted by Bordo (1990), the Barings rescue included commercial banks and the Banque de France as well as the Bank of England.

States. However, as argued by Kaufman (1991), its more recent operation against a background of deposit insurance does not have this function, as a general flight from the banking system to currency is unlikely. Rather, crises tend to lead to a reshuffling of deposits between banks, and the LOLR seeks to limit losses of wealth and GDP that would otherwise take place when such reshuffling occurs.

Focusing now on more recent episodes and the current state of ‘doctrine’ in a modern financial system, LOLR intervention can be by direct lending (discount window) or by open market operations, as well as by off-balance sheet guarantees. Some argue that in an advanced financial system, LOLR should only be via open market operations, since the market will direct liquidity to where it is needed, and the risk of mispricing is avoided (Goodfriend and King 1988; Kaufman 1991). Such a policy was clearly successful in the case of operations associated with the spikes in liquidity demand in the Y2K and September 11 episodes, as well as after the stock market crash of October 1987.

However, Goodhart (1999) argues that LOLR may require direct lending, not open market operations, as market lending may fail to reach banks in distress whose failure threatens the financial system. This motivated, for example, the rescue of Continental Illinois in 1984, which was also thought to give rise to a risk of contagion due to its widespread interbank lending links (179 banks were thought to be vulnerable). In 1974 the Bundesbank let the Herstatt Bank fail, while giving liquidity assistance to the market in line with Goodfriend and King, but the consequence was a global breakdown of payment systems that almost precipitated an international financial crisis (Davis 1995).

Instruments of such direct support can be the discounting of eligible paper (such as government securities), advanced with or without collateral, and repos of the institution’s assets that the central bank is willing to accept. The value of collateral should exceed that of the LOLR support. There should be provisions for repayment and the provision of funds by the LOLR must be for the short term only, allowing examination of the financial institution for long-term viability. If there is default on LOLR loans, closure is needed, or if the bank is too-big-to-fail, it should be nationalised with owners and senior managers dismissed.

Generally, LOLR to date has been for banks and not for non-banks such as securities houses. Reasons are that banks are more systemically important and also so as not to weaken market discipline on less heavily regulated institutions. This was one reason for the refusal of the United States to support Drexel Burnham Lambert in 1989 (although the Bank of Japan did save Yamaichi in the 1990s; see Nakaso 2001). Equally, prudent investment banks, although dependent on wholesale funding, would typically hold short-term assets, protecting them against liquidity risk.

4.2 Costs of LOLR

There are costs to having a LOLR (He 2000). The LOLR is supposed to aid illiquid, but not insolvent, institutions (Humphrey and Keleher 1984). However, as noted by Kindleberger (1996), in a crisis it is hard to distinguish illiquid and

insolvent banks, and a bank that may initially be illiquid can become insolvent. Goodhart and Schoemaker (1995) note that banks generally face illiquidity when solvency is in question. Hence, liquidity assistance may lead to support for insolvent institutions, with direct costs for the central bank and fiscal authorities. Kaufman (1991) notes that the US Federal Reserve System (Fed), for example, supported Franklin National in 1974 and Bank of New England in 1990, which both subsequently failed. Furthermore, doctrine states that LOLR is not an appropriate policy alone in cases of simultaneous macroeconomic shocks to solvency – such as in the contraction of GDP in Finland in 1990 – which may require the fiscal authorities to recapitalise banks.

As noted, beyond direct costs, the safety net reduces the incentive for banks to hold liquidity, as risk is passed to the central bank (Goodhart 2007). It may also facilitate uninsured depositors exiting a bank (Kaufman 1991). Most crucially, LOLR increases moral hazard and consequent risk-taking, as well as weakening market discipline.^{6,7} Arguably, this is particularly the case for direct lending as opposed to open market operations. It is widely argued that the long-term decline in bank capital adequacy up to the 1988 Basel Agreement, as well as lower liquidity buffers, resulted from moral hazard generated by the safety net.

Further costs are that, if offered to insolvent banks, LOLR support increases the scope for forbearance. This is because it removes the pressure on regulators to close failing banks promptly (especially if the regulator is a separate institution from the central bank). If allowed to continue operating, banks with negative net worth can cause major costs, as in the Savings and Loan crisis in the United States in the 1980s. LOLR for the insolvent institution also raises the difficulty of institutions being too-big-to-fail – some banks can become ‘sure’ of rescue owing to their systemic importance, and this is also reflected in ratings (again the rescue of Continental Illinois was arguably the genesis of this).

A further cost is conflict with other policies. There may be conflicts with the monetary policy regime, unless liquidity is fully sterilised (the LOLR action at the time of the stock market crash in 1987 was seen as generating inflation). It may also conflict with fiscal rules if there is a guarantee by the fiscal authority.

4.3 Minimising costs of LOLR

Doctrine maintains that minimising such costs requires that there be only support for institutions whose failure entails systemic risk. The central bank must ensure that banks have made efforts to gain liquidity support and all market sources of funds have been exhausted. Equally, following Bagehot (1873), the authorities should demand high-quality collateral and a penalty interest rate. The former protects the central bank from credit risk and encourages the banks to lend at lower risk

6. As a consequence, Kane (1992) argues that LOLR is inappropriate and should be abolished given the cost of moral hazard.

7. This is illustrated by the existence of ‘support ratings’ for banks alongside their stand-alone ratings.

(Goodhart 2007). The latter, along with harsh conditionality (for example, liquidity restoration, restrictions on new business or on dividend payments), ensures that the borrower only requests LOLR support as a 'last resort'. Bordo (1990) notes, however, that in 1974 the Fed offered Franklin National loans at below market rates.

To further reduce moral hazard, doctrine states that the central bank should seek a private solution before using the LOLR (from the creditors, other major banks, etc). This has been the tradition in Continental Europe and indeed it is enshrined in French law. In Germany, the private Likobank is intended to substitute for the possibility of the central bank needing to undertake LOLR. On the other hand, experience has shown that banks are increasingly less willing to play a role in such rescues, owing to deregulation and international competition (Goodhart and Schoenmaker 1995). The Bank of England experience with the rescue of Johnson Matthey in 1984 showed this. The wholly-private rescue of LTCM in 1998, however, was a recent example of creditors being willing to mount a rescue – of a hedge fund – without guarantee, showing that private rescues are still viable in extreme cases, with suitable moral suasion by central banks.

The LOLR must also ensure that there is adequate information on financial institutions and strict financial regulation; although Goodhart and Schoenmaker do not conclude that there is a benefit to overall financial stability from the central bank being the supervisor.

To avoid monetary conflict, the central bank must sterilise liquidity – otherwise there is a risk of inflation, capital outflows and a collapsing currency (as occurred in Indonesia in 1997; He 2000). This requires instruments be available such as reverse repos, foreign exchange swaps and deposit facilities. There is also a need for backup from the fiscal authorities if the rescued bank is insolvent, otherwise the central bank may itself face solvency difficulties, as in Finland in 1990 when the central bank saved an insolvent savings bank and wiped out its own capital.

The central bank, according to doctrine, should reduce moral hazard by making access to LOLR facilities uncertain – the market is not to take for granted the action to be followed by the authorities, with decisions to be made on a case-by-case basis. The Bank of England has, for example, allowed banks such as Barings in 1995 to fail, since it was judged to be non-systemic. Ambiguity may be heightened by secrecy as to whether LOLR is taking place, as with the small UK banks that were rescued in the early 1990s, so as to avoid wider loss of confidence and ultimately underwriting the whole banking system (George 1994). Confidentiality can also help to prevent knowledge of LOLR support from giving rise to panic, a rise in borrowing costs or a loss of reputation to the bank in receipt of LOLR.

He (2000) suggests that central banks could nevertheless spell out necessary but not sufficient conditions for LOLR (for example, a precondition of solvency and exhausting available sources of funds) – thus reducing incentives for unnecessary crises and giving incentives for stabilising private-sector actions. This might also reduce risks of forbearance and political interference. But *ex ante* transparency may heighten the risk of runs, and give rise to moral hazard (The Economist 2008). There

remains a strong case for *ex post* transparency (that is, saying what has been done after the crisis has subsided, to ensure accountability in the use of public funds).

Generally to date, LOLR has been in domestic currency (on the argument that banks should be responsible for foreign exchange risk management). In this context, there is the unresolved problem for cross-border banks (notably in the European Union) of whether the home or host LOLR should play the largest role in a crisis.

4.4 LOLR in systemic crises

So far I have discussed LOLR for a non-systemic problem. In times of systemic crisis it may act differently (Hoelscher and Quintyn 2003). This is a situation of panic, flight-to-quality and widespread contagion. The aim is to reassure the public that financial disorder will be limited and to stop panic runs, by public announcements and visibility. The central bank may need to provide uniform support for all banks short of liquidity, even if they are suspected to be insolvent, in order to protect the payments system and the macroeconomy. Constructive ambiguity is no longer appropriate (Nakaso 2001). Collateral and solvency requirements may be relaxed, at least if there is a government guarantee. No penalty rates would be imposed as they would worsen the panic. Also the central bank would need to suspend judgment of which institutions are systemically important.

Emergency liquidity assistance in such cases is to be part of the overall crisis management strategy involving the central bank, supervisors and the fiscal authorities. It may require a general macroeconomic policy easing (for example, interest rate cuts) as a crisis by itself constitutes a tightening of financial conditions. However, care is needed to avoid inflation or an exchange rate collapse. There is an option of imposing capital controls (as in Malaysia in 1997). Costs of such emergency assistance policies can be sizeable. Hoelscher and Quintyn (2003) record that liquidity support during the Asian crisis was 16 per cent of GDP in Indonesia in the form of overdrafts from the central bank, and 13 per cent of GDP in Malaysia from central bank deposits (which were, however, repaid).

In a systemic crisis, there may also be a blanket deposit guarantee by the government, as in Japan and Sweden in the 1990s, and the fiscal authorities will have to bear the costs of bank recapitalisation. The overall fiscal costs of crises will thus often far exceed the LOLR assistance – in Indonesia the overall cost was around 50 per cent of GDP. This potential fiscal burden, in turn, helps motivate the separation of regulation from central banks (Goodhart and Schoenmaker 1995). It also underlines the point that liquidity assistance must not be a long-term policy – it should be used to stop panics and buy time for evaluation of the financial system. The government may need to recapitalise or close insolvent banks in a long-term restructuring (as took place in Sweden and Finland in the early 1990s). The LOLR is still needed in a systemic crisis if the credibility of the deposit insurance scheme is lacking (or depositors fear delay in repayments) – in which case the fiscal authorities may also need to guarantee the central bank.

Having outlined liquidity risk, bank liquidity policy and the evolving doctrine of the LOLR, I now go on to assess whether the current sub-prime crisis requires our understanding of these concepts to be revised.

5. Recent Developments in Liquidity Risk

5.1 The sub-prime crisis and liquidity

I suggest that the understanding of the liquidity problems in the current crisis requires theory to go beyond the Diamond-Dybvig (1983) concept of bank funding liquidity risk, to encompass market liquidity risk and its interaction with funding liquidity against a background of heightened credit risk (see also IMF 2008). It also requires consideration of the impact of banks' policies of marking to market, risk management and balance sheet management (Adrian and Shin 2008).

Market liquidity risk can be defined as the ease with which one can liquidate a position in an asset without appreciably altering its price. Institutions and markets were shown to be much more closely integrated than in the past. Systemic market liquidity problems were only apparent before the sub-prime crisis during the LTCM crisis (IMF 1998; Davis 1999) – although in the case of LTCM the banks were relatively unscathed. I first describe the build-up to the sub-prime crisis, as well as the crisis itself, before considering relevant liquidity risk paradigms.⁸

Key developments in the period 2000 to 2007 include the accelerating shift by banks from holding loans on balance sheet to relying on securitisation (which in turn reduced the incentive to monitor loans). Banks held increasingly low levels of on-balance sheet liquid assets and they undertook aggressive wholesale liability management to maintain funding levels. Banks also attempted to shift risk to off-balance sheet conduits and structured investment vehicles (SIVs) in order to save capital under Basel I rules.⁹ These shifts occurred in a context of low global interest rates, arising in turn from high levels of global liquidity, which prompted a hunt for yield (for example, via higher credit risk in structured products and sub-prime loans). More generally, scope for securitisation (and the impression of liquidity it gave), high credit ratings on asset-backed securities (ABS) and the seeming precision of risk models based on inadequate data, may have lulled banks into taking on more credit risk than they otherwise would.

By 2007 there was a growing realisation of potential losses on sub-prime mortgages (that is, credit risk) as US house prices fell and defaults increased. These loans had been widely packaged into ABS. Investors, concerned not only about losses on the underlying assets but also lack of transparency as to how individual ABS would be affected, began to sell them. Sales led in turn not just to price falls but also market liquidity failure for the OTC markets for the ABS. As prices fell,

8. For a more detailed summary see Brunnermeier (forthcoming).

9. The capital charge on credit lines to such subsidiaries was less than those of holding the assets on balance sheet.

trading became difficult or impossible, even among the lowest risk tranches of the relevant securities.

As noted by the European Central Bank (ECB 2008), price falls affected not only the standardised instruments such as index-based collateralised debt obligations (CDOs) but also the ‘bespoke’ structures that are not normally traded but which are nonetheless marked to market. This link followed from the fact that implicit prices for the latter are derived from the former. Furthermore, Scheicher (2008) shows econometrically that, over and above concerns regarding credit risk, there were significant concerns about market liquidity and the lower appetite for risk in accounting for the fall in prices (the rise in spreads). Such liquidity and risk-aversion effects are omitted from standard CDO pricing models.¹⁰

This liquidity failure was aggravated by rising margin requirements, which limited the freedom of speculative investors, such as hedge funds, and led them to sell holdings of ABS. It was also worsened by the lack of risk capital allocated to market-making in such products, due to the rise in volatility and lower revenues to investment banks, which limited their ability to take risks.

The rush to sell securitised assets may also have been worsened by the effects of price falls in the context of mark-to-market accounting on the capital of leveraged institutions. Another factor was the reliance of some institutions on quantitative techniques of trading and risk management that assumed continuous liquidity (IMF 2008).

As a result, long-term investors may have been constrained from taking contrarian positions that could have renewed market liquidity due to excessive leverage (for example, of hedge funds) and consequent credit restrictions in the context of mark-to-market accounting (Palmer 2008). Monoline insurers, that provide some credit guarantees to ABS and credit default swaps (CDS) themselves, also came under financial pressure (BoE 2008).

Banks were also rapidly affected by the loss of liquidity in the market for securitised loans. They had to mark to market ABS held on balance sheet, so price falls affected their solvency. This was unlike banking crises in the past where loans have typically been held at historic cost with no specific price. The fact that a great many ABS were held in conduits and SIVs spread the contagion, since these institutions require financing in the market for asset-backed commercial paper (ABCP). Doubts by money market funds regarding the ABS held by the conduits and SIVs led to a loss of liquidity in the ABCP market also, which meant that sponsoring banks had to take the assets back on their balance sheets. The extensive holding of US ABS by European banks and related conduits and SIVs spread the impact internationally.

Meanwhile, traders’ attempts to hedge, meet margin calls or realise gains in safer or more liquid markets adversely affected liquidity in other markets in a contagious manner. Market-makers in a range of markets were often unwilling to trade at

10. The corollary is that the potential scale of losses is exaggerated by using a mark-to-market approach to value such illiquid securities (BoE 2008).

posted prices (IMF 2008) due to uncertainty, volatility and concern about the risks of counterparty default.

The crisis has revealed new patterns in funding liquidity risk which stem from market liquidity risks. Banks were unable to securitise the mortgages and other loans they were issuing, owing to the collapse of the ABS market. They also experienced calls on backup lines of credit for conduits and SIVs that were unable to issue ABCP. Accordingly, banks hoarded liquidity in order to provide sufficient funding for their ongoing business. This hoarding was aggravated by fear of counterparty risk in the interbank market, due to other banks' undisclosed losses on ABS from stresses affecting credit quality and the availability of liquidity. Mark-to-market becomes a highly uncertain process when liquidity collapses (ECB 2008), giving rise to concern that the assets of counterparties are mismeasured. One consequence of these problems of funding liquidity was the failure of the solvent UK mortgage bank Northern Rock, which had an aggressive reliance on both wholesale funding and the securitisation of assets, which was no longer feasible (House of Commons Treasury Committee 2008). In contrast, the US bank Countrywide was able to rely on liability insurance contracts that limited the scope for a run, a feature not present in earlier crises.¹¹

These combined features led to the emergence of historically large interest rate premia – and quantity-rationing of funds – in the domestic interbank markets in the United States, the United Kingdom and the euro area, at all but overnight maturities. Funding at three months became particularly difficult to obtain. In summary, these patterns in turn meant that funding liquidity risk was closely related to market liquidity risk. Banks were vulnerable to this linkage due to their low holdings of liquid assets, increasing reliance on short-term wholesale funding, dependence on securitisation, backup lines to SIVs, and the rise in overall maturity mismatch on their balance sheets related to 'repatriation' of SIVs and conduits.¹²

5.2 Relevant liquidity risk paradigms

In evaluating the sub-prime crisis, it clearly has elements of the standard liquidity crisis paradigm (Tirole 2008), such as an aggregate liquidity shock (fall in house prices), deterioration of underlying loan quality, fire sales (of ABS) and runs (on Northern Rock and Bear Stearns). Moreover, the run-up to the crisis showed the familiar signs of the procyclicality of financial markets (Borio, Furfine and Lowe 2001). However, there were also a number of less familiar elements.

I suggest that one helpful paradigm for the crisis is to reinterpret the concept of liquidity insurance, central to the Diamond and Dybvig (1983) model in the context of securities markets. Securities markets offer liquidity insurance, but in a different way to banks, by increasing the ease with which assets may be transformed into

11. Goodhart (2007), however, notes that such liability insurance is not a resolution for a systemic crisis, as it merely relocates liquidity risk.

12. Bradley and Shibus (2006) show that US banks' ratios of deposits to liabilities fell from 93 per cent in 1965 to 60 per cent since 2000.

cash prior to maturity (Davis 1994; Bernardo and Welch 2004). Yields are generally lower in highly liquid securities markets, as investors are more willing to hold a claim if they are confident of its liquidity. Unlike at-call deposits at banks, there is no guarantee of a fixed rate at which securities can be liquidated immediately, but short-term high-quality debt securities provide a considerable degree of security. Meanwhile, so long as markets remain liquid, the investor benefits from a shorter effective maturity than offered by the issuer, thus there is again maturity transformation.

Like banking, however, market liquidity depends on all other holders not seeking to realise their assets at the same time. If doubt arises over the future liquidity of the securities market it is rational to sell first, before the disequilibrium between buyers and sellers becomes too great and market failure occurs. That is, prices are driven down sharply, and selling in quantity becomes extremely difficult. Such collapses may result from a fear of deteriorating funding conditions, which leads a number of investors to sell assets simultaneously before they are forced to do so under fire-sale conditions.

A loss of liquidity in debt markets may have externalities similar to bank failures. This may be particularly true if: there are leveraged investors who are forced to sell despite such illiquidity; there is contagion between markets; illiquidity makes investors unwilling to accept new issues; and there are debtors who do not have an alternative source of rollover finance.¹³ Note that all of these channels are relevant to the description of the sub-prime crisis above, particularly with respect to the liquidity failure of the ABS and ABCP markets. Following runs on these markets, the interbank market was adversely affected, as banks that could not securitise – and had to finance backup lines – hoarded liquidity. Such patterns were unprecedented, given the enhanced role of banks as asset sellers and liquidity providers.

The nature of liquidity failure in securities markets is further clarified by analysis of the role of market-makers, whose importance was again outlined in the description above. The response of market-makers to ‘one-way selling’, where the new equilibrium price is uncertain, is often simply to refuse to quote firm prices, for fear of accumulating stocks of depreciating securities. This contributes to a collapse of liquidity. Uncertainty is crucial; if there is a clear new market-clearing price at which buyers will re-emerge, the market-makers will adjust their prices accordingly. Such uncertainty was seen as a key feature of the recent crisis, relating notably to structured products, which had no price history to help predict behaviour under stress (Caruana and Kodres 2008), and which also led to banks being unable to price their own assets.

13. The parallels between banks and securities markets are not exact, since investors who are not constrained to sell and do not suffer defaults do not make a loss by ‘sitting tight’ and can still make a profit on their portfolio of securities. In other words, markets, unlike banks, may become illiquid but cannot become insolvent. Equally, the difficulties for issuers arise only in the case that an existing issue of securities needs rolling over – or there is a pressing need for a further issue – when the liquidity problem arises.

The collapse of dealer markets, even in the absence of generalised uncertainty and one-way selling, may result from perceptions of asymmetric information (Glosten and Milgrom 1985; Kyle 1985). A rise in the share of insiders leads market-makers to widen spreads to avoid losses. This discourages liquidity traders, who withdraw, increasing adverse selection. Some dealers may cease to operate. Once the insiders (with superior information) become too numerous, bid and ask prices may be too disparate to allow any trade. Here I note that banks feared that others were not disclosing their true losses on ABS, directly and via SIVs, so they refused to lend on the interbank market. Equally, ABCP investors doubted the value of assets in SIVs and so refused to finance them. In the case of either one-way selling or acute asymmetric information, the asset market, in effect, ceases to function. The associated decline in liquidity is likely to increase sharply the cost of raising primary debt in such a market (that is, there will effectively be heightened price rationing of credit), or it may even be impossible to gain investor interest at any price (quantity rationing). The closure of markets for securitisation fits this description.

The IMF (2008) argues that market liquidity collapses are particularly likely when market-makers lack absorptive capacity, for example, due to costs of funding inventory and internal capital limits, which will in turn relate to whether returns to market-making are low. Gromb and Vanayos (2008) argue that there is a feedback loop, as price falls hit the capital of dealers, making them less willing to make markets. Indeed they may sell existing inventories, aggravating the problem. Market liquidity collapses may also occur more commonly when there is no clear order of trading, as in OTC markets, and when market-makers are risk-averse (Bernardo and Welch 2004). There can also be spillovers between funding instruments when firms are active in several markets, as market-makers and/or arbitrageurs, as liquidity needs in one market lead to early liquidation of assets in other markets.

Adrian and Shin (2008) also suggest that contagion during the current crisis differed, in quite specific ways, from that in traditional liquidity crisis models. The traditional view, as set out in Section 2, is that credit risk leads to contagion, either via direct exposures or uncertainty over opaque balance sheets. In the current world, Adrian and Shin argue that contagion occurs via changes in market prices, according to the way that risks are measured and the mark-to-market practices of financial institutions. Financial institutions are seen to manage balance sheets actively in response to price changes and measured risk. Moreover, this appears to have led to a positive relation between changes in leverage of commercial banks and balance sheet size, as they have taken on behaviour patterns hitherto more typical of investment banks.

In an upturn, when balance sheets are strong, banks see leverage as too low and seek to expand balance sheets by increasing lending and incurring short-term liabilities. This is seen as boosting aggregate liquidity across the economy as a whole, facilitating lending to sub-prime borrowers in the run-up to 2007. As things turn down, perhaps in response to an adverse shock to market prices (as occurred due to heightened perceptions of credit risk and the collapse of market liquidity in 2007), financial institutions that mark to market find their leverage too high and seek to contract their balance sheets. Cifuentes, Ferrucci and Shin (2005) note

that fire sales of assets by distressed institutions may aggravate such a pattern by further depressing market prices. Note the contrast with traditional crises, in which a deterioration of credit quality would have no immediate direct effect on the balance sheet, assuming that valuations are based on book values. Mark-to-market creates a new and much closer link from illiquidity to insolvency, since a loss of liquidity causes price falls that impact solvency directly, leading in turn to further attempts to sell and further price falls.

Adrian and Shin (2008) show that a pattern of desired reduction in leverage is precisely what happened successfully in the LTCM crisis. However, the current crisis is different because banks found themselves obliged to expand credit to cover backup commitments for SIVs and conduits, due to the closure of the ABCP market. Also, the closure of the ABS market meant that banks had to hold mortgages they were issuing on balance sheet. In such a situation, it is argued that they quickly cut back on discretionary lending, most notably to the domestic interbank market.

A helpful complementary paradigm of funding liquidity that encompasses some of the events of the 2007 and 2008 crisis is provided by Freixas, Parigi *et al* (2000). According to this model, liquidity may dry up for a solvent bank in the interbank market if there is imperfect information, or if there is market tension which reduces the lending bank's excess liquidity and its scope to diversify. The interbank market as a whole may face liquidity problems if each bank refuses to lend to others because it cannot be confident of its own ability to borrow, a form of liquidity crisis akin to the Diamond-Dybvig model.

Brunnermeier (forthcoming) talks of four mechanisms by which small shocks are amplified, leading to a loss of liquidity. These are first, borrowers' balance sheet effects comprising a loss spiral (as an initial loss on a leveraged balance sheet leads to a decline in net worth, sales and price movements, further reducing net worth) and a margin spiral (as increased margins lead to deleveraging and sales, leading to lower prices, further increasing margins). Second is a lending channel effect (notably precautionary hoarding of liquidity). Third are runs on institutions and markets (including the interbank, ABCP and investment bank repo markets). Fourth are network effects; for example, when Goldman Sachs expressed concerns about exposures to Bear Stearns via swap netting arrangement, hedge funds avoided Bear Stearns as a prime broker, thereby helping to bring about its demise.

6. The LOLR and the Sub-prime Crisis

Besides needing a new understanding of the nature of liquidity failure in financial crises, the recent turmoil has raised a number of issues for the traditional LOLR role of central banks (described in Section 4 above), suggesting a need to amend the traditional doctrine. These issues did not come into play in the same way in the otherwise similar LTCM crisis (Davis 1999), where the resolution occurred largely via a private-sector rescue of the hedge fund (albeit under pressure from the Fed) and interest rate cuts by the Fed. Following the same order as Section 4, I now go on to discuss issues relating to open market operations and individual lending; the nature of open market operations; the widening of the safety net from commercial

banks; the issue of illiquidity and insolvency; conflicts with other macroeconomic policies; collateral policies; private-sector rescues; difficulties with information; reputation of banks and LOLR confidentiality; interaction with deposit insurance; and international concerns. I conclude by pointing out the issue of how authorities may exit from current LOLR policies.

I note at the outset that although the sub-prime crisis was seen as giving rise to major risks, the operation has not (yet) involved the fiscal authorities in widespread guarantees and bailouts as is typical of a major systemic banking crisis as cited in Hoelscher and Quintyn (2003). I therefore concentrate on points raised in the non-systemic discussion of current doctrine in Sections 4.1–4.3.

6.1 The sub-prime crisis and the nature of LOLR

Earlier I discussed whether open market operations or individual lending was most appropriate for LOLR. For the most part during the current crisis, LOLR was in the form of open market operations, but under unprecedented conditions. Extreme tightness of the interbank market in all but overnight maturities had not hitherto been a feature of domestic markets in advanced countries. Accordingly, the Fed and ECB, in August 2007 and thereafter, intervened heavily to overcome the liquidity crisis in the interbank markets – which had negated the usual method of distributing liquidity around the banking system, including to banks lacking access to open market operations. Note that such policies do appear to be close to standard open market operations, but I contend that the emergency operations cited were ‘LOLR-like’ in the sense of being to satisfy short-term increases in the demand for reserve money, as opposed to setting interest rates *per se*.¹⁴

Owing to the interbank market difficulties, central banks such as the ECB also felt the need to lend in open market operations at longer maturities than had hitherto been the case. In the United States, the Fed introduced the term auction facility (TAF), making funds available at longer terms than normal. This extension of the maturity of liquidity assistance was a response to the weakness of the longer-term interbank market and the banks’ needs for such funding in the light of the collapse of ABCP issuance and the demand for backup facilities. It also meant that some players with adequate liquidity positions had even more scope to hoard liquidity.

One puzzle in the current crisis is why it is so protracted given the amount of support central banks have offered to markets and institutions. A key issue is of course the underlying uncertainty about the valuation of assets on banks’ balance sheets. But, as Caballero and Krishnamurthy (2008) argue, there may also be underlying uncertainty as to whether central banks have the liquidity and instruments to resolve the crisis.

I noted in Section 4.1 that traditionally LOLR assistance has been provided only to commercial banks. The Fed was forced to implicitly extend safety net protection to include investment banks, incurring a balance sheet guarantee for the Bear

14. Goodhart (1999) maintains that only support for individual banks should be termed LOLR.

Stearns rescue via JPMorgan Chase. It also made emergency liquidity available to investment banks more generally.¹⁵ The Bear Stearns situation showed that some investment banks have become sufficiently systemic to warrant such rescues, not due to the size of their balance sheets but because of their central role in the markets for credit default and interest rate swaps (Palmer 2008). Equally, however, some argue that Bear Stearns had departed from the traditional model of investment banking by holding long-term illiquid assets, making it particularly vulnerable to liquidity risk. Given this precedent, and wider liquidity provision, investment banks are now accorded unprecedented protection for their risk-taking activities, which is widely seen as requiring tighter regulation.

