

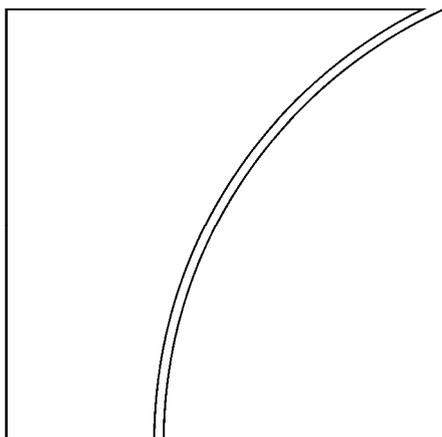


BANK FOR INTERNATIONAL SETTLEMENTS

# BIS Quarterly Review

March 2009

International banking  
and financial market  
developments



BIS Quarterly Review  
Monetary and Economic Department

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ISSN 1683-0121 (print)

ISSN 1683-013X (online)

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### Notations used in this Review

e	estimated
lhs, rhs	left-hand scale, right-hand scale
billion	thousand million
...	not available
.	not applicable
–	nil
0	negligible
\$	US dollar unless specified otherwise

Differences in totals are due to rounding.

## Overview: investors ponder depth and duration of global downturn

Uncertainty about the depth and duration of the economic contraction continued to roil financial markets over the period between end-November 2008 and 20 February 2009. Credit markets generally remained under pressure from weak economic data and earnings reports and the resulting expectations of rising defaults. Pressures were particularly evident in the renewed widening of non-investment grade spreads. Cyclical deterioration also drove the worsening of equity prices, particularly in Japan.

At the same time, policy measures aimed at stabilising markets appeared to gain traction over the period. In money markets, central bank actions and government guarantees helped to calm interbank markets and spreads between Libor and overnight index swaps (OIS) continued to decline gradually. Facilities that included outright purchases of agency mortgage- and other asset-backed securities contributed to signs of normalisation in mortgage markets, while funding facilities and government guarantees of financial sector issues provided a helping hand to primary debt markets, where activity surged to record levels in January.

To be sure, policy measures backstopping debt claims on banks were generally not perceived as positive for financial shares, and financial sector concerns continued to lead overall equity market losses in the United States and Europe. Meanwhile, the lack of detail on key support packages, among other factors, contributed to elevated levels of implied volatility as well as to price/earnings ratios which were extremely low by the standards of the past two decades.

Uncertainties about the severity of the financial crisis and the economic downturn exerted further downward pressure on government bond yields, though mounting concerns over increased issuance limited overall declines in yield during the period under review. At the same time, segments of the bond market were still showing clear signs of being affected by factors other than expectations about economic fundamentals and policy actions.

Although emerging markets generally had little direct exposure to the distressed asset problem plaguing major industrial economies and managed to weather the most acute phase of the financial crisis in late 2008 relatively well, they were much less immune to the deepening recession in the advanced industrial world. Plunging exports and GDP growth bore clear evidence of the

severity and synchronicity of the global economic downturn, which was reflected in declining asset prices, particularly in emerging Europe.

### Credit markets under pressure from further bank losses

Deeply rooted uncertainty about the global economic outlook subjected benchmark credit default swap (CDS) indices to substantial spread volatility between end-November and late February. Having reached new highs in early December amid rising recession fears, spreads tightened into the new year, only for sentiment to turn down on weak economic data and news of further large-scale losses in the banking sector. When these developments triggered another round of policy efforts aimed at stabilising financial systems, spreads were temporarily pushed lower once again in late January, but they reverted to an upward trajectory in the course of the following month.

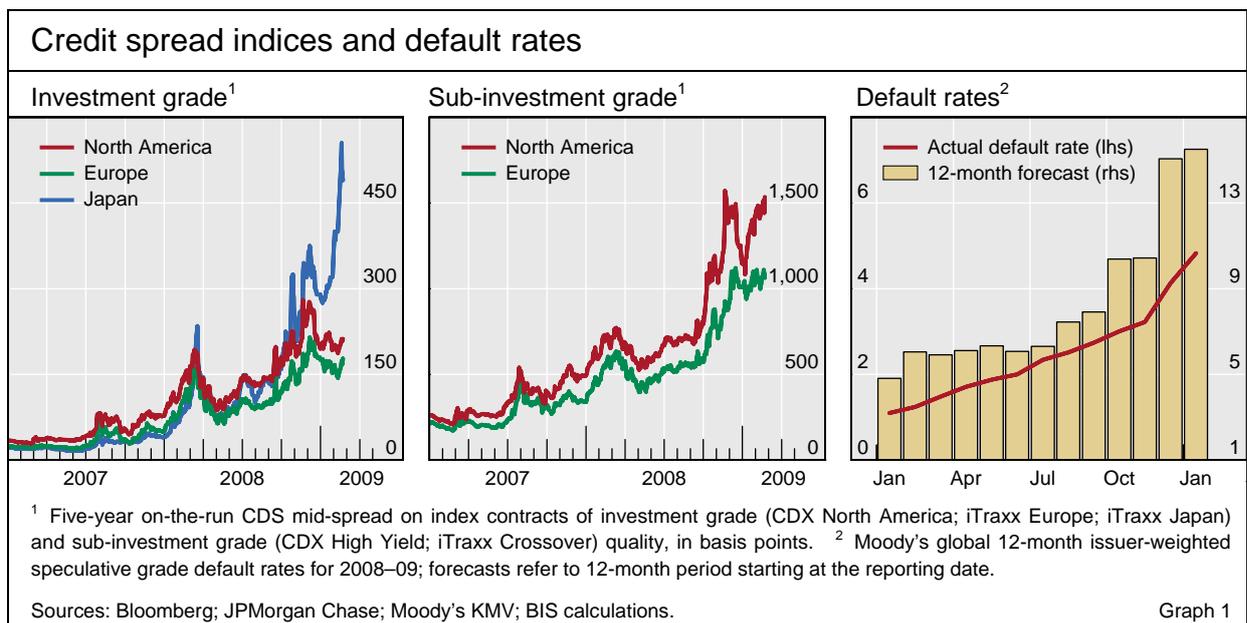
Investment grade spreads generally outperformed those of lower-quality borrowers (Graph 1, left-hand and centre panels). Given continuing problems in the banking sector, the ongoing slowdown in economic activity and constricted credit availability were likely to lead to further fundamental credit deterioration. Default rates, having already increased significantly from the very low levels observed in early 2008, were thus expected to rise further, putting pressure on lower-rated issuers (Graph 1, right-hand panel). In line with these developments, risk tolerance in credit markets remained at depressed levels (Graph 2, left-hand panel). Related uncertainties were also evident from implied volatilities, despite a recent retreat from the record highs established in October 2008 (Graph 2, centre panel).

As a result, by the end of the period under review, the US five-year CDX high-yield index spread had widened by about 148 basis points from its level at end-November to near 1,534, only 38 basis points off its record high in November. Corresponding investment grade spreads, in contrast, declined by 28 basis points, to around 212. European CDS indices broadly mirrored the

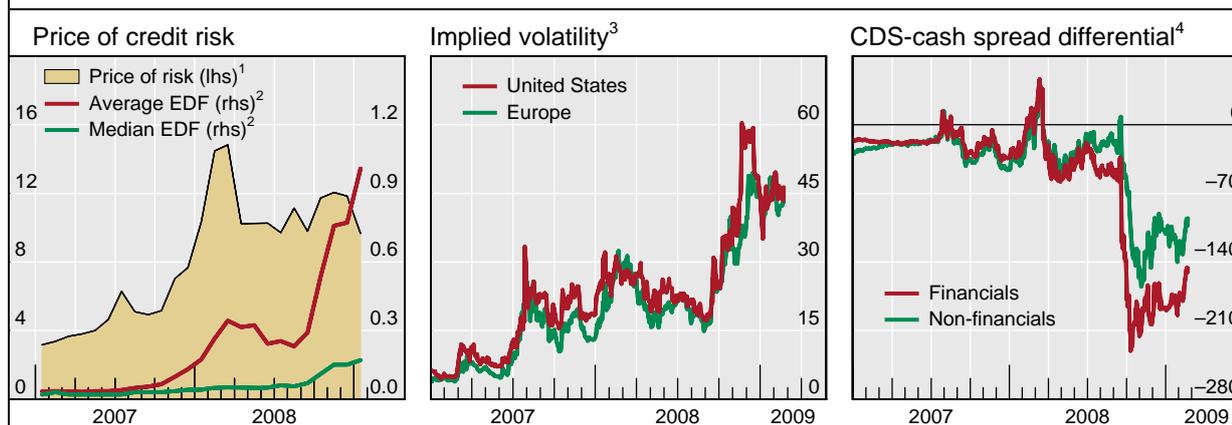
Credit markets are subject to ...

... repeated swings in investor sentiment ...

... amid elevated levels of uncertainty



## Price of risk, credit volatility and CDS-cash basis measures



<sup>1</sup> Ratio of risk neutral to empirical probabilities of default, calculated using the methodology described in J Amato, "Risk aversion and risk premia in the CDS market", *BIS Quarterly Review*, December 2005, pp 55–68. Empirical probabilities are based on Moody's-KMV EDF data. Estimates of risk neutral probabilities are derived from US dollar CDS spreads (document clause MR) and estimates of the recovery rate. The reported ratio is the median in a large sample of investment grade entities. <sup>2</sup> In per cent. <sup>3</sup> Implied daily absolute spread movements; calculated from at-the-money one- to four-month implied volatilities and observed index spreads (CDX High Yield; iTraxx Crossover), in basis points. <sup>4</sup> CDS-cash measures, approximated by the difference between the iTraxx Europe (non-) financials five-year on-the-run CDS mid-spread and the iBoxx (non-) financials cash market spread.

Sources: JPMorgan Chase; Markit; BIS calculations.

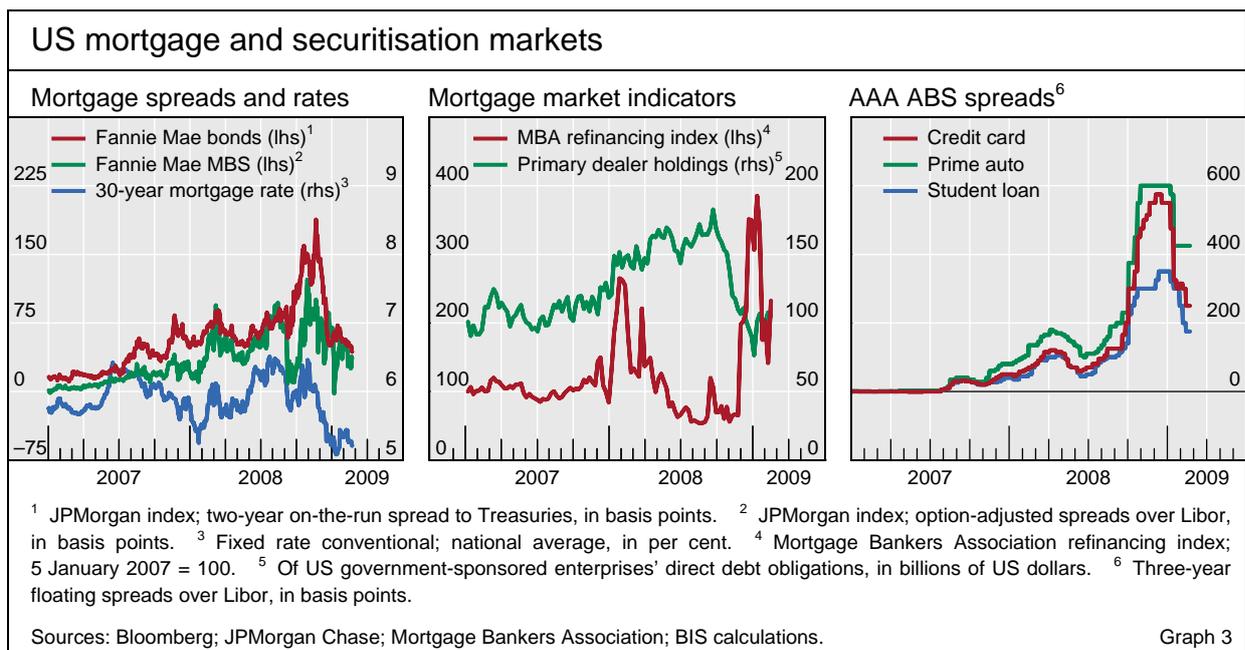
Graph 2

performance of their US counterparts, with investment grade spreads almost unchanged from their end-November levels. Japanese investment grade spreads, on the other hand, widened by 170 basis points (Graph 1, left-hand and centre panels). While being driven in part by a rapidly weakening macroeconomic environment, the move was exacerbated by index composition effects and deteriorating market liquidity, as evidenced by strongly widening bid-ask spreads.

While signs of normalisation are evident ...

One factor supporting credit markets over the period was signs that recent government measures were contributing to improved conditions in key, previously disrupted, segments of the money (see section below) and credit markets. A prime example of a market experiencing tentative, policy-induced normalisation was the US mortgage sector, where agency spreads and mortgage rates continued to ease back from the highs established in October (Graph 3, left-hand panel). Following the announcement by the Federal Reserve, on 25 November, of a programme aimed at outright purchases of agency-related securities, investor demand picked up, as suggested by a significant decline in dealer holdings of agency debt until the end of 2008. Mortgage rates fell sharply, to around 5% for 30-year conventional mortgages. While part of the decline was later reversed on the back of rising Treasury yields, qualifying borrowers were prompted to refinance into lower-cost loans (Graph 3, left-hand and centre panels). Further support came from the substantial Federal Reserve purchases of agency mortgage-backed securities (MBS) that had been announced for the first two quarters of 2009. The size of the programme, at \$500 billion – an average of about \$1.1 billion per trading day – meant that the effect on MBS spreads was felt by the markets even before actual purchases commenced on 5 January. Similar effects were present in the markets for US consumer asset-backed securities (ABS) – which are based on consumer loans rather than mortgages – where spreads at the

... in US mortgage, asset-backed ...



AAA level declined in anticipation of the implementation of the Term Asset-Backed Securities Loan Facility (TALF) in February (Graph 3, right-hand panel).

Another sign of government-assisted normalisation came from primary debt markets, where activity surged to record levels. With a number of country authorities considering outright purchases of corporate bonds, and with guarantee programmes in place to support financial issuers, a long pipeline of pent-up issuance opened up in January. Numerous large corporate bond issues were priced in the dollar, euro and sterling markets, including a dual currency transaction featuring the first European high-yield deal in 18 months. Issuers were generally required to accept wider spreads than those in both the CDS and secondary cash markets, but at these concessionary prices credit supply appeared to be readily available, though only for better-quality borrowers. As a result, global gross corporate issuance reached \$131 billion in January, up more than 150% from the average levels observed over the same month in 2000–08. Supported by government guarantees, activity was also strong in the financial sector, allowing banks to extend the maturity of their market funding (see the Highlights section on p 24).

... and primary credit markets ...

The extension of bank funding in turn appeared to ease pressure in commercial paper markets. In late January, with the first series of issues under the Federal Reserve's Commercial Paper Funding Facility (CPFF) set to mature and CP rates having fallen below the funding costs for CPFF issues, large volumes of paper started to roll back into the broader market. From a level of \$334 billion, the facility's net holdings decreased by about \$85 billion between end-December and late February, accounting for 63% of the \$135 billion reduction in total CP outstanding over the same period; wholesale financing markets thus absorbed the bulk of the maturing CPFF volumes.

At the same time, signs of dysfunction continued, highlighting the fragile state of market conditions and investor sentiment. The fragility was apparent, for example, in measures such as the CDS-cash basis, which reflects the

... broader dysfunctions remain

pricing differential between CDS contracts and corresponding cash market bonds. Though not as pronounced as in the aftermath of the Lehman Brothers bankruptcy, the basis remained unusually wide in the new year, suggesting that arbitrage activities that would usually tend to compress the price differential continued to be constrained by elevated capital and financing costs for leveraged investors (Graph 2, right-hand panel). Similar effects were observed elsewhere, as evident from high and variable liquidity premia in the markets for government bonds and swaps (see bond market section below).

Banks, in particular, remain under strain ...

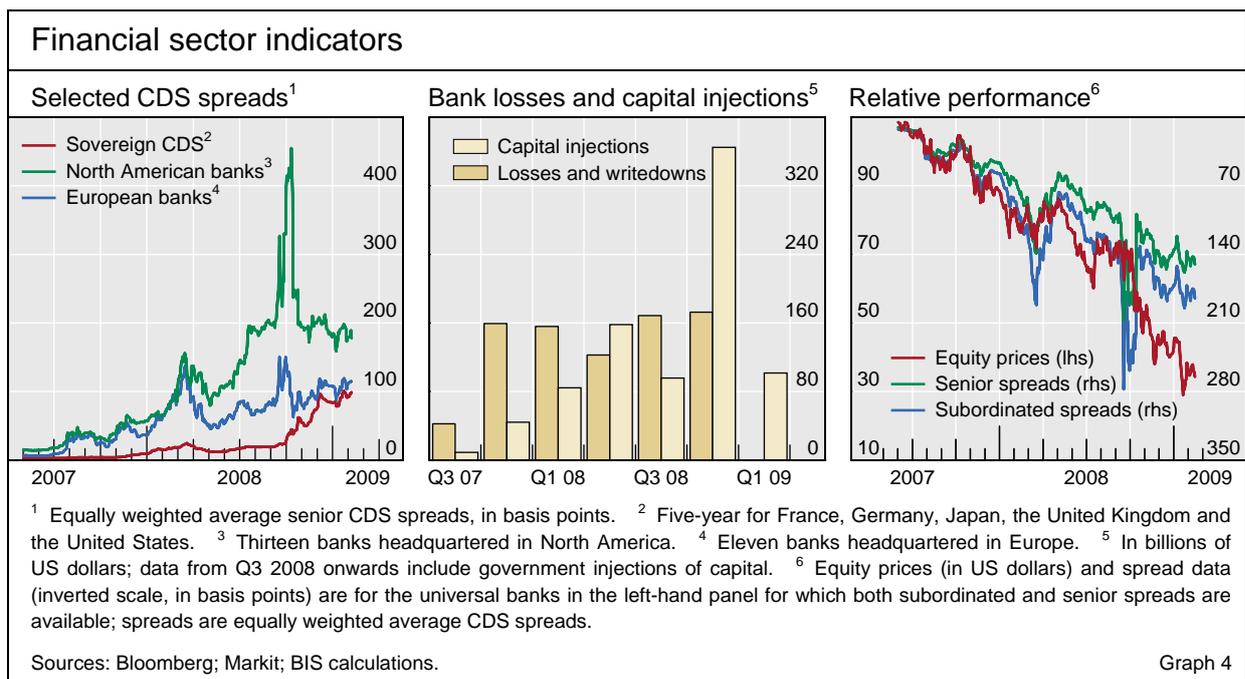
Investor confidence was rattled once again when, despite a combined \$925 billion of private and government capital injected into the global banking sector since the third quarter of 2007, further signs of banking problems emerged in both Europe and the United States. Those problems defeated the view that large-scale government support in the third and fourth quarter of 2008 had restored the sector's stability on a sustained basis. Events started on 8 January, when losses at a newly acquired former rival had to be backstopped by a bailout package for Commerzbank (Table 1), and accelerated as similar news involving other major banks aired during the following week (Graph 4, left-hand and centre panels).

... as evident from pricing across the capital structure

As a result, credit spreads were pushed higher in shallow and volatile markets. While the upward move was led by spreads for financial sector firms, existing guarantees and expectations of further support measures generally served to limit spread movements relative to equity prices (see the equity market section below). Subordinated bank CDS spreads, in turn, remained under pressure from uncertainties about the implications of government interventions for investors in lower-seniority debt instruments, including the treatment of hybrid securities issued to bolster banks' capital positions. Earlier

Selected events over the period under review	
Date	Event
8 January	German lender Commerzbank receives a bailout package to backstop losses at newly acquired Dresdner Bank; the German government takes a 25% stake in the combined entity.
16 January	The Irish authorities seize control of Anglo Irish Bank; Citigroup posts an \$8 billion loss. Replicating an approach taken in the case of Citigroup, the US authorities agree to invest \$20 billion in Bank of America through a preferred equity stake along with guarantees for a pool of \$118 billion of the bank's assets. The measure follows the bank's acquisition of Merrill Lynch earlier in the month.
19 January	Following 2008 losses of about £28 billion at Royal Bank of Scotland, the authorities increase their equity stake in the troubled institution to up to 70%. The move forms part of a further broad-based financial rescue package announced on the same day, which includes the extension of existing guarantees for debt issued by participating banks and offers fee-based protection against losses on asset portfolios of financial institutions.
21 January	The French authorities offer to inject up to €10.5 billion into eligible banks.
26 January	The Dutch authorities grant ING Group a backup facility guaranteeing part of the bank's securitised mortgage portfolio worth \$35 billion.
10 February	Swiss bank UBS reports a fourth quarter loss of CHF 8.1 billion. The US authorities announce a new, comprehensive support package for the financial sector; the plan anticipates an expansion of the scope of existing measures by incorporating commercial MBS into the Term Asset-Backed Securities Loan Facility (TALF) and proposes a public-private investment fund of \$0.5–1.0 trillion to purchase troubled assets from banks.

Sources: Bloomberg; *Financial Times*; *The Wall Street Journal*. Table 1



investor concerns over a large issuer's decision not to call outstanding hybrid securities at the contractual redemption date, in contrast, eased after other borrowers decided to redeem their issues. Related fears about extension risk (ie the risk of maturities on similar securities being extended beyond the agreed call dates) had fed into the markets for subordinated CDS, which are widely used to hedge hybrid instruments (Graph 4, right-hand panel).

Financial sector concerns continued to weigh on spreads in the following weeks, while being counterbalanced in part by a new round of government support measures. A first step in this direction came from the United Kingdom, where earlier efforts to restore financial sector health had proved insufficient: on 19 January, following news of large losses for 2008 at Royal Bank of Scotland, the authorities announced a further broad-based rescue package for UK financial institutions. Authorities in other European countries also took additional support measures in the following days. Those efforts, and reports of plans for a new comprehensive rescue package by the incoming US administration, helped buoy market sentiment in the period up to early February, with US and European investment grade spreads tightening back to levels last seen in November. However, following weak economic data and disappointment about the details of the newly announced US rescue plan, credit spreads drifted upwards once again towards late February.

