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## Central Bank Response to the 2007–08 Financial Market Turbulence: Experiences and Lessons Drawn

*Alexandre Chailloux, Simon Gray,  
Ulrich Klüh, Seiichi Shimizu, and Peter Stella*

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Monetary and Capital Markets Department

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**Prepared by Alexandre Chailloux, Simon Gray, Ulrich Klüh,  
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Authorized for distribution by Peter Stella

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**Abstract**

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The paper reviews the policy response of major central banks during the 2007–08 financial market turbulence and suggests that there is scope for convergence among central bank operational frameworks through the adoption of those elements that proved most instrumental in calming markets. These include (i) rapid liquidity provision to a broad range of counterparties; (ii) a congruence of collateral policies with market developments; (iii) an ability to increase the average maturity of liquidity provision; and (iv) central bank cooperation to facilitate the use of cross-border collateral. Flexible use of open market operations was needed to avoid the stigma associated with traditional standing facilities, and allowed central banks to maintain at least basic market functioning. Having a flexible framework, however, requires careful consideration of the desirable limits to market intervention.

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## GLOSSARY

|       |   |
|-------|---|
| ABS   | Asset Backed Security   |
| BoC   | Bank of Canada  |
| BoE   | Bank of England   |
| BoJ   | Bank of Japan   |
| bps   | Basis points  |
| CMO   | Collateralized Mortgage Obligation  |
| EBF   | European Banking Federation   |
| ECB   | European Central Bank   |
| Fed   | Federal Reserve   |
| FHLB  | Federal Home Loan Bank  |
| FRBNY | Federal Reserve Bank of New York  |
| LOLR  | Lender-of-last-resort   |
| LTRO  | Long-term refinancing operation   |
| LTV   | Loan-to-value   |
| MOF   | Ministry of Finance   |
| MRO   | Main refinancing operations   |
| OMO   | Open market operations (a transaction undertaken at the initiative of the central bank) |
| PDCF  | Primary Dealer Credit Facility  |
| PDs   | Primary dealers   |
| PRA   | Purchase and resale agreement   |
| RBA   | Reserve Bank of Australia   |
| RBNZ  | Reserve Bank of New Zealand   |
| RMBS  | Residential Mortgage Backed Security  |
| RMP   | Reserve maintenance period  |
| SF    | Standing facility (a transaction available at the initiative of a commercial bank)      |
| SIV   | Structured investment vehicle   |
| SLS   | Securities Lending Facility   |
| SNB   | Swiss National Bank   |
| TAF   | Term Auction Facility   |
| TSLF  | Term Securities Lending Facility  |

## EXECUTIVE SUMMARY

There is a high degree of consensus that convergence in the basic principles of monetary policy have contributed to improved outcomes in inflation and output volatility worldwide during the last 15 years. These basic principles include central bank operational independence, greater focus on price stability and a commitment to intervening as little as possible in market outcomes apart—of course—from those very short-term markets whose interest rates serve as central bank operational targets. Important to enabling the success of this strategy is a reliance on smoothly functioning money markets and enhanced communication of policy goals.

There has been less convergence on the operational frameworks for monetary policy, which largely reflect historical antecedents—whose differences appeared relatively inconsequential until recent disruptions in money market functioning.<sup>1</sup> Those disruptions confronted these diverse operational frameworks with common challenges whose resolution, while ongoing, provides tentative insights into those elements that provided their respective central banks better scope to respond robustly to events. We believe that these insights should be useful not only to the major central banks involved as they consider longer-term enhancements to their operational frameworks, but also to many other central banks around the world both in strengthening their own frameworks and responding to future shocks which may affect them more directly. A companion piece examines collateral issues in more detail.<sup>2</sup>

In assessing the central bank response to the challenge of restoring normal money market functionality, the following elements were identified as particularly important:

- Systems allowing rapid liquidity provision to a broad range of counterparties allowed the central bank to interpose itself in the gaps created within customary interbank network relationships.
- Systems whose features had evolved in congruence with market developments—in terms of instruments commonly used for secured financing and in risk control measures (pricing, haircuts, valuations—broadly in line with normal market conditions) proved most useful to market participants while limiting the increased exposure of central banks.
- There is clear evidence that the secular trend of banks using less liquid collateral in central bank operations accelerated during the crisis, pointing to the importance of regularly reviewing the adequacy of risk-control measures and limiting scope for undesirable market arbitrage.

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<sup>1</sup> Notwithstanding this general statement, significant changes to the operating framework were undertaken in the United Kingdom in 2006 and are being contemplated in the United States in the advent of legislative changes effective 2011. The foundation of the ECB provided an opportunity to thoroughly consider the operational framework in an environment characterized, initially, by diverse local money markets. The SNB remains the only central bank in the sample targeting a term (three-month LIBOR) rate.

<sup>2</sup> “Central Bank Collateral Frameworks: Principles and Policies,” IMF Working Paper 08/XXX.

- Systems allowing a rapid increase in the average residual maturity of liquidity provision, while preserving the total level of liquidity in the market, permitted an easing in market tensions without an easing in the monetary stance.
- The ability to provide foreign currency liquidity through local operational frameworks at harmonized market prices proved particularly useful in allowing some central banks to respond to the fact that the same forces disrupting national money markets had disrupted the foreign exchange swaps market, and to demonstrate their ability to respond in unison to a truly global market disruption.
- The stigma associated in some countries with credit Standing Facilities carrying a penal interest rate rendered these facilities ineffective through much of the turmoil, suggesting that a different structure is needed in response to market-wide turmoil.
- Market support measures at times risk delaying market adjustment; but may be necessary to avert market collapse. Pricing incentives which motivate the market to return to normal functioning as soon as possible are a necessary part of a central bank's "exit strategy."

Central bank liquidity provision can be successful in many different forms when the money market is functioning well, but certain systemic features proved their worth in coping with market turbulence. Those features, listed above, allowed central banks to support a resumption of market functioning without necessarily changing monetary policy, i.e., ease market tensions without easing the monetary stance, and to do so without introducing material changes to their routine operations. It would behoove all central banks to carefully consider how their individual operational frameworks could be refined to benefit from the lessons that may be learned from recent events and central bank response thereto.

While adaptable frameworks have desirable features, they do not eliminate the need to be clear as to the desirable limits to market intervention. The central bank cannot come to be seen as the market maker of last resort in all markets nor the lender of last (and sometimes: first) resort for all institutions. Flexible frameworks, for example those that accept a wide variety of collateral, place a burden on the central bank to frequently examine both the breadth and depth of its collateral pool but also the suitability of its pricing policy and risk mitigation measures, so that they are not materially out of line with secular market trends and best practice. To do otherwise would risk distorting market outcomes and potentially entice the financial system to operate with less liquidity than is prudent—anticipating that the central bank would be quick to make a market at the first sign of stress. The aim is to strike the right balance between being supportive in a stressed market environment without sowing the seeds of future crises during normal times.<sup>3</sup>

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<sup>3</sup> This is clearly expounded in the Governor of the Bank of England's submission to the UK Treasury Committee prior to an appearance on September 20, 2007.

## I. GENERAL CONSIDERATIONS

*“Any sudden event which creates a great demand for actual cash may cause, and will tend to cause, a panic in a country where cash is much economized, and where debts payable on demand are large.”*

*“Very large loans at very high rates are the best remedy for the worst malady of the money market when a foreign drain is added to a domestic drain.” [emphasis added]*

*“The peculiar essence of our banking system is an unprecedented trust between man and man: and when that trust is much weakened by hidden causes, a small accident may greatly hurt it, and a great accident for a moment may almost destroy it.”*

*Quotes are from Walter Bagehot’s “Lombard Street,” published 1873.*

Ever since Henry Thornton (1802) and Walter Bagehot (1873) laid the groundwork for the study of emergency liquidity assistance by central banks, views have evolved, in particular during and in the aftermath of major financial crisis. In this respect, the financial crisis that started in the summer of 2007 is no exception, as it has not only resulted in significant – though possibly temporary - changes to some central banks’ operational frameworks, but also in an intense debate about the effects and medium- and long-term desirability of these changes. The purpose of this paper is to review central banks’ response to the crisis, draw lessons the crisis has taught, and to critically assess the future of operational frameworks in light of recent events and more fundamental conceptualizations of good practice in central bank liquidity management.

The well-known popular version of Bagehot’s recommendation for a liquidity crisis is “to lend freely, against good collateral, and at a high price.” In some measure, the response of major central banks to the market turmoil following the sub-prime market problems over the summer of 2007 has been in line with this old recommendation. Different legal, operational and cultural backgrounds mean that the precise understanding or implementation has varied from country to country. Three important glosses are needed:

- (a) First, as a *generalization*, what differentiated this crisis from a “conventional” liquidity shock was that the market wanted not more reserves at the central bank<sup>4</sup>, but a different form of central bank credit (longer-term), and more liquid assets. (Notwithstanding, in those countries where reserve holdings are voluntary and remunerated at or close to the policy rate - notably the UK and Australia – there *was* a substantial increase in demand for reserve balances.)

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<sup>4</sup> Other than during the first few days of the market turmoil in August 2007.

- (b) Second, the definition of *good* collateral has come under scrutiny, as issues in addition to credit risk have become more prominent—in particular, liquidity risk, and the impact on markets of the central bank’s definition of eligibility.
- (c) Third, Bagehot’s recommendation for high interest rates relates to a situation with a “foreign drain” (gold bullion being taken out of the country), when high rates were needed to reverse a balance of payments flow. This particular rationale may have little relevance in a floating exchange rate regime. Moreover, if there is a generalized problem and the market has to borrow substantially from standing facilities, that SF rate will heavily influence the market, and indeed may become the “market” rate. Raising the rate in such a situation might only serve to worsen the crisis. In any case, reputational concerns related to the stigma associated with standing facilities at penalty rates inhibited the use of this instrument.

While central banks have always entertained numerous and often related objectives during a crisis, these questions have come to the fore in this case. A major goal has been to “restore normality” to the money markets while preserving the monetary policy stance. Thus the goal of operations has been to keep the overnight (or short term) interbank<sup>5</sup> rate at the targeted level, adjusting liquidity as needed to achieve this. However, the reason for targeting the overnight rate is its impact on the rest of the yield curve which, in turn, has the primary role in the transmission of monetary policy signals. If this relationship changes, weakens or even breaks down in time of stress, central banks need to ask whether the target should change, or whether they should also seek to influence other parts of the yield curve in order to support the monetary policy target.<sup>6</sup> Conceptually, however, one can separate this question from that of whether one needs to change the monetary policy stance.

The crisis has highlighted that the line between troubled markets and troubled institutions is not easily drawn. Recent academic debates (see, for example, the contributions in Goodhart and Illing, 2002) have focused on whether modern financial systems guarantee the continued functioning of interbank liquidity distribution networks and place central banks in a position where crisis support can rely mainly on open market operations. Those assertions have been questioned during the recent crisis, and whether to deal with troubled markets, troubled institutions, or both, has become a crucial element in policy debates.

Where a particular institution has faced problems (most publicly, Northern Rock in the United Kingdom and Bear Sterns in the US), the central bank can choose whether or not to supply liquidity and at what price. If an institution is deemed systemically important, or

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<sup>5</sup> Most major central banks target the very short-term unsecured interbank rate (measured e.g., by the weighted-average of actual overnight interbank trades, or by the BBA Libor quotations); but they may operate in the wider money markets to achieve this e.g., the Fed’s repo operations with nonbank Primary Dealers.

<sup>6</sup> The Swiss National Bank practice of targeting the 3 month interbank rate, while operating predominantly through short-term repo, arguably worked very well in these circumstances. Some central banks indicated that the increase in term rates reduced or eliminated the monetary policy need to tighten (short-term) policy rates.

solvent but illiquid, a central bank may lend, usually at a penalty rate. In this case, the penalty rate must be borne by the particular institution. It is not transmitted to the rest of the market as the institution in trouble will be a pure price taker and so should not push market rates above the targeted level.

In the face of *widespread market uncertainty and heightened concerns about counterparty credit risk*, the demand for central bank balances (high powered money, or central bank liquidity) might be expected to increase and to become more unstable; and—assuming the central bank wishes to avoid failure in the payment systems—it will have to accommodate this increase in demand. It can supply the additional funds at or around the targeted short-term interest rate, or at its standing credit facility (sometimes known as Lombard, or discount window) rate. Other things being equal, the former should maintain market rates at the targeted level, the latter would see short-term market rates rise. But the central bank has little choice as to whether to supply liquidity or not. In fact, the demand for additional central bank balances during the recent turmoil was very short-lived—a few days during a few episodes.<sup>7</sup> When credit concerns predominate, markets segment: some banks hoard excess central bank reserves, preferring low or zero return to the risk of counterparty default. This behavior has been observed in a number of emerging markets in recent years, but did not characterize the recent turmoil in developed markets. Broadly speaking central banks did provide additional funds at the target rate, as the demand for additional liquidity reflected a generalized loss of confidence. The additional injection of central bank reserves was soon withdrawn, and replaced by the provision of liquidity in a different form. The recent turmoil also indicates that, in the face of an increased instability in market demand for reserves balances, the central bank may need to increase the frequency of its short-term OMO, and also of its communications with the market.

Does the central bank's operational framework and organizational role in financial safety nets allow it to easily distinguish between generalized and specific cases? While this paper does not opine on the allocation of responsibilities for financial supervision and regulation among entities, it is clear that the central bank needs to be well informed about financial market developments and potential threats to systemic stability. Probably most important is that the central bank be correctly appraised as to the solvency of any borrowing institution and take sufficient collateral to protect itself against risk.

While central banks should meet an increased demand for liquidity in the form of central bank reserves (where it is the monopoly legal supplier), a rather more difficult matter to determine is how much, for how long, and under which modalities; and whether it should provide other forms of liquidity, where it may not be the monopoly supplier. The next section surveys the numerous challenges faced by central banks: uncertainty over the scale and maturity structure of liquidity needs; non-linear breakdowns of liquidity distribution

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<sup>7</sup> The United Kingdom and Australia are clear exceptions to this generalization. In the United Kingdom, the ceilings for voluntary remunerated contractual reserves were increased in May 2008 (in practice the ceilings are rarely restrictive; the previous ceilings had permitted a large increase in voluntary reserve holdings from September 2007).

networks; and trade-offs with respect to collateral policies. It also provides an overview of major differences in current operational frameworks.

The paper proceeds as follows. One of the crucial but often underestimated characteristics of liquidity crises is the exceptionally high degree of uncertainty central banks face when making far-reaching decisions. Section II therefore describes and analyzes these uncertainties, both in general terms and with respect to the financial crisis that started in the summer of 2007. Section III reviews the developments since the start of the crisis, with a focus on the actions central banks undertook and the motivations and potential short- and long-term impact of these actions. Section IV discusses exit strategies, which have become an important issue, not least because of the unusually prolonged nature of the turmoil. Section V summarizes the lessons the crisis has so far provided for the design of central bank operational frameworks, distinguishing between lessons for reserve management, the optimal breadth of counterparty and collateral pools, the design of discount window arrangements in the presence of pronounced perceptions of stigma, and the international dimension of liquidity support operations.

## **II. UNCERTAINTIES**

### **A. Market Demand for Liquidity**

In its day-to-day liquidity management, a central bank aims to ensure that the market has a sufficient supply of liquidity, but not an oversupply. Too little will push short-term rates above the target level, and too much will see them fall. In normal times, the central bank should have a reasonable idea of market liquidity needs; but it cannot know precisely how much demand will change in the face of a shock. Its reaction will depend on the consequences of being wrong, the nature of the shock and on how tightly the central bank wants rates to fluctuate around its target.

In practice, many central banks have focused their forecasts largely on “autonomous” factors of liquidity rather than demand by commercial banks for central bank reserve balances. Autonomous factors comprise changes in the central bank’s net foreign assets; in net government balances at the central bank, and in currency in circulation. It tends to be assumed that the required or agreed level of reserve balances targeted for a given reserve maintenance period equates to the daily demand for reserves balances. The recent turmoil has indicated a need also to forecast the demand for liquidity and in some cases the pattern of demand for liquidity within a reserve maintenance period.

