10-1-2010

Harvey Miller Follow Up From Wendy Edelberg

Wendy Edelberg

Harvey R. Miller

Bank for International Settlements (BIS)

October 1, 2010

Via Email & Mail
Mr. Harvey R. Miller
Weil, Gotshal & Manges LLP
767 Fifth Avenue
New York, New York 10153
harvey.miller@weil.com

Re: Financial Crisis Inquiry Commission Hearing on September 1, 2010

Dear Mr. Miller:

Thank you for testifying on September 1, 2010 in front of the Financial Crisis Inquiry Commission and agreeing to provide additional assistance. Toward that end, please provide a written response to the following additional question and any additional information by October 15, 2010.[1]

> Please provide any ISDA studies or studies by other trade groups on the role derivatives played in Lehman's failure and also the impact Lehman's failure had on the derivatives market, including those derivatives contracts where Lehman was a counterparty.

The FCIC appreciates your cooperation in providing the information requested. Please do not hesitate to contact Sarah Knaus at (202) 292-1394 or sknaus@fcic.gov if you have any questions or concerns.

Sincerely,

Wendy Edelberg
Executive Director, Financial Crisis Inquiry Commission

cc: Phil Angelides, Chairman, Financial Crisis Inquiry Commission
Bill Thomas, Vice Chairman, Financial Crisis Inquiry Commission

[1] The answers you provide to the questions in this letter are a continuation of your testimony and under the same oath you took before testifying on September 1, 2010. Further, please be advised that according to section 1001 of Title 18 of the United States Code, "Whoever, in any matter within the jurisdiction of any department or agency often United States knowingly and willfully falsifies, conceals or covers up by any trick, scheme, or device a material fact, or makes any false, fictitious or fraudulent statements or representations, or makes or uses any false writing or document knowing the same to contain any false, fictitious or fraudulent statement or entry, shall be fined under this title or imprisoned not more than five years, or both."

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September 28, 2010

VIA ELECTRONIC MAIL

Honorable Brooksley Born
Commissioner
Financial Crisis Inquiry Commission
1717 Pennsylvania Avenue, NW
Washington, DC 20006-4614

Re: Financial Crisis Inquiry Commission Hearing – September 1, 2010

Dear Commissioner Born:

During the hearing held on September 1, 2010, you asked me if I was aware of any studies that had been done, or information gathered, as to the effect of the Lehman bankruptcy on the derivatives trading market. At the time, I responded that I thought that the International Swaps and Derivatives Association ("ISDA") might have prepared an analysis of the Lehman effect on derivatives trading and volatility. You asked me to furnish any such materials to the Commission, if they existed.

Since September 1, 2010, I have tried to ascertain whether any analyses have been undertaken by ISDA or others. This letter reflects the results of my efforts.

Insofar as I have been able to ascertain, ISDA did not specifically evaluate the direct effects of Lehman's failure on the derivatives market and trading. ISDA has published a survey of the notional amounts outstanding on all surveyed contracts from 1987 to the present, based on semi-annual data. The ISDA survey is attached. It indicates that the first significant decline in the notional amounts of outstanding credit default swaps ("CDS") and total interest rate and currency swaps occurred between the first and second halves of 2008.

The ISDA data does not indicate whether the decline in volume was the direct result of Lehman's bankruptcy or the overall financial crisis. However, it is reasonable to conclude that Lehman's bankruptcy had a very substantial impact on the economic environment and, consequently, must have contributed mightily to the decline in outstanding derivatives.

I have not been able to uncover any analysis by ISDA as to the causes of the decline in outstanding derivatives contracts. While ISDA has issued several comment letters responding to reports for various

governmental agencies and regulatory bodies, they make minor reference to the Lehman failure and do not discuss the actual effects of Lehman's bankruptcy.

The Bank for International Settlements ("BIS") has released a much more fulsome analysis of market data from the time period of Lehman's bankruptcy than the reports available from ISDA. The BIS publishes reports that track derivatives market data on a semi-annual basis. The report for the second half of 2008 is attached. According to that report, "[t]the financial crisis in the second half of 2008 resulted in the first ever decline in the total notional amounts outstanding of over-the-counter ("OTC") derivatives since data collection began in 1998." *OTC Derivatives Market Activity in the Second Half of 2008* (Bank for Int'l. Settlements, Basel, Switz.), Mar. 2009 at 1.

During the second half of 2008, based upon the BIS report, against a backdrop "of severely strained credit markets combined with efforts to improve multilateral netting of offsetting contracts," CDS volume decreased by 26.9%, *Id.* at 2. However, despite the lower outstanding volumes, the gross market value for CDS contracts increased by 78.2% due to credit market turmoil. *Id.*

Foreign exchange and interest rate derivatives markets also recorded their first significant downturns since data collection began. As compared to the prior six month period, in the second half of 2008 amounts outstanding of foreign exchange contracts fell by 21.0%. *Id.* at 1-4. After an above average rate of growth during the first half of 2008, the market for OTC interest rate derivatives declined, with notional amounts for such instruments falling to $418.7 trillion, 8.6% lower than during the prior six months. *Id.* at 1. However, despite the decrease in notional amounts outstanding, declining interest rates resulted in a notable 98.9% increase in the gross market value of interest rate derivatives. *Id.* The BIS also noted that ultimately there was a slightly higher concentration in interest rate derivatives relative to other derivatives as a result of low interest rates. *Id.* at 4.

The BIS also notes that in the second half of 2008 positions in OTC equity derivatives decreased by 36.2%, well below past levels, but also a notable change from the 20.1% increase in the first half of 2008. *Id.* at 4. Markets for commodity derivatives recorded volumes that were 66.5% lower than in the previous period. *Id.* at 3.

According to an article by Ingo Fender and Jacob Gyntelberg in the *BIS Quarterly Review*, the "trigger for [a] new and intensified stage of the credit crisis came on Monday 15. September" when "Lehman Brothers Holdings Inc. filed for bankruptcy protection, one of the biggest credit events in history. I. Fender and J. Gyntelberg, *Overview: Global Financial Crisis Spurs Unprecedented Policy Actions*. BIS QUARTERLY REVIEW, December 2008 at 1. Fender and Gyntelberg's article is attached. Fender and Gyntelberg write:

> As a result of Lehman's failure, "the turmoil in financial markets intensified and quickly spread from credit and money markets into the global financial system more broadly . . .With perceptions of counterparty risk rising, the benchmark US investment grade CDX credit default swap index spread jumped by 42 basis points on 15 September alone, and US high-yield spreads rose 118 basis points. Credit spreads in other major markets increased by similar amounts and continued to move in tandem with U.S. markets through the remainder of the period. As a result,

> at their peak, US high-yield CDS spreads reached an all-time high some 500 basis points above the highest comparable cash spreads realized at the height of the telecom bust in September 2002."

Id. at 4. Fender and Gyntelberg highlight the impact on the CDS market linked to Lehman's failure. The fallout in the $57.3 trillion CDS market attracted the most concern in the immediate wake of Lehman's failure. *Id.* at 6. Lehman was a major counterparty and reference entity with a central role in the CDS market. *Id.* A bankruptcy filing had two immediate effects: it triggered default clauses in CDS contracts referencing Lehman and resulted in terminations of many of such contracts. *Id.* Netting settling and replacing the respective positions raised operational risks. *Id.* Perhaps more importantly, at the time of Lehman's collapse, no discernable public information was available as to the volume of CDS contracts referencing Lehman or the net amounts required to settle such contracts. As a result, there was great uncertainty in the markets about the capacity of already strained money markets to accommodate increased liquidity needs. *Id.*

BIS publications have also noted that disruptions to the foreign exchange swap market during the financial crisis beginning in 2007 attracted considerable attention. At least one pair of commentators has argued that the failure of Lehman exacerbated an existing problem in the derivatives market, causing it to expand from a localized European liquidity crisis to a shortage of dollars on a global scale. In a BIS working paper, Naohiko Baba and Frank Packer analyze the effect of Lehman's collapse on the foreign exchange ("FX") swap market. *See* N. Baba and F. Packer, *From Turmoil to Crisis: Dislocations in the FX Swap Market Before and After the Failure of Lehman Brothers*. BIS WORKING PAPERS, No. 285, July 2009. Baba and Packer's paper is attached. Baba and Packer state that "the functioning of money markets was severely impaired in the summer of 2007, and even more so following the failure of Lehman Brothers in September 2008. What had begun as a deterioration in a relatively limited segment of the US subprime mortgage sector quickly spread to other markets, especially those of credit and securitized products." *Id.* at 1. Spreads of short-term interest rates and treasury bills widened substantially in August 2007, ultimately "exploding by a factor of 3-5 times in the wake of the mid-September failure of Lehman Brothers." *Id.* Baba and Pecker argue that dollar funding shortages of European financial institutions, combined with increased counterparty risks, caused most of the disruption in the FX swap market prior to Lehman's collapse. As European financial institutions converted euros into dollars through FX swaps to combat unfavorable supply and demand conditions and the related impairment of liquidity in the markets, U.S. counterparties were less likely to lend dollars. However, upon Lehman's bankruptcy, concerns over counterparty risk of financial institutions expanded beyond those headquartered in Europe, and the dollar liquidity problem experienced by European banks expanded into a worldwide problem.

In short, the BIS reports provide additional support that Lehman's failure had a dramatic impact on the financial market.

I hope that the foregoing is of some help in your deliberations and those of the Commission.

Respectfully,

Harvey R. Miller

copies via email:

Mr. Phil Angelides - Chairman
Honorable Bill Thomas – Vice Chairman
Byron S. Georgiou, Esq. – Commissioner
Honorable Bob Graham – Commissioner
Mr. Keith Hennessey – Commissioner
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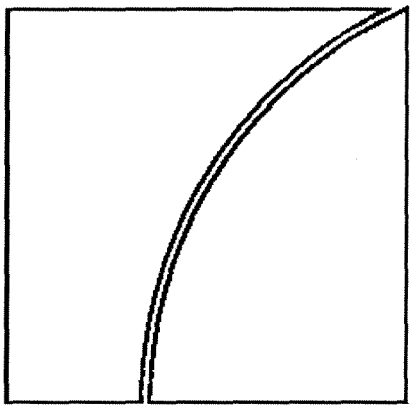

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From turmoil to crisis: dislocations in the FX swap market before and after the failure of Lehman Brothers

by Naohiko Baba and Frank Packer

Monetary and Economic Department

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JEL classification: F31, G15

Keywords: FX swap, Covered interest parity, Financial market turmoil, Counterparty risk, US dollar swap lines, Term auction facility, Central bank cooperation, Lehman bankruptcy

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From turmoil to crisis: dislocations in the FX swap market before and after the failure of Lehman Brothers

Naohiko Baba* and Frank Packer†

Abstract

This paper investigates dislocations in the foreign exchange (FX) swap market between the US dollar and three major European currencies. After the failure of Lehman Brothers in September 2008, deviations from covered interest parity (CIP) were negatively associated with the creditworthiness of US financial institutions (as well as that of European institutions), consistent with the deepening of a dollar liquidity problem into a global phenomenon. US dollar term funding auctions by the ECB, SNB, and BoE, as well as the US Federal Reserve commitment to provide unlimited dollar swap lines are found to have ameliorated the FX swap market dislocations.

Key words: FX swap, Covered interest parity, Financial market turmoil, Counterparty risk, US dollar swap lines, Term auction facility, Central bank cooperation, Lehman bankruptcy

JEL classification: F31, G15

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1. Introduction

The functioning of money markets was severely impaired in the summer of 2007, and then even more so following the failure of Lehman Brothers in September 2008. What had begun as a deterioration in a relatively limited segment of the US subprime mortgage sector quickly spread to other markets, especially those of credit and securitized products (BIS, 2008; IMF, 2008). Uncertainty about losses increased the liquidity needs of financial institutions as well as their reluctance to lend to each other in money markets. Reflecting these and possibly other factors, spreads of interbank short-term interest rates over overnight index swap (OIS) and treasury bill rates widened substantially in August 2007, and then, despite some degree of fluctuation, persisted at high levels (Taylor and Williams, 2009), before exploding by a factor of 3-5 times in the wake of the mid-September failure of Lehman Brothers (Fender and Gyntelberg, 2008).

Foreign exchange (FX) swap markets were immune neither to the turmoil nor crisis. Baba et al. (2008) document heightened volatility in the FX swap markets across several G10 currency pairs beginning in the summer of 2007. As noted in that paper, the three-month FX swap-implied dollar rate using euro as a funding currency moved together quite closely with dollar Libor (London interbank offered rate) prior to mid-August 2007. After that, however, the spread between the FX swap-implied dollar rate and dollar Libor widened considerably, reaching more than 40 basis points in September 2007, pointing towards a large and persistent deviation from the short-term covered interest parity (CIP) condition (Figure 1).[3] Just as in the case of Libor-OIS spread, the deviations from CIP then exploded following the bankruptcy of Lehman Brothers.

Baba and Packer (2009) argue that dollar funding shortages of European financial institutions, combined with increased counterparty risks, were largely responsible for dislocations in the FX swap market prior to September 2008. Facing unfavourable demand and supply conditions and the associated impairment of liquidity in interbank markets, many European financial institutions moved to actively convert euros into dollars through FX swaps, creating a one-sided market as US counterparts became more cautious about lending dollars.[4] As documented in Baba and Packer (2009), FX swap prices began to reflect relative counterparty risks after the onset of financial turmoil, indicating that concern over the counterparty risk for European financial institutions relative to that for US financial institutions was an important factor underlying deviations from short-term CIP. However, the study covers a period that ended prior to the bankruptcy of Lehman Brothers, when the turmoil in many markets became much more pronounced, concerns over the counterparty risk of financial institutions expanded well beyond those headquartered in Europe, and the dollar liquidity problem for European institutions deepened into a phenomenon of global dollar shortage.

Central banks undertook coordinated efforts to make dollar funding more readily available to non-US financial institutions, which were redoubled after the Lehman failure. More specifically, on December 12, 2007, the establishment of swap lines between the US Federal Reserve and both the European Central Bank (ECB) and the Swiss National Bank (SNB) was announced. These swap lines allowed the ECB and SNB to conduct US dollar term funding auctions during European trading hours for depository institutions in continental

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[3] An FX swap is a short-term contract in which two parties borrow and lend different currencies simultaneously by combining the FX spot and forward contracts in the reverse direction. The FX swap-implied dollar rate is defined as the total cost, in terms of the dollar rate, from raising euros in the uncollateralised cash market and converting them into dollars through the FX swap market. See Section 2 for more details.

[4] ECB (2007) stated that many non-US financial institutions moved to actively convert euros into dollars through FX swaps after the turmoil began in early August 2007.

Europe in a fashion that complemented the Federal Reserve's own term auction facility (TAF) for US institutions.[5] The size of the transatlantic swap lines was increased several times beginning in March 2008, while alternative maturities were introduced beginning in August. In the immediate aftermath of the Lehman failure in mid-September, not only was the size of the swap lines to support dollar operations increased by a factor of 3-5 times, but new swap lines with other central banks were introduced, including the Bank of England (BoE) and Bank of Japan (BoJ). On October 13, the maximum limits on the swap lines for the ECB, SNB, BoE and BoJ were lifted altogether, permitting these central banks and eligible counterparties unlimited access to US dollar funding in response to market conditions.

In this paper, we empirically investigate the dislocations in the FX swap market both before and after the failure of Lehman brothers under the turmoil across the euro/dollar (EUR/USD), Swiss franc/dollar (CHF/USD), and sterling/dollar (GBP/USD) pairs. We examine the degree to which the common factor underlying deviations from short-term CIP observed in the FX swap market for these currency pairs can be explained by a small number of variables reflecting the ongoing turbulence in global financial markets. Though we control for other relevant factors, we place particular emphasis on the following two issues: (i) the role of the perception of counterparty risk of European and US financial institutions and (ii) the role of the establishment of the dollar swap lines with the Federal Reserve by major central banks in easing tensions in the FX swap market, as well as the take-up of those swap lines through dollar term funding auctions by the ECB, SNB, and BoE.

In the extant literature, a number of studies test the short-term CIP condition, and some identify the specific periods in which such parity conditions collapsed. However, to the best of our knowledge, this paper, in conjunction with the earlier companion piece which covered only the period prior to the failure of Lehman Brothers (Baba and Packer, 2009), is the first one to examine these deviations in the context of the recent financial crisis. Understanding the dislocations in the FX swap market is all the more important given the rapidly growing role of FX swaps in foreign currency funding by financial institutions globally.

The rest of the paper is organized as follows. Section 2 gives an overview of the basic structure of an FX swap and its relationship to the CIP condition. Section 3 describes the evolution of dollar shortage from the beginning of the turmoil in the summer of 2007 into the crisis conditions following the failure of Lehman Brothers. Section 4 presents the empirical strategy, including a conceptual decomposition of possible deviations from CIP in the FX swap market and the main hypotheses to be tested. Section 5 describes the data and construction of the variables, and Section 6 provides the framework and results of the empirical analysis. Section 7 concludes the paper.

2. The FX swap and covered interest parity

An FX swap is a short-term contract in which one party borrows a currency from, and lends another simultaneously to the same party. FX swaps can be viewed as effectively collateralized transactions, though the collateral does not cover the entire counterparty risk. For example, if the counterparty were to default during the contract period, the party would need to reconstruct the position at the current market price, which entails replacement cost. Further, Duffie and Huang (1996) show that FX swaps are subject to significantly more exposure to counterparty risk than are interest rate swaps, due to the exchange of notional amounts.

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[5] See Section 3 for more details. For the coordinated efforts by the central bank community at early stages of the turmoil, see Borio and Nelson (2008) and CGFS (2008).

When non-US financial institutions need short-term dollar funds, they can borrow directly in the dollar cash market, or combine domestic currency borrowing with an FX swap.[6] For example, an institution funding itself in euros but desiring dollar funding could swap the proceeds for dollars, ie in effect sell euros for dollars at the FX spot rate, while contracting to exchange in the reverse direction at maturity at the FX forward rate. In this paper, we call the total cost of raising dollars using euros as a funding currency through the FX swap market "the FX swap-implied dollar rate from the euro". The equality of the FX swap-implied dollar rate and dollar deposit rate defines a condition of indifference as

$$\frac{F_{t,t+s}}{S_t}\left(1+r_{t,t+s}^{EUR}\right)=1+r_{t,t+s}^{USD}. \quad (1)$$

Here, the left-hand side of equation (1) corresponds to the FX swap-implied dollar rate from the euro, where S_t is the FX spot rate at time *t*, $F_{t,t+s}$ is the FX forward rate contracted at time *t* for exchange at time *t+s*, and $r_{t,t+s}^{EUR}$ is the uncollateralized euro interest rate from time *t* to time *t+s*. $F_{t,t+s}/S_t$ corresponds to the forward discount rate conventionally used as the FX swap price. $r_{t,t+s}^{USD}$ is the uncollateralized dollar interest rate. Equation (1) is equivalent to the CIP condition in the traditional international finance literature.

CIP states that interest rate differentials between currencies should be perfectly reflected in the FX forward discount rates, since otherwise an arbitrageur could transact in money and FX markets to make a risk-free profit. A number of studies assess the degree to which short-term CIP is supported by the data. Most of them show that the deviations from the short-term CIP condition have diminished significantly at least among G10 currencies. However, Taylor (1989) finds that, despite increasing efficiency in FX markets, deviations from CIP tend to be evident during periods of uncertainty and turmoil, and persist for some time.[7]

For CIP to hold strictly depends on negligible transaction costs, as well as the lack of political risk, counterparty (credit) risk, liquidity risk, and measurement error (Aliber, 1973). While transaction costs and political risk are largely negligible in today's G10 currency markets, counterparty risk may have increased significantly under the recent turmoil. To the extent that counterparty risk was concentrated on one end of the FX swap market, a deviation from CIP could have emerged. This is particularly the case, when uncollateralized dollar cash markets malfunctioned under the turmoil, and so the only channel of dollar funding was the FX swap market. For example, if European financial institutions typically on the dollar borrowing side of the FX swap market were perceived as risky by US financial institutions on the dollar lending side, then risk premia could have been added to FX swap prices. One historical precedent dates from the late 1990s, when the perceived creditworthiness of Japanese banks raising dollar funds in global cash markets deteriorated significantly, and large deviations from CIP in the dollar/yen FX swap market emerged.[8]

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[6] FX swaps have been employed to fund foreign currencies, both for financial institutions and their customers, including exporters and importers, as well as institutional investors who wish to hedge their positions of foreign bonds against the FX risk. FX swaps are also frequently used as a tool for speculative trading typically by combining two positions with different maturities.

[7] According to Taylor (1989), significant deviations were observed on such occasions as the flotation of sterling in 1972 and inception of the European Monetary System in 1979. In addition, Akram et al. (2008) investigate deviations from the CIP condition using tick data that covers several months in 2004 and find some economically significant deviations from the CIP condition, albeit short-lived.

[8] See Hanajiri (1999), who suggests that the large deviations from CIP at the time were due chiefly to the deteriorating creditworthiness of Japanese banks, compounded by increased volatility of the FX rate. For an

Liquidity risks may have played a role, as well, particularly if market liquidity was impaired due to outsized or one-sided order flow. This in turn could be due to the realization of funding liquidity risks in the money market. Note, however, that both types of liquidity risk and counterparty risk are most likely intertwined in a complex manner particularly in times of stress, and it is thus quite difficult to distinguish quantitatively between their premia. For example, an illiquid but solvent bank could become insolvent due possibly to inherent maturity mismatch between their assets and liabilities and an inability to roll over short-term funding, combined with an inability to efficiently liquidate positions in certain assets. In the case of dollar funding shortages of European financial institutions, their order flow for dollars in the FX swap market was reported to have surged during the recent financial turmoil. This was due largely to constraints on borrowing in the uncollateralized dollar money market, where US financial institutions appeared less willing to lend dollars to other institutions, resulting from heightened counterparty risk, as well as their own increased demand for dollar liquidity.

Finally, measurement error could have been heightened as well. During the recent turmoil, dollar Libor was reported to have underestimated the dollar funding costs that euro-zone financial institutions actually faced. The non-binding nature of Libor may lead to biased quotes on the part of institutions wary of revealing information that might increase their borrowing costs in times of stress.

3. Global US dollar shortages and central bank policies

3.1 The origins and emergence of US dollar shortages

The origins of the US dollar shortage, as described in a number of recent BIS publications, largely stemmed from a sharp growth in the US dollar assets of European banks over the past decade that sharply outpaced the growth in their retail dollar deposits (McGuire and von Peter, 2008; 2009). As funding from banks and non-banks typically covered only part of this structural shortage of US dollars, European banks were heavily reliant on the FX swap market to obtain such dollar funding.[9] In the summer of 2007, European financial institutions started to increase activity to secure dollar funding to support troubled US conduits to which they had committed backup liquidity facilities, and at the same time interbank funding liquidity deteriorated in line with increased concerns about the creditworthiness of banks. Under these circumstances, an increasing number of European institutions moved to convert European currencies into dollars via FX swaps, resulting in one-sided order flow, and a severe impairment of liquidity in the FX swap markets.

From mid-August to mid-September 2007, market participants indicated that the deteriorating liquidity in underlying term dollar, euro and sterling markets made it very difficult to identify the appropriate interest rates at which to price forward transactions. As a result, FX swap market experienced much wider bid-ask spreads than normal (FRBNY, 2007). Anecdotal evidence also indicated that concerns about counterparty risk were causing on the one hand riskier counterparties to find it more difficult and costly to make transactions, and on the other hand market makers to withdraw from the market. Reflecting these and other factors, as described in Baba et al. (2008), the spreads between the FX swap-implied dollar rates and

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analysis of the so-called "Japan premium" at that time for Japanese banks in interbank lending markets, see Covrig et al. (2004) and Peek and Rosengren (2001).

[9] European banks' reliance on dollars was not met by a proportionate need of US banks for European currencies, which implied that a shock to counterparty risk affected the FX swap market disproportionately (Baba et al, 2009).

dollar Libor rose considerably from late August, moving up to levels by close to 45 basis points when funded in the euro, and more than 20 basis points in the Swiss franc and the sterling. It is the determinants of these deviations that we analyze in this paper.

Though there was some alleviation of tensions in FX swap markets in mid-September 2007, from mid-November, trading liquidity in the FX swap market was again impaired, exacerbated by typical year-end funding pressures. Concerns about counterparty risk and one-sided markets again led to wider bid-ask spreads and wider effective dollar costs of funding via the FX swap market than the cash markets.

3.2 The December 2007 policy response: The establishment of US dollar swap lines

In December 2007, the Federal Reserve, the ECB and the SNB responded in a coordinated fashion to address the US dollar shortages of European financial institutions. To improve financial market functioning by providing liquidity in US dollars abroad, the Federal Reserve announced the establishment of swap lines, or "reciprocal currency arrangements", with the ECB and the SNB on December 12.[10]

In terms of the specifics of the agreement at that time, the ECB could swap euro for up to $20 billion, and the SNB could Swiss francs for up to $4 billion, respectively, through the end of June 2008 (Figure 2). Drawing on these funds, the ECB and SNB were then able to temporarily lend—through auctions conducted in parallel with those of the Federal Reserve's Term Auction Facility (TAF)—the dollar proceeds of swaps to Eurosystem and Swiss counterparties with eligible collateral in need of term dollar funding. On December 17 and 21, the ECB conducted fixed rate auctions for $10 billion of 28-day and 35-day funds, respectively, where the rate was determined by the marginal rate of the same day Federal Reserve TAF auction (Table 1). On December 17, the SNB held a variable rate tender auction for $ 4 billion (Table 2). All auctions were fully subscribed; thus, by the end of the year, both the ECB and SNB had fully drawn down their swap lines with the Federal Reserve. Similar auctions which essentially rolled over the 28-day swap lines were conducted by the ECB in January 14 and 28, and by the SNB of January 14. However, as term funding pressures declined in February, as well as FX swap market deviations, the auctions were subsequently suspended by the ECB and SNB and not held in February.

3.3 The renewal of term funding pressures and March 2008 increase in swap lines

However, towards the end of February and in March, despite a variety of other measures implemented by the Federal Reserve to ease funding pressures such as the expansion of the size of the TAF, and the implementation of the Term Securities Lending facility, concerns about systemic risk in the financial system resurfaced, and stresses in the FX swap markets again intensified. In response, on March 11 the Federal Reserve authorized further increases in the swap lines with the ECB and the SNB to $30 billion and $6 billion, respectively, and also extended the terms of the swap lines through September 30, 2008. The ECB and SNB both reinstituted their dollar auctions and increased their sizes in line with the increased swap lines. On March 25 and April 7, the ECB held two auctions for $15 billion, while the SNB held one auction for $6 billion on March 25.

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[10] These were the first established since September 11, 2001, when swap agreements were put into place to assist financial market functioning after the disruptions to infrastructure due to the terrorist attacks.

3.4 The May / July increases in swap lines and additional measures

But even these amounts were insufficient, and to address further pressures in dollar funding markets, on May 2 the Federal Reserve authorized further increases in dollar swap lines with the ECB and the SNB to $50 billion and $12 billion, respectively, and extended their terms again through January 30, 2009. The ECB and SNB were able to increase the size of their dollar auctions to locally eligible institutions which remained fully booked, and by June 30 both lines were completely drawn.

On July 30, in addition to raising the ECB swap line by another $5 billion to $55 billion, the Federal Reserve announced that it would auction 84-day funds via the TAF (while continuing with the 28-day fund auctions), to counteract the perceived increasing shortages of dollar funds at a longer maturity. It was also announced that, in coordination with the lengthening of the maturity of the TAF loans of the Federal Reserve, the ECB and SNB also would make available funds of 84 day maturity in their dollar auctions. The increase in the ECB's swap line was authorized in order to accommodate a shift of some of its auctions to 84-day terms. Auctions of 84-day dollar funds for local institutions were then held by the ECB and SNB on August 11 and 12, respectively.

3.5 From turmoil to crisis: The failure of Lehman Brothers

Concerns over the health of the financial sector—and related counterparty risks— increased sharply after the bankruptcy of the investment bank Lehman Brothers on September 15. The sharp rise in counterparty credit concerns—which were also damaged by the Federal Reserve's announcement of a bailout package for AIG the next day—led to even more intense pressures in global funding markets. Greater demand for funding coinciding with heightened precautionary hoarding by many institutions hit both secured and unsecured term lending markets. Many financial institutions increasingly funded themselves at very short maturities, raising rollover risks (FRBNY, 2008).

Global funding market pressures were evident in the virtual shut-down of the FX swap market. Dealers reported that bid-ask spreads on FX swaps increased to as much as 10 times the levels that had prevailed before August 2007.[11] They also reported a widespread decline in interbank market making and exceptionally limited trading activity in term maturity tenors. The price action was reportedly driven by demand for dollar funding from global financial institutions, particularly European financial institutions. As many of these institutions increasingly struggled to obtain funding in the unsecured cash markets, they turned to the effectively collateralized FX swap market as a primary channel for raising dollar funding. This extreme demand for dollar funding led a sizable shift in FX forward prices, with the implied dollar funding rate observed in FX swaps on many major currencies rising sharply above that suggested by the other relative interest measures such as the dollar OIS (overnight index swap) rate and the dollar Libor. During the quarter, the spread of the three month FX swap-implied dollar rate from euro and sterling—US dollar FX forward points—over the dollar Libor fixing rate widened to around 330 and 260 basis points, respectively, in early October after the Lehman failure (Figure 1).