Reflecting the impact of these new support packages on budget balances as well as the generally depressed level of risk appetite, spreads on sovereign CDS continued to rise over the period. Actual and anticipated negative rating actions contributed to particularly pronounced spread increases for a number of euro area countries, with Greece, Portugal and Spain being downgraded by Standard & Poor's in January. Banking system exposures to particular markets or regions and related concerns about future government support reportedly also played a role. Yet signs of waning appetite for sovereign risk were also

A new round of government support ...

... adds to upward pressures on sovereign spreads

apparent for other countries and outside the CDS market (see the bond and emerging market sections below).

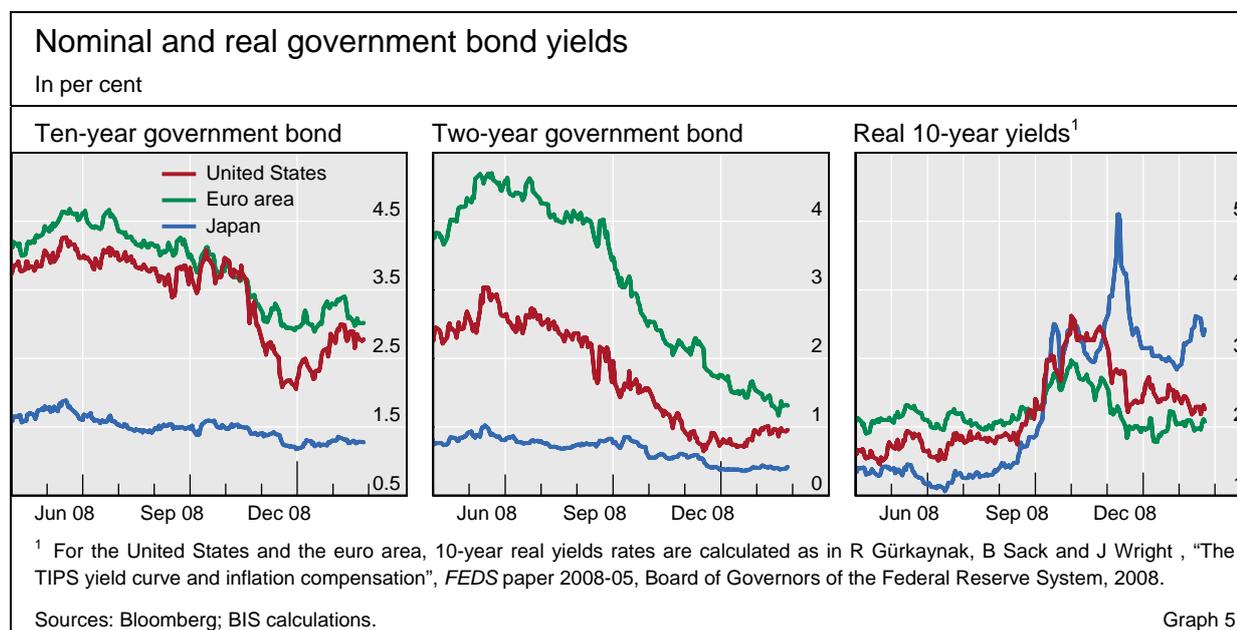
### Fall in government bond yields interrupted by supply concerns

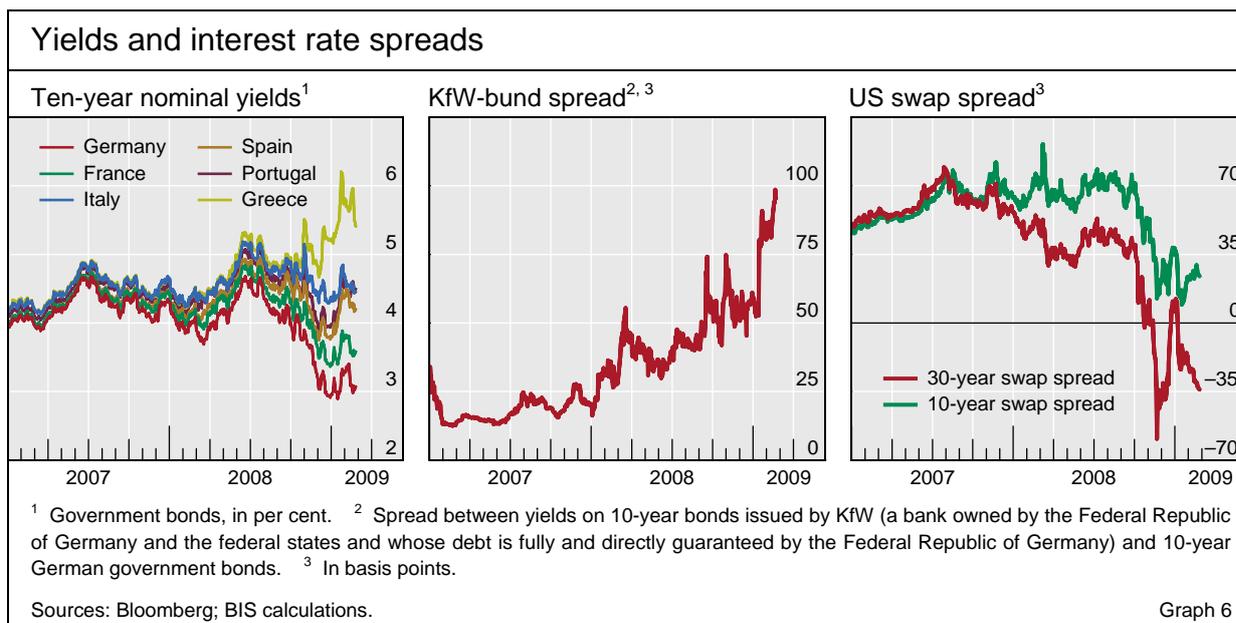
Uncertainties about the severity of the financial crisis and the economic downturn continued to weigh on government bond yields in major bond markets during the period under review. At times, speculation about possible central bank interventions in bond markets contributed to the downward pressures on yields. However, mounting concerns over increased supply of government bonds counteracted these forces, driving yields higher in the first few weeks of 2009, particularly in the United States.

Overall, between end-November 2008 and 20 February 2009, yields on 10-year nominal government bonds fell by around 15 basis points in the United States, 25 basis points in the euro area and 10 basis points in Japan (Graph 5, left-hand panel). These relatively modest yield changes over the period under review were the result of countervailing forces affecting bond prices. In early December, long-term bond yields fell significantly before stabilising and subsequently rising through early January, when a number of risky asset markets saw a brief rally. The rise in yields was temporarily halted in mid-January as the mood of investors soured in the wake of more bad news on the economic outlook and the health of the banking system. Nonetheless, long-term bond yields soon began to rise as supply concerns again took centre stage. Towards the end of the period under review, yields came under some renewed downward pressure as investors worried about the adequacy of the latest US financial sector rescue plan.

The possibility of Treasury purchases by the Fed pushes yields down

In the United States, as the FOMC acted in December to target a federal funds rate of 0–0.25%, speculation intensified among investors on alternative ways in which the Federal Reserve could implement additional easing policies. The fact that such policies might include outright purchases of Treasury bonds





led at times to downward pressure on US long-term yields. The effect was particularly evident in early December, when the Chairman of the Federal Reserve Board referred to the possibility of the central bank purchasing substantial quantities of longer-term Treasury securities; after his remarks, 10- and 30-year yields dropped by around 20 basis points. Similarly, long-term yields plunged about 25 basis points after the release of the December FOMC statement, which mentioned that the Committee was evaluating the benefits of purchasing longer-term Treasuries. The salience of this issue was again apparent following the FOMC statement on 28 January, which disappointed investors given its lack of new details regarding possible outright Treasury purchases and resulted in long-term yields rising 15–20 basis points.

Bond yields continued to show clear signs of being affected by factors other than expectations about economic fundamentals and policy actions. This was particularly evident in the case of index-linked bond markets, where high and volatile liquidity premia and technical factors related to hedging and deleveraging produced unusual swings in real yields. For example, in late November and early December, 10-year real yields on Japanese index-linked bonds rose about 200 basis points, briefly reaching above 5% in the second week of December (Graph 5, right-hand panel). This sharp rise in real yields occurred despite reports indicating that the Japanese economy was suffering its worst downturn in decades. According to market reports, the observed swings in real yields were largely due to the rapid unwinding of positions in the Japanese index-linked market by leveraged investors, including foreign hedge funds.

Technical factors also continued to influence break-even inflation rates in major industrialised countries. While expected rapid disinflation contributed to falling break-even rates at shorter horizons, much of the recent movement in long-term break-even rates seemed to be due to factors not directly linked to inflation expectations. These included rapid unwinding of positions, intense safe haven demand for the liquidity of nominal Treasuries and rising liquidity

Non-fundamental factors continue to affect real yields ...

... and break-even rates

premia in index-linked bonds, all of which helped push break-even rates to unusually low levels (see box). However, with some of these forces easing in early 2009, break-even inflation rates began to edge upwards from their lows.

Bond yields rise on supply worries ...

Concerns about the increased supply of government bonds counteracted the downward pressure on yields resulting from safe haven demand and the worsening economic outlook and ultimately pushed yields higher. As the supply of government debt has been rising, signs have also emerged that governments may be finding it more challenging to raise money in bond markets. Moreover, growing volumes of corporate issuance and government-guaranteed bank debt have meant that governments are facing increasing competition for investors. Some euro area countries have recently cancelled debt auctions because of a lack of demand, and even new issuance by Germany has met with lower demand. In the past few months, Germany has, on a number of occasions, failed to attract sufficient bids (at fixed prices) in the primary market to cover the entire amount offered.

... and uncertainty about sovereign credit risk ...

Uncertainty about the sovereign credit risk implications of large and rapidly rising fiscal deficits, linked to outsize stimulus packages and government bank guarantees, seemed to contribute to rising yields as well. Such concerns were also partly behind the continuing widening of spreads between yields on German bunds and on government bonds of other euro area countries, some of which suffered rating downgrades (see the credit market section). In addition to these concerns, the fact that the market for treasuries in individual euro area countries is in many cases significantly less liquid than the market for bunds is likely to have played an important role too, as investors' appetite for securities with low liquidity dwindled further. The considerable widening of spreads on government-guaranteed bonds issued by KfW (a German state-owned bank) relative to German bunds suggests that liquidity and other factors distinct from credit risk were key drivers of the recent spread widening.

... while investors expect short-term rates to remain low

Short-term yields continued to fall or remained very low from December 2008 through to late February 2009 (Graph 5, centre panel). The low rates reflected ongoing safe haven demand for short-dated government debt as well as the actual and expected easing of monetary policy in an environment in which the near-term economic outlook remained extremely bleak. In line with this, the pricing of federal funds futures suggested that US policy rates were expected to edge upwards from near zero levels only very gradually (Graph 7, left-hand panel). In the case of Japan, overnight index swaps were pricing in rates at essentially zero for the foreseeable future (Graph 7, right-hand panel). In the euro area, where policy rates are not close to their floor, implied forward overnight rates shifted further downwards (Graph 7, centre panel).

Money market conditions improve slowly

In money markets, the situation continued to improve slowly, as central bank actions and government guarantees gradually gained traction. Libor-OIS spreads, for example, edged further downwards, although by late February they were still at levels above those seen during the first year of the financial market turmoil (Graph 8, left-hand panel). To some extent, the still elevated levels of Libor-OIS spreads reflected the fact that bank credit risk and

## Disentangling the drivers of recent shifts in break-even inflation rates

Peter Hördahl

In recent months, break-even inflation rates, ie the difference between yields on nominal and real bonds, have been abnormally volatile, falling to unprecedentedly low levels before recovering somewhat in early 2009. The US 10-year break-even rate, for example, dropped to almost zero in late 2008 after having remained relatively stable at around 2.5% over the past several years (Graph A, left-hand panel). A similar pattern, albeit less pronounced, has been seen in euro area break-even rates (Graph A, centre panel).

A natural question to ask is: to what degree should these recent fluctuations be viewed as representing actual changes in expected inflation? Break-even inflation rates have long been used as an indicator of the markets' inflation expectations over the horizon of the bonds. Of course, during the financial crisis, the huge price swings in many markets, including those for nominal and index-linked bonds, have partly reflected "non-fundamental" factors. All in all, while falling inflation expectations are likely to have contributed to the drop in break-even rates, a substantial part of the decline was probably due to other factors, including liquidity and "market technicals".

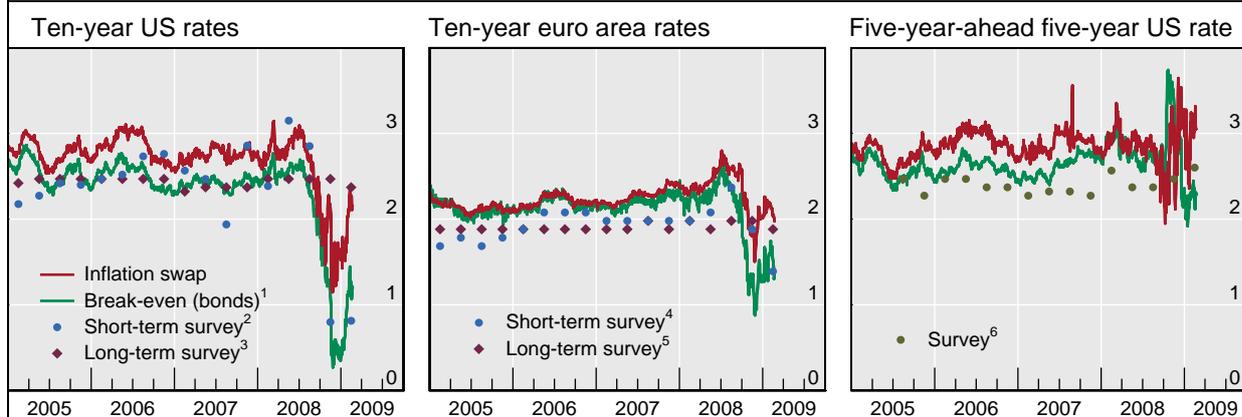
Generally speaking, break-even rates can be thought of as consisting of four major components: (i) expected inflation; (ii) inflation risk premia; (iii) liquidity premia; and (iv) "technical" market factors.<sup>9</sup> The relative importance of these components may vary over time as conditions in the economy and in financial markets change.

One way to assess the role of the first component is to look at other indicators of inflation expectations, such as survey data. According to the Survey of Professional Forecasters (SPF) conducted by the Federal Reserve Bank of Philadelphia, one-quarter-ahead expectations of US inflation fell from 2.9% in Q3 2008 to 0.8% in Q1 2009, but 10-year inflation expectations dipped only 0.1%, to 2.5%. Similarly, even though euro area short-term inflation expectations dropped significantly in recent months, the ECB's SPF also reported a drop of only 0.1% in long-term (five-year-ahead) inflation expectations, to 1.9%, between Q3 2008 and Q1 2009. This pattern suggests that average inflation expectations for the next few years have remained stable despite rapidly falling near-term expectations. However, some have questioned the plausibility of continued stable average inflation expectations over long horizons in view of the very large shocks that have hit the economy recently.

As regards the inflation risk premium, recent estimates suggest that this component has tended to be relatively small and fairly stable.<sup>9</sup> If so, it is unlikely that the inflation premium has been responsible for a major part of the observed changes in break-even inflation rates. Nevertheless, some estimates suggest that inflation risk premia are positively correlated with

### Break-even inflation rates and survey forecasts

In per cent



For the United States, expectations are calculated as the median of the sample; for the euro area, the mean.

<sup>1</sup> For the United States and the euro area, zero coupon break-even rates are calculated as in R Gürkaynak, B Sack and J Wright, "The TIPS yield curve and inflation compensation", *FEDS Paper* 2008-05, Board of Governors of the Federal Reserve System, 2008. <sup>2</sup> One-quarter-ahead CPI inflation expectations. <sup>3</sup> Ten-year CPI inflation expectations. <sup>4</sup> One-year-ahead HICP inflation expectations. <sup>5</sup> Five-year-ahead HICP inflation expectations. <sup>6</sup> Five-year CPI inflation expectations, five years ahead.

Sources: Bloomberg; Federal Reserve Bank of Philadelphia Survey of Professional Forecasters (SPF) and ECB SPF; BIS calculations.

Graph A

inflation, implying that the recent decline in inflation could have brought about a lower inflation premium in line with falling break-even rates. Yet it seems intuitively reasonable to assume that the inflation risk premium may have increased, given higher inflation volatility and uncertainty about the possible effects on prices of recent monetary policy actions.

Liquidity premia, broadly defined, do seem likely to have played a large role in break-even developments. Strong flight-to-liquidity flows during the market turmoil led to soaring demand for nominal government bonds, probably inducing a negative premium in this segment. In other words, nominal yields were pushed to extremely low levels by this effect, which in turn led to strong downward pressure on break-even rates. In addition, because markets for index-linked bonds are substantially less liquid than those for nominal bonds, there is a higher risk that investors in index-linked bond markets will encounter problems when quickly trying to exit positions at prevailing market prices. In normal times, this is typically seen as generating a relatively small liquidity premium on index-linked bonds. That type of premium probably increased considerably as liquidity risk rose, and aversion to such risk grew when the crisis deepened in the second half of 2008. This, in turn, would have increased the yield on real bonds relative to that on nominal bonds, hence adding to the downward pressure on break-even rates.

Linked to these liquidity effects, and to some extent indistinguishable from them, are technical market factors, which also appear to have been important drivers of break-even rates recently. Such factors include sell-side pressures from leveraged investors that were forced to unwind inflation-linked bond positions in adverse market conditions, which in turn resulted in rising real yields and hence falling break-even rates.<sup>③</sup>

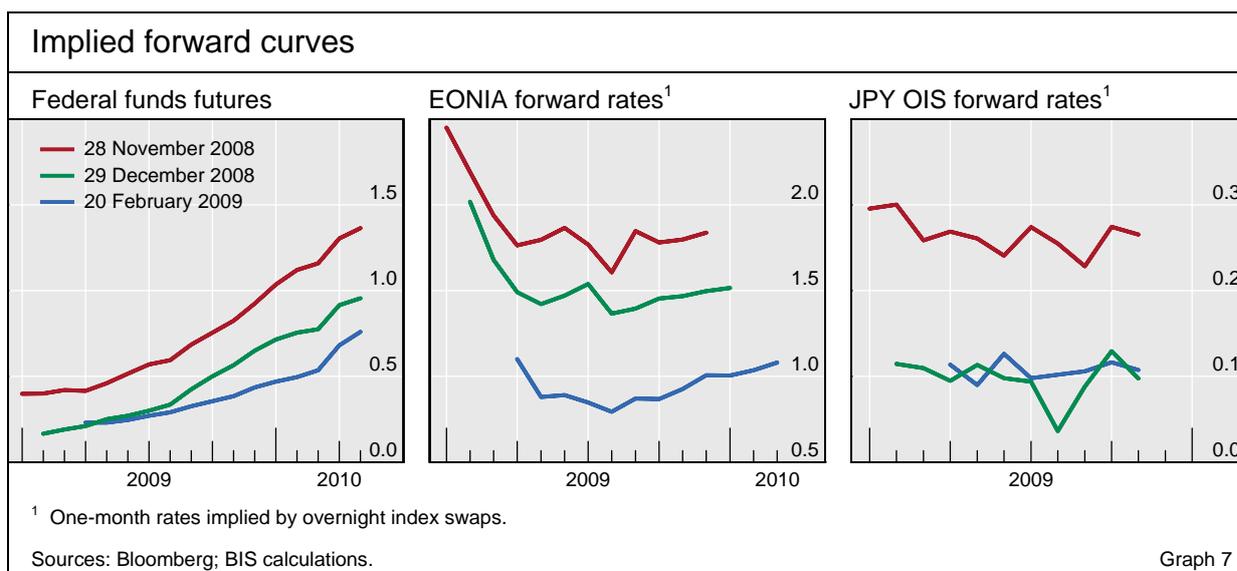
Evidence from inflation swap markets can shed some light on the importance of these effects. An inflation swap is a derivative instrument that is similar to a regular interest rate swap. However, instead of exchanging a fixed payment for a variable payment linked to a short-term interest rate, the inflation swap links the variable payment to a measure of inflation, typically the accrued inflation over the life of the swap. The fixed leg of the inflation swap therefore provides a direct break-even inflation “price”, which is unaffected by any differential liquidity conditions in nominal and real bond markets or by flight-to-liquidity flows.<sup>④</sup>

While the difference between 10-year inflation swap prices and corresponding bond break-even rates had remained stable in the past few years, the spread widened significantly towards the end of 2008 (Graph A, left-hand and centre panels). This suggests that the aforementioned liquidity and technical effects have played a significant role in bond market break-even rates. Nevertheless, inflation swap rates also declined notably in late 2008, a move consistent with expectations of lower inflation but probably also due to hedging of break-even positions in bond markets. Some of the declines in break-even rates were reversed in early 2009, possibly as a result of investors stepping in to take advantage of what was perceived as overly depressed break-even inflation levels.

Finally, a look at distant forward break-even inflation rates can be informative. For example, the five-year forward rate five years ahead is often seen as providing a cleaner indication of long-horizon inflation expectations than, say, a 10-year break-even rate because it should, at least in principle, be unaffected by near-term inflation expectations. Such forward break-even rates have become much more volatile in recent months, but there has been no clear shift in their overall level (Graph A, right-hand panel). The absence of such a shift would suggest that longer-term inflation expectations have remained broadly stable, which is in line with the view that the credibility of central banks with respect to their commitment to price stability has not been eroded despite the recent rapid lowering of policy rates.