At times of market stress, central banks are likely if anything to err on the generous side. The consequences of undersupply—a disrupted payments system and, potentially, a major loss of confidence in banks—are worse than those associated with an excess supply—a softening of short-term interest rates (although this could be misinterpreted as a monetary policy signal). If the central bank can pay interest on deposits, and particularly if it has in place a standing deposit facility, then the impact of oversupply of liquidity on interest rates will be bounded. The ability of the central bank to provide (or absorb) the right amount of liquidity will be

enhanced to the extent more flexibility is provided by reserves averaging<sup>8</sup>, in addition to an accurate liquidity forecast.

## **B. Functioning of Liquidity Distribution Networks**

Funding uncertainties at individual financial institutions can lead to breakdowns in the way liquidity flows through the system. Traditionally, the range of counterparties has differed widely among major central banks, reflecting market size, the structure of operations, and historical differences. But in times of stress, the size and composition of a central bank's group of counterparties becomes more important as the number of routes through which liquidity may flow is reduced. Central banks may not be able to rely on the market to distribute liquidity among banks, and may need to operate more directly with a diverse group of counterparties.

In a small market, it is clearly possible for the central bank to deal directly with all credit institutions. But this would not be possible in the euro area or the United States. In the euro area, dealing with a large number of OMO counterparties is facilitated by the use of T+1 settlement for OMO and uniform treatment of collateral; the United States (and also Australia) deal for T+0 settlement and at a different price in OMO depending on the collateral taken, making it hard to deal with a large number of counterparties. There is a case for dealing with as large a number of OMO counterparties as is administratively practicable. Automation and integration of systems clearly increases capacity to manage the administrative burden, although the cost of maintaining some of the hardware used—e.g., dedicated and encrypted data lines—might preclude access by occasional users.<sup>9</sup> On the other hand, if increasing the number of OMO counterparties has implications for the definition of eligible collateral and the speed of operations, at some point a marginal increase in the number of counterparties may be more than outweighed by the disadvantages of broadening the collateral pool and making other changes to the framework.

Decisions with respect to counterparty eligibility closely relate to other areas of the operational framework. For instance, the ECB can work with a wide group of counterparties for regular OMO with T+1 settlement, because the high level of remunerated reserves together with averaging<sup>10</sup> provides a lot of short-term flexibility for all commercial banks in the management of liquidity. In case of need, fine-tuning operations for same-day settlement are conducted with a smaller group of around 60–70 credit institutions. A number of central banks, both in developed and emerging markets, take advantage of the flexibility which reserve averaging can provide to undertake OMO periodically and at term (typically 7-14

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<sup>8</sup> The UK practice of operating a range around a central (voluntary) reserves target adds flexibility; and this flexibility can be further increased by widening the range (as was done in the UK).

<sup>9</sup> In some circumstances the central bank might need to simplify the minimum access requirements.

<sup>10</sup> Averaging means that, within the reserves maintenance period, banks can be relatively indifferent between funds today and funds tomorrow. If there is an end-of-day constraint, T+0 rather than T+1 may make a significant difference.

days) rather than daily operations with very short maturities. In the United States, the current inability of the Fed to remunerate reserves means in practice their level is low, which puts more pressure on the Fed to operate daily with a same-day settlement basis. This, taken together with its collateral pricing policy, would be difficult with 1,000 counterparties.<sup>11</sup> The very low level of reserves held in Canada also has implications for the need to be able to operate quickly; but in a small market this is manageable, so Canada does not face the same trade-off issues as the United States.

### **C. Collateral: Adverse Selection and Gresham's Law<sup>12</sup>**

When injecting liquidity, whether intraday for payment system purposes, short-term or long-term OMO, or overnight in standing credit facilities, it is standard practice for central banks to take collateral. Credit risk is mitigated by dealing only with institutions believed to be creditworthy, and by appropriate selection of collateral. Central banks do not take collateral with a view to re-using it during the life of the operation, but primarily to protect themselves against credit risk, and have tended to focus on the value of collateral rather than on its liquidity. However, liquidity risk is also important. If the collateral is of good credit quality but not marketable, the central bank's operational flexibility could be constrained if the borrower cannot repay a substantial credit (in relation to the central bank's balance sheet size) as that portion of its assets would be tied up.<sup>13</sup>

Three areas in which major central banks differ are: (i) breadth and depth of collateral pools; (ii) whether the pool is the same for intraday credit, OMO and SF; and (iii) whether there is a pricing difference. These three are explored in some detail below.

It is necessary to distinguish between collateral taken as part of an individual bank rescue, and collateral taken in the course of operations with the market as a whole. In the case of a bank rescue, the central bank can decide how much credit to provide, or indeed whether to provide it at all; and it may have the explicit prior backing of the Ministry of Finance (MoF), so that any losses would be fiscalized. The size and the duration of the impact of default can thus be contained. But there is no such MoF backing for normal operations. It would be

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<sup>11</sup> Evaluating several hundred bids against different collateral pools and at varying market prices (the tranching approach) would be a much more complex process than, say, ranking the same number of bids by the interest rate bid against a single collateral pool. Moreover, the back-office task of dealing with several hundred transactions for same-day settlement would be more onerous than dealing with up to 20.

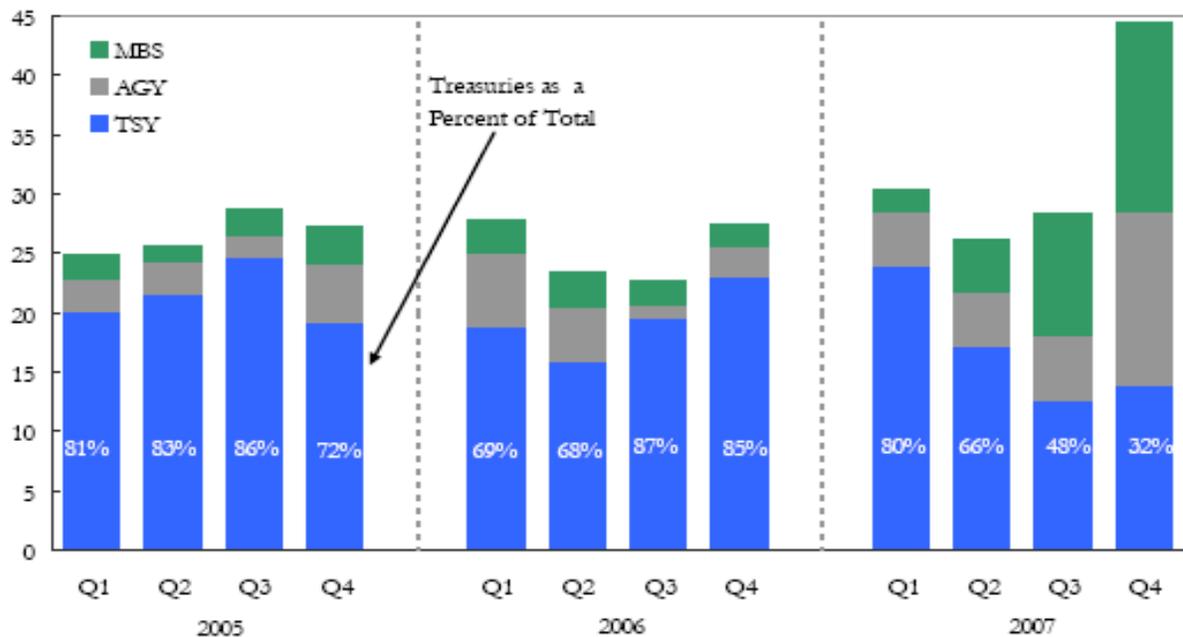
<sup>12</sup> Gresham's law is commonly stated: "Bad money drives out good," that is, when there is a legally determined rate of exchange between two currencies which does not equal the market determined relative values, agents will present the currency less valued by the market (bad money) when making official payments.

<sup>13</sup> The issue of central bank collateral frameworks is discussed more extensively in Chailloux, Gray, and McCaughrin, forthcoming IMF Working Paper, "Central Bank Collateral Framework: Principles and Policies."

natural then to expect the list of eligible collateral for market-wide operations (particularly OMO but also SF) to be narrower.<sup>14</sup>

Commercial bankers, when considering turning to the central bank for finance, compare the cost of central bank funds to alternative sources that may be tapped using the same form of collateral. The availability of market funding, as well as the types of assets they hold and their liquidity position are key factors in the determination of commercial bank bidding behavior. As a rule, treasurers strive to place with the central bank collateral having the lowest “opportunity cost.”<sup>15</sup> All securities having a greater value (i.e., can be used to obtain cheaper funding) on the repo market will be used for refinance via market repos; otherwise the commercial bank loses the spread between the central bank rate and the (lower) interbank repo rate. Collateral selection is therefore made opportunistically.

Figure 1. Composition of Collateral—Federal Reserve  
Quarterly Average Levels of Total RPs Outstanding by Collateral Type  
(in U.S. billion dollars)



Source: “*Domestic Open Market Operations During 2007*,” Markets Group of the Federal Reserve Bank of New York (February 2008).

Opportunities for funding cost arbitrage tend to lower the average quality of collateral provided to the central bank, in particular in situations where central bank price discrimination, haircuts and/or risk control measures drift in the direction of being more

<sup>14</sup> While in principle a Ministry of Finance will normally recapitalize a central bank if need be, in practice this can take a long time—in some cases decades; and the impairment of the central bank’s balance sheet clearly inhibits the implementation of policy in some countries. See Lönnberg and Stella (2008).

<sup>15</sup> The administrative costs of utilizing nonsecuritized collateral can be a significant factor in this.

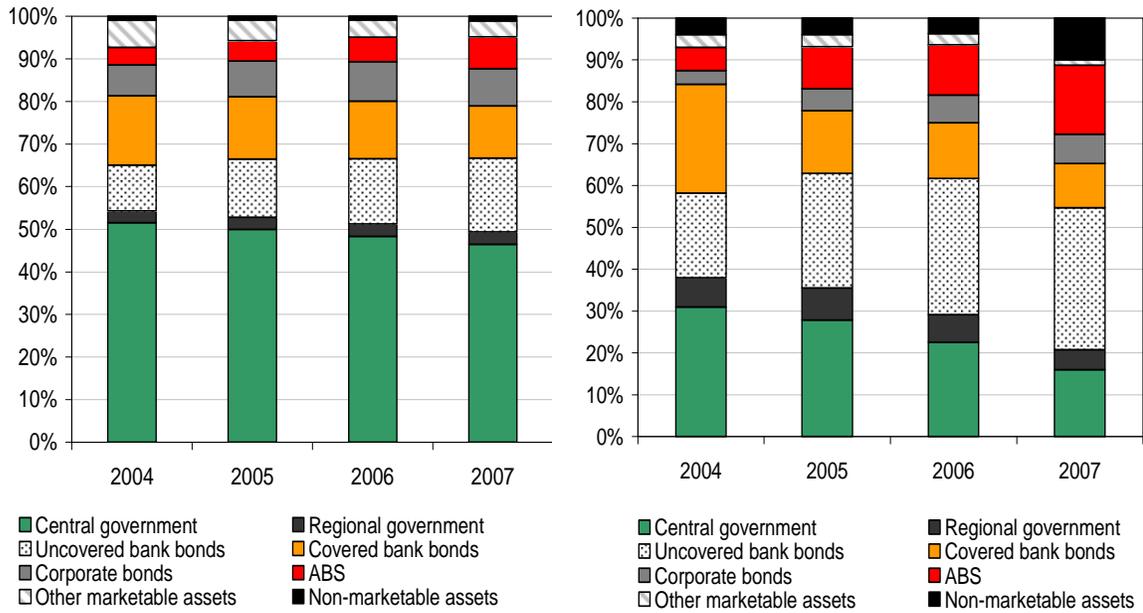
accommodative than market practice. We refer to this as “Gresham’s law of collateral,” see Figures 1-3. The operation of Gresham’s law of collateral can be viewed from several angles. As with any effective market intervention, it tends to change relative prices in the market, in this case increasing the inherent liquidity value of those instruments favored, and so leading to “excess” production of those instruments and less production of or demand (by banks) for “naturally” liquid instruments. Taken to an extreme, the central bank becomes a major supplier of liquidity and purchaser of “illiquidity.”

Another impact of Gresham’s law is on the overall quality of the central bank balance sheet. The accumulation by the central bank of illiquid assets may impact balance sheet flexibility. As long as the borrower repays on schedule, the central bank never needs to utilize the collateral; it is only in the (it is to be hoped very rare) case of default, that the importance of the collateral’s liquidity materializes. But in such circumstances, if a borrowing institution runs into difficulties, a large volume of illiquid assets could constrain the central bank’s ability to undertake monetary operations, whether by reducing its ability to engage in a sufficient volume of operations with healthy institutions or forcing it to expand its balance sheet. On the other hand, Gresham’s law—in as much as it presumes a steady policy—allows the market to quickly respond to shocks to market perceptions of instrument liquidity, thereby allowing the market to economize on the use of liquid instruments which can be very helpful in avoiding interbank market seizure.<sup>16</sup> Consequently the tradeoffs to allowing its operation should be carefully assessed.

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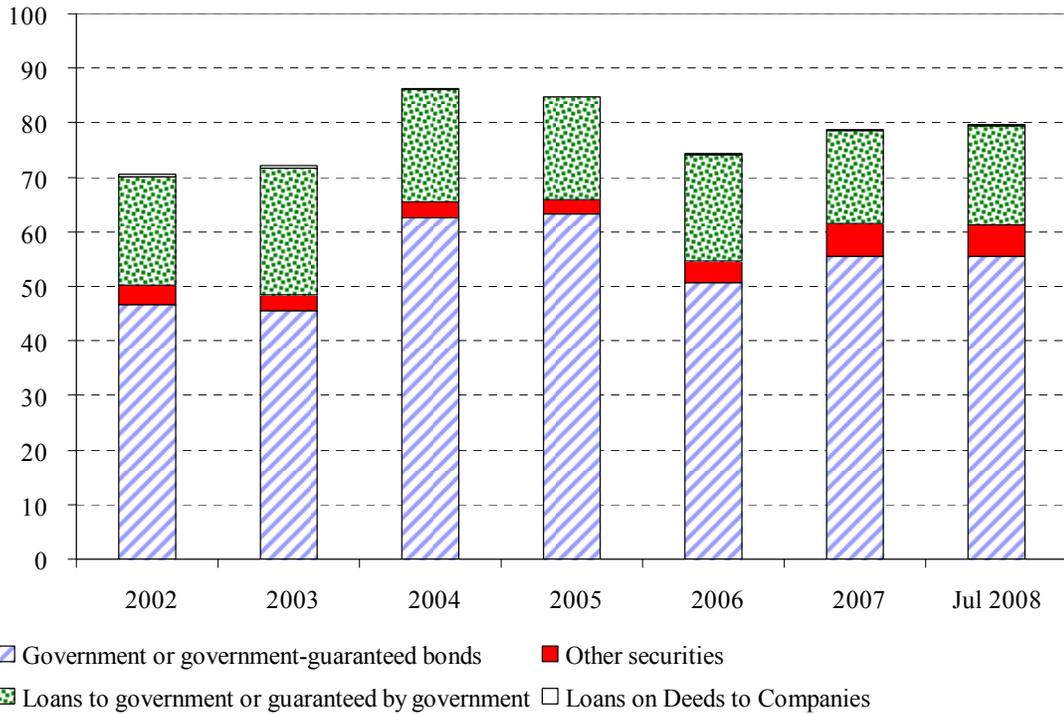
<sup>16</sup> There is an analogy with the benefits of Gresham’s law in a bimetallic standard. An upward shock to gold prices in a gold standard regime would lead to deflationary pressures as the only way for the value of the numeraire to rise is for prices to fall. The alternative use of silver dollars as numeraire allows prices to remain stable mitigating deflationary pressures. Naturally, gold would be hoarded or traded at a premium to the official gold/silver fixing and over time a shortage of silver dollars as means of payment might require monetary policy action. If the government continued to make payments in gold and receive revenues in silver at the parity, hidden deficits would arise and eventually the parity would have to be changed.

Figure 2. Eligible Collateral by Asset Type, (LH) and Collateral Used (RH)  
(in percent, annual averages)



Source: European Central Bank, 2007 Annual Report.

