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Provision: How Much of a Departure is
the Sub-prime Crisis?**

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THE LENDER OF LAST RESORT AND LIQUIDITY PROVISION – HOW MUCH OF A DEPARTURE IS THE SUB-PRIME CRISIS?

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Abstract: The traditional role of the lender of last resort (LOLR) is to avoid unnecessary bank 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 Russia/LTCM episode. Funding risk now interacts with market liquidity risk, to create difficult challenges for central banks. Even in the relatively non-systemic period up to September 2008, the LOLR had to adapt radically, for example, in terms of lending to investment banks, taking lower quality collateral and lending for 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. Since September 2008, although action has mostly been in line with traditional approaches for systemic crises, there have been some further adaptations in line with the systemic nature of the crisis, notably by the Federal Reserve acting as market maker or investor of last resort in illiquid securities markets.

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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 lender of last resort (LOLR) – illustrated by historical examples – and evolving views of LOLR. Note that this “benchmark” is based on current beliefs and attitudes in central banks, academia and international organisations and not on the precise wording of key authors such as Bagehot.

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” (IMF 2008, Davis 1994), while contagion has occurred more via market prices and less via credit risk (Adrian and Shin 2008) and new “amplifiers” of financial instability have become apparent (Brunnermeier 2008). Even in the non-systemic³ period up to September 2008, the LOLR had to adapt radically, for example, in terms of lending to investment banks, taking lower quality collateral and lending for 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. Since September 2008, although action has mostly been in line with traditional approaches for systemic crises, there have been further adaptations in line with the systemic nature of the crisis, notably by the Federal Reserve acting as market maker or investor of last resort in illiquid securities markets. Meanwhile fiscal authorities have stepped into their traditional role in a systemic crisis of recapitalising potentially insolvent banks, this offering some relief to LOLRs.

Readers already familiar with the basic models of liquidity and bank runs, and of the role of bank liquidity policies may wish to turn directly to Section 3; those also familiar with current views of lender of last resort might turn further to Section 4, while noting the distinction we make between the LOLR in non systemic periods (Sections 3.1-3.3) from LOLR in systemic crises (Section 3.4).

1 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, due to the transaction affecting the price (transactional liquidity). A further type of liquidity risk relates to the ease with which one can raise money by borrowing using an asset as collateral (funding risk). 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

³ Whether the period August 2007-August 2008 was strictly non-systemic is of course contestable, but what is clear is that there was a step change in the intensity of the financial crisis in September 2008 which necessitated further and more radical measures of crisis management.

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 *et al* 2000a). 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 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 more 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. Wholesale funding is attractive to banks as a means to rapidly grow balance sheets. 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.

The systemic importance of interbank markets has also been increased by 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 payments 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, in contrast, 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.⁴ 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 *et al* 2000b).

2 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, Bank of England 2008b).

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 (CDs), eurodollars, repurchase agreements (repos), subordinated debt and contingent credit facilities from other banks as well as interbank, time and demand deposits and contingent credit facilities from other banks.⁵ Securitisation is a further instrument for liability management. The second is to ensure the appropriate mix of traditional deposits and investment products. Deposits typically incorporate services, have payoffs that are insensitive to the fortunes of the intermediary, are for small/uninformed users and are insured, so their demand for such deposits is usually stable. Investment products are typically risk-sensitive, for large/informed users, have payoffs that vary with the intermediary's performance, involve monitoring, and hence demand 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

⁴ For a survey of the theory, see De Bandt and Hartmann (2001).

⁵ For some discussion of contingent credit facilities see Gatev *et al* (2006).

banks can suffer runs due to illiquidity. Regulation of bank liquidity is less developed than for capital,⁶ and not subject to international agreement.⁷ 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 by the central bank. It is to the LOLR, that is, liquidity policy in times of emergency, that we now turn.

3 The lender of last resort (LOLR)

We now go on to outline the currently accepted views and attitudes to the LOLR, citing examples from history that are relevant to each point. These are the “accepted wisdom” in central banks, international organisations and in much of academia, which, we argue, is called into question by the sub-prime crisis. See for example Stevens (2008), He (2000) and Freixas et al (2000) for respective recent views.

3.1 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, thereby delaying legal insolvency of an institution and preventing 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.

We 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 high rate against good collateral⁸. Furthermore, the central bank has to act in the public interest and not solely its private interests, as the Bank

⁶ 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.

⁷ See Basel Committee (2008) for a recent discussion of liquidity regulation.