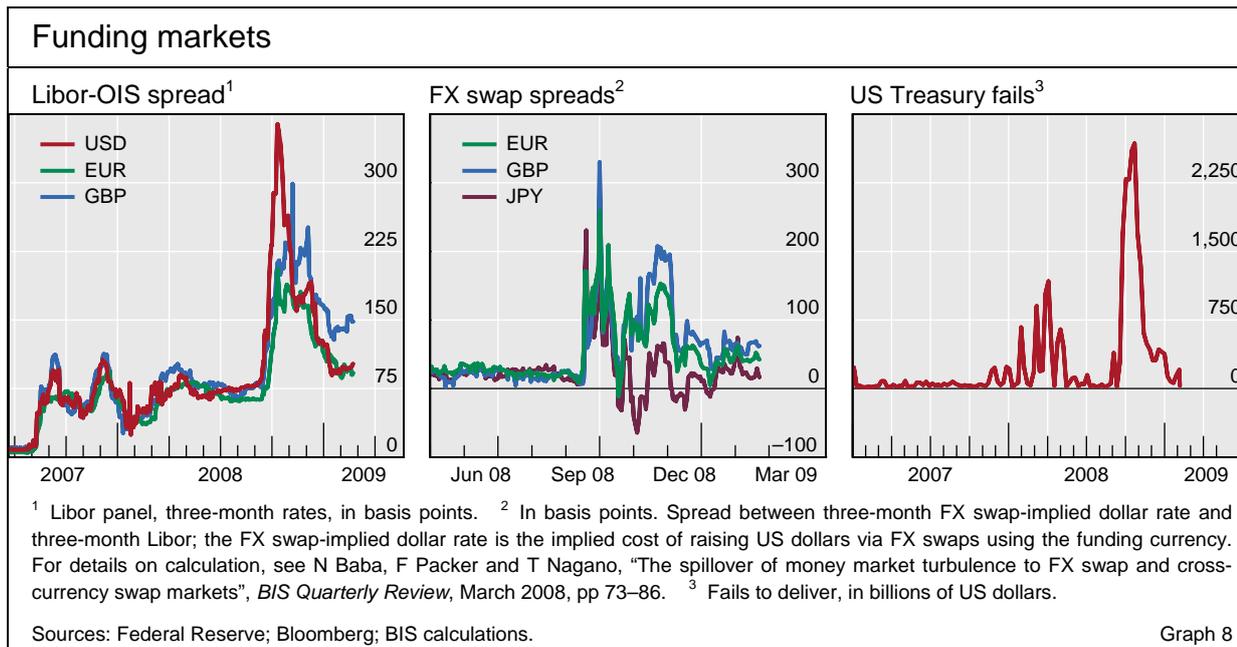
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<sup>③</sup> Other phenomena can affect break-even rates, including inflation seasonality and “carry” effects. Inflation seasonality effects refer to known seasonal fluctuations in consumer prices affecting prices on bonds linked to consumer price indices that are not seasonally adjusted. Carry effects have to do with persistent changes in consumer prices, such as those due to oil price movements, which are known to affect inflation today, whereas index-linked bonds are linked to an index of prices several months old. However, these effects tend to be important mainly for short maturities, say up to a couple of years. <sup>④</sup> See P Hördahl, “The inflation risk premium in the term structure of interest rates”, *BIS Quarterly Review*, September 2008, pp 23–38, and references therein. <sup>⑤</sup> Another such technical factor is the value of the embedded deflation floor, which for many index-linked bonds has increased recently, in particular for newly issued bonds that are close to the floor. Increased deflation floor values imply higher prices for those index-linked bonds that are affected, meaning lower real rates and hence higher break-even rates. This last effect would therefore not explain the recently observed fall in break-even rates. In addition, in our calculations of zero coupon real rates and break-even inflation rates, we do not include any recently issued real bonds. It is therefore likely that the deflation floor has played a minor role in our break-even inflation data. <sup>⑥</sup> Of course, this is not to say that inflation swaps are unaffected by any “technical” market factors, such as hedging effects. In addition, inflation swap markets are typically less liquid than bond markets.



associated premia in early 2009 were higher than before the Lehman bankruptcy (Graph 4, left-hand panel). As with spreads in unsecured lending markets, foreign exchange swap spreads retreated gradually from the highs reached in November, but not back to pre-Lehman levels (Graph 8, centre panel). Conditions seemed to improve in repo markets as well. In particular, US settlement fails, which had reached record levels in October 2008, declined significantly due to easing tensions in funding markets, lower repo trading volumes, and actions taken by the Treasury Market Practices Group (TMPG), a group of private sector market participants sponsored by the Federal Reserve Bank of New York. A settlement fail occurs when a security is not delivered on the date agreed by the buyer and seller, often in connection with a repo transaction. The TMPG recommended the introduction of new market practices, including a charge for failing to settle transactions on time. By mid-February, fails to deliver US Treasuries stood at just over \$30 billion, compared with almost \$2.7 trillion in October (Graph 8, right-hand panel).

Long-term dollar swap spreads (ie the swap rate minus a corresponding Treasury yield) remained at unusually low levels in early 2009 after having fallen substantially in late 2008. Some of the downward pressure was due to Treasury supply concerns pushing up bond yields relative to swap rates. Swap spreads at the 10-year maturity fell to 10–30 basis points in late 2008 and early 2009, compared with a range of about 50–80 basis points during the preceding two years (Graph 6, right-hand panel). Meanwhile, the 30-year US swap spread dropped from a level of around 40 basis points to below zero for the first time ever in late October 2008 and remained negative during much of the period thereafter. Apart from worries about Treasury supply, this sharp decline in very long-term US swap spreads was reportedly also due to hedging of exotic derivative structures.



## Financial sector concerns weigh on equity markets

Equity markets struggle ...

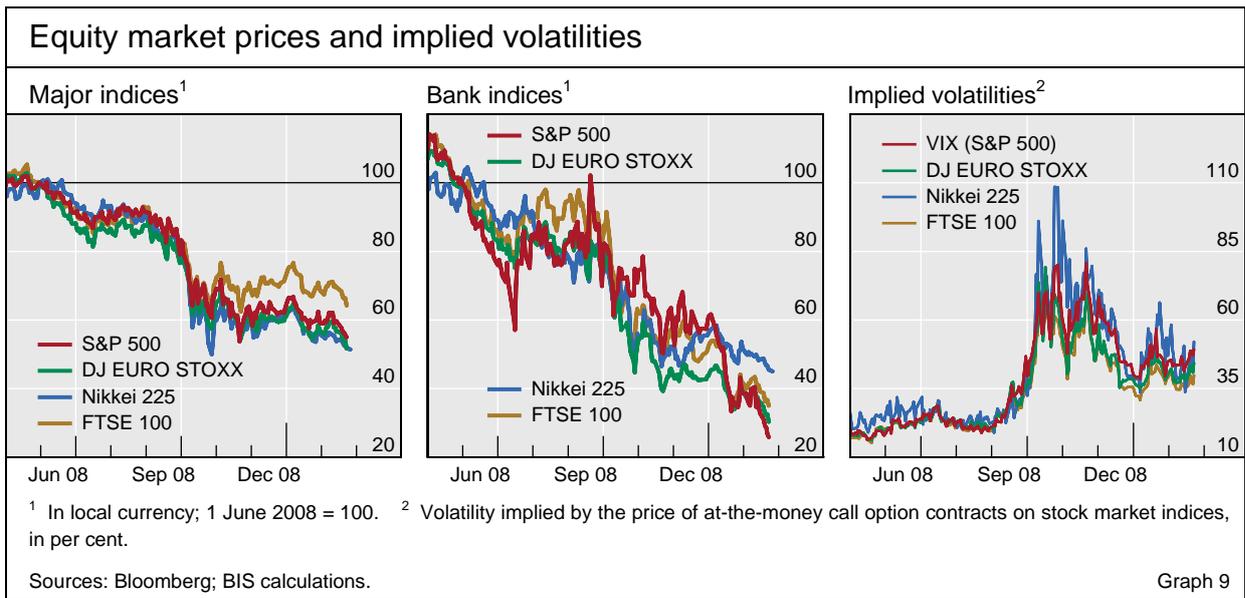
Despite having started 2009 on a strong note, major equity markets performed poorly overall during the period under review, battered by further instances of financial sector problems and a deepening economic downturn. Between end-November 2008 and 20 February 2009, the S&P 500 index fell by 14%. Major bourses in the euro area suffered commensurate losses, while the FTSE 100 shed more than 9% during the same period (Graph 9, left-hand panel).

... amid financial sector concerns ...

Heavy selling in financial sector shares led the way down, fuelled by revelations of outside fourth quarter losses at financial firms on both sides of the Atlantic (see Table 1 in the credit market section). At the same time, new instances of government intervention via large-scale capital injections or outright nationalisations heightened concerns about the state of the troubled sector and the implications of increased government involvement, further hurting investors' appetite for financial sector shares. Against this backdrop, the S&P 500 financial sector sub-index fell by some 40% between the start of the year and 20 February, reaching its lowest levels in over 14 years (Graph 9, centre panel). Financial sector stocks in the United Kingdom were also hit hard, losing about 30% over the same period. The declines in financial sector shares in other European bourses were initially less severe than those in the UK market, but accelerated in the third week of February amid mounting concerns about bank subsidiary exposures to deteriorating eastern European markets (see emerging markets section).

... as well as weak data and earnings reports

The deepening cyclical downturn of major economies also dragged on equity markets. Macroeconomic data releases in January and February continued to point to weakness in the real economy and, in some cases, suggested that activity was in the midst of the worst deterioration in decades. Lacklustre fourth quarter earnings reinforced the gloom already evident in data releases. The impact of recession on corporate performance was particularly



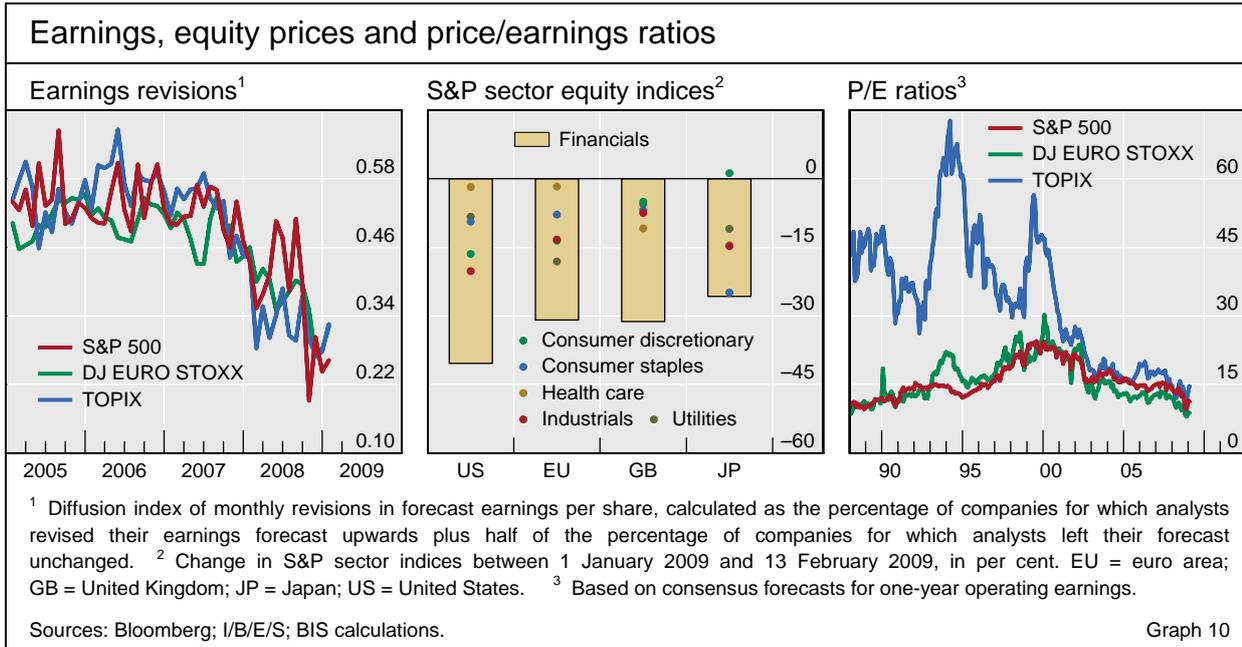
notable in Japan. The Nikkei 225 index fell by some 16% between the start of the year and 20 February, to levels last seen during the more turbulent times of late October. Moreover, the decline of the Japanese market continued to be paced by the consumer goods sector; only in February did the accelerated losses in the financial sector take the lead (Graph 10, centre panel). The strength of the yen, which had appreciated some 20% against the US dollar over the final four months of 2008, hurt export-oriented corporations and their stock prices. The Bank of Japan's 3 February announcement of plans to purchase equity holdings from financial firms did not meet any significant reaction from the market.

In the financial sector, where spreads on senior credit generally narrowed in response to government measures (see credit market section), share prices tended to react poorly. Outright nationalisations, as in the case of Anglo Irish Bank in mid-January, obviously proved devastating for shareholders. Actions that increased the government's equity stake, such as the conversion of Royal Bank of Scotland preferred shares to common shares, also tended to dilute existing shareholders' rights. Although the dilutive effects were often mitigated by the injection of non-equity capital, the conditions attached to such support (eg restrictions on dividend payments) still weighed on share prices. Moreover, with market participants increasingly scrutinising not only the level but also the composition of capital at financial institutions, the fact that many financial institutions might convert hybrid capital instruments into equity shares raised further concerns about dilution.

Other potential government rescue measures also influenced financial sector share prices. Proposals for dealing with banks' bad assets raised uncertainty, as the impact on banks' balance sheets depended on, among other details, the format of the scheme (eg guarantee or outright purchase) and the valuation of assets. Unable to meet market participants' expectations for details, the much awaited announcement on 10 February of the revamped US plan to rescue the financial sector triggered another bout of equity selling, wiping out part of the modest gains accrued after the sell-off in mid-January.

Government interventions depress share prices ...

... as does uncertainty over policy responses to bad assets



The remaining gains evaporated in the third week of February, as heightened worries about possible bank nationalisations haunted financial markets.

P/E ratios still close to historic lows

Much uncertainty remained at the end of the period under review, as suggested by the rebound in volatility measures implied by equity options pricing during the third week of February (Graph 9, right-hand panel). Price/earnings ratios continued to tread at extremely low levels by the standards of the past two decades, even as earnings expectations appeared to be still on the decline (Graph 10, right- and left-hand panels).

### Emerging markets join global slowdown

Emerging markets generally had little direct exposure to the distressed assets that plagued the major industrial economies, and they weathered the acute phase of the financial crisis in late 2008 relatively well. However, they appeared much less immune to the deepening recession in the advanced industrial world. Indeed, evidence of the macroeconomic repercussions mounted throughout the period under review. At the same time, financial market tensions continued to build in selected emerging market economies, especially in eastern Europe.

Sharp and broad-based slowdown in activity ...

The severe and broad-based nature of the global economic downturn was apparent in an array of macroeconomic data releases early in the new year. Singapore's advance fourth quarter GDP estimate (a 2.6% year on year decline), released on 2 January, was among the first to confirm the deepening impact of global downturn on small open economies. The sharper than expected fall in fourth quarter GDP growth in Korea (3.4% down year on year), published on 22 January, bore further evidence to this effect. Among the larger emerging economies, China reported GDP growth of only 6.8% year on year in the fourth quarter, significantly down from 9% in the previous quarter. Similarly, Russia's preliminary corresponding figure, announced on 6 February, came in at only 1.1%, down from 6.2%.

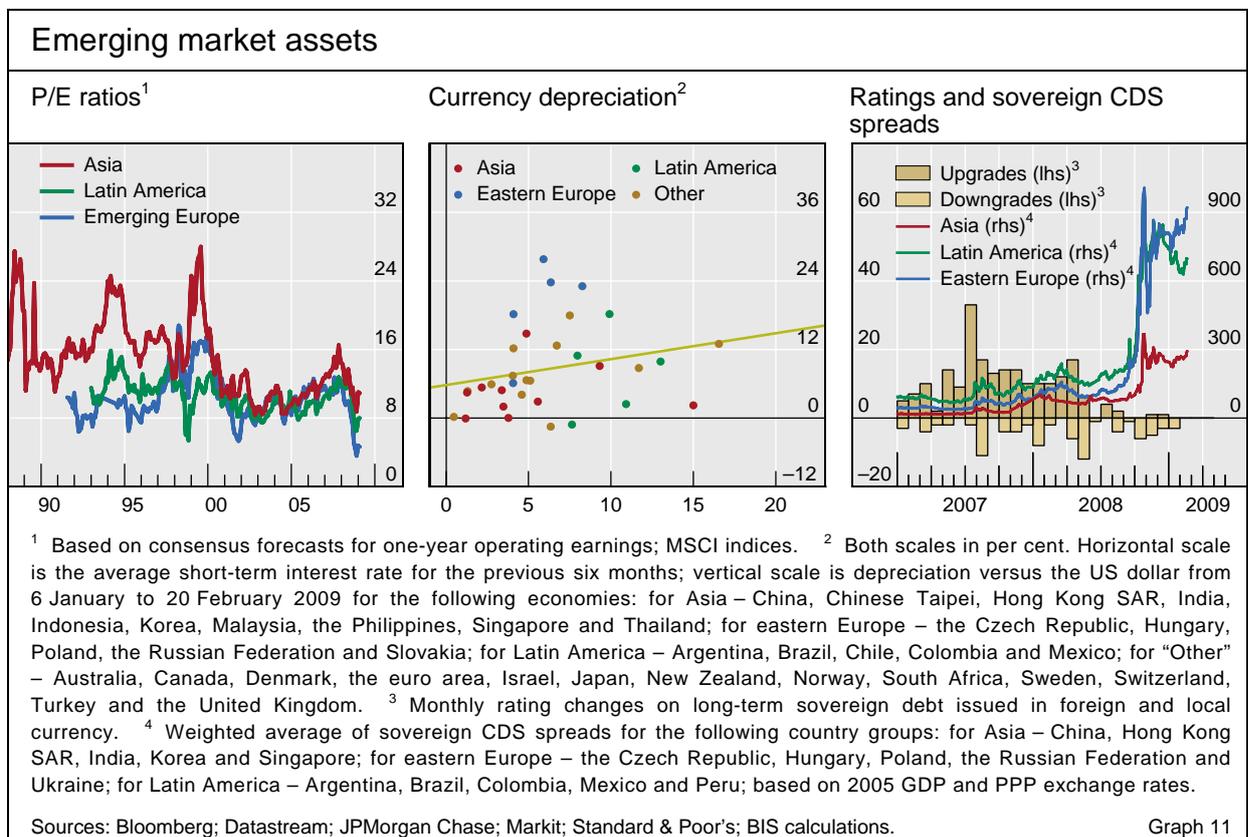
One channel for macroeconomic spillovers from the slowing advanced economies to the emerging market world was export demand. The sharp decline in export growth, already becoming evident for some economies in late 2008, raised particular concerns among those that had depended on exports to support GDP growth. The collapse in trade flows was apparently also linked to the drying-up of trade credit from the industrial world in the wake of the Lehman bankruptcy in September 2008. Available monthly balance of payments figures for Brazil and Korea, for example, indicate that the net flows of trade credit from non-residents turned negative in October 2008 and stayed so up to December.

... accompanied by collapse in trade flows

The deteriorations in economic activity and outlook in emerging markets were reflected in generally depressed equity valuations, particularly in eastern Europe. Between end-November 2008 and 20 February 2009, while the MSCI emerging market indices for Asia and Latin America were flat and up 3%, respectively, the corresponding index for emerging Europe fell by 17%. Valuations, as evident in price/earnings ratios, remained at or close to all-time low levels for all regions (Graph 11, left-hand panel).

Equity valuations remain depressed, especially in emerging Europe

The underperformance of equities in emerging Europe was apparent across a wide range of countries. The benchmark indices of the Czech, Hungarian and Polish stock exchanges fell by over 24%, 18% and 19%, respectively. Russia's Micex index was extremely volatile, climbing by 31% between 23 January and 10 February before plunging by 14% in just three days in mid-February, triggering a temporary suspension of trading on 17 February.



Currency depreciations raise foreign debt concerns

The vulnerabilities of eastern European economies were also highlighted in the foreign exchange markets. Although many emerging market currencies rebounded in December and early January, the Russian rouble continued to depreciate against both the dollar and the euro, as the Russian central bank progressively lowered the currency's trading band amid growing concerns about the country's economic outlook. The Czech koruna, the Hungarian forint and the Polish zloty also suffered sharp losses, which outstripped the declines suggested by the tendency for high-yielding currencies to depreciate more than lower-yielding ones in times of heightened market volatility (Graph 11, centre panel). Given the high exposure of the three economies concerned to a rapidly slowing western Europe via trade and financial links, their ability to finance their sizeable current account deficits and service their foreign currency debt was increasingly called into question. The banks that had been providing financing, mostly subsidiaries of western European banks, were in turn exposed to the worsening outlooks in their host markets. The risk of such two-way exposure was highlighted by a credit rating agency report on 17 February. The news prompted a sell-off in the euro and in eastern European currencies.

Sovereign credit spreads reflect increased differentiation

Investor concerns over selected emerging market economies were echoed in the evolution of sovereign credit spreads. In December and early January, spreads on emerging market sovereign credit in both cash and CDS markets generally retreated from their October peaks (Graph 11, right-hand panel). Notably, the decline in spreads led a number of sovereign issuers to take advantage of the improved conditions around the turn of the year to issue in the primary market. However, the improvement applied mostly to sovereigns from Asia and the better-rated Latin American issuers. Spreads for lower-rated Latin American sovereigns such as Venezuela, in contrast, did not substantially narrow. Meanwhile, spreads for eastern European countries tended to continue rising. Between end-November and 20 February, the five-year CDS spreads for Hungary and Poland, for example, rose by 175 and 180 basis points, respectively, reaching levels close to or beyond their peaks in late October. Extremely wide spreads for Ukraine rose further amid deterioration in the country's economic and political situation.

Though spreads for the better-rated sovereigns were mostly able to sustain their earlier improvements, many appeared to be creeping upwards in late January and February. Most notably, the five-year CDS spreads for Korea widened by over 100 basis points in the second and third weeks of February amid renewed concerns over the ability of Korean banks to service their foreign currency debt.



## Highlights of international banking and financial market activity<sup>1</sup>

The BIS, in cooperation with central banks and monetary authorities worldwide, compiles and disseminates several datasets on activity in international banking and financial markets. The latest available data on the international banking market refer to the third quarter of 2008. The discussion on international debt securities and exchange-traded derivatives draws on data for the fourth quarter of 2008.

### The international banking market

International banking activity continued to reflect the tensions on bank balance sheets in the third quarter of 2008. BIS reporting banks' total gross international claims<sup>2</sup> actually grew, by \$248 billion to \$37.5 trillion, driven largely by greater inter-office activity. Lending to other (unaffiliated) banks fell, however, reflecting the severe market strains following the failure of Lehman Brothers on 15 September. With interbank markets effectively shut down by end-September, banks sought dollar financing elsewhere: their liabilities to official monetary authorities soared in the third quarter, reflecting in part their use of central bank swap lines. Banks also curtailed their lending to emerging markets.