Figure 3. Composition of Collateral Used for Temporary Operations—Bank of Japan  
(Year-end, in JPY trillions)



Source: Bank of Japan.

### **Breadth and depth of eligible collateral pools: OMO and SF differentiation**

Broadly speaking, the U.S. Fed, the Bank of Canada, and the RBA have a narrow definition of assets for OMO (domestic currency good quality securities); and in the case of the first two a wider definition of collateral for SF. The Bank of England and the Swiss National Bank have a broader definition of collateral for OMO, but one that is essentially limited to securities meeting a certain minimum credit-rating; and uses the same definition for SF (in this case narrower than the United States). The Eurosystem<sup>17</sup> and Bank of Japan (BoJ) have a broad definition of collateral, and also use the same definition for both OMO and SF.

Why take a broader category of collateral for SF than for OMO? A narrow pool of high-quality collateral may be sufficient to provide the bulk of the market with the bulk of its needs, most of the time, through OMO. But some banks which do not normally hold such collateral may have occasional need to borrow from the central bank. A broader eligible list for SF can allow access to a wider range of counterparties, for occasional use, without requiring them to manage a collateral pool which does not conform to their normal business. (Banks managing reserve accounts, or with direct access to the wholesale payment system, arguably need potential access to credit SF but not necessarily OMO.) Restricting OMO access to a narrower range of best quality collateral provides an incentive to central bank counterparties to hold such collateral without overly restricting access to the more expensive, “safety valve” SF.

If the central bank wishes to transact OMO at market rates rather than at a policy-determined rate, it may for that reason need to restrict such OMO to securities for which a market price is readily determined. SF are nearly always conducted at a policy rate, so would not be subject to the same restriction.

### **Pricing differentials**

Pricing—the interest rate charged for borrowing—is different from haircuts. Haircuts provide protection against anticipated credit risk, and will always vary between different types of collateral; but may only affect the borrower’s behavior if it is collateral constrained.<sup>18</sup> The Eurosystem, the United Kingdom, the BoC, the BoJ and the SNB do not price OMO and SF differently depending on the type of collateral offered. The U.S. Fed and the RBA do. There are implications arising from both choices.

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<sup>17</sup> The Eurosystem comprises the ECB itself, plus the National Central Banks of euro area member countries.

<sup>18</sup> In some cases the use of an appropriate haircut may have an impact on the type of collateral offered; but this is unlikely to be substantial where a very wide definition of collateral is accepted. If a bank can effectively pledge its loan book to the central bank, it is unlikely to face a collateral constraint. But with a narrower collateral definition, or if the administrative costs of using less liquid collateral are passed on to the borrower, the ability of or incentives for banks to provide lower quality assets may be reduced.

As noted earlier, for a given borrowing rate, banks have an incentive to provide the lowest quality acceptable collateral to the central bank because of the opportunity cost involved. It is not that they expect it to be loss-making, but because it leaves them with better quality collateral for (potential) use in the market—which does operate price discrimination based on collateral type—thus lowering their overall cost of funding (and/or increasing leveraging). This may be particularly problematical where the definition of acceptable collateral is very wide; and if the central bank does not impose counterparty collateral limits.<sup>19</sup>

If central bank lending rates take account of the opportunity cost of the collateral used, the problem of adverse selection should be reduced. Market pricing should approximate opportunity cost (for the market as a whole, rather than for an individual institution); and should track changes in relative opportunity costs. But by definition, this pricing can only be used for traded instruments.

#### **D. Maturity Structure of Liquidity Demand**

As the market turmoil continued, it became clear that the breakdown in term-funding markets was not quickly going to end. Many banks sought not more central bank money, but longer-term central bank money. In their asset-liability management, banks found that term funding from the market evaporated, and, in order to reduce the impact on their liquidity mismatch, sought to replace it with term funding from the central bank. All of the major central banks responded to this, providing an increased proportion of their market funding in the form of longer-term (one to three month) loans.

This also raises questions about the balance of maturities in the central bank's lending. A certain volume of lending arguably needs to be undertaken at or around the policy rate (this is the very short-term lending, normally up to 7-day maturity, other than any SF lending); and the minimum size may need to increase when markets are unsettled, in order to strengthen the implementation of the policy rate. But market demand for longer-term borrowing from the central bank (which represents a longer-term asset for the central bank) may also increase in troubled times. There is no science to calculating what volume of lending, and which maturity, may be needed to guide the markets and avoid yield-curve distortion caused by illiquidity premia; but it is clear that central banks need to monitor the balance sheet impact of current and likely future operations in order to ensure that they can continue to implement effectively the desired monetary policy stance as well as undertaking any needed financial stability interventions.

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<sup>19</sup> The ECB falls into this case. However, while it does not set counterparty or collateral limits, in practice it may find that no one counterparty accounts for a substantial part of its lending (because it operates with several hundred counterparties), whereas central banks operating with 10-20 counterparties would have to be more concerned about such limits.

### III. ANALYSIS OF RECENT DEVELOPMENTS

This section looks at the areas of liquidity management, counterparties, collateral, term operations, stigma and cross-border liquidity, considering how current operational structures impacted different markets during the 2007-08 market turmoil.

#### A. Liquidity Management

Where required or contractual reserves must be held by commercial banks, on average, over a given period, central banks need to forecast and manage the demand for and supply of reserve money sufficiently accurately to stabilize short-term interest rates. The different reserve holding structures in the U.S., the euro area and U.K. produced different results. In Australia and Canada, where there are no required reserves, the central banks arguably had a greater degree of freedom, but less of a cushion in case their forecast was substantially wrong.

- (a) The U.S. Federal Reserve cannot (yet) pay interest, and banks have an incentive to manage their balance sheets in such a way as to minimize balances held at the Fed.<sup>20</sup> The lack of a liquidity cushion meant that, when the Fed injected reserve balances early on, the U.S. market subsequently found itself with “burnt” reserves<sup>21</sup> and overnight rates fell below the targeted Fed funds rate.
- (b) The Eurosystem has a longer reserve maintenance period, a much higher level of reserve balances and the ability to pay interest on short-term deposits. The Eurosystem supplied a substantial amount of additional liquidity in the first few days of the crisis; but was able to offset high balances at the start of a maintenance period with lower balances later, both by reducing the size of later MROs and the use of liquidity-absorbing fine-tuning operations, to keep the market as a whole at the targeted level on average. Burnt reserves were minimal, and short-term euro interest rates stayed closer to the (implicit) targeted level. The Eurosystem varied the pattern of supply of reserves within each maintenance period [see Figure 4], providing reassurance to banks that adequate liquidity would be available but without reserves balances running uncomfortably low.
- (c) In the United Kingdom, the Bank of England (BoE) showed a greater willingness to allow short-term rates to rise to the standing credit facility rate, and there was no immediate injection of additional liquidity. But the banks were able to increase the level of voluntary, remunerated reserves from the September maintenance

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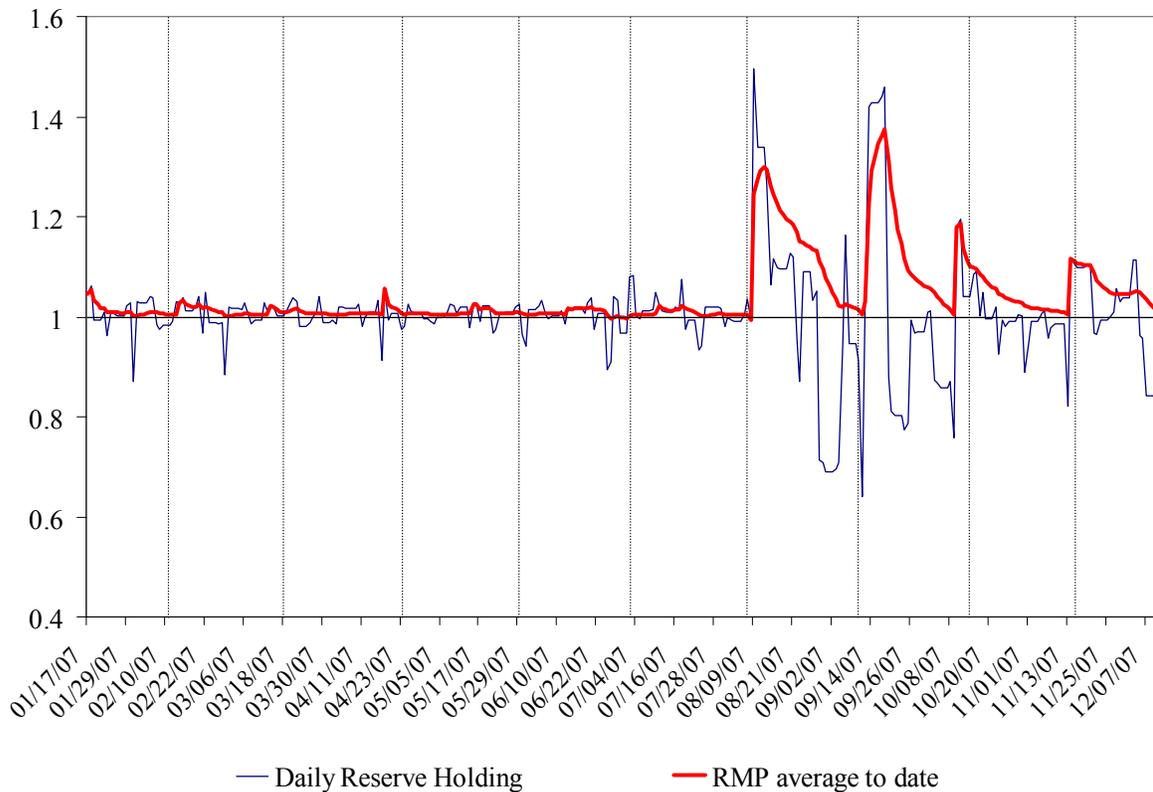
<sup>20</sup> The bulk of required reserves are met by holdings of vault cash.

<sup>21</sup> In a reserve averaging system, if a bank overfulfills its reserve requirement before the end of the maintenance period, then, since it cannot hold negative balances and the excess reserves are not remunerated, they cause an opportunity loss. The excess is sometimes referred to as “burnt” reserves.

period to provide more flexibility in liquidity management. Moreover, the BoE's system incorporates a range, rather than a specific target, for reserves. By widening the target band, the BoE substantially eased short-term liquidity management strains.

- (d) Interestingly, these different reaction functions were not mirrored in a difference in standing facility rates (which could be interpreted as an ex ante indication of the central bank's willingness to tolerate short-term interest rate volatility). The U.S. primary discount window rate, the ECB standing credit facility and the BoE standing credit facility were all set at 100bp above the policy rate. But the Fed and the ECB intervened before market rates approached this level.

Figure 4. Eurosystem Daily and Average Reserve Holdings



Source: European Central Bank.

### **Box 1. Reserve Flexibility through Target Bands in the United Kingdom**

The U.K. system, with a wide target band, could be viewed as providing banks with a synthetic option for forward term borrowing at the expected policy rate, and should in theory be more effective than a simple promise by the central bank to provide adequate liquidity to the market. Normally, the agreed level of reserves must be hit within 1 percent of the average targeted (and, as in the euro area, targeted reserves are remunerated at the policy rate). This flexibility was substantially increased after the onset of the market turmoil, effectively removing much funding uncertainty.

Assume the range is set at  $\pm 30$  percent.<sup>22</sup> A bank which normally holds £1 billion in reserves knows that at some point during the maintenance period it may need to borrow an additional £1 billion (e.g., it might expect a 50 percent probability of having to provide liquidity to a structured investment vehicle (SIV)). For payments purposes, it may be reluctant to hold much less than £0.5 billion; and cannot be certain of obtaining additional funds at any given open market operations (OMO) round (since bids may be prorated, depending on the level of overall market demand), nor of borrowing at a rate close to the Bank Rate in the market. It could increase its target reserves to £1.25 billion, and aim to fund up to £1.5 billion at some point during the first week, either at the OMO or in the market if conditions are suitable. If it runs the whole period at £1.5 billion, the full amount will be remunerated at the Bank Rate. If during a two week period its average balance drops to £0.5 billion, so that its average over the month is £1 billion, the full amount is still remunerated. Thus whether it needs to provide the £1 billion in liquidity to the SIV, and regardless of when during the maintenance period, the reserves funding costs should be around the Bank Rate.

This additional flexibility provided to individual banks could make overall liquidity management more uncertain for the central bank. If banks are on target for the center of the band in the first 3 weeks of the reserves maintenance period, the target range for the final week would be very large (since the  $\pm 30$  percent range applies to the maintenance period as a whole). In the United Kingdom, the central bank explicitly targets the mid-point of the band. This, together with end-period fine-tuning, underpins expectations that the appropriate amount of reserves balances will be supplied, and diminishes any scope for large banks to take advantage of a large position.

### **B. Distribution Networks and Counterparties**

Two main issues have been raised with respect to the relationship between the structure of distribution networks for central bank liquidity and the effectiveness of crisis management arrangements. First, the effectiveness during distressed market conditions of liquidity support to markets in a system dominated by a few key central bank counterparties has been

<sup>22</sup> In the United Kingdom the band was widened to  $\pm 37.5$  percent for the reserve maintenance period (RMP) ending in September 2007, to  $\pm 60$  percent for the RMP ending in October, and subsequently reduced to  $\pm 30$  percent for the RMPs ending in November, December, and January 2008.

questioned. A hub-and-spoke model may, in times of distress, lead to bottlenecks that shut off parts of the system from access to funds provided by central banks.<sup>23</sup> Second, some observers have questioned the competitive neutrality of such arrangements, arguing that, in times of distress, proximity to the central bank provides more extensive implicit insurance against liquidity events—as well as profit opportunities. From an operational perspective, this raises the following policy questions:

- Should the list of eligible counterparties for OMO be as long as is administratively practicable? Should eligible counterparties be subject to more intrusive information revelation requirements?
- Should eligible counterparties be required to participate at least occasionally in OMO, to ensure their readiness in times of distress?
- How far can systems with few counterparties employ direct or indirect market-making obligations to ensure adequate liquidity redistribution in all market conditions?
- Do central banks have sufficient information on overall network topologies, i.e., on the flow structure of liquidity redistribution?

Existing counterparty arrangements have evolved historically, in the context of other money-market characteristics, and trade off multiple objectives. Usually the number of counterparties eligible for OMO is lower than the number of institutions with access to standing facilities, in some cases substantially so (see Table 1 below). In very large banking systems, the administrative intensity of counterparty management and the need to screen and closely monitor eligible institutions—and even the mundane operational issues involved in dealing with a large number of OMO counterparties—implies that limitations will necessarily be present. Additional factors constraining an extension of eligibility can be the nature of the reserve requirement regime and differences in settlement arrangements.

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<sup>23</sup> Independently from emergency liquidity support operations, a money market network in which only few nodes are directly connected to the central bank might expose banks relying on intermediation through counterparties to funding risks.

**Table 1. Counterparty Arrangements**

|            | OMO   | SF                       | Remarks  |
|------------|---|--------------------------|--|
| FED        | 20 primary dealers  | 7500 credit institutions | OMO counterparties are Primary Dealers   |
| Eurosystem | 1700 banks  | 2400 credit institutions | 300–500 banks participate regularly in OMOs ; ad hoc fine tuning operations are open to fewer than 100 of the OMO counterparties   |
| BoE        | banks and securities firms (number not published)           | 60 banks                 | Changed size and composition of counterparty pool in 2006  |
| BoC        | 13 primary dealers  | LVTS members (14)        | Pool of primary dealers was extended by two in 2005<br>The majority of banks are not LVTS members.   |
| RBA        | Members of the Reserve Bank Information and Transfer System | Around 60 banks          | Around 15 banks participate regularly in OMOs  |
| SNB        | On average 19 banks participate in regular repo operations  |                          | 115 banks have access to the SNB's open market operations facility, of which 29 are located abroad. In 2007, 49 banks (21 located abroad) participated at least once in repo auctions. |
| BoJ        | 150 banks and other institutions                            |                          | As of 2004; Counterparty pool broadened repeatedly. Counterparties include foreign banks, securities firms, money market brokers   |

Source: Federal Reserve; Eurosystem; Bank of England; Bank of Canada; Reserve Bank of Australia; Swiss National Bank; and Bank of Japan.