6.2 The sub-prime crisis and the costs of LOLR

The role of markets in the current crisis made the issue of only lending to the illiquid and not the insolvent a more complex one. In effect, central banks were at times lending in order to reliquify markets (also via collateral as discussed below) and only indirectly to provide liquidity to institutions. A market can obviously not become insolvent but its liquidity can impact on institutions' solvency, as the sub-prime crisis showed and Section 5.2 highlighted.

Conflicts with other policies loomed large during the current crisis. Central banks injecting liquidity at times faced the challenge of not changing the overall monetary policy stance in an undesired manner. Given the need for liquidity at longer maturities than normal, sometimes this would entail central banks withdrawing liquidity at shorter maturities to keep the monetary policy stance unchanged. I note that there remained a challenge also to traditional interest rate setting given the unprecedented and persistent spreads between LIBOR and central bank rates, that made official rates a poor indicator of the true stance of monetary policy (Martin and Milas 2008).

An unanswered question in the current crisis is how much moral hazard has been generated by these 'new' LOLR policies. Certainly, aspects such as the extension of the safety net to investment banks and the easing of collateral policies, as discussed below, could have the effect of worsening moral hazard.

6.3 The sub-prime crisis and minimising costs of LOLR

It was noted that requiring good collateral is a key basis of the traditional doctrine of the LOLR. Some central banks implicitly responded to the loss of market liquidity in 2007 and 2008 by reducing collateral standards (accepting residential mortgages, and even ABS). This in turn could be seen as reliquifying the ABS market indirectly, in effect setting prices for those assets, as market-maker of last resort. The Fed and the Bank of England extended their lists of eligible collateral, the Fed including credit derivatives in eligible collateral. Eventually the Bank of England set up a system of long-term swaps for mortgages and ABS with government bonds, thought

15. This was via the new term securities lending facility.

likely to total over £50 billion, but only for assets already held on the banks' balance sheets in December 2007.

This easing of collateral requirements is an inversion of traditional LOLR rules, with central banks possibly accepting excessive credit risk (although the latter is controlled by haircuts, notably by the Bank of England) and also potentially encouraging banks to continue risky lending practices (if such loans can still be used as collateral), and correspondingly justifying the banks' low levels of liquid assets (Goodhart 2008a). Meanwhile, banks have the incentive to hoard top-quality collateral, and central banks may risk becoming lenders of first resort, facing adverse selection as banks have an incentive to offer up the worst-quality assets as collateral. This was an issue for the ECB, which did not expand its already extensive list of eligible collateral, but did find that banks were undertaking ABS securitisations solely for ECB collateral (The Economist 2008).

Doctrine states that private-sector solutions need to be sought in order that LOLR policies avoid generating moral hazard. But in general these were not forthcoming in the sub-prime crisis. Northern Rock had to be rescued by the Bank of England and the UK government rather than a private-sector buyer being found. Bear Stearns was only bought by JPMorgan Chase with a Fed guarantee. These cases underline, on the one hand, the wide scale and scope of the problem, with few banks feeling strong enough to step forward as buyers. On the other hand, they also reflect the uncertainty about valuations, which may have hindered private-sector buyers from stepping forward. In the case of Northern Rock, prospective buyers in advance of the run were put off by the liquidity problems of the bank, as well as the protracted process of takeover in the United Kingdom (House of Commons Treasury Committee 2008, pp 51–52).

Adequate information was noted to be essential for efficient operation of LOLR. Northern Rock presented a challenge for the United Kingdom's nascent tripartite agreement. It was considered that the Financial Services Authority (FSA) did not warn the Bank of England of the risk to Northern Rock in a timely manner. Eichengreen (2008) attributes such problems to differences in bureaucratic incentives and questions whether separation of regulation and LOLR is appropriate. The United Kingdom is introducing an enhanced role in financial stability for the Bank of England to rebalance the relationship between the Bank of England and the FSA.¹⁶

The loss of reputation for banks obtaining support, and the confidentiality of the LOLR, has become an important issue (Goodhart 2008a). In the United Kingdom, LOLR support was offered to the solvent bank Northern Rock as it had suffered a

16. As set out by the UK Chancellor in June 2008, current proposals are: first, for provision of a statutory responsibility for financial stability for the Bank of England; second, changes to the governance structures of the Bank of England, to support the Bank and the Governor in the exercise of these new responsibilities, including the establishment of a new Financial Stability Committee of the Court; and third, provision of a range of tools for the Bank of England to enable it to carry out its responsibility in this area. This will include a leading role in the implementation of the new special resolution regime (SRR), should it be triggered by the FSA, with powers related to deploying and implementing the SRR tools. These proposals will be included in the Banking Reform Bill, to be introduced later in 2008.

loss of wholesale funding, on which it was heavily dependent, and it was considered too big to fail. This support was planned to be announced by the Bank of England, unlike its past behaviour to keep such interventions secret. (It has been reported that the Treasury Solicitor gave advice that secrecy was illegal under EU financial regulations.) However, the announcement was pre-empted by a leak to the British Broadcasting Corporation on the previous day. This is in stark contrast to earlier episodes when support was covert and successfully so.¹⁷ There followed a retail run which was only stopped by a government guarantee – the bank was ultimately nationalised.¹⁸ The internet facilitated the retail run in a manner that would not have been feasible in the past, both via direct withdrawals and panic when the bank's website crashed.

Particularly in the wake of this, banks were unwilling to access central bank lending facilities, for fear of similar reputational risk. Rather they increased market demands for liquidity, for example, via backup facilities, that may have worsened the tight liquidity situation (IMF 2008). The responses to such reputational issues, also present in the United States, included the TAF, whereby the Fed made funds available not only at longer terms but also to a wider range of counterparties and with a wider range of collateral. This was seen as not carrying a stigma in contrast to discount window borrowing (the rate for which was meanwhile reduced, contrary to traditional doctrine, to seek to avoid stigma).

The growing public awareness of limitations of the United Kingdom's deposit insurance scheme was a feature in the Northern Rock case. This featured co-insurance up to a low maximum sum, and no guarantee of a prompt payout. By its nature, it seeks to provide protection from moral hazard, incentives to monitor and a degree of consumer protection – not to protect against runs (Goodhart 2008b). The lesson is that LOLR may be called upon more often in such regimes because of runs – but a comprehensive guarantee risks generating a lot of moral hazard (and makes more urgent a bank insolvency regime for 'prompt corrective action'). Some would argue that it was deposit insurance problems rather than systemic risk that motivated the Northern Rock rescue.

I noted above that the traditional LOLR was confined to the domestic banking system. The crisis revealed that the traditional LOLR is unsuited to the globalised banking system. This was evident in the lack of liquidity in US dollars for European banks, following disruption in the foreign currency swaps market, as underlying money markets dried up. This meant that banks were unable to arrange liquidity to meet payment requirements in different currencies. This was eased in December 2007 by cross-currency swap arrangements between the ECB, Swiss National Bank and the Fed, linked to the TAF mentioned above.

17. The Bank of Japan faced similar challenges in 1998 when deciding not to offer LOLR to the Long-Term Credit Bank of Japan, for fear of a loss of reputation. However, in that case a merger was seen as probable if not certain (Nakaso 2001).

18. Further difficulties arose thereafter for the UK authorities owing to the lack of a special insolvency scheme for banks.

It can be argued that the domestic focus of LOLR worsened uncertainty in the globalised banking community, where banks have exposures in many currencies. Cooperation between central banks had to be increased due to the need to avoid liquidity support operations affecting domestic monetary conditions that could have influenced the euro/US dollar exchange rate. Equally, there may be a need to avoid international banks ‘gaming’ between different collateral requirements at the major central banks (The Economist 2008), which may in turn necessitate further coordination of collateral policy (FSF 2008). On the other hand, there was not a major failure of a cross-border institution. In a future crisis, such an event would severely test cross-border central bank and fiscal authorities cooperation.¹⁹

Finally, the central banks face a challenge in terms of exit strategies from some of the measures that have been adopted for the crisis. They will need to prevent moral hazard, for example, by retightening collateral regimes to avoid banks having long-run incentives to hold less, and lower-quality, collateral. They will also need to ensure that the interbank market is reactivated, for example, by reducing term lending facilities when they are no longer needed. The Economist (2008) suggests that similar issues of generous LOLR holding back the revival of publicly traded markets will arise for the European ABS market, which in mid 2008 consisted mainly of securities for collateral with the ECB.²⁰

7. Conclusion

It is well known that liquidity risks are endemic to banks given the maturity transformation they undertake. The first line of defence should be appropriate liquidity policy for both assets and liabilities, supported by adequate capital and robust supervision. Despite these, solvent banks can face liquidity difficulties at times of stress, necessitating liquidity support.

As doctrine has developed, the role of the LOLR is to avoid unnecessary failures, with suitable safeguards for central bank balance sheets and to minimise moral hazard. The role of LOLR in crisis periods is to prevent contagious panic by all means available – the central bank in such cases requires government support. LOLR must be a temporary policy with restructuring of distressed banks and corporate borrowers in the long term.

The current crisis has shown that traditional models of banking risk and of LOLR require revision, as was already apparent to a lesser extent in the LTCM episode. Funding risk now interacts with market liquidity risk to create difficult challenges for central banks. Runs must be envisaged in markets and not just banks, which given mark-to-market accounting, leads to threats to the liquidity and solvency of banks via changes in market prices.

19. As noted, the Fed accepts credit derivatives in liquidity operations while others do not. The ECB allows for newly created ABS and the Bank of England restricts access to its long-term liquidity to securities already on banks’ balance sheets as at December 2007.

20. The Economist quotes an estimate by JPMorgan that €320 billion in eligible mortgage-backed ABS were created from August 2007 to June 2008 but only €5.8 billion were placed with investors.

As a consequence, extensive changes to the traditional LOLR have been necessary, including: longer-term funding provision with a variety of lower-quality collateral; bringing investment banks into the safety net; and difficult challenges related to confidentiality of bank support and the interaction with deposit insurance. It is an important issue to investigate whether the net effect of these changes has been to increase moral hazard, the Achilles heel of the safety net. There also remains the unresolved issue of failure of cross-border institutions.

Beyond the scope of this paper, there is a further challenge to develop regulation of bank liquidity so that the LOLR is not so essential in future episodes. This could involve a liquidity adjustment to value-at-risk estimates to incorporate maturity transformation, measurement of stock liquidity and appropriate market and funding liquidity stress tests (Goodhart 2007; IMF 2008).

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Discussion

1. Ian Harper

When Christopher Kent asked me at short notice to comment on a paper at the RBA Conference, I was initially wary. My days of slashing through thickets of algebra are well behind me! But when I learned that the paper was written by Phil Davis, I readily agreed. I have always found Philip's work to be both stimulating and instructive, and I am pleased to say that his paper at this year's conference is no exception.

Philip focuses our attention on the implications of the sub-prime crisis for the 'lender of last resort' (LOLR) function of central banks. LOLR is traditionally aimed at resolving liquidity crises in banking systems. It relies on the unique position of central banks as ultimate suppliers of base money or cash. In principle, a liquidity crisis can always be resolved by a central bank because it can continue to exchange base money for less liquid assets until the crisis passes. The trick is to ensure that the crisis is truly a liquidity crisis and not a solvency crisis. Central banks have no business rescuing the shareholders (or even the creditors) of an insolvent bank.

Traditionally, central banks have sought to avoid supporting insolvent banks by demanding high-quality collateral in exchange for last-resort loans. A bank with a ready supply of high-quality but illiquid assets is unlikely to be insolvent. But the line between illiquidity and insolvency is not clearly drawn and, as Philip illustrates in his paper, central banks have often found *ex post* that their liquidity support merely deferred insolvency or that they were in fact supporting banks that were already insolvent.

Philip's main point in this paper is that financial innovation has broadened the definition of liquidity and made liquidity crises even harder to distinguish from solvency crises. The sub-prime crisis is a case in point. It is at base a solvency crisis, deriving from the inability of mortgagors to service their loans and the rapidly declining value of the underlying security (that is, their houses). And yet it has precipitated the need for emergency liquidity support of a range of institutions, many of whom have little or no exposure to sub-prime mortgages or their related mortgage-backed securities.

Two decades of financial innovation have greatly enhanced the reliance on markets for liquidity management. The concept of liquidity can no longer be confined to the ability of an institution to raise funds against the collateral of its assets ('funding liquidity') but must now encompass its ability to sell assets quickly into deep markets at predictable prices ('market liquidity'). Equally, the concept of a 'run' can no longer be conceived simply as an urgent call on the liquid assets of a financial institution but also as a sudden and simultaneous desire to sell assets by those same institutions. Both types of 'run' are equally contagious but the advent of mark-to-market accounting makes a 'market liquidity' crisis far more likely to morph quickly into a solvency crisis as the net worth of all institutions – even

those with what had appeared to be unimpeachable credentials like Freddie Mac and Fannie Mae – spirals downwards in the mayhem.

The widening of the concept of liquidity makes the notion of LOLR hard to pin down. How can central banks extend liquidity support to markets rather than institutions? Should central banks act as market-makers of last resort as well as lenders of last resort? These are the questions Philip examines in his paper but, if I am to express just the slightest frustration with an otherwise excellent discussion, he leaves us with more questions than answers!

So having read Philip's paper I knew a good deal more about the changing nature of liquidity in modern financial systems and the variety of ways in which central banks have extended liquidity support in these testing times. In fact, central banks have been forced to modify their traditional approach to LOLR 'on the run', so to speak. He is asking questions which have been answered *in fact* through the actions of central banks with no alternative but to act in extraordinary circumstances. But this does not lessen the weight of his questions and the importance of knowing whether what central banks are doing is right or sensible.

But having read his paper I also felt the absence of analysis and of lessons drawn from experience so far. Perhaps it is still too early for clear answers but here are some of the questions I was left pondering after finishing Philip's thoughtful and engaging paper:

- What else could or should central banks have done in the current crisis?
- What actions can already be seen, or will be seen, as mistakes?
- What lessons does this experience teach us about the wisdom of separating central banking from prudential supervision?
- There has been a call here in Australia for the creation of a new institution ('AussieMac'), modelled on Freddie Mac and Fannie Mae, to act as market-maker of last resort in the market for mortgage-backed securities. Do we need a separate institution to act as market-maker of last resort while the central bank remains as the lender of last resort, or it is appropriate for the central bank to take on both roles?
- What are the longer-run implications of extending a liquidity safety net beyond the banking system? Some have blamed recent events on commercial banks behaving like investment banks. But if we extend LOLR to investment banks, as the Federal Reserve System did in rescuing Bear Stearns, will we not be obliged to force investment banks to behave like commercial banks and, if so, what does this imply for the risk spectrum in financial markets?

2. General Discussion

The discussion started with some debate about the appropriate role of a central bank during a financial crisis. It was suggested by a number of participants that the LOLR role no longer operates in its traditional form (as set out by Bagehot in

Lombard Street). Some thought that the modern equivalent of ‘lending freely at a penalty rate against good collateral’ was lending at the discount window, which is part of normal operations at most central banks. Along this line of thought, some argued that actions deemed as LOLR should be more narrowly defined than in the Davis paper; for example, some suggested that the only action deemed to be truly last-resort lending should be a government bailout, at which point lending at penalty rates is ineffectual. It was widely agreed that it is sensible for central banks to provide liquid assets to the market when liquidity is scarce, as had been the case during the recent episode.

Some discussion followed about the ‘stigma’ associated with an institution borrowing from a central bank. This manifests in a number of ways. One is that borrowing from a central bank can be seen as a signal to the market that the recipient financial institution is in dire straits. As a result, recipient institutions may ultimately find it difficult to obtain finance to repay the debt to the central bank; to the extent that this is true, LOLR would best be thought of as bridging finance for institutions that are on the road to nationalisation. Another way that stigma arises is through the price of central bank liquidity. It was pointed out that during the recent episode some financial institutions chose not to use some of the more expensive central bank lending facilities. More generally, it was also suggested by one participant that during a time of increased uncertainty, any reduction in balance sheet growth or other cautionary behaviour by a bank may be read by the market as indicating impending liquidity problems; hence, a stigma related to extreme caution may occur in the same way that approaching a central bank for assistance may indicate desperation.

This was followed by much discussion about the degree to which lending by a central bank led to a moral hazard problem. With this in mind, while there was widespread agreement that a central bank should not lend to an insolvent institution, many participants pointed out that insolvency can be very difficult to identify. A number of participants replied by suggesting that a central bank should only lend against good collateral, and that doing so did not constitute a bailout of markets or institutions. However, the problem then becomes identifying good collateral. As one participant suggested, this becomes even more difficult when markets are illiquid; indeed, it is precisely when markets are not functioning properly that it becomes much more difficult to assess an institution’s solvency. In this context, there was also some discussion about whether the central bank should be a market-maker of last resort. Philip Davis suggested that there was a limit here – it would be undesirable for the central bank to be a market-maker in some markets, such as that for collateralised debt obligations.

Finally, putting aside the question of moral hazard, others raised the question of whether some large global financial institutions may be ‘too big’ to be rescued by a central bank (or indeed the fiscal authorities) in a relatively small host country, and that this was an important issue requiring policy-makers’ attention.

Promoting Liquidity: Why and How?

Jonathan Kearns and Philip Lowe¹

1. Introduction

As recent experience all too clearly demonstrates, liquid markets do not exist for all financial assets at all times. In some respects, this can be thought of as a market failure. The broad question that this paper examines is how public policy should best address this market failure, particularly in situations in which there is a potential threat to the stability of the financial system.

This question is of more than academic interest. The events of the past year have served as a stark reminder that a lack of liquidity in asset markets, particularly in times of increased uncertainty, can have significant implications for financial institutions, and the economy as a whole. In particular, the inability to sell assets and/or to raise funding can amplify disturbances in the financial system and contribute to significant losses in output. To the extent that these effects stem from a market failure, there is a public policy case for addressing that failure or, if that is not possible, at least addressing its consequences.

The discussion in this paper centres on two broad issues. The first is how best to promote asset market liquidity, and the second is the appropriate balance between the private and public sector in establishing arrangements for dealing with liquidity problems. A particular focus is to what extent the public sector should provide ‘systemic liquidity services’ to the private sector and, if it is to provide such services, how this should be done, and what conditions should apply to address moral hazard concerns and to ensure that new distortions are not introduced.

The paper is structured as follows. It begins by summarising the ‘first-best’ world of complete markets (and complete contracts) in which institutions are able to sell assets in liquid markets and generate liquidity when it is needed, and discusses how the real world differs from this benchmark. This is followed in Section 3 by a discussion of the various reasons why liquidity problems emerge in the real world. The following three sections then discuss possible ways of dealing with liquidity problems. These include: (i) reducing information asymmetries and improving financial market infrastructure; (ii) restricting the amount of maturity transformation undertaken by the banking sector; and (iii) the public sector providing various liquidity services to the private sector. This is followed in Section 7 with a general discussion of the policy issues.

The paper’s main conclusions can be summarised as follows.

First, improvements in the financial infrastructure – including arrangements for disclosure and post-trade processing – have a role to play in limiting the sharp rise

1. Thanks to numerous colleagues who provided assistance and comments.

in information asymmetries that can occur when conditions in financial markets are strained and at turning points in the financial cycle. In doing so, these improvements can reduce the probability of liquidity drying up during these episodes. It is important, however, to be realistic about what can be achieved in this area, as information asymmetries are pervasive in the financial system, and are likely to remain so.

Second, recent events have shown up shortcomings in the way that financial institutions manage their own liquidity, and these shortcomings need addressing. However, the social costs of financial institutions fully self insuring against liquidity problems arising from market dislocation and/or the inability to sell assets on reasonable terms, are likely to be quite high. The public sector may be able to play a useful role here by providing a range of liquidity services to the private sector that help ameliorate the adverse effects on welfare of a lack of asset-market liquidity.

Third, if the public sector is to provide these liquidity services, then arrangements need to be put in place to ensure that the potential welfare gains from doing so are not undermined by financial institutions taking on greater risk than is warranted. Given that widespread liquidity problems are most likely to emerge at turning points in economic and financial cycles, one possibility is to strengthen the macroprudential dimension of supervision, with increased capital, and possibly liquidity, buffers being built up in the good times.

2. The First-best and the Real World

In thinking about how public policy should respond to asset illiquidity it is useful to step back and ask what the ‘first-best’ world would look like. This was done very nicely at this conference last year in a paper by Franklin Allen and Elena Carletti.²

They note that ‘if financial markets are complete, it is possible for intermediaries to hedge all aggregate risks in financial markets’ (p 207). In such a world, institutions could use securities, derivatives or trading strategies to ensure that liquidity is available when it is needed, with the price system ensuring that the liquidity was appropriately priced in every state of the world. In this perfect world, ‘market liquidity’ would be plentiful so that assets could be readily bought and sold at their fundamental value, and ample ‘funding liquidity’ would enable solvent institutions to easily borrow against their assets.

The real world falls well short of this first-best benchmark in at least two important ways. The first is that not all assets can be bought and sold in liquid markets, and where liquid markets do exist in normal times, they can disappear at short notice, just when they are most needed. The second is that the availability of funding can evaporate quickly, making it difficult for institutions to continue financing their assets. The effect of this can be particularly pronounced if it coincides (as is likely) with illiquid asset markets, as the institution experiencing the funding difficulties cannot

2. See Allen and Carletti (2007), and also Allen and Gale (2004) and Holmstrom and Tirole (1988).

simply downsize its balance sheet by selling assets in an orderly market. The reasons why these liquidity problems can emerge are discussed in the following section.

Given the limitations of the real world, distressed fire sales of assets can occur, and solvent institutions can find themselves unable to obtain funding, or sell assets on reasonable terms. As Allen and Carletti note, the result can be more volatility in asset prices than is socially optimal, and ‘costly and inefficient crises’ (2007, p 209).

While the real world clearly falls short of the first-best, many of the developments in the financial system over recent years can be seen as moving the system closer to this benchmark. One obvious example is the securitisation of loans on banks’ balance sheets, with securitisation offering the promise that historically illiquid assets could be liquefied. Indeed, some financial institutions had included the possibility of securitisation in their contingency planning for a liquidity crisis. Another example is the widespread use of contingent credit lines, with the entity paying for such a line essentially insuring itself against the possibility of funding difficulties and/or being a forced seller of assets. There has also been very strong growth in the trading of a whole range of financial products, which has allowed various assets and risks that previously could not be traded in markets to now be traded; one example is the credit default swap (CDS) market which allows the trading of credit risk.

The paradox here, however, is that while these developments may have moved the system closer to the first-best world in normal times, they do not appear to have had the same effect under more turbulent conditions. Many of these developments assist with the management of *idiosyncratic* liquidity issues and aid the efficient functioning of the market under normal conditions. However, they have not proved particularly resilient under strain, and the comfort that they have provided to institutions under normal conditions may have increased *aggregate* liquidity risk by encouraging the belief that if things changed for the worse, the markets could be relied upon to manage both liquidity and asset positions.

As institutions have become more dependent upon financial markets for the management of their balance sheets, the importance of the smooth functioning of these markets has simultaneously increased. Not only are these markets used for managing many more risks than was once the case, they have also supported the increased use of mark-to-market accounting. One consequence of these developments is that if liquidity dries up, amplifying movements in the prices of financial assets, the potential systemic implications are much larger than they once might have been.³

Reflecting this, in the past decade there have been a number of cases in which concerns about market liquidity have been at the forefront of policy-makers’ minds. The concerns have been most acute in situations in which the failure of an institution was considered a real possibility. In particular, in the cases of both Long-Term Capital Management (LTCM) and Bear Stearns, policy-makers in the United States were extremely concerned that markets could not deal with the closing-out of positions that

3. Gai *et al* (2008) present a model which explains why financial innovation may have made financial crises less likely, but more severe if they occur.

would inevitably follow the failure of a major counterparty. As Bill McDonough, the then Head of the Federal Reserve Bank of New York, said in the wake of LTCM's problems, the closing out of these positions '... would have caused a vicious cycle: a loss of investor confidence, leading to a rush out of private credits, leading to a further widening of credit spreads, leading to further liquidations of positions, and so on' (see McDonough 1998). Similarly, 10 years later, in explaining the Fed's actions in response to Bear Stearns' problems, the Head of the New York Fed, Tim Geithner, said that by agreeing to lend against a pool of assets, the Fed had '... reduced the risk that those assets would be liquidated quickly, exacerbating already fragile conditions in markets' (Geithner 2008).

Similar concerns arose when the US hedge fund, Amaranth Advisors, got into trouble in 2006. In particular, its counterparties were concerned that if its positions had to be closed out on-market, there would be very large movements in prices with potentially destabilising effects. In that case, the situation was resolved by one of Amaranth's bankers eventually taking over its positions off-market at a substantial discount to their apparent market value. One view on why the situation with Amaranth was more easily resolved than LTCM's is that its positions were exchange-traded rather than being over-the-counter (OTC), an issue we discuss in the next section.

Liquidity issues have also been at the forefront of concerns arising from the sub-prime problem in the United States. A sharp fall in the demand for assets with unfavourable liquidity characteristics has seen a marked fall in the price of these assets relative to those whose liquidity is more assured, with many markets having essentially closed. Many financial institutions have also become much less willing to tie up their balance sheets in assets that cannot be sold easily, including term bank loans. This, combined with concerns about the ability to tap various funding markets on an ongoing basis, has resulted in a substantial increase in term spreads and a significant tightening of credit conditions. In some countries, there have also been runs on financial institutions, something that in the past has been quite rare in developed financial systems.

These various liquidity problems have not just affected a small group of institutions, but have been global in nature, and have had significant effects on economic activity. Indeed, the swing from a situation in which liquidity was unusually high, to one in which it is unusually tight, has been the major driver of the current business cycle in many countries.

Given the potential for adverse impacts of liquidity problems on the financial system and the real economy, a relevant question is: how should policy-makers respond? This question has taken on additional importance over time, particularly given that many developments may have moved the financial system further away from the first-best in troubled times. The arrangements for dealing with system-wide liquidity problems and, more broadly, disruptions to markets have become particularly important.

Here there are at least three (not necessarily mutually exclusive) perspectives, which we have stylised to make the views as clear as possible.

The first is that further financial innovation is required, so that the real world looks more like the first-best, not just in normal times, but also in troubled times. According to this perspective, the main problem with current arrangements is that there are still too many missing markets and too many impediments to state-contingent contracts, and that key parts of the financial infrastructure are underdeveloped. The key to a more stable system is to develop these markets, remove these impediments, and shore up the existing markets by improving the financial infrastructure so that participants can transact on reasonable terms in both good and bad times.

A second perspective is that financial markets will never be complete, and that realistically the various forces that periodically cause liquidity problems can never be completely overcome. In response, financial institutions need to hold more liquid assets than they have become accustomed to, and to be more realistic about their true potential liquidity needs (reflecting both explicit and implicit commitments). In doing so they need to take into account the possibility that normally liquid asset markets and reliable funding sources can evaporate in times of stress. According to this perspective, liquidity insurance has been underpriced for too long and many financial institutions have undertaken too much maturity transformation. Reflecting this, institutions need to either voluntarily hold more liquidity, or be forced to do so by regulators. The case for addressing this issue through regulation is strengthened by the idea that the benefits to the system of an institution holding more liquid assets are not fully internalised, with regulation potentially solving the distortion caused by this externality.

A third perspective is that while private financial institutions need to be responsible for ensuring that they can deal with *idiosyncratic* liquidity problems, they should not have to shoulder alone the burden of ensuring themselves against *system-wide* disruptions. According to this view, overall social welfare can be improved by the public sector providing systemic liquidity services to the private sector. In some situations it may be able to do this at little cost and with little risk to the taxpayer. In other cases, the risks may be significant, but so too may be the benefits; in particular, by playing this role, the public sector may be able to reduce the costs that society pays for financial intermediation.

We return to these various perspectives in the following sections. Before this, however, it is useful to discuss the reasons why asset markets are not always liquid.

3. Reasons for Asset Market Illiquidity

In assessing potential policy directions it is worth first considering the reasons why not all assets can be sold in liquid markets and why, on occasions, liquidity can disappear from previously liquid assets. Importantly, there can be close correlations between reductions in market liquidity and funding liquidity. If market-makers (broker-dealers) have more difficulty obtaining funding liquidity, they will be less able to fund short-term holdings and so smooth imbalances in demand/supply over time, thereby reducing market liquidity. Similarly, if market liquidity is low, then a broker-dealer will have more difficulty obtaining a collateralised loan, or that loan

will have a high margin, because the lender is less certain that the market price of that asset can be realised. Consequently, funding liquidity will also be low. Reflecting these interconnections, the following discussion focuses on four explanations for a lack of liquidity in the markets for various financial assets. These are:

- the existence of asymmetric information;
- a sudden rise in uncertainty;
- a lack of adequate market infrastructure; and
- the development of one-sided markets following troubles with a market participant.