⁸ Some would argue that a “high” rate relative to before the crisis need not be a penalty rate but most commentators translate it as such, e.g. Freixas et al (2000). Furthermore, in 1866 the Bank of England was apparently willing to compromise on collateral quality in a crisis (although normally “good” means usually acceptable to the central bank) However, the point is moot since the aim of this paper is to compare LOLR in the sub-prime crisis with current beliefs and attitudes to the lender of last resort, and not what Bagehot wrote.

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.⁹ 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 US. 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 current views of LOLR 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 cases 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 payments systems that almost precipitated an international financial crisis (Davis 1995). The need for direct lending, and the choice it implies means central banks are involved in bank closure policy (a prudential policy) and not just technical liquidity provision (a monetary policy), see Freixas and Parigi (2008).

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 to 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 US to support Drexel Burnham Lambert in 1989 (although the Bank of Japan did save Yamaichi

⁹ As noted by Bordo (1990), the Barings rescue included commercial banks and the Banque de France as well as the Bank of England.

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.

3.2 Costs of LOLR

There are costs to having a LOLR (He 2000). The LOLR is only supposed to aid illiquid and not insolvent institutions (Humphrey and Keleher 1984). However, 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 Schoenmaker (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, it is generally considered 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.^{10,11} 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, results 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 US 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.

3.3 Minimising costs of LOLR

Current views of LOLR maintain 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, it is often argued that 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 (Goodhart 2007). The latter, along with harsh conditionality (for example, liquidity restoration, restrictions on new business or on dividend

¹⁰ As a consequence, Kane (1992) argues that LOLR is inappropriate and should be abolished given the cost of moral hazard.

¹¹ This is illustrated by the existence of “support ratings” for banks alongside their standalone ratings.

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, current views state 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 (1995) 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 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 (Economist 2008b). 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.

3.4 LOLR in systemic crises

So far we 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 judgement of which institutions are systemically important.

Emergency liquidity assistance in such cases is likely 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 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 crisis 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 Schoemaker 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 evolving views of the LOLR, we now go on to assess whether the current sub-prime crisis requires our understanding of these concepts to be revised.

4 Recent developments in liquidity risk

4.1 The sub-prime crisis and liquidity

We 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 closer integrated than in the past. Systemic

market liquidity problems were only apparent before the sub-prime crisis during the Russia-LTCM crisis (Davis 1999, IMF 1998) – although in the case of Russia/LTCM the banks were relatively unscathed. We first describe the build up to the sub-prime crisis, as well as the crisis itself, before considering relevant liquidity risk paradigms.¹²

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 1 rules.¹³ 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, trading became difficult or impossible, even among the lowest risk tranches of the relevant securities. This signalled the beginning of what in retrospect can be seen as the non-systemic period of the crisis, dating from August 2007 to September 2008.

As noted by the 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.¹⁴

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 effects of price falls in the context of mark-to-market accounting on the capital of leveraged institutions. 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 (Economist 2008a).

¹² For a more detailed summary see Brunnermeier (2008).

¹³ The capital charge on credit lines to such subsidiaries were less than those of holding the assets on balance sheet.

¹⁴ The corollary is that the potential scale of losses is exaggerated by using a mark-to-market approach to value such illiquid securities (Bank of England 2008a).

Monoline insurers, that provide some credit guarantees to ABS and credit default swaps (CDS) themselves, also came under financial pressure (Bank of England 2008a). Another factor was reliance of some institutions on quantitative techniques of trading and risk management that assumed continuous liquidity (IMF 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 in the trading book, so price falls affected their solvency. This was unlike banking crises in the past where loans have typically been held at historic cost in the banking book 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. 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 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, despite provision of LOLR. Northern Rock had pursued an aggressive reliance on both wholesale funding and the securitisation of assets, which was no longer feasible (UK Parliament 2008), and its failure was considered likely to cause contagion. 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.¹⁵

These combined features led on to the emergence of historically large premia – and quantity-rationing of funds – in the domestic interbank markets in the US, UK and Euro Area, at all but overnight maturities, alongside the securities markets¹⁶. Funding at three months in particular became very difficult to obtain. 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, growth in reliance on short-term wholesale funding,¹⁷ dependence on securitisation and the rise in overall maturity mismatch on their balance sheets related to SIVs and conduits. Banks in the wake of this sought to reduce balance sheet lending, and hoard liquidity, at the same time that borrowers were rendered cautious by house price falls, leading also to unprecedented falls in mortgage lending. Banks were also concerned about

¹⁵ Goodhart (2007), however, notes that such liability insurance is not a resolution for a systemic crisis, as it merely relocates liquidity risk.