Once again, the central banking community was galvanized into action. To further address the problems in funding markets which had worsened in the wake of the Lehman failure, on September 18, the US Federal Reserve authorized a more than two-fold increase in the swap lines to the ECB and SNB of $110 and $27 billion, respectively. At the same time, new dollar swap lines were opened to the BoJ, BoE and Bank of Canada (BoC) of $60, $40 and $10 billion, respectively. The new swap lines to the BoE were in response to dislocations in

[11] For some examples of indicative bid-ask spreads, see Melvin and Taylor (2009).

the GBP/USD FX swap market which is one of the FX swap currency pairs under investigation in this paper (Figure 2, Table 3).

As the financial crisis continued, there followed rapid-fire increase in the amount of the dollar swap lines over the next few weeks. The swap lines with the ECB and SNB were increased to $120 and $30 billion on September 26, and the ECB, SNB, BoJ, BoE and BoC's swap lines were increased to $240, $60, $120, $80 and $30 billion on September 29. Finally, on October 13, the swap lines were announced to be unlimited with the ECB, SNB, BoE, with the BoJ following the day after.

In a signal of how the crisis had taken on global dimensions, and how seriously the Federal Reserve viewed its role as a provider of global dollar liquidity, new central banks in addition those from Japan, England, and Canada were brought into the swap lines, including many from emerging market economies. The Federal Reserve established swap lines with the Reserve Bank of Australia, the Sveriges Riksbank, the Denmarks Nationalbank and the Norges Bank on 24 September, while the Reserve Bank of New Zealand (RBNZ) was signed up on October 28. On October 29, the Banco Central do Brasil, the Banco de Mexico, the Bank of Korea and the Monetary Authority of Singapore were added to the list of countries with dollar swap lines established with the Federal Reserve. As of the end of October, the authorized swap line amounts were $30 billion for the central banks of Canada, Australia, Sweden, Brazil, Mexico, Korea and Singapore, and $15 billion for the Norges Bank, Denmarks Nationalbank and the RBNZ.[12] As mentioned above, the ECB, the SNB, BoE, and BoJ had unlimited swap line amounts. In late 2008, all swap lines had been authorized through April 30, 2009, though on February 3, 2009, the Federal Reserve extended the swap lines to October 30, 2009.

Financial markets reacted well to the announcements of both the increases in the absolute amounts of the swap lines and the increase in numbers. In particular, the approval of unlimited dollar swap facilities for selected central banks on October 13 was greatly welcomed. Many market participants reported that the expended swap facilities improved term funding conditions: indeed, from the time of the dramatic moves on October 13 to the end of the year, the three-month dollar Libor-OIS declined by approximately 230 basis points to 120 basis points. Meanwhile, over the same time period, the FX swap market deviations from the CIP condition fell sharply, particularly for the EUR/USD and CHF/USD pairs (by more than 60 and 80 basis points, respectively), to the levels which were still above those traced before the Lehman failure, but not by very much (Figure 1).

4. Empirical strategy and main hypotheses

4.1 Overall empirical strategy

In this paper, we analyze three FX swap pairs between the US dollar and each of the three major European currencies (EUR, CHF and GBP). Our sample period covers the period from August 9, 2007 through January 30, 2009 and is divided into subperiods of before and after the Lehman Brothers bankruptcy filing on September 15, 2008.[13] This is because the failure

[12] Interestingly, as of December 31, the BoC, the RBNZ, Banco Central do Brasil, Banco de Mexico, and the Monetary Authority of Singapore had not drawn down on their swap lines, though it was thought that the mere announcement of the swap lines had had an announcement effect on FX swap market dislocations.

[13] Baba and Packer (2009) cover the period from September 1, 2006 through September 12, 2008, putting emphasis on the comparison of the EUR/USD pair deviations from CIP between pre-turmoil and turmoil periods.

of Lehman Brothers ushered in a new period of global US dollar shortages characterized by much higher volatility in financial markets, as discussed above. Specifically, the first period covers from August 9, 2007 through September 12, 2008,[14] and the second period covers from September 15, 2008 through January 30, 2009.

We first attempt to extract a common factor from the FX swap deviations for these three currency pairs, using principal component analysis.[15,16] This common factor should reflect the general supply/demand imbalances for US dollars vis-à-vis European currencies emanating from the whole range of financial institutions operating in the FX swap market of these different currency pairs. The use of the common factor analysis is chiefly motivated by the fact that European financial institutions choose the funding currencies in a very flexible manner depending on the relative funding costs of different options for raising dollars through FX swaps. For example, banks in the euro area often use other European currencies, typically Swiss franc and/or pound sterling, as a funding currency to raise dollars when the dollar-raising cost using these currencies is low compared with the cost using euros. Thus, FX swap-implied dollar rates should be very closely related each other even in the turmoil and crisis periods, particularly among these three currency pairs.

Then, we apply the EGARCH (exponential generalized autoregressive conditional heteroskedasticity) model to the common factor, to estimate the impacts of counterparty risk measures for European and US financial institutions on the level of the common factor, as well as measure the effectiveness of central bank policy initiatives on both the level and volatility of the common factor.

4.2 Decomposition of FX swap deviations

We basically follow the conceptual decomposition formula of FX swap deviations from short-term CIP, as proposed in Baba and Packer (2009), using the OIS rates as a benchmark interest rate. The OIS is an interest rate swap in which the floating leg is linked to a publicly available index of daily overnight rates. The two parties agree to exchange at maturity the difference between interest accrued at the agreed fixed rate and interest accrued through the geometric average of the floating index rate. We regard the OIS rates as a proxy for expected future overnight rates for the following two reasons. First, the counterparty risk associated with the OIS contracts is relatively small because no principal is exchanged.[17] Second, the liquidity risk premia contained in OIS rates should be very small because of the lack of any initial cash flows.

The use of OIS rates as a benchmark enables us to decompose the FX swap deviation measured by Libor rates as follows:

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[14] We follow Taylor and Williams (2009) in the choice of August 9 as a starting date of the turmoil, which is when BNP Paribas, in announcing the freeze of redemptions for three of its investment funds, cited an inability to value them. Subsequently, the risk premia embedded in short-term money market rates, as represented by the Libor-OIS spreads, widened substantially in major currencies.

[15] The aim of the principal component analysis is to reduce the dimensionality of the data with minimum loss of information. This method has recently seen renewed interest to evaluate the common factor across various financial asset classes. See Longstaff et al. (2008) and Pérignon et al. (2007), among others. Furthermore, Baba (2009) utilize the principal component analysis to analyze the common factor between the short-term FX swap and the longer-term cross-currency basis swap markets.

[16] By contrast, Baba and Packer (2009) use the FX swap deviation for the EUR/USD pair as a dependent variable.

[17] Moreover, the residual risk is mitigated by collateral and netting arrangements.

$$F/S\left(1+Libor^{i}\right)-\left(1+Libor^{USD}\right)$$
$$\approx\left[\left(\ln F^{i,USD}-\ln S^{i,USD}\right)-\left(OIS^{USD}-OIS^{i}\right)\right]+\left[\left(Libor^{i}-OIS^{i}\right)-\left(Libor^{USD}-OIS^{USD}\right)\right] \quad (2)$$

i=EUR, CHF, and GBP

Here, the right-hand side of equation (2) can be obtained by first separating the term involving the FX forward discount rate from that involving Libor rates, and then log-approximating the FX forward discount term.[18] This decomposition is useful in choosing explanatory variables for the common factor regressions that follow.

4.3 Two sets of main hypotheses

The following two sets of main hypotheses are tested. The first hypothesis concerns the counterparty risk of European and US financial institutions perceived in the markets. We observe that under normal circumstances European financial institutions are on the US dollar borrowing side of FX swaps, and US financial institutions are on the US dollar lending side. Thus an asymmetry of counterparty risk between European and US financial institutions could potentially show up in the FX swap deviations from CIP. We call this the counterparty risk hypothesis.

The counterparty risk hypothesis is directly related to the first term on the right-hand side of equation (2), which denotes the deviation of the interest rate differential implied in the FX forward discount rate from the differential in the OIS rates of the same currency pair.[19] If European financial institutions facing US dollar shortages are perceived as riskier by US counterparts, then a risk premium may be added to the forward discount rate relative to pure expectations about the interest rate differential between the dollar and the European currency that are reflected in the OIS rates. Thus, an increase in counterparty risk for European financial institutions should always work to raise the FX swap deviations, as we have measured them, while increased counterparty risk for US financial institutions should work in the opposite direction.[20]

On the other hand, when the dollar shortages localized among European financial institutions became a global shortage after the Lehman failure as discussed above, the impact of increasing counterparty risk for US financial institutions may have changed. US financial institutions also suddenly faced considerable difficulty raising US dollar funds in the short-term cash markets, due chiefly to greatly increased concerns over counterparty risk, and these needs could not be entirely met by scheduled TAF auctions of the Federal Reserve. Under such circumstances, US financial institutions would have much less ability to provide dollar funds in the FX swap markets, and many market participants even suggested that some US financial institutions in fact turned to FX swap markets to raise US dollars using

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[18] We abstract from the term $(F/S-1)Libor^{i}$ because it is at least an order of magnitude smaller than the other terms.

[19] The Libor-OIS spreads in the second term on the right-hand side of the same equation may also capture counterparty risk, as argued in Taylor and Williams (2009). However, Libor-OIS spreads should reflect average counterparty risk for Libor panel banks and not necessarily the counterparty risk of European financial institutions relative to US institutions. See Section 5 for more details.

[20] As alluded to earlier, counterparty risk is closely associated with market liquidity risk particularly in times of stress, and thus conceptually speaking, it would be appropriate to control for transactions costs when estimating the effect of counterparty risk. Due to the difficulty in finding reliable time-series measures of market liquidity in the FX swaps market that we could apply to our empirical framework, though, we can control only for funding liquidity conditions. To the extent that market liquidity independently might affect FX swap deviations, and also be correlated to counterparty risks while being relatively uncorrelated to funding liquidity risks (for which we control), the measured effects of counterparty risk may be overstated.

European currencies as funding sources. If US institutions in fact undertook such actions extensively, then we might expect counterparty risk for US institutions to be *positively* related to the level of FX swap deviations during the second period under investigation.

The second set of hypotheses concerns the effects of central bank measures to address the US dollar shortage problem, as discussed in Section 3. Specifically, we test the following two types of measures. The first type is the US dollar auctions conducted by the ECB, SNB and BoE, which are supported by the swap lines with the Federal Reserve. What we call the USD auction hypothesis posits that, because of their associated provision of US dollar funds to European financial institutions, US dollar funding auctions significantly lowered FX swap deviations from CIP. A related hypothesis is that implementation of US dollar auctions also served to stabilize the FX swap market by lowering the volatility of deviations from CIP. We measure the effects of these US dollar auctions on the level and volatility of the common factor. We also estimate the effect of coordinated US dollar auctions across the three central banks on its level and volatility.

The second type of measures is actual commitments by the Federal Reserve to establish and increase dollar swap lines with other central banks. As discussed above, there were eight such announcements that related to Federal Reserve Swap lines with the ECB, SNB and BoE during the sample period. To the extent that these announcements were anticipated to diminish the dollar shortage-related dislocations in FX swap markets, we might expect significantly lower FX swap deviations to be associated with the announcements. In this paper, we focus on two of the announcements identified as significant by market participants: first, when in addition to raising the swap lines with the ECB, the introduction of longer maturity (84-day) TAF auctions by the Federal Reserve, ECB, and SNB were simultaneously announced, and second, when unlimited dollar swap lines were announced between the Federal Reserve and the ECB, SNB and BoE.

5. Data and variables

5.1 FX swap deviation

The common factor estimated from spreads between each of the FX swap-implied three month dollar rates (using Libor in each currency as the funding cost) and the three-month dollar Libor rate is the dependent variable in all the regression analyses that follow.[21] We focus on rates of three-month maturity because it is considered the most representative of all the short-term maturities.[22]

The Libor fixings are released every business day by the British Bankers' Association (BBA). The Libor fixing is meant to capture the rates paid on unsecured interbank deposits at large,

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[21] Another possibility is to use more market-based interest rates instead of Libor rates. A natural candidate would be the eurodollar deposit rate released by the US Federal Reserve for the dollar rate, and the rates reported by a major brokerage company such as the ICAP for the European currency rates. When using these rates to calculate the FX swap deviations, they become much lower than those based on Libor rates, even negative on many occasions, particularly after the failure of Lehman Brothers (this tendency is most evident for the CHF/USD pair, for which the FX swap deviation is negative for most of the post-Lehman period). This characteristic is at odds with market observations that the cost of raising dollar funds via the FX swap market was well above dollar cash rates following the Lehman failure and stayed at very high levels for a prolonged period of time. Further, because the Federal Reserve reports only the US dollar rate in this format, the use of the Federal Reserve's eurodollar rate raises a mismatch problem with the European rates (ICAP) particularly in terms of coverage of reporting institutions and calculation methods.

[22] For the analysis using data of other maturities, see Baba and Packer (2009).

globally active banks. Just prior to 11:00 GMT, the BBA surveys a panel of banks, asking them to provide the rates at which they believe they could borrow reasonable amounts in a particular currency and maturity. However, the banks are under no obligation to prove that they can actually borrow at those rates.[23] The dollar Libor panel consists of 16 banks from 7 nations. The BBA excludes the highest and lowest quartile of rates and takes a simple average.

For the FX forward discount rate, we use the New York composite FX spot and forward rates taken from Bloomberg, where the composite bid rate is equal to the highest bid rate of more than 30 contributing financial institutions (as of end-February 2009), and the composite ask rate is the lowest ask rate offered by the same institutions. The average of the bid and ask rates is used.

5.2 Determinants of common factor

Counterparty risk measures

To test the counterparty risk hypothesis, we use the following measures of counterparty risk perceptions for European and US financial institutions: the (senior) CDS spread index for European financial institutions with investment grade ratings included in the iTraxx Europe series, and the CDS sectoral spread index for brokers/dealers and other US financial institutions with investment grade ratings.[24] Both indices are taken from the Data Query web site managed by JPMorgan Chase. We label each CDS spread index CDS (European) and CDS (US), respectively. The counterparty risk hypothesis posits that before the Lehman failure, CDS (European) and CDS (US) should have significantly positive and negative impacts on the common factor, respectively, and after the Lehman failure, both CDS (European) and CDS (US) should have significantly positive impacts.

Central bank measures

To test the effectiveness of central bank measures, we create the following two sets of indicator variables. The first set attempts to capture the effect of the US dollar auctions conducted by ECB, SNB and BoE. For each date of the bid submissions for the US dollar auction by each central bank, the indicator variable takes the value of 1; and 0 otherwise.[25] We use four such indicator variables depending on the auction maturities. Take the ECB case for example, ECB 1 includes all the US dollar auctions conducted by the ECB from overnight maturity, ECB 2 includes those at maturities of 5 days or longer, ECB 3 includes maturities of 28 days or longer, and ECB 4 includes maturities of 80 days or longer. Together with the use of indicator variables independently for each central bank, we also use the indicator variables labelled ECB&SNB (before the Lehman failure) and ECB&SNB&BOE (after the Lehman failure) in the same maturity zones that take the value of 1 if all the central banks with US dollar auction facilities conducted the auctions on the same day.[26]

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[23] See Gyntelberg and Wooldridge (2008) for details.

[24] Baba and Packer (2009) also use average CDS spreads for dollar Libor panel banks headquartered in the Eurozone and those headquartered in the United States, in addition to the broader indices we use in this paper. They report that the use of the CDS indices covering a broader set of financial institutions than the dollar Libor panel banks provides supporting evidence for the counterparty risk hypothesis.

[25] Baba and Packer (2009) also test a similar dummy for the announcement dates of the US dollar auctions, and find slightly weaker evidence for the effectiveness of the auctions than when using a dummy for the bid submission dates.

[26] BoE did not conduct US dollar auctions before the failure of Lehman Brothers. See Section 3 for details.

The second set of indicator variables labelled Commitment 1 and Commitment 2 takes the value of 1 from July 30, and October 13, 2008 onwards, respectively, when the commitment to address the US dollar shortage problem was reinforced by the central bank community. In particular, Commitment 2 is expected to have a large impact because on that day, a strong joint announcement was made by major central banks, that the dollar swap lines between the Federal Reserves and the ECB, SNB and BoE would be unlimited.

To the extent that these central bank measures were effective in ameliorating the dollar shortage problem, the corresponding indicator variables should have a significantly negative effect on the level and volatility (in the case of US dollar auctions) of the common factor.

Broad-based cash rate-OIS spread

In contrast to Libor that reflects the funding costs of only Libor panel banks, FX swap-implied dollar rates may well reflect the funding costs of a wider range of financial institutions. Thus, the FX swap deviations from CIP may stem from the difference in the financial institutions involved in the FX swap and Libor markets.

To control for this factor, we utilize the three-month eurodollar deposit rate released by the US Federal Reserve. The eurodollar rate is based on rates actually observed in the eurodollar interbank cash market and reflects a much broader array of financial institutions than the Libor panel banks, which are meant to be only large, globally active banks. To maintain consistency with equation (2), we use the spread of the broad-based dollar cash rate over the dollar OIS rate, which is labelled Broad-OIS spread in the analysis that follows. To the extent that the FX swap market price is moved by the demand for US dollar funds of financial institutions outside the Libor universe—institutions that may face different costs of funds—we expect the effects of the Broad-OIS spread on the common factor to be positive. The OIS rate is taken from Bloomberg.

Libor-OIS spread

Under the normal circumstances prior to the financial turmoil that started in the summer of 2007, OIS rates tended to move just below the corresponding currency Libor in a very stable manner. After the onset of the financial turmoil, however, the Libor-OIS spreads widened substantially, particularly for the dollar spread.

Market observers posited several possible drivers for the widened Libor-OIS spreads. One commonly cited factor was a deterioration in funding liquidity for banks, ie a decline in their ability to service or roll-over their short-term liabilities as they fell due (IMF, 2008). This in turn was closely related to greater concerns about banks' ability to liquidate positions in certain assets, ie increased market liquidity risk. Another potential factor was a rise in counterparty risk for the Libor panel banks, as argued in Taylor and Williams (2009), among others. Uncertainty about the potential losses from subprime mortgage-related structured products is reported to have added concerns about counterparty risk among financial institutions in the early stages of the turmoil.

In this paper, we include the dollar Libor-OIS spread in the regression analysis, maintaining consistency with equation (2). The expected sign for this variable is negative. Including this variable is basically meant to control for the funding liquidity conditions in the US dollar cash market (vis-à-vis European counterparts). Namely, using the Libor-OIS spread in our regression reduces the likelihood that we are confounding counterparty risk with funding liquidity risk conditions that may be highly correlated with our CDS-based measures. While there may be a counterparty risk component in Libor-OIS spreads, several studies suggest that liquidity factors have been the more important (Michaud and Upper, 2008; Schwarz, 2008). Further, since counterparty risk possibly embedded in the Libor-OIS spread is the counterparty risk averaged over the Libor-panel banks, it does not necessarily reflect the risk

for the categories such as European and US financial institutions for which our counterparty hypothesis is tested.[27]

6 Empirical analysis

6.1 Framework

We test the above-mentioned two sets of main hypotheses after controlling for relevant factors discussed above. To account for stochastic volatility, as well as to measure the effect of central bank policy measures on it, we employ the EGARCH (1,1) model proposed by Nelson (1991).[28] The EGARCH (1,1) model for the common factor can be written as

Mean (level) equation:

$$\begin{aligned}\text{Common factor}_t = {} & a + b_1\text{CDS(European)}_t + b_2\text{CDS(US)}_t \\ & + b_3\text{USD auction}_t + b_4\text{Commitment}_t \\ & + b_5\text{Broad - OIS spread}_t + b_6\text{Libor - OIS spread}_t + \varepsilon_t \quad \varepsilon_t \sim N\left(0, \sigma_t^2\right)\end{aligned} \tag{3}$$

Variance (volatility) equation:

$$\ln\left(\sigma_t^2\right) = \alpha + \beta \ln\left(\sigma_{t-1}^2\right) + \gamma\, \varepsilon_{t-1}/\sigma_{t-1} + \eta\left(\left|\varepsilon_{t-1}/\sigma_{t-1}\right| - \sqrt{2/\pi}\right) + \lambda\text{USD auction}_t \tag{4}$$

In the mean equation, b_1 and b_2 are the coefficients reflecting the effect of the counterparty risk for European and US financial institutions, respectively, on the level of the common factor, and b_3 and b_4 are those capturing the effect of the central bank policy measures. In the variance equation, λ measures the effect of the dollar auctions by each central bank on the volatility of the common factor.[29]

The major advantage of the EGARCH model over other GARCH models is that the conditional variance is specified in the log-form and thus we do not need to impose any non-negativity constraints on the variance equation. We can also test the asymmetric leverage effects by the coefficient of γ such that when ε_{t-1} is positive, the total effect of ε_{t-1} on the log of the conditional variance can be measured by $(\eta + \gamma)\left|\varepsilon_{t-1}/\sigma_{t-1}\right|$, and when ε_{t-1} is negative, it can be measured by $(\eta - \gamma)\left|\varepsilon_{t-1}/\sigma_{t-1}\right|$. The expected signs of each determinant in the regression are summarized in Table 4.

6.2 Summary statistics and principal component analysis

Table 5 reports summary statistics of each variable under study before and after the Lehman failure. Almost all the variables are found to experience a large increase in mean and

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[27] In fact, as 14 of 16 Libor panel banks are the same between the dollar and the euro, the difference in Libor-OIS spreads between this currency pair is not likely to capture fully the changing perceptions of the difference in counterparty risks between European and US financial institutions.

[28] EGARCH is widely used in analyzing the effects of central bank communications on financial asset prices. See Beine et al. (2009) and Ehrmann and Fratzscher (2007), for example.

[29] Volatility persistence can be measured by β in the EGARCH model.

standard deviation after the Lehman failure. Before the Lehman failure, the FX swap deviations are about 0.16 percentage points on average, but they increased to the range of 0.5-1.0 percentage points afterwards. The standard deviation of the FX swap deviation also surged to about five times its level in the preceding period. Meanwhile, the CDS spread variables increased quite a bit in the later period, particularly for US financial institutions. While both the Broad-OIS spread and Libor-OIS spread increased significantly after the Lehman failure, the former spread jumped by considerably more, from 0.8 to 2.7 percentage points on average. The broad-based eurodollar deposit rate reached around 6 percent at the height of market stress in October 2008, more than 1 percentage point higher than the dollar Libor at that time, as shown in Figure 3.[30] This result suggests an increasing importance of including the Broad-OIS spread as an explanatory variable in the regressions, so as to control for the limited representativeness of dollar Libor.

Table 6 shows the results of principal component analysis for the three FX swap deviations.[31] 82 and 88 percent of the total variance of the FX swap deviations are explained by just the first principal component before and after the Lehman failure, respectively. Factor loadings of the first principal component take on very similar values across the three FX swap pairs in both periods. This suggests that we can safely regard the first principal component as a common factor to the FX swap deviations of the three currency pairs (also note here that correlation between the first principal component and each FX swap deviation is very high).

Table 7 reports the results of two standard unit root tests (Augmented Dickey-Fuller test and Phillips-Perron test) for all the variables. In both periods, the principal component, as well as each original series of FX swap deviations, are significantly found to be I(0). Based on this test result, in the analysis that follows, we use the level of the common factor of the FX swap deviations as a dependent variable, not the changes in that variable, since taking the first difference in the common factor is likely to lead to a serious loss of information without corresponding benefit.[32] Thus, our presumption is that US dollar liquidity provision by central banks is aimed at mitigating the US dollar shortage problem that shows up in the level of the common factor of FX swap deviations.

By contrast, the results are mixed for the determinants of the common factor. Before the Lehman failure, both CDS spread indices are found to be I(1), and after the Lehman failure, CDS (US) and both Broad-OIS and Libor-OIS spreads are found to be I(1). Since our dependent variable is the level of the common factor as mentioned above and we follow the decomposition formula (2), we choose to use the level of each determinant in the analysis below. That said, we will report the results of complete robustness checks in this regard later in this Section.

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[30] It should be noted, however, that the broad-based spread and the Libor-OIS spread are very highly correlated, where coefficients of correlation are 0.92 and 0.95 before and after the Lehman failure, respectively. We will conduct a robustness check concerning these issues later in this Section.

[31] The principal component is a standardized series with zero mean and one standard error.

[32] By contrast, McAndews et al. (2008) use the change of the US dollar Libor-OIS spread as the dependent variables when investigating the effects of the TAF conducted by the Federal Reserve on it. One major stated reason for their approach is that the level of the Libor-OIS spread has a unit root in their sample period.

6.3 Estimation results

Table 8 reports the estimation results of EGARCH analysis of the common factor (first principal component) for the period before the Lehman failure.

First of all, the counterparty risk hypothesis is found to hold during this period in all cases. The coefficient on CDS (European) is always significantly positive, and that on CDS (US) is always significantly negative. This result is consistent with Baba and Packer (2009), who find that the difference in CDS spreads between broad-based European and US financial institutions has a significantly positive association with the EUR/USD swap deviation during the same period.

Second, while none of the dummy variables of the USD auctions nor the included swap lines commitment variable (commitment 1)[33] have significantly negative coefficients on the level of the common factor, by contrast, the USD auction dummies do have a significantly negative impact on the volatility of the common factor in all cases. Estimates of the variance coefficient are more negative and statistically significant when the variable is limited to auctions conducted at maturities of 80 days or longer. For example, the estimates of λ =-2.634 and -2.232 for ECB 4 and SNB 4 in Table 8 suggest that volatility drops by 92 and 89 percent on average on the day of the auctions, respectively.[34]

Third, both control variables, the Broad-OIS and Libor-OIS spreads, have significantly positive and negative coefficients, respectively, in all cases, which is consistent with equation (3).[35] The results also support the view that higher demand for US dollar funds by a wider range of financial institutions than the dollar Libor panel banks should have a significantly positive effect on the level of the common factor of FX swap deviations.

Fourth, the variance equation is well estimated in all specifications.[36] The ARCH (η) and GARCH (β) effects are significantly positive in all cases. The estimated high coefficients of the GARCH term indicates the existence of volatility clustering, such that large changes tend to be followed by large changes. The asymmetric ARCH leverage effect (γ) is found to be significant such that a negative shock tends to have a larger impact on volatility than a positive shock.

Next, Tables 9-12 report the results of EGARCH analysis after the Lehman failure.[37] First, in all cases, CDS (European) has a significantly positive coefficient on the level of the common

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[33] As discussed earlier, we included an indicator variable that takes the value of 1 after the July 30 announcement of an increase in the ECB's swap lines as well as an increase in term of the dollar funds that would be made available by both the ECB and SNB, supported by the swap lines. In other regressions (not reported), other dates in which swap lines were increased during the period were also found to be insignificant.

[34] The instantaneous drop rate is calculated as $\exp(\lambda)-1$.

[35] The coefficients on the Broad-OIS and Libor-OIS spreads, always of the opposite sign, are often found to be roughly of the same magnitude. This suggests that information of both spreads for the FX swap deviation might be captured more efficiently by the spread between the broad-based dollar rate and dollar Libor. We conduct a robustness check for this specification later in this Section.

[36] The Ljung-Box Q statistics for the autocorrelation of the squared standardized residuals from the EGARCH model (not reported) are found to be insignificant for various lag lengths. This turns out to be always the case throughout the analysis that follows.

[37] In comparing the size of coefficients between the two periods, it should be noted that our dependent variables (first principal component) in both periods are standardized variables with 0 mean and 1 standard deviation. Based on regression results of the original FX swap deviation series on the principal component in each period, we find that, in terms of the impact on the original FX swap deviation series, an estimated coefficient of 1 in the pre-Lehman period roughly corresponds to a coefficient of 0.2 in the post-Lehman period. Thus, a smaller coefficient in the latter period can still correspond to a larger impact on the original FX swap deviation.

factor, consistent with the results before the Lehman failure. CDS (US) also has a significantly positive coefficient in all cases except one. This result is in marked contrast to that for the earlier period, but consistent with our counterparty risk hypothesis, as posited for after the Lehman failure. As discussed above, after this event, US financial institutions also faced difficulty raising US dollar funding in cash markets, due to greatly increased concerns over counterparty risk. Under such circumstances, US financial institutions had much less ability to provide dollar funds in the FX swap markets, and many market observers even suggested that some US financial institutions turned to FX swap markets to raise dollars chiefly using European currencies as funding sources.

Second, USD auction dummies at maturities of 28 days or longer have significantly negative coefficients on the level of the common factor in all cases for the ECB (Table 9), SNB (Table 10) and BoE (Table 11), including the case of the same-day coordinated auction dummy (Table 12). These results suggest that US dollar auctions conducted by each of the central banks, particularly at maturities of 28 days or longer, successfully alleviated the dollar shortage problem to the extent it showed up in FX swap deviations from the CIP condition. In the case of the ECB's auctions, the auction dummy at maturities of 5 days or longer also have a significantly negative coefficient.