3.1 Asymmetric information

The first, and most obvious, reason for liquidity problems is the existence of asymmetric information between the potential buyers and sellers. If buyers are concerned that sellers know more about the quality of the asset than they do – either because they are unwilling to reveal, or unable to credibly reveal, the relevant information – they will be reluctant to purchase the asset unless this asymmetry can be overcome. This has, for example, been one reason why bank loans, particularly to small and medium-sized businesses, have typically not been traded in deep and liquid markets. Similarly, a rapid change in investors' concerns about the degree of information asymmetries can see liquidity in previously liquid markets dry up quickly.

As financial markets have matured, various ways of ameliorating the effects of asymmetric information have developed. One is for investors to rely on credit rating agencies, with many investors taking advantage of the economies of scale by delegating the monitoring of asset quality to these agencies. Another is for institutions to develop reputations for comprehensive and accurate disclosure. A third is for lenders to retain a financial interest in assets that they originate, that is, to keep some 'skin in the game'. In securitisation markets this can be achieved by the lender, or a related entity, holding the first-loss tranche, or in syndicated lending by the lead lender holding a large portion of the loan. In addition, where possible, counterparty risk could be reduced by the novation of transactions to a central counterparty.

One of the main reasons that the recent strains in credit markets have been so pervasive is that investors' confidence in some of these antidotes to information asymmetries has been severely shaken. This is particularly the case in relation to structured credit products, but also for bank balance sheets more generally.

An important element here is that the reputations of the credit rating agencies have been badly dented. Over recent years, many investors have taken comfort in the belief that these agencies were spending the necessary time and effort to understand and assess the risk associated with a wide range of assets. As a result, many felt, perhaps inappropriately, that they did not need to fully understand the details of the investment themselves. When the difficulties emerged, these same investors began questioning whether the rating agencies had really understood the

assets that they were rating (or had applied appropriate ratings), and whether they had been too close to those selling the assets.

A second factor is the perception that many banks have been slow to ‘come clean’ about the structure of their portfolios and the extent of their losses. This perception was reinforced by some banks writing down the same assets numerous times within a relatively short period. Some investors interpreted this as banks holding back information, at least initially, particularly given the lack of transparency about the exact assets that were in the portfolio, and how those assets were being valued. Similarly, when some banks announced write-downs this led to the perception that competitor banks with assumed similar portfolios that had made no announcement were hiding their losses. In turn, this generated increased concerns that banks knew something that outside investors did not.

3.2 A sudden rise in uncertainty

A second reason that liquidity issues can emerge, including the loss of liquidity in previously liquid markets, is that uncertainty about the future increases suddenly. Here the issue is not so much that buyers think that sellers might have more information than they do, but rather that there is a general increase in uncertainty about the future economic and financial environment by both buyers and sellers of assets.

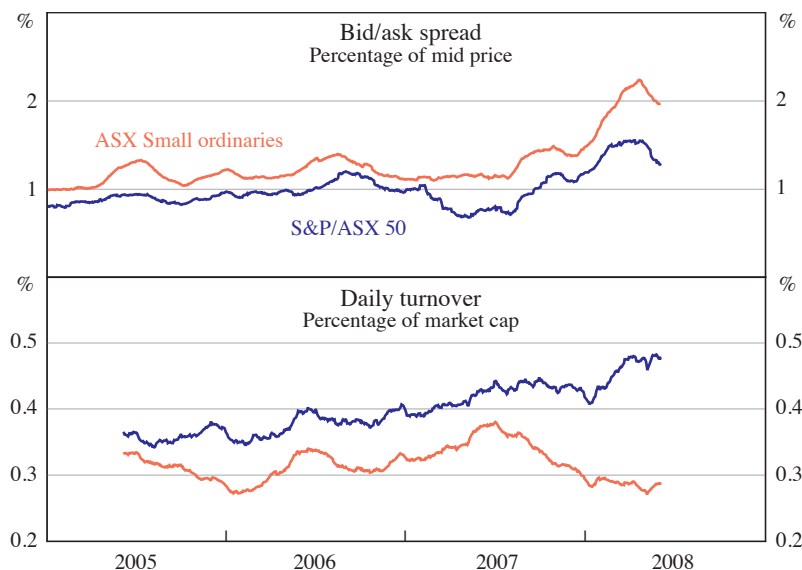
A high level of uncertainty is itself, of course, not necessarily an inhibitor to a liquid market, with many assets with highly uncertain pay-offs trading in liquid markets. Instead, the issue is more that liquidity can disappear when the degree of uncertainty suddenly increases. During such episodes, investors can come to question both existing norms of behaviour and the usefulness of the historical record in valuing assets. The result can be a significant reduction in the willingness to transact. When there are asymmetric pay-offs, an increase in uncertainty can also amplify the agency problem that an investor or lender faces.

In a sense, a rapid increase in uncertainty can itself prevent the market-clearing process, with investors choosing to stand on the sidelines until they have reassessed the risk-return characteristics of many assets. In this environment, because of the information asymmetries discussed above, sellers of assets can be seen as particularly desperate, further undermining the ability to sell assets.

Structured debt markets appear particularly prone to this problem. Credit derivatives also seem subject to evaporating liquidity; Fitch Ratings (2004), for example, found that for individual-name CDS, liquidity declined substantially when the relevant company encountered some form of stress. In contrast, in foreign exchange markets a change in the economic environment and a sharp increase in uncertainty can result in very large movements in prices, but liquidity is not normally absent for extended periods. One explanation for this is that in the foreign exchange market most of the factors that influence exchange rates are public knowledge, whereas in debt and credit derivative markets, periods of sharply increased uncertainty typically coincide with increased concerns about information asymmetries. Similarly, equity markets, as a whole, do not suffer from sharp reductions in liquidity as a result of increased

uncertainty because the high levels of disclosure and considerable public analysis of stocks mean that uncertainty is less likely to result in higher perceived information asymmetries. However, even in equity markets, liquidity has recently declined more for stocks with small market capitalisation, for which there is typically less analysis and so potentially greater information asymmetries, than for large market capitalisation stocks (Figure 1).

Figure 1: Liquidity in Large and Small Australian Listed Firms



Sources: Bloomberg; RBA

A generalised increase in uncertainty can also cause liquidity problems through banks becoming markedly less willing to make new loans. This can occur if the increase in uncertainty triggers a reassessment by banks of their ability to raise funds in the future and the extent to which existing clients will call on lines of credit. In this environment, banks may themselves seek to increase their own holdings of liquid assets, as protection against this more uncertain world. This has the potential to generate self-perpetuating liquidity problems, with banks becoming reluctant to lend and withdrawing from financial markets.

3.3 Market infrastructure

A third factor influencing liquidity is the underlying market infrastructure. Market design – involving how buyers and sellers interact to reveal their private information and how they settle their trades – can have a significant influence on how the market responds when conditions become strained. It is notable that in the current turmoil, dislocation has tended to be greater in the markets for financial assets and derivatives that trade in OTC markets and settle bilaterally.

Structured finance products and many derivatives typically trade OTC because of their inherent idiosyncratic features. Products trading in OTC markets can be tailored to the specific requirements of the counterparties and these markets are often more suitable for new and developing products. Therefore, it is no surprise that structured financial products and many derivatives typically trade in OTC markets.

At the heart of the recent turmoil has been an increase in perceived counterparty risk, related to a large extent to asymmetric information as discussed above. Since most derivatives that trade in OTC markets settle bilaterally, confidence in one's counterparty to meet all obligations is critical to the willingness to trade. This is particularly so for many long-lived derivatives – including credit derivatives – for which the relationship with a counterparty may last many years. Not surprisingly, heightened counterparty risk has led to a significant reduction in liquidity in many bilateral markets. Indeed, it is notable that liquidity in foreign exchange swap markets declined more at longer horizons where counterparty risk is greater.

Other aspects of OTC markets can also make them more susceptible to potential buyers or sellers remaining on the sidelines. Trading in competitive markets is often concentrated, either at a point in time or a particular location, because the more traders there are, the greater the odds that a buyer or seller can find a matching order and so trade at the market price. Because OTC markets can be more fragmented than exchange-traded markets, they may be more susceptible to a loss of liquidity – in essence there is an unwillingness to transact because it can be harder to locate buyers or sellers.

Lack of transaction transparency can also reduce the willingness to trade. If market participants cannot observe recent transaction prices, then, in a period of increased uncertainty or volatility, they may be less willing to trade for fear of trading away from the true market price. In general, OTC markets have lower transaction transparency than exchange markets.

One example of a market in which low transaction transparency appears to have hampered liquidity is the market for Australian residential mortgage-backed securities (RMBS). Unlike the case in the United States, Australian RMBS have not suffered a deterioration of fundamentals, with arrears and default rates remaining low. Yet in early 2008, large selling by offshore structured investment vehicles contributed to a substantial fall in the prices of Australian RMBS. In the following months, liquidity in the market was low as buyers continued to bid at the low prices at which 'distressed' sales had reportedly taken place, while sellers asked for higher prices on the basis that the distressed selling had abated. One factor contributing to wide bid/ask spreads was a lack of timely information about actual transaction prices.

3.4 The need to close out large positions in a short period (particularly after a failure)

A fourth factor that can lead to liquidity problems is the failure, or near failure, of a large institution or investor. The news, and rumour, surrounding such an event can result in a sharp increase in uncertainty and perceived information asymmetries,

thereby decreasing liquidity through the channels described above. Ordinarily, large investors build up or sell positions gradually so as to reduce the price impact that can result from large changes in their positions. However, in a time of stress, a large investor may not have the luxury of selling gradually in order to minimise the price impact. While an asset's price falling below its fundamental value might ordinarily provide opportunities for other traders, large price falls in one market can have significant ongoing adverse consequences for that market and related markets.

The feedback mechanisms largely result from the use of debt to fund positions in those markets. The fall in asset values means that investors are less able to obtain funding, because in effect their gearing has increased. The resulting margin calls require further asset sales to repay debt, causing further price falls. Brunnermeier (forthcoming) has termed this mechanism a 'loss spiral', with Brunnermeier and Pedersen (forthcoming) presenting an additional 'margin spiral' channel that compounds the loss spiral. They argue that lending standards tighten when prices fall, so that margins increase. This reduction in funding liquidity results in additional asset sales and further price falls. Furthermore, the price fall in one market can spill over to other markets. If price falls lead to a general tightening of lending standards then the 'margin spiral' will spread to other markets. Similarly, investors may sell other assets to meet margin calls or redemptions because liquidity in the market with the initial price falls has declined and so the 'loss spiral' will spread.

Given the prevalence of borrowing to fund positions and use of margins to provide security for these loans it is difficult to avoid loss spirals and margin spirals, particularly in the case of the failure of a large investor. Hence it is important to attempt to minimise their impact by providing a market framework that reduces information asymmetries and uncertainty, thereby lessening any decline in liquidity.

3.5 Summarising reasons for illiquidity

The existence of asymmetric information and increases in uncertainty are central to explaining illiquidity in asset markets. As described in the paper so far, these factors alone are sufficient to hamper the development of liquid markets, or cause liquid markets to become illiquid. But their interaction with inadequate market infrastructure or one-sided markets following the failure of a large participant can result in severe illiquidity across many asset markets. In the following sections we consider measures that have been used, or could be used, to make liquidity in financial markets more resilient to these problems. One possibility is the promotion of financial infrastructure that reduces information asymmetries. But, acknowledging that these initiatives may not always be successful or be possible, we then consider how to mitigate the impact of shocks that would reduce liquidity, either through financial institutions holding more liquid assets or the public sector providing liquidity services.

4. Promoting Financial Infrastructure that Reduces Information Asymmetries

Given the central role that information asymmetries play in market illiquidity, an obvious way in which to address liquidity issues is to reduce these asymmetries, particularly at turning points in the economic cycle.

Here, there are a number of possibilities, including: further improving disclosure by financial institutions; improving the credit rating process; and improving settlement procedures, including facilitating the increased use of central counterparties.

4.1 Disclosure

While the amount of information disclosed by banks has increased over recent years, the level of disclosure remains, in many cases, well short of what is required. Looking at recent announcements of write-downs by international banks, it is very difficult, even for sophisticated investors, to make an assessment of whether the new asset valuations are realistic. The disclosure statements typically contain only rather general statements of valuation policies, and little specific information about particular assets or portfolios of assets.

In part, the limited disclosure reflects the fundamental difficulty of valuing some assets. But it also reflects the reluctance by financial institutions to provide information about the specifics of their portfolios for fear of revealing trading strategies or portfolio positions to their competitors and counterparties.

4.2 Credit ratings

A second possibility is to improve the credit rating process – particularly as it relates to structured credit products – in order to rebuild confidence in the rating process, and ensure that ratings convey more complete information to investors. There are many positive aspects to ratings arrangements, including avoiding the inefficiency that can arise if each investor is required to undertake his/her own analysis. But there is little doubt that ratings arrangements can be improved. One concern that has been highlighted by recent events is that the rating agencies are paid by the issuers, rather than the investors for whom they provide information. Particularly for structured finance products, which can be designed to adhere to the rating agency's ratings criteria, the close relationship between issuers and rating agencies may distort incentives and additionally lead to structures that only just qualify for a given rating. One possible solution would be for users, rather than issuers, to pay for ratings, but the coordination or free-rider problem among investors would make such a change very difficult to achieve. A more practical modification would be to limit the degree to which rating agencies can be paid to consult on the structure of a product to be rated, acknowledging that sellers could still use their experience to attempt to structure according to ratings criteria.⁴

4. See IOSCO (2008) for a proposal along these lines.

An issue that is at the heart of this debate is the extent to which ratings convey useful information to investors (and how investors use that information). While there is, understandably, a strong demand for simplicity, in many cases summarising all the relevant risk information in a single rating is too simplistic. Mechanisms need to be found to present investors with more complete information, without undermining the very useful role rating agencies can play in overcoming information asymmetries. This additional information could include the robustness of models typically used to rate structured finance products, and the sensitivity to external parameters, including changes in the economic environment.

One way in which ratings might become less simplistic is through the introduction of different ratings scales for different asset classes, such as structured finance products or corporate bonds. More useful still might be multi-dimensional ratings. For example, ratings could consist of both a letter rating (AAA, AA, etc) and an indicator that makes the distinction between the probability of default and the expected loss given default, or an indicator that summarises the transition probability matrix, thereby providing information about the likelihood of the asset suffering multiple notch downgrades. There have been several suggestions along these lines over the past year (see, for example, CGFS 2008b; IOSCO 2008; SEC 2008) and comments by the rating agencies (Fitch Ratings 2008; Moody's 2008). For structured finance products, these aspects of risk are much more critical than for standard corporate or government bonds which have generally been served well by a simple letter rating scale.

4.3 Market design

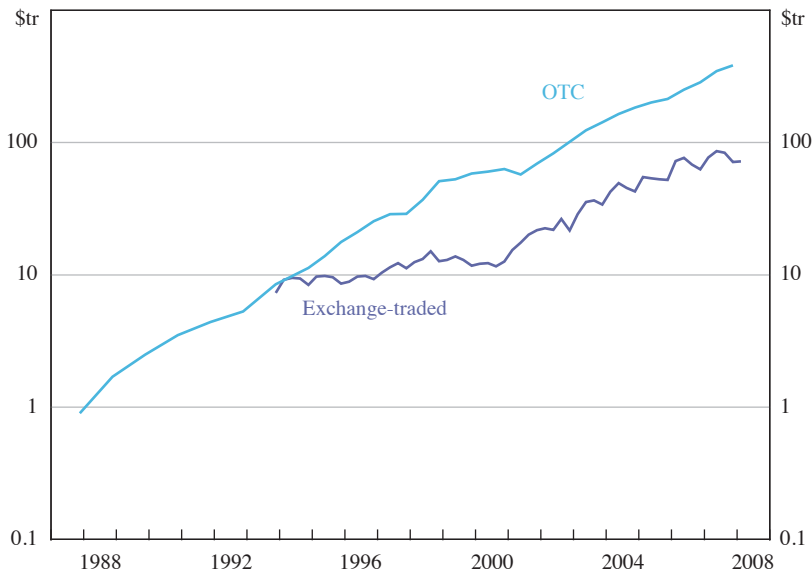
A third possibility is for the trading in some derivatives and securitised assets to move from OTC markets to exchanges (see, for example, Cecchetti 2007; Alexander 2008). As discussed above, the nature of OTC markets may accentuate the problems of asymmetric information, especially at turning points, leading to sharp reductions in liquidity when conditions unexpectedly change. Several features of exchange-traded markets reduce or eliminate risks that exist in OTC markets, making them potentially more robust. One of these is that settlement typically occurs through a central counterparty. This means that instead of buyers and sellers having counterparty risk with other market participants, the risk is to a highly rated, and in many cases regulated, entity. As a result, concerns about counterparty risk which have contributed to reduced liquidity in many markets in the past year are largely obviated. Having assets traded on an exchange also increases price transparency, so that even in periods of increased uncertainty, market participants are more likely to know where the market price is and so this source of information asymmetry is avoided. The observability of the price can also reduce uncertainty elsewhere because marking assets to market is simpler, which, for example, would reduce information asymmetry about financial institutions' balance sheets.

There are other benefits of exchange-traded markets over OTC markets in that there are lower settlement and legal risks, lower transaction costs, and potentially greater liquidity through participation by a wider range of investors.

Often new financial products start out with diffuse characteristics, but over time evolve into having more standard features, making them more suited to being exchange-traded. This migration can, however, be quite difficult, requiring overcoming legal and market frictions, and the incentive that some institutions may have to retain OTC trading, where profit margins might be higher. Given these difficulties, there may be a case for regulatory policies to play a role in encouraging exchange-traded markets.

One relatively new product, which in many cases has become fairly standardised and thus suited to being exchange-traded, is the CDS. However, to date, attempts by several exchanges to list credit default derivatives have been unsuccessful.⁵ One guide for how credit derivatives could evolve is the development of interest rate derivatives, which have a longer history. As Figure 2 shows, OTC markets in these derivatives grew much more rapidly through the 1990s than the exchange-traded markets. This partly reflected the fact that interest rate derivatives were still evolving reasonably quickly and there was considerable innovation. In contrast, in more recent times – as the products have become more standardised – the two market types have seen similar growth rates.⁶

Figure 2: Interest Rate Derivatives
Amounts outstanding, log scale



Sources: BIS; International Swaps and Derivatives Association, Inc

5. Attempts by several exchanges in the United States (CME, CBOT and CBOE) and Europe (Eurex) to list credit derivatives have been unsuccessful because of a lack of support from market participants.
6. The levels of outstanding derivatives in OTC and exchange-traded markets cannot be directly compared as exchanges have netting whereas the outstanding value in OTC markets is a gross figure.

A transition from OTC to exchange-traded markets is obviously not universally possible, nor desirable, given the customised features of many financial assets. For these assets, improvements in clearing and settlement procedures can bring some of the benefits that come from exchange-based trading. In particular, it is important that the post-trade arrangements encourage the matching and clearing of trades on the trade date, or as soon as is practicably possible. The establishment of the Depository Trust Clearing Corporation's (DTCC's) Trade Information Warehouse in the United States has been a useful step forward in this regard, particularly for credit derivatives. Moreover, the use of central counterparties need not be restricted to exchange-traded markets. Indeed, there is a strong case for the use of such arrangements for a variety of OTC markets. On this front there have been some positive developments in recent months. DTCC and the Clearing Corporation (CCorp) have agreed to provide central counterparty services for some OTC credit derivatives, using DTCC's Trade Information Warehouse and the central counterparty services of CCorp.⁷ There is a good chance that a central counterparty will become a feature for some OTC credit derivatives; at a recent meeting hosted by the New York Fed, industry participants and regulators agreed to support a central counterparty for CDS (see FRBNY 2008). However, there are notable challenges to overcome in developing a functional central counterparty, not the least of which is determining how to value bespoke credit derivatives in order to set margins.

One means of facilitating more products to trade on exchanges, and also directly reducing information asymmetries, is to increase the standardisation of the structure of various financial assets. Increased standardisation can concentrate liquidity, making the market more robust to shocks that would otherwise tend to cause liquidity to dry up. For RMBS, one possibility is for an exchange or another entity to set and monitor 'qualifying' standards, with RMBS that meet these standards being traded on an exchange. It is also possible to imagine continuous disclosure requirements being placed on the entity managing the underlying assets.⁸ In a sense, such arrangements would make the processes and infrastructure for trading of a variety of structured debt products more like those currently widely used for equities.

4.4 The way forward

There is little doubt that further steps along the lines discussed above could, and should, be taken to reduce existing information asymmetries and to improve market infrastructure. The main challenge is to develop arrangements that work not just in good times, but in bad times as well. Particular attention needs to be paid to ensuring that the integrity of information and the smooth functioning of infrastructure

7. Initially CCorp will act as a central counterparty for US index trades, but it has plans to expand to cover other CDS products. The announcement is available at <<http://www.clearingcorp.com/press/pressreleases/20080528-dtcc-cds.html>>. See also Alexander (2008). For earlier discussion, see Ledrut and Upper (2007).

8. While not advocating a move to exchange trading, the American Securitization Forum has recently proposed standardising disclosure for RMBS to facilitate comparison of different securities and publishing monthly information on the performance of RMBS loan pools. See ASF (2008).

are not impaired when credit conditions or market sentiment deteriorates. Simply developing arrangements that add to the amount of information in good times, but that do not hold up in turbulent conditions may actually increase the probability of systemic liquidity problems.

It is, however, important to be realistic about what can be achieved in this dimension. The recent market strains are the end result of a long boom in the financial sector, underpinned by generally favourable economic conditions. During that boom – as has been the case in almost all preceding booms – investors and institutions simply did not pay enough attention to counterparty risks and the information that was available, applying an overly optimistic lens when looking to the future. This inherent excess optimism during the boom, followed by a period of pessimism when the risk built up during the boom materialises, is endemic and drives the procyclicality of the financial system. It means that simply providing more information and improving market infrastructures is unlikely to be enough to address the liquidity problems that can emerge at the end of a long boom.

One consequence of this is that financial institutions and policy-makers need to consider other ways of reducing the probability of such problems emerging and dealing with them when they do emerge. These issues are addressed in the following sections.

5. An Increase in Holdings of Liquid Assets

In the various assessments of the recent credit market turmoil, a frequent conclusion has been that financial institutions and supervisors did not pay enough attention to liquidity risk. FSF (2008), for example, lists a number of shortcomings in liquidity management. These include banks: not adequately planning for system-wide stress; not adequately considering the links between market liquidity, funding and credit risk; and not anticipating the need to honour committed lines of credit or the need to provide financing to clients in order to protect their own franchise value.

Essentially, these reviews are arguing that banks have held too few liquid assets, or assets of unpredictable liquidity, and have under-priced the provision of liquidity services to their customers. It is difficult to argue with this conclusion, as it now seems clear that, over recent years, proper liquidity management slipped off the radar screen for many financial institutions. A number of recent reports have pointed to the way forward here, including the more extensive use of stress tests, the development of robust contingency funding plans, and the need to allocate appropriate liquidity to all business lines (see, for example, BCBS 2008; IIF 2008; IMF 2008). Financial regulators are likely to have a role to play in achieving progress on a number of these fronts, as private institutions are unlikely to fully internalise the benefit to the system as a whole of maintaining high levels of liquidity.

This points to important questions that do not seem to have attracted the attention that they deserve: that is, to what extent financial institutions should be required to fully ‘self-insure’ against system-wide liquidity problems, and to what extent the public sector should assist when such problems emerge. In raising these questions,

we want to make it clear that, in most cases, institutions should be able to deal with idiosyncratic liquidity problems, without any assistance from the public sector. Furthermore, institutions need to be able to deal with significant disruptions to asset markets and to their funding sources. But full self-insurance against generalised and widespread disruptions could come at a significant cost to both financial institutions and the economy more broadly. As a very rough illustration, suppose that such insurance required institutions to hold an extra 10 per cent of their balance sheets in highly liquid, high-quality assets, and that the expected return on these assets was 1 percentage point lower than the alternative. This type of portfolio shift would reduce the banking system's return on assets by 0.1 of a percentage point, and the return on equity by around 2 percentage points. Institutions might then be expected to increase their lending margins, which in turn might lead to a lower stock of capital in the economy and less output than might otherwise be the case.⁹ In addition, if financial institutions had to fully self-insure they might not be prepared to provide as much long-term funding as is currently the case. The issue is whether some insurance by the public sector is a better way to deal with these problems than financial institutions having to deal with them alone.

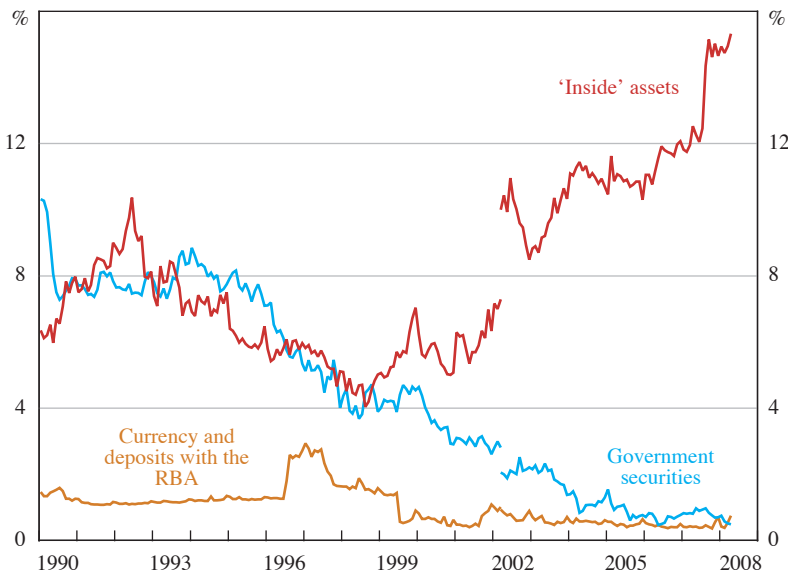
The extent to which financial institutions insure against system-wide liquidity problems is a current issue in Australia, as it is in many other countries. Over recent decades, the Australian banking system's holdings of 'liquid' assets have fallen significantly as a share of their aggregate balance sheet. In the 1960s, around 30 per cent of the banks' total assets were held in government securities, and a further 8 per cent were held on deposit at the Reserve Bank of Australia (RBA) (although the vast bulk of these assets were held to meet regulatory requirements and so were not available for short-term liquidity purposes). Today, government securities account for just 0.5 per cent of total assets, and deposits at the RBA account for a further 0.2 per cent. This decline reflects both regulatory changes and a reduction in the supply of government securities on issue.¹⁰

A related feature of the Australian environment is that around 90 per cent of the Australian banking system's liquid assets are 'inside assets', by which we mean the liabilities of other financial institutions (Figure 3). As at May 2008, these assets accounted for around 15 per cent of the system's domestic assets, which is up from 12 per cent a year earlier. When the strains first developed in financial markets in August/September last year, the banks' demand for liquidity increased significantly and, in response, they issued securities to one another, allowing each to record an increase in their liquid assets. Of course, at the same time, the banks' short-term liabilities also increased. This heavy reliance on inside assets is unusual by international standards. In the United States, for example, banks' holdings of such assets account for around 6 per cent of their total assets, with securities issued by the US government and federal agencies accounting for a higher 14 per cent.

9. Of course, if the cost of funding was reduced for an institution that held more liquid assets, the effect would be less than outlined here.

10. See Grenville (1991) for a discussion of these changes.

Figure 3: Banks' Liquid Assets
Per cent of domestic assets



Note: Break in series due to change in reporting requirements in March 2002

Source: APRA

This reliance on inside assets poses some challenges for dealing with system-wide liquidity problems, particularly if those problems are associated with system-wide credit quality concerns (which has not been the case recently). There are, however, simply not enough 'outside assets' in Australia for banks to hold the bulk of their liquid assets in securities issued by entities other than banks. Currently, the total stock of outstanding Commonwealth Government bonds is around \$55 billion, with another \$70 billion of state government bonds, and \$45 billion of supra-national debt. This is in comparison to the total liquid assets of the banking system of around \$350 billion.

Reflecting these developments, the RBA has, over the past decade, broadened the range of assets it will accept in repurchase agreements ('repos') to include securities issued by financial institutions. This has substantially increased the stock of securities that the RBA will accept under repo in its market operations. In comparison to a situation in which banks hold their liquid assets in outside assets, this potentially exposes the RBA to more risk; however, this increase in risk is limited by the fact that in the normal course of operations, banks are not able to sell their own or related securities to the RBA under repo.

In the following section we discuss in further detail the various ways in which the public sector can help deal with system-wide liquidity problems, including by providing some form of liquidity insurance or other services to the private sector.

6. The Provision of Systemic Liquidity Services by the Public Sector

To some extent, liquidity can be considered a public good. As discussed above, it is possible that social welfare is improved if financial institutions do not have to fully self-insure against system-wide liquidity problems. Indeed, in some situations it may be almost impossible for them to do so, particularly if there is only a limited supply of outside liquid assets.