¹⁶ The remaining paragraphs of this section are based on Barrell and Davis (2008).

¹⁷ Bradley and Shibut (2006) show US banks' ratios of deposits to liabilities has fallen from 93 per cent in 1965 to 60 per cent since 2000.

counterparty risk given the opacity of bank balance sheets in general and the difficulty of valuing CDOs in particular. Central banks offered massive volumes of liquidity to supply banks and sought to restart the interbank funding markets. Beyond Northern Rock, failures in 2007 included two small German banks. The casualties of this ongoing pattern in the period up to Summer 2008 were much more important. They included Bear Stearns (taken over with government guarantees), IndyMac (failed) and Fanny Mae and Freddy Mac (effectively nationalised).

The ongoing process unleashed by the crisis can be referred to as deleveraging (IMF, 2008b), as banks and other institutions sought to reduce exposure to high risk sectors, selling assets or reducing asset growth, as well as reducing dependence on unstable wholesale funding and rebuilding capital adequacy. Arguably, it is also involving a reduction in the excess capacity that has built up in the financial system over many years (Davis and Salo, 1998). The process was aggravated by the ongoing fall in asset prices and rise in private sector defaults on loans, as noted above, as well as by closure of securitisation markets, notably in Europe.

By September 2008 it seemed that the crisis was ongoing, but not worsening. However, following the bankruptcy of Lehman Brothers (unsupported by the authorities) in mid-September, there was a sharp worsening of market conditions and the process of deleveraging became disorderly as counterparty risk perceptions ballooned. This began what can now be seen as the systemic period of the crisis.

The equity market, which had been surprisingly little affected by the crisis up to that point, began to fall sharply. This particularly reflected low confidence in banks that were dependent on wholesale funding. They suffered shrinking capital due to mark-to-market losses, while markets for wholesale funds, that had previously been costly and restrictive, proved to be totally closed to such institutions after Lehman's failure. Cross-border lending was even more sharply curtailed than domestic, showing again the historic instability of the international interbank market (Bernard and Bisignano, 2000).

Money market funds in particular underwent losses on Lehman's short-term debt when that firm collapsed, and this led to one of them, Reserve Primary, 'breaking the dollar' (i.e. with a unit value falling below a dollar) and needing to be liquidated. The sector then suffered loss of public confidence and underwent massive redemptions (\$184 billion in two weeks). Similar patterns of sizeable redemption emerged for hedge funds and mutual funds, leading to forced asset sales in illiquid markets, which intensified the downward spiral in asset prices and widening of credit spreads. Instead of offering liquid funds to banks, money market funds began rather to compete with them for financing. A large number of creditors, including significant hedge funds, had their assets frozen in the Lehman bankruptcy, and were forced to find alternative funds, adding to selling pressure in equity, bond and money markets. A major flight to quality occurred, with investors seeking the safe haven of government debt.

The authorities acted in the wake of the worsening of market conditions. The US authorities devised and passed the Paulson plan, which was designed to restore liquidity to the markets by using \$700 billion to buy up mortgage backed securities. However, this plan as initially proposed did not initially address the solvency of the banks directly, and left many exposed. Money market funds were supported in due course by the Treasury and Federal Reserve. The Fed also began to purchase commercial paper directly from non-financial companies to avoid a liquidity crunch for them, after the investor base dried up. The American Insurance Group (AIG) had made a major foray into insuring complex products, and had lost most of its capital base when default rates rose to ten times those on which policies were based. It, along with Bradford and Bingley in the UK, had to be nationalised in succession. Merrill Lynch and

Wachovia were taken over. Washington Mutual was closed by regulators and sold to JP Morgan Chase. The remaining US investment banks had to become bank holding companies.

Banks dependent on cross-border financing were hardest hit. For example, the two major Belgian banks have had to be nationalised and all three Icelandic banks failed in October. Significant public sector stakes totalling £37 billion were taken in three major lenders in the UK, HBOS, RBS and Lloyds, in order to ensure their solvency, while guarantees were offered for their liabilities and the Bank of England expanded its swap facility for illiquid assets. The effective nationalization of a large part of the UK banking sector ensured that this system would remain solvent, and a number of European countries announced that they would also strengthen the equity base of banks by taking a public share. It also appeared that the Paulson plan could be redirected to the same purpose, and in mid-October \$250 billion was made available to US banks to increase their capital adequacy ratios with public stakes in their equities being taken in return.