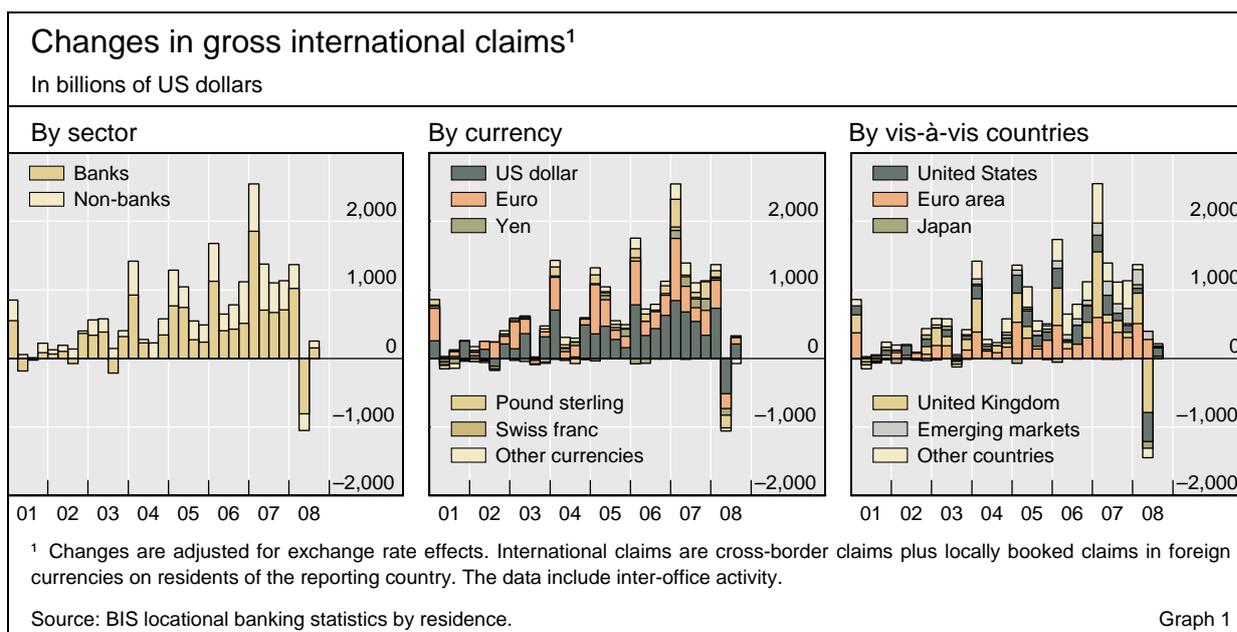
#### *Funding pressures continue*

Interbank lending continued to contract in the third quarter of 2008, reflecting the ongoing tensions in interbank credit markets. On a residency basis, total claims on banks (including inter-office claims) grew by \$150 billion, following the unprecedented decline of more than \$800 billion in the previous quarter (Graph 1). However, net of inter-office activity, lending to other (unaffiliated)

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<sup>1</sup> Queries concerning the banking statistics should be addressed to Patrick McGuire and Blaise Gadanecz, and queries concerning international debt securities, exchange-traded derivatives and over-the-counter derivatives statistics to Jacob Gyntelberg.

<sup>2</sup> In the BIS locational banking statistics by residence, international claims (liabilities) are cross-border claims (liabilities) plus locally booked claims (liabilities) in foreign currencies vis-à-vis residents of the reporting country.



banks actually fell in the third quarter as well, this time by \$173 billion. The BIS consolidated banking statistics,<sup>3</sup> which track banks' worldwide consolidated positions by *lender nationality*, suggest that reduced interbank lending by French, Belgian and German banks accounted for much of this decline (Graph 2, left-hand panel).<sup>4</sup>

Amidst these funding pressures, banks received liquidity support from official monetary authorities. Their liabilities to these counterparties soared in the third quarter, by \$190 billion, following two consecutive quarterly declines (Graph 3, centre and right-hand panels). The BIS statistics do not include information on which countries' official monetary authorities accounted for these moves. However, the foreign exchange reserve data reported to the IMF by the monetary authorities in 63 countries suggest that many central banks continued to *reduce* their placements of foreign exchange reserves in commercial banks in the third quarter (Graph 3, left-hand panel). Thus, the surge in banks' reported liabilities to official monetary authorities in the BIS banking statistics would seem to reflect, at least in part, borrowing from the US dollar swap lines established between the Federal Reserve and European (and other) central banks.

Banks' liabilities to official monetary authorities surge

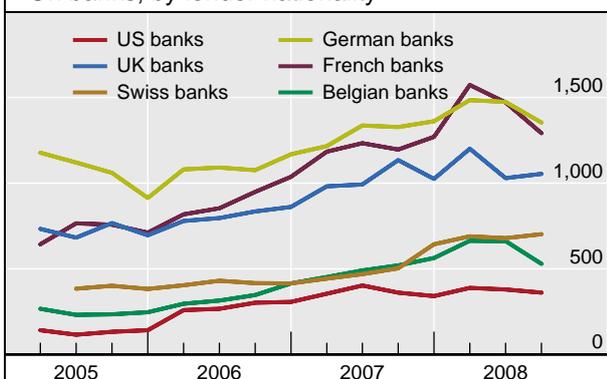
<sup>3</sup> The BIS consolidated banking statistics on an ultimate risk basis track banking systems' consolidated worldwide foreign claims (excluding inter-office positions). Foreign claims include cross-border claims booked by offices worldwide plus local claims booked by banks' foreign offices.

<sup>4</sup> Across all reporting countries, the outstanding stock of foreign claims on other banks declined by \$744 billion (9%) in the third quarter of 2008. However, the reduction of \$146 billion reported for Dutch banks in part reflected the sale of business units by ABN AMRO. More generally, the depreciation of the euro against the US dollar in the third quarter accounted for an estimated 70% of the overall reduction. For a discussion of currency effects in the consolidated banking statistics, see B Gadanez and K von Kleist, "Currency effects in consolidated bank claims", *BIS Quarterly Review*, June 2007, p 20.

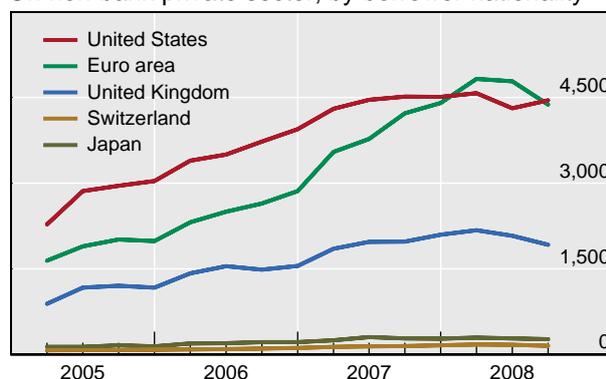
## Consolidated foreign claims

Amounts outstanding, in billions of US dollars

On banks, by lender nationality



On non-bank private sector, by borrower nationality



Source: BIS consolidated banking statistics on an ultimate risk basis.

Graph 2

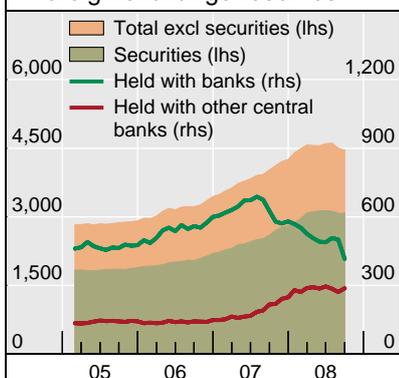
### Claims on non-banks change little

Following a sizeable contraction in the second quarter of 2008, international claims on non-banks in major industrial countries remained relatively stable during the third. Total international claims on this sector grew by a modest \$99 billion, with claims in all currency segments rising. Claims of banks in the euro area expanded the most (\$80 billion), reflecting greater intra-euro area cross-border lending (\$75 billion), primarily to borrowers in the Netherlands, Luxembourg, Spain and Belgium. In contrast, claims on non-banks in the United Kingdom declined for a second consecutive quarter, this time by \$66 billion. Banks' cross-border claims on non-banks in the United States grew by \$44 billion in the third quarter, to \$2.9 trillion. Claims booked by banks in the euro area and Japan actually contracted (by \$17 billion and \$15 billion, respectively), while claims booked by banks in the United Kingdom expanded by a robust \$71 billion, the first increase since mid-2007.

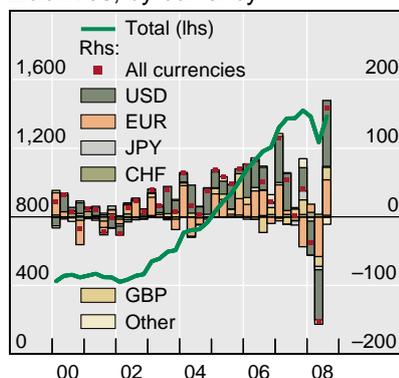
## Foreign exchange reserves and liabilities to official monetary authorities

In billions of US dollars

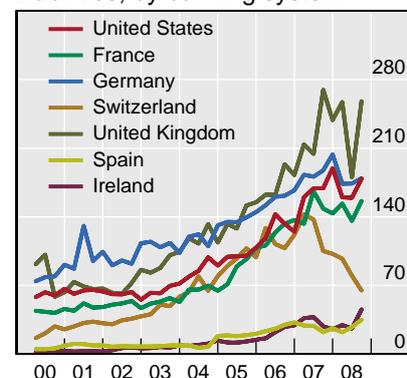
Foreign exchange reserves<sup>1</sup>



Liabilities, by currency<sup>2</sup>



Liabilities, by banking system<sup>2</sup>



<sup>1</sup> Holdings of foreign exchange reserves by 63 monetary authorities which report SDDS data to the IMF. <sup>2</sup> Liabilities booked by BIS reporting banks vis-à-vis official monetary authorities; expressed at constant end-Q3 2008 exchange rates.

Sources: IMF SDDS; BIS locational banking statistics by nationality.

Graph 3

The BIS consolidated banking statistics, which contain a finer counterparty sector breakdown, shed more light on the degree to which banks have unwound their exposures to US non-bank *private sector* borrowers. Overall, BIS reporting banks' consolidated foreign claims on US non-banks (on an ultimate risk basis) grew by \$109 billion in the third quarter of 2008. Claims on the US public sector remained relatively stable (at \$639 billion), whereas claims on the US non-bank private sector rose by a modest \$137 billion, to \$4.4 trillion (Graph 2, right-hand panel).<sup>5</sup> This constitutes a mere \$12 billion reduction in reporting banks' total outstanding claims on these borrowers since the start of the crisis in the second quarter of 2007, although differences across banking systems are apparent. Since then, Canadian, Irish and Japanese banks' claims on the US non-bank private sector have expanded, by a combined \$201 billion or 26%, whereas Belgian, French, German and Swiss banks' claims have fallen by a combined \$240 billion, or 12% per cent.<sup>6</sup>

#### *International lending to emerging markets slows*

The growth in credit to emerging markets continued to slow in the third quarter of 2008. On a nominal basis, the outstanding stock of BIS reporting banks' foreign claims (on an immediate borrower basis) vis-à-vis all emerging regions declined significantly during the quarter, by \$286 billion (Graph 4). However, the depreciation of many emerging market currencies (as well as the euro and Swiss franc) against the US dollar during the quarter exaggerates the size of the real contraction when figures are expressed in US dollars. While there are differences across borrower regions, the data suggest that, in real terms, banks' local claims in local currencies remained relatively stable, while their international claims declined.

In nominal terms, banks' consolidated foreign claims on borrowers in Asia-Pacific contracted by \$83 billion (Graph 4, top right-hand panel), reflecting reduced local claims in local currencies as well as lower international claims. However, a simple currency adjustment for banks' local claims in local currencies indicates that these positions actually rose slightly during the quarter. Although a precise correction for exchange rate movements is not possible for banks' international claims, the BIS locational statistics, for which a currency adjustment is possible, show that *cross-border* claims on the region contracted for the first time since end-2005 (by \$31 billion), driven by reduced claims on China (–\$24 billion) and Malaysia (–\$12 billion).

Banks' reported foreign claims on Latin America also declined, by \$101 billion (Graph 4, bottom left-hand panel). While exchange rate movements also played a role here, the decline also reflected in part the sale

Cross-border credit  
to Asia-Pacific  
contracts

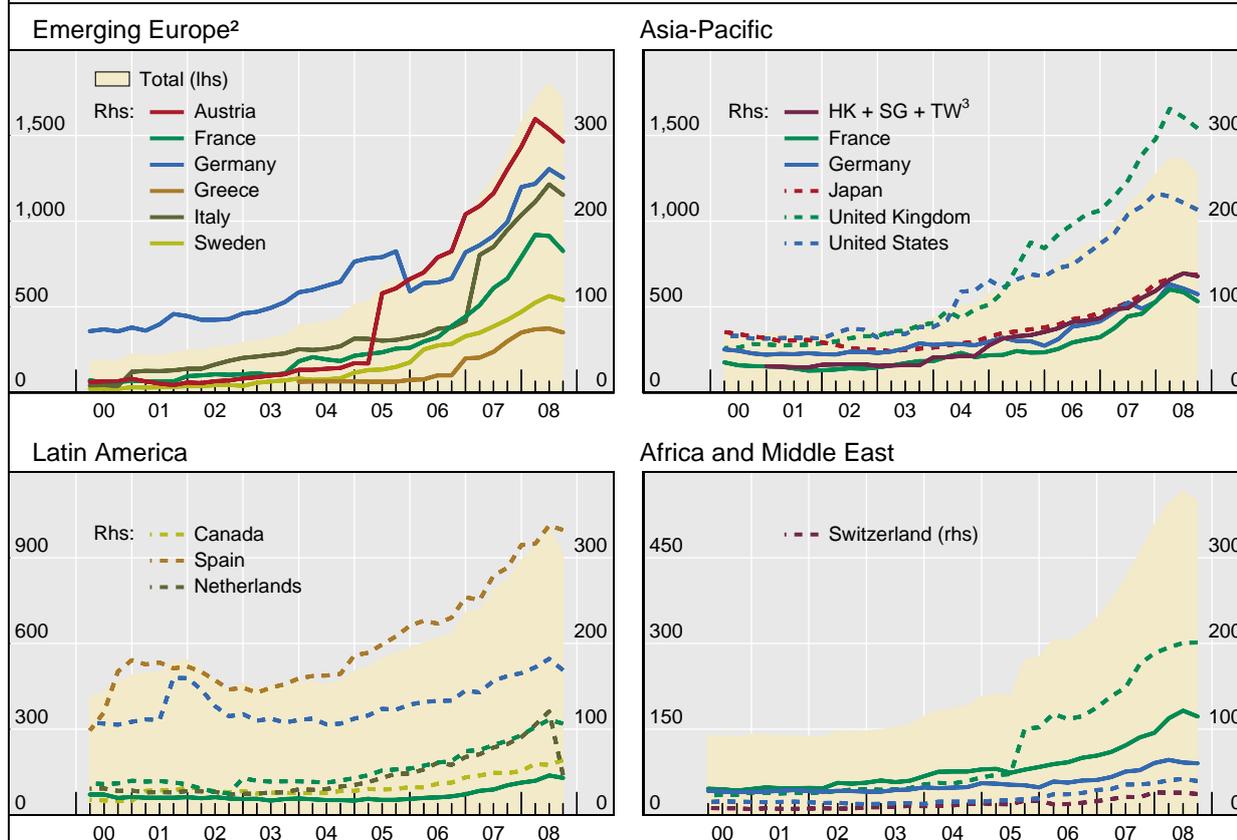
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<sup>5</sup> UK-headquartered banks accounted for most of this increase in the third quarter. Part of the large increase in foreign claims on the United States was due to a major acquisition within the population of reporting banks.

<sup>6</sup> Data on signings of international syndicated loan facilities suggest a slowdown in credit in the *fourth quarter* of 2008. Signings of such facilities worldwide totalled \$294 billion in the fourth quarter, while facilities granted to US non-bank residents amounted to \$100 billion, in both cases less than half the volume of one year before.

## Foreign claims on emerging markets<sup>1</sup>

In billions of US dollars



<sup>1</sup> Consolidated foreign claims (on an immediate borrower basis) on emerging markets grouped into four regions (panel headings), as reported by banks of the nationalities shown in the legends. Foreign claims consist of cross-border claims and local claims (ie claims booked by local offices of foreign banks). They include loans and securities, but exclude contingent exposures such as credit commitments and guarantees. <sup>2</sup> Includes Cyprus, Malta and Slovenia. <sup>3</sup> Hong Kong SAR, Singapore and Chinese Taipei combined.

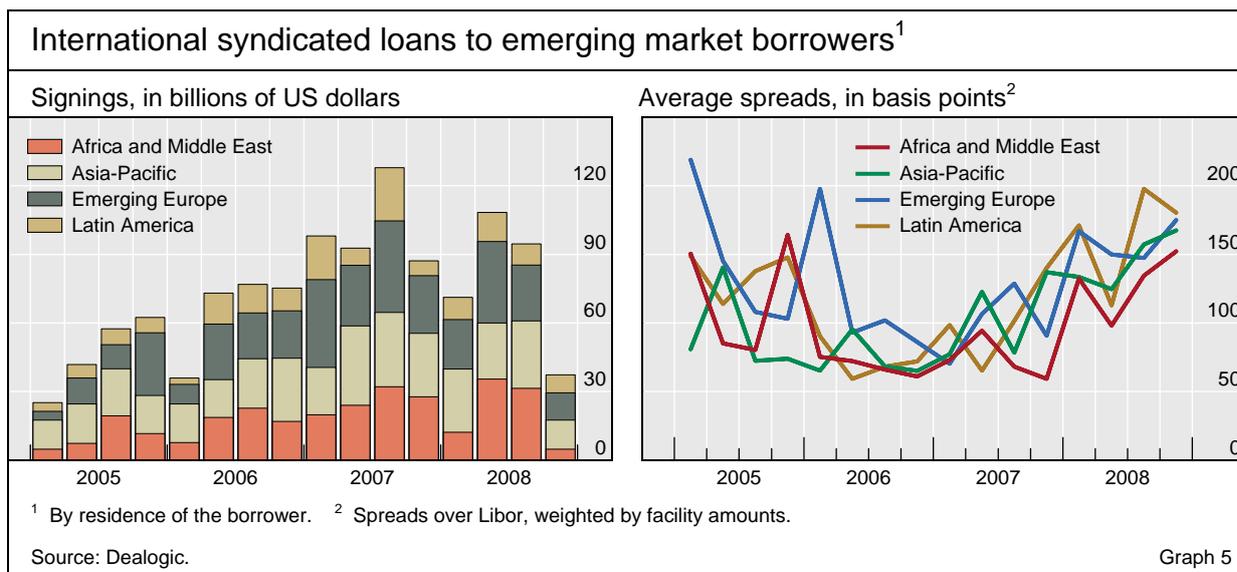
Source: BIS consolidated banking statistics on an immediate borrower basis.

Graph 4

of ABN AMRO's business in Latin America, resulting in a large reduction in outstanding claims reported by Dutch banks.

The sources of change in banks' consolidated foreign claims on emerging Europe are less clear (Graph 4, top left-hand panel). On a nominal basis, foreign claims decreased by \$89 billion, or 5%, driven by reduced positions reported by Austrian, French, German and Italian banks. Banks' local claims in local currencies, however, changed little once exchange rate movements are taken into account. And though international claims on the region, which are largely euro-denominated,<sup>7</sup> fell \$36 billion in nominal terms, the BIS locational statistics show that banks' cross-border positions, adjusted for currency movements, increased during the quarter. Thus, exchange rate movements may have masked a small increase in total foreign claims on the region.

<sup>7</sup> In the third quarter of 2008, the share of euro- and Swiss franc-denominated gross international claims on the region was 41% and 5%, respectively.



Information on syndicated lending to emerging markets, available up to the *fourth* quarter of 2008, lends some support to the hypothesis that credit to emerging markets has slowed. Total signings of international syndicated loan facilities to borrowers in emerging markets came to \$37 billion in the fourth quarter of 2008, less than half the volume signed in the fourth quarter of 2007 (Graph 5, left-hand panel). The average spread (weighted by facility amounts) over Libor on the facilities granted to all the major emerging regions spiked in the fourth quarter, rising above the levels observed in third quarter of 2007 when the period of financial turbulence began (Graph 5, right-hand panel).

Syndicated lending to emerging markets slows in the fourth quarter

### The international debt securities market

Borrowing in the international debt securities market rebounded in the fourth quarter of 2008 as the turmoil in financial markets subsided. Net issuance of international bonds and notes increased to \$624.3 billion, up substantially from \$253.3 billion in the third quarter. The increase was well beyond normal seasonal patterns: the year-on-year rise over the fourth quarter of 2007 was 30.0%. Money market borrowing continued to decline, however, with net issuance falling further into negative territory in the fourth quarter.

Borrowing rebounds ...

By sector, financial institutions recorded the largest increase, with net issuance of bonds and notes rising from \$252 billion to \$570 billion in the fourth quarter. Borrowing by financial institutions was supported by government guarantee schemes for bank bonds in Europe as well as in the United States. Gross issuance of guaranteed bonds by financial institutions exceeded \$210 billion in the fourth quarter, corresponding to almost half of total net issuance by financial institutions. Even more important was much greater issuance of mortgage-backed bonds in the United Kingdom as well as in Belgium, Germany, Italy and Spain (see box). The notable increase in issuance coincided with the introduction of government-led policy initiatives which included asset purchase programmes and swap facilities. In contrast to the increase in net issuance by financial institutions, government net issuance was negative and corporate borrowing remained low at \$44 billion.

... particularly for financial institutions

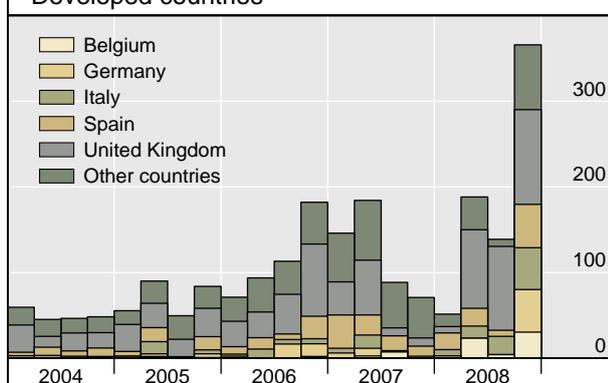
## International issuance of mortgage-backed bonds

*Naohiko Baba and Denis Pêtre*

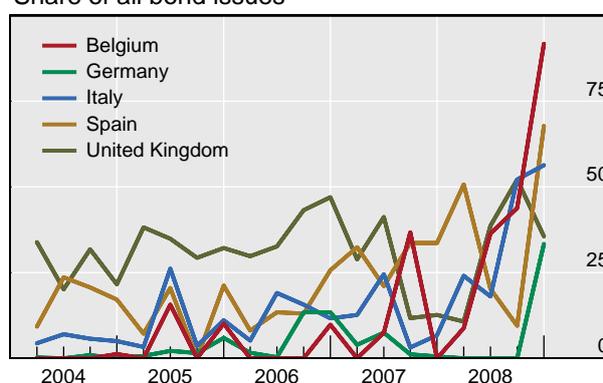
Mortgage-backed international bond issuance by industrial countries has swung dramatically since the onset of the financial turmoil in mid-2007 (Graph A, left-hand panel). By the first quarter of 2008, it had fallen to less than one third of the peak in the second quarter of 2007. But in the second quarter the trend was reversed, chiefly driven by the large rebound in issuance by UK nationals. In the fourth quarter, aggregate issuance of mortgage-backed bonds reached the highest level ever, reflecting increased borrowing by nationals of a wide range of European countries including the United Kingdom, Spain, Germany, Italy and Belgium. Net issuance figures that take account of repayments show changes of similar magnitude.