How can these impacts be evaluated in economic terms? Based on the results of regressions that measure the association between the common factor and each original series of FX swap deviation, we can approximate the impacts of the US dollar auctions in terms of the original series of FX swap deviations: the estimated coefficient on the USD auction dummy of -0.2 roughly corresponds to a reduction of the FX swap deviation of 6.0 (EUR/USD), 6.9 (CHF/USD), and 6.5 (GBP/USD) basis points, respectively. The US dollar auctions with relatively long maturities also exert a significantly stabilizing effect on the volatility of the common factor. Specifically, US dollar auctions at maturities of 28 days or longer have a significantly negative impact on volatility in all cases, corresponding to the reduction in volatility of 69 (ECB 3), 61 (SNB 3), and 65 (BoE 3) percentage points on average. Results for maturities of 80 days or longer are very similar except for the case of SNB 4 (Table 10).[38]

Third, the shift by the Federal Reserve to unlimited dollar swap lines for the ECB, SNB and BoE, as captured by the "commitment 2" dummy variable, always has a significantly negative effect on the level of the common factor. As discussed above, on October 13, 2008, major central banks jointly announced measures to improve short-term US dollar liquidity conditions including the unlimited dollar swap lines. In terms of the original series of FX swap deviations, the estimated coefficient on this commitment dummy of -1 corresponds to reductions in the FX swap deviations of 30.2 (EUR/USD), 34.6 (CHF/USD), and 32.6 (GBP/USD) basis points, respectively. The results are consistent with the view expressed by many market observers that the moves by the central banking community to address the US dollar shortage problem in the FX swap markets were especially effective from mid-October.[39]

Fourth, as is the case with the estimation results before the Lehman failure, Broad-OIS and Libor-OIS spreads have significantly positive and negative coefficients, respectively, in all cases, which is consistent with equation (3).[40]

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[38] We further tested the hypothesis that joint USD auctions by three central banks are more effective than the auctions conducted by a single central bank by including both the same-day dummy and a dummy variable that takes the value of 1 if each central bank conduct auctions alone. We were not able to find significant evidence supporting this hypothesis, though.

[39] We also tested whether indicator variables for other dates when swap line increases were announced, but they were not found to be significant.

[40] The coefficients on both spreads drop in magnitude by 90 percent from the pre to post-Lehman regressions. Even when considering the (above-mentioned) fact that a coefficient of 1 pre-Lehmann would correspond to

6.4 Robustness checks

As mentioned earlier, some of the determinants of the common factor are found to be I(1) and there is very high correlation between the Broad-OIS spread and the Libor-OIS spread, so we report the summary of a complete set of robustness checks based on the following specifications.

First, in both periods, we use the spread of the eurodollar rate reported by the Federal Reserve over dollar Libor, which is found to be I(0) in both periods, instead of using the Broad-OIS and Libor-OIS spreads, separately. This is to cope with the high correlation between these spreads and potential non-stationarity problems, as well as the point mentioned earlier that the information of both spreads for the FX swap deviation might be captured more efficiently by the single variable, given the rough equivalence of the absolute value of the coefficients on the variables estimated separately.

Second, at the same time, we use the changes in both CDS (European) and CDS (US) in the pre-Lehman regressions, and the change in CDS (US) in the post-Lehman regressions. This is based on the unit root test results, as reported in Table 7, in which the level of those variables are found to be I(1), which might potentially pose non-stationarity problems for the estimation.

The EGARCH analysis based on the above specifications shows that our main results remain almost intact in both periods.[41] More specifically, in the pre-Lehman regressions, the CDS (European) and CDS (US) have a significantly positive and negative coefficients, respectively, for determining the level of the common factor, respectively, and USD auction dummies at 28 days or longer have a significantly negative coefficients for determining its volatility in most cases. In the post-Lehman regressions, both the CDS (European) and CDS (US) have significantly positive coefficients for determining the level of the common factor, while the same USD auction dummies have a significantly negative impact on its level and volatility in most cases, and the commitment dummy 2, which takes the value of 1 from October 13, 2008 onwards, has a significantly negative impact on its level.

6.5 Discussion: Assessing policy effectiveness

As documented above, the policy measures to ensure that adequate term dollar funding was available to European banks intensified in the wake of Lehman bankruptcy. That the renewed efforts met with more success is indicated by the significance of the dollar auction variable in reducing both the level and volatility of the common factor in the post-Lehman regression, as opposed to the more limited results of reduced volatility in the earlier pre-Lehman period. At the same time, it should be remembered that perhaps the objectives of policy had changed after September 15, when interbank rates and measures of dislocation in FX swap markets spiked by many times their previously elevated values. Central banks may have been determined to get out "ahead of the curve" and took back the clock on dislocations, as opposed to merely stabilize their movements. The pronounced impact of the move to unlimited dollar swap lines by the Federal Reserve with the central banks under study may also reflect the increased aggressiveness of central bank intent.

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the same impact on the original FX swap deviation as a coefficient of one-fifth that size post-Lehmann, coefficients on the Broad-OIS and Libor-OIS spreads in the post-Lehman period still appear to be relatively small compared with those of the preceding period. We would lean towards ascribing this outcome to simple increased measurement error in the later, more volatile period, for reasons such as the deterioration of market liquidity after the Lehman failure, for which we find it difficult to control as described above.

[41] Detailed results are available upon request.

Policymakers post-Lehman were also dealing with dollar shortages that were now global in nature, as underscored in the results by our findings suggestive that even US financial institutions found themselves short of term funding and some turned to FX swap markets to raise dollars. Swap lines were extended to central banks across many continents and time zones. Though not explicitly addressed in our empirical exercise, the fact that central banks undertook a shift to a "full court press" in their defensive strategies, with swap lines increases announced simultaneously with an increase in the number of countries receiving term dollar funds, may also have increased the effectiveness of the policy measures post-Lehman.

Of course, the increase in dollar swap lines among central banks after the Lehman failure cannot take sole credit for the alleviation of dislocations in the FX swap market around that time. To be sure, these measures were widely welcomed by market participants and credited with alleviating funding pressures in term funding markets. However, the increase in the dollar swap lines to unlimited amounts occurred shortly after the adoption of many other measures by the authorities to stabilize the financial system by reducing counterparty credit and liquidity risks. In particular, the US Treasury's guarantee for money market funds' net asset value which sought to stop a run on money market funds, as well as the Federal's Reserve's ABCP money market fund liquidity facility (AMLF) which granted money market funds indirect access to Federal Reserve funding was announced on September 19. Further, the Federal Reserve announced a Commercial Paper Funding Facility (CPFF) on October 7, which financed repayments to money market funds of maturing CP that money market funds did not roll over, as well as reduced the risk of CP on money market fund portfolio balance sheet. The combination of the above measures was likely important in alleviating funding pressures on non-US banks in particular, since money market funds had been the largest suppliers of dollar funding to non-US banks (Baba et al, 2009). It is quite possible that the shift to unlimited dollar swap lines was more effective in the wake of these other measures.

7. Concluding remarks

Financial markets shifted from turmoil to crisis mode following the failure of Lehman Brothers on September 15, 2008. This paper has empirically investigated dislocations in the FX swap market around this seismic event. As documented in Baba and Packer (2009), well before the Lehman failure, there had already been a striking change in the relationship between perceptions of counterparty risk and FX swap prices. That is, after the onset of financial turmoil the summer of 2007, CDS spread differences between European and US financial institutions were positively related to deviations from CIP observed in the FX swap market. The findings suggested that concern over the counterparty risk of European financial institutions was one of the important drivers of the deviation from covered interest parity in the FX swap market.

However, after the bankruptcy of Lehman Brothers, the turmoil in many markets became much more pronounced. In FX and money markets, what had principally been a dollar liquidity problem for European financial institutions deepened into a phenomenon of global dollar shortage. The empirical results spanning the failure of Lehman are consistent with this globalization of the dollar shortage problem. US financial institutions after the failure faced difficulty raising US dollar funding possibly as much as European institutions, and in striking contrast to the pre-Lehman period of turmoil, declining credit worthiness of US institutions provided an independent source of imbalances in the FX swap markets to the decline in creditworthiness of European institutions.

Central bank measures to counter the dollar shortage were redoubled after the Lehman failure. In December 2007, the Federal Reserve had initiated dollar swap lines with the ECB and SNB so as to facilitate the provision of US dollar term funds to Eurosystem and Swiss counterparties. These amounts were increased two to three times over the following nine

months. But in response to the greatly increased pressure following the failure of Lehman Brothers, the central banks ramped up at an unprecedented pace their transatlantic dollar funding of non-US banks, culminating in the establishment of unlimited swap lines by the Federal Reserve with the ECB, SNB and the BoE on October 13. 2008.

While the establishment of dollar swap lines had not had a significant impact on the level of the FX swap deviation before the failure of Lehman Brothers, if anything, indicating that central banks had fallen behind the curve, our empirical evidence suggests that they became effective in diminishing the level of FX swap market deviation in the later period. The impacts of the moves on the FX swap market deviations were such that the deviations were at least 30 basis points less than those otherwise might have been after the introduction of the unlimited swap lines. Since we are controlling for the effects of funding liquidity problems in the interbank markets, this is likely a lower bound estimate on the effectiveness of the measures.

We also test whether the actual provision of funds by the ECB, SNB and BoE in auctions, designed to occur on the same day as those of the Federal Reserve's Term Auction Facility, had an impact on the FX swap market deviations. In contrast to the results before the failure of Lehman Brothers, dollar auction dummies have a significantly negative effect on the level of the common factor for EUR/USD, CHF/USD and GBP/USD FX swap deviations, as long as the auction dummies include maturities of 28 days or longer. The result suggests that US dollar auctions at longer maturities conducted by the European central banks successfully ameliorated the problem of US dollar shortage in the FX swap markets. In addition, both prior to and after the Lehman failure, the US dollar liquidity-providing operations by the central banks under study appear to have lowered the volatility (and thus the associated uncertainty) of the FX swap deviations. Our estimation results thus support the view that the dollar term funding auctions conducted by the ECB, SNB and BoE, supported by dollar swap lines with the Federal Reserve, played a positive role in stabilizing the FX swap market for the euro/dollar, Swiss franc/dollar and sterling/dollar currency pairs.

This study focuses on the degree to which FX swap markets for European currencies vis-à-vis the US dollar were shaken by the failure of Lehman Brothers, as well as the effectiveness of concerted policy measures to overcome dollar shortages in the major currency areas of industrialized Europe. After the Lehman failure, as dislocations in FX swap markets reflected dollar shortages that were global in nature, the provision of dollar funds in coordination with the Federal Reserve expanded greatly to include central banks in five continents including many emerging market economies. Future researchers might focus on the degree to which the heterogeneity of institutions and financial systems influenced the effectiveness of the provision of dollar funds during the crisis.

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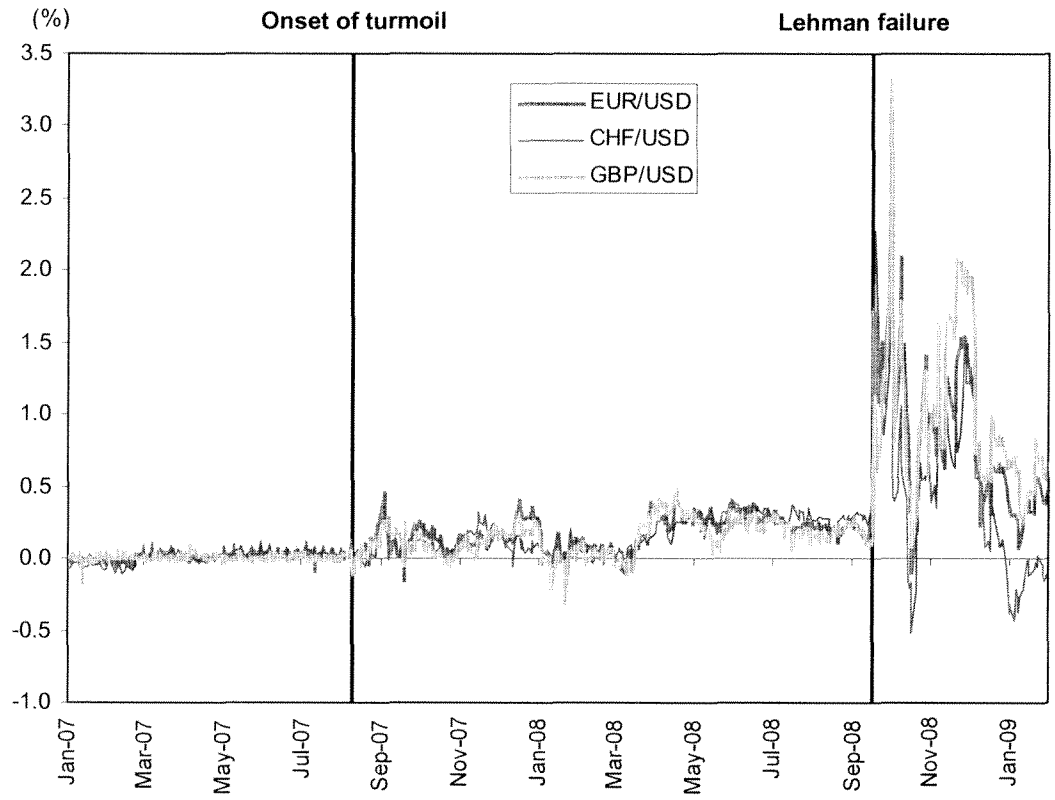
Figure 1

FX swap deviations from the covered interest parity condition

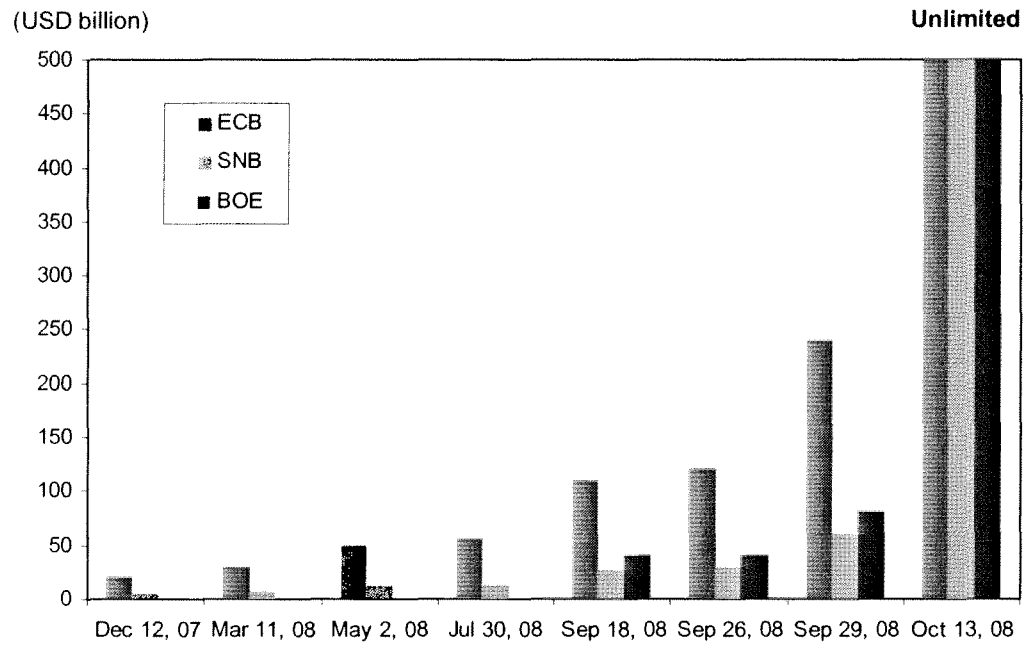


Note: FX swap deviations are calculated as the difference between the FX swap-implied dollar rate and uncollateralized dollar cash rate, where the FX swap-implied dollar rate is defined as a total cost, in terms of a dollar rate, from raising each of European currencies in the uncollateralized cash market and converting them into dollars through the FX swap market. Libor rates are used as the uncollateralized cash rates for all currencies involved.

Source: Bloomberg; Authors' calculations.

Figure 2

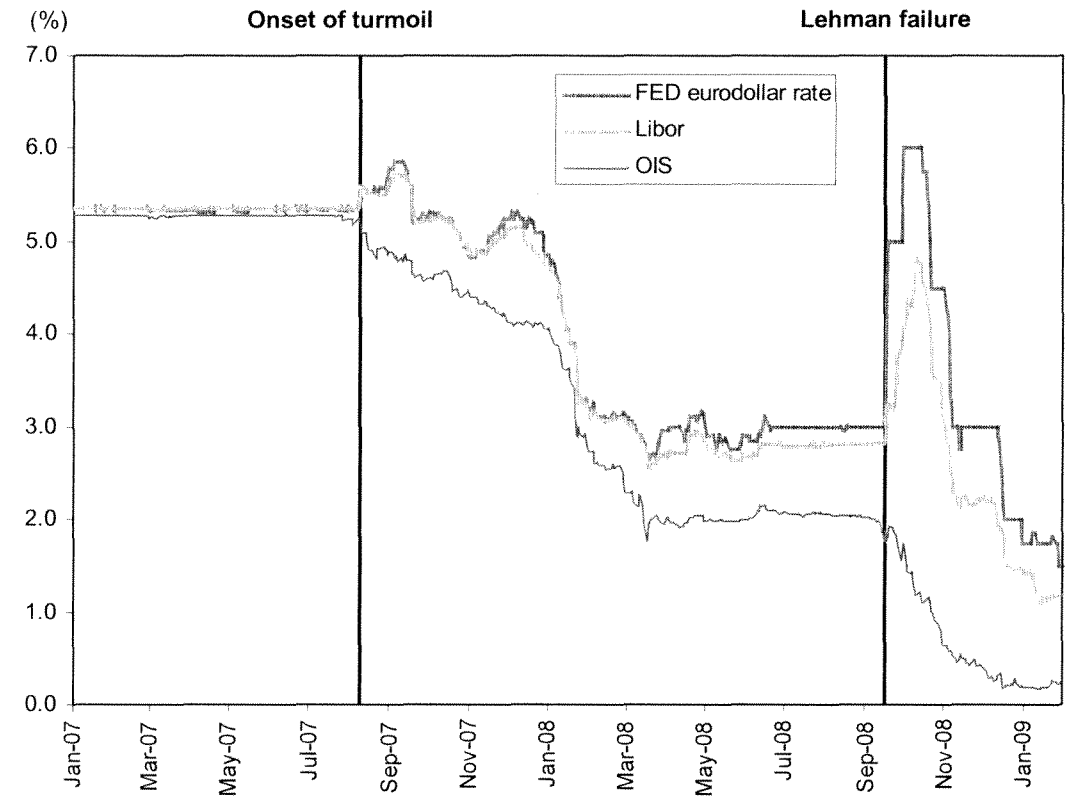
US dollar swap lines with US Federal Reserve



Source: Central banks.

Figure 3

US dollar interest rates



Source: Federal Reserve; Bloomberg.

Table 1

US dollar auctions by European Central Bank

Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)	Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)
12/17/07	10/22	28	10/03/08	50/83	3
12/21/07	10/14	35	10/06/08	20/89	85
01/14/08	10/15	28		50/91	1
01/28/08	10/12	28	10/07/08	50/109	1
03/25/08	15/31	28	10/08/08	70/122	1
04/07/08	15/31	28	10/09/08	100/116	1
04/21/08	15/30	28	10/10/08	94/94	4
05/05/08	25/40	28	10/14/08	98/98	1
05/19/08	25/59	28	10/15/08	100/120	1
06/02/08	25/65	28		171/171	7
06/16/08	25/78	28	10/21/08	102/102	28
06/30/08	25/85	28		23/23	28
07/14/08	25/90	28	10/22/08	68/68	7
07/28/08	25/102	28	10/29/08	92/92	7
08/11/08	10/39	84	11/04/08	71/71	84
08/12/08	20/91	28	11/05/08	59/59	7
08/25/08	20/89	28	11/12/08	61/61	7
09/08/08	10/32	84	11/18/08	52/52	28
09/09/08	10/43	28	11/19/08	72/72	8
09/18/08	40/102	1	11/26/08	85/85	6
09/19/08	40/97	3	12/02/08	67/67	84
09/22/08	25/110	28	12/03/08	75/75	7
	40/82	1	12/10/08	57/57	7
09/23/08	40/78	1	12/16/08	48/48	28
09/24/08	40/62	1	12/17/08	42/42	5
09/25/08	40/73	1	12/23/08	52/52	16
09/26/08	30/41	3	12/30/08	11/11	83
	35/82	7	01/07/09	41/41	7
09/29/08	30/57	1	01/13/09	21/21	28
09/30/08	30/77	1	01/14/09	58/58	7
	31/31	1	01/21/09	60/60	7
10/01/08	50/71	1	01/27/09	24/24	84
10/02/08	50/67	1	01/28/09	61/61	7

Source: European Central Bank.

Table 2

US dollar auctions by Swiss National Bank

Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)	Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)
12/17/07	4/17	28	10/16/08	4/4	1
01/14/08	4/11	28	10/17/08	1/1	1
03/25/08	6/15	28	10/20/08	1/1	1
04/22/08	6/15	28	10/21/08	1/1	1
05/06/08	6/10	28		13/13	28
05/20/08	6/8	28	10/22/08	1/1	1
06/03/08	6/11	28		3/3	7
06/17/08	6/18	28	10/23/08	2/2	1
07/01/08	6/16	28	10/24/08	6/6	1
07/15/08	6/16	28	10/27/08	7/7	1
07/29/08	6/11	28	10/28/08	7/7	1
08/12/08	2/10	84	10/29/08	2/2	1
08/13/08	4/12	28		6/6	7
08/26/08	6/11	28	10/30/08	1/1	1
09/09/08	2/8	84	10/31/08	1/1	1
09/10/08	2/6	28	11/03/08	0.3/0.3	1
09/18/08	10/10	1	11/04/08	1/1	1
09/19/08	10/21	1		2/2	84
09/22/08	10/16	1	11/05/08	1/1	1
09/23/08	10/15	1		2/2	7
	8/23	28	11/12/08	1/1	7
09/24/08	10/14	1	11/18/08	7/7	28
09/25/08	10/11	1	11/19/08	1/1	8
09/26/08	7/8	1	11/26/08	6/6	6
	5/5	7	12/02/08	3/3	84
09/29/08	8/8	1	12/03/08	0.3/0.3	7
09/30/08	10/13	1	12/10/08	0.3/0.3	7
10/01/08	10/12	1	12/16/08	2/2	28
10/02/08	9/9	1	12/17/08	0.2/0.2	5
10/03/08	6/6	1	12/23/08	0.2/0.2	16
10/06/08	7/7	1	12/30/08	2/2	80
10/07/08	10/12	1	01/07/09	1/1	7
	4/9	88	01/13/09	0/0	28
10/09/08	10/11	1	01/14/09	1/1	7
10/10/08	10/12	1	01/21/09	1/1	7
10/14/08	8/8	1	01/27/09	0/0	84
10/15/08	9/9	1	01/25/09	1/1	7
	7/7	7			

Source: Swiss National Bank.

Table 3

US dollar auctions by Bank of England

Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)	Allotment date	Allotment/Bid amount (USD billion)	Maturity (days)
09/18/08	14/14	1	10/23/08	4/4	1
09/19/08	21/21	3	10/24/08	3/3	3
09/22/08	26/26	1	10/27/08	3/3	1
09/23/08	30/30	1	10/28/08	3/3	1
09/24/08	30/30	1	10/29/08	3/3	1
09/25/08	35/35	1		46/46	7
09/26/08	10/12	3	10/30/08	1/1	1
	30/32	7	10/31/08	1/1	3
09/29/08	10/13	1	11/03/08	0.4/0.4	1
09/30/08	10/14	1	11/04/08	0.4/0.4	1
10/01/08	7/7	1		12/12	84
	13/13	6	11/05/08	0.3/0.3	1
10/02/08	9/9	1		21/21	7
10/03/08	8/8	3	11/06/08	0.3/0.3	1
	30/35	7	11/07/08	0.3/0.3	3
10/06/08	10/11	1	11/12/08	15/15	7
10/07/08	8/8	1	11/18/08	23/23	28
10/07/08	18/18	7	11/19/08	10/10	7
10/08/08	9/9	1	11/26/08	19/19	7
	12/13	6	12/02/08	11/11	84
10/09/08	10/10	1	12/03/08	4/4	7
10/10/08	8/8	4	12/10/08	0.1/0.1	7
	30/39	7	12/16/08	10/10	28
10/14/08	9/9	1	12/17/08	0.1/0.1	10
	30/36	3	12/24/08	0.1/0.1	4
10/15/08	10/12	1	12/30/08	0.5/0.5	84
	76/76	7	12/31/08	0/0	7
10/16/08	9/9	1	01/07/09	0/0	7
10/17/08	9/9	3	01/13/09	9/9	28
10/20/08	9/9	1	01/14/09	0/0	7
10/21/08	6/6	1	01/21/09	0/0	7
	26/26	28	01/27/09	2/2	84
10/22/08	4/4	1	01/28/09	0/0	7
	45/45	7			

Source: Bank of England.

Table 4

Expected signs of determinants

	CDS (European)	CDS (US)	USD auction	Commitment 1 (30 Jul 08)	Commitment 2 (13 Oct 08)	Broad-OIS spread	Libor-OIS spread
	Level	Level	Level & Vol	Level	Level	Level	Level
Before Lehman	+	–	–		–	+	–
After Lehman	+	+	–	–		+	–

Table 5

Summary statistics

(1) Before Lehman failure

Sample: 9 August 2007 – 12 September 2008

	Mean	Maximum	Minimum	Std. dev	Skewness	Kurtosis
FX swap deviation (%)						
EUR/USD	0.171	0.446	-0.272	0.115	-0.344	3.060
CHF/USD	0.166	0.406	-0.290	0.123	-0.186	2.241
GBP/USD	0.138	0.481	-0.313	0.120	-0.232	3.252
Determinants of common factor (%)						
CDS (European)	0.703	1.610	0.205	0.288	0.670	3.404
CDS (US)	2.263	4.695	0.846	0.784	0.310	2.992
Broad-OIS spread	0.806	1.201	0.250	0.207	-0.384	2.232
Libor-OIS spread	0.690	1.635	0.243	0.142	-0.176	3.336

(2) After Lehman failure

Sample: 15 September 2008 – 30 January 2009

	Mean	Maximum	Minimum	Std. dev	Skewness	Kurtosis
FX swap deviation (%)						
EUR/USD	0.831	2.602	-0.093	0.511	0.734	3.246
CHF/USD	0.478	2.386	-0.512	0.609	0.798	3.617
GBP/USD	0.987	3.302	0.082	0.577	1.097	4.304
Determinants of common factor (%)						
CDS (European)	1.182	1.560	0.920	0.136	0.565	3.250
CDS (US)	5.079	8.542	3.571	1.064	1.247	4.377
Broad-OIS spread	2.679	4.826	1.234	1.059	0.583	2.244
Libor-OIS spread	1.803	3.644	0.893	0.738	0.819	2.812

Source: Federal Reserve; Bloomberg; JPMorgan.

Table 6

Principal component analysis

(1) Before Lehman failure

Sample: 9 August 2007 – 12 September 2008

	Factor loadings (correlations)	
	1st component	**2nd component**
FX swap deviation (EUR/USD)	0.597 (0.938)	-0.253 (-0.154)
FX swap deviation (CHF/USD)	0.551 (0.865)	0.819 (0.497)
FX swap deviation (GBP/USD)	0.582 (0.914)	-0.515 (-0.313)
Eigenvalues	2.465	0.368
Cumulative variance explained	0.822	0.944

(2) After Lehman failure

Sample: 15 September 2008 – 30 January 2009

	Factor loadings (correlations)	
	1st component	**2nd component**
FX swap deviation (EUR/USD)	0.594 (0.963)	-0.033 (-0.017)
FX swap deviation (CHF/USD)	0.570 (0.924)	-0.687 (-0.351)
FX swap deviation (GBP/USD)	0.567 (0.920)	0.726 (0.370)
Eigenvalues	2.623	0.261
Cumulative variance explained	0.876	0.963

Note: Principal component analysis is done based on the correlation matrix.

Table 7

Unit root test

(1) Before Lehman failure

Sample: 9 August 2007 – 12 September 2008

	Augmented Dickey-Fuller Test		**Phillips-Perron Test**	
	Level	1st difference	Level	1st difference
FX swap deviations				
EUR/USD	-4.392***	-19.578***	-4.251***	-22.786***
CHF/USD	-3.415**	-13.337***	-3.542***	-34.728***
GBP/USD	-3.018**	-15.799***	-3.763***	-21.888***
Principal component	-3.804***	-18.459***	-3.451***	-21.150***
Determinants of common factor				
CDS (European)	0.013	-16.742***	0.020	-16.741***
CDS (US)	0.409	-11.576***	0.586	-11.451***
Broad-OIS spread	-3.546***	-18.282***	-3.525***	-18.289***
Libor-OIS spread	-4.691***	-19.298***	-4.799***	-19.322***

(2) After Lehman failure

Sample: 15 September 2008 – 30 January 2009

	Augmented Dickey-Fuller Test		**Phillips-Perron Test**	
	Level	1st difference	Level	1st difference
FX swap deviations				
EUR/USD	-2.877*	-8.428***	-3.046**	-9.556***
CHF/USD	-1.767**	-9.210***	-2.035*	-14.875***
GBP/USD	-3.100**	-8.083***	-3.197**	-9.913***
Principal component	-3.218***	-8.781***	-2.767***	-11.061***
Determinants of common factor				
CDS (European)	-4.201***	-8.252***	-3.734***	-8.647***
CDS (US)	-2.057	-9.859***	-2.009	-9.931***
Broad-OIS spread	-0.544	-6.712***	-0.492	-6.713***
Libor-OIS spread	-0.473	-6.219***	-0.518	-6.313***

Note: Unit root test is done with a specification including a constant term. When the constant term is not significant at the 5% level, the test is redone without it.