If the public sector is going to play a role in providing ‘systemic liquidity services’ to the private sector, there are a number of channels through which this can be done, including:

- the central bank’s open market operations;
- the outright purchase of assets where liquidity is a problem;
- the provision of liquidity assistance to an institution experiencing funding difficulties; and
- assisting with off-market transfers of assets.

Each of these is discussed in turn below. The following section then discusses some of the conditions that might apply to the provision of these services.

6.1 Open market operations

A basic function of a central bank is to manage the supply of settlement balances or reserves to ensure that the relevant interest rate (typically, an overnight money market rate) is close to the target level set for the purposes of monetary policy. The way in which this is done can have significant implications for how financial institutions manage their own liquidity, and for the liquidity characteristics of various assets. Through its open market operations, the central bank can create assets with unquestionable liquidity for the financial sector to hold, and by deeming assets as eligible for market operations, it can reduce illiquidity premia that apply to those assets. Market operations can also affect the maturity structure of banks’ liabilities and can be used, under some circumstances, as a channel to provide funding to institutions suffering temporary liquidity difficulties.

It has become commonplace for central banks to conduct these operations primarily in repos. Doing so makes it possible to undertake operations in a wide range of assets without taking on a high level of risk, since for a loss to occur, the central bank’s counterparty would need to fail, and the value of the underlying asset would need to fall significantly. Many central banks, however, also still use outright transactions to inject or withdraw cash from the system, although these operations are largely restricted to assets of the highest credit quality that trade in very liquid markets, typically government securities.

6.1.1 Accommodating an increase in the demand for liquid assets

As we have seen recently, during a period of strain in financial markets, the demand for assets of unquestionable liquidity increases significantly. The central bank is ideally placed to respond to this increase, as it is in the unique position of being able to create such assets easily. It can do this by buying other assets from the private sector and, in exchange, providing institutions with the most liquid asset of all – a deposit at the central bank. If this is done through a repo, the incremental risk to the central bank need only be small.

In effect, such operations – which involve an expansion of the central bank's balance sheet – allow private institutions to improve the liquidity characteristics of their own portfolios; while the assets that are sold to the central bank may themselves normally be traded in liquid markets, there is always the possibility that some disruption to these markets will reduce their liquidity in times of stress. This possibility does not exist with central bank balances.

This type of expansion in the central bank's balance sheet is more likely if the central bank pays a close-to-market interest rate on deposits. If interest is not paid, there can be a high opportunity cost for financial institutions of holding large balances, so that if the supply of these balances increases significantly, the overnight interest rate is likely to fall below the central bank's target as institutions seek to lend these balances. An expansion is also more likely to occur in countries where the supply of 'outside' liquid assets is limited, since if system-wide credit quality concerns emerge, the demand for 'inside' assets is likely to decline significantly, with central banks' balances being the main alternative very liquid investment.

The central bank can also accommodate an increase in demand for liquid assets by altering the structure of its own balance sheet (without changing its size). In particular, it can reduce its own holdings of assets that are highly liquid (primarily government securities) and, in exchange, increase its holdings of assets that are less liquid.

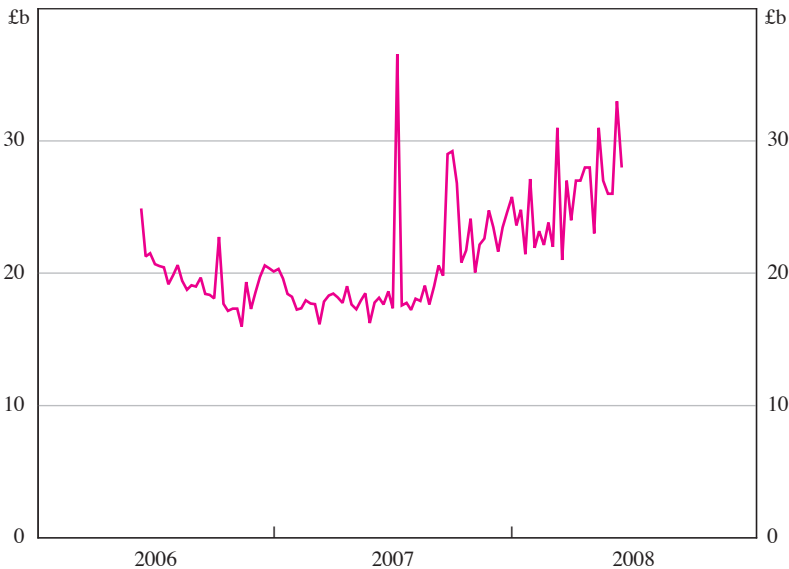
Arguably, during periods in which liquid assets are very highly valued (forcing down the relative yields on these assets), it makes little sense for the central bank to hold the most liquid assets in the financial system. Provided the risk issues can be addressed, the central bank can play a type of smoothing role, by being prepared to reduce its own holdings of the most liquid assets at the very time that the private sector most values these assets. It is important to stress that, in playing this role, the central bank is in no sense bailing out banks, or funding the balance sheet expansion of the banking system. It is simply reducing its own call on the assets with the most favourable liquidity characteristics at a time when the private sector most values liquidity. In doing so, it can help reduce the amplitude of swings in the price of liquidity, and it can do so without taking significant risks.

Over the past year or so, many central banks have responded in this way, expanding their balance sheets and/or changing the composition of their assets.¹¹

11. See Borio and Nelson (2008) and CGFS (2008a) for a discussion of recent changes in central bank operations, Debelle (2008) for more detail on Australia, and Hilton (this volume) for more detail on the United States.

The exact details have, to a significant extent, depended on institution-specific factors, including the composition and size of the central bank's balance sheet, the assets accepted in open market operations, and whether interest is paid on balances at the central bank. For example, reserve balances at the Bank of England rose from an average of around £20 billion in the first half of 2007, to an average of around £26 billion over the past six months (Figure 4). Similarly, in Australia, the banking system's balances at the RBA have also risen, from a daily average of around A\$0.8 billion in the first half of 2007, to a peak of almost A\$7 billion in December 2007 (Figure 5).¹² Early on in the current episode the RBA also reduced its limited holdings of Commonwealth Government securities held on an outright basis, as well as both its government securities held under repo and its US dollar assets held under swap arrangements (Figure 6). At the same time, the RBA increased its holdings of bank-issued paper held under repo. In the United States, there has also been a significant change in the structure of the Fed's balance sheet, with a large decline in the Fed's holdings of government securities held outright and an increase in the value of agency-backed mortgage-backed securities held under repo (Figure 7). With the introduction late last year of the term auction facility (TAF), there has also been a very large increase in the Fed's holdings of the wide range of relatively illiquid assets that banks pledge for use at the discount window. The Fed and the Bank of England also introduced facilities allowing banks to swap assets

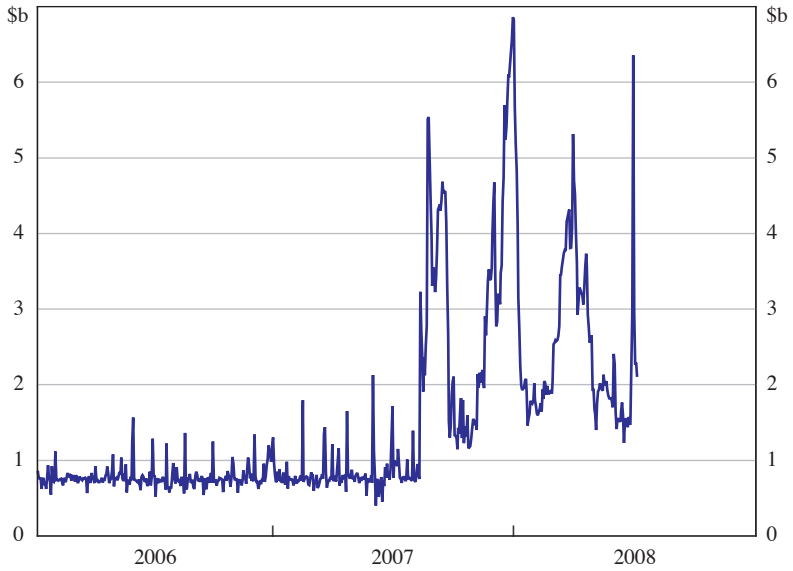
Figure 4: Reserves Balances at the Bank of England



Source: Bank of England

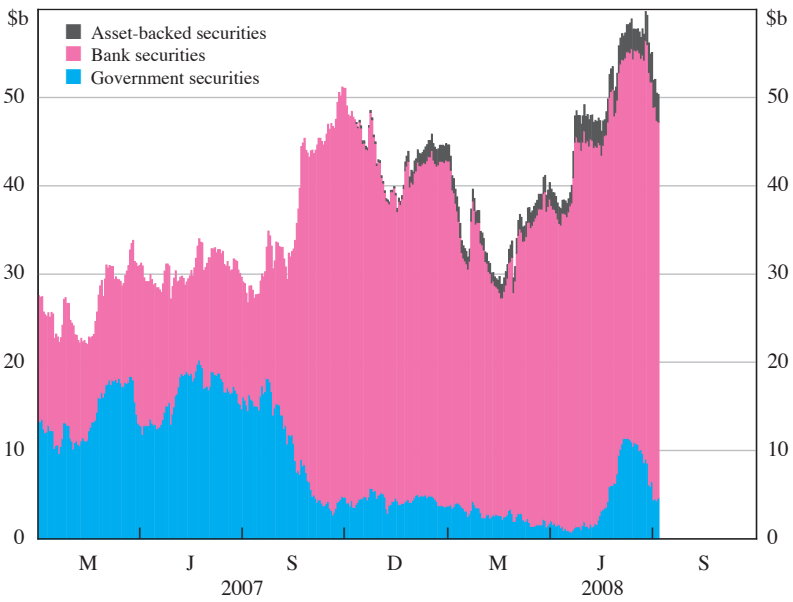
12. In both the United Kingdom and Australia, interest is paid on balances at the central bank. In the United Kingdom, it is paid at the policy rate for reserves within the threshold around the reserves target. In Australia, the interest rate paid is 25 basis points below the target cash rate.

Figure 5: RBA Exchange Settlement Balances

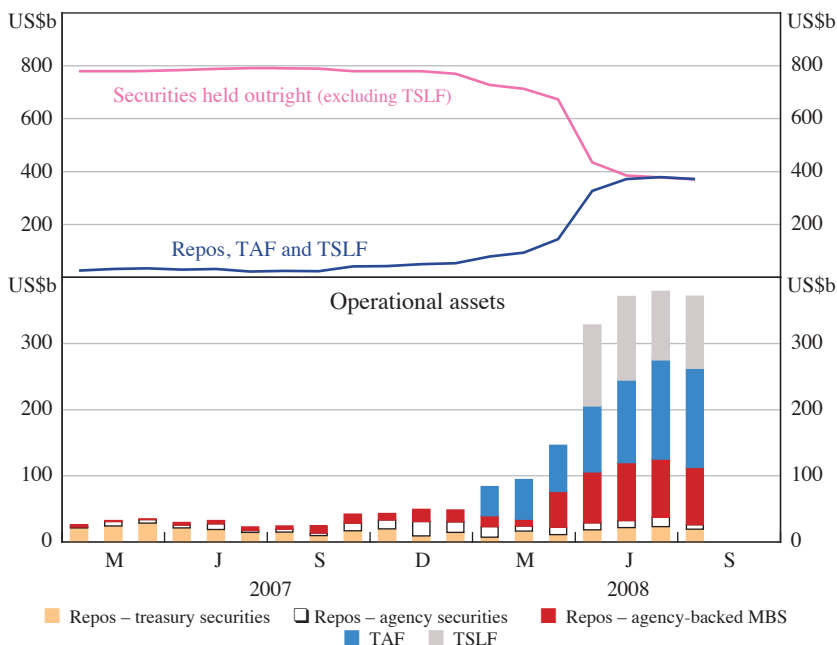


Source: RBA

Figure 6: RBA Repo Assets



Source: RBA

Figure 7: Federal Reserve Assets

Sources: Board of Governors of the Federal Reserve System; Federal Reserve Bank of New York; Thomson Reuters

that were not particularly liquid for highly liquid government securities (the term securities lending facility, TSLF, for the Fed).

6.1.2 The choice of assets eligible for a repurchase agreement

A related issue that has attracted considerable attention is the range of assets that the central bank is prepared to purchase under repo.

As recent experience illustrates, during a period in which conditions are strained, financial institutions have a strong preference to hold assets that can be used in operations with the central bank. This partly reflects a concern that other assets may not be easily sold in the private market if the institution needs funds at short notice. By making an asset eligible for repos, the central bank can reduce the (illiquidity) premium that might otherwise be needed to induce investors to hold that asset. Increasing the range of eligible assets is also likely to give institutions greater confidence that should liquidity pressures emerge, they have appropriate assets to undertake operations with the central bank.

Historically, in many countries, including Australia, the list of eligible assets has been relatively narrow. The logic for this was that the central bank simply did not need to accept a wide range of assets to conduct its markets operations effectively, and/or that accepting assets other than of the highest credit quality exposed the central bank to an unacceptable degree of risk.

One alternative to this historical view is that, in principle, all assets on the balance sheets of financial institutions should be eligible, subject to the risks to the central bank being adequately addressed. By accepting all assets, illiquidity premia that exist because of a lack of market infrastructure or market turmoil would be reduced, and the banking system would be less susceptible to liquidity crises, with both effects potentially increasing welfare. According to this perspective, the risk issue is best addressed, not by the central bank refusing to deal in some asset classes, but by setting appropriate haircuts, advancing fewer funds against more risky assets.

Some central banks have gone a considerable way towards adopting this approach. Since the onset of the turmoil the central banks that had a relatively narrow range of eligible assets for their regular operations, including the Fed, have tended to widen the range, joining the European Central Bank and the Bank of Japan which already had very broad ranges of eligible collateral. At a practical level, one concern with accepting *any* assets under repo is that it can be very difficult to value illiquid assets, and to determine the true nature of the risks, especially where information asymmetries are acute. This can make setting appropriate haircuts very difficult. One possible response to this uncertainty would be to apply ultra-conservative haircuts to hard-to-evaluate assets, although this may undermine any benefit that might otherwise be gained from making these assets eligible for repos. Furthermore, within a class of illiquid and difficult-to-value assets with idiosyncratic properties – typically non-traded assets such as loans – there is the potential for a ‘lemons’ problem if a common haircut is applied. Within such an asset class, it would be possible that the central bank would only be presented with inferior assets for which a sizeable haircut was effectively less punitive.

A related issue is whether assets that have been either originated or sponsored by an institution (say its housing loans) should be accepted under repo from *that* institution. The main concern here is that taking such assets as part of normal market operations can increase the risk to the central bank, as the ‘double protection’ that arises from conducting repos in third-party, or non-related, assets is significantly reduced. Doing so may also lead to financial institutions reducing their holdings of other liquid assets, while accepting assets from the institution that originated them may crowd out secondary markets because it reduces the incentive for originators to stimulate markets for those assets.

Again, an in-principle case could be made to take such ‘related’ assets, subject to appropriately calibrated haircuts. Doing so would seem less problematic if the lemons problem could be reduced, say through some combination of credit quality conditions on the loans or the loans being securitised and rated. This approach can be used to overcome, to a significant extent, the information asymmetries that might otherwise arise from taking mortgages directly from an institution, particularly where the central bank does not have the expertise, or in a crisis, time, to evaluate the quality of those mortgages. The RBA has adopted a variant of this approach for banks to have access to additional securities that they can use to obtain liquidity from the RBA in a period of turmoil. Here the RBA will accept only the AAA tranche of a securitisation of an institution’s own *prime* mortgages. The Australian Prudential Regulation Authority has indicated that these so-called ‘self-securitisations’, of which

banks have constructed \$53 billion in the past six months, should not be substitutes for financial institutions' holdings of more conventional liquid assets.

6.1.3 The maturity of repos

Another aspect of market operations that has drawn attention is the maturity of these operations.

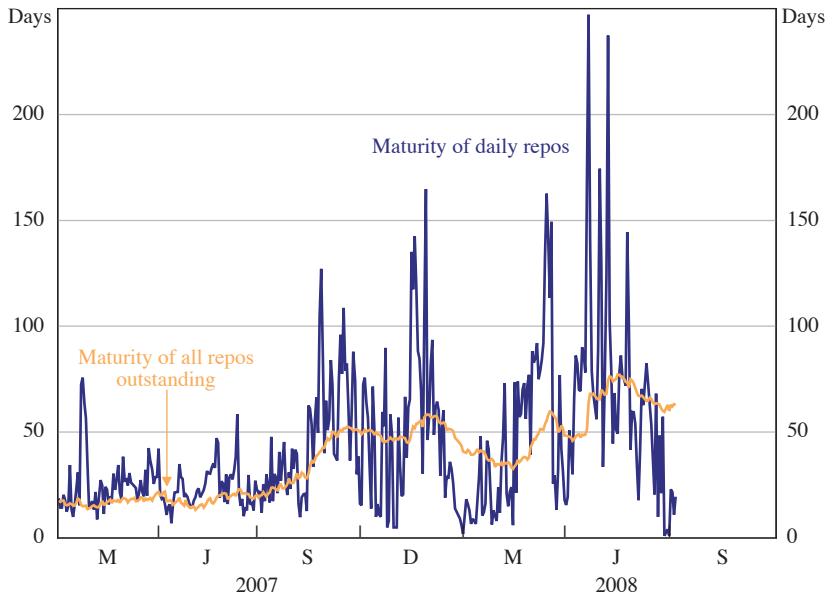
If, at one extreme, the central bank undertakes all its operations in overnight repos, the banking system is required to sell securities to the central bank each and every day, buying them back the next. In this world, an institution that sold securities would get cash only overnight, and would then need to bid again in the open market operations with other institutions the following day. In the event that this institution was unsuccessful on the second day, it might need to arrange a repo (or another transaction) with a private counterparty to obtain the funding it was seeking. If market conditions are unsettled, this may be difficult or costly. To the extent that institutions are concerned about this possibility, they are likely to be less willing than otherwise to provide term funding to their clients.

In contrast, if the central bank conducts longer-term repos, say for a maturity of six months, repo turnover is reduced, but institutions that sell securities to the central bank obtain cash for a longer period, thus reducing their rollover risk. At the margin, this may promote term funding. Similarly, conducting longer-term repos may encourage institutions to purchase longer-term securities in order to repo to the central bank, reducing term premiums. Also, as discussed above, to the extent that repos are used by institutions to substitute less-liquid assets for more-liquid assets, the benefit of doing so is likely to be greater if the substitution is in place for a longer time.

Not surprisingly, given the benefits of undertaking longer-term repos at times when illiquidity premiums are high, most central banks have responded by increasing the maturity of their operations. In Australia, the RBA has long had a flexible approach, and has avoided having fixed maturities. Recently, it has used this flexibility to extend the average maturity of its outstanding repos from around 20 days over the first half of 2007, to around 75 days in May this year (Figure 8).¹³ The average maturity of repos in other countries tends to be shorter than that in Australia, although in almost all cases it has increased over recent times (Figure 9).

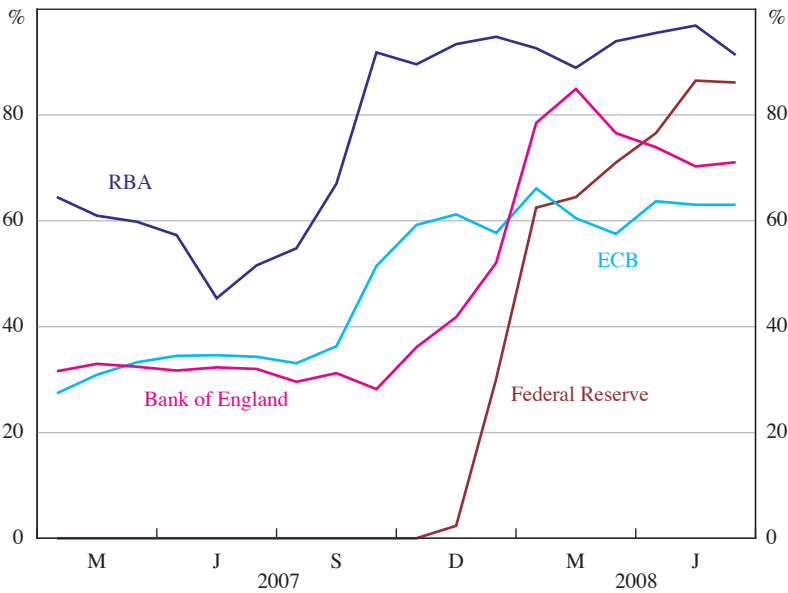
13. The longest single maturity has been 365 days.

Figure 8: Average Maturity of RBA Repos



Source: RBA

Figure 9: Long-term Repos
Share of total repos



Notes: Long-term repos are 28 days or more; includes the TAF for the Federal Reserve
Sources: Thomson Reuters; central banks

6.1.4 Provision of funding to an institution experiencing difficulties

Finally, while a central bank's market operations are typically thought of as dealing with *system-wide* liquidity issues, they can also address liquidity strains being experienced by an individual institution. In particular, an institution having difficulty funding itself in the market is able to bid aggressively for funds in the central bank's operations, providing it has appropriate assets to repo. It might do this if the private repo or outright markets in the relevant assets have been disrupted or, for some reason, market participants do not want to take any counterparty exposure to a troubled institution, even by way of a well-secured repo. For this to be a practical option, the central bank would have to conduct open market operations frequently, preferably daily, so that a troubled institution does not have to wait to access funding.

There is, however, a limit to the extent to which market operations can be used in this way, as the size of daily operations is often relatively small compared to the funding requirements, particularly of a large bank. Furthermore, an institution that bid very aggressively for large volumes of funds over a number of days might expect to attract follow-up inquiries from the central bank and/or prudential supervisor, and to the extent that its activities become known, this has the potential to heighten market concern.

6.2 Direct transactions in markets

A second possible way in which the public sector can address liquidity issues is to purchase assets outright. This can be done by either the central bank or another public sector body.

This idea is sometimes seen as being quite controversial, although it has been applied to the foreign exchange market on numerous occasions. In particular, central banks (including the RBA) have been prepared to intervene in the foreign exchange market to provide two-way liquidity, and have also intervened when the value of the domestic currency was judged to be inconsistent with its fundamental value.¹⁴ Similar intervention in other asset markets is rare, although in Hong Kong the authorities purchased equities during the late-1990s Asian financial crisis.

In principle, the same logic that has been used to justify direct purchases or sales of domestic currency for foreign currency could be used to justify direct purchases of other assets. If an asset market lacks two-way liquidity, or prices have moved far from fundamental value, a case could be made that the public sector should step in. Indeed, in Australia, two proposals have argued recently that an entity sponsored by the Australian Government should be prepared to acquire highly-rated home loans/RMBS if funding conditions in the mortgage market are severely disrupted.¹⁵ Similar arguments have been made by Buiter and Sibert (2007) in an international context.

14. For a discussion of the RBA's intervention in the foreign exchange market see Becker and Sinclair (2004).

15. See Joye and Gans (2008) and Australian Securitisation Forum (2008).

This type of direct intervention can, however, expose taxpayers to considerable risk, distort the operation of markets in allocating resources, and potentially delay the recovery of the secondary market. Given this, there would seem to be a strong case to consider such intervention only if:

- the lack of liquidity, or misalignment in prices, was likely to have first-order adverse effects on the macroeconomy;
- the lack of liquidity, or misalignment in prices, was the result of some clear market failure, and was not likely to be rectified in a timely way; and
- any intervention was not likely to materially distort the pricing of similar assets or affect the structure of the market in normal times.

If applied, these criteria would significantly restrict the types of assets for which intervention might be considered. They would almost certainly rule out purchases of assets with idiosyncratic features and where there were large information asymmetries. The most likely candidates are perhaps mortgage-backed securities and other high-quality bonds, although even here the likelihood of the above criteria being satisfied would appear to be quite low. Notwithstanding this assessment, it is possible that situations arise where the outright purchase of financial assets is in the public interest. *In extremis*, the public sector, with its long-time horizon and large balance sheet, may be able to play a role in providing necessary liquidity to key asset markets, and to limit the consequences of severe market disturbances driving asset prices a long way from their fundamental value.

6.3 Emergency liquidity assistance

A third possibility is to provide an explicit loan to a solvent, but troubled, institution; this is typically known as ‘emergency liquidity assistance’ or lender-of-last-resort (LOLR) loan. While no such loans have been made in Australia for many decades, emergency liquidity assistance was recently provided by the Bank of England to Northern Rock, and by the Federal Reserve Bank of New York to Bear Stearns/JPMorgan Chase.¹⁶

This type of liquidity support can expose the public sector to considerably more risk than that incurred through market operations. Not only is the value of any collateral likely to be more uncertain (as the standard assets used for repos will have been exhausted), but the ‘double protection’ offered by repos in third-party assets does not apply. Moreover, liquidity problems will almost certainly reflect market concerns about the ongoing ability of the institution to repay its liabilities. While in some cases such concerns may be unfounded, in others they may have some basis in fact. Finally, as evidenced by Northern Rock, if the liquidity support is extensive, the need to repay the loan can be a major impediment to the institution remaining in the hands of the private sector.

16. For a history of ‘emergency liquidity assistance’ in Australia see Fitz-Gibbon and Gizycki (2001). For a more recent discussion on the lender of last resort see Stevens (2008).

Despite these considerable difficulties, such support might be justified in some circumstances. This is particularly the case if the troubles reflect the breakdown of markets and an extreme increase in risk aversion. If an institution clearly has significant positive net asset value, yet cannot fund its liabilities because of severe dislocation in markets, the central bank can play a stabilising role, preventing a fire sale of assets and perhaps a loss of confidence in the system as a whole.

Under some scenarios, there is likely to be a connection between the degree of flexibility in the central bank's market operations and the probability that a troubled institution will need to seek emergency liquidity support. In particular, the more flexible are market operations – in terms of frequency, volumes, maturities and acceptable assets – the more likely it is that an institution with assets eligible for repos will be able to exchange those assets for liquidity in the course of normal market operations when the need arises. Indeed, an argument for flexibility in regular market operations is that it can avoid the non-linear effects – partly due to adverse effects on public confidence – that can arise when an institution is known to have sought support.

Flexibility in market operations is, however, not without risks. In particular, if the liquidity problems reflect the poor health of the institution, which is seen by the other market participants, then it is possible that flexible market operations might allow the institution to delay the action required to correct its problems, thereby increasing losses if the institution does ultimately fail. This possibility means that in times of strain, close cooperation is required between the central bank and the prudential supervisor.

Finally, given the flexibility that many central banks now have in their market operations, it is highly likely that an institution requiring an emergency loan will have very serious balance sheet problems. Hence, an emergency loan is perhaps best thought of as a bridging loan while new ownership is arranged, or the institution is fundamentally restructured. LOLR might then be thought to stand for 'lender of last rights'. In today's world it seems unlikely (although not impossible) that an institution would be granted emergency assistance for a short period of time, repay that loan, and then continue as normal. To the extent that emergency assistance is really bridging finance, there is a strong case for it to be accompanied by a credible plan for private-sector support or recapitalisation (Bear Stearns), or some form of government support or recapitalisation (Northern Rock). In either case, the management and shareholders would be expected to incur very significant losses.

6.4 Assisting off-market transfers

A fourth way in which liquidity issues could be addressed is through assisting with the off-market transfer of assets.

As noted in Section 3, the failure of a financial firm with extensive activities in financial markets raises concerns, not just because of the direct counterparty exposures, but also because of the potential cascading effects through financial markets. The fear is that many markets are simply not deep enough to deal with the

rapid closing-out of positions and the flow-on effects from margin calls that would likely follow a failure. In the event that an institution with extensive operations in markets was forced into liquidation, the potential flow-on effects could undermine the stability of the financial system.

While these concerns are widely held and appear to be soundly based, it is important to note that this scenario has never played out in practice, with no major participant in financial markets having been forced into liquidation. This lack of experience makes it difficult to assess exactly what might happen in the event of such a failure. Notwithstanding this, a reasonable question is how policy-makers should respond to this possibility (over and above providing general liquidity to the market and ensuring that the overall regulatory framework is sound).

It can be argued that these distressed situations are best dealt with by a *measured* selling-down of positions, rather than an immediate sale in turbulent conditions where information asymmetries are likely to be acute. In some situations such an outcome might be able to be organised by the private sector, either by a single institution, or group of institutions, purchasing the positions off market, at a substantial discount. The public sector may be able to play a useful role here, particularly if coordination issues among the troubled institution's counterparties prevent an effective solution that is in their collective interest.