Public intervention had been made urgent by the fact that the equity market seemed to foresee a liquidity crisis for many banks when medium-term funding became due in coming years. The UK bank HBOS seemed close to failure until it was announced that a takeover by Lloyds would occur. In the week of 6–10 October, stock markets around the world fell by 25 per cent, despite approval of a rescue package for US banks and the announcement of a yet more comprehensive plan to support UK banks' capital and liquidity. Emerging markets, that had hitherto been relatively unscathed, began to be badly affected (IMF, 2008b) as external finance became much harder to obtain.

The period from October 2008 to end-year saw a calming of the systemic risks that had become apparent, but a spreading of the crisis to the real economy in a range of countries, with growing concerns over credit rationing, including by banks that had received significant public assistance, and major bankruptcies in the non-financial sector. Unemployment has begun to rise sharply, notably in the UK and US, while house prices continue to fall and loan defaults were increasing. There is at the time of writing (January 2009) growing concern over the risk of price deflation, that could lead to rising real interest rates on debt and the risk of a debt-deflation. Furthermore, although extreme turbulence had subsided, the authorities remained concerned about an adverse feedback loop, in which economic weakness exacerbates financial stress, which in turn leads to further economic damage (Bernanke 2008).

4.2 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, Bear Stearns and Lehman Brothers). Moreover, the run up to the crisis showed the familiar signs of the procyclicality of financial markets (Borio *et al* 2001). However, there were also a number of less familiar elements.

We 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 cash prior to maturity (Davis 1994; and 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 including SIVs who do not have an alternative source of rollover finance.¹⁸ 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 this decade.

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.

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; and 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 we 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

¹⁸ 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.

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) argue 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 1 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 as 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 *et al* (2004) 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 Russia/LTCM crisis. However, the current crisis was 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 *et al* (2000b). 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 banks' excess liquidity and reduces 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 (2008) 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.

5 The lender of last resort and the sub-prime crisis – the non systemic period

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 3 above), suggesting a need to amend some traditional views. These issues did not come into play in the same way in the otherwise-similar Russia/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 3, we 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.

The sub-prime crisis can be seen in two parts, non systemic and systemic, as noted above. In the latter, policy involved the fiscal authorities in widespread guarantees and bailouts outside the LOLR framework as is typical of a major systemic banking crisis as cited in Hoelscher and Quintyn (2003). This is dealt with separately in Section 6.

5.1 The sub-prime crisis and the nature of LOLR

Earlier we 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, although as noted it has been common in emerging markets, and in the international interbank market. Accordingly, the Fed and ECB in August 2007 and the Bank of England also 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 we 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*.¹⁹ Interestingly, the impact of such action on spreads was at most temporary, suggesting liquidity policy was not sufficient to offset a generalised shift of the interbank market to risk

¹⁹ Goodhart (1999) maintains that only support for individual banks should be termed LOLR.

aversion (Fernandez de Lis 2008), particularly because of asymmetric information making it impossible to distinguish solvent and insolvent banks (Freixas and Parigi 2008).

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 US, the Fed introduced the Term Auction Facility (TAF) making funds available at longer terms than normal (up to 84 days), and also allowed lending from the discount window for up to 90 days. 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. Fernandez de Lis (2008) argues that such long term provision is contrary to the traditional view of LOLR which did not envisage a prolonged liquidity crisis in interbank markets.

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.

We noted in Section 3.1 that traditionally LOLR assistance has been provided only to commercial banks.²⁰ The Fed was forced to implicitly extend safety net protection to include investment banks, incurring a balance sheet guarantee for the Bear Stearns rescue via JP Morgan. It also made emergency liquidity available to investment banks (primary dealers in government securities) more generally.²¹ 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 (Economist 2008a). 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 were considered at the time to be accorded unprecedented protection for their risk taking activities (leveraged balance sheet and total dependence on wholesale funding), which was widely seen as requiring tighter regulation. In fact the model of the standalone investment bank itself came under strain, and in effect proved unviable in the wake of the Lehmans bankruptcy, with the remaining firms either merging with commercial banks or becoming banks themselves. It can be argued that the rescue of Bear may have caused complacency among the remaining banks about risk taking that contributed to the failure of Lehmans.

5.2 The sub-prime crisis and the costs of LOLR

The role of markets in the 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 4.2 highlighted.

²⁰ This focus was retained in the Eurozone, partly reflecting a more bank based financial system and also a more inclusive definition of what a bank is.

²¹ This was via the new Term Securities Lending Facility (TSLF).

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. We 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 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.

5.3 The sub-prime crisis and minimising costs of LOLR

It was noted that requiring good collateral is a key basis of the traditional view of the LOLR (although this could be eased in a systemic crisis). 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, (the Special Liquidity Scheme) initially thought 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 2008b). Meanwhile banks had the incentive to hoard top quality collateral, and central banks were thought to 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 (Economist 2008b).