The Fed has a narrow range of OMO counterparties. In normal times, central bank credit flows easily through the PDs to the rest of the market; but in stressed times the narrow group of OMO counterparties proved to be a bottleneck. Fed operations are same-day settlement, in part because the low level of reserves means that averaging cannot easily take the strain of liquidity shocks: the use of a restricted number of counterparties facilitates this. In countries characterized by a lower degree of competition and possibly market segmentation, the use of a restricted group of OMO counterparties could pose problems even in normal times.

The Eurosystem regularly deals with several hundred OMO counterparties. This is facilitated by the use of T+1 settlement for OMO and uniform treatment of a wide range of collateral: these factors increase the amount of time available for the relevant back-office work, and reduce the administrative complexity involved.<sup>24</sup> Credit risk is minimized by controlling both the quality of the counterparties and of eligible collateral. In some countries, expanding both counterparties and eligible collateral—beyond a certain point—could lead to a deterioration in risk control if the central bank does not have a sufficient number of skilled staff to handle the additional workload.

<sup>24</sup> The use of pre-pledging of collateral allows some of the administrative work to be undertaken well in advance of OMO.

In the United Kingdom, banks and securities houses can opt to be OMO counterparties; and banks can opt to hold reserve accounts and have access to standing facilities. An important rationale for the money market reforms introduced in May 2006 was to increase the number of counterparties, so as to strengthen competition and ensure a better feed-through of the policy rate to the market in normal times, and to avoid a counterparty bottleneck in stressed times.

As evidenced by the high participation in the Fed's Term Auction Facility (TAF), particularly early on,<sup>25</sup> a broadening of the pool of counterparties has the potential to ease market strains (Table 2 and Box 2). This insight has also informed earlier moves by other central banks to widen access to OMOs, for example in Japan. The BoJ's decision to expand the pool of institutions it deals with had largely been based on the necessity to deal with a prolonged situation of market tension.

Nevertheless, while the drawbacks of a very narrow pool of OMO counterparties have been apparent, it is notable that a huge expansion in the number of counterparties has not been seen. In the United States, fewer than 100 banks have accessed the TAF, implying that over 7,000 (mostly small) banks did not. In the Eurosystem, there has been if anything a contraction in the average number of banks accessing *each* MRO (although reportedly an increase in the number of banks making periodic use of the MRO); and only a small increase in those accessing the LTRO.

It may be that the current crisis impacted predominantly the larger, wholesale-funded banks while smaller, retail-funded banks fared better. This raises two issues. First, the number of counterparties with which the central bank needs to deal in crisis times will relate to the nature of the crisis; a system that targets the major wholesale banks (but is open to all in principle) may be sufficient to meet the central bank's goals if those are the banks in need. Second, and linked to this, in the trade-off between restricting the collateral pool to good quality, liquid assets and broadening the counterparty pool to allow for efficient monetary policy transmission and effective financial stability support, consideration could be given to targeting a counterparty group which accounts for a minimum combined market share, rather than a certain proportion of the *number* of counterparties. This would require judgment depending on the number of institutions involved and distribution of market share. For example, if in a market of 500 banks, the top 50 accounted for 2/3 of the market, it may be sufficient to deal with this smaller group. In a market of 20 banks where the top 2 accounted for 2/3 of the market, it may be preferable to deal with all 20 in order to ensure a better level of competition. In short, depending on the nature of the crisis and structure of the banking system, it may not be necessary to have a framework which is directly and easily accessible by all banks.

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<sup>25</sup> Participation was typically 60-90 banks, three to five times the number of Primary Dealers.

**Table 2. Initial Participation in the Federal Reserve’s Term Auction Facility**

| Date of Auction   | Volume offered,<br>\$ billions | Number of<br>Bidders | Cut-off<br>yield | Spread over<br>minimum bid rate, bp | Bid-Cover<br>Ratio |
|-------------------|--------------------------------|----------------------|------------------|-------------------------------------|--------------------|
| December 17, 2007 | 20                             | 93                   | 4.17             | 48                                  | 3.08               |
| December 20, 2007 | 20                             | 73                   | 4.15             | 52                                  | 2.88               |
| January 24, 2008  | 30                             | 56                   | 3.88             | 7                                   | 1.85               |
| January 28, 2008  | 30                             | 52                   | 3.10             | 2                                   | 1.25               |
| February 11, 2008 | 30                             | 66                   | 2.86             | 15                                  | 1.95               |

Source: Federal Reserve Bank of New York—Various Press Releases. [www.frbdiscountwindow.org](http://www.frbdiscountwindow.org)

### **Box 2. The Term Auction Facility**

In mid December, the Fed announced the introduction of a temporary Term Auction Facility—the TAF—which would make term (28 day) funds available to all depository institutions at a spread over the overnight interest swap (OIS) rate. The provision of term OMO funds directly to a wide range of potential borrowers (a minimum participation size was used to guard against a large number of very small bids), and against a broad definition of collateral, did not carry the stigma associated with SF borrowing.

The TAF was also linked to swap operations conducted with the ECB and the Swiss National Bank, allowing the latter two to provide U.S. dollar funding to their usual counterparties, on the same interest-rate terms as funds provided in the TAF, but with the pledge of collateral to the Eurosystem and SNB, rather than to the Fed.<sup>26</sup> This aimed to ease pressures caused by the current weakness of the foreign exchange swap market. For market participants, this was an important signal of cross-border cooperation, indicating that central banks can work together to overcome the cross-currency funding issues for nondomestic commercial banks. The provision of U.S. dollars to European banks in an operation whose volume was agreed with the Fed, and with a price in line with that of the U.S. operation, meant that it did not interfere with Fed’s liquidity management.

Following the announcement, a reduction in market stress was clearly perceivable, as can be seen from Figure 14 in the Appendix. This shows daily changes in the spread, along with a measure of the probability of being in a situation of extreme volatility, as inferred from a Markov-Switching Model. The Fed announced in July 2008 that the TAF would continue to be made available until at least January 2009 (unless at an earlier point it was clearly not needed); and extended the maturity of alternate TAF auctions to 84 days.<sup>27</sup>

<sup>26</sup> Interestingly, the SNB auctions are open to all Swiss and nonresident banks which are eligible to participate in its main financing and fine-tuning operations.

<sup>27</sup> For detailed analysis of the impact of the TAF, see “A Black Swan in the Money Market,” Taylor and Williams (2008); and “The Effect of the Term Auction Facility on the London Interbank Offered Rate,” McAndrews, Sarkar and Wang (2008).

### C. Collateral

The differences between counterparty groups and eligible collateral are greatest in the United States, which meant that in stressed conditions the imperfect substitutability between credit SFs and OMO was most likely to become a problem.<sup>28</sup> In the Eurosystem and the BoE cases, most banks which do not normally access OMO funds directly had the option of participating in the main or longer-term OMO, using the same collateral as they would use for SF, although published data does not indicate any substantial increase in participants. But in the United States in practice, none of the SF counterparties (commercial banks) is authorized as a PD, and so they cannot participate in OMO (and might not hold eligible collateral). The Fed brought its OMO and SF closer together in price by reducing the discount rate (its SF credit rate) spread over the Fed funds target to 50 basis points (bp) on August 17, 2007 and to 25bp on March 16, 2008. Use of this facility was notably higher than in the past from mid August to end September, and again during December 2007; and following the March reduction in the rate. There are indications (see Section E) that pricing may be as important as stigma in determining usage of the DW. There are also indications that, as money-market term funding evaporated, many banks had recourse to the Federal Home Loan Bank (FHLB) system rather than using the discount window. Banks could use mortgage assets to obtain term funding from the FHLB system at a rate midway between the Fed funds rate and the discount rate, and without the perceived stigma of discount window borrowing. The assets, repackaged by the FHLB system, are eligible as OMO collateral. Thus the market could access term funding at close to the Fed funds rate.

The Eurosystem has a very wide definition of eligible collateral; and revised procedures since early 2007 have made it easier for banks to pledge nonmarketable collateral. Moreover, there is no distinction between OMO and SF collateral; and in principle any bank which can use SFs can also sign the documentation necessary to access OMO. Fine Tuning Operations (FTOs) are available only to a small number of counterparties; but the collateral pool is the same as for other operations. There has been no need to revise collateral policy in order to broaden access to facilities. (The BoJ has long operated with a very broad range of collateral, in particular after major revisions to its collateral framework in 2001 and 2002; like the ECB, it had no need to broaden its collateral policy.<sup>29</sup>)

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<sup>28</sup> Mostly using regular OMO in the form of repos, mature market central banks typically aim to provide the market with a certain amount of short-term funding at or close to the target policy rate. Longer-term OMO are conducted at market/bid rates. For the Fed, these are mostly in the form of outright purchases of long-term securities. The ECB provides 3 month repos; the BoE provides 3, 6, 9, and 12 month repos as well as outright purchases of longer-term securities. All three also make available a credit standing facility: overnight funds (normally) at 100bp above the policy rate. Pricing is set to make the facility expensive but usable. However, in some countries there is a reluctance to use the standing facility because of a perceived stigma attached, despite central bank statements that this should not be the case (in theory, the market should not know who has used a standing facility, but in practice it can become known).

<sup>29</sup> The breadth and nature of the collateral pool has been strongly influenced by lessons from the episodes of financial fragility in the 1990s.

In the United Kingdom, there is no collateral distinction between OMO and SF.<sup>30</sup> But the BoE subsequently chose to accept a broader range of collateral in certain term operations. Four term repo auctions were held in late September and October 2007, accepting a wider range of collateral (in particular, mortgages meeting certain requirements), with a minimum bid rate equal to the SF credit rate. But no bids were received at any of these auctions: this may reflect both the cost, and perceived stigma associated with the facility. In December, when term rates had jumped ahead of the normal year-end tightening and there were renewed concerns about the scale of losses facing some banks, the BoE broadened the range of collateral acceptable in its regular three month repo auction, and set a T+3 settlement to accommodate the broader range of collateral. On this occasion bids exceeded the £10 billion on offer, and the highest bid rate was just above the standing facility credit rate.<sup>31</sup> Bids at this and subsequent auctions at rates close to or above the credit SF rate and the 3 month BBA Libor rate indicate either that banks were borrowing using collateral not eligible at the credit SF (or other BoE OMO), or perhaps were prepared to pay a margin for 3-month funding albeit less than they would have had to pay in the interbank market.<sup>32</sup>

Central banks with larger differences between OMO and SF made adjustments to their definition of OMO-eligible collateral during the turmoil. This pattern has not only been observed for the Fed and the BoE, but also for other major central banks:

- The Bank of Canada, which had a split similar to that in the United States between OMO counterparties and a narrow range of collateral, and SF access to a (slightly) broader group with a broader definition of eligibility, announced that it would accept SF collateral in its OMO. (Initially, some concerns were expressed as to whether the Bank of Canada Act was flexible enough to permit this.)<sup>33</sup> With a narrower initial spread between its policy rate and the SF rate, reducing the relative cost of accessing the SF would have been more difficult.
- The RBA, has, over the past decade, continuously widened the range of securities it accepts in repos, and can implement discretionary collateral changes almost immediately. The broadening of its collateral pool in 2007 has therefore been partly

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<sup>30</sup> The BoE accepted in its September and October 2007 facilities to Northern Rock collateral which fell outside its usual definition. This in itself is not uncommon (though a few central banks pre-define what collateral is acceptable in lender-of-last-resort (LOLR) operations). Under the Tripartite MoU with HM Treasury and the Financial Services Authority, Treasury authorization was required before this lending could be undertaken.

<sup>31</sup> The 6, 9, and 12 month auctions on the same date, against the normal collateral pool, settled at rates below the prevailing Bank Rate.

<sup>32</sup> The BBA Libor quotes are for rates prime banks would expect to pay for borrowing in reasonable size; for other banks or very large amounts, rates will of course vary.

<sup>33</sup> Jacome, Ishi, and Stella, “*Legal Constraints to Making Central Bank Operational Frameworks More Flexible*,” IMF Working Paper forthcoming presents a worldwide survey of this issue.

viewed as a continuation of this trend, and an attempt to converge to practices of other major central banks.<sup>34</sup>

- The RBNZ announced in May that RMBS meeting certain criteria, and bank bills (both subject to volume limits) would be acceptable as collateral from June-July 2008, with a review on their eligibility to be undertaken 12 months later. There was no immediate demand for use of the RMBS; its inclusion was in part to anticipate possible problems associated with other funding sources, but also to support the development of a new market by defining minimum terms for central bank eligibility in terms of asset quality and data provision.

While these changes have been judged largely successful, adjustments of an operationally very complex subject matter carry potential risk, and imply substantial challenges to central bank communication, especially when undertaken quickly in response to market pressures.

Recent changes in money market pricing conditions may have provided an environment conducive to further changes in the collateral pool, as illustrated by changes in the relative opportunity costs of collateral (Table 3 and Appendix Figure 15).

**Table 3. European Central Bank Weekly Main Refinancing Operation Marginal Rate vs. Coincident Market Rates Before and After the Crisis**

(One-week rates at the time of the auction)

|  | From beginning 2007 to 1 <sup>st</sup> of August (average) | From August 1 <sup>st</sup> to January 2008 (average) |
|--|--|---|
| Spread main refinancing operations (MRO)—Eurepo 1/ | 0  | 15  |
| Spread Euribor - MRO                               | 4  | 0   |

Source: European Central Bank; and European Banking Federation.

1/ Eurepo is the rate at which one prime bank offers funds in euro to another prime bank against a basket of euro area government securities. The Eurepo index is calculated daily following a method similar to Libor and Euribor (on the basis of declarative lending rates with elimination of extreme quotations from the panel) and published at 11HAM CET.

<sup>34</sup> In its statement on December 6, 2007, the RBA stated “Over the past decade, the Reserve Bank has gradually widened the range of securities which it is prepared to accept under repurchase agreements, to take account of the changing structure of financial markets. ... As a continuation of this trend, and after reviewing the range of international practice by other central banks, the Reserve Bank has decided to further widen the range of securities eligible for its repo operations.”

The credit market dislocation observed in the money market since August 2007 has brought about a repricing of risk and asset values, as reflected in money market spreads, that is likely to have an impact on central banks' collateral pool quality. In the euro area money markets, interest rate differentials between the government repo rate, the ECB marginal rate and Euribor rates (representative of unsecured funding costs) have widened significantly, substantially increasing the incentives to make use of secured transactions<sup>35</sup> and to arbitrage among different types of collateral:

- After the onset of the crisis, MRO marginal rates were, on average, 15 basis points above comparable Eurepo rates. Interestingly enough, the MRO marginal rates seem to have drifted upward following the Euribor (unsecured) rate. This suggests that banks have been confronted with an average 15 basis points opportunity cost when using government security collateral at the MRO, highlighting the potential for some hoarding of better quality collateral and a greater recourse to lower-rated or less liquid collateral.
- Federal Reserve Bank of New York OMO collateral data also highlight the move toward Agencies and Mortgage-backed securities, suggesting a re-pricing of available collateral in a liquidity-distressed environment (Table 4). Moreover, with the introduction of the TAF in December 2007, the Fed's short-term OMO have constituted a much smaller proportion of its credit provision.

**Table 4. Federal Reserve Bank Short-Term OMO Collateral**

(In billions of U.S. dollar)

|                | Treasuries |         | Agencies |         | MBS    |         | Total  |         |
|----------------|------------|---------|----------|---------|--------|---------|--------|---------|
|                | Volume     | Percent | Volume   | Percent | Volume | Percent | Volume | Percent |
| Jan.–Jul. 2007 | 881        | 66.1    | 321      | 24.1    | 130    | 9.8     | 1333   | 100     |
| Aug. 2007–now  | 485        | 35.7    | 477      | 35.1    | 398    | 29.3    | 1361   | 100     |

Source: Federal Reserve Bank of New York

Changing market incentives influence counterparty behavior, and can affect long-run market outcomes by altering the relative prices of assets. Changes to the collateral provided may affect monetary policy transmission via the impact on market spreads. Although the existence of significant collateral eligibility premia may not be evident in “benign” money market conditions, the widening of money market spreads by a factor 10 in the second half of 2007 indicates a need to review collateral policies in light of a rapidly changing environment. However, any tightening of collateral policy needs to wait until the market turmoil has subsided.