Table 8

EGARCH analysis before Lehman failure

Sample: August 9, 2007-September 12, 2008

Mean equation

CDS (European)	2.912*** (0.283)	2.939*** (0.299)	2.920*** (0.300)	2.885*** (0.297)	2.680*** (0.303)
CDS (US)	-1.169*** (0.099)	-1.134*** (0.107)	-1.181*** (0.107)	-1.131*** (0.106)	-1.102*** (0.110)
USD auction (ECB 3)	0.144 (0.101)				
USD auction (ECB 4)		-0.052 (0.111)			
USD auction (SNB 3)			0.168* (0.089)		
USD auction (SNB 4)				0.080 (0.117)	
USD auction (ECB&SNB 3)					-0.059 (0.144)
Commitment 1	0.039 (0.078)	0.020 (0.081)	0.023 (0.083)	-0.001 (0.083)	0.052 (0.081)
Broad spread (USD)	10.678*** (0.515)	10.580*** (0.495)	10.841*** (0.513)	10.765*** (0.504)	10.908*** (0.513)
Libor-OIS (USD)	-9.684*** (0.795)	-9.733*** (0.299)	-9.982*** (0.801)	-9.968*** (0.787)	-10.223*** (0.809)
Constant	-1.085*** (0.236)	-1.047*** (0.229)	-0.988*** (0.236)	-1.009*** (0.229)	-0.890*** (0.238)

Variance equation

$$\ln(\sigma_t^2) = \alpha + \beta \ln(\sigma_{t-1}^2) + \gamma\, \varepsilon_{t-1}/\sigma_{t-1} + \eta\left(|\varepsilon_{t-1}/\sigma_{t-1}| - \sqrt{2/\pi}\right) + \lambda \text{USD auction}_t$$

α	-0.678*** (0.154)	-0.677*** (0.153)	-0.708*** (0.159)	-0.697*** (0.154)	-0.655*** (0.157)
β	0.770*** (0.053)	0.788*** (0.052)	0.761*** (0.059)	0.775*** (0.055)	0.794*** (0.056)
γ	-0.178** (0.009)	-0.193** (0.088)	-0.188** (0.093)	-0.204** (0.090)	-0.191** (0.087)
η	0.739*** (0.177)	0.690** (0.177)	0.737*** (0.177)	0.706*** (0.176)	0.676*** (0.180)
λ (USD auction ECB 3)	-0.854*** (0.236)				
λ (USD auction ECB 4)		-2.634*** (0.282)			
λ (USD auction SNB 3)			-0.615*** (0.257)		
λ (USD auction SNB 4)				-2.232*** (0.243)	
λ (USD auction ECB&SNB 3)					-1.057** (0.452)
Log likelihood	-342.6	-342.9	-343.9	-344.0	-344.7

Note: Numbers in parentheses are Bollerslev-Wooldrige robust standard errors. ***, ** and * denote the 1%, 5%, and 10% significance level, respectively.

Table 9

EGARCH analysis after Lehman failure (1)

Sample: September 15, 2008 – January 30, 2009

Mean equation

CDS (European)	1.014*** (0.186)	3.705*** (0.493)	1.569*** (0.205)	0.698*** (0.178)	2.680*** (0.303)
CDS (US)	0.104** (0.053)	-0.043 (0.112)	0.207*** (0.046)	0.248*** (0.037)	
USD auction (ECB 1)	0.132*** (0.040)				
USD auction (ECB 2)		-0.301*** (0.057)			
USD auction (ECB 3)			-0.249*** (0.034)		
USD auction (ECB 4)				-0.247*** (0.024)	-0.059 (0.144)
Commitment 2	-1.019*** (0.072)	-1.108*** (0.087)	-0.959*** (0.084)	-1.166*** (0.045)	0.052 (0.081)
Broad-OIS spread	1.322*** (0.080)	1.410*** (0.091)	1.390*** (0.069)	1.205*** (0.063)	10.908*** (0.513)
Libor-OIS spread	-0.973*** (0.092)	-0.628*** (0.148)	-1.234*** (0.085)	-1.090*** (0.077)	-10.223*** (0.809)
Constant	-3.091*** (0.181)	-5.992*** (0.423)	-3.985*** (0.235)	-2.762*** (0.190)	-0.890*** (0.238)

Variance equation

$$\ln(\sigma_t^2) = \alpha + \beta \ln(\sigma_{t-1}^2) + \gamma \varepsilon_{t-1}/\sigma_{t-1} + \eta\left(|\varepsilon_{t-1}/\sigma_{t-1}| - \sqrt{2/\pi}\right) + \lambda \text{USD auction}_t$$

α	-2.184*** (0.206)	-1.611*** (0.173)	-1.794*** (0.127)	-2.185*** (0.151)	-0.655*** (0.157)
β	0.742*** (0.065)	0.799*** (0.062)	0.770*** (0.063)	0.825*** (0.063)	0.794*** (0.056)
γ	0.269 (0.171)	0.156 (0.208)	0.321* (0.175)	0.274 (0.205)	-0.191** (0.087)
η	2.217*** (0.220)	1.748*** (0.205)	2.041*** (0.178)	2.477*** (0.249)	
λ (USD auction ECB 1)	0.266 (0.194)				
λ (USD auction ECB 2)		0.283 (0.275)			
λ (USD auction ECB 3)			-1.182*** (0.289)		
λ (USD auction ECB 4)				-1.299*** (0.354)	-1.057** (0.452)
Log likelihood	-119.0	-124.3	-117.6	-116.9	-344.7

Note: Numbers in parentheses are Bollerslev-Wooldrige robust standard errors. ***, ** and * denote the 1%, 5%, and 10% significance level, respectively.

Table 10

EGARCH analysis after Lehman failure (2)

Sample: September 15, 2008-January 30, 2009

Mean equation

CDS (European)	1.067*** (0.193)	1.471*** (0.193)	1.465*** (0.218)	1.128*** (0.180)	2.680*** (0.303)
CDS (US)	0.083* (0.047)	0.237*** (0.040)	0.165*** (0.049)	0.140*** (0.048)	
USD auction (SNB 1)	0.081* (0.043)				
USD auction (SNB 2)		0.021 (0.040)			
USD auction (SNB 3)			-0.178*** (0.032)		
USD auction (SNB 4)				-0.218*** (0.020)	-0.059 (0.144)
Commitment 2	-1.042*** (0.065)	-1.031*** (0.102)	-1.130*** (0.117)	-1.220*** (0.056)	0.052 (0.081)
Broad-OIS spread	1.448*** (0.100)	1.309*** (0.075)	1.312*** (0.087)	1.201*** (0.070)	10.908*** (0.513)
Libor-OIS spread	-1.165*** (0.099)	-1.188*** (0.088)	-1.100*** (0.113)	-0.960*** (0.083)	-10.223*** (0.809)
Constant	-3.016*** (0.185)	-3.934*** (0.223)	-3.586*** (0.283)	-2.906*** (0.224)	-0.890*** (0.238)

Variance equation

$$\ln(\sigma_t^2) = \alpha + \beta \ln(\sigma_{t-1}^2) + \gamma\, \varepsilon_{t-1}/\sigma_{t-1} + \eta\left(|\varepsilon_{t-1}/\sigma_{t-1}| - \sqrt{2/\pi}\right) + \lambda \text{USD auction}_t$$

α	-2.069*** (0.206)	-1.864*** (0.157)	-1.646*** (0.139)	-2.141*** (0.169)	-0.655*** (0.157)
β	0.706*** (0.069)	0.773*** (0.088)	0.737*** (0.071)	0.838*** (0.054)	0.794*** (0.056)
γ	0.198 (0.193)	0.253 (0.196)	0.246 (0.158)	0.315* (0.183)	-0.191** (0.087)
η	2.081*** (0.213)	1.962*** (0.164)	1.867*** (0.177)	2.361*** (0.242)	
λ (USD auction SNB 1)	0.293 (0.209)				
λ (USD auction SNB 2)		0.223 (0.247)			
λ (USD auction SNB 3)			-0.951*** (0.322)		
λ (USD auction SNB 4)				0.439 (0.376)	-1.057** (0.452)
Log likelihood	-119.9	-123.0	-119.8	-118.6	-344.7

Note: Numbers in parentheses are Bollerslev-Wooldrige robust standard errors. ***, ** and * denote the 1%, 5%, and 10% significance level, respectively.

Table 11

EGARCH analysis after Lehman failure (3)

Sample: September 15, 2008-January 30, 2009

Mean equation

CDS (European)	1.249*** (0.182)	1.346*** (0.179)	1.488*** (0.234)	0.581*** (0.152)	2.680*** (0.303)
CDS (US)	0.244*** (0.044)	0.180*** (0.035)	0.193*** (0.062)	0.283*** (0.032)	
USD auction (BOE 1)	0.087*** (0.026)				
USD auction (BOE 2)		-0.031 (0.038)			
USD auction (BOE 3)			-0.192*** (0.033)		
USD auction (BOE 4)				-0.241*** (0.022)	-0.059 (0.144)
Commitment 2	-1.166*** (0.090)	-1.093*** (0.081)	-1.050*** (0.105)	-1.166*** (0.038)	0.052 (0.081)
Broad-OIS spread	1.207*** (0.077)	1.288*** (0.066)	1.287*** (0.090)	1.158*** (0.052)	10.908*** (0.513)
Libor-OIS spread	-1.150*** (0.079)	-1.104*** (0.092)	-1.094*** (0.096)	-1.049*** (0.064)	-10.223*** (0.809)
Constant	-3.477*** (0.198)	-3.499*** (0.226)	-3.758*** (0.274)	-2.747*** (0.163)	-0.890*** (0.238)

Variance equation

$$\ln(\sigma_t^2) = \alpha + \beta \ln(\sigma_{t-1}^2) + \gamma \varepsilon_{t-1}/\sigma_{t-1} + \eta(|\varepsilon_{t-1}/\sigma_{t-1}| - \sqrt{2/\pi}) + \lambda \text{USD auction}_t$$

α	-2.300*** (0.189)	-2.066*** (0.195)	-1.705*** (0.136)	-2.314*** (0.133)	-0.655*** (0.157)
β	0.820*** (0.052)	0.727*** (0.069)	0.768*** (0.063)	0.821*** (0.057)	0.794*** (0.056)
γ	0.300** (0.153)	0.339 (0.215)	0.318** (0.161)	0.237 (0.194)	-0.191** (0.087)
η	2.189*** (0.199)	2.070*** (0.201)	1.890*** (0.181)	2.600*** (0.219)	
λ (USD auction BOE 1)	0.477** (0.196)				
λ (USD auction BOE 2)		0.499** (0.243)			
λ (USD auction BOE 3)			-1.056*** (0.325)		
λ (USD auction BOE 4)				-1.174*** (0.351)	-1.057** (0.452)
Log likelihood	-120.5	-121.4	-118.7	-117.0	-344.7

Note: Numbers in parentheses are Bollerslev-Wooldrige robust standard errors. ***, ** and * denote the 1%, 5%, and 10% significance level, respectively.

Table 12

EGARCH analysis after Lehman failure (4)

Sample: September 15, 2008-January 30, 2009

Mean equation

CDS (European)	1.020*** (0.237)	1.164*** (0.216)	1.345*** (0.218)	1.336*** (0.199)	2.680*** (0.303)
CDS (US)	0.247*** (0.055)	0.226*** (0.043)	0.313*** (0.057)	0.235*** (0.050)	
USD auction (ECB&SNB&BOE 1)	0.028 (0.037)				
USD auction (ECB&SNB&BOE 2)		-0.037 (0.041)			
USD auction (ECB&SNB&BOE 3)			-0.227*** (0.046)		
USD auction (ECB&SNB&BOE 4)				-0.236*** (0.036)	-0.059 (0.144)
Commitment 2	-1.145*** (0.109)	-1.170*** (0.093)	-0.924*** (0.105)	-0.966*** (0.081)	0.052 (0.081)
Broad-OIS spread	1.261*** (0.095)	1.237*** (0.086)	1.360*** (0.077)	1.356*** (0.067)	10.908*** (0.513)
Libor-OIS spread	-1.161*** (0.103)	-1.120*** (0.103)	-1.353*** (0.109)	-1.221*** (0.081)	-10.223*** (0.809)
Constant	-3.283*** (0.240)	-3.301*** (0.239)	-3.981*** (0.284)	-3.791*** (0.219)	-0.890*** (0.238)

Variance equation

$$\ln(\sigma_t^2) = \alpha + \beta \ln(\sigma_{t-1}^2) + \gamma\, \varepsilon_{t-1}/\sigma_{t-1} + \eta\left(|\varepsilon_{t-1}/\sigma_{t-1}| - \sqrt{2/\pi}\right) + \lambda \text{USD auction}_t$$

α	-1.994*** (0.156)	-1.884*** (0.185)	-1.697*** (0.135)	-1.936*** (0.152)	-0.655*** (0.157)
β	0.737*** (0.092)	0.758*** (0.076)	0.762*** (0.062)	0.754*** (0.069)	0.794*** (0.056)
γ	0.264 (0.192)	0.291 (0.209)	0.355** (0.179)	0.386** (0.192)	-0.191** (0.087)
η	1.926*** (0.182)	1.958*** (0.193)	1.910*** (0.180)	2.121*** (0.214)	
λ (USD auction ECB&SNB&BOE 1)	0.465** (0.226)				
λ (USD auction ECB&SNB&BOE 2)		0.337 (0.273)			
λ (USD auction ECB&SNB&BOE 3)			-1.162*** (0.328)		
λ (USD auction ECB&SNB 4&BOE 4)				-1.165*** (0.460)	-1.057** (0.452)
Log likelihood	-121.3	-121.9	-119.7	-120.1	-344.7

Note: Numbers in parentheses are Bollerslev-Wooldrige robust standard errors. ***, ** and * denote the 1%, 5%, and 10% significance level, respectively.

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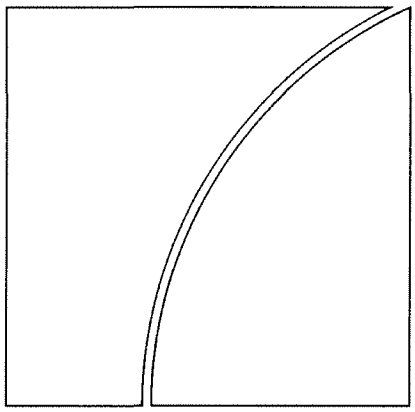

Monetary and Economic Department

OTC derivatives market activity in the second half of 2008

May 2009

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Contents

I. Market developments in the second half of 2008

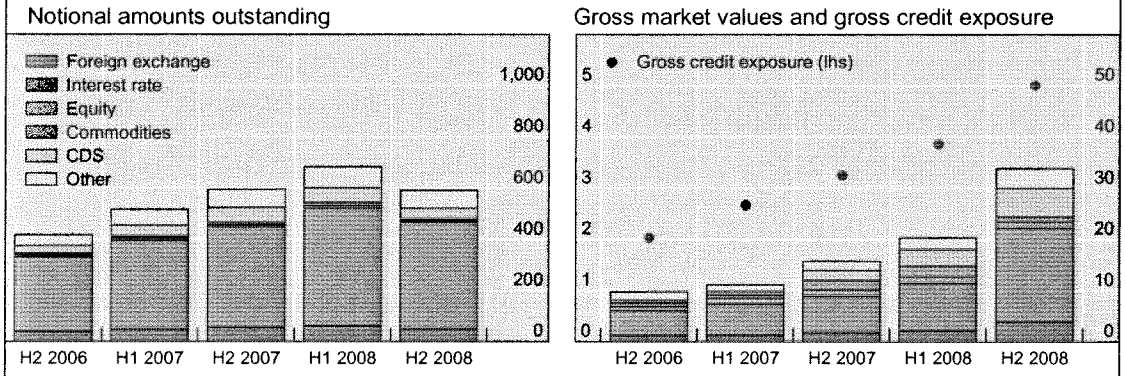
The financial crisis in the second half of 2008 resulted in the first ever decline in the total notional amounts outstanding of over-the-counter (OTC) derivatives since data collection began in 1998. Notional amounts of all types of OTC contracts stood at $592.0 trillion at the end of December 2008, 13.4% lower than their total of $683.7 trillion six months before (Graph 1, left-hand panel, and Table 1).

Facing significant price drops, markets for commodity and equity derivatives recorded volumes which were 66.5% and 36.2% lower, respectively. Against a background of severely strained credit markets combined with efforts to improve multilateral netting of offsetting contracts, credit default swap (CDS) volumes decreased by 26.9%. Foreign exchange and interest rate derivatives markets recorded their first significant downturns. Amounts outstanding of foreign exchange contracts fell by 21.0%, while amounts outstanding of interest rate contracts slid by 8.6%.

Gross market values, which measure the cost of replacing all existing contracts, represent a better measure of market risk than notional amounts. Despite the drop in amounts outstanding, significant price movements resulted in notably higher gross market values, which increased by 66.5% to $33.9 trillion at the end of December 2008 (Graph 1, right-hand panel). The higher market values were also reflected in gross credit exposures, which grew 29.7% to $5.0 trillion.[1]

Global OTC derivatives

By data type and market risk category, in trillions of US dollars



Source: BIS. Graph 1

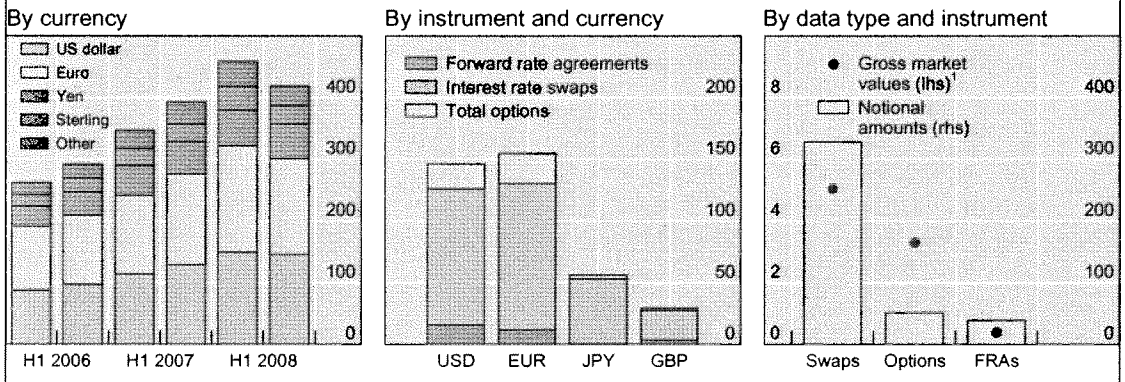
1. Market value of interest rate products almost double

In the second half of 2008 the market for OTC interest rate derivatives declined for the first time, after recording an above average rate of growth in the first half of the year. Notional amounts of these instruments fell to $418.7 trillion at the end of December 2008, 8.6% lower than six months before (Graph 2 and Table 3). Despite the decrease in notional amounts outstanding, declining interest rates resulted in a notable 98.9% increase in the gross market value of interest rate derivatives, to $18.4 trillion.

[1] Excluding CDS contracts for all countries except the United States. Gross credit exposures take into account legally enforceable bilateral netting agreements.

Interest rate derivatives

In trillions of US dollars and in per cent



[1] As a percentage of the notional amount outstanding.

Source: BIS. Graph 2

The amount outstanding of interest rate swaps decreased 8.0% to $328.1 trillion. Outstanding volumes of US dollar- and yen-denominated interest rate swaps remained virtually unchanged relative to the previous quarter. In contrast, interest rate swap markets denominated in euros (–10.6%), sterling (–24.2%), Australian dollars (–27.8%), Canadian dollars (–16.7%), Swedish kronor (–21.2%) and Swiss francs (–6.9%) all saw declines in the amounts outstanding.

The gross market value for interest rate swaps – the largest market by far – grew 105.7%, from $8.1 trillion to $16.6 trillion. The most significant increase took place in the US dollar swap market, where the gross market value surged 201.2% to $9.3 trillion.

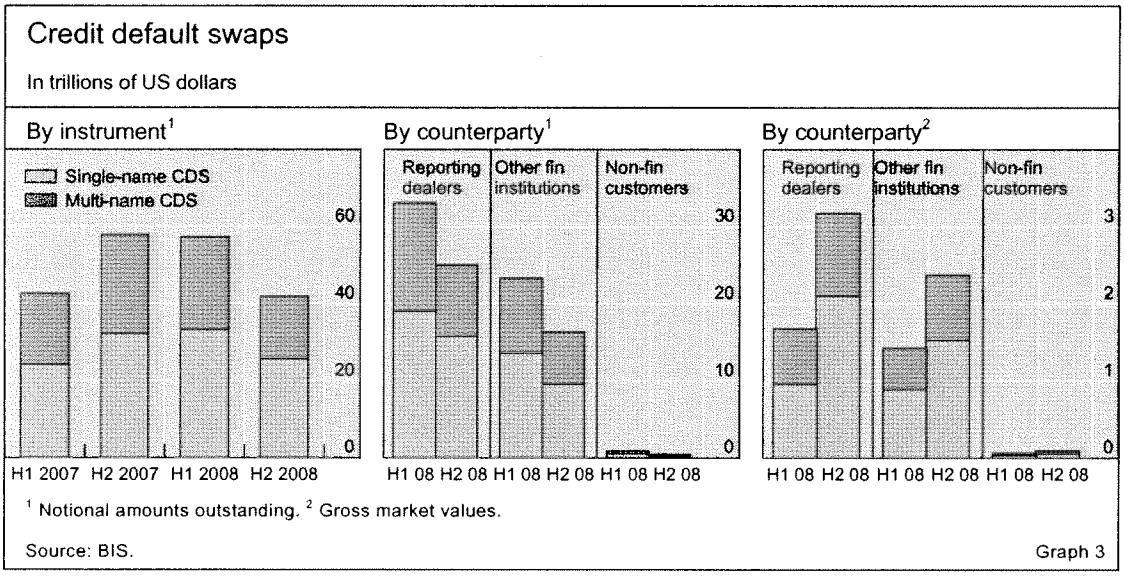
Outstanding volumes of options contracts declined 17.5% to $51.3 trillion. The gross market value of options grew by 51.3% to $1.7 trillion. The amounts outstanding of forward rate agreements (FRAs), the smallest of the interest rate derivative segments, remained stable at $39.3 trillion, while the gross market value of outstanding FRAs grew 74.4% to $153 billion.

2. Credit default swap volumes continue to contract

The volume of outstanding CDS contracts fell 27.0% to $41.9 trillion against a background of severely strained credit markets and increased multilateral netting of offsetting positions by market participants. This was a continuation of the developments seen in the first half of 2008 (Graph 1 and Table 4). Single-name contracts declined by 22.8% to $25.7 trillion while multi-name contracts, a category that includes CDS indices and CDS index tranches, saw a more pronounced decrease of 32.7%, to $16.1 trillion.

Despite the lower outstanding volumes, the gross market value for CDS contracts increased by 78.2% to $5.7 trillion as a result of the credit market turmoil. Gross market values grew 95.6% to $3.7 trillion for single-name contracts and 52.5% to $2.0 trillion for multi-name contracts.

Greater use of multilateral netting during the second half of 2008 also resulted in a change in composition across contract types (Graph 3, left-hand panel). Amounts outstanding of multi-name contracts fell 32.7% to $16.1 trillion, while the 22.8% decline in single-name contracts to $25.7 trillion was somewhat smaller.



The composition across counterparties also changed during the second half of 2008 (Graph 3, centre panel). Although the amount of CDS contracts between reporting dealers declined 24.4%, this was smaller than the 29.8% decrease in outstanding contracts between dealers and other financial institutions and the 47.7% drop in contract volumes between dealers and non-financial institutions.

Developments in gross market values across counterparties reflected the uneven declines in the outstanding volumes for the different market segments (Graph 3, right-hand panel). The market value of contracts between reporting dealers grew by 89.3% to $3.2 trillion, representing 56.2% of the total market value of outstanding CDS contracts. The market value of contracts between reporting dealers and other financial institutions increased by 66.3%, while the market value of contracts between dealers and non-financial institutions was 51.0% higher.

3. Global downturn in FX derivatives

Notional amounts outstanding of foreign exchange derivatives decreased by 21.0% to $49.8 trillion. Gross market values rose by 73.2% to $3.9 trillion (Table 2). Volumes of forwards and forex swaps, which account for almost half of total OTC FX derivatives in terms of notional amounts, declined by 23.1%, while options volumes fell 28.8%. In contrast, outstanding volumes of currency swaps saw a more moderate contraction of 9.7%. The US dollar and the euro remained the most important vehicle currencies, followed by the yen and sterling.

4. Commodity derivatives markets decline by two thirds

Amounts outstanding of OTC commodity derivatives fell by a solid 66.5% in the second half of 2008 to $4.4 trillion. Contracts on gold contracted by 39.2%, to $0.4 trillion at the end of 2008, while other commodity derivatives slid by 68.0% to $4.0 trillion. The continued decreases in commodity prices during the second half of 2008 also had a substantial impact on the gross market value of commodity contracts, which fell by 56.8% to $1.0 trillion.

5. Equity derivatives markets reflect sharply lower volumes and prices

In the second half of 2008 positions in OTC equity derivatives decreased by 36.2% to $6.5 trillion, well below the levels seen in recent years and a notable change of pace from the 20.1% increase in the first half of 2008. The decline in outstanding amounts was of the same relative size across contract types.

Reflecting lower outstanding positions and significantly decreased equity prices, the gross market values of outstanding equity derivatives declined a moderate 2.8%. This change was driven mainly by the gross market value of options, which account for around three quarters of all notional amounts outstanding. The market value of options fell 10.1% to $0.8 trillion, while the gross market value of forwards and swaps increased by 19.5% to $0.3 trillion.

6. Slightly higher concentration in interest rate derivatives markets after crisis

Concentration in increased slightly across all markets in the second half of 2008. According to the Herfindahl indices calculated on the basis of responses from individual dealers, interest rate derivatives in US dollars and sterling saw growth across all contract types, albeit from relatively low levels. In both cases the increases in concentration were more noticeable for contracts between dealers and non-reporters. Concentration did, however, also increase slightly in inter-dealer markets. Herfindahl indices also rose for FRAs in Japanese yen, with the higher concentration being more noticeable in the inter-dealer market.

II. Statistical notes

1. Coverage

As of end-June 1998, the central banks of the G10 countries introduced the regular collection of statistics on derivatives markets through reporting by leading global dealers. The objective of the reporting exercise is to obtain reasonably comprehensive and internationally consistent information on the size and structure of over-the-counter (OTC) derivatives markets.

The semiannual OTC derivatives market statistics (Tables 1 to 3) provide data on notional amounts and gross market values outstanding of forwards, swaps and options of foreign exchange, interest rate, equity, commodity and credit derivatives. All published figures are adjusted for double-counting resulting from positions between reporting institutions. Notional amounts outstanding are adjusted by halving positions vis-à-vis other reporting dealers. Gross market values are adjusted by adding the total gross positive market value of contracts to the gross negative market value of contracts with non-reporting counterparties only.

As of end-June 2004, the BIS started releasing statistics on concentration measures in the context of the semiannual OTC derivatives statistics. The central banks of the G10 countries provided the BIS with data back to June 1998, including concentration measures for foreign exchange, interest rate and equity-linked derivatives (Tables 6a to 6i).

In response to a request made by the Committee on the Global Financial System (CGFS), as of end-December 2004 the BIS started releasing semiannual statistics on credit default swaps (CDS) (Tables 4 and 5), which include notional amounts outstanding and gross market values for single- and multi-name instruments. As of December 2005, additional information by counterparty, sector and rating has been made available.

2. Definitions

2.1 Types of data collected

Notional amounts outstanding: Nominal or notional amounts outstanding are defined as the gross nominal or notional value of all deals concluded and not yet settled on the reporting date. For contracts with *variable nominal or notional principal amounts*, the basis for reporting is the nominal or notional principal amounts at the time of reporting.

Nominal or notional amounts outstanding provide a measure of market size and a reference from which contractual payments are determined in derivatives markets. However, such amounts are generally not those truly at risk. The amounts at risk in derivatives contracts are a function of the price level and/or volatility of the financial reference index used in the determination of contract payments, the duration and liquidity of contracts, and the creditworthiness of counterparties. They are also a function of whether an exchange of notional principal takes place between counterparties. Gross market values provide a more accurate measure of the scale of financial risk transfer taking place in derivatives markets.

Gross positive and negative market values: Gross market values are defined as the sums of the absolute values of all open contracts with either positive or negative replacement values evaluated at market prices prevailing on the reporting date. Thus, the gross positive market value of a dealer's outstanding contracts is the sum of the replacement values of all contracts that are in a current gain position to the reporter at current market prices (and therefore, if they were settled immediately, would represent claims on counterparties). The gross negative market value is the sum of the values of all contracts that have a negative value on the reporting date (ie those that are in a current loss position and therefore, if they were settled immediately, would represent liabilities of the dealer to its counterparties).

The term "gross" is used to indicate that contracts with positive and negative replacement values with the same counterparty are not netted. Nor are the sums of positive and negative

contract values within a market risk category such as foreign exchange contracts, interest rate contracts, equities and commodities set off against one another.

As stated above, gross market values supply information about the potential scale of market risk in derivatives transactions. Furthermore, gross market value at current market prices provides a measure of economic significance that is readily comparable across markets and products.

Current credit exposure and liabilities: Current credit exposure represents the gross value of contracts that have a positive market value after taking account of legally enforceable bilateral netting agreements. Liabilities arising from OTC derivatives contracts represent the gross value of contracts that have a negative market value taking account of legally enforceable bilateral netting agreements.

Herfindahl index: The Herfindahl index represents a measure of market concentration and is defined as the sum of the squares of the market shares of each individual institution. It ranges from 0 to 10,000. The more concentrated the market, the higher the measure becomes. If the market is fully concentrated (only one institution), the measure will have the (maximum) value of 10,000.

2.2 Instrument types

Forward contracts: Forward contracts represent agreements for delayed delivery of financial instruments or commodities in which the buyer agrees to purchase and the seller agrees to deliver, at a specified future date, a specified instrument or commodity at a specified price or yield. Forward contracts are generally not traded on organised exchanges and their contractual terms are not standardised. The reporting exercise also includes transactions where only the difference between the contracted forward outright rate and the prevailing spot rate is settled at maturity, such as non-deliverable forwards (ie forwards which do not require physical delivery of a non-convertible currency) and other contracts for differences.