Current views of the LOLR state that lending should be at penalty rates to give appropriate incentives. In fact central banks tended to narrow spreads over bank rates, as for example in the US where the primary credit rate for the Fed’s discount window was reset at only 25bp over the federal funds rate from 100bp hitherto. This can be seen as a response to the problem of stigma for banks accessing penalty rate facilities, which risked causing runs on themselves by doing so, as well as because a massive intervention at a penalty rate could have worsened interbank market tensions.

Ideally 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 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 UK (UK Parliament 2008, pp51-52).

Adequate information was noted to be essential for efficient operation of LOLR. Northern Rock presented a challenge for the UK's nascent tripartite agreement. Some commentators suggested 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 UK 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.²²

The loss of reputation for banks obtaining support and the confidentiality of the LOLR has become an important issue (Goodhart 2008b). In the UK, LOLR support was offered to the solvent bank Northern Rock as it had suffered a 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.²³ There followed a retail run which was only stopped by a government guarantee – the bank was ultimately nationalised.²⁴ 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 reputation 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 US, 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 as noted meanwhile reduced, contrary to traditional views, to seek to avoid stigma).

The growing public awareness of limitations of the UK's deposit insurance scheme in 2007 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 2008a). 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”).

²² The Banking Reform Act includes, first, 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 includes a leading role in the implementation of the new special resolution regime (SRR), should it be triggered by the FSA, including powers related to deploying and implementing the SRR tools.

²³ The Bank of Japan faced similar challenges in 1998 when deciding not to offer LOLR to the bank LTCB, for fear of a loss of reputation. However, in that case a merger was seen as probable if not certain (Nakaso 2001).

²⁴ Further difficulties arose thereafter for the UK authorities owing to the lack of a special insolvency scheme for banks in that country.

Some would argue that it was deposit insurance problems rather than systemic risk that motivated the Northern Rock rescue. The UK switched directly after the Northern Rock debacle to 100% coverage.

We noted above that the traditional LOLR was confined to the domestic banking system. The crisis revealed that the traditional LOLR is unsuited to the internationalised banking system. This was evident in the lack of liquidity in 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.

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/dollar exchange rate. Equally, there may be a need to avoid international banks “gaming” between different collateral requirements at the major central banks (Economist 2008b), which may in turn necessitate further coordination of collateral policy (Financial Stability Forum 2008). On the other hand, there was not a major failure of a European cross border bank in the non systemic period,²⁵ that it was acknowledged would severely test cross-border central bank and fiscal authorities’ cooperation.

6 The lender of last resort and the sub-prime crisis – the systemic period

We noted above that when a crisis becomes systemic, the view of the LOLR changes and many of the safeguards against moral hazard may be abandoned. The priority is given to preventing wholesale collapse of the system by offering protection of all banks, for example. Equally, an important role for the fiscal authorities emerges, taking over the safety net from the LOLR to a great extent. This is precisely what was seen in September-October 2008, so in that sense there were not radical innovations in crisis management procedures.

Crucially, the fiscal authorities stepped in widely to recapitalise banks. It was realised that central bank liquidity assistance was no longer sufficient, and the crisis concerned solvency and the unsustainability of the banks’ funding model (King, 2008). In the UK, the Treasury’s response entailed a voluntary recapitalisation valued at up to £50 billion for major banks, in the form of preference shares or ordinary shares. The government aimed to be a temporary investor, with the preference shares in particular repaid over a short period of time. This was aimed to cut default risk and hence stem funding pressures and markets’ tendencies to value banks by market and not economic intrinsic value.

In October 2008, a number of countries undertook similar recapitalisation policies following the UK initiative (Bank of England, 2008b). Of the \$700 billion Paulson plan in the US, \$250 billion was earmarked for recapitalisation, to be based on preference shares yielding 5%, and 9% if not redeemed in five years. Countries in the Euro area as well as Switzerland and Sweden have also announced recapitalisations, for example amounting to Euro 41 billion for France and Euro 130 billion for Germany. There were fiscal rescues of banks such as Dexia and Fortis in Belgium that tested cross border policies in the EU with at least initial success;

²⁵ As noted, the Fed accepts credit derivatives in liquidity operations while others do not, while the ECB allows for newly created ABS while the Bank of England restricts access to its long-term liquidity to securities already on banks’ balance sheets in December 2007.

on the other hand, the experience of the Icelandic crisis showed that such cross border failures can cause major difficulties for authorities in a range of countries.