<sup>35</sup> There has been a long-term trend in some markets towards secured transactions; the current turmoil may have accelerated that trend. It is not clear whether this acceleration is likely to be reversed.

#### **D. Term Operations and Monetary Policy**

The recent events have highlighted a new challenge in maintaining consistency between central bank market operations and monetary policy, as previously stable relationships can break down in times of market stress. In developed markets, the provision of term liquidity which extends beyond the day of the next policy meeting is typically undertaken at market rates, and is in most cases clearly a liquidity management rather than a monetary policy operation. But some of the term funding, as well as the asset swaps,<sup>36</sup> provided since August 2007 was clearly intended to influence, although not to determine, market rates. While the intention was to reduce distortions caused by illiquidity, such operations could misguide public expectations on monetary policy. Central banks could point to the difference between OIS rates (a noncash transaction which gives an indication of the market's view of future official rates) and interbank (cash transaction) rates as a measure of the distortion caused by market illiquidity: normally the two are very close. It is quite possible that the two rates will not fully converge in the future, if the market places more weight on the pricing of funding liquidity; but some reduction in the Libor-OIS spreads seems likely as markets return to more normal functioning.

In some cases, the longer-term operations have mistakenly been portrayed as expanding the monetary base in a potentially inflationary way; in practice, there has not been any significant expansion of unremunerated reserves.<sup>37</sup>

Longer-term liquidity has been provided by major central banks to offset the impact on the yield curve of the lack of availability of unsecured money market term lending. For the Eurosystem, which lends a large amount to the market and had existing operations at 7 and 91 day maturities, this was relatively straightforward. For both the Fed and the BoE, it required a certain amount of balance sheet restructuring. This pointed to the importance of having some balance sheet flexibility to be able to respond appropriately to market problems. The Fed created some balance sheet room for the TAF by reducing its SOMA portfolio: this was facilitated by a maturity profile providing a regular flow of maturing investments which can simply not be renewed. The BoE increased the volume of its longer-term operations in response to market conditions, resulting in a fall in the volume of short-term, policy rate operations. This was complicated by the massive liquidity provision to Northern Rock, which had already reduced the volume of reserves balances funded by short-term OMO.

These efforts have been reinforced by the coordinated actions of several central banks in mid December 2007 when the Fed set up a more systematic facility for term liquidity (TAF), and the ECB and SNB announced linked operations; and the BoE announced a significant increase of its long-term operations as did the Bank of Canada on December 12. Thanks to

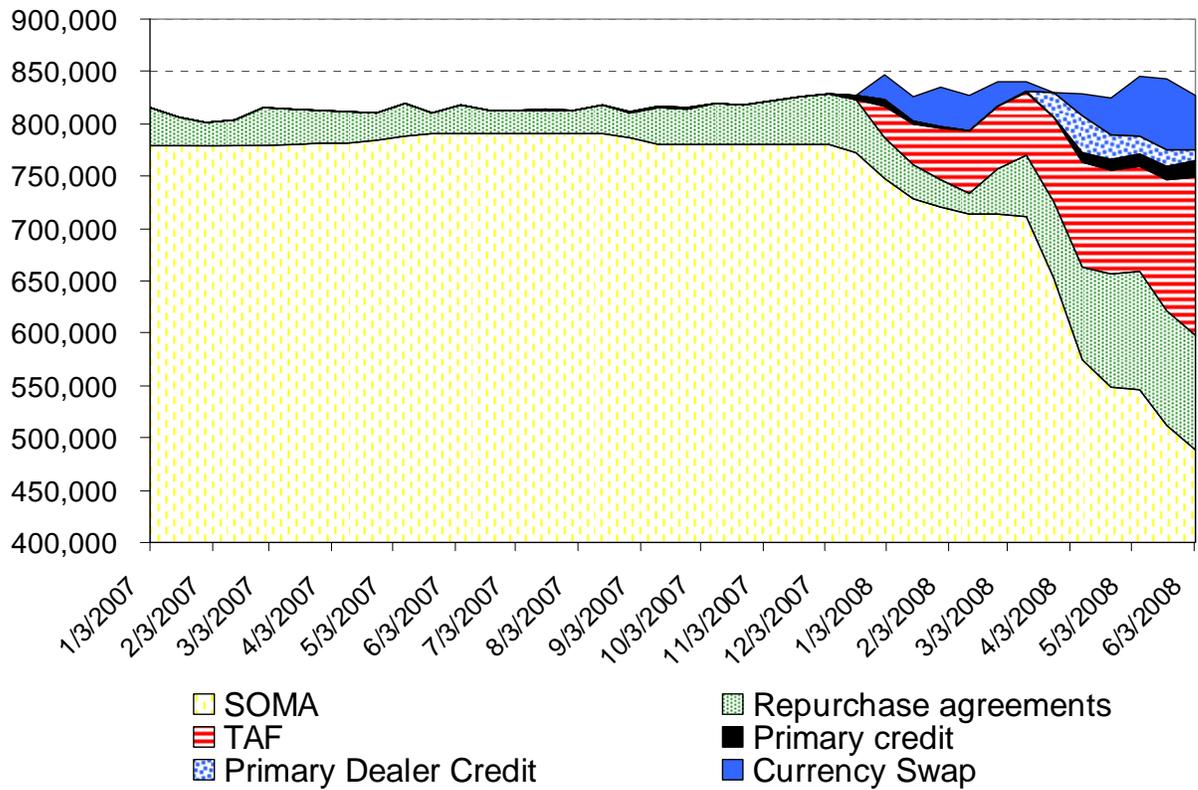
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<sup>36</sup> The Fed's TSLF and the BoE's SLS.

<sup>37</sup> An increase in unremunerated reserves might be expected to alter banks' behavior. But if reserves are remunerated at or close to market rates, the opportunity cost to banks is small, and any negative impact on their behavior should also be small.

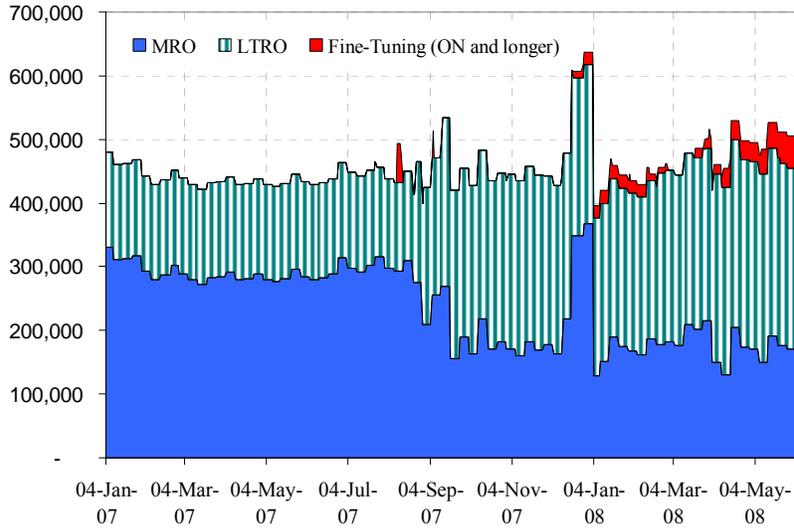
these measures, strains in short-term funding markets, including those for year-end liquidity, eased at least temporarily although some uncertainty continued to be reflected in the composition of central bank balance sheets (Figures 5–8) and in spreads (Figures 12-15, at the end of the paper).

Figure 5. Total Domestic Portfolio  
(maintenance period averages, in U.S. million dollars)



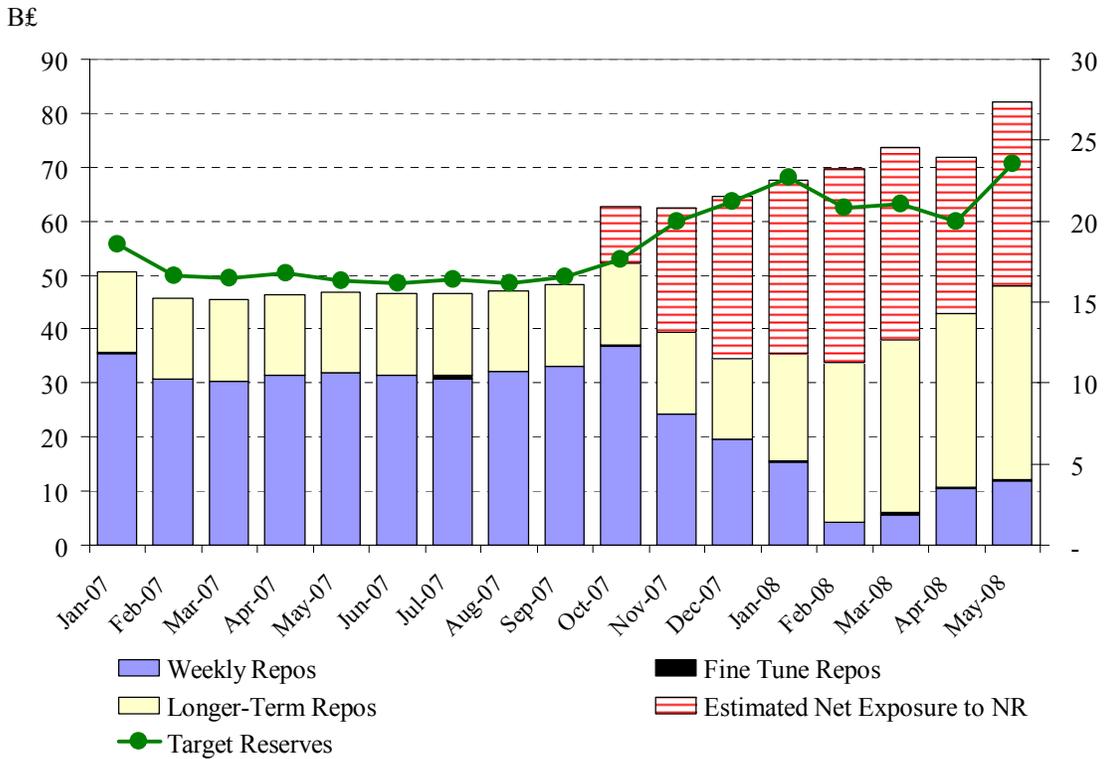
Source: Federal Reserve Bank of New York.

Figure 6. A Structure of Overall Liquidity Provision by Type of Operation (in EUR millions)



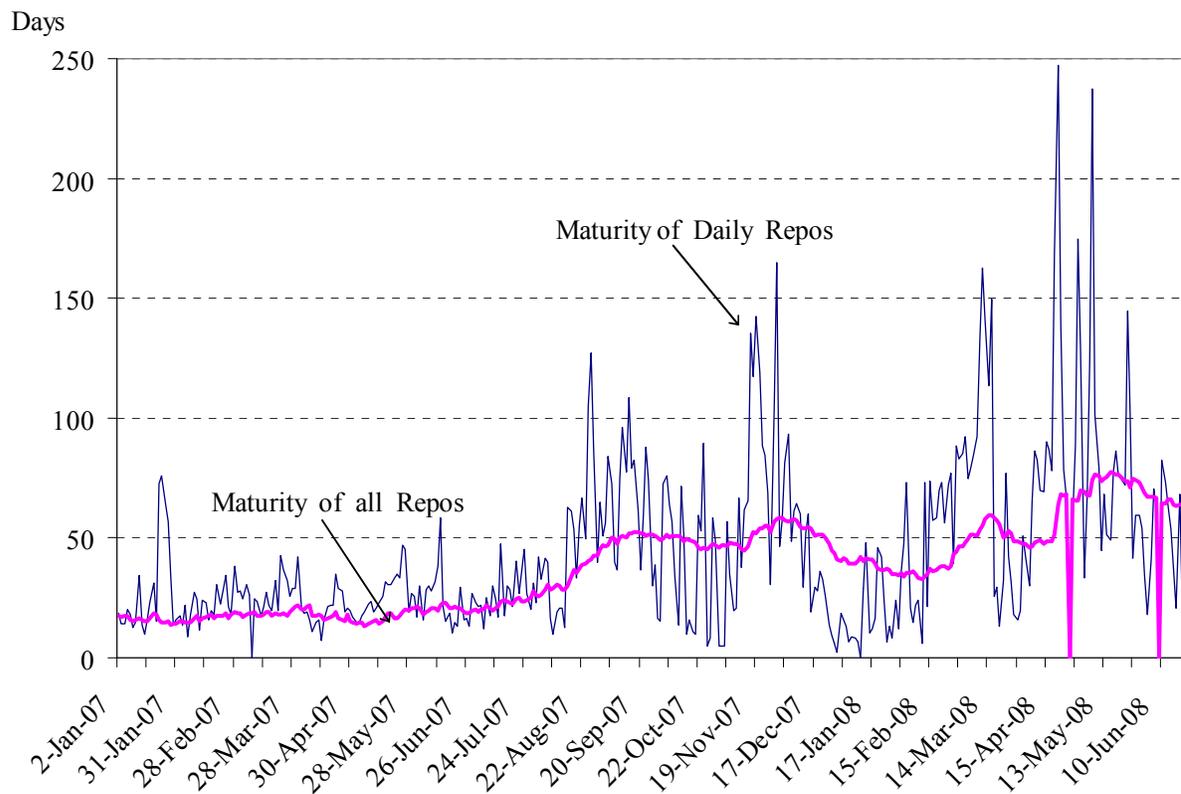
Source: European Central Bank.

Figure 7. Bank of England OMOs: Monthly Average Amount Outstanding Central Bank Repos (2007-2008)



Source: Bank of England.

Figure 8. Term of Reserve Bank of Australia Repos 2007



Source: Reserve Bank of Australia.

Central banks have been careful to avoid causing misperception about the monetary policy stance when increasing term operations. These efforts are twofold; operational measures and communication.

- Term operations have been aimed at offsetting the impact on the yield curve of a shortage of term lending, which caused a sharp steepening. But central banks rarely set term interest rate targets. (The SNB is an exception—see below.) Although a minimum bid rate is established in some cases (TAF), in principle the market decides the price through auctions. This is fully consistent with targeting the overnight rate. Further, rather than expanding reserve money (a liability of the central bank), they restructured their assets, increasing the proportion of medium-term (1-3 month) lending and reducing either short-term, policy-rate lending or, in the case of the Fed, outright holdings of government securities. In fact, an expansion in response to demand should not be inflationary; most central banks operate on the price of reserve money rather than short-term control of its volume.
- Central banks have tried to explain the intention of market operations while anchoring inflation expectations. At the onset of the crisis, the Fed and ECB published

statements saying that they were (i) providing liquidity to facilitate the orderly functioning of the financial market, and (ii) promoting short-term interest rates close to the policy target. The BoE emphasized liquidity provision was not intended, nor could be expected, to lower term rates, pointing out that the objective was to guide the overnight rate close to the policy rate. Fed and ECB officials repeatedly underlined the distinction between monetary operations and monetary policy, and that the liquidity management response to the crisis would not undermine their price stability objective.

- The policy target for the SNB is the three-month Swiss franc LIBOR rate. The sharp widening of spreads and surge in volatility impacting all LIBOR rates presented the SNB with difficult operational and communications challenges, as it operates primarily via 7-day repo.

The distinction between monetary operations and monetary policy does not of course rule out a change of policy stance in tandem with emergency liquidity provision. Indeed, several central banks have eased policy since last summer (Box 3). However, this should be interpreted as responding not to market turbulence directly but to its second-round impact on the real economy and inflation.

### Box 3. Changes in the Monetary Policy Stance since July 2007

This box briefly reviews major central banks' policy responses (in contrast to liquidity management responses) since last summer. Note that all these central banks have shared interest in restoring the function of money markets.