### Gross issuance of mortgage-backed bonds<sup>1</sup>

Developed countries<sup>2</sup>



Share of all bond issues<sup>3</sup>



<sup>1</sup> Asset-backed securities whose cash flows are backed by the principal and interest payments of a set of mortgage loans. Payments are typically made monthly over the lifetime of the underlying loans. <sup>2</sup> In billions of US dollars. <sup>3</sup> In per cent.

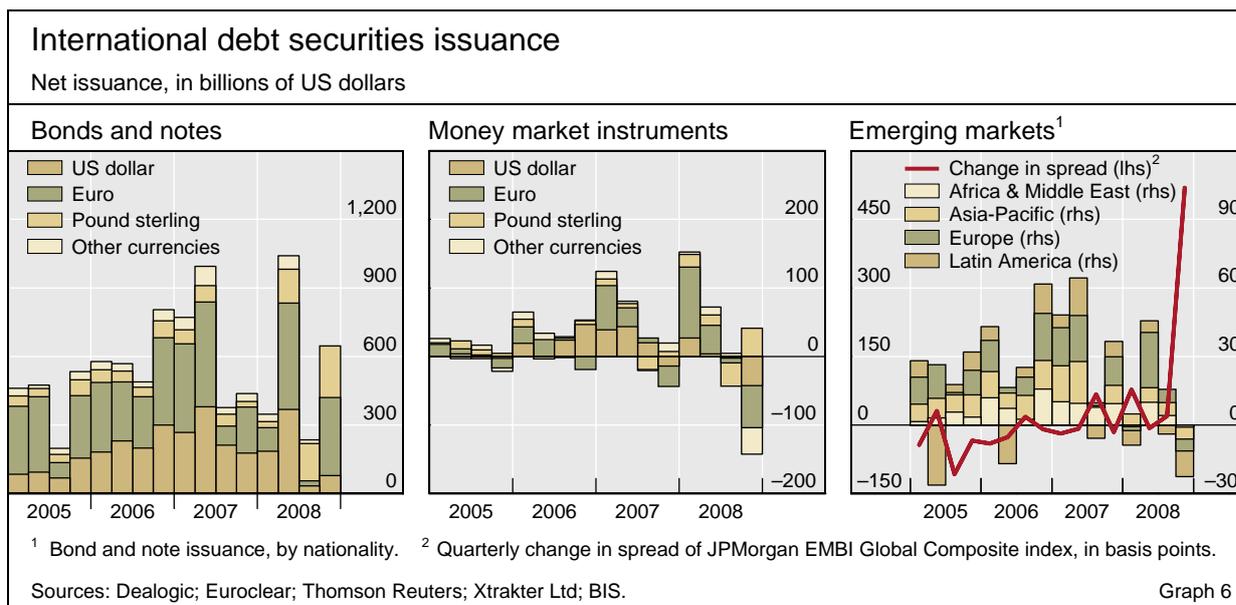
Sources: Dealogic; Thomson Reuters; BIS.

Graph A

The surge by UK issuers followed the implementation of the Special Liquidity Scheme by the Bank of England in April 2008. This enabled UK banks (and building societies) to swap currently illiquid high-quality assets such as mortgage-backed securities for UK Treasury bills for up to three years. The drawdown period, which was initially scheduled to run until end-October 2008, was subsequently extended to end-January 2009. The usage of this scheme amounted to £185 billion (\$263 billion) of Treasury bills.

The later surge in issuance across Europe followed the deepening of the financial crisis after the failure of Lehman Brothers in September 2008. In subsequent months, many European countries announced temporary rescue plans to support banks and unfreeze credit markets.<sup>⓪</sup> The rapid and substantial increase in mortgage-backed bond issuance in these European countries coincided with the introduction of these government-led policy initiatives. The rescue plans include asset purchase programmes (Germany, Spain), through which governments purchase illiquid and distressed assets on the banks' balance sheets, swap facilities similar to the one introduced in the United Kingdom (Italy, Spain), and government guarantees of new debt issuance (Belgium, Germany, Italy, Spain). Amid the continued slump in the overall credit market, the share of mortgage-backed bonds in the total gross issuance of international bonds has reached all-time peaks in Belgium (92%), Spain (68%), Italy (56%) and Germany (33%) (Graph A, right-hand panel).

<sup>⓪</sup> See D Domanski and S Ramaswamy, "Government-led bank rescue initiatives", *BIS Quarterly Review*, December 2008, p 10.



By currency, the euro-denominated segment experienced the largest increase in borrowing, followed by the sterling segment (Graph 6, left-hand panel). Net issuance in euros spiked to \$337 billion in the fourth quarter from \$30 billion in the previous one. Borrowing in pounds sterling rose from \$155 billion to \$233 billion. By contrast, US dollar net issuance, although higher than in the previous quarter, remained subdued at \$63 billion. Yen borrowing decreased from \$8 billion to a net repayment of \$11 billion. The breakdown by nationality of issuer indicates that the largest increase in net issuance came from UK and euro area borrowers, reflecting in large part the rise in mortgage-backed borrowing referred to above.

Issuance of euro-denominated bonds and notes rises sharply

Borrowing via international money market instruments, which include euro commercial paper and other short-term instruments such as certificates of deposit, continued to decline. Borrowing decreased from -\$30 billion to -\$112 billion in the fourth quarter, the lowest level since 1989, when the BIS began collecting these statistics (Graph 6, centre panel). Net issuance by financial institutions was -\$147 billion while governments borrowed \$29 billion. The rapid decline for financial institutions is consistent with investor withdrawal from more risky money market assets in the United States.<sup>8</sup> In terms of currency, the largest decreases were in the euro-, US dollar- and yen-denominated segments. In contrast, sterling-denominated money market instruments saw a significant rebound from -\$35 billion in the third quarter to \$40 billion in the fourth, mainly due to an increase in commercial paper issuance.

Money market issuance continues to decline ...

Reflecting difficulties in global credit markets, emerging economies repaid \$23 billion on a net basis in the fourth quarter (Graph 6, right-hand panel), a notable decline in net issuance from the previous quarter, in which they borrowed a net \$12 billion. With a \$2 billion bond issue in mid-December, Mexico was the first sovereign to borrow since the \$5 billion issue by Turkey in

... and emerging markets repay debt

<sup>8</sup> See the special feature by Baba et al in this issue for a detailed discussion.

early September. The contraction in borrowing was most pronounced in Latin America, where \$11 billion was repaid, of which \$7 billion by Argentina. In Asia and the Pacific there was broad-based repayment of debt totalling \$5 billion.

## Derivatives markets

Exchange-traded derivatives trading decreases significantly ...

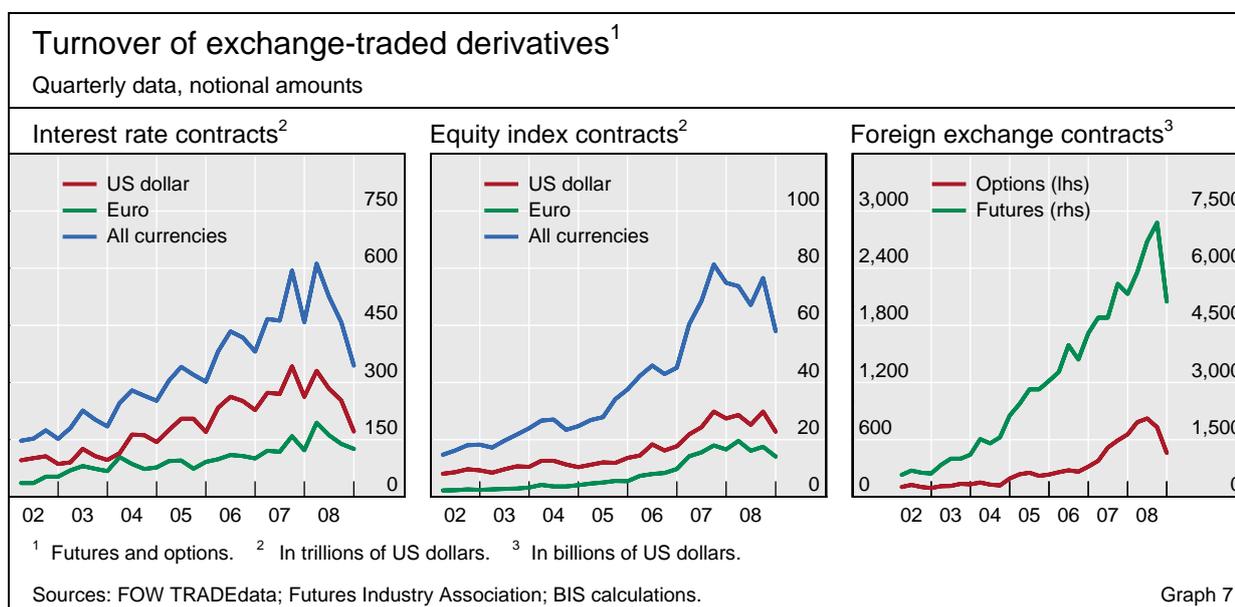
The fourth quarter of 2008 saw a continued decline of activity on the international derivatives exchanges to the lowest levels in more than two years (Graph 7). Total turnover based on notional amounts decreased to \$408 trillion from \$543 trillion in the previous quarter. The decline in trading activity reflects a combination of significantly reduced risk appetite, expectations of stable low interest rates in major markets and lower hedge fund activity.

During the fourth quarter, major central banks lowered policy rates to historical lows and interbank money markets became more stable after having frozen in September and early October. Reflecting these developments, after reaching record highs during the crisis, interest rate derivatives turnover decreased to \$345 trillion from \$458 trillion in the previous quarter (Graph 7, left-hand panel). In contrast to the overall picture, a few Asia-Pacific currencies including the New Zealand dollar and the Malaysian ringgit saw an increase in the turnover for interest rate derivatives. This may be partly due to portfolio rebalancing as these currencies weakened vis-à-vis the US dollar.

... as markets become less volatile

Activity in equity index derivatives also saw a significant decline in the fourth quarter as markets became less volatile (Graph 7, centre panel). Towards the end of the fourth quarter both options and futures turnover fell sharply to \$58 trillion from a historically high level of \$77 trillion in the previous quarter. The significant contraction in part reflects lower hedge fund participation in these markets.

After reaching a record of \$7.9 trillion in the previous quarter, foreign exchange derivatives turnover in the fourth quarter plunged to \$5.6 trillion (Graph 7, right-hand panel). The decrease in activity among the main currencies was most pronounced for the US dollar and sterling, followed by the



euro and yen segments. The decline was particularly notable for the US dollar segment, which had been characterised by high turnover since the beginning of the market turmoil in the third quarter of 2007.

Trading in commodity derivatives, observable only in terms of the number of contracts, increased from 411 million contracts in the third quarter to 450 million in the fourth, 10.4% higher than the same quarter in 2007. This ended a one-year period of declining turnover. The increase was due in part to higher turnover for non-precious metals such as copper and aluminium, most likely reflecting uncertainty about future demand.

## Assessing the risk of banking crises – revisited<sup>1</sup>

*Historically, unusually strong increases in credit and asset prices have tended to precede banking crises. Could the current crisis have been anticipated by exploiting this relationship? We explore this question by assessing the out-of-sample performance of leading indicators of banking system distress developed in previous work, also extended to incorporate explicitly property prices. We find that they are fairly successful in providing a signal for several banking systems currently in distress, including that of the United States. We also consider the complications that arise in calibrating the indicators as a result of cross-border exposures, so prominent in the current episode.*

*JEL classification: E37, E44, F34, G21.*

The current banking crisis is already widely regarded as among the most severe since the Great Depression. It has given renewed impetus to work on developing frameworks to address financial stability threats more effectively. Quantitative tools to inform assessments of the build-up of risk in the financial system are a natural element of any such framework. But the construction of reliable ones has proved elusive (eg Borio and Drehmann (2008)).

In previous work, Borio and Lowe (2002a,b) argue that focusing on the behaviour of credit and asset prices is a promising line of enquiry to develop simple and transparent leading indicators of banking system distress. Across a variety of policy regimes, these variables have tended to grow at unusually rapid rates for long periods prior to crises. However, a serious concern has been that, while performing fairly well with the benefit of hindsight, leading indicators based on those variables might not produce reliable signals for *future* crises. That is, they might work well in sample, but not out of sample.

In this special feature, we investigate this question by assessing the out-of-sample performance of those indicators over the period 2004 to 2008, in the light of the current financial crisis. We carry out two variants of out-of-sample exercises. In the first, we use the indicators as specified in the original studies, based exclusively on credit and equity prices. In the second, we also incorporate the information from property prices. While recognised as important

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<sup>1</sup> We would like to thank Stephen Cecchetti, Bob McCauley, Pat McGuire, Frank Packer, Kostas Tsatsaronis and Karsten von Kleist for helpful comments and Marjorie Santos for excellent research assistance. The views expressed are the authors' and not necessarily those of the BIS.

in those studies, this was not possible there because of data limitations. We find that the indicator based exclusively on equity prices fails to issue warnings of the current financial strains, while the one that incorporates property prices does so for several countries, including the United States. At the same time, one significant limitation of the indicators is that they do not take into account cross-border exposures of banking systems. As a result, they fail to pick up crises associated with losses on foreign portfolios when the domestic economy does not show signs of credit and asset price booms. Drawing on the BIS international banking statistics, we show how these limitations can be addressed, although not fully resolved.

The first section recalls briefly the structure of the indicators, the basic philosophy underlying them and the findings of the previous studies. The second evaluates the in-sample and out-of-sample performance of the indicators. The third considers the limitations associated with the failure to incorporate explicitly cross-border exposures. The conclusions discuss possible future extensions.

## The indicators: structure, rationale and previous findings

The indicators are based on the view that banking crises often result from the growing fragility of private sector balance sheets during benign economic conditions – henceforth referred to as “financial imbalances”. These financial imbalances, associated with aggressive risk-taking, are driven by, but also feed, an unsustainable economic expansion. At some point, however, they unwind, potentially causing widespread financial strains. The precise timing of the unwinding is impossible to predict, but the longer the imbalance persists, the higher the likelihood of the reversal. This view is rooted in a long intellectual tradition that sees occasional financial crises as inherent in the dynamics of the economy and as the result of mutually reinforcing processes between the financial and real sides of the economy: the boom sows the seeds of the subsequent bust.<sup>2</sup>

Banking crises are often preceded by a build-up of financial imbalances ...

The obvious difficulty, however, is how to identify in a reliable way the build-up of the imbalances as they develop, ie to distinguish what is sustainable from what is not in real time. After all, expansions of this kind are typically associated with developments supporting the belief that the trend growth of the economy has increased (eg structural reforms, real and financial innovations). Under these conditions, there is a very fine line between what is “far” and “too far”. And the relevance of historical relationships is unclear. Moreover, to be useful for policy, any indicator has to identify the risk of future financial strains with a lead sufficient to allow the authorities to take remedial action.

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<sup>2</sup> In the postwar period, prominent exponents of this view include Kindleberger (2000) and Minsky (1982). The full formalisation of such endogenous financial cycles has proved more elusive, but elements can be found in models that stress the interaction of credit and asset price “bubbles” (eg Allen and Gale (2000)). See Borio and Drehmann (2008) for a further discussion of these issues.

... that manifest themselves in unusually rapid credit expansion and buoyant asset prices

Despite these difficulties, previous work suggests that even some simple exercises can help us make progress towards an answer. Borio and Lowe (2002a,b) argue that it is possible to construct indicators that provide a fairly good sense of the build-up of imbalances as they develop (see the box for details).<sup>3</sup> The basic idea is that the imbalances manifest themselves in the *coexistence* of unusually rapid cumulative growth in private sector credit and asset prices. The indicators are intended to capture the coexistence of asset price misalignments with a limited capacity of the system to withstand the asset price reversal. Both of these are measured based on deviations of variables from their trends (“gaps”). The gaps are calculated so as to incorporate only information that is available at the time the assessments are made (ie are based on one-sided trends). Asset price misalignments are captured by asset price gaps, in inflation-adjusted terms, while the shock absorption capacity of the system is proxied by credit gaps, in terms of the ratio of private sector debt to GDP – a coarse measure of leverage for the economy as a whole. Signals of future crises are issued when these gaps exceed certain thresholds. As the precise timing of the unwinding of the financial imbalances is impossible to predict, the authors use a flexible horizon.

Simple leading indicators of banking crises can exploit this relationship

That body of work finds that, in sample, the performance of these indicators is quite good. They identify episodes of banking distress with a lead that, depending on the calibration, can vary between one and four years (Borio and Lowe (2004)). They also exhibit comparatively low noise-to-signal ratios<sup>4</sup> despite their parsimony, alleviating the false positives problem.<sup>5</sup>

One drawback stressed in those studies is that, owing to data limitations, the only asset price that could reliably be used in the construction of the indicator was equity prices (stock price indices). Property prices, which have played such a prominent role in banking crises, were not available for many emerging market countries. Moreover, for many industrial countries the length of the series was not regarded as sufficient to allow estimation of the initial trend values with an acceptable degree of confidence.<sup>6</sup> With the benefit of several more years of observations, in this exercise we also consider versions of the previous indicator that incorporate property prices.

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<sup>3</sup> There is a small but growing literature on estimating early warning indicators for banking crises. For recent surveys, see Demirgüç-Kunt and Detragiache (2005) and Davis and Karim (2008a). Davis and Karim (2008b) examine whether different early warning indicators developed by them could have predicted the current crises but find them not to be successful. Alessi and Detken (2008) propose real-time indicators for costly asset price booms and find that some specifications would have issued persistent warning signals prior to the current crisis.

<sup>4</sup> The noise-to-signal ratio is the ratio of the fraction of type 2 errors (ie the number of (false) positive signals issued relative to non-crisis periods) over 1 minus the fraction of type 1 errors (ie the number of instances in which no signal was issued relative to the number of crises observed).

<sup>5</sup> In addition, Tarashev (2008) finds that these indicators improve the performance of widely used indicators of credit risk, such as KMV EDFs (probabilities of borrowers' default).

<sup>6</sup> The first decade of data is used simply to calculate the trend, before any forecast is actually made.

## Determining the optimal indicator

The indicators are based on a signal extraction method, which is one of the most common approaches to estimating early warning indicators (Kaminsky and Reinhart (1999)). For each period,  $t$ , a signal,  $S$ , is calculated. The signal takes the value of 1 (is “on”) if indicator variables ( $V_{1,2,3}$ ) exceed critical thresholds ( $\theta_{1,2,3}$ ); it is 0 (is “off”) otherwise. In the special feature, we analyse combinations of two- and three-indicator variables. For a signal to be issued, both critical thresholds have to be breached in the case of two-indicator variables. In the case of three-indicator variables, a signal is issued if the first indicator variable,  $V_1$ , exceeds its threshold,  $\theta_1$ , and at the same time at least one of the remaining two variables breaches its own (see panel below).  $V_1$  always refers to a credit variable and  $V_2$  and  $V_3$  to an asset price (see the main text for a definition of the series).

Two-indicator variables	Three-indicator variables
$S_t = \begin{cases} 1 & \text{if } (V_1^t > \theta_1 \ \& \ V_2^t > \theta_2) \\ 0 & \text{else} \end{cases}$	$S_t = \begin{cases} 1 & \text{if } (V_1^t > \theta_1 \ \& \ (V_2^t > \theta_2 \ \text{or} \ V_3^t > \theta_3)) \\ 0 & \text{else} \end{cases}$

The individual indicator series  $V_i$  are all measured as deviations from one-sided Hodrick-Prescott trends (“gaps”), calculated recursively up to time  $t$ , which is the point at which the signals are issued. The value of the smoothing parameter (lambda) for the estimation of the trend is quite high for the annual frequency of the data, 1600. The high degree of smoothing is intended to better capture the gradual and cumulative build-up of imbalances, which could be missed if the trend followed the actual data too closely.

We use multiple horizons to analyse the performance of the signals. A signal of 1 (0) is judged to be correct if a crisis (no crisis) occurs any time within the chosen horizon, ie any time within one, two or three years ahead, respectively.

Ideally, the vector of thresholds  $\theta$  would be chosen so that the indicator variables would always exceed the critical thresholds ahead of crises and never during non-crisis periods. Empirically, however, type 1 errors (no signal is issued and a crisis occurs) and type 2 errors (a signal is issued but no crisis occurs) are observed. In general, lower thresholds for  $\theta$  predict a higher percentage of crises (as more positive signals are issued), reducing the fraction of type 1 error ( $T_1$ ), but at the cost of predicting more crises that do not occur, raising the fraction of type 2 errors ( $T_2$ ). The optimal indicator has to find the right trade-off. Ultimately, this will depend on the relative costs of type 1 errors versus type 2 errors.

In this box, we explore three different approaches, which minimise different loss functions,  $L$ , with respect to the vector of thresholds,  $\theta$ :

$$\min_{\theta} [L_1] = \min_{\theta} [\alpha T_1 + (1 - \alpha) T_2] \quad (1)$$

$$\min_{\theta} [L_2] = \min_{\theta} [\text{noise - to - signal ratio}] = \min_{\theta} \left[ \frac{T_2}{1 - T_1} \right] \quad (2)$$

$$\min_{\theta} [L_3] = \min_{\theta} \left[ \frac{T_2}{1 - T_1} \mid (1 - T_1) \geq X \right] \quad (3)$$

In the first approach, we minimise the weighted sum of type 1 and type 2 errors, given different weights  $\alpha$  for type 1 and  $(1-\alpha)$  for type 2 errors. This approach would be ideal if policymakers could express their preferences based on views about their relative costs (eg Demirgüç-Kunt and Detragiache (1998)). It requires the costs to be sufficiently measurable and the preferences over them identifiable, which is hard in practice. In the second, we minimise the noise-to-signal ratio (eg Kaminsky and Reinhart (1999)), a very popular method. This in fact amounts to trading off type 1 and type 2 errors in proportion to the noise-to-signal ratio itself. The third, mixed, approach is to minimise the noise-to-signal ratio subject to predicting a minimum percentage of crises,  $X$ . For example, the thresholds chosen by Borio and Lowe (2002a,b) and Borio and Drehmann (2008) are broadly consistent with, although not formally derived from, this method, with minimum thresholds for crises predicted varying between around 60% and two thirds. Of course, if the minimum  $X$  is set to 0, this approach is equivalent to just minimising the noise-to-signal ratio.