Controversially, there has also been overriding of merger policy guidelines in the UK to permit the merger of Lloyds and HBOS, where the latter was seen as vulnerable to failure as a standalone entity. Similar tradeoffs of financial stability against competition in financial markets also arise from mergers elsewhere.

Deposit insurance for retail depositors has been extended to reduce risk of runs in Autumn 2008. In the US, the FDIC increased the insured level for individual accounts from \$100,000 to \$250,000. In the UK the ceiling was raised from £35,000 to £50,000. The lack of further retail runs meant there was less need for LOLR as at times in the past in a systemic crisis to cover a deposit insurance scheme whose credibility is lacking, giving rise to retail runs.²⁶

Some fiscal authorities set out to guarantee wholesale liabilities, covering money market borrowing and term debt. In the US, these guarantees as estimated by Bank of England (2008b) to be worth \$1400 billion. They include for example willingness to insure, for a fee, the entire amount of each non-interest bearing account, and for another fee of 75bp to insure all senior liabilities of the bank. The UK authorities offered guarantees of bank liabilities up to three years' maturity (financed by fees²⁷) amounting to £250 billion for banks seen as adequately capitalised. Germany has offered for a fee to guarantee Euro 400 billion of bank debt. Other countries have gone further and guaranteed all wholesale liabilities, including Ireland, Canada, Denmark and Australia. BIS (2008) note that government recapitalisation leading to a junior equity stake may entail a market perception of implicit state guarantees on all existing liabilities, even when this is not explicit. This may in turn distort markets for debt seen as a close substitute for that of banks.

Third, the fiscal authorities have set out to purchase illiquid and/or impaired assets. In the US the balance of the Paulson plan of \$450 billion was initially so earmarked, but eventually was diverted to support of consumer finance. Belgium, Spain, Norway, Canada, Australia and South Korea have set up funds for the purpose of purchasing illiquid assets. Such policies face the difficulty of coping with the vast quantities of such assets outstanding.

In the US, as noted, there was a specific problem for money market mutual funds after the Lehman Brothers' bankruptcy. The "breaking the dollar" by the firm Reserve Primary led to a run on the remaining money market funds, aggravating selling pressures in markets and shortage of liquidity. Accordingly, the US Treasury temporarily stepped in to guarantee the value of money fund shares at a minimum value of \$1, markedly extending the safety net.

Although fiscal authorities thus took over much of the safety net function, there remained a need for massive liquidity assistance. Central banks vastly expanded their balance sheets in the wake of the Lehman Brothers failure. The Fed and Bank of England's assets doubled in a matter of weeks, while those of the ECB and Swiss National Bank grew by more than 30% (BIS 2008). This reflects their growing role as intermediaries in the money market, via direct lending, standing facilities, open market operations and (for the Fed) lending to foreign central banks. One underlying factor was narrowing of spreads for central bank borrowing and lending where following the earlier action of the Fed, the Bank of England and ECB also

²⁶ Cross border liabilities of Icelandic banks were a matter of concern, but were generally dealt with by Ministries of Finance.

²⁷ The fee payable to HM Treasury on guaranteed liabilities is based on a per annum rate of 50 basis points plus 100% of the institutions' median five-year Credit Default Swap (CDS) spread during July 2007-July 2008 as determined by HM Treasury.

reduced the corridor between borrowing and lending rates from 200bp to 50bp and 100bp, respectively. This again reduces the incidence of “penalty rates”, which as noted above is generally deemed appropriate in times of systemic crisis to prevent widespread runs and contagion that penalty rates might cause.

In this context, for the most part, central banks’ role has been to expand existing facilities, as set out in Section 5 above, rather than create new ones. Hence, the role of lender of last resort has for the most part not been further amended relative to the innovations that occurred up to Summer 2008. The action of the fiscal authorities to some extent protected the central banks from the need for radical and risky new LOLR and other policies, as has at times been deemed necessary in past systemic crises (for example, 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, see Hoelscher and Quintyn (2003)). Indeed, to some extent the fiscal guarantees offer more protection to the central banks in some countries than was hitherto available, although this is probably offset in terms of overall credit risks taken by the central banks by the expanded exposures.

As an example of adaptation of existing policies, the UK expanded its Special Liquidity Scheme to £200 billion, and the US grew its Term Securities Lending Facility to \$198 billion in October. The Bank of England also further expanded the list of acceptable collateral for their operations three times in October 2008, to include for example MBS, ABS and covered bonds rated at least at A-.²⁸ At the same time the ECB lowered its minimum credit rating for collateral from A- to BBB-.