#### Central banks who cut the policy rate:

- The BoC lowered the target rate by a total of **150** bps in **December and April**, citing the downside risk to demand and inflation due to tightened credit conditions and the weaker U.S. economic outlook.
- The BoE reduced the bank rate **three times** by a total of **75** bps in **December, February and April**. It judged that conditions in financial markets had deteriorated and credit supply to households and businesses was tightening, posing downside risks to the outlook for both output and inflation.
- The Fed cut the FF target rate by a total of **3.25** percent on **seven** occasions (including one unscheduled FOMC), judging that U.S. financial markets remain under considerable stress and credit has tightened for some businesses and households. It concluded that lowering interest rates would be appropriate to help offset the effects of tighter financial conditions on the economic outlook.
- The RBNZ cut its rate in July, citing weak prospects for domestic and international growth.

#### Central banks who raised interest rates

- The ECB maintained interest rates until July 2008 when the policy rate was raised by 25bp. It recognized unusually high uncertainty about the overall impact of financial turmoil on the real economy, but emphasized that the firm anchoring of inflation expectations is of the highest priority, reflecting ECB's mandate.
- The RBA raised the policy rate by a total of **100** bps on **four** occasions by March. Although there has been some tightening of lending standards to risky borrowers, RBA weighed significant inflation pressures, and judged a slowing in demand was likely to be necessary to reduce inflation over time.
- The Riksbank (Sweden) raised the repo rate by a total of **75** bps on **three** occasions in September, October, and February. Although the unease in the financial market was expected to slow down growth in Sweden somewhat, increasing cost pressures and inflation above the target prompted the bank to raise the policy rate.
- The SNB increased the target for three-month Libor by 25 bps in September, while cutting its short-term operational rate in line with the steepening of the yield curve. Under the framework of targeting three-month Libor, the adjustment of the target mainly reflected the rise in the market rate owing to an increase in the risk premium. While admitting the inflation outlook had deteriorated, the SNB judged that uncertainty associated with the forecast was greater, and emphasized its aim to calm the money markets.

#### Central banks who held the policy rate unchanged

- The BoJ kept its policy target stable. It shifted its economic outlook downward somewhat, but maintained that the economy is likely to continue its moderate growth. Given that the outlook for economy and prices is highly uncertain, BOJ has remained neutral for the direction of future monetary policy.

Central banks have argued that disturbed financial market conditions exert downside risks to economic growth. These decisions are understandably based on a consideration of the deepening interaction between financial markets and the real economy, in this case an "adverse financial accelerator." Potential losses from the sub-prime loan problem and consequent shortage of capital in financial institutions could tighten credit conditions sharply for some businesses and households, calling for more aggressive policy easing than otherwise would be required.

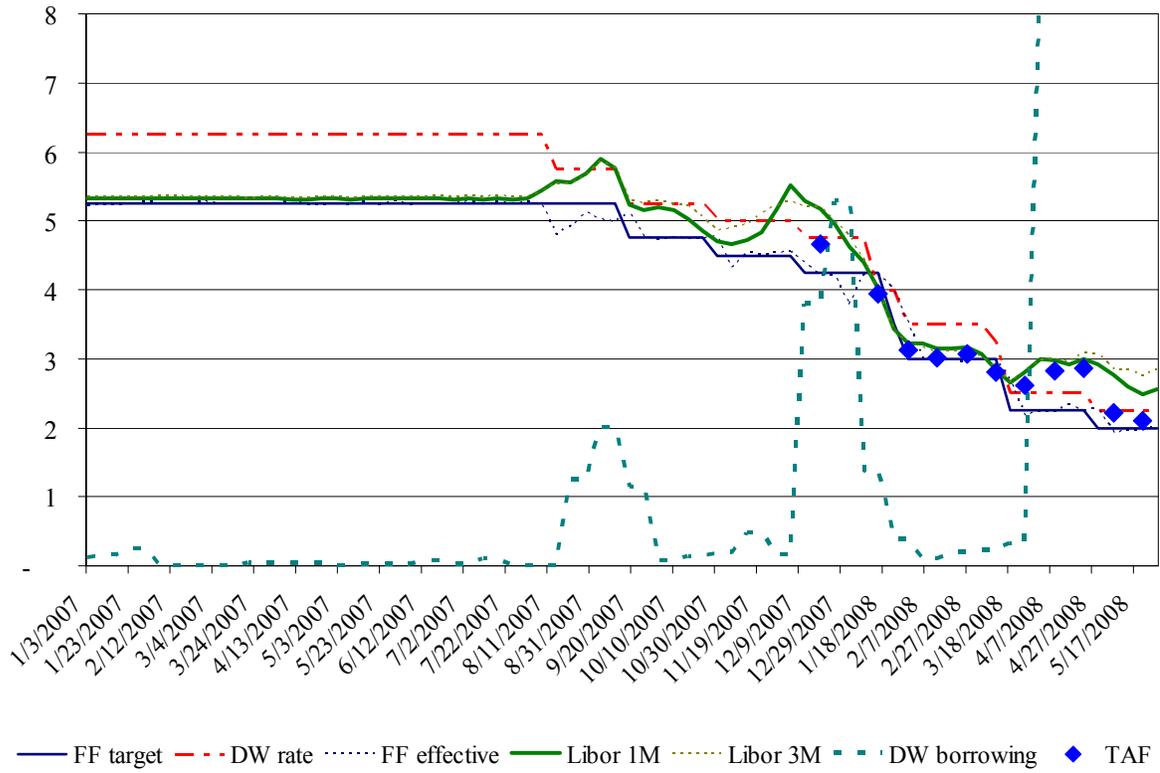
The different policy responses of central banks reflect differing economic situations and individual judgment as to the balance of risks between growth and inflation. Central banks were broadly acting in consort with their common price stability mandate; specific decisions were colored by both additional idiosyncratic mandates (the precise formulation of price stability targets, and whether they must be balanced against other targets) and their view as to whether the inflation outlook would deteriorate.

### **E. Instruments “Stigma”**

Substantial attention has been paid to the issue of “stigma” attached to certain central bank instruments. Stigma here refers to the unwillingness of financial institutions to take liquidity from central banks in circumstances which they are afraid would be interpreted in the markets as suggesting a specific problem. This applies particularly to standing facilities, which banks at times refuse to use owing to fears of creating a perception of liquidity shortage which could cause reputational damage. At the outset of the crisis, the Fed prompted banks to apply to the discount window by addressing cost issues, reducing the premium to 50 bps (from 100bp), and by allowing the provision of term financing for as long as 30 days (previously overnight). However, addressing cost and maturity issues did not appear to solve the problem of stigma, and initially only a small number of banks used the window. The BoE faced similar challenges in its lending facility and in special funding auctions in September-October. The Eurosystem reportedly did not: overnight interest rates in the euro area did not rise above the credit SF rate, by contrast with the US and UK cases.

That said, there are indications that the market was sensitive to the pricing of SF credit. The chart below shows official US interest rates (the Fed funds target and the Discount Rate) together with a selection of market rates, and indicates that when market rates (or the TAF) stood above the Discount Window rate, the use of the Discount Window rose substantially. The facility can currently be used for term borrowing, and is used when the cost is cheaper than alternative term funds. It may be that some market participants are reluctant to use the facility for overnight borrowing and will on occasion pay a higher rate in the market; but this too has a cost angle. Paying an extra 250bp on \$1 million for one night costs \$68—scarcely worth reputational risk.

Figure 9. U.S. Dollar Short-term Rates  
(in percent)



Source: Federal Reserve Board.

In some cases, anonymity of use has not been adequately preserved. In the United States, data on SF usage is published by each Federal Reserve Bank; this may give some clue to the identity of the user, if a large amount is involved. In the United Kingdom, one bank confirmed its usage in response to market rumors (a newspaper reportedly telephoned all banks eligible to use the facility and asked them to deny having used it), and although the usage reflected a payment system problem, the bank was clearly unhappy to be identified in this way.<sup>38</sup> In the Eurosystem, there appears to have been a readier acceptance of the central bank's insistence that SF usage should not be seen as indicative of a problem; but it is not clear why the U.S. and the U.K. banks have been more reluctant to accept this.

#### F. Cross-border Liquidity Provision: Does the Cross-Border Market Matter?

Prior to the recent crisis, many banks globally used foreign exchange swaps as part of their routine funding transactions. It is often more efficient to borrow or lend large sums in the U.S. dollar markets (whether New York or euro-dollar markets), whose better liquidity

<sup>38</sup> The U.K. government is considering, via consultation, whether to remove the requirement for the BoE to release weekly data returns detailing its summary balance sheet, to facilitate the provision of appropriate liquidity assistance.

allows for finer margins and larger size transactions, and then swap into the desired currency rather than transact directly in the final currency. This is true for the euro, sterling and yen markets, and even more so for smaller markets (e.g., Australia, Canada, New Zealand). Swap transactions do not need to match the terms of the U.S. dollar cash leg exactly. For example, a bank could borrow US\$1 billion for three months, and swap half into euro and half into sterling for one-month if it judged it could roll over the swap more cheaply than locking into a three month swap at the start.

The drying-up of FX swap markets following the financial market turmoil in August could have been caused by several factors:<sup>39</sup>

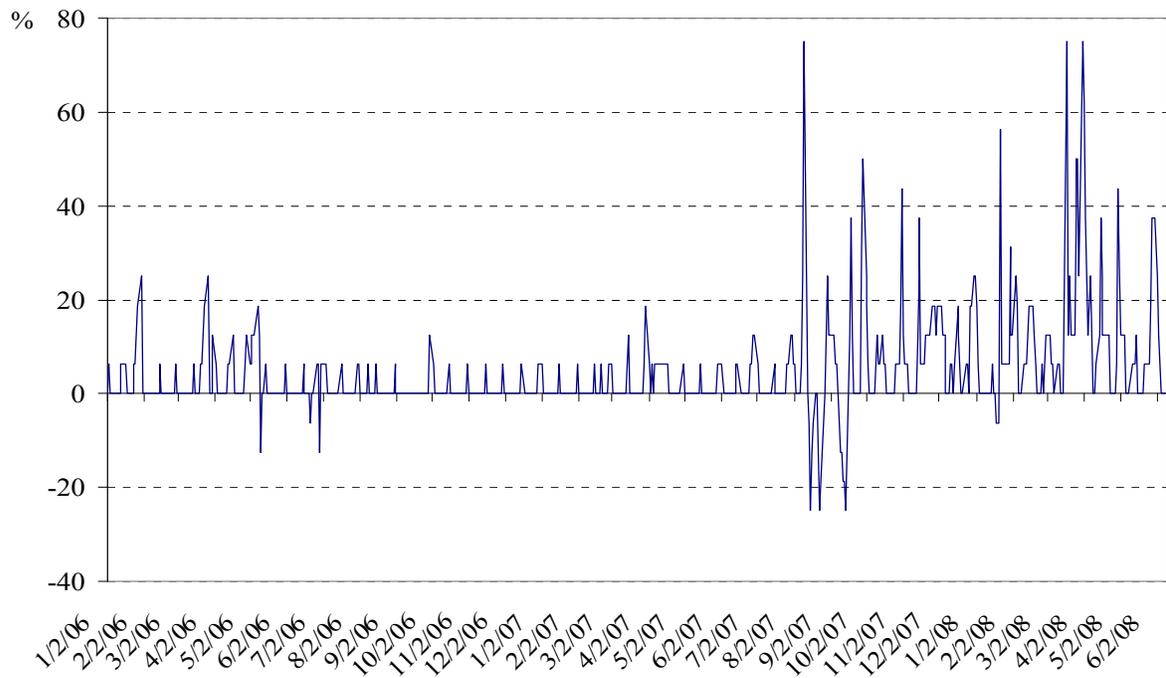
- U.S. dollar lenders might be reluctant to provide term funds to European (and other) borrowers, both for credit reasons (uncertainty about sub-prime losses) and liquidity reasons (not wanting to lock up funds in an uncertain environment).
- If the term money market dries up, particularly for loans to European firms, the swaps market will also dry up as there is less underlying funding business to support.
- Against the background of volatile interest rates - which are used to price the swaps - the arbitrage opportunities which make it cheaper to borrow in U.S. dollar and swap into the target currency may be obscured.

It is clear that some of the volatility in U.S. money markets was related to cross border transactions. As can be seen in Figures 10 and 11, from August 2007 onwards, volatility in Fed funds rates was much higher at the beginning of the day while Europe was open for trading, than at the end of the day. Normally the converse might have been expected: more liquidity in the market when both sides of the Atlantic are trading resulting in lower volatility in the morning than in the afternoon. This greater liquidity is one reason the FRBNY operates in the morning.

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<sup>39</sup> Some swaps business continues, of course. In some cases, banks may have borrowed term funds from central banks (instead of the interbank market) and swapped into the target currency to obtain a pricing arbitrage. Uncollateralized interbank funding may be more efficient, but collateralized central bank funding is a useful second-best. See BIS Quarterly (2008), Baba, Packer, and Nagano.

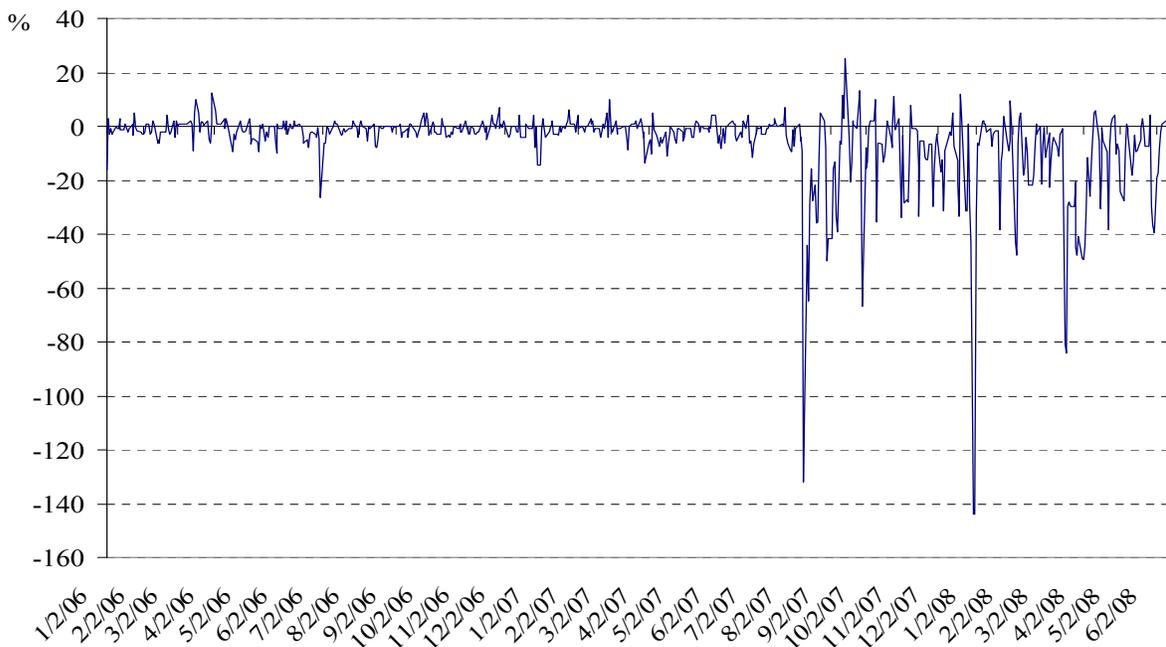
Figure 10. Spread Between Morning Rate and Federal Reserve Funds Target Rate 1/



Source: Bloomberg L.P.

1/ Fed short term repos are usually arranged at 9:30 a.m. ET, while long-term operations may be conducted earlier in the morning when the financial market is customarily more liquid.

Figure 11 Spread Between Federal Reserve Funds Effective Rate and Morning Rate



Source: Bloomberg L.P.

For a given currency area, the central bank might theoretically replace the disrupted liquidity networks by interposing itself, taking the place of the market. The liquidity that been transmitted between institutions through the now-disrupted links would be re-routed—with no change in the overall amount of central bank reserves in the system. Provided a sufficient number of banks can access the central bank directly,<sup>40</sup> this re-routing could take place fairly automatically.

However, as globally active institutions manage their liquidity through a range of global counterparts, typically using the foreign exchange swap market to make conversions into the currency (and final market) of choice, two potential network failures emerge:

- First, a single central bank may not have direct connections with all major institutions in its currency market which have disrupted relationships.
- Second, were these connections to be offered de novo, differences in the “transfer protocol” might mean that institutions would not have the appropriate collateral and technical interface with the relevant central bank.