A more difficult problem emerges if a private buyer cannot be found quickly. One option here would be for the public sector to purchase the assets/positions and then sell them over time when conditions are more settled; the Fed's approach to Bear Stearns can be seen in this light. The argument for such an approach is that it might avoid a fire sale of financial assets that could prejudice the stability of the overall financial system. Furthermore, provided that the assets/positions are bought at a substantial discount to current value, the purchase may deliver a favourable risk-adjusted return to the public sector.

Such actions are, however, not without considerable risks. Not only is there the obvious risk that the assets may ultimately be worth less than the price that the public sector paid, but the possibility of such actions may change the behaviour of the private sector. In addition, when decisions have to be made very quickly, a type of game can develop between the public and private sectors, particularly if the private sector believes that the public sector will go to considerable lengths to protect the stability of the financial system. This game may lead to the public sector paying more for the assets than is desirable.

These are difficult issues to resolve, but as financial markets continue to grow, ways need to be found to allow large participants in these markets to exit without causing instability in the rest of the system. As discussed earlier, improving the financial infrastructure can be helpful here, but mechanisms also need to be found to prevent the fire sale of financial assets and limit the build-up of problems in the first place.

7. Policy Discussion

It is clear that liquidity problems can have significant effects on the financial system and the real economy. It is equally clear that there is no single solution to addressing these problems. Reducing information asymmetries and improving market infrastructure have an obvious role to play. An improvement in the way that institutions manage their own liquidity is also required. Further, at the supervisory level, attention needs to be paid to the potential for system-wide liquidity problems, and not just problems that are restricted to a single institution. Central banks (and possibly other public sector bodies) also have an important role to play. At issue is how extensive this role should be, and what conditions should apply.

Unfortunately, too often discussions of this issue are derailed by quick references to the dangers of ‘moral hazard’. It is sometimes argued that if the public sector provides *any* form of liquidity services to the private sector, the result will be more risk-taking, and ultimately either a more crisis-prone system, or higher costs to the taxpayer.

While not wishing to downplay the risks, this argument misses a key point, namely that, while the provision of liquidity services by the public sector will undoubtedly change the behaviour of the private sector, this change in behaviour need not be welfare-reducing. If some form of systemic liquidity services are not provided, private institutions need to provide their own insurance by holding more liquid assets than would otherwise be the case. The end result may be a higher cost of financial intermediation and, in turn, a lower capital stock. Institutions may also be less prepared to commit funding for longer-term projects and more likely to cut back credit lines when troubled conditions emerge (although presumably the emergence of such conditions would be less likely). Indeed, making a credible *ex ante* commitment to provide a certain degree of liquidity assistance may actually reduce moral hazard relative to a statement that the central bank will not provide liquidity assistance. If the private sector does not believe that such a statement is credible, then it is likely to condition its behaviour on the level of liquidity assistance that it *thinks* the central bank would provide.

None of this is to imply that institutions themselves should not have responsibility for managing their own liquidity. They clearly do. Moreover, they need to be prepared for significant dislocations in the key markets in which they operate and disruptions to their normal funding patterns. Over recent years, many institutions appear not to have done this adequately, undertaking too much maturity transformation, with too little capital, and on a funding base that was much less stable than widely assumed. It is important, though, that in responding to these shortcomings there is not an overreaction the other way which requires the private sector to fully self-insure against system-wide liquidity problems. Given that, to some extent, these problems arise from underlying distortions or market failures, full self-insurance is unlikely to be consistent with welfare maximisation.

In our view there is a strong case for the central bank to play the sort of liquidity smoothing role discussed in the previous section, increasing the supply of liquid assets at a time when the market places a very high value on these assets. It can do

this by increasing the size of its own balance sheet and/or changing the composition of its assets during times of strain. While playing such a smoothing role will lead to an increase in the risk carried on the central bank's balance sheet, this increase can be limited by the use of appropriate haircuts, and the central bank will be compensated for this additional risk through higher expected returns on its asset holdings.

For this role to be played effectively, the central bank needs to have a considerable degree of flexibility in its market operations, including the frequency, maturity and scale of these operations. Many central banks have moved in this direction over the past year.

We also see a strong case for the central bank being prepared to purchase a wide range of third-party assets under repo. Doing so can reduce illiquidity premia that apply to these assets and reduce the possibility that solvent financial institutions find themselves needing to seek emergency support. One useful criterion to apply in considering where the boundary should be between acceptable and non-acceptable assets is the degree of information asymmetry, with the greater the asymmetry, the weaker the case for the central bank buying the asset under repo. In some situations, this criterion might rule out accepting assets that an institution has originated itself, or at least requiring greater protection through larger haircuts.

In extremis, there may also be grounds for the public authorities to purchase outright a very limited range of assets. However, the risk-return trade-off from such purchases is, in most cases, likely to be much less attractive than the actions discussed above. This means that the 'burden of proof' that the public sector needs to meet in justifying such intervention should be set very high. One variant of this approach is for the public sector to assist with the off-market transfer of assets of a troubled financial firm, including possibly, *in extremis*, taking assets directly onto the public-sector balance sheet and disposing of those assets gradually over time. One argument for doing this is that in some extreme situations it is in the public interest for the assets owned by a troubled institution to be sold in a measured way, rather than dumped onto markets when risk and illiquidity premia are at their highest.

As discussed above, situations can also emerge where providing a loan directly to a troubled, but solvent, institution may also be in the public interest. Over time, however, with market operations becoming more flexible, the probability of such support being used to assist an institution over temporary funding difficulties has probably declined. It is more likely that such support provides bridging finance while new ownership and management are put in place.

In supporting a role for the public sector in providing a range of systemic liquidity services to the private sector, the moral hazard concerns discussed above need to be addressed. In doing so, it is important to recognise that the relative public versus private benefits of the various liquidity services differ across these services. In particular, there is a strong public good element in the central bank to play a contrarian role when liquid assets are in high demand, and in helping reduce illiquidity premiums in financial assets. While financial institutions benefit from these services, these benefits are spread widely and are not concentrated in a particular institution. In contrast, providing a direct loan to an institution can lead

to significant benefits to those associated with that institution; of course there may be also benefits to the market more generally, particularly if, in the absence of the liquidity support, the troubled institution would be liquidated, causing widespread dislocation in financial markets.

How then can the moral hazard concerns be addressed? We see three not mutually exclusive possibilities.

- i. The first is a strengthening of the macro-prudential elements of supervision.

While we have argued that there are strong grounds for the central bank to take a contrarian position in the sense we discuss above, and to assist more generally when system-wide liquidity problems emerge, there is a certain asymmetry if such actions occur only when conditions are unsettled. It is not implausible that this asymmetry itself could affect private-sector behaviour. One way of addressing this is for supervisory requirements to be tightened in the good times, when liquidity is judged to be ample and credit risk low. The case for this type of cyclical supervisory response is strengthened by the observation that system-wide liquidity problems invariably have their roots in the underestimation of risk in good times.¹⁷ If the public sector is to provide some form of systemic liquidity insurance – and inevitably accept a higher level of risk in doing so – the trade-off may be a tightening of supervisory requirements in good times. In a sense, such a tightening could be thought of as part of the ‘insurance premium’ that the private sector pays for the liquidity services that the public sector provides. It would also assist in the building-up of the system’s buffers in good times and reduce the probability of liquidity problems emerging when conditions eventually deteriorate.

- ii. A second possibility is to ensure that institutions are subject to prudential regulation if there is any possibility that the public sector might need to offer some form of institution-specific support.

Significant moral hazard issues arise if an institution is able to sit outside the regulatory net but obtain support when times are troubled. Again, submitting to prudential regulation can be part of the ‘insurance premium’ that institutions are required to pay if they are to ever obtain institution-specific assistance. There is a strong case for them to be required to pay this ‘premium’ if they are large and have complicated dealings in financial markets.

A tangentially-related issue is who the central bank should be prepared to deal with in its daily market operations.¹⁸ Where these operations are conducted in high-quality, third-party assets, the counterparty risk being run by the central bank is normally low. There is, therefore, a strong case for the eligibility requirements to be largely limited to operational issues related to the effective implementation of monetary policy. If this is the case, then a very wide range of institutions – including non-banks – can participate in market operations (as is the case in

17. For a fuller discussion of this option see Borio (2007) and Borio, Furfine and Lowe (2001).

18. See Hilton (this volume) for a discussion of recent changes in the Fed’s range of eligible counterparties.

Australia). The situation is somewhat different when it comes to transactions in assets that have been originated or sponsored by the central bank's counterparty. Accepting related assets can involve significant additional risk, and the case for doing so in the course of normal market operations appears weak. This is particularly so for an institution that is not subject to prudential regulation.

- iii. A third way of addressing moral hazard relates directly to the conditions that apply to liquidity assistance outside normal market operations.

As discussed earlier, if despite the central bank having flexible operating procedures, an institution requires emergency liquidity assistance, then that institution is probably in very significant trouble. Extending support to such an institution may be in the public interest, but it also risks providing benefits to those directly associated with the institution, including its managers and shareholders. Given this, it may be better to think of emergency liquidity support as the public sector providing bridging finance, while new ownership of the institution is being arranged. This was what essentially happened in the cases of Northern Rock and Bear Stearns, with in one case the new owner being the government, and the other, a private bank. It seems likely that the days are gone (if indeed they ever existed) in which an institution could obtain emergency support, then repay that support after the funding problems resolve themselves, with the bank institution then continuing on as normal.

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Discussion

1. Prasanna Gai

I very much enjoyed reading this clear and thought-provoking paper. It raises important questions about the nature of financial stability policy, forcing us to think hard about what the accompanying architecture should look like. As Jonathan Kearns and Philip Lowe make plain, the issues they raise have no easy solutions.

The key theme underpinning the paper concerns the trade-off between *ex ante* moral hazard and *ex post* crisis resolution. *Ex ante*, it is desirable to provide good incentives to keep agents from indulging in excessive risk-taking behaviour. *Ex post*, however, it is generally socially desirable to limit the costs of financial system distress through policy intervention of one form or another. The two goals are generally in conflict and the design problem for financial stability architects is to balance them in a sensible way.

Absent financial frictions of any kind, the threat of crisis and the real costs that ensue provides the market discipline that curbs undesirable risk-taking behaviour. For example, Calomiris and Kahn (1991) argue that demand deposits provide the adequate instrument for disciplining the (*ex ante*) moral hazard of bank managers.¹ At the sign of potential problems, investors withdraw their deposits. Jonathan and Philip are therefore careful to identify the financial frictions that they feel might help establish the welfare case for policy intervention, before considering what forms such intervention could take.

Recent theoretical work points in the authors' favour on this issue. Gai, Hayes and Shin (2004) demonstrate how, when faced with a world of financial frictions of the kind considered by Jonathan and Philip, policy intervention improves social welfare under plausible circumstances. The two factors that determine this are: (a) the quality of the discipline that the public sector can impose; and (b) the efficacy of the crisis management framework deployed. If policy actions provide a reasonable check on agents' incentives and behaviour *ex ante*, then welfare is increasing in the degree to which the real costs of premature liquidation are alleviated by the central bank. But beyond some point, the lower discipline that results from the reduction in *ex post* crisis costs can offset the discipline from *ex ante* policy measures. In other words, the trade-off between *ex ante* moral hazard and *ex post* crisis resolution is likely to be non-linear in nature.

The absence of a simple relationship implies that policies aimed at financial system stability must strike a delicate balance between crisis prevention and crisis management. Moreover, the subtlety of these interactions means that policy-makers need to be very clear about the nature of the financial frictions with which they are confronted. The main concern of Jonathan and Philip's paper is with frictions in the interbank market. The benchmark setting in this case is provided by Goodfriend

1. Eichengreen and Portes (1995) and Dooley (2000) explore similar ideas in the sovereign debt arena, emphasising debt workouts and country liquidity runs respectively.

and King (1988). They argue that with efficient interbank markets central banks should not lend to individual banks but should instead provide sufficient liquidity via open market operations which the interbank market could then allocate efficiently among banks.

There are a number of externalities that might plausibly take us away from this frictionless ideal. Interbank markets may fail to allocate liquidity efficiently due to: asymmetric information about the quality of banks' assets (Flannery 1996; Freixas and Jorge 2007); banks' free-riding on each other's liquidity or on central bank liquidity (Bhattacharya and Gale 1987; Repullo 2005); the exercise of market power in the interbank market (Acharya, Gromb and Yorulmazer 2008); or as a consequence of predatory behaviour forcing inefficient liquidation of bank assets (Brunnermeier and Pedersen 2005).

A further cause of market failure in the interbank market stems, perhaps, from the deep financial friction highlighted by Kiyotaki and Moore (2002), when they remind us that 'evil is the root of all money'. For them, the enforcement of contracts and the collateral underpinning borrowing assume centre stage. Understanding the nature of collateral in the interbank market could well prove crucial to system stability design. If assets and collateral are bank-specific, then liquidation of assets by a bank in distress could be socially costly, and changes in ownership (whether private or public) could be counter-productive from a welfare perspective. Relatively little is known about this subject and it merits further attention by policy-makers and academics. But it is the intertwined nature of a number of these frictions in the present crisis that makes the policy problem particularly difficult.

Jonathan and Philip proceed to consider the *actual form* that policy intervention might take. They consider several measures that can be classed as *ex ante* or *ex post* in spirit. On the *ex ante* side, they suggest that supervisory requirements be tightened in good times when liquidity is ample and credit risk low. Liquidity policies that encourage 'self-insurance' by banks may also have a place, along with arrangements and infrastructure that facilitate greater disclosure by financial institutions. On the *ex post* front, they raise the possibility that the central bank could purchase a much wider range of assets under repurchase agreements, purchase some of these assets outright (under well-defined conditions) as a market-maker of last resort, and stand ready to provide assistance with the off-market transfer of assets.

One might reasonably add monetary policy to this mix, particularly if the central bank is to play the lead role as the guardian of systemic stability. The use of monetary policy for financial stability purposes remains a contentious subject. But, at root, financial stability is about optimising the *intertemporal margin* – the price of money and goods today and tomorrow. Whereas monetary stability policy focuses on the *intratemporal margin* – the relative price of money and goods today. When confronted with one instrument (the interest rate) and two margins, the *ex ante* policy design problem for the central bank becomes akin to an optimal tax problem.

An alternative possibility, one that does not run counter to Tinbergen's rule or place the central bank's balance sheet under risk, would be to regulate financial balance sheets more directly – explicitly altering capital settings, liquidity requirements and

patterns of concentration. Existing regulatory instruments are calibrated according to measures of idiosyncratic risk in individual institutions. Is it possible to quantify an institution's marginal contribution to systemic risk? This could be used to specify systemic risk 'taxes' or regulatory requirements that sit alongside idiosyncratic risk requirements. Progress along this dimension requires quantification of systemic risk. Despite some recent work in this area by central banks, notably the Bank of England and the Austrian central bank, more remains to be done.

A final observation. I am struck by the extent of the overlap of the current debate with the debates on the 'international financial architecture' of a few years ago. Back then, the focus was on *PSI – Private Sector Involvement*. We also considered self-insurance (in the form of Greenspan-Guidotti rules of thumb for the liquidity of sovereign borrowers), circuit breakers to curb country runs, and methods for preventing boom-bust cycles in international lending. There was also policy consensus that the role of the public sector (chiefly in the form of the International Monetary Fund) should be limited and 'catalytic' in nature. The private sector, it was argued, should bear the brunt of the burden. Arguably, the nature of the frictions and the creditor collective action problem was much clearer then.

In the recent financial turmoil, *PSI* seems to have returned. The emphasis in the current paper – quite rightly – has been on *Public Sector Involvement*. But the lessons of past financial crises suggest that there may be some scope for involving the private sector still further in dealing with this crisis. Developing a greater understanding of how burden-sharing between the official sector and financial institutions might work when liquidity has features of both a public and a private good seems an important next step.

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2. General Discussion

The discussion began with some debate about the appropriate role of the central bank in dealing with systemic versus idiosyncratic shocks. It was suggested that prudent banks often argue against bailouts of imprudent institutions, as these bailouts would hurt the competitive position of those who had acted with restraint. However, in arguing this, prudent banks are often ignoring that the failure of an institution can have systemic effects that may adversely impact on them. It was suggested that while the extent to which a central bank should 'fight a fire' at a particular bank is not clear, social welfare is enhanced by the public sector preventing the 'fire' from spreading to other sound financial institutions. There was general agreement that there should be some role for central banks in ensuring systemic stability, and that it was not socially optimal to have institutions 'insure' themselves fully, for example, by holding a sizeable share of their assets in liquid form. Nevertheless, some suggested that private institutions needed to be better prepared to deal with adverse shocks, both idiosyncratic and systemic. This could perhaps be achieved by banks holding more liquid assets and also holding liabilities with a broader range of term structures. This greater preparedness by private institutions could be thought of as complementing, rather than replacing, prudential and liquidity management policy at central banks. One participant suggested that it was worth considering whether there should be a tax on systemically important banks, which might otherwise free ride on the willingness of central banks to offer them assistance if needed. Others argued that requiring a bank to hold liquid assets can be thought of as a tax. Yet another participant noted, however, that if the market valued this type of behaviour, banks should benefit from being prudent via a lower cost of raising debt.

There was a discussion about issues related to collateral used to obtain funds from central banks. One participant questioned the effectiveness of central banks requiring good collateral before providing liquidity to a financial institution, given

that depositors would take preference if the bank was insolvent, which could leave the central bank out of pocket. It was pointed out that, under Australian law, the Reserve Bank has priority similar to that of a depositor in the event of a bank collapse, allowing the Bank to recover some of the funds provided to the collapsed institution. Another participant highlighted that this pointed to the importance of central banks and supervisory authorities (where they are not one and the same) maintaining close relationships, since the former would need to rely on the judgments regarding solvency made by the latter. There was also some consideration of the appropriate size of haircuts. Some participants noted that sufficiently large haircuts were required to allow central banks to extend the pool of eligible collateral, and while others agreed, they argued that overly large haircuts would limit the amount of liquidity provided. Finally, there was some debate about whether the tendency for central banks to provide liquidity against a wider pool of collateral would be sustainable, given that it could make banks less likely to hold prudent levels of liquid assets in the future.

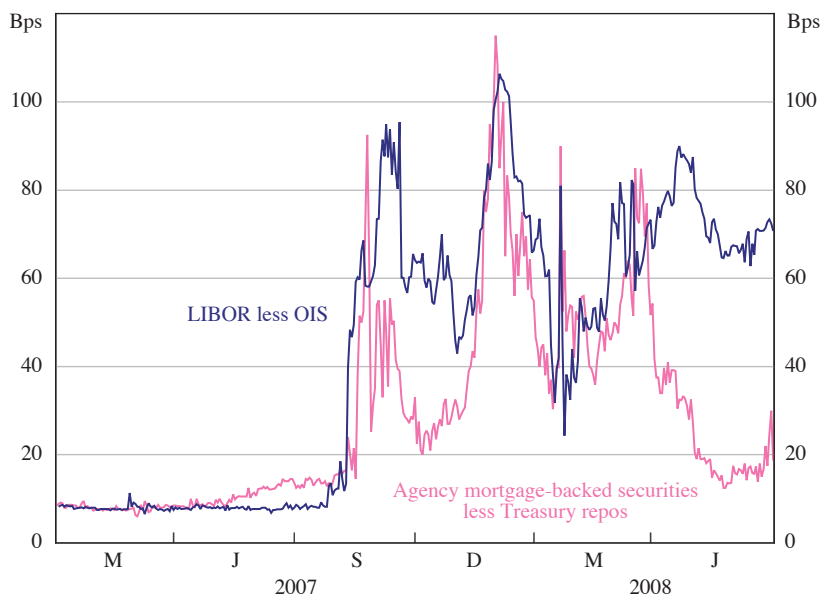
Recent Developments in Federal Reserve System Liquidity and Reserve Operations

Spence Hilton¹

1. Introduction

In August 2007, a deteriorating US housing sector and increasing uncertainty about the value of sub-prime mortgages and other securitised assets triggered a sudden and dramatic increase in funding pressures on commercial banks. These pressures were clearly evident in elevated rates in bank term unsecured borrowing markets that emerged at that time (Figure 1). Dislocations in these bank term funding markets spilled over into the overnight interbank funding market as well. Financial strains persisted and spread, and in mid March 2008 growing concerns about the financial condition of a large US investment bank threatened to undermine the ability of financial institutions to finance a wide range of even some high-quality assets in markets for repurchase agreements (repos).

Figure 1: 3-month Rate Spreads



Sources: Bloomberg; Federal Reserve Bank of New York

1. Reserve Bank of New York, 33 Liberty Street, New York, NY 10045. The views expressed in this paper are those of the author and do not necessarily reflect the position of the Federal Reserve Bank of New York or the Federal Reserve System.

The Federal Reserve System undertook a series of monetary policy actions to help address macroeconomic risks to the economy, including those linked to financial market strains. From September 2007 to April 2008, the Federal Open Market Committee (FOMC) reduced the target for the nominal overnight federal funds rate by 325 basis points. Alongside these monetary policy actions, the Federal Reserve undertook a series of initiatives aimed at improving market liquidity and overall market function. These arrangements allowed financial intermediaries to finance with the Federal Reserve, assets they could no longer finance as easily in the markets.

This paper reviews the impact that these new liquidity facilities and associated financial market strains had on the balance sheet of the Federal Reserve and on reserve operations over the period August 2007 through June 2008. It presents a comprehensive view of the implementation of monetary policy and the management of the balance sheet during this period, one that focuses on operational considerations and challenges. The paper is organised as follows. Section 2 outlines the features of the operating framework used to implement monetary policy that are most critical for understanding the responses and the challenges faced in managing liquidity since August 2007. Section 3 reviews the structure of new liquidity activities introduced since that time through June 2008, and examines their impact on reserve operations. Section 4 discusses the challenges faced in meeting the operating objective for the implementation of monetary policy – the overnight federal funds rate. Section 5 concludes with a discussion of some of the issues the Federal Reserve System will confront regarding liquidity and reserve operations going forward.

2. Monetary Policy Implementation Framework and Procedures

The current institutional framework and the operating practices used by the Federal Reserve System to implement monetary policy are outlined in this section.² Components of the overall framework most critical for understanding the design of recent liquidity facilities and the operational challenges that the Federal Reserve has faced since August 2007 are highlighted.

2.1 Key elements of the current operating framework

2.1.1 Operating objective

The stance of US monetary policy is set by the FOMC in the form of an operating objective for open market operations. After each of its meetings, the FOMC issues

2. Detailed descriptions of the components of this operating framework are available from numerous sources, including various official Federal Reserve publications available on the websites of the Board of Governors (<<http://www.federalreserve.gov/>>) and the Federal Reserve Bank of New York (<<http://www.newyorkfed.org/>>). However, few integrated descriptions of the framework and operating procedures are available. One of the most comprehensive presentations can be found in Board of Governors of the Federal Reserve System (2005).

a directive stating the operating objective to the Trading Desk (Desk) at the Federal Reserve Bank of New York (FRBNY), which the FOMC authorises to conduct open market operations for the System Open Market Account (SOMA).³ For many years the operating objective has been a target for the federal funds rate, the overnight interest rate paid by commercial banks and other depository institutions operating in the United States on their unsecured borrowings from other banks and select entities.⁴ The minutes from the FOMC meeting of April 2008 read in part:

To further its long-run objectives, the Committee in the immediate future seeks conditions in reserve markets consistent with reducing the federal funds rate to an average of around 2 percent. (FOMC 2008)

To keep the federal funds rate around its target, the Desk uses open market operations to align the supply of balances held by depository institutions at Federal Reserve Banks (reserves) with estimates of demand.⁵ The Desk's regular operating procedures are described below in Section 2.3, and how these procedures help to maintain the funds rate around the target is discussed in Section 4. Data on overnight transactions in this market are collected by the Desk from brokers who arrange most of the trades between larger banks, and these data are used to track how effectively this operating objective is met.

2.1.2 Reserve requirements and contractual clearing balance obligations

Depository institutions are subject to reserve requirements assessed against their deposit liabilities. Only a narrow set of transaction deposits within the M1 monetary aggregate currently has a positive requirement. Reserve requirements must be satisfied every two-week reserve maintenance period in one of two ways: with cash held on a bank's premises or with balances held on deposit in an account at a district Federal Reserve Bank.⁶ Federal Reserve Banks are not currently authorised to pay interest

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3. The FRBNY manages SOMA on behalf of the Federal Reserve System. SOMA assets are allocated among, and reported on, the financial statements of the Federal Reserve Banks. Discount window loans are Federal Reserve Bank assets and not part of SOMA. Some decisions involve one or more entities within the Federal Reserve System: the Board of Governors, the individual Federal Reserve Banks, the FRBNY (transacting on behalf of SOMA) and/or the FOMC. These distinctions are important for understanding the structure of, and roles of, various entities comprising the Federal Reserve System. For the purposes of this paper and to facilitate readability, this discussion dispenses with these distinctions for the most part, and simply refers to the Federal Reserve or Federal Reserve System.
 4. These borrowings are differentiated from the deposit liabilities of banks by being exempt from reserve requirements.
 5. The term 'reserves' is used in a colloquial sense in this paper to refer to all balances held by depository institutions in their accounts at Federal Reserve Banks, whether used to satisfy reserve requirements, clearing balance obligations or held as excess reserves. As used in this paper, the term does not include banks' holdings of vault cash used to satisfy reserve requirements.
 6. Some smaller depository institutions have a weekly maintenance period. Reserve requirements and the portion that is satisfied with cash holdings (vault cash) are calculated before the start of each reserve maintenance period.

on the balances held to satisfy reserve requirements. A bank may also contract with its district Federal Reserve Bank to have a clearing balance obligation, whereby the bank agrees to hold a specified level of balances in its Federal Reserve Bank account (Fed account), on average over a reserve maintenance period. A bank earns income credits on balances held to satisfy these obligations, at a rate linked to short-term market rates. But such income credits may only be used to offset charges for certain services offered by Federal Reserve Banks, thereby limiting their value.⁷ Penalties apply if a bank has not accumulated enough balances over a two-week maintenance period to meet its reserve requirements and clearing balance obligations, or if it ends any day overdrawn in its Fed account.⁸

Binding requirements in the monetary policy implementation framework provide a basis for estimating reserve demand, and the ability of a bank to meet its requirements over a maintenance period on an average basis makes daily demand for reserves more elastic. However, aggregate total requirements to hold balances in a Fed account – reserve requirements less the portion satisfied with vault cash (called required reserve balances) plus clearing balance obligations – are relatively low by past historical measures (Figure 2). Required reserve balances fell dramatically in the 1990s as banks developed ‘retail sweep programs’ in order to evade these

Figure 2: Requirements to Hold Reserve Balances
Bi-weekly maintenance period values



Source: Federal Reserve Bank of New York

7. These charges include, for example, fees charged to banks by the Federal Reserve for use of its cheque-clearing services.
8. Banks have limited ‘carryover privileges’ from one maintenance period to the next for purposes of meeting their reserve requirements, and a clearing balance obligation may be satisfied within a narrow band.

requirements because they earn no interest.⁹ Moreover, many large banks operating in the United States have a low level of reserve requirements because they have a relatively small base of transaction deposit liabilities, and few incur enough Federal Reserve service charges to warrant having a significant clearing balance obligation. As a result, aggregate total requirements provide limited protection against potential aggregate daily shocks to reserve supply, and many individual banks active in the interbank market have indicated that their total requirements are low when measured against the uncertainties they face every day about their payments flows.

2.1.3 Standing facilities¹⁰

Banks that are in sound financial condition can borrow directly from their local Federal Reserve Bank through the primary credit facility (PCF) which is one of the regular discount window programs of the Federal Reserve Banks. From its inception to August 2007, loans were extended only for short terms, typically overnight, and the rate was set 100 basis points above the federal funds target.¹¹ As a general rule, a bank will utilise the PCF rather than incur the penalties associated with ending a day overdrawn in its Fed account or falling short of meeting its requirements at the conclusion of a maintenance period. However, individual banks have been observed paying rates in the market above the PCF rate, which is evidence of the stigma associated with PCF borrowing. Even so, the availability of PCF credit at a fixed rate helps limit the upward pressure that can develop on the overnight federal funds rate. Federal Reserve Banks do not pay interest on excess reserves, so no corresponding facility is available to help set a floor on market rates.

2.1.4 Eligible assets and counterparties for monetary policy operations

The *Federal Reserve Act* (FRA) limits the types of assets that the Federal Reserve may acquire through open market operations. In practice, these operations have been limited to transactions in US Government securities: Treasury debt and debt issued or fully guaranteed by US federal agencies, which includes agency mortgage-backed securities (agency MBS). Other types of securities eligible under the FRA would not support particularly large or variable open market operations. Counterparties to open market operations are the ‘primary dealers’ designated by the Desk. These institutions are active dealers in the government securities market, and they routinely finance large inventories of government securities through repo agreements in the market each day. In recent years, few primary dealers have been banks, although many have been part of a larger holding company that has included a banking organisation.