The cross border element of the crisis has also been enhanced. The US Federal Reserve expanded the provision of bilateral currency swap agreements to 14 foreign central banks instead of 2 prior to September, including those of a number of emerging market countries (Brazil, Korea, Mexico, Singapore), at a much greater potential value and using a wider range of instruments.²⁹ Other cross border arrangements were announced in Euros and Swiss Francs. International aspects of the crisis were emphasized by the common announcement of recapitalisations and also of interest rate reductions in early October, as well as coordinated announcement of availability of dollar funds under the above mentioned swap facilities. These thus further developed central banks’ response to a novel aspect of the crisis, its international dimension affecting LOLR and other policies.³⁰ On a more negative side, the Icelandic crisis revealed the potential difficulties of cross border failure, with lack of co-operation among authorities being rife.³¹

There have also been new LOLR policies to address some of the difficulties that have arisen in the earlier period. For example in the UK there was a replacement of Standing Facilities by so-called Operational Standing Facilities with the sole aim of dealing with money market imbalances and not giving support to firms in distress, with penalty rates of 25bp at all times. This responds to a perception of stigma in the use of Standing Facilities in the non-systemic period (Tucker, 2008).³² Emerging market central banks at times decumulated foreign exchange reserves to satisfy banks’ needs for foreign currency.

²⁸ BIS (2008).

²⁹ See BIS (2008), p14.

³⁰ We noted above however that Barings crisis in 1895 involved the French as well as UK central banks.

³¹ The UK authorities even impounded assets of an Icelandic bank under anti terrorism provisions, apparently in an attempt to seek to ensure provision for UK depositors.

³² At the same time, the UK introduced a Discount Window allowing banks to get liquidity at times of stress in the form of government bonds or cash for up to 30 days against a range of collateral, and also a permanent long term repo open market operation against classes of collateral, where counterparts bid separately and against different types of collateral (Bank of England 2008c).

On the other hand, the US Federal Reserve has been more radical in late 2008, when facing systemic risks. It has further widened the boundaries of the traditional LOLR to provide funds direct to borrowers and investors in markets rather than via intermediaries, thus acting as “market maker of last resort” or even “investor of last resort”. This is arguably in line with the paradigm of market liquidity risk argued above, as well as the market based financial system in the US. Note that the intervention is explicitly to bring relief to borrowers and investors in an illiquid market and not, as per Goodfriend and King (1988) using a liquid market to direct funds to institutions in distress. It is to overcome market failure and “breathe life into impaired markets”.

Thus, for example, the Commercial Paper Funding Facility (CPFF) provides a liquidity backstop to U.S. issuers of commercial paper through a special purpose vehicle (SPV) that purchases three-month unsecured and asset-backed commercial paper directly from eligible issuers. There is also the creation of the Term Asset-Backed Securities Loan Facility (TALF), a facility that will help market participants meet the credit needs of households and small businesses by supporting the issuance of asset-backed securities (ABS) collateralised by student loans, auto loans, credit card loans, and loans guaranteed by the Small Business Administration (SBA).

The Fed also introduced a programme to purchase the direct obligations of housing-related government-sponsored enterprises (GSEs) of up to \$100 billion, and up to \$500 billion in mortgage-backed securities (MBS) backed by GSEs. This is “with the view to reduce the cost and increase the availability of credit for the purchase of houses, which in turn should support housing markets and foster improved conditions in financial markets more generally”.³³ However, BIS (2008) note that it also was necessitated by the introduction of guarantees for bank debt as noted above, that widened the spreads on unguaranteed agency debt. Meanwhile, Bernanke (2008) suggests that “substantial” direct purchases of long term Treasury bonds with a view to lowering yields could also be considered, a form of “quantitative easing” of monetary policy.

Under the Money Market Investor Funding Facility, the Fed also acted indirectly to liquify markets by extending loans to banking organizations to finance their purchases of high-quality asset-backed commercial paper (ABCP) from money market mutual funds. This was expected to facilitate participation by depository institutions and bank holding companies in this special lending program as intermediaries between the Federal Reserve and money market mutual funds. Thereby it would enhance the effects of the CPFF but also support directly the money market funds after the Treasury guarantee expired, limiting further redemptions and market impact.