Swaps: Swaps are transactions in which two parties agree to exchange payment streams based on a specified notional amount for a specified period. Forward-starting swap contracts are reported as swaps.

Options: Option contracts convey either the right or the obligation, depending upon whether the reporting institution is the purchaser or the writer, respectively, to buy or sell a financial instrument or commodity at a specified price up to a specified future date.

2.3 Specific definitions for credit default swaps

Single-name CDS: A credit derivative where the reference entity is a single name.

Multi-name CDS: A contract where the reference entity is more than one name, as in portfolio or basket CDS or CDS indices. A basket CDS is a CDS where the credit event is the default of some combination of the credits in a specified basket of credits.

3. Data availability and next publication date

Detailed tables on OTC derivatives and concentration measures from end-June 1998 are available, with their main breakdowns, on the BIS website under www.bis.org/statistics/derstats.htm.

These published data may be subject to revisions. In most cases such revisions are likely to be minor. Should significant revisions occur, users will be informed of the revisions on the BIS website.

The next OTC derivatives statistics, covering the first half of 2009, will be released no later than 30 November 2009.

III. Statistical tables

Table 1

The global OTC derivatives market[1]

Amounts outstanding in billions of US dollars

	Notional amounts outstanding				Gross market values			
	Jun 2007	Dec 2007	Jun 2008	Dec 2008	Jun 2007	Dec 2007	Jun 2008	Dec 2008
GRAND TOTAL (including CDS)	**516,407**	**595,341**	**683,726**	**591,963**	**11,140**	**15,813**	**20,353**	**33,889**
A. Foreign exchange contracts	**48,645**	**56,238**	**62,983**	**49,753**	**1,345**	**1,807**	**2,262**	**3,917**
Outright forwards and forex swaps	24,530	29,144	31,966	24,562	492	675	802	1,732
Currency swaps	12,312	14,347	16,307	14,725	619	817	1,071	1,588
Options	11,804	12,748	14,710	10,466	235	315	388	597
Memo: Exchange-traded contracts[2]	*303*	*291*	*367*	*220*	...	...	...	...
B. Interest rate contracts[3]	**347,312**	**393,138**	**458,304**	**418,678**	**6,063**	**7,177**	**9,263**	**18,420**
FRAs	22,809	26,599	39,370	39,262	43	41	88	153
Swaps	272,216	309,588	356,772	328,114	5,321	6,183	8,056	16,573
Options	52,288	56,951	62,162	51,301	700	953	1,120	1,694
Memo: Exchange-traded contracts[2]	*86,150*	*71,051*	*73,779*	*52,712*	...	...	...	...
C. Equity-linked contracts	**8,590**	**8,469**	**10,177**	**6,494**	**1,116**	**1,142**	**1,146**	**1,113**
Forwards and swaps	2,470	2,233	2,657	1,632	240	239	283	338
Options	6,119	6,236	7,520	4,862	876	903	863	775
Memo: Exchange-traded contracts[2]	*8,637*	*7,735*	*7,862*	*4,945*	...	...	...	...
D. Commodity contracts[4]	**7,567**	**8,455**	**13,229**	**4,427**	**636**	**1,899**	**2,209**	**955**
Gold	426	595	649	395	47	70	68	65
Other	7,141	7,861	12,580	4,032	589	1,829	2,142	890
Forwards and swaps	3,447	5,085	7,561	2,471	...	...	...	...
Options	3,694	2,776	5,019	1,561	...	...	...	...
E. Credit default swaps[5]	**42,581**	**57,894**	**57,325**	**41,868**	**721**	**2,002**	**3,172**	**5,652**
Single-name instruments	24,239	32,246	33,334	25,730	406	1,143	1,889	3,695
Multi-name instruments	18,341	25,648	23,991	16,138	315	859	1,283	1,957
F. Unallocated[6]	**61,713**	**71,146**	**81,708**	**70,742**	**1,259**	**1,788**	**2,301**	**3,831**
GROSS CREDIT EXPOSURE[7]	...	...	...	...	**2,672**	**3,256**	**3,859**	**5,004**
Memo: Exchange-traded contracts[2, 8]	*95,091*	*79,078*	*82,008*	*57,876*	...	...	...	...

[1] All figures are adjusted for double-counting. Notional amounts outstanding have been adjusted by halving positions vis-à-vis other reporting dealers. Gross market values have been calculated as the sum of the total gross positive market value of contracts and the absolute value of the gross negative market value of contracts with non-reporting counterparties. [2] Sources: FOW TRADEdata; Futures Industry Association; various futures and options exchanges. [3] Single currency contracts only. [4] Adjustments for double-counting partly estimated. [5] See Tables 4 and 5. [6] Includes foreign exchange, interest rate, equity, commodity and credit derivatives of non-reporting institutions, based on the latest Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity, in 2007. [7] Gross market values after taking into account legally enforceable bilateral netting agreements. Excludes CDS contracts for all countries except the United States. [8] Excludes commodity contracts.

Table 2

The global OTC foreign exchange derivatives market[1, 2]

Amounts outstanding in billions of US dollars

	Notional amounts outstanding				Gross market values			
	Jun 2007	Dec 2007	Jun 2008	Dec 2008	Jun 2007	Dec 2007	Jun 2008	Dec 2008
Total contracts	**48,645**	**56,238**	**62,983**	**49,753**	**1,345**	**1,807**	**2,262**	**3,917**
With reporting dealers	19,173	21,334	24,845	19,380	455	594	782	1,427
With other financial institutions	19,144	24,357	26,775	21,214	557	806	995	1,753
With non-financial customers	10,329	10,548	11,362	9,158	333	407	484	737
Up to 1 year[3]	36,950	40,316	43,639	32,375	...	...	...	...
Between 1 and 5 years[3]	8,090	8,553	10,701	9,664	...	...	...	...
Over 5 years[3]	3,606	7,370	8,643	7,715	...	...	...	...
US dollar	40,513	46,947	52,152	42,170	1,112	1,471	1,838	3,133
Euro	18,280	21,806	25,963	20,969	455	790	1,010	1,567
Yen	10,602	12,857	13,616	12,128	389	371	433	916
Sterling	7,770	7,979	8,377	5,606	174	260	280	692
Swiss franc	3,056	3,662	3,964	3,239	54	91	119	197
Canadian dollar	2,239	2,404	2,226	1,711	106	134	93	127
Swedish krona	1,390	1,525	1,589	1,261	23	29	30	88
Other	13,440	15,297	18,078	12,421	377	470	721	1,114
Memo: Exchange-traded contracts[4]	*303*	*291*	*367*	*220*	...	...	...	...

[1] See footnote 1 to Table 1. [2] Counting both currency sides of every foreign exchange transaction means that the currency breakdown sums to 200% of the aggregate. [3] Residual maturity. [4] See footnote 2 to Table 1.

Table 3

The global OTC interest rate derivatives market[1]

Amounts outstanding in billions of US dollars

	Notional amounts outstanding				Gross market values			
	Jun 2007	Dec 2007	Jun 2008	Dec 2008	Jun 2007	Dec 2007	Jun 2008	Dec 2008
Total contracts	**347,312**	**393,138**	**458,304**	**418,678**	**6,063**	**7,177**	**9,263**	**18,420**
With reporting dealers	148,555	157,245	188,982	162,970	2,375	2,774	3,554	6,629
With other financial institutions	153,370	193,107	223,023	214,107	2,946	3,786	4,965	10,731
With non-financial customers	45,387	42,786	46,299	41,601	742	617	745	1,061
Up to 1 year[2]	132,402	127,601	153,181	137,278	...	...	...	...
Between 1 and 5 years[2]	125,700	134,713	150,096	138,263	...	...	...	...
Over 5 years[2]	89,210	130,824	155,028	143,137	...	...	...	...
US dollar	114,371	129,756	149,813	146,249	1,851	3,219	3,601	10,200
Euro	127,648	146,082	171,877	154,773	2,846	2,688	3,910	5,200
Yen	48,035	53,099	58,056	56,419	364	401	380	815
Sterling	27,676	28,390	38,619	29,593	627	430	684	1,189
Swiss franc	3,921	4,101	5,253	4,967	52	42	71	108
Canadian dollar	2,828	3,014	3,286	2,701	43	37	60	176
Swedish krona	5,155	5,176	6,454	5,104	48	43	73	122
Other	17,678	23,520	24,946	18,872	232	317	484	610
Memo: Exchange-traded contracts[3]	*86,150*	*71,051*	*73,779*	*52,712*	...	...	...	...

[1] See footnote 1 to Table 1. [2] Residual maturity. [3] See footnote 2 to Table 1.

Table 4

Credit default swap market[1]

Amounts outstanding in billions of US dollars

	Notional amounts outstanding									Gross market values		
	December 2007			June 2008			December 2008			Dec 2007	Jun 2008	Dec 2008
	Bought	Sold	Total	Bought	Sold	Total	Bought	Sold	Total			
Total CDS contracts	**44,298**	**45,626**	**57,894**	**45,853**	**44,555**	**57,325**	**33,866**	**33,024**	**41,868**	**2,002**	**3,172**	**5,652**
With reporting dealers	31,387	32,673	32,030	33,309	32,858	33,083	25,033	25,010	25,022	938	1,678	3,177
With other financial institutions	12,513	12,661	25,174	12,010	11,287	23,297	8,526	7,826	16,352	1,011	1,430	2,377
Banks and securities firms	6,843	7,163	14,006	6,985	6,698	13,683	5,841	5,505	11,345	489	737	1,575
Insurance firms	328	176	504	279	119	398	284	115	399	19	26	58
Other	5,342	5,322	10,664	4,746	4,469	9,216	2,401	2,207	4,608	504	667	744
With non-financial customers	399	291	690	534	410	944	306	188	494	52	65	98
Up to 1 year	2,575	2,482	3,130	3,327	3,092	3,968	2,436	2,337	2,975	...	...	...
Between 1 and 5 years	27,640	28,693	35,954	29,538	29,145	36,923	21,464	21,112	26,714	...	...	...
Over 5 years	14,084	14,451	18,811	12,988	12,318	16,433	9,965	9,576	12,179	...	...	...
Single-name instruments[2]	24,554	24,740	32,246	26,610	25,812	33,334	21,070	20,470	25,730	1,143	1,889	3,695
Multi-name instruments	19,745	20,885	25,648	19,243	18,743	23,991	12,796	12,554	16,138	859	1,283	1,957

[1] Data on total CDS and gross market values are shown on a net basis. Data on CDS bought and sold are shown on a gross basis, ie not adjusted for inter-dealer double-counting. [2] See Table 5.

Table 5

Credit default swap market[1]

Single-name instruments

Amounts outstanding in billions of US dollars

	Notional amounts outstanding									Gross market values		
	December 2007			June 2008			December 2008			Dec 2007	Jun 2008	Dec 2008
	Bought	Sold	Total	Bought	Sold	Total	Bought	Sold	Total			
Total single-name instruments	**24,554**	**24,740**	**32,246**	**26,610**	**25,812**	**33,334**	**21,070**	**20,470**	**25,730**	**1,143**	**1,889**	**3,695**
With reporting dealers	16,916	17,181	17,049	19,139	19,037	19,088	15,878	15,741	15,810	485	959	2,103
With other financial institutions	7,365	7,340	14,706	7,057	6,589	13,646	4,996	4,612	9,608	634	893	1,530
Banks and securities firms	3,954	3,932	7,886	4,070	3,745	7,814	3,328	3,030	6,358	320	451	999
Insurance firms	173	107	280	146	96	242	185	89	274	13	18	43
Other	3,238	3,301	6,540	2,841	2,749	5,590	1,483	1,492	2,976	301	425	488
With non-financial customers	272	219	492	415	185	600	196	117	313	24	36	62
Up to 1 year	1,590	1,512	2,003	2,294	2,150	2,786	1,864	1,791	2,274	...	...	...
Between 1 and 5 years	16,033	16,397	20,896	17,511	17,275	21,812	13,280	12,967	16,265	...	...	...
Over 5 years	6,931	6,831	9,346	6,805	6,388	8,736	5,926	5,713	7,191	...	...	...
Sovereigns	1,410	1,390	1,798	1,659	1,641	2,177	1,277	1,282	1,650	...	...	...
Non-sovereigns	23,144	23,350	30,448	24,951	24,171	31,157	19,793	19,188	24,080	...	...	...
Investment grade	15,249	16,071	20,659	17,380	17,218	22,155	13,728	13,627	16,957	...	...	...
Below investment grade	3,751	3,716	5,011	5,535	5,343	6,756	4,672	4,100	5,492	...	...	...
Non-rated	5,553	4,954	6,576	3,696	3,251	4,423	2,671	2,743	3,281	...	...	...

[1] Data on total CDS and gross market values are shown on a net basis. Data on CDS bought and sold are shown on a gross basis, ie not adjusted for inter-dealer double-counting.

Table 6a

Herfindahl indices for all OTC interest rate derivatives contracts

	Canadian dollar			Swiss franc			Euro			Sterling			Japanese yen			Swedish krona			US dollar		
	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]	FRAs[1]	IRS[2]	Opts.[3]
Jun 1998	824	681	999	1,053	504	953	...	...	...	713	419	723	779	440	500	1,160	539	975	521	393	869
Dec 1998	810	647	962	1,133	542	1,077	...	...	...	828	406	628	860	440	436	965	542	899	617	415	901
Jun 1999	923	737	1,438	1,085	678	937	834	572	525	856	433	828	942	484	949	870	549	824	655	495	847
Dec 1999	1,373	800	1,340	1,317	643	1,154	937	522	578	641	444	686	932	528	596	914	601	987	710	490	734
Jun 2000	1,418	856	1,458	1,421	655	1,432	851	511	530	614	429	677	1,014	545	715	936	586	1,036	755	500	782
Dec 2000	1,452	876	1,791	1,274	688	2,439	1,107	500	565	728	448	662	1,109	585	791	957	640	1,076	879	528	819
Jun 2001	1,347	874	1,621	1,264	678	1,239	936	486	559	693	438	648	1,937	613	708	1,125	592	989	888	529	764
Dec 2001	1,812	1,044	1,702	1,252	788	1,228	740	524	584	638	476	727	1,758	706	1,217	1,002	608	1,081	1,145	730	1,143
Jun 2002	1,556	1,044	1,682	1,234	824	1,461	556	478	561	605	489	648	1,763	779	1,202	944	532	1,149	907	666	1,044
Dec 2002	1,818	1,047	2,112	1,218	846	1,693	571	492	546	610	515	615	1,942	790	1,624	886	569	1,224	1,042	682	1,038
Jun 2003	1,530	1,041	2,161	1,264	896	1,684	539	481	608	607	544	643	1,972	806	1,223	839	561	1,174	901	701	961
Dec 2003	1,522	1,039	2,226	1,269	852	1,616	639	478	591	1,095	565	666	1,647	744	1,065	947	570	1,230	786	672	877
Jun 2004	1,965	1,048	2,313	1,169	797	1,796	670	473	675	930	594	747	1,308	728	978	965	583	1,137	725	626	847
Dec 2004	1,741	973	2,697	1,222	807	1,292	597	481	607	923	578	1,452	1,852	693	739	861	583	995	645	673	767
Jun 2005	1,659	1,000	2,955	1,158	936	1,508	631	479	567	855	614	1,288	2,565	664	781	811	564	1,077	652	650	756
Dec 2005	1,649	1,017	3,052	1,630	1,015	1,584	667	484	539	1,210	661	905	3,025	635	793	767	571	1,259	690	691	762
Jun 2006	1,670	1,018	2,703	1,698	1,080	1,398	690	503	534	1,083	707	958	3,280	613	824	847	586	1,431	788	678	816
Dec 2006	1,499	1,020	2,952	1,919	1,149	1,205	783	561	569	1,024	692	916	3,468	620	768	1,068	594	1,638	917	679	830
Jun 2007	1,234	1,038	2,604	2,043	1,150	1,045	812	623	604	1,120	736	806	2,569	675	799	1,096	628	1,945	850	686	865
Dec 2007	1,122	985	2,962	2,032	1,162	948	709	596	596	1,066	765	777	2,302	673	745	1,242	660	2,337	967	698	982
Jun 2008	1,400	1,001	3,253	1,712	1,336	899	648	562	594	1,055	830	824	1,981	660	938	1,152	677	1,904	880	729	1,020
Dec 2008	1,160	1,072	2,920	1,847	1,353	949	558	598	645	1,257	953	876	2,861	727	880	1,110	729	1,389	924	783	1,132

[1] Forward rate agreements. [2] Interest rate swaps. [3] Interest rate options.

Table 6b

Herfindahl indices for all OTC foreign exchange derivatives contracts

	Forwards, forex swaps and currency swaps	Options
Jun 1998	302	519
Dec 1998	333	504
Jun 1999	372	525
Dec 1999	413	544
Jun 2000	423	507
Dec 2000	423	528
Jun 2001	416	546
Dec 2001	471	564
Jun 2002	427	518
Dec 2002	434	503
Jun 2003	438	498
Dec 2003	429	605
Jun 2004	442	560
Dec 2004	446	605
Jun 2005	440	591
Dec 2005	464	624
Jun 2006	475	606
Dec 2006	481	567
Jun 2007	486	558
Dec 2007	497	570
Jun 2008	496	636
Dec 2008	513	628

Table 6c

Herfindahl indices for all OTC equity-linked derivatives contracts

	Europe		Japan		Latin America		Other Asia		United States	
	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options
Jun 1998	909	627	2,655	1,074	5,484	3,545	1,232	1,447	1,086	1,362
Dec 1998	869	659	2,837	970	2,849	4,307	1,313	1,271	1,111	759
Jun 1999	715	639	2,170	1,462	3,071	6,169	3,506	1,388	1,215	1,042
Dec 1999	787	613	3,416	1,102	9,274	4,330	3,606	2,341	1,895	1,275
Jun 2000	618	657	2,501	1,018	6,881	6,776	5,119	1,586	1,088	749
Dec 2000	750	779	2,043	1,386	5,015	6,703	1,663	1,600	1,132	759
Jun 2001	693	891	1,461	860	5,163	4,353	1,631	1,188	1,048	663
Dec 2001	733	880	2,005	841	6,063	8,084	5,294	1,447	1,070	751
Jun 2002	770	952	1,822	1,072	7,546	7,585	6,086	1,550	1,174	890
Dec 2002	762	791	1,946	1,132	7,281	4,807	1,677	1,675	1,037	665
Jun 2003	768	985	1,854	2,322	8,839	9,332	3,197	1,894	964	793
Dec 2003	698	1,013	3,106	1,718	3,808	6,432	2,233	5,464	1,040	1,031
Jun 2004	611	1,195	1,984	2,553	3,732	6,304	2,010	5,435	855	836
Dec 2004	631	659	1,734	1,203	4,243	4,029	1,536	1,674	849	915
Jun 2005	597	661	2,064	898	6,953	4,427	1,355	1,177	722	725
Dec 2005	650	614	2,347	3,973	7,039	5,790	1,334	5,566	947	787
Jun 2006	613	690	1,408	3,409	6,704	3,918	1,294	5,537	946	1,385
Dec 2006	687	775	1,278	3,158	7,199	3,902	1,066	5,615	1,487	751
Jun 2007	782	716	1,168	2,333	7,876	3,735	1,343	1,098	1,057	804
Dec 2007	732	668	1,423	1,310	7,420	4,415	1,350	2,882	803	755
Jun 2008	707	706	1,044	989	5,979	6,292	1,180	1,249	847	741
Dec 2008	740	856	1,094	1,187	4,566	4,934	989	850	729	898

Table 6d

Herfindahl indices for OTC interest rate derivatives contracts between reporters[1]

	Canadian dollar			Swiss franc			Euro			Sterling			Japanese yen			Swedish krona			US dollar		
	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]
Jun 1998	972	740	1,193	1,231	551	1,110	...	...	...	673	414	866	832	494	489	1,021	610	816	653	454	722
Dec 1998	983	671	1,041	1,194	530	1,458	...	...	...	862	400	678	869	460	521	897	591	876	631	421	896
Jun 1999	1,008	772	1,436	1,176	776	1,044	744	595	591	982	408	1,145	894	501	546	819	563	786	692	537	873
Dec 1999	1,707	834	1,341	1,480	701	1,371	961	549	583	736	456	928	973	568	795	862	617	859	757	508	822
Jun 2000	1,594	876	1,212	1,505	724	1,495	956	543	584	666	427	886	1,073	600	822	964	607	969	932	533	858
Dec 2000	1,876	910	1,622	1,256	708	1,186	1,071	530	619	788	468	795	1,386	629	876	939	662	900	894	562	931
Jun 2001	1,365	818	1,558	1,211	705	1,350	954	506	618	769	458	826	2,319	691	803	1,279	601	857	934	577	832
Dec 2001	2,266	1,008	1,474	1,270	822	1,041	727	571	642	697	490	828	2,194	801	1,381	979	623	898	1,046	784	1,111
Jun 2002	1,992	949	1,720	1,262	854	1,220	540	503	636	647	497	786	2,095	866	1,665	962	530	1,143	1,070	719	1,239
Dec 2002	2,325	893	2,426	1,594	890	1,441	547	505	558	648	550	685	2,316	895	1,749	938	570	1,148	1,440	757	1,144
Jun 2003	2,000	974	2,695	1,606	835	1,487	555	474	600	576	522	670	2,379	935	1,423	970	569	1,101	1,142	757	991
Dec 2003	1,814	1,018	2,811	1,475	833	1,347	540	478	575	746	547	661	1,803	894	1,383	1,211	602	1,232	978	751	899
Jun 2004	2,118	1,008	2,722	1,348	800	1,691	506	474	605	1,012	723	721	1,463	843	1,158	1,125	651	1,111	791	678	820
Dec 2004	2,218	1,045	3,135	1,401	815	1,634	576	470	649	939	691	845	2,291	792	855	996	664	1,098	625	716	770
Jun 2005	1,815	938	2,333	1,244	932	1,223	661	483	556	977	695	842	3,163	749	871	902	641	1,036	604	682	783
Dec 2005	1,979	978	2,659	1,710	1,043	1,214	679	496	547	1,180	751	870	3,447	706	903	769	650	1,265	703	729	807
Jun 2006	1,698	996	2,686	1,813	1,169	1,296	707	515	557	1,090	756	908	3,841	661	881	771	658	1,830	782	695	979
Dec 2006	1,687	1,007	2,738	2,321	1,229	1,034	819	514	577	1,024	702	890	3,662	646	842	892	654	1,350	884	683	880
Jun 2007	1,321	993	2,437	2,086	1,217	901	700	512	616	936	729	801	2,354	705	972	918	676	1,504	825	672	889
Dec 2007	1,088	945	2,578	2,183	1,176	935	637	542	669	1,003	799	832	2,853	731	814	1,131	744	2,278	916	694	767
Jun 2008	1,322	988	2,719	1,868	1,470	844	642	566	665	1,177	944	813	2,279	748	1,063	1,193	785	1,721	952	764	925
Dec 2008	1,124	1,016	2,825	2,044	1,414	930	554	585	728	1,394	1,167	856	2,730	732	1,029	1,171	857	1,393	960	802	970

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers. [2] Forward rate agreements. [3] Interest rate swaps. [4] Interest rate options.

Table 6e

Herfindahl indices for OTC foreign exchange derivatives contracts between reporters[1]

Period	Forwards, forex swaps and currency swaps	Options
Jun 1998	323	527
Dec 1998	342	517
Jun 1999	385	539
Dec 1999	425	543
Jun 2000	437	550
Dec 2000	430	558
Jun 2001	411	496
Dec 2001	464	614
Jun 2002	444	526
Dec 2002	452	512
Jun 2003	478	538
Dec 2003	463	518
Jun 2004	499	683
Dec 2004	491	700
Jun 2005	493	635
Dec 2005	534	705
Jun 2006	532	656
Dec 2006	523	603
Jun 2007	516	588
Dec 2007	544	634
Jun 2008	557	761
Dec 2008	566	683

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers.

Table 6f

Herfindahl indices for OTC equity-linked derivatives contracts between reporters[1]

	Europe		Japan		Latin America		Other Asia		United States	
	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options
Jun 1998	1,539	796	4,147	1,042	8,578	2,815	2,964	2,477	1,648	906
Dec 1998	1,192	582	4,424	1,081	4,350	2,127	2,370	2,001	1,154	1,347
Jun 1999	851	725	4,756	1,403	6,230	3,206	6,146	2,386	1,157	1,448
Dec 1999	883	750	2,539	1,316	8,613	6,936	6,097	5,268	1,049	1,796
Jun 2000	694	943	3,614	1,288	4,116	7,398	7,915	2,502	850	975
Dec 2000	938	874	5,209	1,758	5,115	3,433	3,550	1,604	1,136	1,020
Jun 2001	948	834	2,844	908	10,000	3,613	4,962	2,152	2,424	753
Dec 2001	859	912	2,541	924	10,000	4,273	9,879	2,120	1,315	783
Jun 2002	840	737	3,220	1,137	6,242	4,772	9,740	3,290	2,542	765
Dec 2002	753	728	2,435	968	4,863	8,724	5,494	3,678	1,632	951
Jun 2003	639	655	2,225	2,433	5,556	3,090	7,022	3,520	708	1,555
Dec 2003	705	676	2,789	1,698	6,932	7,515	5,918	3,166	889	668
Jun 2004	582	697	1,275	1,127	3,851	5,133	3,675	2,526	800	774
Dec 2004	670	715	2,367	1,102	3,284	4,587	2,467	874	931	762
Jun 2005	618	748	2,068	838	3,387	5,707	2,482	1,000	870	803
Dec 2005	757	779	1,836	5,063	5,729	9,957	2,062	995	787	851
Jun 2006	568	829	1,600	3,606	7,743	1,784	1,924	873	629	1,316
Dec 2006	705	873	1,699	2,216	5,273	3,253	1,189	931	1,118	915
Jun 2007	862	760	1,495	1,218	6,676	3,744	1,819	982	677	884
Dec 2007	1,068	751	1,904	1,147	7,056	2,948	2,114	991	879	765
Jun 2008	797	832	1,335	989	5,350	5,032	1,909	1,159	815	796
Dec 2008	887	1,095	1,291	906	9,659	4,112	1,561	1,218	981	926

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers.

Table 6g

Herfindahl indices for OTC interest rate derivatives contracts between reporters[1] and non-reporters

	Canadian dollar			Swiss franc			Euro			Sterling			Japanese yen			Swedish krona			US dollar		
	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]	FRAs[2]	IRS[3]	Opts.[4]
Jun 1998	828	826	1,072	862	820	909	...	...	...	859	561	739	1,033	518	660	1,703	717	1,570	666	512	1,483
Dec 1998	885	786	1,047	1,959	711	731	...	...	...	1,234	521	663	1,709	501	466	1,371	649	1,121	750	501	987
Jun 1999	1,026	885	1,500	1,055	696	936	1,415	645	567	1,372	599	704	3,035	578	2,701	1,272	710	1,100	939	526	980
Dec 1999	1,613	982	1,589	1,063	763	928	999	597	973	754	503	634	3,055	592	688	1,535	799	1,398	883	558	756
Jun 2000	1,567	1,050	1,963	1,961	741	1,361	1,294	557	615	735	541	689	3,153	571	729	1,340	760	1,260	805	545	815
Dec 2000	1,412	1,050	2,065	1,638	725	4,531	1,449	513	541	884	503	717	2,502	632	759	1,341	784	1,444	1,338	574	814
Jun 2001	2,114	1,167	1,917	1,639	703	1,147	1,032	515	543	683	489	704	3,915	575	656	2,073	716	1,209	1,395	538	792
Dec 2001	2,003	1,495	2,111	2,171	951	2,146	1,040	540	578	797	562	766	4,132	625	1,009	1,771	771	1,379	1,978	731	1,275
Jun 2002	1,681	1,568	1,996	2,250	1,082	2,061	831	529	499	773	599	772	4,983	717	946	1,849	751	1,221	1,089	694	1,058
Dec 2002	1,991	1,631	2,451	2,079	1,099	2,254	931	559	607	879	604	719	3,782	739	1,402	1,690	717	1,339	1,319	683	1,018
Jun 2003	1,681	1,374	2,174	1,933	1,261	2,354	814	563	707	1,247	669	797	2,431	767	911	916	707	1,330	1,265	725	1,030
Dec 2003	2,079	1,366	2,269	1,990	1,035	2,140	1,209	551	684	2,928	685	781	2,105	762	802	879	638	1,327	859	674	915
Jun 2004	2,092	1,423	2,448	2,049	1,026	1,929	1,295	565	861	881	546	946	1,692	807	1,008	980	662	1,322	813	661	937
Dec 2004	1,773	1,276	2,632	1,371	1,099	1,496	876	656	943	1,203	583	2,809	1,395	1,077	1,275	908	879	1,104	917	871	933
Jun 2005	1,978	1,235	3,559	1,490	1,074	1,943	859	545	716	1,158	602	2,907	1,503	775	670	1,097	572	1,187	923	702	770
Dec 2005	1,448	1,220	3,339	1,907	1,125	2,054	891	556	632	1,693	687	1,127	1,409	775	732	1,174	611	1,531	928	747	751
Jun 2006	2,003	1,177	2,763	1,744	1,086	1,847	959	570	583	1,741	757	1,285	1,581	736	901	1,459	660	2,240	1,001	757	718
Dec 2006	1,656	1,158	3,167	3,516	1,185	1,644	1,032	685	698	1,449	773	1,144	2,406	734	901	2,006	708	2,065	1,404	765	863
Jun 2007	1,227	1,221	3,108	2,011	1,208	1,598	1,467	852	697	2,149	824	951	4,351	785	1,103	1,737	829	2,426	1,132	794	940
Dec 2007	1,811	1,158	3,137	1,737	1,248	1,498	1,759	779	798	2,995	904	1,409	1,893	822	1,716	1,852	857	2,531	1,289	844	1,745
Jun 2008	1,778	1,127	3,539	1,329	1,282	1,709	1,849	683	888	2,896	965	1,731	1,837	820	3,196	1,801	946	2,344	1,231	891	1,944
Dec 2008	1,529	1,695	3,412	1,491	1,378	1,485	1,224	673	870	3,496	975	1,806	3,600	939	2,049	1,551	843	1,596	1,697	949	2,190

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers. [2] Forward rate agreements. [3] Interest rate swaps. [4] Interest rate options.