9. Also, reserve requirement ratios were cut in 1990 and 1992.

10. Use of the term ‘standing facility’ simply means that the facility is always available on pre-set terms, and it should not be read as suggesting that the Federal Reserve Bank extending credit does not have the discretion to decline to extend credit to the requesting institution.

11. The PCF was established in 2003 to replace the adjustment credit facility, which was administered differently although it served a similar general function.

Individual Federal Reserve Banks may extend loans on a collateralised basis to depository institutions through discount window facilities under terms and conditions set by the Board of Governors. The PCF is such a facility. Under the FRA, a wide variety of assets may be pledged as collateral against discount window loans, including government and private-sector securities, mortgages and consumer and commercial loans.¹² In addition, under the FRA, in unusual and exigent circumstances, the Board of Governors may authorise Federal Reserve Banks to lend to non-depository institutions.¹³ Such loans must be secured to the satisfaction of the lending Reserve Bank.

2.2 Historical composition of the domestic portfolio

The composition of the Federal Reserve System balance sheet on the eve of the onset of the financial market turmoil in August 2007 is representative of its structure for much of recent history to that point (Table 1). The total size of the portfolio of domestic financial assets held by the Federal Reserve mirrors the net value of autonomous factors on the balance sheet (liabilities less assets) and reserve balances. By far the single largest of these autonomous factors is Federal Reserve banknote liabilities. By comparison, the net value of all the other factors is very small.¹⁴

Assets acquired over the years through open market operations are divided between repos against government securities and outright holdings of US Treasury debt.¹⁵ The split between these two asset categories has been a function of historical volatility and uncertainty in autonomous factor movements, such as seasonal swings

Table 1: Balance Sheet of the Federal Reserve System
8 August 2007, US\$ billion^(a)

Assets		Liabilities and capital	
Treasury securities	791	Reserve balances of banks	12
<i>of which – bills</i>	277	Federal Reserve banknotes	777
Conventional repos	19	Treasury deposits	5
PCF loans	0	Other liabilities and capital	75
Other assets	59		
Total assets	869	Total liabilities and capital	869

(a) All values are averages for the week ended 8 August 2007 except the following: total assets, total liabilities and capital, and Federal Reserve banknotes, which are values as of 8 August 2007; and other assets and other liabilities and capital, which are calculated as a residual item for assets and liabilities and capital, respectively.

Source: Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release: H.4.1

12. Asset types currently accepted at the discount window are listed in Table 2.

13. This authority is found in Section 13(3) of the FRA.

14. Autonomous factors on the Federal Reserve's balance sheet that are the most difficult to predict on a daily basis include deposits of the US Treasury, the Federal Reserve Bank float, and overnight reverse repos offered as a short-term US dollar investment facility to foreign central banks with an account relationship with the FRBNY.

15. The repos arranged by the Desk are reserve-adding operations.

in demand for Federal Reserve notes around major holidays, and reserve demand. In determining the appropriate size of total outright holdings, an objective has been to avoid a need for frequent temporary downward adjustments to outright holdings. This goal has been met largely by maintaining a layer of repos in the portfolio which acts as a shock absorber, adjusted up or down as needed in response to temporary movements in autonomous factors or reserve demands. Otherwise, outright holdings of Treasury securities generally have been preferred on the basis of their comparative safety, various operational considerations and a preference for limiting direct extensions of central bank credit to private market participants where not necessary.

Over time, most of the steady expansion of the portfolio of assets has been in outright holdings of Treasury securities and has been driven by a need to match growth in Federal Reserve banknote liabilities. An expansion of outright holdings is typically achieved by making direct purchases in the secondary market; the level of outright holdings can then be maintained by exchanging maturing holdings for newly issued Treasury debt at primary auctions.¹⁶ Reverse repos can be arranged in the market as needed to reduce reserve supply for temporary periods, but historically these operations have been infrequent.

The repos outstanding typically contain a mix of shorter-term maturities, which in recent years have ranged from overnight to 14 days, but occasionally longer. Historically, outright holdings of Treasury securities as a share of total available market supply have been disproportionately weighted towards bills – discount instruments with maturities of under one year.¹⁷ This structure was designed to provide liquidity in the event that a large-scale reduction in the portfolio was needed. Holdings of coupon securities have historically tended to be spread across the yield curve in proportions roughly corresponding to total outstanding Treasury issuance.

2.3 Traditional operating practices

The Desk's approach for achieving its operating objective is predicated on the view that a 'neutral' supply of reserves – that is, a cumulative level provided over an entire maintenance period that allows all banks to meet their reserve requirements and clearing balance obligations with minimal levels of excess reserves – ordinarily is needed to maintain the overnight federal funds rate around its target.¹⁸ How this

16. Historically the Desk has also purchased Treasury securities directly from foreign central banks that have an account with the FRBNY. The Federal Reserve cannot increase its holdings of Treasury debt at primary auctions.

17. As at the end of 2006, the Federal Reserve held 18 per cent of all marketable Treasury debt outstanding, but this included 36 per cent of all Treasury bills outstanding.

18. Historically, smaller-sized depository institutions that do not have access to funding markets have demanded some level of excess reserves each day, as a source of liquidity to guard against reserve-draining shocks. As a group, these smaller institutions have typically held between US\$1½ billion and US\$2 billion of reserves in excess of their requirements. This 'frictional' demand of smaller banks has largely proven to be insensitive to both daily trading conditions in the funds market and to the level of the funds target. The Desk must take account of this source of reserve demand in its daily calculations of reserve supply needed to maintain the funds rate around the target.

approach helps foster this outcome is explored in more detail in Section 4. Because requirements and maintenance period rules provide banks scope to hold varying daily levels of reserves within a maintenance period, so long as requirements are met by the end of the period, the daily distribution of this neutral cumulative level of reserve supply can be of secondary importance. But in the US case, the overnight funds rate has proven to be sensitive to daily reserve supply patterns, because total requirements are low relative to the volatility and uncertainty surrounding even daily movements in factors affecting reserve supply. For this reason, the Desk must evaluate reserve supply and demand conditions closely every morning.¹⁹ Marginal daily changes to reserve levels are most commonly made by adjusting up or down the level of short-term repos outstanding, mostly using overnight operations, and the Desk typically intervenes in the morning when the repo market is most active.²⁰

Rates on all the Desk's open market operations with primary dealers are determined by auction and are not directly tied to any official policy rate.²¹ In practice, when it arranges its repos, the Desk collects bids from dealers in three distinct collateral buckets (called collateral 'tranches') for Treasury securities, agency debt and agency MBS.²² The rates on bids in different collateral tranches are normalised by subtracting from each bid rate a reference repo rate for the corresponding collateral type that is based on a survey of market rates performed by the Desk each morning. Each of the primary dealers designates one of two clearing banks, JPMorgan Chase or Bank of New York Mellon, as its correspondent bank for the purposes of cash and collateral management for the Desk's repos. Collateral held by the Federal Reserve against outstanding repos is maintained in securities accounts at the clearing banks operating under tri-party service agreements.²³

The Desk also makes available to the primary dealers a portion of the Treasury securities that it holds in its portfolio by extending overnight loans of individual issues. The Desk offers to the dealers the opportunity to participate in securities lending auctions every day for specific Treasury issues, and dealers may participate at their discretion. These securities loans can help increase the market supply of individual issues that may be temporarily in high demand, thereby supporting the functioning of the Treasury market. Dealers must pledge other Treasury securities of their choosing as collateral on these loans, so these operations have no reserve impact.

19. Unlike many other central banks, the Federal Reserve does not publish its daily forecasts of reserves or autonomous factors.

20. The Desk rarely intervenes later in the day because of the absence of any additional definitive information about reserve factors and due to reduced liquidity in the repo market.

21. These operations are arranged over a proprietary electronic auction platform that links the Desk to the primary dealers.

22. For accepted propositions in the agency tranche, dealers also have the option to deliver Treasury collateral; and for the agency MBS tranche, dealers have the option to deliver either Treasury or agency debt.

23. The Desk first adopted tri-party collateral arrangements for its repos in 1999.

3. New Federal Reserve Liquidity-providing Facilities

In response to widespread financial market strains that emerged in August 2007, the Federal Reserve established several entirely new facilities to provide liquidity and made several important modifications to existing facilities and operations. This section begins with a listing of these new and revised facilities and activities, noting their critical and distinctive features. It ends with a review of how these new facilities have altered the balance sheet of the Federal Reserve and were coordinated with other reserve management operations.

3.1 Development of new liquidity arrangements

Key liquidity innovations are listed below according to when they were first announced to the public. In some instances, new initiatives were coordinated with measures taken by other central banks to address related financial pressures in their jurisdictions.

- **On 17 August 2007**, the Board of Governors announced temporary changes to the PCF. It cut in half the spread between the PCF rate and the target federal funds rate, from its previous 100 basis points to 50 basis points. It also allowed for term loans of up to 30 days, renewable by the borrower. The rate spread was reduced further to 25 basis points and term loans extended to up to 90 days on 16 March 2008.
- **On 12 December 2007**, the Board of Governors approved the establishment of the term auction facility (TAF), providing for auctions of term loans to depository institutions. The first such auction was scheduled for 17 December, and in general, auctions of 28-day term loans through this discount window facility were to be arranged on a bi-weekly basis. Initial auction sizes were US\$20 billion, but these were gradually increased in subsequent months.

Also on 12 December, the FOMC announced the establishment of temporary reciprocal currency arrangements (swap lines) with the European Central Bank (ECB) and the Swiss National Bank (SNB), to provide US dollars in amounts of up to US\$20 billion and US\$4 billion to the ECB and SNB, respectively, for a period of up to six months, for lending to depository institutions in their jurisdictions. On 11 March 2008, the FOMC increased these swap lines and extended their term. In general, the lending of these funds by the ECB and SNB was linked to TAF auctions held by the Federal Reserve.

- **On 7 March 2008**, the Federal Reserve announced it would initiate a series of 28-day term repo transactions, expected to cumulate eventually to as much as US\$100 billion. On all accepted propositions, dealers could freely submit any type of collateral eligible for the Desk's conventional repos – Treasury, agency debt, or agency MBS. It was expected that most collateral actually delivered on these single-tranche repos would be agency MBS, because financing rates in the market for this collateral are normally higher than rates for the other eligible collateral types.

- **On 11 March 2008**, the Federal Reserve announced an expansion of its securities lending program with the creation of the term securities lending facility (TSLF). Under the TSLF the Fed would lend up to US\$200 billion (par values) of Treasury securities in its portfolio to the primary dealers, secured for a term of 28 days by a pledge of other securities, including collateral eligible on open market operations (OMO) and top-rated private-label MBS. Weekly auctions began on 27 March. Subsequent adjustments were made to the pool of eligible collateral.
- **On 16 March 2008**, the Board of Governors announced it had authorised the Federal Reserve Bank of New York to create the primary dealer credit facility (PDCF), for a period of at least six months, to provide overnight loans to the primary dealers against a broad range of investment-grade securities. The PDCF rate was set equal to the PCF rate, with additional back-end fees tied to the frequency of use.

The establishment of the PDCF was preceded by a decision on 14 March to extend an overnight loan to JPMorgan Chase, so that JPMorgan Chase could in turn lend that money to Bear Stearns. Also on 16 March, the FRBNY, with the Board's approval, agreed in principle to provide up to US\$30 billion in financing to facilitate JPMorgan's purchase of Bear Stearns, with terms and the structure of the financing to be finalised later.

These initiatives were aimed at improving market liquidity and functioning in ways that the Federal Reserve's normal liquidity operations could not, by allowing financial intermediaries, some of whom lacked discount window access on a routine basis, to finance assets with the Federal Reserve which they could no longer finance as easily in the markets. In this way these liquidity facilities could reduce the need for those institutions to take the types of actions which could amplify market pressures, such as selling other assets into distressed markets or withdrawing credit lines extended to other financial institutions.

Although all these various innovations were aimed at addressing turmoil in financial markets, they were structured differently from one another in terms of counterparties, eligible collateral for lending, whether they operated as discretionary or standing facilities, in their collateral management and other operational mechanisms, and in their statutory basis. Some key structural differences between four of these facilities are highlighted in Table 2.²⁴ In establishing these new lending facilities, key features of the infrastructure for existing operations and lending activities were used, to facilitate their rapid and effective deployment. The TAF was established under existing discount window authority for lending to depository institutions, and it adopted the same collateral conventions and administrative arrangements in place for PCF and other discount window programs. But entirely new auction procedures involving a potentially large number of banking institutions and all 12 district Federal Reserve Banks had to be developed. The single-tranche term repos involved a very minor tweaking of conventional repo operations. The TSLF built on the existing securities lending arrangements that have been available to

24. More detailed descriptions of these programs and their functioning can be found at 'Understanding the Recent Changes to Federal Reserve Liquidity Provision' (<http://www.newyorkfed.org/markets/Understanding_Fed_Lending.html>) and on related links on the public website of the FRBNY.

Table 2: Summary Features of Select Liquidity Facilities^(a)

	PCF	TAF	TSLF	PDCF
Counterparties	Depository institutions	Depository institutions	Primary dealers	Primary dealers
Credit allocation	Standing facility for overnight and term loans	Discretionary auctions of 28-day term loans	Discretionary auctions of 28-day term loans of Treasury securities	Standing facility for overnight loans
Eligible collateral	Discount window collateral, including: broad range of AAA-rated debt securities; OMO-eligible collateral; money market instruments; foreign government securities; foreign-denominated corporate and municipal securities; and residential real estate, commercial, and consumer loans.		Initially, AAA/Aaa-rated private-label residential MBS and OMO-eligible collateral. Later expanded to include more AAA/Aaa-rated ABS.	Broad range of investment-grade debt securities
Collateral management	Loans are extended against pools of collateral maintained by Federal Reserve Banks		Collateral is held in accounts at tri-party service agents	
Comments	Rate reduced to 50 bps over target funds rate then to 25 bps over target funds rate. Loan terms extended to 30 days then to 90 days	ECB and SNB lent US dollars acquired through currency swaps on similar terms	Reserve neutral	Same rate as PCF, with back-end fees tied to frequency of use

(a) Summary features are intended to be general descriptions; exceptions may apply.
Source: Federal Reserve Bank of New York

the primary dealers for many years, including use of the same electronic auction platform used by the Desk to arrange conventional open market operations with the dealers and existing securities lending legal agreements between the FRBNY and the primary dealers, which have had some slight modifications. But it required developing new tri-party settlement arrangements between the Desk, the primary dealers and the two clearing banks to manage the collateral exchange and to include new collateral types not accepted under the Desk's tri-party repos.²⁵ For the PDCF, new tri-party settlement arrangements were also established for securing loans, and

25. Securities loaned and received as collateral under the ordinary securities lending program do not utilise tri-party collateral arrangements.

new procedures were developed for dealers to communicate loan requests through their clearing bank to the FRBNY discount window.²⁶

3.2 Reserve management and portfolio implications of new liquidity arrangements

3.2.1 Reserve neutrality and asset maturity

The large scale on which these new liquidity facilities were deployed had equally sizable implications for the structure of the portfolio of financial assets on the balance sheet of the Federal Reserve and for open market operations. Throughout this period, with one notable exception discussed in Section 4, the Desk adhered to its standard operating practice of providing a level of reserves consistent with requirements in each maintenance period. There is little evidence that maintenance period demand for excess reserves changed in any significant way as a result of developments in broader financial markets, nor does the level of total requirements seem to have been substantially impacted. Furthermore, underlying levels of autonomous factors, such as banknotes in circulation, were largely unaffected. Consequently, the cumulative build-up in TAF loans outstanding, swap lines drawn down by the ECB and SNB, the expansion of single-tranche repos, and greater use of standing facilities (PDCF and the PCF) were offset largely via a reduction in the stock of Treasury securities held outright in the portfolio. Conventional three-tranche repos were adjusted as needed to facilitate daily reserve management and to bridge gaps between periods of growing use of new liquidity facilities and reductions in outright holdings of Treasury securities. Temporary reserve-draining reverse repos were seldom used. Thus, all these new liquidity arrangements involved a comparable increase in the supply of Treasury securities broadly held by investors, at least implicitly, even if these increases were achieved through separate operations. The TSLF, by design, was reserve neutral and required no offsetting operations to sterilise any reserve effects. But this facility did place a claim on Treasury securities in the portfolio and increased the available supply of these securities in the market as a direct result of its operation.²⁷

The maturity structures chosen for the new liquidity operations reflected a balance of considerations, foremost being a desire to influence conditions in term funding

26. Credit extended through the PDCF takes the form of repos, but in this paper these extensions will be described as loans.

27. The means by which the increased supply of Treasury securities was distributed across investors in the market varied depending on the type of operation used to reduce Treasury holdings in the portfolio. For outright sales, primary dealers would have been the initial holders of increased Treasury securities. For redemptions that the Treasury offset by issuing more securities to the public, again most of the increased supply would initially have been held by the primary dealers who are the largest bidders at primary auctions. However, in both these cases the dealers would then have been free to distribute these securities to their customers. In contrast, with the TSLF the Treasury securities lent to the primary dealers had to remain within the dealer's tri-party clearing bank, and so they remained on the balance sheet of the borrowing dealer who could then use them as collateral to borrow in the tri-party repo market.

markets where stress was most apparent. But collateral and risk management implications for the Federal Reserve also influenced the maturity choice. It was believed that a program's effectiveness as a backup source of liquidity in term markets would be derived not just from the maturity of the operations themselves, but also from the commitment to maintain a facility for as long as needed. As the offset to most new liquidity operations was a reduction in outright holdings of Treasury securities that carried various maturities, a change in the maturity structure of the assets in the portfolio was not itself the principal objective. Instead, these liquidity innovations relied for their effectiveness primarily on a shift in collateral and counterparties for Federal Reserve extensions of credit.

3.2.2 Open market operations and reserve uncertainty

From their historical peak of US\$791 billion, between August 2007 and June 2008 outright holdings by the Federal Reserve of Treasury securities fell by nearly US\$300 billion, with much of that decline concentrated after mid March.²⁸ Most of this reduction, US\$159 billion, was achieved by redeeming holdings of Treasury bills when they matured rather than replacing them with newly issued debt at primary auctions.²⁹ But the size and timing of maturing holdings did not always align with portfolio needs.³⁰ For this reason, and given other objectives for the composition of outright holdings, the Desk also sold US\$89 billion of Treasury bills and US\$55 billion of Treasury coupon securities outright in the market. These constituted the first outright sales of Treasury securities from the portfolio since the years 1989–1991, when the Federal Reserve was intervening in foreign exchange markets to purchase foreign-denominated assets, and the first sales ever of coupon securities in the market. At the same time, an additional US\$200 billion of Treasury holdings was earmarked for possible lending through the TSLF, making these securities unavailable for other purposes.³¹ Altogether, the level of unencumbered outright holdings of Treasury securities fell some US\$500 billion from August 2007 to June 2008, to a level of roughly US\$300 billion, and holdings of bills were nearly exhausted (Table 3 and Figure 3).³²

28. All references to Treasury holdings in this paper are for par values unless otherwise indicated.

29. In August 2007, US\$3 billion of maturing Treasury coupon securities in the portfolio were redeemed, for reasons having to do with portfolio limits on holdings of individual securities and unrelated to financial market turmoil.

30. And logistically, the lag between when a portfolio decision is made and when the reserve effect is felt is longer in the case of redemptions than for outright sales of Treasury securities.

31. At their peak during this period, the par value of Treasury securities lent under the TSLF was US\$159 billion. For its tri-party collateral arrangements, the Desk has the flexibility to substitute daily the specific Treasury securities it lends through the TSLF on outstanding term agreements.

32. The level of unencumbered outright holdings was actually somewhat smaller than this. About US\$40 billion of Treasury securities must be set aside every day to collateralise overnight reverse repos arranged between the FRBNY and foreign central banks that maintain US dollar holdings at the FRBNY. Moreover, the Desk preserves some holdings of more recently auctioned Treasury coupon securities so that they will be available to loan through its regular securities lending program to meet potentially high demand.

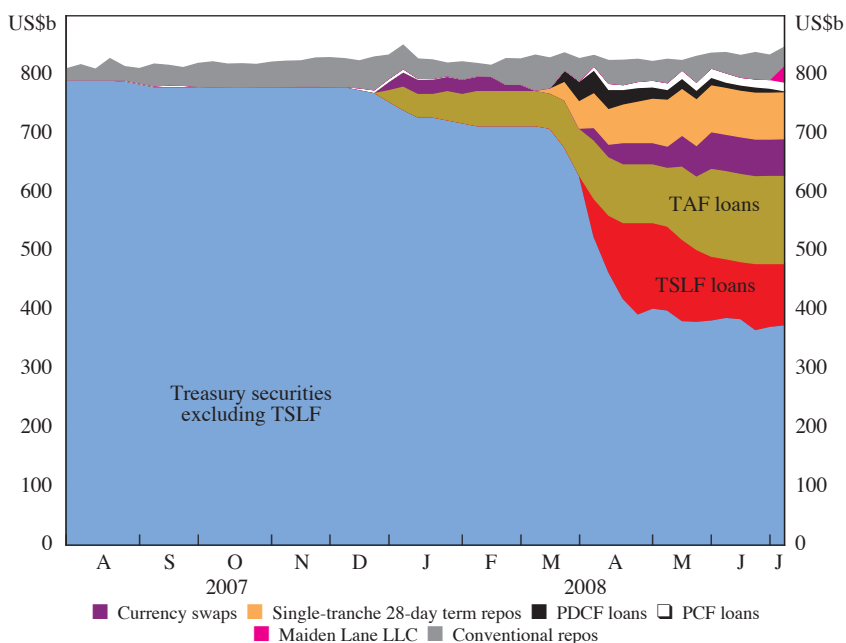
Table 3: Balance Sheet of the Federal Reserve System
2 July 2008, US\$ billion^(a)

Assets		Liabilities and capital	
Treasury securities	479	Reserve balances of banks	21
of which – bills	22	Federal Reserve banknotes	795
– sent through the TSLF	104	Treasury deposits	5
Conventional repos	30	Other liabilities & capital	85
Single-tranche 28-day term repos	80		
TAF loans	150		
Currency swaps	62		
PDCF loans	2		
PCF loans	15		
Maiden Lane LLC	29		
Other assets	59		
Total assets	906	Total liabilities & capital	906

(a) All values are averages for the week ended 2 July 2008 except the following: total assets, total liabilities and capital, and Federal Reserve banknotes, which are values as of 2 July 2008; and other assets and other liabilities and capital, which are calculated as a residual item for assets and liabilities and capital, respectively.

Source: Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release: H.4.1

Figure 3: Federal Reserve Domestic Financial Assets
Weekly averages



Sources: Board of Governors of the Federal Reserve System, Federal Reserve Statistical Release: H.4.1; Federal Reserve Bank of New York

Although the need to reduce outright holdings was large and concentrated in a relatively short timeframe, planning for the necessary open market operations was facilitated by the fact that many of the new lending operations – TAF auctions, currency swaps, single-tranche repos – were discretionary activities with pre-set amounts. Each operation was planned some time in advance and each had some delay between its auction and settlement dates, and the TSLF was reserve neutral by design. As a result, on no day was the Desk unable to arrange the level of open market operations necessary to provide the level of reserves it estimated was required to achieve the operating objective for the overnight federal funds rate. But the PDCF and revamped PCF are standing facilities that require no advance notification and have no settlement lag, and term PCF loans may also be extinguished early at the borrower’s initiative without penalty. This feature of these facilities did make daily estimates of reserve supply more uncertain and presented a challenge to daily reserve management, which is described in Section 4. At their peak, PDCF loans and term loans extended through the PCF were well below amounts that were extended through the other new liquidity facilities, but the PDCF and PCF carry a contingent reserve exposure that would be difficult to anticipate and potentially large.³³

4. Challenges Meeting the Operating Objective

This section describes how the operating framework and the Desk’s daily procedures help to maintain the overnight federal funds rate around its target as well as the normal daily rate dynamics in this market. Challenges meeting the operating objective and in daily reserve management since August 2007 are also presented.

4.1 Federal funds rate control and rate behaviours under normal conditions

The daily operating procedures described in Section 2.3 are aimed at maintaining the overnight federal funds rate around its target. Under this framework, if reserve balances for the maintenance period are too far above requirements, then lenders will push rates down as far as the rate paid on excess reserves (0 per cent). Similarly, if balances are not sufficient to allow banks to meet their total requirements for the maintenance period or to avoid overdrafts at the end of any day, then borrowers will bid up market rates to the level of the PCF rate (or higher where there is a stigma associated with PCF borrowing). However, maintaining the overnight rate around a level in between those two extremes rests primarily on the ability to shape the interest rate expectations of participants operating in this market.

33. The maximum weekly average level of PDCF borrowing during this period was US\$38 billion. The maximum weekly average level of all PCF credit outstanding since August 2007 was US\$16 billion.

For an individual bank that has not yet accumulated enough reserves to meet all its requirements in the maintenance period that is underway, a decision whether to borrow or lend in the federal funds market on the current day, rather than wait until a day later in the same period to adjust its reserve position, will depend importantly on its expectations for rates on later days in the period relative to current market rates.³⁴ Through this mechanism, expectations for rates later in the maintenance period can strongly influence current rates, so long as banks retain sufficient scope for deferring or accelerating their accumulation of reserves in the period for meeting their requirements. While empirical studies have found that historically there have been persistent unexplained patterns to daily average federal funds rates by day in the maintenance period cycle – which suggest that a pure ‘martingale’ process for determining current market rates does not hold in the US case – future rate expectations undoubtedly are an important determinant of current rates.³⁵

To maintain market rates around the policy objective, central banks with frameworks similar to the current Federal Reserve structure – featuring reserve requirements, multi-day maintenance periods, and standing facilities at which banks can borrow or lend with the central bank – ensure as best they can that expectations for rates on future days in the maintenance period are around the target rate. Often this involves setting the rates on standing facilities in a symmetric fashion around the policy objective and using discretionary operations to provide an expected level of reserves consistent with the maintenance period requirements. With the probabilities that banks will experience either a reserve deficiency or surplus over the maintenance period being roughly equal, and the costs associated with these outcomes symmetric around the policy rate, in a competitive market expected future rates should align with the policy objective.

The Desk’s standard approach has been to aim to provide a level of reserves that at the end of each maintenance period is close to requirements (allowing for those frictional sources of excess demand). But given that banks have no opportunity to earn interest on any excess reserves they might hold, the cost of holding excess reserves is generally greater than that associated with being deficient, which according to the preceding description of rate determination should impart some

34. In the US case, banks have limited or no scope for either altering the level of reserve balances they must hold to meet their requirements (remunerated or not) or for adjusting their reserve positions via participation in open market operations with the central bank at established rates. Adjusting their reserve position in the market at a future date is the only alternative to doing so in the market on the current day. These alternative options are features of operating frameworks of other central banks; the rates associated with their use can also influence current market rates.

35. A fact demonstrated by the many instances when widely-held expectations that the funds rate target would be changed mid-period strongly influenced rates in days ahead of the expected policy switch.

downward bias in rates relative to the operating target.³⁶ A factor that may help maintain rate expectations more closely around the target is the Desk's daily fine-tuning of reserve supply, and its demonstrated willingness to respond to deviations in the rate from the target by adjusting daily reserve supply in a way that ultimately induces rate movements in the other direction.³⁷ This behaviour helps ensure that the balance of risks for future rates is centred around the target level, which can in turn influence current rates.

Historically there have been distinct intraday rate patterns in the US market.³⁸ The funds rate normally exhibits very low volatility from the time trading begins in the morning until late-afternoon. Most intraday volatility in the rate is observed late in the trading session, especially in the last hour or so, after payment flows involving transactions of banks' customers are completed and banks are making final adjustments to their reserve balances. At this point in the day, very abrupt and erratic rate movements can occur when individual banks are faced with the possibility of ending overdrawn or accumulating unwanted excess levels for the period. But even on days when aggregate reserve supply ultimately has proven to be sufficiently low or high relative to requirements so as to induce sharp rate movements, rate volatility has generally been confined to trading very late in the session.

36. A more formal representation for the market rate expected for the maintenance period settlement date is:

$$E(r_{\text{settlement day}}) = E(D) * r^d + E(X) * r^x, \text{ where:}$$

$E(r_{\text{settlement day}})$ is the level of the funds rate expected to prevail on the maintenance period settlement day;

r^d is the primary credit discount rate;

r^x is the rate paid on excess reserves;

$E(D)$ represents the expected likelihood that final reserve levels will be below the point at which all requirements are just met (the 'neutral' level of reserves); and

$E(X)$ represents the expected likelihood that final reserve levels will be above requirements.

In operating systems with a symmetric interest rate corridor around the desired market rate, and in which the central bank aims to provide enough reserves for all banks to meet requirements with minimal excess reserves, and where reserve shocks are symmetric (that is, $E(D) = E(X) = 50$ per cent), the expected market rate on the settlement day should be the policy rate. But with this formulation, in the US case, where r^x is 0 and r^d is above but generally closer to the target, the expected rate would be below the target rate.