The participation of the ECB and SNB in the Fed TAF addressed both of these problems simultaneously. The swap arrangement between the Fed and two European central banks (the ECB and the SNB) allowed the Fed to provide U.S. dollar liquidity indirectly to the institutions in Europe whose links to the U.S. dollar market had been disrupted, while maintaining control of overall supply of U.S. dollar balances held by commercial banks. By utilizing the ECB and SNB operating frameworks, the “protocol” problem was resolved, i.e., non-U.S. borrowers could utilize their existing transfer protocol and—importantly for some—their European collateral pool.

Data about TAF participation offer useful insights about the network topology during the turmoil (Table 5). It is not necessary for the majority of potential bidders to participate for such an operation to be successful; and – implicitly at least – the majority did not want to participate. It is probably more important that the operation is accessible to institutions which account for a large part of the relevant market, rather than that a large number participate.<sup>41</sup>

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<sup>40</sup> As discussed elsewhere, in some countries it was necessary to increase the number of direct links (counterparties) to accomplish this.

<sup>41</sup> An increase in cover at the Eurosystem’s TAF auctions in July-August 2008 may indicate a growing demand for USD from this source; but may also reflect the fixed-interest nature of the auction. If a bank wants a higher share of the amount on offer, it cannot bid a higher price (as it can in other ECB OMO), but may over-bid in the expectation that all bids will be pro-rated.

**Table 5. Term Liquidity Bidders**

(December 2007 to June 2008)

|               | Number | Counterparties<br>in Main<br>Operations | Hypothetical<br>Number of<br>Bidders |
|---------------|--------|---|--------------------------------------|
| United States | 75     | 20                                      | 7,500                                |
| ECB           | 38     | 400                                     | 2,000                                |
| SNB           | 13     | 19                                      | 115                                  |

Source: European Central Bank; Federal Reserve Bank of New York; and Swiss National Bank.

### **G. Innovations: Asset-based Operations (TSLF and SLS) and the PDCF**

The Treasury Securities Lending Facility (TSLF), announced by the Fed at the end of March 2008, and the Special Liquidity Scheme (SLS), announced by the Bank of England at the end of April 2008, represented an important innovation in the way central banks have dealt with liquidity disruptions. Both operations represent an instrument substantively different from the traditional liability-based reserve money approach, where central bank loans are used for liquidity management and to impose a short-term interest rate on the market. The TSLF and SLS take an asset-based approach—exchanging one type of collateral for another—but without impacting the volume or price of reserve money directly. Such operations are closer to “credit policy” than traditional monetary policy operations, to the extent that the choice of additional eligible collateral targets a particular economic sector, notably residential mortgages.

The TSLF and the SLS were both set up to address a continuing shortage of liquidity in the money markets. By swapping top quality assets (government securities) for assets whose access to the repo market was closed (ABS, RMBS, CMO), both central banks aimed “to promote liquidity in Treasury and other collateral markets and thus foster the functioning of financial markets more generally” (FRBNY) by allowing Primary Dealers/commercial banks holding illiquid ABS and RMBS to obtain access to the inexpensive and broadly available refinancing of the GC repo market. Although the TSLF and the SLS share rather similar goals, they differ substantially as to their detailed features.

The terms of the operations differ markedly. The TSLF consists of weekly auctions with Primary Dealers, carried out for a 28 day maturity, and will be continued until January 2009; while the SLS consists of a facility, available from April to October 2008, for banks to enter into one-year swaps potentially rolled-over for three years. (In some respects the TSLF is similar to the TAF, which allows banks to borrow cash for 28 days against illiquid assets, and invest the cash in treasuries which are released from the SOMA portfolio; the TSLF targets PDs while the TAF targets banks.) The collateral taken under both operations includes AAA ABS and RMBS, but also credit card securitizations and foreign currency-denominated assets

in the case of the SLS.<sup>42</sup> Overall the scope of the collateral eligible is a bit more broad for the SLS (including covered bonds and G10 government paper).

The two operations have a different impact on the central bank's own asset portfolio. While the Fed is lending securities from its SOMA portfolio, the BoE operations will be done using Treasury Bills especially issued to that end and lent to the BoE. The TSLF could in theory impact the Fed's operational capacity (securities obtained will not be available for liquidity-draining repos), although as yet the Fed's balance sheet still has plenty of capacity: demand at the TSLF has been strong but far from overwhelming. In the case of the BoE (press release dated April 21, 2008): "The scheme will involve the government, through the Debt Management Office, issuing new Treasury Bills to lend to the Bank of England...this scheme will be completely ring-fenced from, and independent of, the Bank of England money market operations. So it will not interfere with the Bank's ability to implement monetary policy."

While the TSLF is an auction-based security lending operation priced via a market-driven process (the fee is subject to two floors, 10 and 25 basis points depending on the basket of collateral used, type 1 or type 2), the SLS is a standing facility. The cost of resorting to the SLS is not determined by the demand expressed by banks, but by the 3 months Libor – 3 Months T-Bills rate spread subject to a floor of 20bp. The SLS appears more expensive than the TSLF, but provides funds for up to 3½ years. Should market sources offer cheaper funding before the end of these instruments, the pricing gives users a strong incentive to replace their use with market alternatives as soon as possible.

The TSLF auctions' outcomes are published weekly on the website, as are all FRBNY operations. Conversely, the BoE decided not to make the SLS details public while drawings under the scheme remain possible. This is meant to deal with the "stigma" issue (the standing facility nature of the SLS makes this more likely than with the TSLF OMO nature), and the negative signaling effect that large individual transactions could create. Some indications were given as to the likely size of the program (GBP 50 billion).

The market response has been positive. The repo market has settled down, and with it the funding gridlocks faced by banks seem to have abated. In both cases, the operations are intended to provide liquidity to the term market (specifically the 3 month money markets), not least since this affects the effective transmission of monetary policy. In general, it is important that any central bank considering such a scheme recognize the potential deleterious effects of adopting a definition of eligible collateral favoring a particular economic sector, and that the market should pay for the liquidity provided, rather than being subsidized.<sup>43</sup>

The Primary Dealer Credit Facility (PDCF) was announced by the Fed on March 16, 2008, in the context of the operations undertaken to avoid the bankruptcy of Bear Sterns. Although

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<sup>42</sup> The SLS stipulates that any securities used must have been on a bank's balance sheet before end-2007 or eligible securities formed from loans held on balance sheet as at December 31, 2007.

<sup>43</sup> Both the FRBNY and the BoE should make a small profit from "selling liquidity" to the market.

the technical features of the PDCF make it very similar to discount window operations, it nonetheless represents a significant expansion of the scope of the Fed liquidity management framework. The PDs are the Fed's OMO counterparties, but have not hitherto had access to standing facilities—those having been restricted to deposit-taking institutions. Dealers, in particular, are not subject to reserve requirements, nor to Fed regulation, oversight and supervision. Although effective in dealing with the liquidity stress undergone by these systemic institutions, and possibly also removing some of the stigma associated with the DW, the PDCF has opened a contentious debate on whether or not broker-dealers should fall within the regulatory umbrella of the Fed, and be subject to some of the supervisory and prudential constraints imposed on traditional commercial banks.

#### IV. EXIT STRATEGIES

A number of central banks are considering exit strategies from the operational measures introduced in response to the market turmoil. Indeed, for the Fed, certain measures are only possible legally in order to meet a “crisis,” and so cannot simply be maintained indefinitely.<sup>44</sup> Central banks could simply drop the use of certain instruments once the crisis is over; or—provided the instruments are appropriately priced—allow them to fade gradually from use as alternative market solutions become more attractive. In other cases they could make permanent the new instruments or features on the grounds that, while introduced during a crisis, they may represent useful enhancements to their operational frameworks. The question of an exit strategy raises a number of issues, which are just touched on here.

- *Will it be clear when the crisis is over?* It was hoped in October 2007 that a reduction in term spreads signaled a return to normality; but this proved to be short-lived. Central banks will be reluctant to unwind market support measures too early, only to have to re-introduce them shortly afterwards. This could do more harm than good.
- *Could market support measures delay the re-building of market functioning?* To the extent a central bank has replaced some market functions, because of a market failure, it may crowd out those market functions when the underlying causes of the crisis have been resolved. For instance, if term financing can be obtained easily and cost-effectively from the central bank, why go to the market?
- *What will “normal” look like?* There is no expectation that markets will return to their pre-crisis mode of operation soon, if ever. Market spreads taking account of credit and liquidity risk had arguably become too compressed pre-August 2007, and are now wider than they should be long-term. But it is not clear what the appropriate level should be.

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<sup>44</sup> On July 30, 2008 the Fed announced an extension to end January 2009, or as long as conditions in the market remain “unusual and exigent.”

At the outset of the crisis, it was commonly said that the Eurosystem operational framework worked very well, because it allowed for a wide range of direct participants, accepted a wide range of collateral, and provided a useful liquidity buffer via the level of required reserves. By contrast, the United States and the United Kingdom had to introduce changes to their frameworks to cope with the crisis (and other central banks introduced some changes, if only on a contingency basis). But this may put the latter two in a stronger position as regards exit strategies.

- All major central banks have extended the average maturity of their operations. It is relatively easy to revert to the previous maturity mix, or whatever mix is deemed suitable, by changing the volumes of liquidity provided in the various OMOs.
- The Fed could return to a narrow group of OMO counterparties by closing the TAF. If it wishes to convert the TAF into a permanent operational feature, it can adjust the maturity and the list of eligible collateral in light of lessons learned.
- Similarly, the Bank of England could maintain a wider eligible collateral list for its 3 month repo, or revert to the narrower list; and it can adjust the size of the target band for contractual reserves to suit changing market conditions.
- The Fed's TSLF and the Bank of England's SLS, which allow the market to swap illiquid securities against liquid treasuries, are priced such that PDs and banks have an incentive to revert to market sources for liquidity as soon as markets normalize. Moreover, both are time-limited. The United States could consider moving TSLF operations to the treasury balance sheet and leave the Fed in solely an agency role.
- The change in the mix of collateral provided to the Eurosystem, which has effectively allowed the market to substitute illiquid for liquid assets<sup>45</sup> - and in that respect is similar to the TSLF and the SLS - does not reflect any change in collateral policy, just in the use made of it. If the Eurosystem wishes the market to revert to using more liquid collateral, it may need to change its procedures or pricing. This would have the practical impact of reducing the number of banks which access the operations.

There are clear benefits to having a well-defined exit strategy. This in itself may point to the benefits of preparing a crisis tool-box in advance, since it may be hard, once a crisis has broken, to give sufficient thought to an exit strategy. It may be helpful to time-limit emergency measures (e.g., "the new facility/extension of collateral /participants/maturity will be in place for 12 months, or as long as deemed necessary" - both of which imply a finite and relatively short-lived existence). Terms can of course be extended if necessary. It would also make sense for all central banks which have undergone major market turmoil, to take the

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<sup>45</sup> Not all the new assets provided are securitized.

opportunity to review their operational frameworks once the dust has settled, and so benefit from the lessons they have drawn. All the major central banks may benefit from reviewing:

- Counterparty lists and the impact of different choices on the transmission mechanism and financial stability;
- The collateral demands of the existing system; collateral eligibility, and the benefits/drawbacks of tranching;
- The structure of reserves targets and liquidity flexibility which they provide;
- The maturity mix of OMO;
- The flexibility of the central bank's balance sheet;
- Legal constraints on the agility with which central bank operational frameworks can be changed; and
- The scope for addressing market failures at points of the yield curve important for monetary policy transmission, without sending unintended monetary policy signals.

## **V. CONCLUSIONS**

### **A. Liquidity Management**

An ample level of commercial bank reserves, with averaging, can cushion the impact on interest rates of a shock to supply or demand, although in stressed market conditions the martingale property tends to break down. Remuneration of reserves makes it easier for the central bank in a developed market to ensure that banks hold a sufficient level (although averaging around a zero level can achieve the same results). Two additional points have been less-well discussed, perhaps because they are more technical. First, a range for reserves, rather than a point target, provides more flexibility: the U.K. model may have lessons for others (provided reserves are remunerated: otherwise most banks would operate permanently at the lower acceptable boundary). Second, it may be possible for required reserves to be too high, even if they are fully remunerated: an excessive level of required reserves risks draining too much collateral from the market, and increases market incentives to provide lower quality collateral to the central bank.

### **B. Distribution Networks and Counterparties**

In many of the larger markets, central banks tend not to deal directly with all commercial banks (and securities firms) in their open market operations. As pointed out above, this has essentially been a matter of trade-offs between speed of operations, type and pricing of collateral, and of administrative capacity. But provided the number of actual intermediaries is sufficient for competition to exist, this is not a problem: the intermediaries perform a

distribution function, on-lending funds in response to market demand. This is a normal function in any market.

In times of stress, the distribution function can break down and may require direct access by a larger number of counterparties. Given the nature of liquidity stress, incomplete connectedness might indeed lead to patterns in which pockets of unused liquidity co-exist with regions of liquidity shortage. During situations of extreme liquidity stress, information asymmetries combine with behavioral patterns based on Knightian uncertainty. As a result, redistribution of central bank liquidity is inhibited. Broad access to SFs is usually seen as a natural way to attenuate these dynamics (Flannery, 1996), but as has been clearly observed in recent months, SFs are a far from perfect substitute for access to OMO.

But there is a caveat to the “more is better” argument. If accepting a larger number of counterparties implies also accepting a broader range of collateral, a central bank will at some point prefer the marginal enhancement to collateral quality over a marginal expansion of the number of counterparties.

### **C. Collateral**

Recent events have illustrated some benefits of a broad definition of eligible collateral. In a crisis, it is expedient for the central bank to be able to operate with a wide range of collateral that provides banks broad access to liquidity, increases the pool of potential counterparties, and releases more liquid collateral for interbank use. It is useful if planning for the broader range of collateral is undertaken and tested before a crisis strikes.

Accepting lower quality collateral may help to stem an excessive fall in its price. Collateralized operations may reduce distressed selling, which can put strong downward pressure on prices. If a market participant is forced to sell assets to an unwilling market to raise funds, other market participants may be forced to write down the value of their assets, prompting further distress sales – there may be a systemic risk. But if the assets can be pledged to the central bank to obtain funding, the distressed selling may be avoided. It is possible that the valuations used for such collateralized lending may help establish an indicative floor for the value of the assets; but the more important impact is likely to be that they effectively stem a downwards market and funding liquidity spiral which appears unjustified by the underlying risks.

However, following such a strategy increases credit risk for central banks. Accepting illiquid assets encourages banks to retain tradable collateral to post with other counterparties, and to see the central bank as “liquidity provider of first resort.” This “adverse selection” means the central bank is likely to accumulate inferior collateral.

Moreover, homogenous pricing of a wide range of collateral (in contrast to the “tranching approach” where repos are differentiated depending on the nature of the collateral) risks distorting the market. Although central banks can accommodate credit risk via ad hoc risk control measures, determining the value of nontraded instruments is problematic and exposes the central bank to “model risk.” The Fed’s TAF represents something of a compromise: the rate is market-determined by contrast to the normal Discount Window (although the eligible

collateral pool is the same), and is higher than short-term OMO lending via repos; but there is no pricing distinction among different types of collateral used in the TAF itself.

If collateral is to be priced differentially, there are three possible approaches:

- (a) If the central bank fixes the interest rate, the most straightforward is to use different collateral pools for OMO and SF, imposing a fixed and (at least in normal times) substantial additional cost on the SF.<sup>46</sup>
- (b) The second approach is to use market pricing. Different repo rates can be observed in the United States for government securities, agency bonds and mortgage-backed securities, for instance, and the central bank can therefore follow the market pricing in its own OMO. But market pricing cannot be observed for different elements of a bank's nonsecuritized loan portfolio.<sup>47</sup> This would indicate that variable differential pricing on the basis of collateral type can only be undertaken if the collateral pool is restricted to traded (not just tradable) securities. It may also be the case that multiple pricing by collateral type is only possible where the central bank uses a variable price for its OMO anyway. This fits in with the approach taken by the Fed and the RBA. It is not obvious how it would work with a minimum bid price (ECB, and Fed's TAF) or fixed price OMO (BoC, BoE and SNB).
- (c) A third possibility would be to have an add-on e.g., 50bp to policy rates for the use of nontraded collateral, as well as a penalty rate for the SF. A more finely differentiated pricing policy—with several tiers of pricing and several pools of collateral—could be difficult. Should mortgage collateral be priced differently depending on average LTV; and more or less expensively than corporate loans? What signals might be sent if such pricing differentials were changed? If only rated collateral were accepted, the central bank could mechanically add on a certain number of basis points per ratings notch, depending on the maturity of the loan.