Table 6h

Herfindahl indices for OTC foreign exchange derivatives contracts between reporters[1] and non-reporters

Period	Forwards, forex swaps and currency swaps	Options
Jun 1998	330	691
Dec 1998	357	640
Jun 1999	401	596
Dec 1999	432	646
Jun 2000	438	566
Dec 2000	444	576
Jun 2001	453	646
Dec 2001	516	675
Jun 2002	469	638
Dec 2002	468	603
Jun 2003	460	592
Dec 2003	443	995
Jun 2004	445	670
Dec 2004	518	638
Jun 2005	454	672
Dec 2005	461	645
Jun 2006	475	659
Dec 2006	484	635
Jun 2007	492	632
Dec 2007	533	673
Jun 2008	530	744
Dec 2008	562	697

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers.

Table 6i

Herfindahl indices for OTC equity derivatives contracts between reporters[1] and non-reporters

	Europe		Japan		Latin America		Other Asia		United States	
	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options	Forwards and swaps	Options
Jun 1998	1,158	995	2,508	1,236	5,291	3,715	1,468	812	1,227	1,700
Dec 1998	1,187	1,254	2,691	912	2,883	4,570	1,487	1,357	1,260	941
Jun 1999	802	892	1,877	2,028	3,093	7,075	3,134	1,680	1,304	1,450
Dec 1999	900	945	4,186	1,909	9,277	4,538	2,677	1,527	2,277	1,774
Jun 2000	706	743	2,616	1,822	6,919	7,794	3,734	1,346	1,290	884
Dec 2000	841	1,312	2,359	918	5,051	6,875	1,645	1,702	1,228	1,023
Jun 2001	733	1,962	1,924	1,412	5,524	4,945	1,848	1,146	1,321	851
Dec 2001	831	1,541	2,494	1,108	6,324	8,829	1,676	1,352	1,288	955
Jun 2002	824	2,235	2,059	1,096	7,932	8,324	2,256	1,059	1,390	1,212
Dec 2002	947	1,327	2,458	2,110	7,526	9,561	2,088	2,443	1,229	812
Jun 2003	984	1,788	2,910	2,132	8,863	9,622	1,273	2,454	1,265	809
Dec 2003	857	1,863	5,520	1,988	4,353	7,604	1,485	6,074	1,419	1,457
Jun 2004	879	2,227	3,114	4,446	3,839	6,678	1,536	6,013	1,276	1,063
Dec 2004	761	832	2,209	1,932	4,681	4,072	1,667	2,207	1,246	1,213
Jun 2005	837	794	2,330	1,583	7,270	4,623	1,313	1,616	929	852
Dec 2005	767	814	3,014	2,080	7,122	5,481	1,431	6,399	1,187	962
Jun 2006	803	721	1,942	3,099	6,857	3,971	1,240	7,619	1,234	1,612
Dec 2006	748	1,140	1,645	4,896	7,330	3,953	1,189	7,309	1,709	896
Jun 2007	822	1,073	1,582	4,599	8,167	3,842	1,549	1,513	1,415	924
Dec 2007	603	965	1,316	2,197	7,603	4,487	1,483	5,167	1,028	861
Jun 2008	949	918	1,217	1,786	6,809	6,529	1,207	1,841	1,014	836
Dec 2008	744	1,065	1,026	2,499	4,747	5,063	1,091	1,260	807	1,043

[1] Reporters (reporting dealers) are defined as those institutions whose head office is located in the G10 countries and which participate in the semiannual OTC derivatives market statistics; in addition, reporting dealers include all branches and subsidiaries of these entities worldwide; reporting dealers will mainly be commercial and investment banks and securities houses, including their branches and subsidiaries and other entities which are active dealers.

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Overview: global financial crisis spurs unprecedented policy actions

Financial stability concerns took centre stage once again over the period between end-August and end-November. In the wake of the mid-September failure of Lehman Brothers, global financial markets seized up and entered a new and deeper state of crisis. As money market funds and other investors were forced to write off their Lehman-related investments, counterparty concerns mounted in the context of large-scale redemption-driven asset sales.

The ensuing sell-off affected all but the safest assets and left key parts of the global financial system dysfunctional. With credit and money markets essentially frozen and equity prices plummeting, banks and other financial firms saw their access to funding eroded and their capital base shrink, owing to accumulating mark to market losses. Credit spreads surged to record levels, equity prices saw historic declines and volatilities soared across markets, indicating extreme financial market stress. Government bond yields declined in very volatile conditions, as recession concerns and safe haven flows increasingly outweighed the impact of anticipated increases in fiscal deficits. At the same time, yield curves steepened from the front end, reflecting repeated downward adjustments in policy rates.

Emerging market assets also experienced broad-based price declines, as depressed levels of risk appetite and associated pressures in the industrialised world spilled over into emerging financial markets. With confidence in the continued viability of key parts of the international banking system collapsing, the authorities in several countries embarked on an unprecedented wave of policy initiatives to arrest the plunge in asset prices and contain systemic risks.

Market developments over the period under review went through four more or less distinct stages. Stage one, which led into the Lehman bankruptcy in mid-September, was marked by the takeover of two major US housing finance agencies by the authorities in the United States. Stage two encompassed the immediate implications of the Lehman bankruptcy and the wide-spread crisis of confidence it triggered. Stage three, starting in late September, was characterised by fast-paced and increasingly broad policy actions, as responses to the crisis evolved from case by case reactions to a more international, system-wide approach. In the fourth and final stage, from mid-October, pricing patterns were increasingly dominated by recession fears, while markets continued to struggle with the uncertainties surrounding the large number of newly announced policy initiatives.

Fannie Mae and Freddie Mac under government control

Housing markets continue to deteriorate ...

Financial markets entered September amid growing expectations of a broad-based cyclical deterioration. The prices of financial assets had started to experience downward pressure during the summer as markets adjusted to the outlook of weak earnings, rising defaults and associated financial sector losses. With the hoped-for stabilisation in house prices expected to be still some time off and activity in securitisation markets weighed down by heavy subprime losses (Graph 1, left-hand and centre panels), loss expectations also continued to build for the US government-sponsored housing finance agencies Fannie Mae and Freddie Mac.

... putting pressure on Fannie and Freddie ...

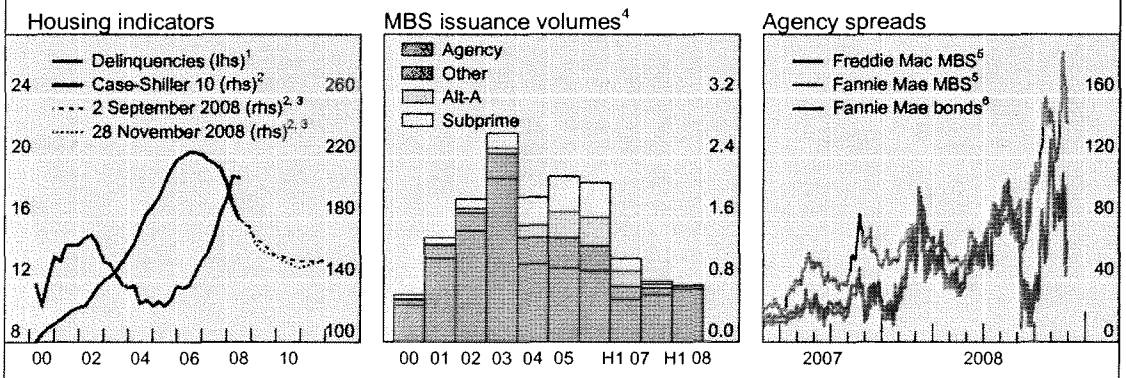
In a bid to support the US housing market, which had come to depend on agency securitisation for virtually all remaining mortgage origination activity, the US government formally took control of the two agencies on Sunday 7 September (see Table 1 for a timeline of events). The move had been broadly anticipated and, by essentially making the agencies' formerly implicit guarantees explicit, largely lifted credit risks from both senior and subordinated holders of the agencies' debt. Spreads on agency-sponsored mortgage-backed securities (MBS) and debt instruments (Graph 1, right-hand panel) tightened as a result. In contrast, the remaining value of equity claims was effectively wiped out owing to the government's new senior preferred equity stake, resulting in losses for regional US banks and other holders of the agencies' shares.

... which are subsequently taken over by the authorities

The relief provided by these measures proved limited, however. Expectations of further writedowns and losses continued to weigh on other parts of the financial sector. As the macroeconomic outlook darkened, actual announced global losses related to the credit crisis, which had soared to a total of around $510 billion by the end of August 2008, continued to rise (Graph 2, centre panel). When attention turned away from the US mortgage finance agencies, financial equity prices and credit spreads came under renewed pressure. Weakness in both markets, in turn, added to the problems faced by

The relief provided by the takeover is short-lived ...

US mortgage markets and agency spreads



[1] Subprime loan delinquencies as a percentage of total subprime loans; seasonally adjusted. [2] House price index; Q1 2000 = 100. [3] Implied by prices on futures contracts on the Case-Shiller 10 index. [4] Mortgage-backed securities (MBS); in trillions of US dollars. [5] JPMorgan index; option-adjusted spreads over Libor, in basis points. [6] JPMorgan index; two-year on-the-run spread to Treasuries, in basis points.

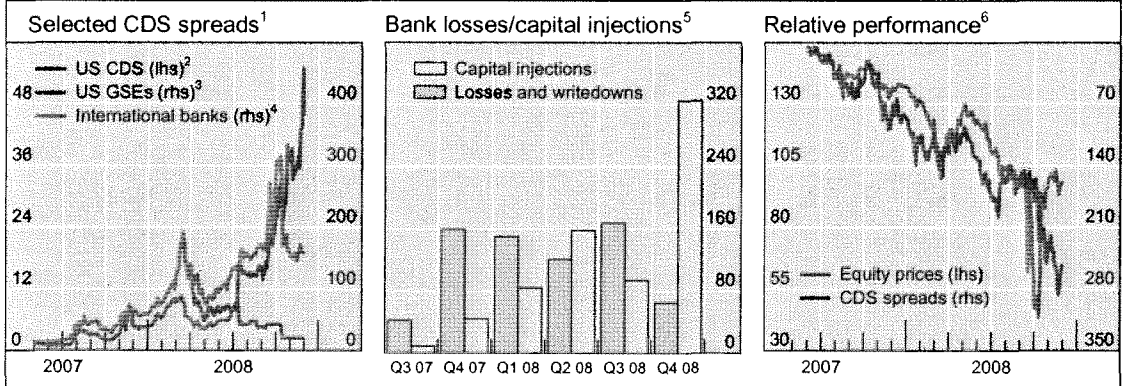
Sources: Bloomberg; JPMorgan Chase; Markit; UBS; BIS calculations. Graph 1

Timeline of key events over the period

7 September	Two US mortgage finance agencies (Fannie Mae and Freddie Mac) are taken into conservatorship.
15 September	Lehman Brothers Holdings Inc files for Chapter 11 bankruptcy protection.
16 September	Reserve Primary Fund, a US money market fund with more than $50 billion in assets, "breaks the buck", triggering large volumes of fund redemptions and contagion effects across money and short-term credit markets; the US government steps in to rescue insurance company AIG.
18 September	UK bank HBOS announces its merger with rival Lloyds TSB; new round of coordinated central bank measures address the squeeze in US dollar funding with $160 billion in new or expanded swap lines; the UK authorities prohibit short selling of financial shares.
19 September	The US Treasury announces a temporary guarantee for money market fund investors; the SEC announces a ban on short sales in financial shares; early details emerge of a $700 billion US Treasury proposal to remove troubled assets from bank balance sheets (the Troubled Asset Relief Program, TARP).
29 September	UK mortgage lender Bradford & Bingley is nationalised; banking and insurance company Fortis receives a $16 (€11.2) billion capital injection; German commercial property lender Hypo Real Estate secures a government-facilitated credit line (subsequently raised to $70 (€50) billion); troubled US bank Wachovia is taken over; the proposed TARP is rejected by the US House of Representatives.
30 September	Financial group Dexia receives a $9 (€6.4) billion capital injection; the Irish government announces a guarantee safeguarding all deposits, covered bonds and senior and subordinated debt of six Irish banks; other governments follow up with similar initiatives or expand existing guarantee schemes over the following weeks.
3 October	The US Congress approves the revised TARP plan.
7 October	The US Federal Reserve announces the creation of a new Commercial Paper Funding Facility aimed at buying three-month unsecured and asset-backed commercial paper.
8 October	Major central banks undertake a coordinated round of policy rate cuts; the UK authorities announce a comprehensive support package, including capital injections for UK-incorporated banks and guarantees for new short- to medium-term senior unsecured bank debt.
13 October	Major central banks jointly announce measures to improve liquidity in short-term US dollar fund markets, supported by uncapped US dollar swap lines between the Federal Reserve and the other central banks; euro area governments pledge system-wide bank recapitalisations and guarantees for new bank debt.
14 October	The US government announces that up to $250 billion of previously approved TARP funds are to be used to recapitalise banks; 9 large US banks agree to public recapitalisation.
21 October	The US Federal Reserve announces the creation of a new Money Market Investor Funding Facility, under which it will finance the purchase of short-term debt from money market funds.
28 October	Hungary secures a $25 billion support package from the IMF and other multilateral institutions aimed at stemming growing capital outflows and related currency pressures.
29 October	To counter the spread of difficulties in obtaining US dollar funding, the US Federal Reserve establishes US dollar swap lines with the monetary authorities in Brazil, Korea, Mexico and Singapore.
12 November	The US Treasury announces that TARP funds previously earmarked for the purchase of troubled assets will be reallocated to supporting consumer credit.
23 November	The US government agrees to protect $306 billion worth of loans and securities on Citigroup's books and to inject $20 billion of cash in return for a $27 billion preferred equity stake
25 November	The US Federal Reserve announces the creation of a $200 billion facility to extend loans against securitisations backed by consumer and small business loans; under another programme, up to $500 billion will be used for purchases of bonds and mortgage-backed securities issued by Fannie Mae, Freddie Mac and the Federal Home Loan Banks.

Sources: Bank of England; Federal Reserve Board; Bloomberg; *Financial Times*; *The Wall Street Journal*. Table 1

Financial sector indicators



[1] Equally weighted average spreads, in basis points. [2] US sovereign five-year CDS spread. [3] US government-sponsored enterprises (GSEs): Fannie Mae and Freddie Mac. [4] Thirteen banks headquartered in North America and 11 banks headquartered in Europe. [5] In billions of US dollars; third and fourth quarters of 2008 include government injection of capital. [6] Equally weighted average spreads (inverted scale, in basis points) and equity prices (in US dollars) for the 24 universal banks in the left-hand panel.

Sources: Bloomberg; Markit; BIS calculations. Graph 2

the affected institutions in replenishing their capital bases and satisfying their ongoing funding needs (Graph 2, left- and right-hand panels). Strains mounted mainly for market participants primarily dependent on wholesale funding and known to be exposed to troubled assets, including the major standalone investment banks.

... with Lehman Brothers facing particular problems

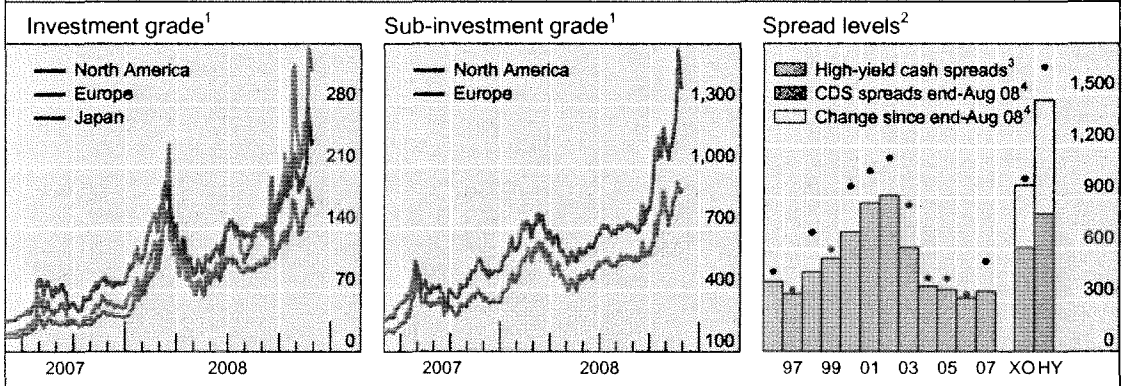
Lehman Brothers, in particular, faced increasing pressures. When, on 9 September, a large Asian investor pulled out of talks about a long-awaited capital injection, the company's already depressed stock price was pushed further down. Weak results for the third quarter of 2008 were released the following day. Despite the simultaneous announcement of plans to spin off major business units in a bid to raise funds, confidence in the ability of Lehman's management to secure urgently needed funding faded quickly. This, in turn, triggered speculation that the authorities would try to arrange a solution over the following weekend.

Lehman Brothers bankruptcy triggers confidence crisis

In this environment of tension over the continued viability of Lehman Brothers, financial market developments entered a completely new phase. The spotlight was now being turned on the ability of key financial institutions to maintain solvency in the face of accumulating losses. The trigger for this new and intensified stage of the credit crisis came on Monday 15 September. That day, following failed attempts by the US authorities to broker a takeover by another financial institution over the weekend, Lehman Brothers Holdings Inc filed for bankruptcy protection, one of the biggest credit events in history.

The Lehman failure ...

Credit spread indices



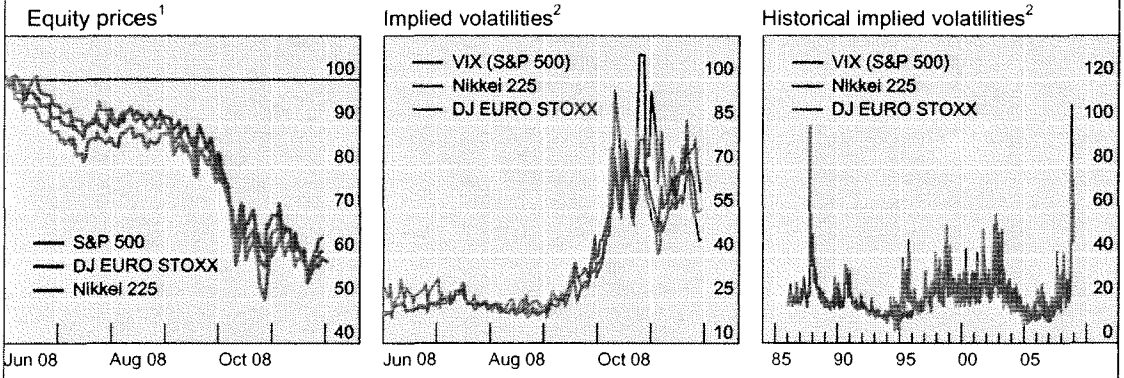
[1] Five-year on-the-run CDS mid-spread on index contracts of investment grade (CDX IG; iTraxx Europe; iTraxx Japan) and sub-investment grade (CDX High Yield; iTraxx Crossover) quality; in basis points. [2] The dots indicate the maximum spread levels over the respective periods. [3] Average monthly global high-yield bond spreads over Treasuries. [4] CDS spread levels over Treasuries (XO: iTraxx Crossover; HY: CDX High Yield) at end-August and end-November 2008; adjusted with five-year swap spreads.

Sources: JPMorgan Chase; Markit; BIS calculations. Graph 3

... causes counterparty risks to mount ...

The turmoil in financial markets intensified and quickly spread from credit and money markets into the global financial system more broadly (see Box 1 for details on the Lehman bankruptcy and some of its implications). With perceptions of counterparty risk rising, the benchmark US investment grade CDX credit default swap (CDS) index spread jumped by 42 basis points on 15 September alone, and US high-yield spreads rose 118 basis points. Credit spreads in other major markets increased by similar amounts (Graph 3, left-hand and centre panels) and continued to move in tandem with US markets through the remainder of the period. As a result, at their peak, US high-yield CDS spreads reached an all-time high some 500 basis points above the highest comparable cash spreads realised at the height of the telecom bust in September 2002 (Graph 3, right-hand panel). Equity prices fell by some 4% in the United States and Europe on the day of the Lehman bankruptcy, and other stock markets declined by similar amounts (Graph 4, left-hand panel).

Equity market prices and implied volatilities



[1] In local currency; 1 June 2008 = 100. [2] Volatility implied by the price of at-the-money call option contracts on stock market indices, in per cent.

Sources: Bloomberg; BIS calculations. Graph 4

Box 1: Three market implications of the Lehman bankruptcy

Ingo Fender, Allen Frankel and Jacob Gyntelberg

Lehman Brothers Holdings Inc (LBHI) filed a petition under Chapter 11 of the US bankruptcy code on 15 September, listing consolidated bank and bond debt of more than $600 billion; its US broker-dealer subsidiary was acquired by Barclays a few days later. The filing marked the first failure of a major investment bank since the demise of Drexel Burnham Lambert in February 1990. Lehman's problems originated from large-scale losses and writedowns taken on exposures to troubled assets and concerns that future losses would outstrip the company's previous efforts to replenish its capital base (Graph A, centre panel). As such, its failure revived questions about investment banks' highly leveraged balance sheets and associated dependence on wholesale funding that had been raised when Bear Stearns had nearly failed in early 2008. Thus, when confidence in the continued viability of the company collapsed (Graph A, left-hand panel), its access to wholesale markets was cut off, forcing Lehman into bankruptcy.[1]

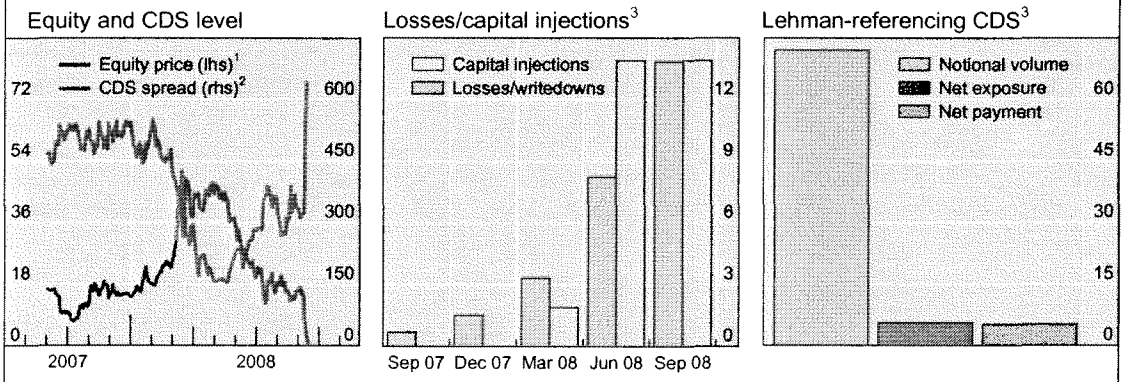
An event of this magnitude obviously raised a multitude of issues, given the company's size and its central position as a dealer and counterparty in a variety of financial markets. This box discusses three particular market implications linked to the failure of Lehman Brothers that had the potential to cause systemic liquidity disturbances: (1) the impact on the CDS market; (2) the liquidation of money market funds due to losses suffered on Lehman debt; and (3) the consequences of the bankruptcy for the company's prime brokerage clients.

(1) CDS markets

The potential fallout of a Lehman bankruptcy in the $57.3 trillion CDS market[2] was the one issue that attracted most attention in the days surrounding the company's bankruptcy filings. The concerns arose from Lehman's central role as a major counterparty and reference entity in that market. It was known that its bankruptcy filing would have two immediate effects: it would trigger default clauses in CDS contracts referencing Lehman, and it would terminate the contracts that the firm had entered into as a counterparty. Netting, settlement and replacement of the respective positions were known to raise operational risks. More importantly, however, no hard public information on the volume of CDS contracts referencing Lehman or the net amounts required to settle them was available at the time of the bankruptcy. The absence of such information created great uncertainty about the capacity of already strained money markets to accommodate the anticipated corresponding liquidity needs.

To manage the situation and address the uncertainties involved, the following initiatives were undertaken. First, a special trading session was organised on Sunday 14 September, right before the bankruptcy filing. The objective was to help the main CDS dealers net out counterparty positions involving Lehman and to rebalance their books through the replacement of trades. Second,

Lehman Brothers: selected indicators



[1] In US dollars. [2] In basis points. [3] In billions of US dollars.

Source: Bloomberg. Graph A

following established ISDA (International Swaps and Derivatives Association) procedures, an auction among CDS dealers was conducted on 10 October to determine the recovery rate to be used in the cash settlement of CDS contracts referencing Lehman and, thus, the net amounts to be exchanged between parties.[3] Third, the DTCC (Depository Trust and Clearing Corp) made public its count of $72 billion worth of outstanding CDS contracts referencing Lehman and an estimate of $6 billion for related net settlement payments. In the end, on 21 October, a total of $5.2 billion in net payments were made on such contracts (Graph A, right-hand panel). While these relatively modest volumes had no noticeable impact on liquidity conditions at the time of settlement, earlier uncertainties related to these claims are likely to have contributed to volatile conditions in money markets following the bankruptcy filing. Added strains from a potential failure of insurer AIG, in turn, were averted only through a government rescue.

(2) Money market funds

A major source of funding for Lehman was its issuance of commercial paper and other forms of short-dated debt. Money market funds were attracted to these securities by their high credit ratings and yield premiums relative to US government paper. Money market fund investors also felt protected against principal loss because of regulatory restrictions imposed on fund managers and because fund managers had avoided losses in the past.

In the aftermath of the Lehman bankruptcy, 25 money market fund advisers took actions to protect their investors against losses on the company's debt. However, the net asset value of a public money market fund, Reserve Primary, fell below $1.00 per share. As a result, the fund was to be liquidated and distributions made to investors as cash accumulated either through the maturing of portfolio holdings or their sale.

The fund's liquidation prompted massive redemptions by investors in other US money market funds, especially "prime" funds invested in commercial paper. To stop the run on these funds, the US Treasury instituted a temporary programme of insurance for money market fund investors, which was followed up by Federal Reserve rescue programmes aimed at outright purchases of commercial paper and of short-term debt from money market funds (see Box 2 on recent government initiatives).

(3) Prime brokerage activities

Lehman was managed as a global firm, which involved in particular the centralisation in the United States of its funding activities. Despite the global nature of the firm, separate administration and bankruptcy applications were filed by Lehman outside the United States and by the parent firm in New York. These filings in different jurisdictions made this one of the first truly global bankruptcies of a large and complex financial institution. The complexity of the Lehman operation, and the takeover of its US broker-dealer subsidiary immediately after the holding company's bankruptcy filing, raised questions related to the use of different legal procedures across countries for a collapsed firm that was previously managed and run along global product lines. One manifestation of the resulting issues concerns Lehman's prime brokerage activities.

Lehman provided prime brokerage services to a large number of hedge funds. As part of these prime brokerage relationships, hedge funds placed investment assets with Lehman's broker-dealer units in different jurisdictions. These assets, posted as collateral for funding activities, could then be reused by Lehman to meet its own obligations, a process called re-hypothecation. Given its insolvency, many of Lehman's prime brokerage clients suddenly lost access to (and, potentially, part of their claims on) their collateral assets for the duration of the administration process. They were thus forcibly locked into positions of changing value whose future accessibility would depend on different legal proceedings and contractual arrangements in various jurisdictions. To the extent that this resulted in adjustments to the size and location of hedge funds' activities with their prime brokers, the reallocation of funds across jurisdictions, combined with attempts to reduce leveraged risk exposures, would generate potentially sizeable asset sales and withdrawals from individual prime brokerage accounts. These transactions, in turn, would add to pressures in funding and securities lending markets in the wake of the Lehman bankruptcy.

[1] On similar cases of bank run-type effects in financial markets, see C Borio, "Market distress and vanishing liquidity: anatomy and policy options", *BIS Working Papers*, no 158, July 2004. [2] CDS market size is usually measured in notional amounts, while replacement costs are better captured by gross market values (estimated at an overall 5.5% of notional market size in mid-2008). [3] The auction process, defined by ISDA's 2008 Lehman CDS protocol, set the recovery value for Lehman bonds at 8.625%, based on quotes submitted by 14 dealers. As Lehman's bonds had been trading increasingly lower since its bankruptcy filing, the auction price was only slightly lower than bond prices right before the auction, limiting the "gap risk" arising from the auction process.