The table below illustrates how these different approaches perform over the period used for the in-sample exercise.<sup>①</sup> To save space, we only show the results for the (cumulative) three-year horizon, ie assessing the validity of the signal depending on what happens any time within the three years following the one in which it is issued. We evaluate the indicators based on different weights for type 1 and type 2 error and different thresholds of minimum percentages of crises predicted. Some points are worth highlighting.

### Selecting the optimal indicator<sup>1</sup>

	Weight on type 1 error ( $\alpha$ )					Min N/S	At least x% of crises predicted	
	5	10	25	50	75–95 <sup>2</sup>		0%	66% <sup>3</sup>
Credit and equity gaps								
Credit ( $\theta$ )	8	6	2	2	2	8	2	2
Equity ( $\theta$ )	60	60	60	40	40	60	60	60
Predicted (%)	46	62	77	92	92	46	77	77
Type 2 error (%)	2	3	4	11	11	2	4	4
Noise/Signal	0.04	0.04	0.06	0.12	0.12	0.04	0.06	0.06
Credit and aggregate asset price gaps								
Credit ( $\theta$ )	18	18	6	6	6	18	6	6
AAP ( $\theta$ )	10–20	10–20	10	10	5	10–20	10	10
Predicted (%)	15	15	77	77	85	15	77	77
Type 2 error (%)	0.3	0.3	11	11	27	0.3	11	11
Noise/Signal	0.02	0.02	0.14	0.14	0.32	0.02	0.14	0.14
Credit and either property or equity price gaps								
Credit ( $\theta$ )	8	6	2	2	2	22–24	6	2
Property ( $\theta$ )	40–50	40–50	25	30–50	30–50	10–25	25	40–50
Equity ( $\theta$ )	60	60	60	40	40	20–150	60	60
Predicted (%)	46	62	85	92	92	8	69	77
Type 2 error (%)	2	3	6	11	11	0	4	4
Noise/Signal	0.04	0.04	0.07	0.12	0.12	0.00	0.06	0.06

<sup>1</sup> The estimation period is 1980–2003. The figures refer to the cumulative three-year horizon. N/S = noise-to-signal ratio; AAP = aggregate asset price index. The thresholds  $\theta$  shown are optimal with respect to the criteria listed in the rows of the table. The first set weighs type 1 errors (no signal issued but crises occurred) as indicated, with the corresponding weight on type 2 errors (signal issued but no crises occurred) equal to 1 minus the weight on type 1 error. The second minimises the noise-to-signal ratio. The third minimises the noise-to-signal ratio conditional on at least x% of the crises being predicted. <sup>2</sup> The results are the same for this range of weights. <sup>3</sup> Relative to the minimum of 75% of crises predicted, the 66% minimum is binding only in the case of the indicator that disaggregates property and equity prices.

Sources: National data; authors' calculations.

First, as expected, the more concerned a policymaker is about missing crises (type 1 error), the lower are the critical thresholds to be crossed before signalling crises and the noisier the indicators become. The noise can be quite high. For example, if the policymaker puts at least 75% weight on type 1 error, the corresponding indicators pick between 85 and over 90% of the crises, but with a noise-to-signal ratio in the range of 12 to 32%. This means that even more than one in four signals can be incorrect. In fact, the table above shows that the noise-to-signal ratio can be cut by half while still predicting an acceptable number of crises (see below).

Second, at the other end of the spectrum, minimising the noise-to-signal ratio generally results in an unacceptably low percentage of crises predicted. The percentage of crises predicted is as low as 8 and 15% for two of the indicators, with a noise-to-signal ratio never exceeding 0.04 and being effectively 0 in the case of the indicator that includes both the property and equity price gaps.

On balance, minimising the noise-to-signal ratio subject to at least two thirds of the crises being correctly predicted appears to provide a good compromise and is our preferred criterion.

Depending on the indicator, the noise-to-signal ratio is reduced by at least half compared with assigning a 75% weight to type 1 error. Raising the bar further by setting a floor of at least three quarters of crises predicted has very little effect on the performance of the indicators. The noise-to-signal ratio increases only for the indicator which disaggregates property and equity prices (and beyond the level of accuracy shown in the table). In this case, however, we feel there may be a risk of “overfitting”, given the exceptional performance of the indicators despite the very ambitious floor. If so, better in-sample performance could be gained at the expense of out-of-sample predictive power.

At the same time, the strict statistical approach used in the table can provide a spurious degree of precision. We observe only 13 crises in our sample of 18 countries. This implies that capturing one more crisis increases the percentage of crises predicted by as much as 7.7 percentage points. As non-crisis periods far outnumber crises, percentage changes in type 2 errors are far smaller per observation. Generally, type 2 errors are minimised by higher thresholds. Therefore, a mechanical optimisation procedure implies that any “optimal” indicator will be just at the tipping point of indicating one more crisis: this ensures a given number of predicted crises with the lowest percentage of type 2 errors. Policymakers should keep this in mind and not focus on specific thresholds but look at broad ranges, especially given the concern with out-of-sample performance. This is what we do in the analysis in the main text.

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<sup>Ⓞ</sup> The optimisation procedure was run using a grid search with a relatively coarse grid. Incremental changes for credit are set at 2, for asset and property at 5 and for equity at 10, so as to avoid misleadingly precise numbers. A different grid will lead to different thresholds. However, as shown in Table 2 in the main text, the performance of the indicators across a range of thresholds is very robust.

## The indicators: recent performance

We now explore formally the performance of various versions of the leading indicator. We first calibrate them in sample, from 1980 to 2003, and then perform an out-of-sample exercise for the years 2004 to 2008.

We consider three versions of the indicator (see the box for a technical description). All of them include a credit gap, but differ in terms of the asset prices included. The first version includes only equity prices as originally specified by Borio and Lowe (2002a,b). The second aggregates equity, commercial and residential property prices based on some rough estimates of their shares in private sector wealth – an aggregate asset price index (Borio et al (1994)). The third splits equities out, but aggregates the two types of property prices. In this case, a signal is issued if the credit gap exceeds the critical threshold together with either the equity or the property price gap. Following previous work, when equities are included separately, the corresponding gap is lagged two periods, in order to take into account the fact that they peak well ahead of a crisis.<sup>7</sup>

Because of limitations in the availability of property prices, the sample covers only 18 industrial countries.<sup>8</sup> A gap is only calculated if at least 10 years of data are available before any prediction is made. This is why the period used for the in-sample calibration of the thresholds is only from 1980

Original indicators extended to incorporate property prices with benefit of more data

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<sup>7</sup> Equities are not lagged in the aggregate asset price index because the index is seen as a simple measure of aggregate private wealth.

<sup>8</sup> Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States. Property price indices for residential and commercial property are available for most countries only from 1970 onwards.

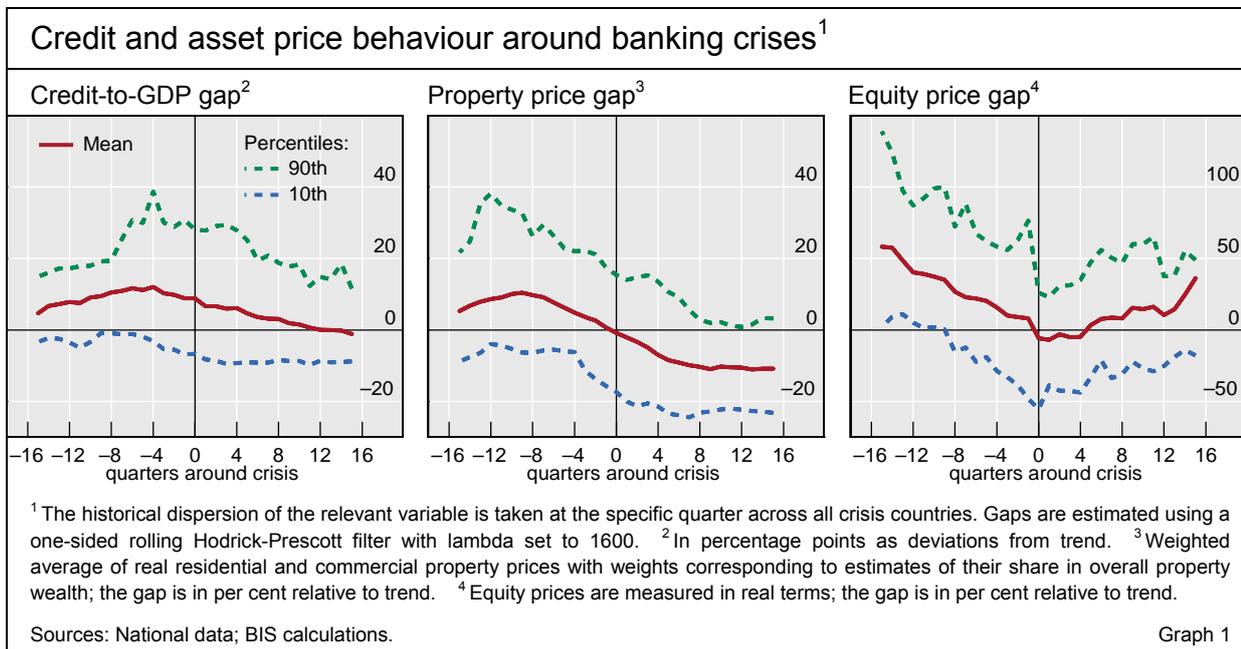
until 2003. In this period, 13 crises occur. The identification and timing of banking crises is based on Borio and Lowe (2002a), who draw on Bordo et al (2001),<sup>9</sup> and extended based on Laeven and Valencia (2008). The data are annual.

Technical features of the indicators

We pay particular attention to the criterion for the choice of “optimal” indicator (see box). Rather than minimising the noise-to-signal ratio per se, we explore different criteria for optimality. The reason is that policymakers may assign more weight to the risk of missing crises (type 1 error) than calling those which do not occur (type 2 error) as the costs of the two differ. Below we initially present our preferred choice: minimising the noise-to-signal ratio subject to predicting at least three quarters of the crises. In our view, given how the indicator behaves, this provides a good balance between identifying costly crises and missing them, without being too ambitious. But we then explore the robustness of the resulting thresholds by checking their sensitivity to specific choices and focus more on ranges.

The use of a flexible horizon means that we consider the performance of the indicator over multiple ones. Specifically, a signal that points to a crisis is judged to be correct if a crisis occurs any time within three possible horizons, namely within one, two and three years ahead, respectively. We therefore expect the performance to improve as the (cumulative) horizon is lengthened.<sup>10</sup>

Before the performance of the indicators is discussed, Graph 1 illustrates



<sup>9</sup> Following Borio and Lowe (2002b), and in contrast to Borio and Lowe (2002a) and to the crises identified by Bordo et al (2001), we added two serious financial stress episodes in the United Kingdom and United States in the early 1990s. These are intended to capture severe financial strains experienced in these economies at the time.

<sup>10</sup> We consider only the first year of any given crisis: correctly predicting a crisis in its second year would be too late; moreover, signals are not designed to predict the length of crises. Technically, we do not use any signals that are issued during the first year of the crises and for the following two years.

the empirical basis for their possible predictive ability. The graph plots the behaviour of credit, equity and property price gaps around the crisis episodes in the sample. It shows that, on average, credit, property and equity price gaps tend to be large and positive in the run-up to crises. In addition, the property and equity price gaps peak well before the crisis, with those of equity prices peaking before property prices and being much larger. By contrast, the credit gap exhibits more inertia. At the same time, there is considerable dispersion around this central tendency.

### *In-sample performance*

The core in-sample results are shown in Tables 1 and 2. Table 1 indicates the performance of the three indicators based on our preferred optimisation criterion. Table 2 explores the sensitivity of the performance to a range of thresholds.

The general performance of the indicators is quite good, confirming previous work. At the three-year (cumulative) horizon, between 69 and 77% of the crises are predicted with a noise-to-signal ratio ranging from 6 to some 14% (Table 1). This means that, for every 20 signals issued, between one and three incorrectly point to a crisis. By construction, the performance tends to improve as the valid horizon over which a crisis may occur is lengthened, as the noise-to-signal ratio necessarily falls.<sup>11</sup>

In-sample performance of the optimal indicators, 1980–2003 <sup>1</sup>									
Horizon (years)	Credit >2 & Equity >60 <sup>2</sup>			Credit >6 & AAP >10 <sup>2</sup>			Credit >6 & (Property >25 or Equity >60) <sup>2</sup>		
	Pred (%) <sup>3</sup>	Type 2 error (%)	Noise/Signal	Pred (%) <sup>3</sup>	Type 2 error (%)	Noise/Signal	Pred (%) <sup>3</sup>	Type 2 error (%)	Noise/Signal
1	46	7	0.16	54	14	0.27	46	6	0.13
1, 2	62	5	0.09	69	12	0.18	62	5	0.08
1, 2, 3	77	4	0.06	77	11	0.14	69	4	0.06

<sup>1</sup> Optimal indicators are chosen based on minimisation of the noise-to-signal ratio conditional on capturing at least two thirds of the crises over a cumulative three-year horizon (see box). A signal is correct if a crisis occurs in any of the years included in the horizon ahead. The noise is measured by the wrong predictions within the same horizon. <sup>2</sup> All variables are measured as gaps, ie as percentage point (credit-to-GDP ratio) or as percentage deviation (asset price indices) from an ex ante (one-sided), recursively calculated Hodrick-Prescott trend with lambda set to 1600. Numbers that follow the sign ">" indicate the critical threshold. Credit is the ratio of private sector credit to GDP. Equity is the (real) equity price (stock market) index, lagged by two periods. AAP is the (real) aggregate asset price index, which combines equity prices and residential property and commercial property prices based on rough estimates of their shares in private sector wealth. Property is the price index that combines residential and commercial property prices, based on the weights used in the AAP. <sup>3</sup> Percentage of crises predicted (1 minus type 1 error).

Sources: National data; authors' calculations. Table 1

<sup>11</sup> Closer examination reveals that a number of these signals are "wrong" only in the sense that the indicators *start* going on too early, ie they signal a crisis which will materialise in four to five years. Similarly, the percentages of crises predicted over a one-year horizon tend to be rather low compared with those over longer ones. The reason is precisely that the indicators are designed to identify risks of distress during boom conditions, and before crises emerge asset prices gaps narrow as asset prices soften, possibly switching signals off. These observations indicate that the indicators' lead is quite long. Moreover, they also suggest that, if so desired, calibration could be quite successful also starting the valid interval of prediction not one, but as far as three years ahead, as done in Borio and Lowe (2004), where the relevant interval is three to five years ahead.

Sensitivity of the indicators to different thresholds									
Horizon (years)	Predicted <sup>1</sup>			Type 2 error			Noise-to-signal ratio		
	Mean <sup>2</sup>	Min <sup>2</sup>	Max <sup>2</sup>	Mean <sup>2</sup>	Min <sup>2</sup>	Max <sup>2</sup>	Mean <sup>2</sup>	Min <sup>2</sup>	Max <sup>2</sup>
Credit (4–6) & Equity (40–60) <sup>1</sup>									
1	47	38	54	7	4	10	0.15	0.10	0.19
1, 2	62	54	69	6	3	9	0.10	0.06	0.13
1, 2, 3	69	62	77	6	3	8	0.08	0.04	0.11
Credit (4–6) & AAP (5–10) <sup>1</sup>									
1	63	54	77	18	14	23	0.28	0.26	0.30
1, 2	75	69	77	16	13	21	0.22	0.18	0.28
1, 2, 3	77	77	77	15	11	20	0.19	0.14	0.26
Credit (4–6) & (Property (15–25) or Equity (40–60)) <sup>1</sup>									
1	56	46	62	10	6	15	0.18	0.12	0.25
1, 2	71	62	77	9	5	14	0.12	0.08	0.18
1, 2, 3	72	69	77	8	4	13	0.11	0.06	0.18
<sup>1</sup> Percentage of crises predicted (1 minus type 1 error). <sup>2</sup> Mean, minimum and maximum of the percentage of crises predicted, type 2 error (in per cent) and the corresponding noise-to-signal ratio if the thresholds for the indicator vary between the numbers in brackets.									
Sources: National data; authors' calculations.								Table 2	

In-sample, indicators show strong performance ...

Across the different types of indicator, the picture varies somewhat. In sample, the credit-cum-equity indicator performs remarkably well. At a three-year horizon, it captures the highest percentage of crises (77%) with the lowest noise-to-signal ratio (6%). Separating out property prices, however, improves the performance slightly at the one- and two-year horizons. The aggregate asset price index is not as good as the other two indicators. It performs better at shorter horizons only if a high value is attached to predicting crises correctly at the expense of issuing wrong positive signals. This probably reflects the loss in predictive content that results from not lagging equity prices once they are aggregated with property.

... and are robust to different specifications

The performance of the indicators is quite robust to the specific choice of the threshold (Table 2). For example, for the disaggregated indicator, ranges that vary between as far as 4 and 6 (credit), 15 and 25 (property) and 40 and 60 (equities) yield a range of crises predicted between 69 and 77% over a three-year horizon, with an average noise-to-signal ratio of 0.11, varying from 0.06 to 0.18.<sup>12</sup> This is encouraging for policy purposes, in the sense that the success of the indicator does not hinge on very specific combinations of thresholds. In assessing the out-of-sample performance, therefore, we will consider these ranges rather than taking particular point estimates of the thresholds too literally (see also the box).

<sup>12</sup> Similarly, calibrating the thresholds so as to optimise the performance of the indicator over a cumulative two-year horizon, instead of the three-year one as shown in Table 1, changes the specific thresholds but has little impact on the performance (not shown).

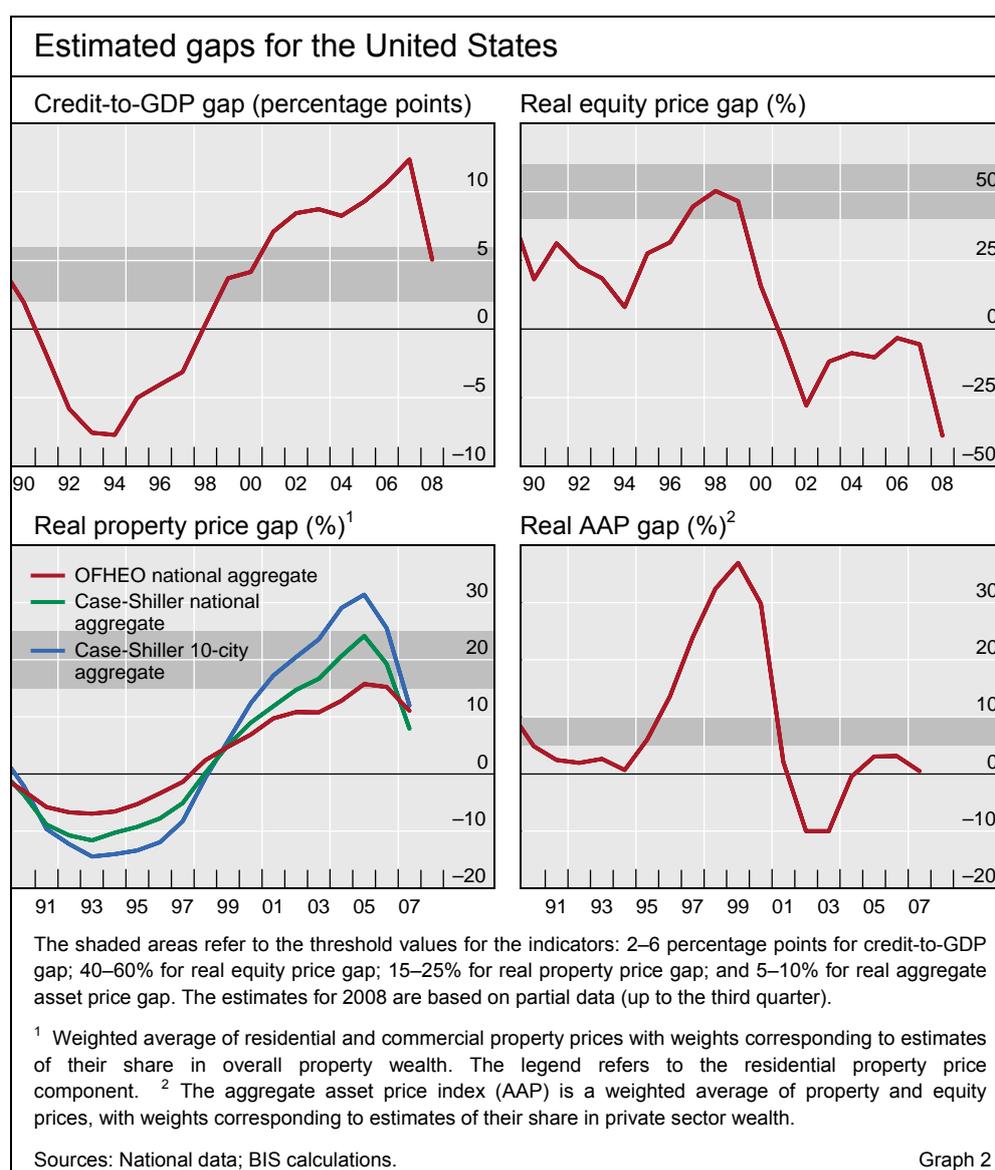
### Out-of-sample performance

How do the indicators perform out of sample, from 2004 to 2008? We explore this question in two steps. First, we consider the United States, the epicentre of the current crisis and one where financial distress has been particularly acute. It would be problematic if the indicators failed to issue warnings for that country. We then assess their performance across countries.

#### (i) The case of the United States

Graph 2 plots the behaviour of the various gaps for the United States, together with the discussed ranges for the thresholds. While the credit gap indicates a potential build-up of vulnerabilities at least as early as 2001, when it crosses the relatively strict threshold of 6%, the performance of the overall indicator varies depending on how asset prices are treated.

The graph indicates that those indicators that rely on equity prices on their own would have failed to signal the build-up of risks. Admittedly, if calibrated on pre-2000 data, the indicator would have given some warnings of the



The indicators that disaggregate property prices signal rising risks before the current crisis in the United States ...

impending strains and recession associated with the dotcom bust.<sup>13</sup> But the bust, despite the subsequent recovery, undermines the information content of the gap in the more recent period. Moreover, the weight of equity prices in the aggregate asset price index is such that the same shortcomings are transferred to the corresponding indicator.