Features which evolved in congruence with market developments proved most useful to market participants while limiting the increased exposure of central banks to loss. Congruence with market developments does not only refer to accepting instruments commonly used for secured market financing: indeed, a *short-term* mirroring of assets in which the market was active could represent a detrimental procyclical behavior. It also refers to ensuring that the terms under which these instruments are accepted, and the risk control measures in place (pricing, haircuts, valuations, concentration limits) are broadly in line with normal market conditions.

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<sup>46</sup> In fact, the U.S. Discount Window Rate is fixed by reference to the Fed funds target rate, but not by reference to the Fed's OMO transactions; the latter can vary, at times substantially, from the target rate.

<sup>47</sup> And even observing market prices accurately might become difficult in times of market stress.

### **D. Term Operations and Monetary Policy**

The increase in term lending by central banks has worked smoothly. There has been clear demand for 1-3 month money. Perhaps the most difficult issue relates to pricing. In normal circumstances, term lending can be conducted at market prices. But when the market has broken down, price formation becomes less robust. Setting a minimum rate, as in the TAF, may then be helpful.

All central banks have adapted their communications to unexpected developments. Effective central bank communication is critical in times of stress and elevated uncertainty, because the situation is so fluid and can change rapidly. Under such circumstances, market participants are keen to understand the central banks' responses and therefore information from central banks is scrutinized.<sup>48</sup> Central banks should aim at lessening uncertainty, maintaining confidence in the market, and clarify their readiness to address upcoming developments. Several general principles can be drawn.

- (a) First, more information needs to be provided than in normal times, including detail on operational aspects. As described above, the intention of market operations must be explicit. In retrospect, central banks might have spent more time explaining their operational frameworks but it is not clear that market participants would have been adequately engaged in learning while money markets were functioning smoothly.
- (b) Second, information should be delivered in a timely manner, even during the inter policy meeting period, so as to fill the information gap between the central bank and the market.
- (c) Third, and most importantly, communicating a consistency of operations with the policy objective is essential, and should help anchor inflation expectations.

### **E. Stigma**

Avoiding stigma should be an objective. Indeed, central banks increasingly use the penal interest rate involved in normal SFs as the sole disincentive.

There may be a relationship between stigma considerations, the width of central bank interest rate corridors and liquidity management tools. Good liquidity management and short-term rate control may mean that recourse to SF becomes very rare. Stigma could then make the SF ineffective. Indeed, a very high penal rate may lead to excessive holding of precautionary liquidity, and damage interbank trading. An appropriate balance needs to be found between

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<sup>48</sup> In normal market conditions, even market counterparties pay relatively little attention to the philosophy of the monetary operations framework.

encouraging market development and accepting an occasional, routine, use of standing facilities.

### **F. Cross-border Liquidity**

The introduction of the foreign exchange swaps linked to the Fed's TAF, as part of a wider package of measures to provide cross-border term funding, clearly contributed to the normalization of global interbank market pressures. In addition to the psychological value of demonstrating the commitment of major central banks to act in consort to deal with market turbulence, it also provided foreign banks access to U.S. dollar term funding at US market-determined rates, but using European-based collateral.

The future of these central-bank intermediated foreign exchange swaps is a topical question. The Fed may continue use of the TAF in the domestic market—dealing in OMO with a broader range of U.S. counterparties, at term, and at market rates. But will it be useful, or necessary, for the ECB and SNB to continue to provide access to term US dollar funds through their operational frameworks? Certainly one would not expect the globalization of liquidity management to decrease over time. But in normal market conditions, one would not expect central banks to need to intermediate in the foreign exchange swaps market either. In either case, the maintenance for the time being of the current swap arrangements—which could be broadened to include other countries—would appear to be beneficial to all parties concerned and helps to underpin market confidence that central banks are ready to act in unison.<sup>49</sup>

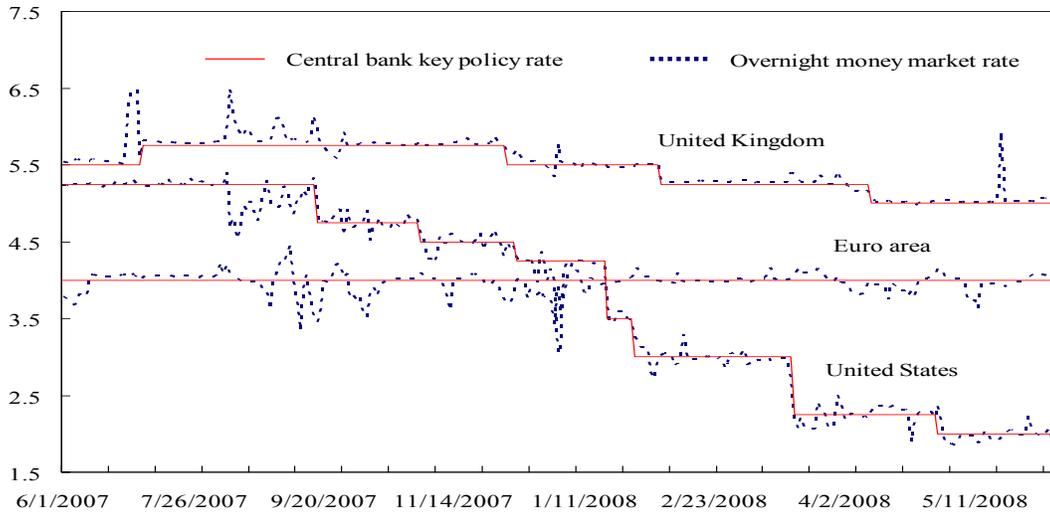
There have been some calls for the establishment of a global, cross-border collateral pool to facilitate the flow of liquidity across currency areas, and to facilitate liquidity management by multinational banks which may currently need to hold liquid assets in several currency zones. It is certainly conceivable that a group of central banks could identify a pool of high-quality liquid assets which were acceptable to all as eligible collateral. For some this might just formalize an existing practice of accepting certain foreign currency securities settled in other jurisdictions, and support the cross-border use of such collateral by something akin to the Eurosystem's Correspondent Central Banking Model (CCBM); but it might make little practical difference. A notable feature of the cross-border TAF usage is that the Fed provides US dollars without needing to take a view on the ECB or SNB's collateral policies. This arrangement may offer more scope for development than a common collateral pool as such; but realistically is likely to remain limited to small groups of central banks.

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<sup>49</sup> This is indeed observed among Asian central banks, e.g., the Chiang Mai initiatives; and more recently in regard to Iceland.

## Appendix I. Selected Figures

Figure 12. Central Bank Key Policy and Overnight Money Market Rates 1/  
(in percent)

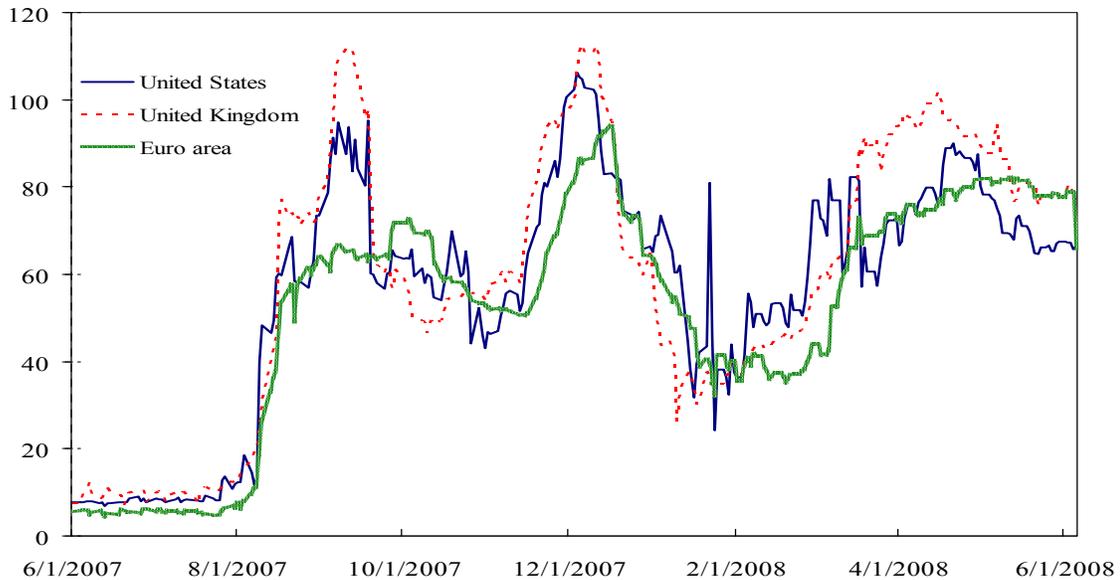


Source: Bloomberg L.P.

Note: Central bank key policy rates are the following: for the United States, Federal funds target rate; for the United Kingdom, Bank of England's official bank rate; and for Euro area, main refinancing operation minimum bid rate.

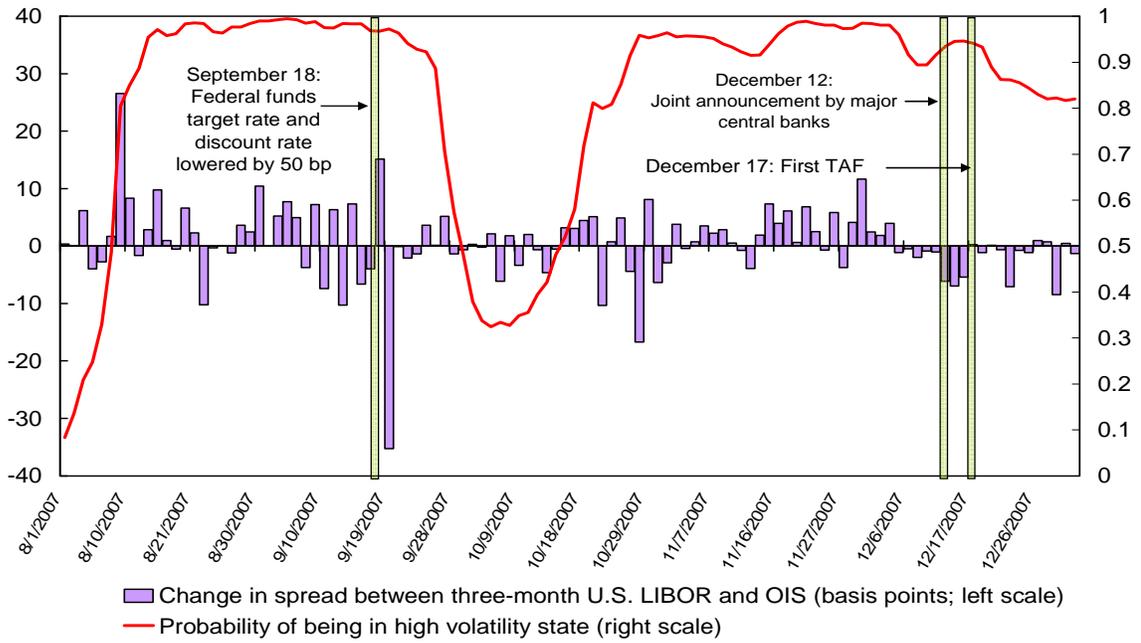
1/ Overnight money market rates are the following: for the United States, Federal funds effective rate; for the United Kingdom, Sterling overnight interbank average; and for Euro area, Euro overnight interbank average.

Figure 13. Three-Month LIBOR to Overnight Index Swap Spreads  
(difference in basis points)



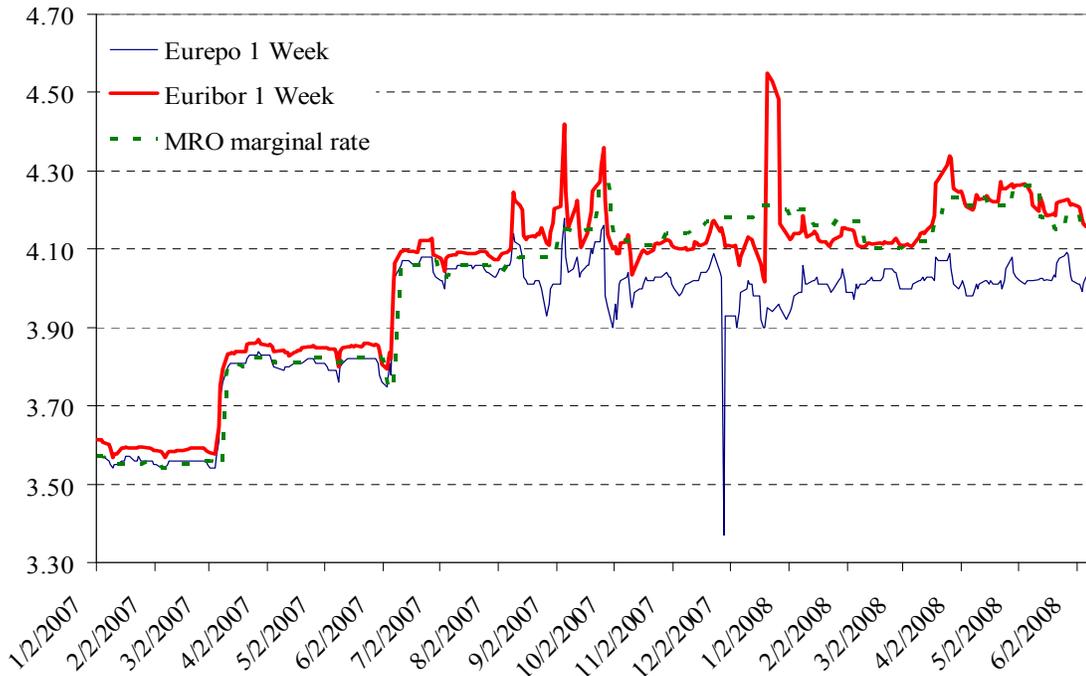
Source: Bloomberg L.P.

Figure 14. United States: Selected Federal Reserve Policy Actions and Term Funding Stress



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

Figure 15. European Central Bank Main Refinancing Rate vs. Eurepo One Week and Euribor One Week



Source: European Central Bank; and European Banking Federation websites.

## Appendix II. Chronology of Key Measures Taken by Central Banks

| <b>Date</b> | <b>Central Bank</b>     | <b>Measure</b>   |
|-------------|-------------------------|--|
| <b>2007</b> |                         |  |
| Aug. 9-14   | Eurosystem              | Carried out series of liquidity-providing fine-tuning operations, totaling more than €200 billion  |
| Aug. 10     | Fed                     | Issued statement that it will provide reserves as necessary to keep Fed funds rate at 5.25 percent.  |
| Sep. 14     | BoE                     | Northern Rock liquidity support facility announced.  |
| Dec. 12     | Fed, ECB, BoE, BoC, SNB | Announced measures designed to address elevated pressures in short-term funding market. First joint action by major central banks since financial market recovery needed after 9/11. |
| Dec. 17     | Fed                     | Conducted auction of \$20 billion in 28-day credit through its Term Auction Facility.  |
| Dec. 17     | Eurosystem, SNB         | Conducted U.S. dollar auctions of \$10 billion and \$4 billion respectively, on the same terms as Fed's TAF.   |
| Dec. 17     | ECB                     | Announced that it would allow banks to borrow an unlimited amount of 2-week funds: most determined effort to date to keep market rates closer to policy rate (4 percent).            |
| <b>2008</b> |                         |  |
| Mar. 11     | Fed                     | Fed: Introduced a Term Securities Lending Facility (TSLF).   |
| Mar. 16     | Fed                     | Announced the introduction of a Primary Dealer Credit Facility (PDCF).   |
| Apr. 21     | BoE                     | Launched a Special Liquidity Scheme.   |

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Sources: Central Bank websites; and Committee of the Global Financial System (2008).

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