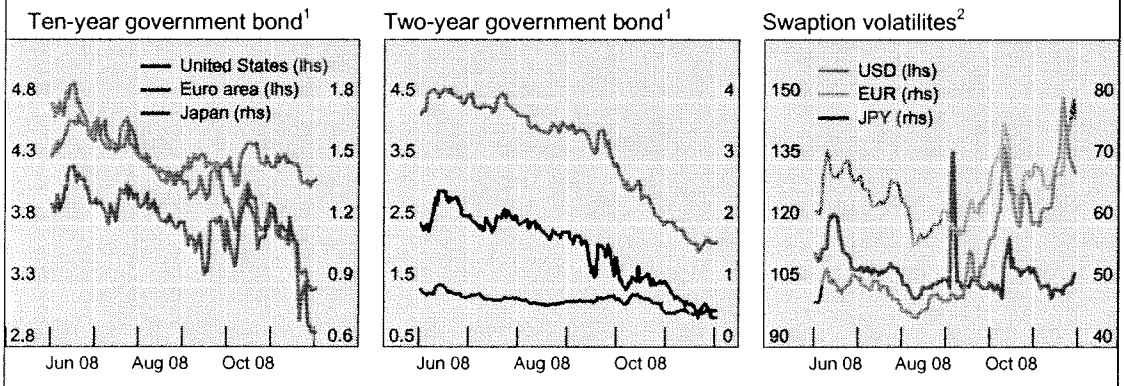
Longer-term government bond yields also declined (Graph 5, left-hand panel) and foreign exchange carry trades started to be unwound as the developing crisis of confidence resulted in a renewed flight to quality. Volatilities spiked across markets (Graphs 4 and 5, right-hand panels) and climbed even further in the following weeks as investors withdrew from all but the safest assets.

... with pressures spreading quickly across markets

Concerns related to the Lehman bankruptcy initially centred on the firm's role as a broker and key counterparty in the CDS market. In the first half of 2008, unprecedented CDS terminations had reduced outstanding volumes of existing CDS trades by $17.4 trillion worth of closed-out offsetting positions (see the highlights section on pages 25–35 for more detail on CDS volumes). More specific attempts by key CDS counterparties to adjust their exposures to Lehman were aided by a special trading session on Sunday 14 September, the day before the bankruptcy filing. However, worries about CDS exposures grew further when, late on 15 September, AIG, a large US insurer with substantial CDS positions, had its credit ratings downgraded by all major rating agencies. These downgrades, in turn, were known to trigger sizeable collateral calls by counterparties of AIG's financial products unit and early termination of additional contracts. In response, intraday on 16 September, most major CDS indices rose above their March peaks and receded only on speculation that the insurer would receive some kind of assistance. Government support materialised later that day, when a decision was made to extend an $85 billion loan under Section 13(3) of the Federal Reserve Act (which allows loans to non-banks under "unusual and exigent circumstances") to avoid the disorderly failure of AIG and its prospective effects on already fragile markets. The loan would later be restructured and supplemented by additional facilities totalling $27.5 billion, with the US government receiving a stake of up to 79.9%in the company in return.

Initial concerns are centred on the CDS market ...

Government bond yields and swaption volatilities

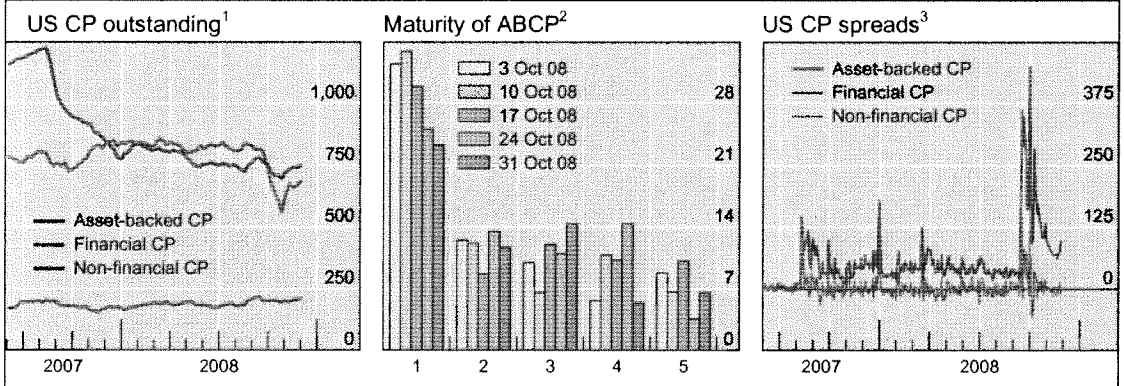


[1] In per cent. [2] Deutsche Bank volatility estimate on one-year swaptions.

Source: Bloomberg.

Graph 5

US commercial paper (CP) markets



[1] In trillions of US dollars. [2] Maturity of outstanding asset-backed CP (ABCP), weeks after date; as a percentage of total outstanding. [3] CP overnight yield minus the effective federal funds rate, in basis points.

Sources: Federal Reserve Board; Bloomberg; BIS calculations. Graph 6

... but quickly refocus on traditional debt ...

With the immediate concerns about CDS markets alleviated, traditional exposures to Lehman's outstanding debt securities turned out to be of even greater importance. The systemic nature of those exposures became fully apparent the day after the bankruptcy filing. It was then that Reserve Primary, a major US money market mutual fund, wrote off $785 million worth of short- and medium-term notes issued by Lehman. As a result, Reserve Primary became the first money market mutual fund in 14 years to "break the buck", ie to report less than one dollar's worth of net assets for each dollar invested. This triggered unprecedented volumes of US money market fund redemptions.

... and spillovers into the money ...

Between 10 and 24 September alone, investors pulled out $184 billion, forcing fund managers to liquidate assets into essentially illiquid markets. Short-term credit and money markets froze.

... and CP markets

Commercial paper (CP) markets, in which money market funds are traditionally the largest investor group, were among the first to suffer from the ensuing wave of redemptions and reallocations. In contrast to similar spillovers during the onset of the credit crisis in the summer of 2007, both asset-backed and non-asset backed CP markets were hit hard (Graph 6, left-hand panel). Unsecured financial paper suffered the largest outflows, adding pressure to already strained markets for bank funding. Durations shortened and borrowing rates shot up. Outstanding CP volumes in the United States plummeted by more than $325 billion from a total of about $1.76 trillion on 10 September (Graph 6, centre and right-hand panel). Volumes would start to recover only in late October, following the announcement and subsequent initiation by the Federal Reserve of a new facility to buy both unsecured and asset-backed CP.

Money markets freeze ...

Confronted with soaring demand for liquid funds in the wake of the contraction in the money market mutual fund sector, global interbank markets seized up, curbing banks' access to short-term funding. Money markets had already been strained for over a year and had failed to recover even with massive central bank liquidity injections. But conditions abruptly deteriorated even further as of mid-September, when the Lehman bankruptcy caused a

Box 2: Government-led bank rescue initiatives

Dietrich Domanski and Srichander Ramaswamy

Government initiatives to strengthen bank balance sheets have evolved from a case by case approach to system-wide intervention. Until September, governments injected capital into individual institutions to avoid their failure and facilitate mergers. This strategy essentially rested on the premise that massive support through liquidity operations by central banks would at some point encourage other banks to lend to each other. As this could not prevent the rapid erosion of market confidence, governments in virtually all advanced economies announced more comprehensive initiatives to stabilise banking systems in late September and early October.

The government initiatives tackled the crisis of confidence on two fronts: one set of measures aimed at ensuring bank funding through explicit government guarantees on retail deposits and other bank liabilities; another set aimed at reducing bank leverage through government purchases of distressed assets or capital injections (see the table).

The announcement of government programmes had a strong signalling effect. Bank CDS spreads fell and funding market conditions stabilised. However, programmes are being modified as the crisis evolves, and details still need to be spelled out in many cases. As a consequence, the impact of government measures on competition and incentives in the financial industry remains uncertain, and whether these measures are sufficient to restart financial intermediation in the broader economy is yet to be seen.

Elements of government programmes announced in September and October

Expansion of retail deposit insurance. Guaranteeing retail bank deposits has been widely used to ensure continued access to deposit funding. The amounts covered by the deposit guarantee schemes have varied substantially across countries, with some extending a blanket guarantee of retail deposits.

Guarantee of wholesale liabilities. To address the drying-up of the wholesale funding market, many governments have announced state guarantees on bank wholesale debt. The range of liabilities covered and fee structures vary widely across countries, with some charging a flat fee and others linking fees to bank CDS spreads.

Capital injections. Direct capital injections have been the main mechanism used to directly support balance sheets. Cross-country differences in instruments and conditions of capital injections have also been considerable. For instance, dividend payments on government preferred shares ranges from 5 to 12.5%. Moreover, some countries impose restrictions on executive compensation and/or dividend payments to common shareholders.

Asset purchases. While removing distressed assets from bank balance sheets is part of several programmes, it has not yet been used on a substantive scale. One issue is determining the price at which the government purchases distressed assets. A substantial support to bank balance sheets may require a purchase price close to par – which may effectively amount to a covert recapitalisation. Moreover, the range of eligible assets might have to cover all distressed credit instruments to have a strong and immediate impact on market confidence. This would require large programmes.

Side effects of government intervention

Impact on broader credit markets. Government guarantees affect the relative price of credit. An extension of the pool of government-guaranteed debt may, other things equal, increase the relative cost of borrowing for debt instruments that are close substitutes for bank debt. For instance, the increase in the spreads of GSE debt in early October could be attributable to this effect. Moreover, the combination of different government actions may complicate assessing and pricing the relative credit risk of various forms of bank liabilities. With capital injections, governments typically take junior positions in the capital structure of banks. This may be interpreted as an implicit state guarantee on all existing liabilities. While the stabilisation benefits of government guarantees are likely to outweigh the costs associated with such market distortions in the near term, a clear exit strategy appears important to limit adverse effects on credit markets in the medium term.

Cross-border issues. While rescue plans follow common principles, national differences in their concrete design and practical implementation are considerable. Differences in the scope and price of government guarantee schemes for new debt issuance may put banks in different jurisdictions at a disadvantage in wholesale funding markets as funding costs will become a function of the specific insurance fee structure and of the solvency of the country that provides the guarantee of bank liabilities. In the extreme case, sovereign risk may be used as a proxy to assess the credit risk of bank debt. Another issue concerns retail deposits in foreign-owned banks, for in many cases there is little clarity about how foreign depositors would be treated in the event of bank failure. The instrument choice and terms for capital injection may also affect competitive positions in global markets. One aspect is differences in the effective cost of capital provided by governments. Another is that the terms of capital injections, and the associated conditions, may affect access to private equity capital.

Elements of banking system rescue plans in developed economies[1]

Country	Expansion of retail deposit insurance	Guarantee of wholesale liabilities[2]		Capital injections[3]	Asset purchases
		New debt	Existing debt		
Australia	✓	✓	✓		✓
Austria	✓	✓		✓	
Belgium	✓	✓			
Canada		✓			✓
Denmark	✓	✓	✓		
Finland	✓				
France		✓		✓	
Germany	✓	✓		✓	✓
Greece	✓	✓		✓	
Ireland	✓	✓	✓		
Italy		✓		✓	
Netherlands	✓	✓		✓	
New Zealand	✓				
Norway					✓
Portugal	✓	✓			
Spain	✓	✓		✓	✓
Sweden	✓	✓		✓	
Switzerland				✓	✓
United Kingdom	✓	✓		✓	
United States	✓	✓		✓	✓

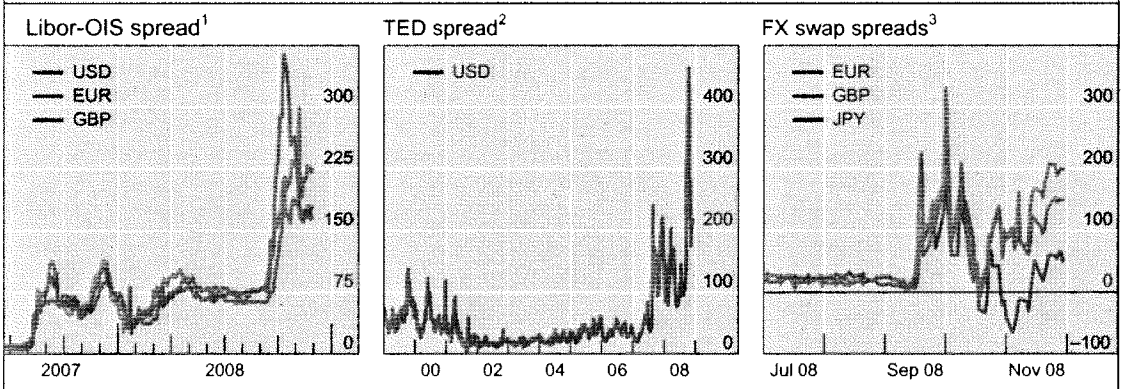
[1] As of mid-November 2008. [2] Includes bond issuance, interbank lending and other wholesale liabilities. Coverage of the guarantee on these items varies across countries. [3] Refers to announced programmes only (excluding standalone actions).

Source: BIS.

complete collapse of confidence in the financial health of money market counterparties. With banks hoarding liquidity, interbank rates soared to historical highs. Spreads between US dollar Libor and corresponding overnight index swap (OIS) rates, which reflect a combination of counterparty credit risk and liquidity factors, rose from near 80 basis points in early September to 232 basis points at the end of the month. Treasury-eurodollar (TED) spreads reacted similarly (Graph 7, left-hand and centre panels). While movements in other markets, such as those for euro and sterling funds, were somewhat less violent, they still showed clear signs of a major disruption (Graph 7, left-hand panel). At the same time, rising financial sector credit spreads and the surging

Libor-OIS, TED and FX swap spreads

In basis points



[1] Libor panel, three-month rates. [2] Three-month Libor minus three-month futures contract for US Treasuries. [3] Spread between three-month FX swap-implied dollar rate and three-month Libor; the FX swap-implied dollar rate is the implied cost of raising US dollars via FX swaps using the funding currency. For details on calculation see N Baba et al, "The spillover of money market turbulence to FX swap and cross-currency swap markets", *BIS Quarterly Review*, March 2008.

Sources: Bloomberg; BIS calculations. Graph 7

global demand for US dollar funds also manifested themselves in related markets: the market for foreign exchange swaps saw historically high spreads for various key industrialised country and emerging market currencies vis-à-vis the US dollar (Graph 7, right-hand panel).

... forcing a first round of policy measures

Amid largely dysfunctional wholesale funding markets, policymakers stepped up the pace and scope of their initiatives. On 18 September, in a sign of growing pressures, UK bank HBOS was forced into a government-brokered merger with one of its competitors. On the same day, in an effort to take pressure off the financial sector, the UK Financial Services Authority suspended the short selling of financial stocks. This move was emulated the following day by the authorities in the United States. Major central banks, in turn, reacted with a new round of coordinated measures to address the squeeze in US dollar short-term funding. Notably, they signed new or significantly enlarged currency swap facilities worth $180 billion (see Boxes 2 and 3 for details on government-led bank rescue initiatives and measures taken to alleviate foreign currency liquidity shortages, and Box 4 on the impact of these initiatives on central bank balance sheets). These actions were followed on 19 September by the US Treasury's announcement of a temporary guarantee for money market fund investors, aimed at arresting the escalating run on the US money market mutual fund sector. Redemptions slowed in response, with total assets gradually rising back to their levels before the Lehman failure, reaching $3.6 trillion by early November.

While markets reacted with signs of relief, the pressure on banks and other financial sector firms failed to recede. The policy measures taken hitherto, and early details of a $700 billion US proposal to take troubled assets off the books of financial institutions, helped credit spreads retreat temporarily from the highs reached immediately after the Lehman bankruptcy. Equity markets also recovered, aided in part by the new ban on short sales. The S&P 500 rebounded by 4% on 19 September, with several high-profile banking

stocks rising even more sharply, and European stock markets gained more than 8% on the same day. Similarly, there were signs of growing expectations that observed dislocations in funding markets would not persist: forward US dollar markets slowly started to point to a notable decline in three-month Libor-OIS spreads over the coming months. Even so, on Sunday 21 September, reflecting the continuing funding squeeze and associated concerns about counterparty risk, investment banks Goldman Sachs and Morgan Stanley obtained permission from the US authorities to convert themselves into bank holding companies. The move was aimed at halting ongoing transfers of counterparty positions and client funds to third parties, with CDS spreads for both credits tightening sharply as a result.

Policy responses to a global confidence crisis

Decisive action is taken ...

At this point, mounting financial sector problems forced the authorities in an increasing number of countries to take decisive action in support of key financial institutions. On 25 September, the US authorities took over Washington Mutual, the largest US thrift institution, and sold its banking assets to a larger rival. In European countries as well, a variety of measures were taken in quick succession to counter threats to the stability of individual institutions within national banking systems. Following negotiations over the weekend, the United Kingdom moved on Monday 29 September to nationalise mortgage lender Bradford & Bingley, while banking and insurance company Fortis received a capital injection from the Belgian, Dutch and Luxembourg governments. Fortis eventually had its Dutch activities nationalised and most of its remaining assets bought by one of its French peers. Also on 29 September, German commercial property lender Hypo Real Estate secured a government-facilitated credit line provided by a consortium of financial sector institutions.

... though the stalling of a comprehensive package shakes markets

Despite such dramatic actions aimed at individual institutions, financial markets were by now focused on the need for comprehensive approaches. Later on 29 September, the US House of Representatives voted to reject the first version of the Treasury's proposed $700 billion rescue plan for the US financial industry (it was passed into law in revised form at the end of the week). The response to the rejection by the House was immediately visible in US equity markets, which suffered steep declines in a matter of minutes and continued to sell off during the day. The S&P 500 fell 8.8%, led again by financial shares; other indices also declined, though by smaller percentage amounts (Graph 4, left-hand panel).

Individual bank rescues ...

Losses deepened during the following days as further bad news on financial sector health prompted an even sharper weakening of investor confidence. A capital injection by the Belgian, French and Luxembourg governments for financial group Dexia was announced on 30 September. This was followed by initiatives in Ireland and, in response, other countries granting new or raising existing guarantees for bank deposits and similar claims.

Box 3: Central bank measures to alleviate foreign currency funding shortages

Corrinne Ho and François-Louis Michaud

What had been mainly a US dollar liquidity problem for European banks turned into a broader phenomenon in September 2008. The seizing-up of money markets in the second half of September and early October rendered it exceptionally difficult to obtain US dollar funding in both uncollateralised and collateralised markets. Banks in emerging markets, which had until then been relatively little affected by the strains in the dollar money markets, also became embroiled in funding shortages. Moreover, these shortages were no longer in US dollars only. Some financial institutions with foreign currency liabilities in euros and Swiss francs also faced similar funding difficulties.

The spreading of foreign currency shortages has led to a variety of central bank responses. There are three main ways for a central bank to provide foreign currency funding to its counterparties. It can mobilise its existing foreign exchange reserves; it can use foreign exchange borrowed from the market; and it can use foreign funds borrowed from another central bank, including the central bank of issue.[1] All three options have precedents, but in the current financial crisis, the first and the last have been more widely used.[2] In particular, borrowing from another central bank under swap or collateralised lending arrangements may be preferred when there are insufficient foreign reserves in the needed currency, when there is unwillingness to dip into existing foreign reserves, or when there is concern that selling less liquid foreign reserve assets might reinforce negative market dynamics. Moreover, as illustrated by recent events, the desire to demonstrate a cooperative approach to the problem is also a strong reason for engaging in inter-central bank arrangements instead of – or in addition to – using one's own foreign reserves.

Inter-central bank swap lines and collateralised lending

The use of inter-central bank swap lines – most notably those with the Federal Reserve – has received much attention.[3] This is not only because the crisis originated in the dollar market, but also because the swap lines expanded considerably in both scale and scope over the past year (see the table). Between December 2007 and mid-September 2008, only the ECB and the Swiss National Bank (SNB) used swap lines with the Federal Reserve to deliver US dollar funds to their counterparties, complementing the Federal Reserve's Term Auction Facility. These two transatlantic swap lines had been increased in size over time to support larger dollar operations. With the intensification and spread of US dollar shortages in mid-September, swap lines with the Federal Reserve grew in number (from two to 14 by late October), time zone and geographical coverage (from one continent to five), and size. In particular, the maximum limits for the SNB, ECB, Bank of England and Bank of Japan were lifted in mid-October to allow them to conduct full-allotment US dollar operations at fixed rates. The range of US dollar distribution operations on offer at partner central banks also broadened from mainly longer-term (one- and three-month) offers to include one-week and, for a period, overnight[4] offers as well, and from mainly repos and collateralised loans to include FX swaps.

There are also arrangements in euros and Swiss francs, albeit on a more regional basis. In May 2008, the central banks of Sweden, Norway and Denmark announced an agreement to swap euros for Icelandic krónur with the Central Bank of Iceland. In October 2008, the ECB and the SNB entered into a swap arrangement to facilitate the distribution of Swiss franc funding in the euro area, particularly to smaller banks that did not have direct access to SNB market operations. In the same month, the ECB established a swap line with the National Bank of Denmark to support the latter's efforts to improve liquidity in euro short-term markets and agreed to provide euros to Magyar Nemzeti Bank of Hungary via a repo agreement. In November, the SNB and the ECB concluded Swiss franc- and euro-supplying agreements, respectively, with the National Bank of Poland.

A number of these arrangements, though publicly announced, have not been drawn upon. This suggests that these arrangements signal precaution and the availability of a backstop, rather than an immediate need for actual external financial support.

Drawing on existing foreign reserves

Central banks have also deployed their existing foreign reserves to alleviate foreign currency shortages. Since the onset of the more acute phase of the financial turmoil in mid-September 2008, most major emerging market central banks have conducted *outright sales* of foreign reserves to

help meet the local market's demand for foreign currency funding, as well as to relieve pressure on the exchange rate.[3] In addition, some central banks have sought to offer foreign reserves to counterparties under *repurchase agreements* (eg Brazil, the Philippines). A complementary method is to conduct foreign currency-providing *FX swap transactions* with counterparties. For central banks that have long counted FX swaps among their normal money market operations (eg Australia), this method constitutes only an extension of purpose of an existing tool and does not require a new tool. Some central banks have announced modifications (eg widening of counterparty eligibility, extension of term) to their existing FX swap facilities to make the distribution of foreign currency more efficient and flexible (eg Korea, Indonesia). Others have set up new swap facilities (eg Brazil, Chile, Poland) or announced their readiness to conduct swaps with counterparties as needed (eg Hong Kong SAR). Moreover, some central banks also stand ready to be on both sides of FX swap transactions (eg Hungary), helping to ameliorate counterparty credit concerns.

[1] In some cases, such borrowing may be done in conjunction with other official financial assistance, such as that from the IMF. [2] Apart from injecting foreign exchange, a central bank can also use other measures, such as changing the reserve requirement framework, to improve the availability of foreign currency funds in the financial system. [3] Swap lines are by no means a novel policy option, though historically they have been used to support foreign exchange market interventions rather than to alleviate foreign currency funding difficulties. [4] The daily overnight dollar auctions offered by the ECB, the SNB and the Bank of England between mid-September and mid-November 2008 (mid-October for the ECB) aimed specifically at alleviating dollar shortages early in the European trading day. [5] With the usual dollar funding channels (borrowing and FX swap market) impaired, many firms reportedly turned to the spot market to purchase dollars, resulting in sharp depreciations of the local currencies.

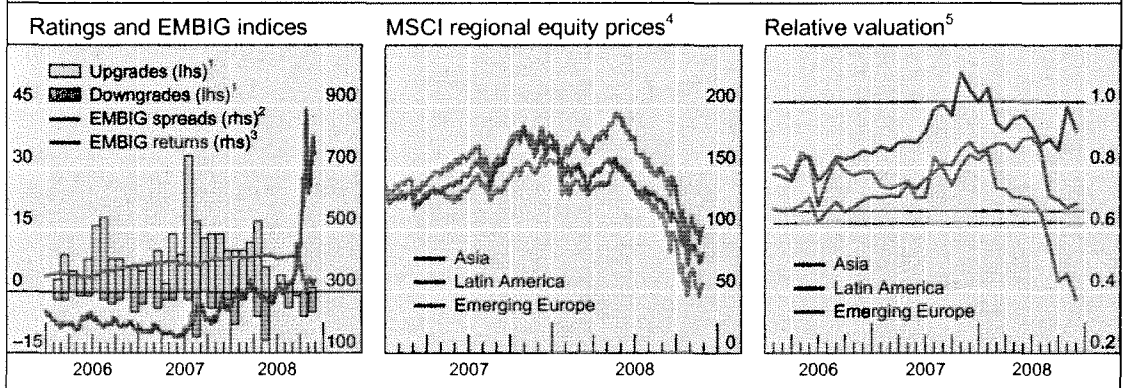
Announced inter-central bank arrangements[1]

Partners	First announced	Max amount	Drawn	Supported operations[2]
Federal Reserve providing USD:				
Swiss National Bank	12 Dec 07	–	Yes	1M, 3M, 1W
European Central bank	12 Dec 07	–	Yes	1M, 3M, 1W; and FX swaps
Bank of England	18 Sep 08	–	Yes	1M, 3M, 1W
Bank of Japan	18 Sep 08	–	Yes	1M, 3M
Bank of Canada	18 Sep 08	$30 bn		–
Reserve Bank of Australia	24 Sep 08	$30 bn	Yes	1M, 3M
Sveriges Riksbank	24 Sep 08	$30 bn	Yes	1M, 3M
National Bank of Denmark	24 Sep 08	$15 bn	Yes	1M, 3M
Central Bank of Norway	24 Sep 08	$15 bn	Yes	1M, 3M
Reserve Bank of New Zealand	28 Oct 08	$15 bn		–
Central Bank of Brazil	29 Oct 08	$30 bn		–
Bank of Mexico	29 Oct 08	$30 bn		–
Bank of Korea	29 Oct 08	$30 bn		–
Monetary Authority of Singapore	29 Oct 08	$30 bn		–
Swiss National Bank providing CHF:				
European Central Bank	15 Oct 08	–	Yes	FX swaps; 1W, 3M
National Bank of Poland	07 Nov 08	–	Yes	FX swaps; 1W, 3M
ECB providing EUR:				
Magyar Nemzeti Bank	16 Oct 08	€5 bn[3]	–	O/N FX swap[4]
National Bank of Denmark	27 Oct 08	€12 bn	Yes	1M, 3M[5]
National Bank of Poland	21 Nov 08	€10 bn[3]	–	–
Nordic central banks providing EUR:				
Central Bank of Iceland	16 May 08	€1.5 bn	Yes	–

[1] Information as of 21 November 2008; refer to swap lines, unless otherwise indicated; – indicates not specified. [2] Refer to operations for distributing foreign currency to counterparties (not the inter-central bank transactions). Central banks may have other foreign currency-supplying facilities that draw on existing foreign reserves. Repo or collateralised loans, unless otherwise indicated. 1M = one-month; 3M = three-month; 1W = one-week; O/N = overnight. [3] Based on repo agreement. [4] A standing facility was announced but its usage is confidential. [5] A three-month auction is planned for 10 December 2008.

Source: Central banks.

Emerging market assets



[1] Monthly long-term foreign and local currency sovereign rating changes from Fitch, Moody's and Standard & Poor's. [2] EMBI Global index; sovereign spread over government bond yields, in basis points. [3] EMBI Global index; cumulative total returns. [4] In local currency; 31 December 2005 = 100. [5] P/E ratios based on consensus forecasts for one-year operating earnings; MSCI indices divided by P/E ratio of S&P 500; the horizonal lines indicate long-term averages.

Sources: Bloomberg; Datastream; JPMorgan Chase; Standard & Poor's; BIS calculations. Graph 8

... stronger deposit guarantees ...

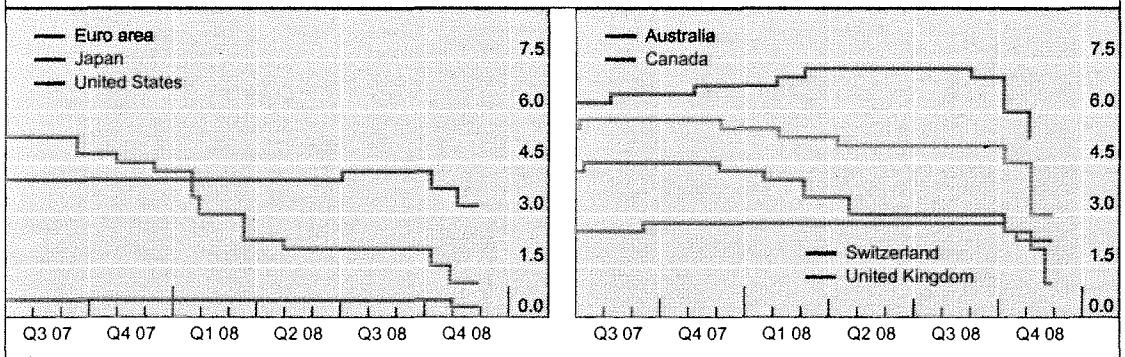
In the United Kingdom, the authorities announced comprehensive measures to recapitalise UK banks, to provide short-term liquidity and to ensure the availability of sufficient medium-term funding for the banking system through guarantees for new unsecured senior bank debt. Yet, despite the increased pace of government intervention, financial market turmoil continued, with credit and stock markets suffering losses on a broad scale into October. The universal scope of the sell-off was particularly apparent from broader global equity indices, which experienced record losses in late September and early October. While the S&P 500 dropped about 25% between 22 September and 10 October, the MSCI World index plummeted more than 28% over the same period. Emerging market equities declined by similar amounts, losing 24% in local currency terms (Graph 8, centre panel); selling pressures were most intense for countries with large current account deficits and relatively high private sector reliance on foreign currency borrowing. Money markets also continued to show signs of extreme dislocation, with Libor-OIS spreads setting new records on a daily basis (Graph 7, left-hand panel).

... globally coordinated rate cuts ...

At this point, uncoordinated policy actions by national authorities no longer appeared to be sufficient. On 8 October, the first coordinated international policy response aimed at arresting the deepening crisis of confidence came in the form of an unprecedented round of 50 basis point policy rate cuts by six major central banks, including the Bank of England, the ECB and the Federal Reserve (Graph 9). Futures-based indicators showed that the move was immediately reflected in monetary policy expectations, particularly in Europe (Graph 10).