The Fed also acted jointly with the Treasury as LOLR by direct lending to a number of institutions whose failure was thought to threaten financial stability, unlike the other central banks who for the most part left such “solvency lending” in the systemic phase to the fiscal authorities. For example, the Fed provided the 2 year credit line needed for the support of the insurance company AIG, thus extending the safety net further beyond investment banks to insurance companies as well as money market funds. AIG had to be saved because of its involvement in the CDS market and consequent potentially-contagious links to banks. The Fed also participated in the recapitalisation of Citigroup, the bringing of the GSEs into conservatorship and assisted in the resolution of troubled banks such as Wachovia. This is arguably contrary to the view that central banks are advised to avoid such recapitalisations in

³³ Federal Reserve (2008).

a systemic crisis, although the Fed did benefit either from good collateral or a Treasury guarantee.

Federal Reserve Chairman Bernanke (2008) noted the absence of LOLR in the case of the liquidity crisis at Lehmans, and suggests that it was due to lack of a legal framework for resolution of systemic non banks, lack of a potential buyer (unlike Bear Stearns) and inadequate value of assets given the firms' obligations (unlike for AIG). He notes that the authorities obtained greater flexibility in the wake of the later passing of the Emergency Economic Stabilisation Act (EESA), which permitted bank recapitalisation by the Treasury. The implication seems to be that Lehmans would not have been allowed to fail had this Act been in force. Bernanke appears to take the view that moral hazard and the too-big-to-fail problem must wait for the crisis to be over to be resolved, not least in the light of the damage caused by the Lehmans bankruptcy. Such remarks risks diluting any salutary effect on market discipline that could have arisen from the Lehman's failure (i.e. as an illustration of constructive ambiguity), again revealing that moral hazard considerations are not to the forefront when there is systemic risk.

On balance, overall crisis resolution policies in the systemic phase rightly aimed to recapitalise, guarantee liabilities (by fiscal authorities) and provide extensive central bank liquidity (by central banks), until market conditions return to normal. These are classic and appropriate responses to systemic financial crises, 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 (Hoelscher and Quintyn, 2003) and action by fiscal as well as monetary authorities. All of these attempt to minimise damage to the non-financial sector due to credit rationing, as occurred following bank failures in the Great Depression (Bernanke, 1983). We have suggested that in terms of the argument of this paper, the (generally subsidiary) role of central banks did not entail a radical further amendment to the view of lender of last resort over the non-systemic period, the main exception being the expanded role of the US Federal Reserve as “market maker or investor of last resort”. This in turn may link to the more securitised nature of the US financial system, and the more flexible central bank law in the US.

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 on the asset and liability side, supported by adequate capital and robust supervision. Despite these, solvent banks can face liquidity difficulties at times of stress, necessitating liquidity support. As views have 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 Russia/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, as well as threatening institutions that rely on market liquidity for funding or transactions purposes.

As a consequence, extensive changes to the traditional LOLR have been necessary, even during the period of the crisis which in retrospect was non-systemic, 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.

In the systemic period the fiscal authorities stepped in extensively with recapitalisation and guarantees, taking over much of the safety net role from central banks. This is in line with past crises rather than being radical innovations. Equally, most central banks have expanded their liquidity provision but not adapted further from the innovations already introduced in the non systemic period. What has been more radical has been actions by the Fed to support new markets such as those for commercial paper as well as money market funds.

The central banks face a challenge in terms of exit strategies from some of the measures that have been adopted for the crisis. As noted, their balance sheets have been vastly expanded by the liquidity assistance, which is seen by Bernanke (2008) as posing a risk for inflation in the long term. It may also be crowding out the recovery of private sector lending (BIS 2008). They will also need to prevent moral hazard, for example, by retightening collateral regimes to avoid banks having long run incentives to hold less, low quality collateral. The interbank market needs to be reactivated, for example, by reducing term lending facilities when they are no longer needed, and rewidening central bank rate corridors to give banks incentives to lend to each other and not the central bank. The Economist (2008b) suggests that similar issues of generous LOLR holding back revival of publicly traded markets will arise for the European ABS market, that in mid 2008 consisted mainly of securities for collateral with the ECB.³⁴ These problems may have been intensified by the more generous support available after the crisis became systemic in the Autumn.

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 (IMF 2008, Goodhart 2007). A possible example is the new FSA policy announced in December 2008 (FSA 2008), which is likely to include a liquid assets buffer. The FSA assumes banks would be required to hold 6-10 per cent of assets in government bonds. There will also be individual quantitative liquidity adequacy standards (ILAS) for firms based on their being able to survive liquidity stresses of varying magnitude and duration.

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³⁴ The Economist quotes an estimate by JPMorgan that euro 320 billion in eligible mortgage backed ABS were created from August 2007 to June 2008 but only euro 5.8 billion were placed with investors.

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