By contrast, the graph suggests that the indicator that treats equity and property prices separately would have picked up the vulnerabilities. How early depends on the specific thresholds and property price series used (shaded area in the graph).<sup>14</sup> Signs of financial imbalances began to emerge as far back as the beginning of the century, as both the credit gap and the property price gap started to exceed indicative thresholds jointly. If the residential component of the property price index is measured by the Case-Shiller 10-city index, the strictest criterion, which has the property price gap exceeding 25%, is met as early as 2004. On the other hand, if the much less variable OFHEO index is used, the property price gap peaks at nearly 16% in 2005.

(ii) *The cross-country experience*

Extending the out-of-sample exercise to all the industrial countries in our sample is harder to perform at this early stage, in the midst of the crisis. At least two problems arise. First, given that the flexible horizon extends up to three years, we can only fully assess the predictive content of the signals issued in 2005; for subsequent ones, the full horizon has not yet materialised. This is an issue whenever banking distress has not yet emerged. Second, and more importantly, defining which country is in distress can be ambiguous. The datasets that identify the crises used in sample have not as yet been extended to cover the recent episode.

To address the ambiguity in the identification of the crisis, we adopt two definitions, going from the more to the less restrictive:

Definition 1: Countries where the government had to inject capital in more than one large bank and/or more than one large bank failed.

Definition 2: Countries that undertook at least two of the following policy operations: issue wholesale guarantees; buy assets; inject capital into at least one large bank or announce a large-scale recapitalisation programme.

Which definition of distress is more appropriate? Definition 1 may be too narrow, and definition 2 too broad as it may include cases where measures are only announced as a precaution or in response to policies adopted in other countries. The extension of guarantees to prevent a drain of funding in the

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<sup>13</sup> This is based on the thresholds highlighted in the original Borio and Lowe (2002a) study, on a different sample of countries and different period, ending before 2000. Technically, if taken literally, the indicator was very close, but did not quite issue a full signal. While the equity gap, at 46.6, did indeed breach the threshold of 40, the credit gap reached 3.7, slightly below 4.

<sup>14</sup> The in-sample results indicated in the table use the Case-Shiller national home price index extended backwards with the OFHEO national aggregate house price index using the first common period link method. We examined the sensitivity of these in-sample results to the choice of these two indices as well as to the Case-Shiller 10-city index and found that they were quite robust, resulting only in very small changes in the noise-to-signal ratio.

domestic market is an obvious such example. For instance, it might be argued that, so far, despite the measures taken, the actual strains faced in Australia, Canada and Italy have been quite mild. Together, however, the two definitions encompass a reasonable range.

By the end of January 2009, based on definition 1, seven countries had faced a crisis: the United States, the United Kingdom, Belgium, France, Germany, Ireland and the Netherlands. Based on definition 2, 14 out of the 18 countries had faced distress: the ones just mentioned plus Australia, Canada, Denmark, Italy, Spain, Sweden and Switzerland. In all countries, the criteria for a crisis are fulfilled only in 2008.<sup>15</sup>

As in the case of the United States, the indicators based exclusively on credit and equity prices fail to issue warning signals (not shown in the table). The likely reason is the longer lag between peaks in equity and property prices compared with the experience in sample. In sample, equity prices typically peaked two years before property prices (BIS (1993), Borio and McGuire (2004)). Using equity prices, with the appropriate lead, could thus also partially proxy for them.<sup>16</sup> In the current episode, however, equity prices peaked in the early 2000s and property prices peaked around 2006 or later. In the late 1980s, the time of the previous property boom in industrial countries, monetary policy had to be tightened in several countries in order to fight emerging inflation pressures, thereby triggering the reversal in property prices. This was not the case in more recent years, as inflation pressures remained subdued until at least 2006.

... as well as in a number of other countries

Not surprisingly, the performance of the indicator that includes also the property price gap is encouraging, although far from perfect (Table 3).<sup>17</sup> The variant of the indicator based on the lowest threshold for property prices (15%) performs best; that based on the top of the range (25%) appears too strict. The lower bound predicts over 50% of the crises, regardless of the definition; the higher bound only the one in the United States, and based on the Case-Shiller 10-city index. Inevitably, not least given the small sample, the noise-to-signal ratios increase substantially compared with the in-sample estimates.<sup>18</sup>

A look behind the aggregate numbers is instructive. Using definition 2, three false positive signals are issued: for Finland, Norway and New Zealand.

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<sup>15</sup> The exception is Denmark, where some measures were taken only in January 2009. For present purposes, we treat them as if they had been taken in 2008.

<sup>16</sup> Moreover, as found in Borio and Lowe (2002b) for emerging market economies, a measure of (real) exchange rate appreciations could also help. The reason is that appreciations tend to go hand in hand with the capital flow surges that typically fuel property price booms.

<sup>17</sup> The performance of the indicator with the aggregate asset price index falls somewhere in between the indicators discussed.

<sup>18</sup> The increase arises for three reasons. First, for some countries signals are issued even though no crises according to the definition used have as yet materialised. Second, most type 2 errors occur for countries for which signals are issued quite early, eg in 2004, which is too early for our three-year horizon, even if the crisis eventually does materialise. Finally, given that the out-of-sample exercise only covers the period from 2004 to 2008, the number of "non-crisis" periods is very low, which can lead to large swings in the noise-to-signal ratio in response to small changes in the absolute number of type 2 errors.

Out of sample performance, 2004–08						
	Crisis definition 1 <sup>1</sup>			Crisis definition 2 <sup>1</sup>		
Horizon (years)	Predicted <sup>2</sup>	Type 2 error (%)	Noise/Signal <sup>3</sup>	Predicted <sup>2</sup>	Type 2 error (%)	Noise/Signal <sup>3</sup>
Credit >4 & (Property >15 or Equity >40)						
1	29	38	1.35	29	40	1.39
1, 2	57	36	0.63	50	36	0.73
1, 2, 3	57	35	0.62	50	33	0.67
Credit >6 & (Property >20 or Equity >60)						
1	0	18	–	7	19	2.66
1, 2	29	17	0.60	29	16	0.56
1, 2, 3	29	18	0.62	29	17	0.47
Credit >6 & (Property >25 or Equity >60)						
1	0	6	–	0	7	–
1, 2	14	5	0.36	7	7	0.95
1, 2, 3	14	4	0.27	7	7	0.93
<sup>1</sup> Crisis definition 1: Countries where the government had to inject capital in more than one large bank and/or more than one large bank failed (seven crises). Crisis definition 2: Countries that undertook at least two of the following policy operations: issue wholesale guarantees; buy assets; inject capital into at least one large bank or announce a large-scale recapitalisation programme (14 crises). Signals are assessed over a three-year horizon. <sup>2</sup> Percentage of crises predicted (1 minus type 1 error). <sup>3</sup> If no crisis is predicted, the noise-to-signal ratio cannot be calculated.						
Sources: National data; authors' calculations.						Table 3

The latter two countries have already taken extra policy measures to enhance financial stability, but without meeting the criteria of our definitions.<sup>19</sup>

However, they do not signal potential vulnerabilities emerging from cross-border exposures ...

By contrast, the countries that are missed, based on the lower bound of the range, are Germany and the Netherlands (definitions 1 and 2) as well as Switzerland and Canada (definition 2). The indicator does not capture these cases as banks have run into trouble as a result of losses on their international exposures in the absence of clear signs of financial imbalances in the domestic economy. This is no surprise, since by construction the indicator assumes that banks in any given country are exposed only to the financial cycle in that country.

On balance, these findings suggest that the recent credit crisis confirms the usefulness of this type of indicator. At the same time, they point to some of its limitations and the potential scope for improvement. A key limitation is its failure to consider cross-border exposures, to which we turn next.

### The indicators: cross-border exposures

One possible way of incorporating the risks arising from the cross-border exposures of a banking system whilst maintaining the underlying logic of the

<sup>19</sup> New Zealand introduced retail as well as wholesale guarantees, and Norway introduced a programme allowing banks to swap collateralised debt obligations for government securities.

indicator is the following.<sup>20</sup> First, establish the geographical distribution of the foreign exposures of the institutions in the system. Second, calculate the preferred indicator(s) for the countries to which those institutions are exposed. Check if a signal is issued (the value of the indicator is 1), or not (the value is 0). Third, calculate a weighted average of the indicator (0 or 1) for the overall balance sheet exposure, including that to the domestic market. The resulting number, which varies between 0 and 1, is an index of the riskiness of the overall portfolio. A value of 1 would indicate that all the exposures of a banking system are to countries for which the indicator signals future banking distress; a value of 0, that none is. Finally, if the data went back sufficiently in time and covered a sufficient number of crises, one could go one step further. It would in turn be possible to calculate critical thresholds for this derived index, and seek to predict crises along similar lines as before.<sup>21</sup>

Ideally, this exercise would be performed based on individual bank data and a full picture of the exposures. In practice, this is not possible except for national supervisors, as this type of information is not publicly available. The BIS international banking statistics, however, can provide useful information at the national banking system level. The data are drawn from the consolidated banking statistics, which capture the exposures of reporting banks to counterparties, regardless of the location of the office from which the funds are provided. These data include a counterparty breakdown (interbank, public sector, non-bank private sector) and therefore allow different possible aggregations.

... which can partly be captured by the BIS international banking statistics

There are two main drawbacks of any such exercise, combining as it does the BIS statistics with other data sources. First, the BIS statistics include information on reporting countries as counterparties only since 1999. This implies that the consolidated exposures to industrial countries are available only as from that date. More importantly, because of limitations on the availability of property prices, the indicator of domestic financial imbalances cannot be constructed for most of the countries outside our sample, which includes emerging market economies. This means excluding those foreign exposures from the analysis.

As a result, at this stage we can only perform an indicative exercise. We can calculate the weighted average of the riskiness of foreign exposures of a given banking system in the years just prior to the crisis, but are unable to estimate the critical values of the index. Moreover, that weighted average is not complete, as we are unable to construct a leading indicator of banking distress for a varying, at times sizeable, portion of the foreign exposures.

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<sup>20</sup> Another dimension of the cross-border exposures is direct cross-border lending *into* a given country. The figures that we have used in this feature are based on national statistics. As such, they only include lending by institutions *located* in a given country. The BIS statistics could also be used to remedy this deficiency. We leave this potential improvement to future work.

<sup>21</sup> An alternative to this two-step procedure would be to estimate the thresholds specific to a given banking system in one go, based on the information of the geographical distribution of its exposures.

Table 4 summarises the results of the exercise. The left-hand side of the table provides a weighted average of the riskiness of the foreign exposures, based on two representative thresholds of the disaggregated indicator that incorporates property prices. It also indicates the percentage of foreign exposures covered. The right-hand side includes an estimate of the riskiness of the domestic portfolio, with its size approximated by the private sector domestic credit aggregate used in the previous analysis.<sup>22</sup> It also shows the weight of the foreign exposures in the overall portfolio.

Two points stand out. First, the riskiness of the cross-border exposures of the banking systems for which the indicator failed to predict crises in the previous analysis is considerably higher than that of their domestic ones. This partly helps to explain the financial strains incurred in those systems. For example, the ranges for the index of foreign exposures for Germany and

Indicators weighted by domestic and international exposures <sup>1</sup>						
	Foreign <sup>2</sup>			Foreign plus domestic <sup>3</sup>		
	Credit >4 & (Property >15 or Equity >40)	Credit >6 & (Property >20 or Equity >60)	% of foreign portfolio captured	Credit >4 & (Property >15 or Equity >40)	Credit >6 & (Property >20 or Equity >60)	Foreign as % of total portfolio captured
Belgium	0.62	0.36	81	0.32	0.18	48
Canada	0.89	0.69	84	0.14	0.11	14
Germany	0.79	0.46	78	0.30	0.18	34
France	0.59	0.38	78	0.87	0.82	27
Ireland	0.77	0.27	88	0.94	0.11	43
Italy	0.35	0.21	62	0.05	0.03	14
Japan	0.79	0.65	73	0.14	0.11	15
Netherlands	0.67	0.44	84	0.31	0.21	43
Norway	0.73	0.47	67	0.98	0.03	6
Spain	0.78	0.28	69	0.97	0.87	15
Sweden	0.60	0.31	80	0.87	0.77	27
Switzerland	0.80	0.61	77	0.48	0.40	47
United Kingdom	0.68	0.60	73	0.92	0.26	32
United States	0.54	0.14	63	0.99	0.98	3

<sup>1</sup> Sum of indicators corresponding to the country to which the banks headquartered in the country shown in the table are exposed, weighted by the share of the exposure in the portfolios indicated (foreign and foreign plus domestic). Indicator is 1 if thresholds were exceeded in any of the years 2005 to 2007 in a particular country. <sup>2</sup> Foreign claims are cross-border claims plus locally booked claims in all currencies on residents of a given country. Only claims on banks and the non-bank private sector considered. <sup>3</sup> Domestic and foreign claims on non-bank private sector.

Sources: BIS; authors' calculations. Table 4

<sup>22</sup> In technical terms, the "foreign" index of riskiness  $FIR_i$  for country  $i$  is  $FIR_i = \sum_{j \neq i} (E_j * S_j / \sum_j E_j)$ , where  $S_j$  is the signal in country  $j$  and  $E_j$  are all cross-border claims vis-à-vis country  $j$  plus locally booked claims in all currencies on residents of country  $j$ . All foreign claims are on an ultimate risk basis, and only claims on banks and the non-bank private sector are considered. The combined "foreign and domestic" index  $FDIR_i$  is constructed as  $FDIR_i = [\sum_{j \neq i} (E_j * S_j / (\sum_j E_j + D_i)) + D_i * S_i / (\sum_j E_j + D_i)]$ , where  $S_j$  and  $E_j$  are defined as in the case of  $FIR$  except that  $E_j$  only takes account of foreign claims on the non-bank private sector, in order to increase the comparability of the figures as no information on domestic interbank exposures is available.  $S_i$  is the signal in the home country and  $D_i$  is domestic credit to the non-bank private sector. For a more detailed description of the international banking statistics, see McGuire and Wooldridge (2005).

Switzerland are 0.46–0.79 and 0.61–0.80, respectively, depending on the thresholds chosen. For Switzerland, in particular, this raises the index for overall exposures from 0 to nearly 0.5; the impact on Germany is lower, owing to the smaller relative weight of cross-border assets. Second, for most banking systems in the sample the riskiness of foreign exposures is quite high. This suggests that ignoring them could miss a significant source of vulnerabilities. One exception is Italy (0.21–0.35). For that country, however, we only capture a comparatively low percentage of cross-border exposures (slightly above 60%), most of which is to Germany.

## Conclusion

This special feature suggests that it is possible to build relatively simple indicators that can help inform assessments of the build-up of risks of future banking distress in an economy. These indicators are based on the coexistence of unusually strong and protracted increases in credit and asset prices. We find that they perform reasonably well also out of sample, as indicated by their ability to point to potential banking distress ahead of the current crisis.

At the same time, a number of caveats should be borne in mind. First, the analysis confirms the critical role of judgment. And for some, this role may be uncomfortably large. The out-of-sample performance is not an unqualified success. The indicators would have failed in recent years had they been based exclusively on equity prices, which perform so well in sample. The extension to property prices is essential for the current episode. Similarly, we caution against deciding on “optimal” performance in sample purely based on strict statistical criteria, without acknowledging the “fuzzy” nature of the exercise. This, too, could have failed to identify the risks correctly. For policy purposes, we support the use of ranges rather than point thresholds. Second, a full assessment of the indicators’ performance will require more time, as the current financial strains are still unfolding.

The indicators could be improved in several dimensions. First, one could seek to incorporate cross-border exposures more systematically. While the BIS international banking statistics can be helpful, they do not provide a complete picture. This would require specific data collection efforts at the national level. Similarly, considering the information content of more global measures of credit and asset price increases, rather than country-by-country, could help to better capture the international dimension of the problems. Second, one could seek to make improvements to the individual series included. It is worth exploring how to overcome the current heterogeneity of the property price series across countries. Efforts by national authorities to improve the underlying data, in terms of both quality and historical availability, could be extremely useful. Third, the performance of further asset price series could be examined. Beyond exchange rates, as in Borio and Lowe (2002b), credit risk spreads merit particular attention: prolonged periods of unusually *low* credit risk spreads during expansion phases would signal potential stress further down the road. Finally, one could improve on the measures of “leverage” included. For

example, the indicators do not consider leverage *within* the financial system itself, which appears to have been so prominent in the current episode. We would conjecture, however, that the basic architecture of the indicators would survive. This would involve the *coexistence* of a measure of asset price misalignments with one that captures the limited shock absorption capacity of the economy and hence its “leverage”.

## References

Alessi, L and C Detken (2008): “Real time early warning indicators for costly asset price boom/bust cycles: a role for global liquidity”, paper presented at the Euro Area Business Cycle Network and CREI conference on *Business cycle development, financial fragility, housing and commodity prices*, Barcelona, 21–23 November.

Allen, F and D Gale (2000): “Bubbles and crises”, *The Economic Journal*, no 110, pp 236–56.

Bank for International Settlements (1993): *63rd Annual Report*, Basel, June.

Bordo, M, B Eichengreen, D Klingebiel and M S Martinez-Peria (2001): “Financial crises: lessons from the last 120 years”, *Economic Policy*, April.

Borio, C and M Drehmann (2008): “Towards an operational framework for financial stability: ‘fuzzy’ measurement and its consequences”, 12th Annual Conference of the Central Bank of Chile, *Financial stability, monetary policy and central banking*, Santiago, 6–7 November.

<http://www.bcentral.cl/eng/conferences-seminars/annual-conferences/2008/program.htm>

Borio, C, N Kennedy and S Prowse (1994): “Exploring aggregate asset price fluctuations across countries: measurement, determinants and monetary policy implications”, *BIS Economic Papers*, no 40, April.

Borio, C and P Lowe (2002a): “Asset prices, financial and monetary stability: exploring the nexus”, *BIS Working Papers*, no 114, July.

——— (2002b): “Assessing the risk of banking crises”, *BIS Quarterly Review*, December, pp 43–54.

——— (2004): “Securing sustainable price stability: should credit come back from the wilderness?”, *BIS Working Papers*, no 157, July.

Borio, C and P McGuire (2004): “Twin peaks in equity and housing prices?”, *BIS Quarterly Review*, March, pp 79–93.

Davis, E P and D Karim (2008a): “Comparing early warning systems for banking crises”, *Journal of Financial Stability*, vol 4, June, pp 89–120.

——— (2008b): “Could early warning systems have helped to predict the sub-prime crisis?”, *National Institute Economic Review*, vol 206(1), pp 25–37.

Demirgüç-Kunt, A and E Detragiache (1998): “The determinants of banking crises: evidence from developing and developed countries”, *IMF Staff Papers*, vol 45, pp 81–109.

——— (2005): “Cross-country empirical studies of systemic bank distress: a survey”, *IMF Working Paper*, no 05/96, May.

Kaminsky, G L and C M Reinhart (1999): “The twin crises: the causes of banking and balance-of-payments problems”, *American Economic Review*, vol 89(3), pp 473–500.

Kindleberger, C (2000): *Manias, panics and crashes*, Cambridge University Press, Cambridge, 4th edition.

Laeven, L and F Valencia (2008): “Systemic banking crises: a new database”, *IMF Working Paper*, WP/08/224.

McGuire, P and P Wooldridge (2005): “The BIS consolidated banking statistics: structure, uses and recent enhancements”, *BIS Quarterly Review*, September, pp 73–86.

Minsky, H P (1982): “Can ‘it’ happen again?”, *Essays on Instability and Finance*, Armonk: M E Sharpe.

Tarashev, N (2008): “An empirical evaluation of structural credit risk models”, *International Journal of Central Banking*, vol 4(1), March, pp 1–53. Also available as *BIS Working Papers*, no 179, July 2005.

## The US dollar shortage in global banking<sup>1</sup>

*Understanding the global financial crisis and the stresses on bank balance sheets requires a perspective on banks' international investment positions and how these positions were funded across currencies and counterparties. This special feature uses the BIS international banking statistics to identify the cross-currency and counterparty funding patterns for the largest banking systems, and to assess the causes of the US dollar shortage during the critical phases of the crisis.*

*JEL classification: F34, G01, G21.*

The current financial crisis has highlighted just how little is known about the structure of banks' international balance sheets and their interconnectedness. During the crisis, many banks reportedly faced severe US dollar funding shortages, prompting central banks around the world to adopt unprecedented policy measures to supply them with funds. How could a US dollar shortage develop so quickly after dollar liquidity had been viewed as plentiful? Which banking systems were most affected? And how have funding pressures affected lending to non-bank end users of funds?

This special feature draws on the BIS international banking statistics to provide some tentative answers to these questions. It splices together two sets of statistics to reconstruct the global balance sheet positions for each of the major *national banking systems*.<sup>2</sup> The dynamics of the crisis can then be analysed across banks' consolidated balance sheets rather than along geographical (ie residency-based) lines. With information on both the *currency* and the type of *counterparty* for banks' foreign assets and liabilities, we can investigate how banks *funded* their foreign investments, and thus can better identify the vulnerabilities that threatened the financial system.

Global banking activity had grown remarkably between 2000 and mid-2007. As banks' balance sheets expanded, so did their appetite for foreign

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<sup>1</sup> The authors thank Claudio Borio, Linda Goldberg, Már Gudmundsson, Robert McCauley, Perry Mehrling, Frank Packer and Philip Wooldridge for helpful comments, and Emir Emiray, Sebastian Goerlich and Swapan Pradhan for research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

<sup>2</sup> In the context of this special feature, a national banking system refers to the set of large internationally active banks *headquartered* in a particular country (eg US banks, German banks, Swiss banks, etc), as opposed to banks *located* in a particular country.

currency assets, notably US dollar-denominated claims on non-bank entities, reflecting in part the rapid pace of financial innovation during this period. European banks, in particular, experienced the most pronounced growth in foreign claims relative to underlying measures of economic activity.

We explore the consequences of this expansion for banks' financing needs. In a first step, we break down banks' assets and liabilities by currency to examine *cross-currency funding*, or the extent to which banks fund in one currency and invest in another (via FX swaps). After 2000, some banking systems took on increasingly large net on-balance sheet positions in foreign currencies, particularly in US dollars. While the associated currency exposures were presumably hedged off-balance sheet, the build-up of large net US dollar positions exposed these banks to *funding risk*, or the risk that their funding positions could not be rolled over.