37. However, it is not generally possible to control with any precision the extent of the eventual rate response to these daily adjustments to reserve supply, and so the potential for substantial overshooting of rates is high.

38. A discussion of intraday rate behaviours and volatility in the overnight federal funds market is found in Bartolini *et al* (2005).

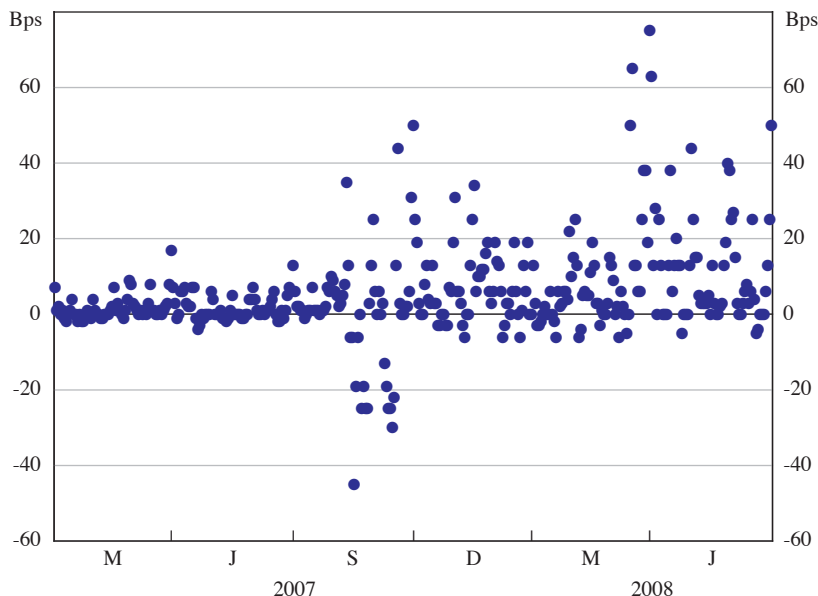
4.2 Challenges since August 2007

4.2.1 Sources of pressure on overnight rates

The period since August 2007 has been marked by a dramatic increase in the volatility of the overnight federal funds rate. While most of this volatility has remained confined to trading late in the session, there has been a significant rise in volatility earlier in the day as well.

As trading activity in unsecured term funding markets contracted, both borrowing and lending banks turned to overnight markets to meet more of their funding and investments needs, but the effects were not equally felt. The daily funding uncertainties that banks with structural deficiencies faced dominated, and the overnight funds rate frequently traded with a strong premium, particularly in early trading hours (Figure 4). Several factors contributed to this pattern. As a group, European-based institutions operating through US affiliates or directly in European markets are structurally short US dollars. Their demand for funding early in the trading session can be inelastic both because they wish to meet a significant portion of their daily needs while home markets remain open and because they may lack deep trading lines with some US regional banking institutions that are important providers of market liquidity later in the trading session. Moreover, because many of these US affiliates have low requirements, their reserve management flexibility is further limited. The resulting upward pressure on funding rates was even more dramatic

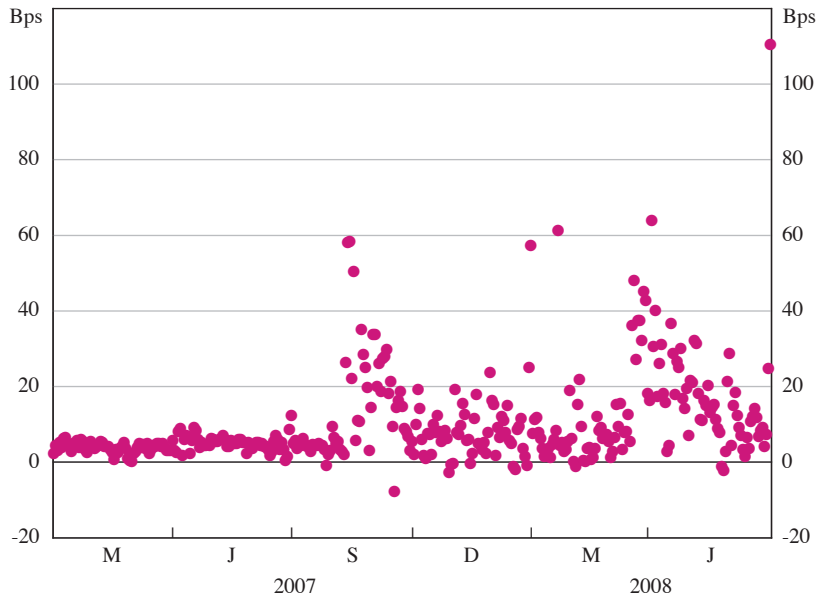
Figure 4: Overnight Federal Funds Rate Spread
Indicative morning rate less FOMC target rate



Source: Federal Reserve Bank of New York

in the closely-linked overnight market for eurodollars in Europe ahead of trading in the federal funds market (Figure 5).

Figure 5: Overnight LIBOR less Morning Federal Funds Rate

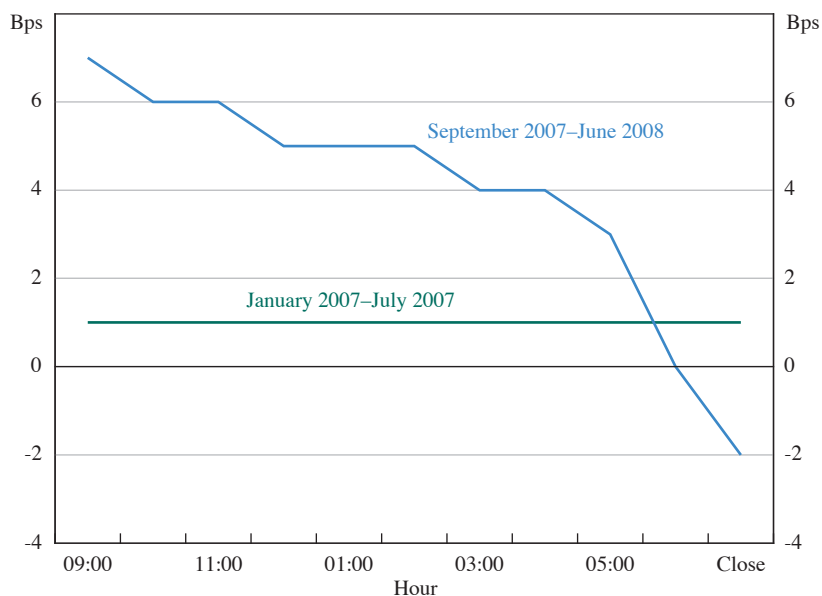


Sources: Bloomberg; Federal Reserve Bank of New York

At the same time, institutions with surplus funds were not willing to lend these funds despite these upward rate pressures, even when reasonably certain that lower rates would dominate later in the day. Many were constrained in their ability to expand their balance sheet to take advantage of favourable rates, and they faced heightened uncertainties about their own funding requirements and payment flows. Available evidence also suggests that the stigma associated with use of the discount window (PCF) increased amidst the financial market turmoil, which made borrowers and lenders alike more cautious in preserving liquidity intraday. Concerns about the credit risk of borrowers appeared to be a lesser cause of the new rate patterns seen in the overnight federal funds market, and there is little evidence that banks sought to hold higher levels of reserve balances at the end of each day in any systematic way.

4.2.2 Desk responses

The factors just described contributed to a recurring intraday pattern with rates close to the target in the morning and then drifting down later in the trading session (Figure 6). This pattern was most pronounced on days when trading flows were seasonally high and uncertain, for example around the end of the month. However, Desk efforts to ensure that rates remained around the target 'on average', over time if not each day, added to intraday rate volatility.

Figure 6: Intraday Cumulative Federal Funds Rates

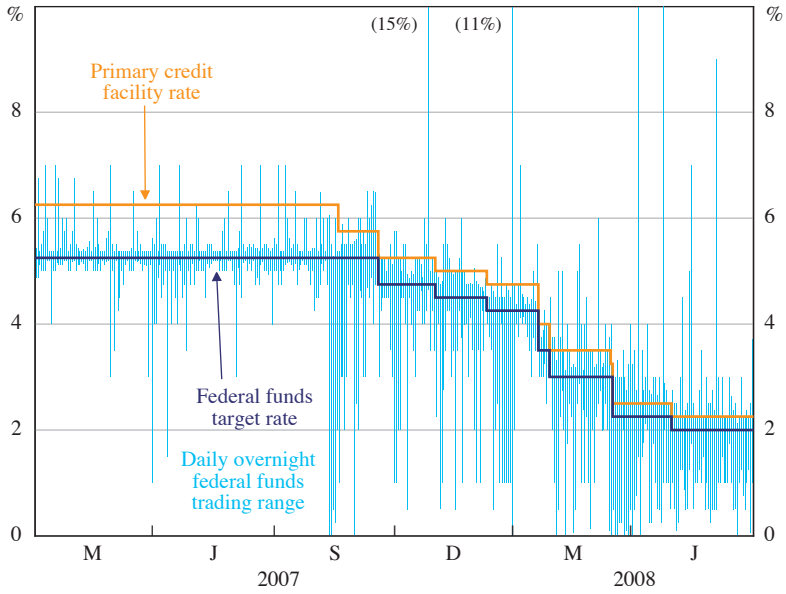
Notes: Hourly cumulative average overnight federal funds rate less target rate of transactions brokered by ICAP. Data from September 2007 to June 2008 begin on 19 September 2007 and end on 1 June 2008 and exclude 31 December 2007.

Source: ICAP

In the two-week reserve maintenance period ending 15 August, underway when financial market stresses first appeared in the US overnight funding market on 9 August, the Desk responded extremely aggressively, so that by the next day the accumulated level of reserves far exceeded the amount needed for all banks to meet their remaining period requirements, and it operated outside of its normal intervention timeframe to stress its commitment to combat upward rate pressures. For the remainder of that period the average funds rate was very low, with some late-day trading occurring at rates near zero. Subsequently, while the Desk aimed to provide a more neutral level of reserves with respect to maintenance period requirements, for several maintenance periods it remained particularly responsive to bouts of upward rate pressure in its daily reserve provisions. As a result, the overnight funds rate was on average below the target for a period of several weeks. More generally since August 2007, the Desk has resisted alternating bouts of high and low rates by leaving either unusually elevated or low daily reserve levels with much greater frequency than before. Even so, with the exception of the 15 August maintenance period, period average levels of reserves provided were generally close to levels of requirements and normal frictional levels of excess demand (Figure 7).

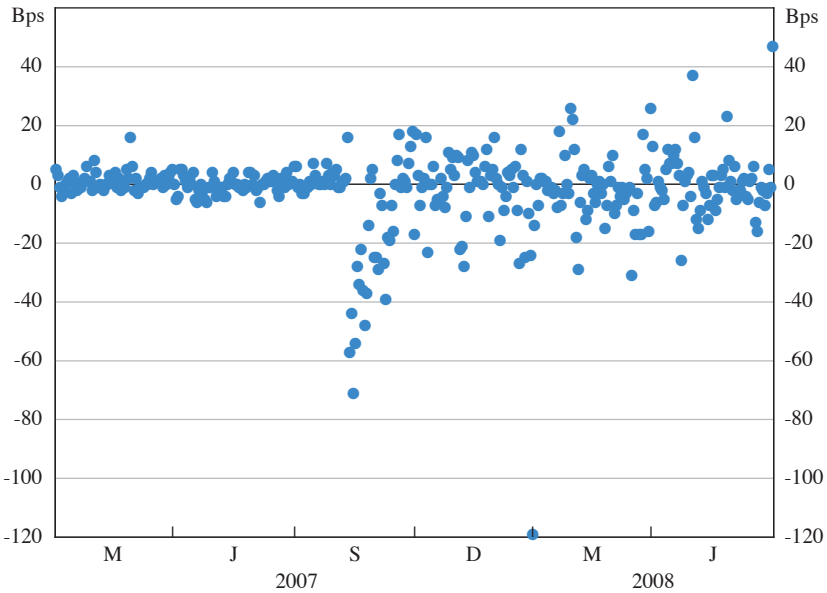
For the most part, the operations of the new discretionary liquidity facilities created by the Federal Reserve did not have a direct impact on the behaviour of the overnight rate. But the standing facilities, both the PDCF for the dealers and term loans under

Figure 8: Federal Funds and Primary Credit Facility Rates



Source: Federal Reserve Bank of New York

Figure 9: Daily Average Overnight Federal Funds Rate less Target Rate



Source: Federal Reserve Bank of New York

5. Future Considerations

Experiences with reserve operations since the onset of financial market turmoil highlight several important issues regarding the management of the balance sheet. These include: how a significant further expansion of credit on the Federal Reserve balance sheet could be offset or accommodated if it were needed, the ultimate disposition of the new liquidity facilities and their coordination with conventional reserve operations, and the composition of the portfolio of assets held by the Federal Reserve in a new steady state. Financial market conditions have not returned to their pre-August 2007 state, and lessons from the use of new liquidity innovations are still being absorbed, so only some general observations can be offered at this time. The *Financial Services Regulatory Relief Act of 2006* amended the FRA to provide explicit authority to pay interest on all balances held by depository institutions at the Federal Reserve, beginning in October 2011. That authority could have an important influence on possible outcomes.

The fact that the Federal Reserve had accumulated a substantial portfolio of outright holdings of Treasury securities on its balance sheet as of mid 2007 enabled it to fully fund the expansion of the new liquidity facilities in the manner that it did, and the availability of those holdings influenced the design of some of the new liquidity facilities in important ways. Despite the presence of a still large unused pool of Treasury holdings as of June 2008, experience since August 2007 shows that even larger expansions of credit by the Federal Reserve through non-traditional facilities must be viewed as a possibility, however unlikely. Moreover, as a general operating principle, a central bank may not wish for its ability to address financial market strains through its extension of credit to be impeded by the size of its existing portfolio or other balance sheet constraints.

Other central banks have used various methods to support or offset a large expansion of assets on their balance sheets, albeit under different circumstances, and their use could be explored by the Federal Reserve. In some instances, the fiscal authority has increased its issuance of debt to the public, and placed the additional funds raised in its deposit account at the central bank in an amount corresponding to the expansion of assets on the central bank's balance sheet. Alternatively, some central banks have issued their own marketable debt in considerable amounts to sterilise the reserve effects of an expansion of assets. Either approach would raise important policy questions, would require close coordination with the fiscal authority's debt management, and involve new operating practices. Further options for supporting a sustained expansion of the balance sheet become possible with payment of interest on reserves. With that authority, several mechanisms could be devised to insulate market rates from the effects of a large increase in reserve supply, such as would occur with a significant expansion of central bank credit, even if left unsterilised.

Most of the new liquidity facilities introduced since August 2007, when first announced, were described as being temporary programs. Two facilities, the TSLF and the PDCF, were established under provisions of the FRA which require 'unusual and exigent circumstances' for their lending. An eventual phase-out of any of the new liquidity facilities will entail making judgments about the absence or

persistence of the market conditions that gave rise to their creation, but for which few objective measures may be available. Use of the facilities themselves may offer some guidance, although for standing facilities in particular (and even for the new discretionary auction facilities which serve as market backstops), actual use may not always be a reliable measure of underlying market risks.

Policy-makers could explore the possibility of maintaining some of these facilities in a more permanent state, either in their present form or with structural modifications, with corresponding changes to the regulatory and supervisory environment as may be necessary. In the case of the TAF, the possibility of a permanent facility was recognised in the initial announcement, which reads: ‘Experience gained under this temporary program will be helpful in assessing the potential usefulness of augmenting the Federal Reserve’s current monetary policy tools ... with a permanent facility for auctioning term discount window credit’.⁴⁰ If made permanent, such a program could take several forms. For example, it could be an off-the-shelf option that is employed only when market conditions warrant or it could be employed from time to time on a planned basis to maintain operational readiness.

Maintaining a large volume of TAF loans outstanding on a permanent basis might not provide any further ability to address market stress than simply having a facility that is small under normal conditions, but which would be expanded significantly when needed. Having regular TAF auctions that are large but fixed in size could serve as a liquidity backstop for individual banks, even ones that did not regularly fund themselves in this way. However, in the absence of a substantial increase in auction amounts, such a facility might be much less effective in addressing periods of general market stress that affect a wide range of financial institutions simultaneously. Maintaining a large volume of TAF loans on a permanent basis would introduce additional collateral and counterparty risk management issues for the central bank. It could also foster reliance by banks on direct central bank credit which is unnecessary in normal periods.

Any winding-down of new liquidity facilities will need to be coordinated with operations to re-stock conventional assets in the portfolio. In the past, the need to expand outright holdings has been driven mainly by growth in banknotes outstanding, which even during years of peak growth was fairly gradual. The largest volume of secondary market purchases in any one year was US\$61 billion, made in 2001.⁴¹ An expansion of outright holdings to offset a large and rapid decline in lending through new liquidity facilities would be without precedent.

The composition of the assets traditionally held in the portfolio – outright holdings of Treasury securities and repos against Treasury and agency debt – could be reviewed based on experiences gained managing the portfolio since August 2007. Those experiences have underscored the importance of maintaining a very liquid

40. Board of Governors of the Federal Reserve System (2007).

41. This figure only includes purchases made outright in the secondary market and does not include purchases made directly with foreign central banks. A large portion of the purchases in 2001 offset redemptions that were made to conform to portfolio limits on holdings of individual issues. The largest net expansion in outright holdings in any one year was US\$51 billion in 2004.

portfolio, that is, one which can be reduced on a large scale within short timeframes with minimum disruption to the markets in which the central bank operates. Either maintaining a much higher level of repos in the portfolio or holding an even greater share of outright holdings in the form of shorter-term Treasury bills could add to portfolio liquidity, although other portfolio or operational considerations could also influence this composition. Alternatively, operating regimes that become feasible with authority to pay interest on reserves, or a more developed capacity to create liabilities on the balance sheet on a large scale, could affect the minimum liquidity requirements for the Federal Reserve's portfolio.

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Discussion

1. Donna Howard

Spence Hilton's paper provides a comprehensive overview of the Fed's mechanisms for the provision of liquidity for both monetary policy and financial system purposes.

In the monetary policy function, the Fed uses its powers as the ultimate supplier of liquidity to achieve the proximate target of monetary policy. Essentially, the Fed supplies a level of reserves to achieve the overnight Fed funds target rate, the first step in the transmission of monetary policy. The paper outlines this process and highlights the current challenges of achieving the target, particularly during periods of market turbulence. Required reserves are no longer sufficient to buffer large unanticipated payment flows, which means that there is greater potential for volatility in the overnight Fed funds rate. This is accentuated by the lack of appropriate price incentives to help ensure that Fed funds trade around target given that the rate is bounded by a floor of zero (with the Fed unable to pay interest until 2011) and by a ceiling rate on the discount rate (where access to the primary credit facility is affected by 'stigma').

The financial system function is linked to the traditional lending role of a central bank to the banking system through loans to solvent institutions facing liquidity problems (that is, the role of lender of last resort). The paper describes how, in the most recent episode, loans were also made to market participants facing liquidity problems, in order to – in the words of the paper – 'improve market liquidity and overall market functioning and thus support the stability of the financial system'.

In order to lend to market participants, the Fed enhanced existing liquidity facilities and created new ones. These in turn affected the management of the Fed's balance sheet as well as the Fed's monetary policy operations. The paper does an excellent job of describing the details of these effects and the associated challenges. The paper could benefit, however, from discussion of the analysis behind, and the motivation for, the creation of these new facilities.

The main focus of the following comments will be on describing a framework that would focus on the motivation for central bank actions (why intervene?) as well as address the policy considerations for when and how to intervene.¹

1.1 Why intervene?

In a market-based financial system, liquid markets support economic efficiency as the channel through which scarce economic resources are allocated to the most productive uses. An efficient market-based system relies on the market price of an asset not deviating too far from the fundamental value of that asset. However, during the height of the market turmoil, market-makers – relied on to buy and sell assets at prices close to their fundamental value – did not have access to sufficient liquidity

1. For further context on these issues, see Engert, Selody and Wilkins (2008) and Carney (2008).

from the banking system to perform this function and market liquidity suffered, ultimately threatening the stability of the financial system. Altering liquidity using traditional monetary policy tools or through reallocations to banks was no longer sufficient to maintaining liquidity in the financial system.

In response, central banks, as the ultimate providers of the liquidity, responded by introducing new variants of traditional lending operations to markets as well as to institutions.

1.2 When is intervention appropriate?

More specifically, when does a policy-maker decide to take extraordinary action for the purpose of addressing financial system stresses that could have material macroeconomic consequences? That is, what constitutes ‘exigent’ circumstances in the terms of the Fed’s legislative authority or ‘exceptional’ circumstances in the terms of the *Bank of Canada Act*?

To address this requires policy-makers to consider three further questions: Can the problem/market failure, be clearly identified? Will the instruments of the central bank be effective in addressing the market failure? Finally, do the benefits outweigh the costs?

Beginning in August 2007, the broad problem was easily identified. A lack of market liquidity in various sectors of international markets, particularly the interbank market and certain credit markets, was clearly evident and there was an associated flight to ‘risk-free’ assets.

Determining *ex ante* the effectiveness of central bank tools was more challenging. An important consideration for entering into transactions was to identify whether the problem was temporary or permanent. This reflects the fact that although a central bank can provide liquidity, it cannot create (or recreate) markets where there is no private-sector interest in them.²

Finally, the assessment of whether the benefits outweigh the costs is perhaps the most challenging aspect of the decision, since assumptions must be made about the future impact of central bank actions. Clearly, the objective was to restore confidence by providing ‘temporary’ liquidity support, thus facilitating the transition to well-functioning markets and avoiding further ‘excessive prudence’.³ The costs

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2. With respect to the Canadian asset-backed commercial paper (ABCP) market, the Bank of Canada’s approach to the third-party sponsored programs (with exposures to collateralised debt obligations and, to a certain extent, US sub-prime mortgages) differed significantly from that to the bank-sponsored programs (which were predominately of a classic structure relying on loan receivables). This was based on an assessment of the permanent versus temporary nature of the problem. In the former case, a private resolution to the problem was encouraged, leading to a proposal (the Montreal Accord) to restructure the programs into long-term securities that matched the duration of the underlying liabilities. In contrast, the Bank indicated its willingness to accept bank-sponsored ABCP programs for traditional assets as eligible collateral for its standing liquidity facilities, subject to certain transparency criteria and explicit commitments by the banks to provide liquidity support to their own programs.
 3. In Canada, the extension of non-routine term purchase and resale agreements – term repos – ended in mid July 2008.

to consider include the potential financial risks to the central bank, as well as the potential for moral hazard – the concern that central bank intervention will have detrimental effects on private incentives to manage liquidity and counterparty risks and therefore lead to less robust and well-functioning markets in the future.

1.3 What form should intervention take?

The nature of any intervention will depend on the circumstances and should be targeted at any market failures that have been identified. An auction mechanism, such as that utilised by the Fed for its special facilities, has a number of advantages. The competitive pricing process helps to minimise the potential for distortionary pricing of credit risk, minimises the effect of stigma (since an auction is a collective mechanism involving several borrowers simultaneously), facilitates the distinction between the monetary policy target rate and the lending rate, and also provides flexibility to vary the key parameters of the transaction (term, eligible counterparties and eligible securities) depending on the circumstances.

The term-liquidity operations can be placed into three broad categories, each targeting specific problems and each paralleling the Fed's facilities:

1. **term repos** can be offered to any financial market participant with marketable securities when the liquidity premium in the market is distorted;
2. **term loans** can be offered when individual (solvent) institutions are unable to access liquidity in markets. The collateral supporting such loans can be expanded beyond marketable securities (to loans, for example); and
3. **term securities lending** can be offered when premia for both high-quality and illiquid marketable securities are distorted.

With respect to future issues for Fed policy, Spence identified a number of important operational issues, including the composition of the Fed's balance sheet. For instance, Figure 3 in his paper highlights the asset allocation of the Fed's balance sheet according to the impact of each of the Fed's lending operations. It might be useful to also look at the composition by potential exposure to various assets to support an assessment of the overall risk to the Fed.

The paper does not explicitly address the broader policy issues regarding not only what a central bank can do, but also what it should do. However, the principles applied when deciding whether to enter into transactions can also apply to deciding when to withdraw a particular facility or to make it a more permanent feature of the Fed's complement of tools.⁴ From this perspective, it would be instructive to discuss how a central bank might answer the following important (and difficult) questions:

4. In Canada, the decision to phase out the term purchase and resale facilities was taken when a range of indicators pointed to a reduction in adverse liquidity pressures. For example, when the auction rate was judged as being close to the implied future policy rate and the market rate, when bid-ask spreads narrowed sufficiently, and according to anecdotal evidence. As liquidity recovered, the Bank phased out the special facilities and again relied on markets to set prices out along the term structure, while continuing to intervene as necessary to reinforce its target overnight rate.

- Is the problem still viewed as temporary?
- Are the bank's actions still assessed to be effective in resolving the situation?
- Do the benefits still outweigh the costs?

Answering this latter question requires an assessment of whether private incentives have been distorted further such that risks to the financial system are increasing rather than diminishing, whether there are risks to the independence of the central bank in a blurring between its role and that of the fiscal authority, and whether there is too much risk being borne by the central bank such that its future effectiveness as the monetary authority is compromised.

Spence Hilton's paper provides an overview of the Fed's liquidity provision and associated challenges currently and in the future, but it goes without saying that there is sufficient fodder to feed discussion and debate about central bank policies during financial market turmoil – as well as the associated operational aspects – for years to come.

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2. General Discussion

The general discussion focused on the effect that new liquidity facilities offered by the US Federal Reserve may have on its operations. One participant was interested in what would happen to the ability of the Fed to act as a lender of last resort if US treasury securities fell to a very low share of the Federal Reserve's balance sheet, given that the Fed was prevented from purchasing treasury securities directly from the US government. In response, Spence Hilton reiterated points made in his paper, indicating that in this scenario the Fed would have the option of issuing its own securities, or requesting the US government to issue securities, with the money raised to be deposited at the Fed. Another participant noted that the reserve maintenance period for US banks was longer than the daily management system used in Australia and Canada and questioned whether this reduces the ability of the Fed to gauge the demand for cash by banks, which varies on a daily basis. Yet another participant wondered whether an authority to pay interest on overnight funds would allow the Fed to move towards setting a daily reserve target. In reply, Spence Hilton suggested that the Fed generally thought the longer maintenance period was a helpful feature that smoothed volatility.

In terms of the effect of the new liquidity facilities on the financial system, one participant questioned whether the Fed was in fact providing equity – and not merely liquidity to financial institutions – at effectively negative interest rates via these mechanisms, and thus encouraging distortions in the behaviour of market participants. Spence Hilton stressed that facilities such as the primary dealer credit facility (PDCF) are not providing equity as they are swap facilities, which may help stretch out the adjustment process by the financial system to a crisis caused by excessive risk-taking. One participant suggested that there did not appear to be any stigma associated with use of the term auction facility (TAF), which may be one test of its effectiveness as a liquidity management tool. Spence Hilton suggested that this may be because the facility operates as an auction, for which there was a sense of ‘safety in numbers’. While liquidity problems appear to have been stemmed somewhat with the help of these new facilities, a number of participants pointed out that LIBOR/OIS spreads were still usually high, which was a reason for continued concern.

Wrap-up Discussion

1. Satyajit Das

The Credit Default Swap Market – Will It Unravel?¹

I would like to focus my attention on the first part of this Conference, which covered issues associated with financial innovation and the problems which led to and exacerbated the recent episode of financial turmoil. These have prompted a lot of discussion about ways in which financial markets allow risk to be shared and raised concerns about how these markets have operated. There has also been much discussion of the appropriate role of regulators in this environment. For my part, I would like to extend this general discussion with some specific points about the market for a particular credit instrument which has grown very rapidly in recent years; that of the credit default swap (CDS). I contend that some of the insights that we can draw from examining this market give us a general sense of the types of problems that we need to address. I am also of the view that the effects of the financial turmoil on this particular market are yet to be played out fully.

In May 2006, Alan Greenspan, the former Chairman of the Fed, noted:

The CDS is probably the most important instrument in finance ... What CDS (credit default swaps) did is lay-off all the risk of highly leveraged institutions ... on stable American and international institutions.²

The reality may prove different.

A CDS is economically similar to credit insurance. The buyer of protection (typically a bank) transfers the risk of default by a borrower (the reference entity) to a protection seller, who for a fee indemnifies the protection buyer against credit losses.³ The CDS contract and the entire structured credit market were originally predicated on hedging credit risk. Over time the market changed focus – in Mae West’s words: ‘I used to be Snow White, but I drifted’.