Policy rates[1]

In per cent



[1] For the ECB, minimum bid rate on the main refinancing operations; for the Bank of Japan, uncollateralised target rate; for the Federal Reserve, federal funds target rate; for the Reserve Bank of Australia, target cash rate; for the Bank of Canada, target overnight rate; for the Swiss National Bank, midpoint of the three-month Libor target range; for the Bank of England, Bank rate.

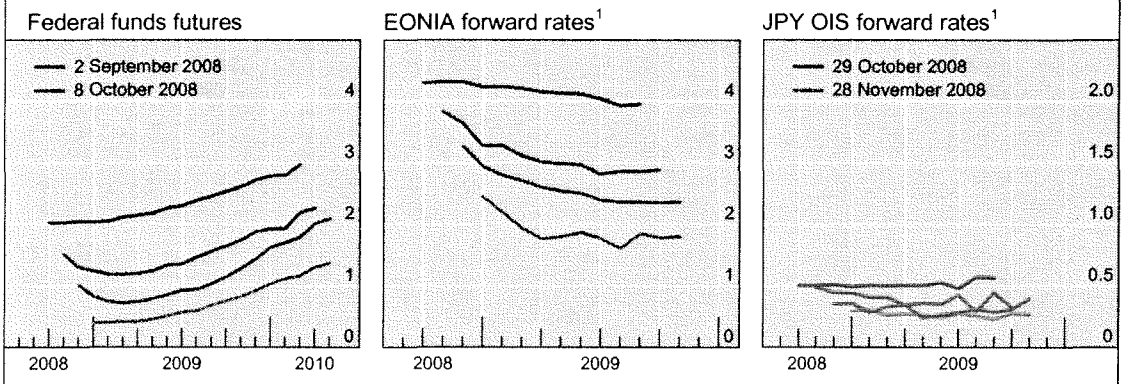
Source: Bloomberg. Graph 9

... and system-wide bank recapitalisations ...

Efforts towards implementing more system-wide, coordinated policy measures continued in the following days. One example was the joint announcement on 13 October by the Federal Reserve, the ECB, the Bank of England and the Swiss National Bank that they would supply US dollar funding at maturities of seven, 24 and 84 days at fixed rates for full allotment to further ease tensions in the money market. Simultaneously, existing swap lines between the Federal Reserve and the other major central banks were increased to accommodate whatever quantity of US dollar funding would be demanded. On the same day, the euro area member countries made unprecedented coordinated announcements of guarantees and equity injections aimed at restarting interbank lending and at replenishing banks' capital positions. This was followed by notice from the US Treasury on 14 October that it would use $250 billion of the previously legislated rescue package to recapitalise major banks.

Forward curves

In per cent



[1] Implied one-month rates from overnight index swaps.

Sources: Bloomberg; BIS calculations. Graph 10

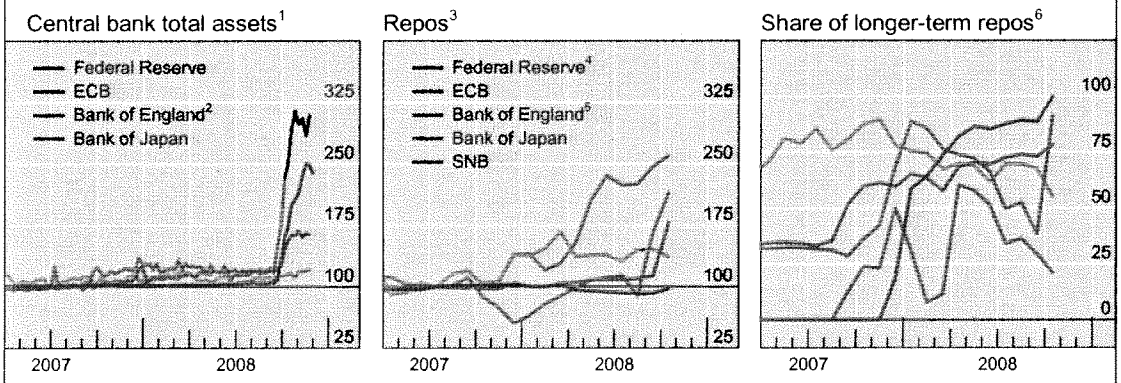
Box 4: Central bank balance sheets

François-Louis Michaud and Gert Schnabel

Central banks in major advanced economies have taken a wide range of actions to address the tensions in the interbank and money markets since August 2007. As a result the size, composition and risk profile of their balance sheets have changed substantially. Major central banks have provided more term funding to a wider range of institutions and against wider collateral than in the past. In some cases, they stepped in to provide direct lending to distressed institutions and took other exceptional measures to improve funding conditions in credit markets. This box outlines how these actions have affected central bank balance sheets.

During the initial stages of the turmoil, until mid-September 2008, central bank measures did not lead to a significant expansion of the size of their balance sheets. However, there was a major shift in the composition of their assets, as central banks conducted, in general, more frequent and longer-term liquidity-providing operations than in the past (Graph A). In some cases, they also broadened the range of eligible collateral.

Central bank assets and open market operations



[1] End-Q2 2007 = 100; weekly data. [2] Adjusted by BIS for estimates of items in the course of settlement related to unlimited dollar operations. [3] Repurchase agreements (and term auction credit (TAF) for the Fed) including foreign currency auctions; amounts outstanding; monthly averages, June 2007 = 100. [4] Sum of the amount outstanding of repurchase agreements, TAF and US Treasury securities held in the Fed's portfolio. [5] Decline from August to December offsets supply of reserves to the market via lending to Northern Rock (NR). The subsequent increase offsets the drain of reserves brought about as mainly the UK government, but also NR, repaid borrowing from the Bank of England. [6] Outstanding repos (and TAF for the Fed) including foreign currency auctions of 28 days and beyond as percentage of total outstanding repos (and TAF for the Fed); monthly averages.

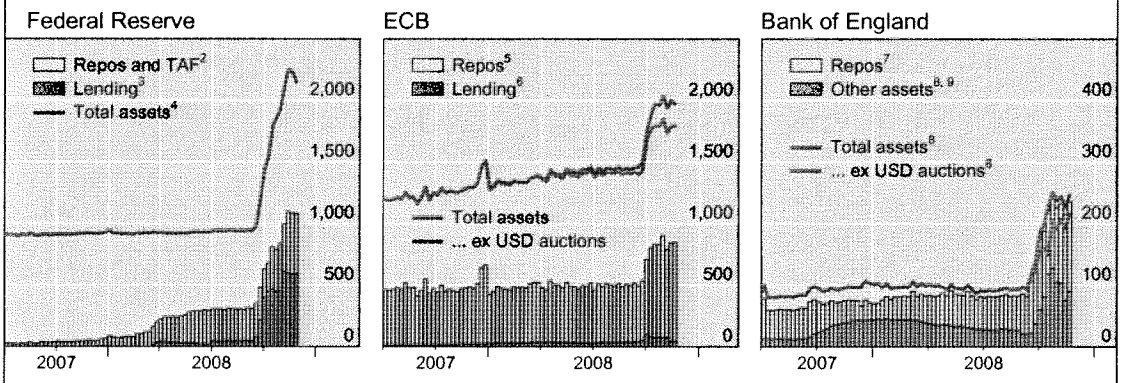
Source: Central banks. Graph A

In the United States, the Federal Reserve (Fed) lengthened the maturity of its refinancing operations. Their size also increased, but this was offset by the shrinking of its portfolio of Treasury securities. In addition, an increasing share of the latter was lent to primary dealers against a wide range of less liquid securities to help liquefy their balance sheets via the Fed's Term Securities Lending Facility (with no net impact on bank reserves or on the size of the central bank balance sheet). Similarly, the Bank of England (BoE) allowed banks to swap less liquid securities against more liquid ones under its Special Liquidity Scheme. The BoE, European Central Bank (ECB) and Swiss National Bank (SNB) substituted longer-term open market operations (OMOs) for shorter-term operations. While the ECB and SNB established swap lines with the Fed to distribute dollar liquidity to European banks, the amounts involved were relatively limited, and there was little or no use of central bank standing lending facilities.

After the failure of Lehman Brothers, the balance sheets of several major central banks expanded sharply, reflecting their growing intermediation role in money markets. The assets of the Fed and the BoE more than doubled in a matter of weeks, while those of the ECB and the SNB increased by more than 30%. In the Fed's case, this reflected direct lending to banks and dealers through existing and new lending facilities, including those providing indirect lending to money market funds and purchasing commercial paper through special purpose vehicles, and drawings by foreign central banks on dollar swap lines. In Europe, there was also some increase, albeit less marked, in the use of central banks' standing facilities. Most of the growth of central banks' balance

sheets reflected higher net amounts of domestic and dollar liquidity-providing OMOs, representing mostly term funding (Graph B). More auctions were also conducted at a fixed rate with full allotment. The maximum amount of dollar swap lines and related dollar liquidity-providing transactions was significantly increased (and subsequently made unlimited). The US dollar swap lines of the Fed with the ECB, BoE and SNB were increased by more than $300 billion between end-August and end-September; US dollar lending of these central banks increased by about half that amount over the same period.

Central bank open market operations and lending[1]



[1] In billions of national currency units. [2] Repurchase agreements and term auction credit (TAF). [3] Primary discount credit, primary dealer credit facility, Maiden Lane (Bear Stearns), AIG, commercial paper and money market mutual fund support measures. [4] Total factors supplying reserve funds. [5] Main refinancing, long-term refinancing and fine-tuning operations in euros. [6] Marginal lending and other claims in euros on euro area credit institutions. [7] Short and long-term reverse sterling repos. [8] Adjusted by BIS for estimates of items in the course of settlement related to unlimited dollar operations. [9] Includes US dollar lending and lending to UK deposit protection.

Source: Central banks. Graph B

The corresponding growth of central bank liabilities took various forms. There was often a rise in bank reserve balances with the central bank. The ECB saw a sharp increase in the use of its deposit facility. In addition, several central banks took steps to manage their liabilities more flexibly. In the United States, the Treasury issued supplementary bills and held the proceeds at the Fed (nearly $500 billion). Importantly, the Fed began to pay interest on bank reserves – currently at the average (lowest) FOMC target rate during the reserve maintenance period for required (excess) reserves – making it easier to expand its balance sheet at positive interest rates. The BoE and ECB narrowed the corridor between the rates of their lending and deposit facilities from 200 to 50 and 100 basis points, respectively. The ECB also announced that it might raise one-week fixed-term deposits. Several central banks started to issue their own bills (the BoE, Riksbank and SNB).

State guarantees for bank debt may slow the growth and increase in riskiness of central bank sheets. To the extent that government-guaranteed facilities help to stabilise markets, they can make private liquidity providers less reluctant to lend to banks. This would allow central banks to gradually scale back their role in bank funding. And as central banks start accepting government-guaranteed debt as collateral, the risk profile of their balance sheets may also improve.

The greatly increased level of central bank intermediation is often viewed as a temporary substitute for impaired private financial intermediation. However, interbank lending has not resumed, and money markets remain dysfunctional despite increased central bank intermediation and state guarantees. This may of course reflect banks' continued balance sheet and capital constraints. An additional factor may be the differences in state guarantees across countries and their gradual implementation. Banks' funding liquidity management may also be evolving, and banks may wish to rely less on wholesale funding markets. Finally, increased central bank intermediation may in some cases weaken banks' incentives to resume their intermediation function. For instance, borrowing from the central bank at close to the policy rate with no counterparty risk may arguably reduce banks' incentives to raise funds from market sources. And narrow spreads between central bank target rates and the rates paid on excess balances also discourage banks from lending to other banks. It is unclear how much, and for how long, central banks may need to expand their balance sheets.

... prevent complete collapse of confidence

With the flurry of unprecedented policy initiatives taken across countries up to mid-October increasingly adding up to a joint approach, market prices finally responded. As potentially large amounts of financial institutions' senior liabilities had effectively become quasi-government debt, financial sector spreads rallied back from the peaks reached earlier during the period (Graph 2, left-hand panel). The recovery in financial credit initially helped to drag broader credit spread indices lower (Graph 3, left-hand and centre panels). However, markets remained under strain from ongoing portfolio liquidations by leveraged investors suffering from margin calls and redemptions.

Signs of relief prove temporary

Signs of gradually easing pressures were also evident in other markets. The three-month US dollar Libor-OIS spread peaked at 364 basis points on 10 October and maintained a steady downward trend into November, with spreads reaching around 170 basis points. Similar pricing patterns were seen in euro and sterling Libor-OIS spreads, suggesting that interbank markets were finally beginning to stabilise (Graph 7, left-hand panel). In the meantime, major equity markets were showing at least temporary signs of relief (Graph 4, left-hand and centre panels), with the Dow Jones Industrial Average rising 11% on 13 October alone, its largest one-day percentage increase since 1933. Other equity indices also rallied back from their previous lows, as did emerging market equities and bonds (Graph 8, left-hand and centre panels).

At the same time, unintended side effects of recent policy initiatives were starting to show up in markets such as those for US agency securities. After an initial decline, spreads on agency debt and MBS soared even beyond the peaks experienced prior to the government takeover of Fannie Mae and Freddie Mac in early September (Graph 1, right-hand panel). Given newly announced FDIC guarantees for eligible unsecured bank debt issued before 30 June 2009, investors had started to anticipate a potentially sizeable new asset class of AAA-rated bank debt that would compete directly with agency paper. Uncertainties about the exact nature of the government guarantee for the agencies' longer-maturity debt and ongoing investment fund redemption sales put further upward pressure on agency spreads. Similar side effects were evident in collateralised lending markets, especially those for repurchase agreements (see the special feature by P Hördahl and M King on pages 37–53 for a discussion).

The scope and magnitude of the bank rescue packages also meant that significant risks had been transferred onto government balance sheets. This was particularly apparent in the market for CDS referencing sovereigns involved either in large individual bank rescues or in broad-based support packages for the financial sector, including the United States. While such CDS were thinly traded prior to the announced rescue packages, spreads widened suddenly on increased demand for credit protection, while corresponding financial sector spreads tightened (Graph 2, left-hand panel).

Recession fears take centre stage

Recession fears ...

By mid-October, accumulating evidence from macroeconomic data releases was starting to overshadow the immediate effects of government initiatives

... fed by negative macroeconomic news ...

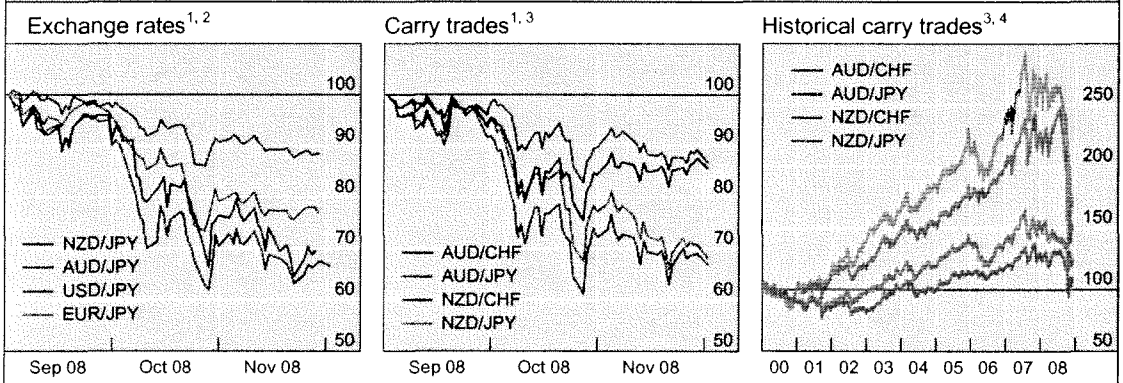
across markets. Reports on economic activity confirmed that numerous major economies had officially moved into recession or were about to do so. Thus, while the combined efforts of central banks and governments appeared to have successfully arrested the global crisis of confidence, gains across most asset classes turned out to be short-lived. The main exception was short-term funding markets, where conditions continued to gradually recover, with US money market fund assets stabilising and Libor-OIS spreads declining, though still at levels higher than those before the credit crisis.

... drive credit spreads up ...

Credit markets quickly refocused on expectations of an approaching global recession and the associated increase in default-related losses. Contracting bond issuance and depressed bank lending were consistent with growing concerns about the lack of availability of credit for households and non-financial companies. Following weak macroeconomic data releases for the United States on 16 October, credit spreads resumed their earlier upward drift. To be sure, the widening of credit spreads at times reflected policy uncertainty in addition to recession fears. The mid-November announcement that TARP funds previously meant for the purchase of troubled assets were being reallocated in support of the consumer finance sector – where lending activity had increasingly been impaired by collapsing securitisation volumes – pushed CDS spreads to new highs, reflecting expectations that the anticipated asset purchases would not materialise (Graph 3, centre and right-hand panels). Signs of recovering credit spreads emerged only in late November, following the announcement of a support package for Citigroup and of measures aimed at supporting the markets for asset-backed securities and US agency debt. Stresses remained, however, as suggested by the continued widening of spreads in troubled sectors, such as commercial real estate.

At the same time, the unwinding of currency carry trades, which had begun after the Lehman event, gained new momentum in the wake of elevated market volatilities and the investor retreat from risky assets (Graph 11, left-hand and centre panels). Lower-yielding currencies appreciated and carry

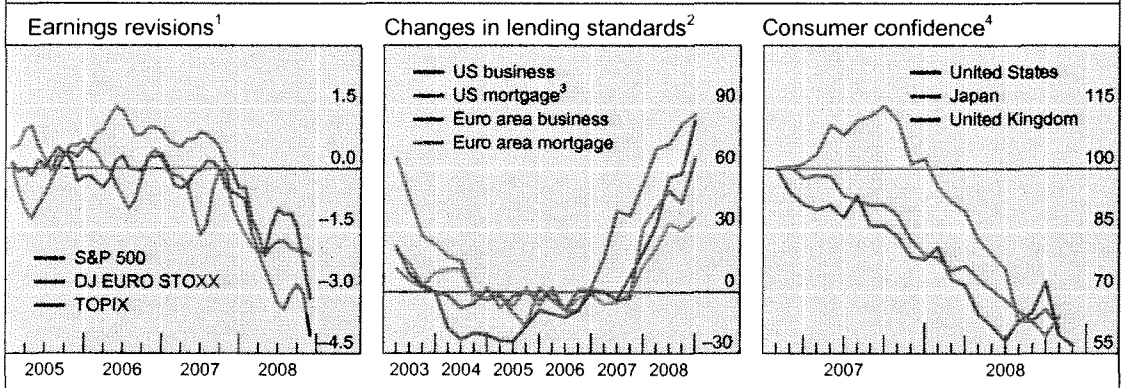
Carry trade unwinding



[1] 1 September 2008 = 100. [2] First currency is the base currency. [3] Daily return index that tracks cumulative carry trade performance between currency pairs. First currency is the one in which the long position is taken and second currency is that in which the short position is taken. [4] 1 January 2000 = 100.

Sources: Bloomberg; BIS calculations. Graph 11

Earnings, lending standards and consumer confidence



[1] Diffusion index of monthly revisions in forecast earnings per share, calculated as the percentage of companies for which analysts revised their earnings forecast upwards plus half of the percentage of companies for which analysts left their forecast unchanged; to adjust for analysts' systematic overestimation of earnings, the mean of the diffusion index over the 2003–05 period (S&P 500 = 43.8; DJ EURO STOXX = 40.8; TOPIX = 45.9) was subtracted from each monthly observation; three-month moving average. [2] Net percentage of banks reporting tightening standards. [3] From 2007, simple average of prime, subprime and non-traditional credit. [4] 1 January 2007 = 100.

Sources: Bloomberg; I/B/E/S; BIS calculations. Graph 12

trade returns turned strongly negative, eroding some six years' worth of accumulated gains (Graph 11, right-hand panel).

... and equity markets down

Equity markets also reflected the fact that recession fears came into focus in late October and November: declines in global equity markets over the quarter exceeded those during any of the crises since the 1930s. Major indices fell sharply on almost universally negative earnings-related news, tightening lending standards and rapid declines in consumer confidence (Graph 12). By end-November, despite additional monetary easing by several central banks and a late-month recovery, global stock markets had fallen by some 35% from their end-August levels. As a result, price/earnings ratios for many major indices were down to levels not seen for at least a decade.

As investors retrench ...

The prices of emerging market assets continued to adjust to a combination of collapsing exports, more limited private sector access to funding and rapidly declining commodity prices. Signs of indiscriminate asset disposals emerged in mid-October, as plummeting risk appetite and concerns about the availability of trade finance increasingly translated into large-scale redemption flows out of emerging market assets. Pressures came to a head in the week of 21 October, when speculation that the authorities in Argentina might nationalise the public pension system caused concerns about political risk to soar. This occurred despite efforts by emerging market central banks to enhance their domestic and foreign currency lending operations and the announcement of full or partial guarantees of bank deposits in several economies.

... and concerns about political risk soar ...

... emerging markets assets sell off

Emerging market sentiment temporarily recovered in late October and early November, but was weighed down by recession fears during the remainder of the period. Reaching their highest levels since 2002, EMBIG spreads widened to a peak near 891 basis points on 24 October, before tightening by about 276 basis points into early November. Emerging equity

markets also extended their previous declines, reaching new lows on 27 October. Conditions stabilised only after the announcement of a $25 billion support package for Hungary on 28 October and news of dollar swap lines between the Federal Reserve and the monetary authorities in Brazil, Korea, Mexico and Singapore the next day (Graph 8, left-hand and centre panels). By end-November, emerging credit and equity markets had recovered somewhat from their late October levels, mirroring the performance of their industrialised country counterparts. Nevertheless, reflecting the heavy losses experienced since August, price/earnings multiples in emerging market economies generally adjusted more sharply than those in the United States and other major markets, with relative valuations across countries broadly back in line with historical discounts relative to the industrialised world (Graph 8, right-hand panel).

Bond yields decline ...

At the same time, recession fears put shorter-term yields squarely on a downward trajectory. The lowering of policy rates as well as a flight to safety pushed two-year yields dramatically lower in both the United States and the euro area, to 0.96% and 2.1%, respectively, by end-November. Likewise, expectations about the path of near-term policy rates were also revised downwards. As a result, federal funds futures prices signalled expectations of low and broadly steady policy rates in the United States for much of 2009, consistent with depressed to negative growth over the coming quarters (Graph 10, left-hand panel). In the euro area, EONIA swap prices pointed to a further lowering of policy rates by the ECB over the next 12 months (Graph 10, centre panel), reflecting in part the greater leeway for additional rate adjustments compared to the United States. In Japan, the policy rate was adjusted downwards by 20 basis points on 31 October, reaching a level of 30 basis points for the first time since March 2001. Japanese forward rates, in turn, suggested expectations of unchanged policy rates for most of 2009.

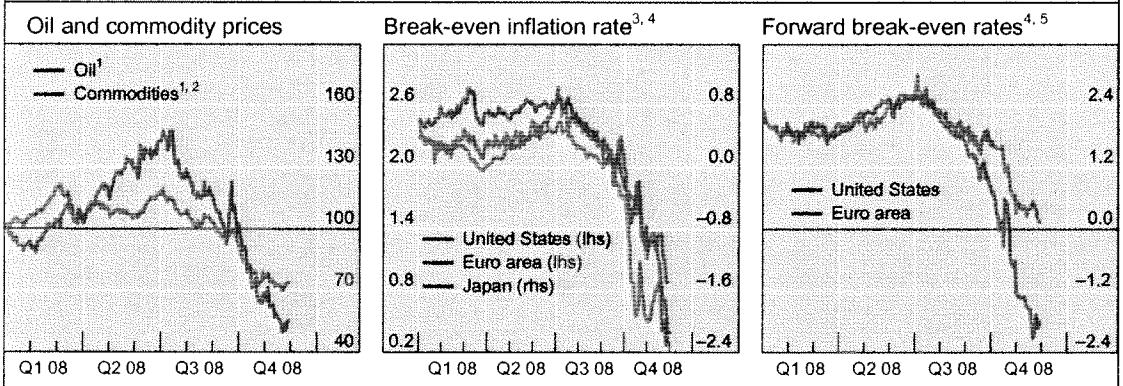
... on lower policy rates ...

... expectations of lower inflation ...

In this environment, break-even inflation rates derived from the yields of nominal and inflation-indexed bonds fell significantly across all maturities. The declines were particularly pronounced in the United States, where the 10-year break-even rate dropped by 1.9 percentage points between end-August and end-November, although substantial declines were seen in the euro area and Japan as well (Graph 13, centre panel). Even sharper drops took place at the short end of the maturity spectrum, with, for example, US implied one-year forward break-even rates two years ahead plunging by 3.5 percentage points during this period to reach levels deep inside negative territory (Graph 13, right-hand panel). With break-even inflation rates typically seen as indicators of investors' inflation expectations, the observed declines appeared to be in line with perceptions of rapidly easing price pressures amid accumulating signs of a broad-based global slowdown. Moreover, the declines that took place at the short end of the break-even curve largely reflected developments in both oil and commodity prices, which declined by over 50% and 30%, respectively, between end-August and end-November (Graph 13, left-hand panel).

... falling commodity prices ...

Commodity prices and break-even inflation rates



[1] 1 January 2008 = 100. [2] Non-Energy CRB Index. [3] Nominal minus real 10-year zero coupon bond yields. [4] For the United States and the euro area, zero coupon break-even rates are calculated as in R Gürkaynak et al, "The TIPS yield curve and inflation compensation", *FEDS* paper 2008-05, Board of Governors of the Federal Reserve System; for Japan: Bloomberg; in per cent. [5] One-year forward break-even inflation rate two years ahead.

Sources: Bloomberg; BIS calculations. Graph 13

Nevertheless, another important factor behind the sharp drops in break-even rates is likely to have been rising liquidity premia and sell-side pressures from leveraged investors unwinding their positions. Consistent with this, much of the decline in US break-even rates that took place in September and October was due to real bond yields rising faster than nominal yields, suggesting that more technical factors may have played a significant role in driving the dynamics of break-even rates during this period. However, by early November, real yields had stabilised while nominal yields again fell as recession fears and concerns about the health of the financial sector intensified, leading to renewed downward pressure on break-even rates.

... as well as recession fears

ISDA Market Survey

Notional amounts outstanding, semiannual data, all surveyed contracts, 1987-present

Notional amounts in billions of US dollars, adjusted for double-counting

	Interest rate swaps		Cross-currency swaps		Interest rate options		Total IR and currency		Credit default swaps	Equity derivatives
	Activity	Outstanding	Activity	Outstanding	Activity	Outstanding	Activity	Outstanding	Outstanding	Outstanding
1H87	$ 181.50		$ 43.50				$ 225.00			
2H87	206.30	682.80	42.30	182.80			248.60	865.60		
1H88	250.50		60.30				310.80			
2H88	317.60	1,010.20	62.30	316.80		327.30	379.90	1,654.30		
1H89	389.20		77.60		186.80		653.60			
2H89	444.40	1,502.60	92.00	434.80	148.70	537.30	685.10	2,474.70		
1H90	561.50		94.60		138.00		794.10			
2H90	702.80	2,311.50	118.10	577.50	154.30	561.30	975.20	3,450.30		
1H91	762.10		161.30		198.80		1,122.20			
2H91	859.70	3,065.10	167.10	807.20	183.90	577.20	1,210.70	4,449.50		
1H92	1,318.30		156.10		293.60		1,768.00			
2H92	1,504.30	3,850.80	145.80	860.40	298.80	634.50	1,948.90	5,345.70		
1H93	1,938.40		156.80		509.70		2,604.90			
2H93	2,166.20	6,177.30	138.40	899.60	607.30	1,397.60	2,911.90	8,474.50		
1H94	3,182.90		181.00		850.20		4,214.10			
2H94	3,058.00	8,815.60	198.30	914.80	663.00	1,572.80	3,919.30	11,303.20		
1H95	3,428.90	10,817.00	153.80	1,039.70	675.80	2,066.20	4,258.50	13,922.90		
2H95	5,269.90	12,810.70	301.30	1,197.40	1,339.60	3,704.50	6,910.80	17,712.60		
1H96	6,520.30	15,584.20	374.00	1,294.70	1,415.70	4,190.10	8,310.00	21,068.90		
2H96	7,157.90	19,170.90	385.10	1,559.60	1,921.50	4,722.60	9,464.50	25,453.10		
1H97	10,792.20	22,115.40	463.10	1,584.80	2,566.60	5,033.10	13,821.90	28,733.30		
2H97	6,274.90	22,291.30	672.30	1,823.60	1,411.80	4,920.10	8,359.00	29,035.00		
1H98								36,974.00		
2H98								50,997.00		
1H99								52,710.50		
2H99								58,265.00		
1H00								60,366.00		
2H00								63,009.00		
1H01								57,305.00	631.50	
2H01								69,207.30	918.87	
1H02								82,737.03	1,563.48	2,312.13
2H02								101,318.49	2,191.57	2,455.29
1H03								123,899.63	2,687.91	2,784.25
2H03								142,306.92	3,779.40	3,444.08
1H04								164,491.72	5,441.86	3,778.15
2H04								183,583.27	8,422.26	4,151.29
1H05								201,413.54	12,429.88	4,825.98
2H05								213,194.58	17,096.14	5,553.97
1H06								250,829.99	26,005.72	6,383.03
2H06								285,728.14	34,422.80	7,178.48
1H07								347,093.64	45,464.50	10,012.90
2H07								382,302.71	62,173.20	9,995.71
1H08								464,694.95	54,611.82	11,888.13
2H08								403,072.81	38,563.82	8,733.03
1H09								414,089.08	31,223.10	8,788.36
2H09								426,749.60	30,428.11	6,771.58