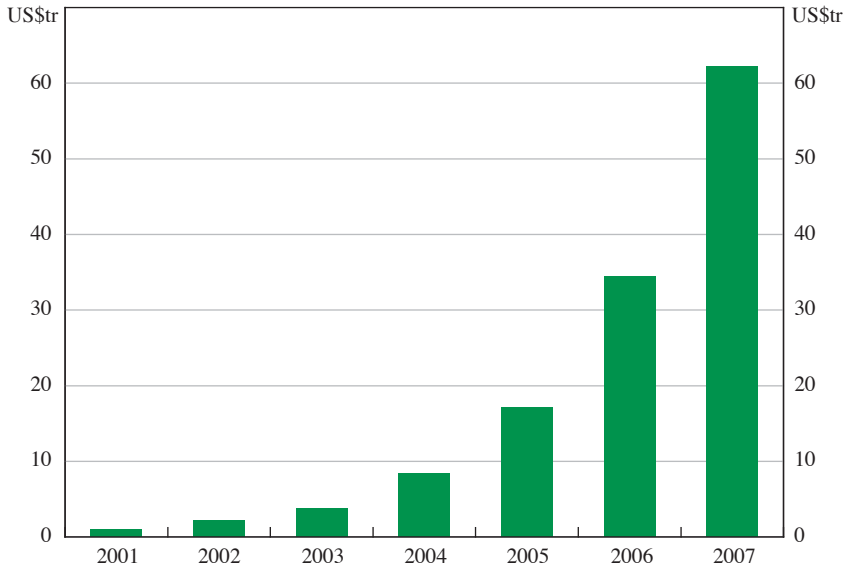
The abilities to short-sell credit instruments, leverage positions and trade in credit instruments in a way that is unrestricted by the size of the underlying debt market have become the dominant drivers of growth in the markets for these instruments. As a result, the CDS market has grown exponentially to around US\$62 trillion in 2007 (Figure 1). While these figures involve some double-counting of volumes, even when we abstract from this the figures are impressive, especially when you consider that the market was less than US\$1 trillion in 2001. Nonetheless, the size of the market – which has attracted much attention – is not the major issue.

1. An earlier version of this paper appeared as Satyajit Das ‘How Supposed Risk Hedgers Could Become Risk Creators’, FT.com site, 6 February 2008. Available at < <http://www.ft.com/cms/s/0/65739114-d456-11dc-a8c6-0000779fd2ac.html>>.

2. See ‘Greenspan Slams CDS Paperwork’, *Asia Risk*, June 2006, p 4.

3. For a more technical treatment of CDS contracts see Das (2005).

Figure 1: Credit Default Swaps
Outstanding notional value



Source: International Swaps and Derivatives Association, Inc

1.1 Documentary SNAFUs

Banks have used CDS contracts extensively to hedge credit risk on bonds and loans. The key issue is: will the contracts protect the banks from the underlying credit risk being hedged? As Mae West noted: ‘An ounce of performance is worth pounds of promises’.

Documentation and counterparty risk means that the market may not function as participants and regulators hope if actual defaults occur. CDS documentation is highly standardised to facilitate trading and so it generally does not exactly match the terms of the underlying risk being hedged. CDS contracts are also technically complex. There are issues regarding the identity of the entity being hedged, the events that are covered and how the CDS contract is to be settled. This means that the hedge may not provide the protection sought. In fairness, all financial hedges display some degree of mismatch or ‘basis’ risk.

A CDS contract is triggered by a ‘credit event’, broadly defined as default by the reference entity. For each corporate grouping only one or, in exceptional cases, a few reference entities are traded in the CDS market. Therefore there are substantial mismatches in ‘who’ is being hedged with ‘whom’. If there are corporate actions (takeovers, mergers, leveraged buyouts) then the reference entity can change according to a set of complex rules. A hedging bank may end up ‘hedged’ on a counterparty to which it has no exposure. Alternatively, a bank seeking exposure to a particular credit risk can end up with exposure to an entity to which it did not intend to be exposed.

The buyer of protection is not protected against ‘all’ defaults. They are only protected against defaults on a specified set of obligations in certain currencies. Even if there is a loan default, ‘technical difficulties’ may make it difficult to trigger the CDS hedging that loan. CDS contracts are specified in different and complex ways, so that for example, ‘restructuring’ is often classified as one of the following: R (restructuring); MR (modified restructuring); MMR (modified-modified restructuring); or NR (no restructuring). To trigger the CDS contract publicly available information must generally be used. Many of the recent credit events have been straightforward Chapter 11 filings and bankruptcy, however, for other credit events (failure to pay or restructuring) there may be problems in establishing that the credit event took place.

These issues have a systemic dimension. A CDS protection buyer may have to put the reference entity into bankruptcy or Chapter 11 in order to be able to settle the contract. A study by Hu and Black (2008) concluded that CDS contracts may create incentives for creditors to push troubled companies into bankruptcy. This may exacerbate losses in the case of defaults. In this case, the protection buyer of the CDS must deliver a defaulted bond or loan – the deliverable obligation – to the protection seller in return for receiving the face value of the delivered item (known as physical settlement). For example, when Delphi defaulted, the volume of CDS outstanding was estimated at US\$28 billion against US\$5.2 billion of bonds and loans (not all of which qualified for delivery). On actively traded names, CDS volumes are substantially greater than outstanding debt, which is likely to make it difficult to settle contracts.

Shortage of deliverable items and practical restrictions on settling CDS contracts has forced the use of ‘protocols’ – where any two counterparties, by mutual consent, substitute cash settlement for physical delivery. In cash settlement, the seller of protection makes a payment to the buyer of protection. The payment is intended to cover the loss suffered by the protection buyer based on the market price of defaulted bonds established through a so-called ‘auction system’. The auction is designed to be robust and free of manipulation. In the case of Delphi, the protocol resulted in a settlement price of 63.38 per cent (which was the market’s estimate of recovery by the lender). The protection buyer received 36.62 per cent (100 less 63.38) or US\$3.662 million per US\$10 million of CDS contracts. Fitch Ratings assigned an R6 recovery rating to Delphi’s senior unsecured obligation, which equated to a 0–10 per cent recovery band – far below the price established through the protocol (Batterman and Rosenthal 2005). It is clear from this example that the buyer of protection, depending on what was being hedged, can potentially receive a payment on its hedge well below its actual losses – and in practice may therefore not be fully hedged.

The settlement mechanics may cause problems even when there is no default. In one example, a company (Sainsbury) refinanced its debt using commercial mortgage-backed securities (CMBS). The company was downgraded by rating agencies. It had a shortage of deliverable obligations – having used the funds from the CMBS to repay its bond and loans – which meant that the CDS fee for the company fell sharply. While this is generally indicative of an improvement in credit

quality, it resulted in mark-to-market losses for bemused hedgers. This is known, in the trade, as an ‘orphaned CDS’.

In general, the intricacies of CDS contracts and their operation are not well understood by users. In the words of an anonymous trader:

Credit derivative dealers talk about their market in much the same way spotty teenagers talk about sex. A lot of people profess to be accomplished experts, but when it really boils down to it, most of them are still fumbling in the dark.

In the case of actual defaults, the CDS market may provide significant employment to a whole galaxy of lawyers trying to figure out whether and how the contract should work. Unfortunately though, the contract may not always provide buyers of protection with the hedge against losses that they assumed they had purchased.

1.2 Encounters with counterparty risk

CDS contracts allow the buyer of protection to substitute the risk of the protection seller for the risk of the loan or bond being hedged. However, if the protection seller is unable to perform, then the buyer obtains no protection. A significant proportion of protection sellers are financial guarantors (monoline insurers) and hedge funds. Concerns about the credit standing of the monolines are well documented. Recently, a number of banks created substantial provisions against the counterparty risk on hedges with financial guarantors. This was done to cover the possibility that the counterparty is not able to perform under the contract, leaving the hedger exposed to a loss on the risk being hedged. The financial institutions included Merrill Lynch (US\$3.1 billion), Canadian Imperial Bank of Commerce (US\$2 billion) and Calyon (US\$1.7 billion).

For hedge funds, CDS contracts are marked to market daily, and any gain or loss is covered by collateral (cash or high quality securities) to minimise risk. If there is a failure to meet a margin call then the position must be closed out and the collateral applied against the loss. In practice, banks may not be willing or able to close out positions where collateral is not posted. In a recent example of these problems, ACA Financial Guaranty sold protection totalling US\$69 billion while having capital resources of around US\$425 million. When ACA was downgraded to a credit rating of below A in late 2007, it was required to post collateral of around US\$1.7 billion. ACA was unable to meet this requirement. The banks made a ‘forbearance agreement’ whereby the buyer of protection waived the right to collateral temporarily. ACA has subsequently been downgraded to a credit rating of CCC, reducing the value of the CDS contract and the protection offered. The problems at ACA are not unique.

A critical element is the level of over-collateralisation. A buyer of protection will want an initial margin to cover the risk of a change in the value of the CDS contract and any failure by the seller of protection to meet a margin call. The seller of protection wants to increase leverage by reducing the amount of cash it must post as an initial margin. It is possible that the initial collateral may prove to be too low, particularly as collateral models use historical volatility and correlations that

may underestimate risk. Also, the entire process assumes liquidity in the underlying CDS market that may be absent in a crisis.

The use of collateral also poses liquidity risks for sellers of protection. When its credit rating declines, a bank may have to post increased collateral. There is anecdotal evidence that large hedge funds are now asking banks to post collateral as surety to mitigate credit risk in transactions. Merrill Lynch estimated that a downgrade of its credit rating by one category (notch) would require it to post an additional US\$3.2 billion of collateral on over-the-counter derivative transactions. Similarly, Morgan Stanley and Lehman Brothers estimated that a single notch downgrade would require posting US\$973 million and US\$200 million of additional collateral, respectively. Following its recent credit ratings downgrade, MBIA may be required to post an additional US\$7.4 billion in collateral. Collateral arrangements, in reality, may not provide the desired credit enhancement to CDS contracts but rather, they may exacerbate liquidity pressures on financial institutions.

CDS contracts can also entail significant operational risks. Delays in documenting CDS contracts forced regulators to step in, requiring banks to confirm trades more promptly. Where collateral is used, there are additional challenges of ensuring the accuracy of the marking to market of CDS and monitoring of collateral. Paradoxically, in the course of the May 2006 speech praising CDS contracts, Alan Greenspan expressed shock and horror at the appalling state of settlements in the credit derivatives market. He was dismayed that banks trading CDS seemed to document trades on scraps of paper. The ex-Chairman, perhaps unfamiliar with the reality of financial markets, had difficulty reconciling a technologically advanced business with this ‘appalling’ operational environment. Then again, in finance as in life, appearances are misleading.

If the CDS contracts fail then ‘hedged’ banks are exposed to losses on the underlying credit risk. Recently, one analyst suggested that losses from failure of sellers of CDS protection to perform could total between US\$33 billion and US\$158 billion (Cicione 2008). This compares to the US\$300 billion or so that banks have written off to date in the sub-prime crisis. While it may be unlikely that the CDS market will fail entirely, it is possible that losses on the hedges will add to the losses that the banks have already incurred.

1.3 Concentration risks

The CDS market entails complex chains of risk. This is similar to the reinsurance chains that proved so problematic in the case of Lloyds. Like reinsurance premiums, CDS fees are received up-front. In both cases, the risks are potentially significant and ‘long-tailed’ – they do not emerge immediately and may take some time to be fully quantified. As in the reinsurance market, the long chain of CDS contracts may create unknown concentration risks. Defaults may quickly cause the financial system to become gridlocked as uncertainty about counterparty risks restricts normal trading.

The impact of a bankruptcy filing by Bear Stearns on the over-the-counter derivatives market, including CDS contracts, was probably one of the factors that influenced the Federal Reserve and US Treasury's decision to support the rescue of this investment bank. Barclays Capital recently estimated that the failure of a dealer with US\$2 trillion in CDS contracts outstanding could potentially lead to losses of between US\$36 billion and US\$47 billion for counterparties (Wood 2008). This underlines the potential concentration risks that are present.

1.4 Conclusions

Over the past year, securitisation and the collateralised debt obligation market have become dysfunctional. As the credit crisis deepened, the risk of actual defaults became real. Analysts expect the level of defaults to increase further. My contention is that the next stage of the crisis will involve the CDS market, which has not yet been fully tested. While there have been a few defaults, the market has not had to cope with a large number of simultaneous defaults. CDS contracts may experience problems and may be found wanting.

Ludwig von Mises, the Austrian economist from the early part of the twentieth century, once noted:

It may ... be expedient for a man to heat the stove with his furniture. But ... he should not delude himself by believing that he has discovered a wonderful new method of heating his premises. (von Mises 1949, p 650)

CDS contracts may not actually improve the overall stability and security of the financial system but may create additional risks in much the same way that occurred with many of the financial innovations that have underpinned the sub-prime crisis.

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2. Malcolm Edey

The papers for this Conference were structured around three themes, namely:

- the unfolding turmoil;
- innovation, disintermediation and capital regulation; and
- the role of central banks as providers of liquidity.

Let me start by recapping briefly how the papers addressed these themes.

Ben Cohen and Eli Remolona's paper started by reviewing the background to the crisis. Like a number of the other authors, they point to several contributing factors. These include: a low-interest rate environment in the years leading up to the crisis; financial innovations, especially the growth of off-balance sheet vehicles and complex structured securities; an increased appetite for risk; and a range of weaknesses in regulation and in market infrastructure. Included in the latter were shortcomings in disclosure and in the role of the rating agencies. Eli and Ben hold out some hope that the implementation of Basel II, along with the various recommendations from recent official reviews, will help to alleviate these weaknesses.

The paper by Nigel Jenkinson, Adrian Penalver and Nicholas Vause covered some of the same territory but, I think, gave greater weight to the endogenous dynamics of financial innovation. The authors argue that innovations like structured debt instruments brought genuine improvements in the capacity of markets to allocate risk efficiently. They recognise that the amount of risk-taking went too far, but they also point to the capacity of these markets for self-correction. They predict markets will learn from recent mistakes and deliver some of the needed changes, like improvements in transparency, product simplification and better performance from rating agencies.

The next paper, by Adrian Blundell-Wignall and Paul Atkinson, differed from Ben and Eli's paper in the other direction, by focusing more of the story on regulatory shortcomings. Like the other authors, they agree that low interest rates and the search for yield were key preconditions of the crisis. But they argue that it was the regulatory transition from Basel I to Basel II that created the incentives for banks to innovate and expand in the direction they did. And this in turn helps to explain the form that the financial crisis took. This is an interesting thesis, and one that deserves to be examined further. Before I am convinced, I would like to see some more detailed analysis of how the incentive structures worked. On the face of it, the incentive to use off-balance sheet vehicles to economise on capital already existed under Basel I, and would already go a long way towards explaining the innovations and risk-taking that were characteristic of the crisis.

The remaining three papers brought us on to the question of how central banks should respond to events like this in their role as providers of liquidity. Philip Davis's paper gave us a helpful discussion of the nature of liquidity risk, the way financial contagion can spread, and the issues central banks face in deciding how to meet liquidity needs in a crisis. Spence Hilton gave us a detailed account of how the Fed modified its operations in response to the crisis, and the new liquidity facilities

that were introduced. He also raised the interesting question of whether these new facilities should be maintained in normal times. These issues were taken up and explored in a more general way in the paper by Jonathan Kearns and Phil Lowe.

Finally, we have heard from Das that the crisis might not yet be over. He makes the case that the resilience of the credit default swap market, in particular, is yet to be fully tested. And of course, we have had news in the past few days of the difficulties in the US federal mortgage agencies, which has formed an important part of the background to our discussions here.

All of that amounts to a fairly comprehensive coverage of the issues that arose out of these recent events. They are complex issues, and it is easy to get lost in the complexity. So to try and focus this final discussion, let me draw together a few of the common themes that seem to emerge.

The first theme is that periodic bouts of financial over-exuberance, followed by their unpleasant aftermath, are to some degree unavoidable. All of the papers presuppose this to be the case. That is why bank assets are worth more in good times than in bad times, which in turn is why banks need a lender of last resort. It is also why we need prudential regulators, to contain risk-taking and to make sure the system has some buffer against the financial cycles that are inevitably going to occur.

It is interesting to observe in history the way each successive financial cycle is both similar to, and different from, its predecessors. The common elements are very familiar: the build-up of leverage; the rise in asset prices, often from what starts out as a sound basis; the development of innovative financial instruments; the elements of reckless or near-fraudulent behaviour that get drawn into the mix; and, above all, the belief that this time it is different. What differs each time is the set of assets or financial instruments at the centre of the event, be they railway shares, tech stocks, emerging market debt or sub-prime mortgage securities. People are unlikely to jump on the same bandwagon twice in quick succession, so we can be sure that next time there is a crisis, it will be something different again.

Obviously, those of us who work in central banks, or financial supervisory agencies, make it our business to do what we can to reduce the risk that these kinds of events will occur, or to mitigate their effects when they do occur. But we have to be realistic about what can be achieved. History suggests we are never going to be able to eliminate financial cycles entirely.

The second theme is that low interest rates in the major economies were a key factor in promoting excessive risk-taking in the lead-up to the crisis. The major economies all ran with unusually low interest rates in the first half of this decade, for reasons that can be debated, but which can at least be understood given circumstances at the time. The low-interest rate environment encouraged both credit expansion and the much-discussed 'search for yield', which saw risk spreads on a range of financial instruments bid down to unsustainably low levels.

Adrian and Paul's paper used the analogy of a dam wall containing structural weaknesses and with water piling up behind it. Eventually the dam will break, but

what cannot be predicted is exactly when it will happen, or which villages will be destroyed. There seems to be general agreement that the low-interest rate environment contributed to the build-up of financial pressure, while various regulatory and other weaknesses eventually allowed the structure to give way.

This brings me to the third theme, which is that unintended consequences of financial regulation were responsible for shaping the types of risk that were being taken. The most obvious example of this is bank capital regulation. Banks responded to the incentive to economise on capital by shifting more and more of their business into off-balance sheet vehicles, and by embracing the originate-and-distribute model for mortgage lending. In this way, a set of regulations intended to contain a certain type of risk actually had the effect of shifting risk into the unregulated or less regulated parts of the financial system. And in the process, other kinds of risk-taking were being encouraged.

I am not an expert on financial regulation, but my impression is that there are many examples of this phenomenon. And it is not just bank regulation *per se* that contributes to these unintended consequences. It is the whole network of market conventions, investment mandates, and even things like investor rules of thumb that help to channel the direction of financial innovation.

When I first heard about how collateralised debt obligations (CDO) work, I was puzzled as to what could be the economic rationale for the existence of this kind of instrument. Here was a security that concentrates risk in highly unpredictable ways, and I wondered where the underlying demand for it could come from. The paper from Adrian Penalver *et al* discusses this and suggests a possible rationale – namely, that a CDO allows investors to take a position on the size of an aggregate default event. That sounds plausible enough, but I suspect the main demand for CDOs didn't arise from that kind of deliberate position-taking. It came from rule-based investors whose mandates required them to invest in securities with a minimum credit rating; or from naïve investors like local governments, who were using rules of thumb roughly along the lines of 'invest in the AAA securities with the highest yield'. CDOs seem to have been designed, at least in part, to meet this kind of demand.

My fourth theme is that the process of regulatory reform in response to these events will necessarily be a dynamic one, with no final end-point. Eli's remarks at the beginning of the Conference make this very clear. There are certain aspects of regulation and market conduct that need to be fixed, including in areas like bank capital regulation, disclosure and reporting practices, and the role of rating agencies. The same goes for the various conventions and rules of thumb that influence investor behaviour. Investors are going to have to go through the process of adjusting those rules and conventions in response to what they have just learned. But, for reasons I have already discussed, the next crisis is going to be different from this one. Market practitioners will continue to innovate around regulations, and regulators and supervisors will continue to adjust their approach as best they can, trying to anticipate where the next source of systemic risk is coming from. As I said earlier, perfect results are not going to be attainable on this front, but the effort has to be made.

Finally, I want to sum up some of the discussion concerning the role of central banks in providing liquidity. One important distinction here is that between providing liquidity to an institution and providing it to the system as a whole. It is the institution-level support that raises the major difficulties, particularly in relation to questions of moral hazard, whereas system-wide liquidity provision by the central bank is generally regarded as uncontroversial. This conventional view makes a good deal of sense. Nevertheless, I am not sure that the two concepts can be kept entirely separate, since the routine liquidity operations of the central bank necessarily work through the institutions that are bidding for funds.

In fact, this whole area is one where neat formulations and principles are hard to come by. We can see this by thinking about the extreme approaches to liquidity provision discussed by Jonathan and Phil. At one extreme would be an approach that offered banks unlimited liquidity support on demand. There is, in fact, some economic rationale for such an approach. Central bank liquidity costs no real resources to produce. It could, in principle, be offered to commercial banks in volumes that would meet all conceivable liquidity demands. Why not do so? The answer has to be that such an approach would involve unacceptable risk to the central bank. I think it would also mean a significant extension of the central bank's function. Why? Because presumably that risk would have to be managed, and this in turn would mean taking some ongoing involvement in the risk management decisions of the commercial banks.

At the other extreme is the approach that commits itself to providing no emergency liquidity support at all to institutions, or providing such support only under tightly specified preconditions. This deals with the moral hazard problem, but runs up against a problem of credibility: that is, circumstances may well arise in which it is not realistic to withhold liquidity support, and it is impossible to specify in advance exactly what those circumstances might be.

For these reasons, the two extreme positions I have just outlined do not seem to be workable, and all of the papers that addressed this question looked for a middle ground between them. These intermediate approaches need to find a balance between freely providing central bank liquidity, which can be viewed as an essentially costless public good, and containing the moral hazard that can flow from that. I sense the general balance being struck by participants here involves a relatively liberal approach to liquidity provision in crisis conditions, but a reluctance to get too involved in funding the balance sheets of commercial banks in normal times. But this still leaves a lot of the details up for grabs, and no doubt these are issues that will continue to be debated for some time.

3. General Discussion

The discussion in the final session started with a call by one participant for the scope of the regulatory net (as it applies to banking) to be more clearly defined and for the authorities to be more explicit about which types of banks would be permitted to fail. It was suggested that this could involve a starker distinction between commercial and investment banks, and perhaps regulations restricting commercial banks from owning or conducting investment banking business. It was argued that doing so would better protect public funds and avoid problems of moral hazard. Along the same lines, a number of participants suggested that perhaps regulators needed to define a group of institutions that were considered ‘too big to fail’. These institutions could be required to operate as ‘narrow banks’ that only issue on-balance sheet loans and hold government securities but no derivatives. Others were somewhat sceptical that narrow banks could somehow be ‘ring-fenced’ from the rest of the financial system. Also on the question of investment banks (and some of the riskier commercial banks), the issue of their culture of risk-taking was raised in the context of the remuneration of executives. One participant questioned the benefit of shorter-term, equity-related executive bonus structures. Another questioned whether very high remuneration for financial executives was justifiable given their performance which had little true social value and suggested that it could be due to their excessive influence over boards.

The discussion moved on to the magnitude and duration of the current financial turmoil. One participant suggested that a key distinguishing feature of the current episode was its long duration. Another participant claimed that this was because the turmoil had centred on assets that were held off-balance sheet, and that exposures had been widely spread across institutions and around the world. If instead problem assets had been on the balance sheets of only a handful of institutions, the crisis may have resolved more rapidly – since it would have been feasible for the institutions and authorities to agree on a resolution, as had been done in many previous crises. It was less clear, however, whether the nature of this financial crisis implied more or less of an adverse impact on the real economy than earlier crises, with one participant doubting that the overall quantum of risk would have been as great had the problematic mortgage assets been on-balance sheet. One participant suggested that the spiral of falling asset prices, leading to falls in demand for credit and further falls in asset prices, had only just begun, and that there was likely to be more weakness yet to come, particularly in real activity. In this light, it was suggested that problems of moral hazard should take a ‘back seat’ in current policy considerations. A number of participants agreed that the moral hazard problem had perhaps been over-emphasised given that: first, much of the empirical evidence appeared to indicate that bailouts had only a limited effect on market behaviour; and second, in a number of cases where institutions had failed, shareholders had suffered sizeable losses and management had lost their positions and reputations, which provided market discipline on its own.

There was also some discussion about the causes of the recent turmoil. Some participants highlighted the role of macroeconomic factors, including low interest

rates and a ready supply of funds which found their way into housing markets, most notably in the United States. On the contribution of the financial system, one participant suggested that an appropriate policy response depended on the extent to which the crisis reflected: first, positive correlations across different assets, which were not properly appreciated; second, a more general inability to assess risk – in part reflecting the information problems highlighted in a number of the papers at the Conference; or third, financial market participants knowingly selling financial products that were overpriced. Another participant thought that it was likely that all three were at work, making the policy choices more complicated. Yet others suggested that while the purpose of the originate-to-distribute model and products such as collateralised debt obligations was to distribute risk to those most able and willing to hold it, it seemed that what had actually been achieved was an unexpected concentration of risk.

One participant argued that in the longer run of history, innovation in financial markets had a mixed track record. In the early 1980s, crises took the form of sovereign debt defaults and a failure of prudent fiscal policy. The 1990s brought the Asian crisis, which was associated with fixed exchange rates and the assumption that domestic financial systems could borrow in foreign currency. During these episodes, the developed nations and international agencies argued that the developing nations needed to deregulate their financial systems. But the two largest financial problems of this decade have occurred in the deepest financial markets: the ‘tech’ bubble and the bubble in house prices. It was contended that this is a significant blow to the argument that deregulated and flexible financial markets are superior. However, other participants suggested that the benefits of financial innovation still far outweighed the costs. It was argued that the technology is available to better deal with the costs, for example, by the use of collateral, subordination and delegation to the credit rating agencies, but the way in which these technologies are applied is important and there is clearly a significant role for public policy.

Biographies of Contributors

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Paul E Atkinson joined the Groupe d'Economie Mondiale de Sciences Po in 2005 after nearly 15 years as a senior official at the Organisation for Economic Co-operation and Development (OECD). From 2001–2004 he served as Deputy Director of the Directorate for Science, Technology and Industry where he had responsibility for the Structural Policy Branch. His work there focused on analytical and policy issues relating to the 'knowledge economy' and, among other activities, included oversight of the preparation of the 2nd OECD Conference of Ministers Responsible for Small and Medium-Sized Enterprises held in Istanbul in June 2004. Prior to that he worked on macroeconomic issues in a number of posts in the OECD's Economics Department, including that of editor of *Economic Outlook* for eight years. Outside the OECD during the 1980s, Dr Atkinson worked on macroeconomic policies and structural reform issues at the New Zealand Treasury in Wellington and the Institute of International Finance in Washington DC. He obtained his undergraduate degree at Williams College in Massachusetts and received his PhD in Economics from the University of Cambridge.

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Benjamin H Cohen is a Senior Economist at the Bank for International Settlements (BIS). Currently he is a member of the BIS-based secretariat of the Financial Stability Forum, where he has supported the Forum's work on short- and long-term responses to the 2007 and 2008 financial market turmoil as well as its ongoing analysis of systemic risks and vulnerabilities. Previously he has worked in the Financial Markets group of the BIS Monetary and Economic Department, the Independent Evaluation Office of the International Monetary Fund, and the secretariat of the Committee on the Global Financial System. His research interests include the study of volatility and liquidity in financial markets as well as the causes and consequences of financial crises. He holds a PhD in Economics from the Massachusetts Institute of Technology.

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Satyajit Das is an international specialist in the area of financial derivatives and risk management. Since 1994, Mr Das has acted as a consultant to financial institutions and corporations in Europe, North America, Asia and Australia. Between 1988 and 1994, Mr Das was the Treasurer of the TNT Group, an Australian-based international transport and logistics company. Between 1977 and 1987, he worked in banking with the Commonwealth Bank of Australia, Citicorp Investment Bank and Merrill Lynch Capital Markets, specialising in fund raising in domestic and international capital markets and risk management/derivative products. Mr Das is the author of a number of key reference works on derivatives and risk management. His works include *The Swaps & Financial Derivatives Library* (2005), a four-volume, 4 200-page reference work for practitioners on derivatives, and *Credit Derivatives: CDOs and Structured Credit Products* (2005). He is the author of *Traders, Guns & Money: Knowns and Unknowns in the Dazzling World of Derivatives* (2006). He is also the author (with Jade Novakovic) of *In Search of the Pangolin: The Accidental Eco-Tourist* (2006). Mr Das holds a BA in Commerce (Accounting, Finance and Systems) and a BA in Law from the University of New South Wales, and an MBA from the Australian Graduate School of Management. In 1987, Mr Das was a Visiting Fellow at the Centre for Studies in Money, Banking and Finance, Macquarie University.

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Acknowledgment

The editors are grateful to Wendy Baker, Herman Bugeja, Bhuvnesh Chaudry, Danièle Di Paolo, Paula Drew, Joanne Flynn, Amelia Hadley, Andrew Hodge, Kylie Lowe, Shirley Sam Yue, John Strumfin and the staff of the Economic Research and Financial Stability Departments for much help in organising the Conference and producing this volume.

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