To gauge the magnitude of this risk, we next analyse banks' *US dollar funding gap*. Breaking down banks' US dollar assets and liabilities further, by counterparty sector, allows us to separate positions vis-à-vis non-bank end users of funds from interbank and other sources of short-term funding. A lower-bound estimate of banks' funding gap, measured as the net amount of US dollars channelled to non-banks, shows that the major European banks' funding needs were substantial (\$1.1–1.3 trillion by mid-2007). Securing this funding became more difficult after the onset of the crisis, when credit risk concerns led to severe disruptions in the interbank and FX swap markets and in money market funds. We conclude with a discussion of how European banks, supported by central banks, reacted to these disruptions up to end-September 2008.

## The long and short of banks' global balance sheets

The propagation of the global financial crisis runs along the contours of banks' consolidated global balance sheets, rather than along national borders. That is, banks have become so globalised that residency-based data (eg domestic credit, or a country's external position) are insufficient for identifying vulnerabilities in the global banking system. Understanding the causes of the crisis requires measurement of banking activity at the level of the decision-making economic unit, ie an internationally active bank taking decisions on its worldwide consolidated asset and liability positions.<sup>3</sup>

While not at the level of individual banks, the BIS international banking statistics can be used to reconstruct the global balance sheet positions for specific national banking systems.<sup>4</sup> Details on how this is done are provided in the box on page 61. The advantages of this data compilation are that it provides (1) the consolidated foreign assets *and* liabilities for each banking

The BIS banking statistics track banks' funding positions

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<sup>3</sup> Bank-level information on assets and liabilities broken down by currency and type of counterparty (ie location and sector) may be available to bank examiners but is not included in publicly available sources (eg BankScope, national data).

<sup>4</sup> See Lane and Shambaugh (2008) for an examination of the international balance sheets and foreign currency exposures of particular countries.

system, (2) estimates of the gross and net positions *by currency*, and (3) information on the sources of financing (ie interbank market, non-bank counterparties and central banks). The data cover the Q2 1999 – Q3 2008 period at a quarterly frequency. While this dataset facilitates an analysis of banks' funding patterns, it is important to emphasise that the figures presented here are, at best, estimates. They provide an incomplete picture of the structure of any particular banking system, and in places are based on imperfect underlying data (see box).

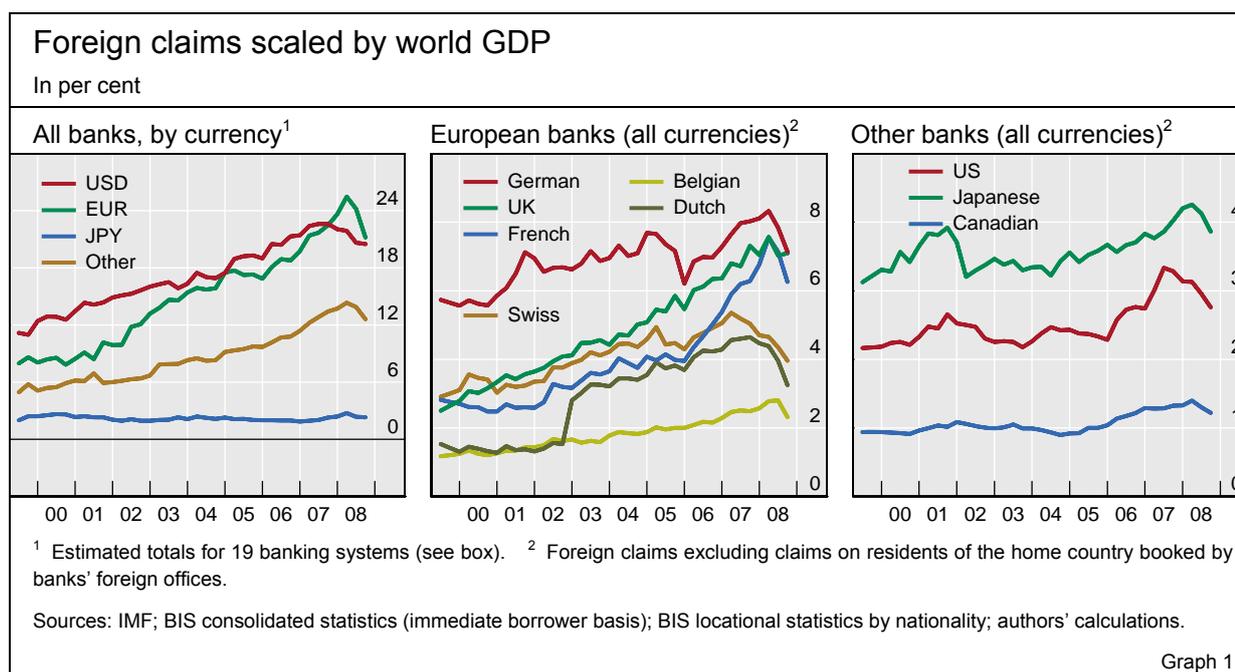
### Banks' global expansion

Banks' foreign positions have surged since 2000. The outstanding stock of BIS reporting banks' foreign claims grew from \$11 trillion at end-2000 to \$31 trillion by mid-2007, a major expansion even when scaled by global economic activity (Graph 1, left-hand panel). The year-on-year growth in foreign claims approached 30% by mid-2007, up from around 10% in 2001. This acceleration coincided with significant growth in the hedge fund industry, the emergence of the structured finance industry and the spread of "universal banking", which combines commercial and investment banking and proprietary trading activities.

At the level of individual banking systems, the growth in European banks' global positions is particularly noteworthy (Graph 1, centre panel). For example, Swiss banks' foreign claims jumped from roughly five times Swiss nominal GDP in 2000 to as much as eight times in mid-2007. Dutch, French, German and UK banks' foreign claims expanded considerably as well. In contrast, Canadian, Japanese and US banks' foreign claims grew in absolute terms over the same period, but did not significantly outpace the growth in domestic or world GDP (Graph 1, right-hand panel). While much of the increase for some European banking systems reflected their greater intra-euro area lending following the introduction of the single currency in 1999, their

Financial innovation since 2000 ...

... spurs bank balance sheet growth



estimated US dollar- (and other non-euro-) denominated positions accounted for more than half of the overall increase in their foreign assets between end-2000 and mid-2007.

### *Banks' foreign currency positions*

How did banks finance this expansion, especially their foreign currency positions? In principle, a bank can finance foreign currency assets in several ways. It can borrow foreign currency from the interbank market or from non-bank market participants or central banks.<sup>5</sup> Alternatively, the bank can use FX swaps to convert liabilities in other currencies into the desired foreign currency for the purchase of the foreign currency assets.<sup>6</sup>

This section examines *cross-currency* funding, or the extent to which banks invest in one currency and fund in another. This requires a breakdown by currency of banks' gross foreign positions, as shown in Graph 2, where positive (negative) positions represent foreign claims (liabilities). For some European banking systems, foreign claims are primarily denominated in the home country (or "domestic") currency, representing intra-euro area cross-border positions (eg Belgian, Dutch, French and German banks). For others (eg Japanese, Swiss and UK banks), foreign claims are predominantly in foreign currencies, mainly US dollars.

These foreign currency claims often exceed the extent of funding in the same currency. This is shown in Graph 3, where, in each panel, the lines indicate the overall *net* position (foreign assets minus liabilities) in each of the major currencies. If we assume that banks' on-balance sheet *open* currency positions are small, these cross-currency net positions are a measure of banks' reliance on FX swaps. Most banking systems maintain long positions in foreign currencies, where "long" ("short") denotes a positive (negative) net position. These long foreign currency positions are mirrored in net borrowing in domestic currency from home country residents.<sup>7</sup> UK banks, for example, borrowed (net) in pounds sterling (some \$800 billion, both cross-border and from UK residents) in order to finance their corresponding long positions in US dollars, euros and other foreign currencies. By mid-2007, their long US dollar positions surpassed \$300 billion, on an estimated \$2 trillion in gross US dollar claims.

Banks fund foreign  
currency  
investments ...

... by borrowing  
at home and  
converting via  
FX swaps

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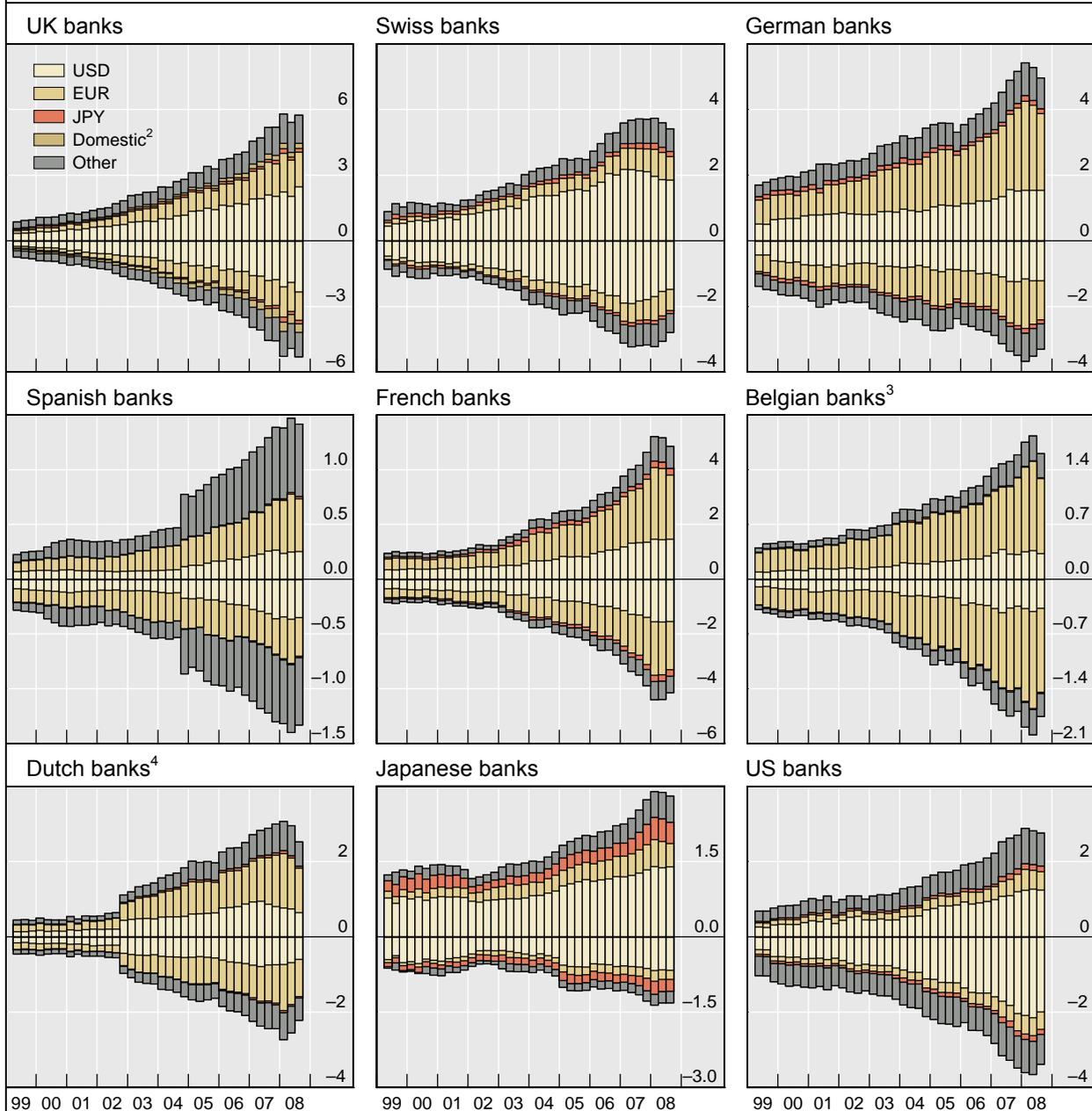
<sup>5</sup> In the BIS locational banking statistics by nationality, reporting banks' liabilities to official monetary authorities typically reflect international deposits of foreign exchange reserves in commercial banks.

<sup>6</sup> A third funding option, which produces no subsequent foreign currency needs, is to convert domestic currency through a single FX spot transaction. Doing so, however, exposes the bank to currency risk, as the on-balance sheet mismatch between foreign currency assets and domestic currency liabilities remains unhedged. Our working assumption is that banks employ FX swaps to fully hedge any on-balance sheet currency mismatch (see Stigum and Crescenzi (2007), Chapter 7).

<sup>7</sup> Banks' "strictly domestic" banking activity is not reported in the BIS banking statistics. Their *gross* positions in their domestic currency vis-à-vis home country residents are therefore unknown, but their *net position* (shown as the shaded area in Graph 3) can be inferred as a residual from the balance sheet identity (see box). German banks' foreign claims in Graph 2, for example, comprise *all* of their foreign currency positions, but their euro positions only vis-à-vis counterparties outside Germany.

## Gross foreign assets and liabilities, by currency<sup>1</sup>

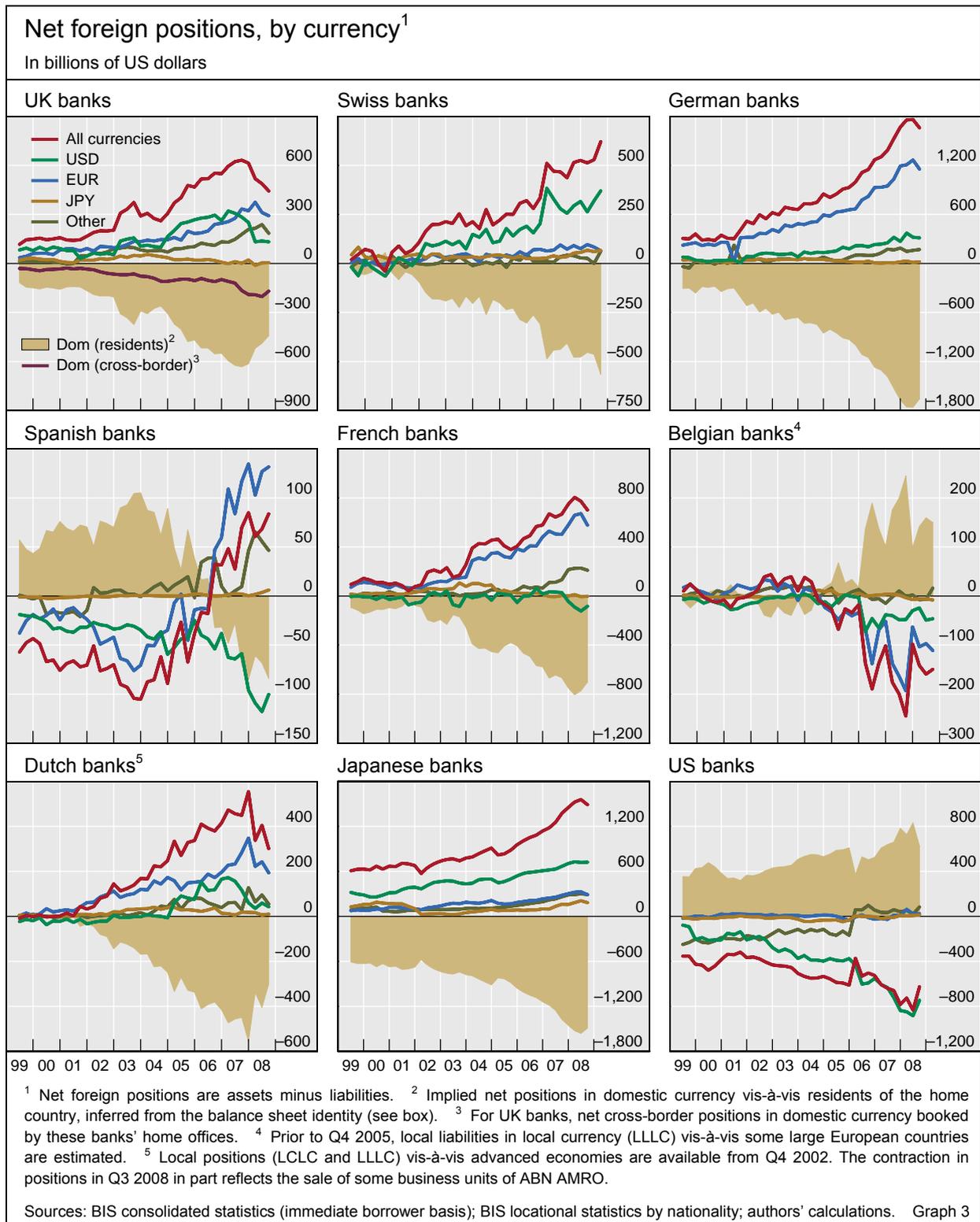
In trillions of US dollars



<sup>1</sup> Positive (negative) values are assets (liabilities). <sup>2</sup> For UK banks, gross positions in domestic currency booked by these banks' home offices. <sup>3</sup> Prior to Q4 2005, local liabilities in local currency (LLC) vis-à-vis some large European countries are estimated. <sup>4</sup> Local positions (LCLC and LLLC) vis-à-vis advanced economies are available from Q4 2002. The contraction in positions in Q3 2008 in part reflects the sale of some business units of ABN AMRO.

Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 2

Similarly, German and Swiss banks' net US dollar books approached \$300 billion by mid-2007, while that of Dutch banks surpassed \$150 billion. In comparison, Belgian and French banks maintained a relatively neutral overall US dollar position prior to the crisis, while Spanish banks had borrowed US dollars to finance euro lending at home, at least until mid-2006.



Taken together, Graphs 2 and 3 thus show that several European banking systems expanded their long US dollar positions significantly after 2000, and funded them primarily by borrowing in their domestic currency from home country residents. This is consistent with European universal banks using their retail banking arms to fund the expansion of investment banking activities, which have a large dollar component and are concentrated in major financial

centres. In aggregate, European banks' combined long US dollar positions grew to more than \$800 billion by mid-2007 (Graph 5, top left-hand panel), funded by short positions in pounds sterling, euros and Swiss francs. As banks' cross-currency funding grew, so did their hedging requirements and FX swap transactions, which are subject to funding risk when these contracts have to be rolled over.

#### *Maturity transformation across banks' balance sheets*

From the perspective of financial stability, a key metric of interest is the extent to which banks engage in *maturity transformation*. A sudden inability to roll over their short-term funding positions will require that banks "deliver" foreign currency, which may force them to sell or liquidate assets earlier than anticipated, typically in distressed market conditions ("distress selling").<sup>8</sup> Unfortunately, data limitations make it difficult to obtain an aggregate maturity profile of banks' foreign assets and liabilities. However, the counterparty sector breakdown available in the BIS banking statistics may serve as a rough proxy for maturity transformation, and hence funding risk, since the maturity of positions is likely to vary systematically with the type of counterparty. We use this counterparty information to construct a measure of banks' *US dollar funding gap*, or the amount of US dollars invested in longer-term assets which is not supported by longer-term US dollar liabilities, this gap being the amount that banks must roll over before their investments mature. We build up this argument in several steps.

Counterparty sector  
can proxy for  
maturity

The counterparty sector breakdown for European banks' gross US dollar assets and liabilities is shown in Graph 5 (top right-hand panel). Interbank claims, which include interbank loans and debt securities, tend to be shorter-term or can be realised at shorter notice than claims on non-banks. We think of US dollar claims on non-banks as banks' desired US dollar investment portfolio, which includes their retail and corporate lending, and lending to hedge funds, as well as holdings of securities, ranging from US Treasury and agency securities to structured finance products.<sup>9</sup> Whether these non-bank assets can be readily converted to cash depends upon the maturity of the underlying positions as well as on their market liquidity.

These US dollar investments are funded by liabilities to various counterparties. Banks can borrow US dollars directly from the interbank market. They also raise US dollars via FX swaps (with bank or non-bank

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<sup>8</sup> Banks also face risks inherent in transforming maturities in their domestic currency alone. However, in a purely domestic banking context the central bank can act as lender of last resort. By contrast, *foreign currency* funding needs may have to be met from sources abroad.

<sup>9</sup> No counterparty sector breakdown is available for banks' US dollar claims on US residents booked by their offices in the United States (LCLC and LLLC or "Local US positions" in Graph 5, top right-hand panel). However, alternative sources of data indicate that the bulk of these positions is likely to be transactions with *non-bank* counterparties. For instance, BankScope data suggest that European bank subsidiaries in the United States book a small share (below 5%) of their total assets as interbank assets. Data on foreign banks' offices in the United States from the Federal Reserve H.8 release point in the same direction. Thus, our estimate of US dollar positions vis-à-vis non-banks (in Graphs 4 and 5) is the sum of banks' *international* US dollar positions in non-banks and their local US positions.

counterparties), which are even shorter-term on average.<sup>10</sup> In contrast, US dollar funding provided directly by non-banks includes corporate and retail deposits, as well as financing from money market funds, and is thus of varying maturities. If banks' liabilities to non-banks were *all* short-term, then an upper-bound estimate of banks' US dollar funding gap is their *gross* US dollar investment position in non-banks. If, on the other hand, the effective maturity of liabilities to non-banks matches that of their investments in non-banks, then a lower-bound estimate of their funding gap is the *net* position vis-à-vis non-banks. Below we focus on this latter measure.

As shown in Graph 4, there is considerable heterogeneity in the way European banks met their US dollar funding requirements. For example, Dutch, German, Swiss and UK banks had the largest funding gaps by mid-2007 (green line). However, their reliance on the interbank market (blue line), central bank deposits (red line) and FX swaps (shaded area) differed markedly.<sup>11</sup> UK banks maintained largely balanced net interbank US dollar positions, thus implying cross-currency funding, while German banks relied relatively more on interbank funding.

Taken together, these estimates suggest that European banks' US dollar investments in non-banks were subject to considerable funding risk. The net US dollar book, aggregated across the major European banking systems, is portrayed in Graph 5 (bottom left-hand panel), with the non-bank component tracked by the green line. By this measure, the major European banks' US dollar funding gap reached \$1.1–1.3 trillion by mid-2007.<sup>12</sup> Until the onset of the crisis, European banks had met this need by tapping the interbank market (\$400 billion) and by borrowing from central banks (\$380 billion),<sup>13</sup> and used FX swaps (\$800 billion) to convert (primarily) domestic currency funding into dollars.

The funding patterns for Japanese and US banks in Graph 4 deserve comment as well. Japanese banks' estimated net US dollar claims on non-banks rose beyond \$600 billion by end-2007 and, compared with other banking

Funding patterns ...

... differ across banking systems

<sup>10</sup> Evidence from the BIS Triennial Central Bank Survey (2007) indicates that 78% of FX swap turnover is accounted for by contracts with a maturity of less than seven days.

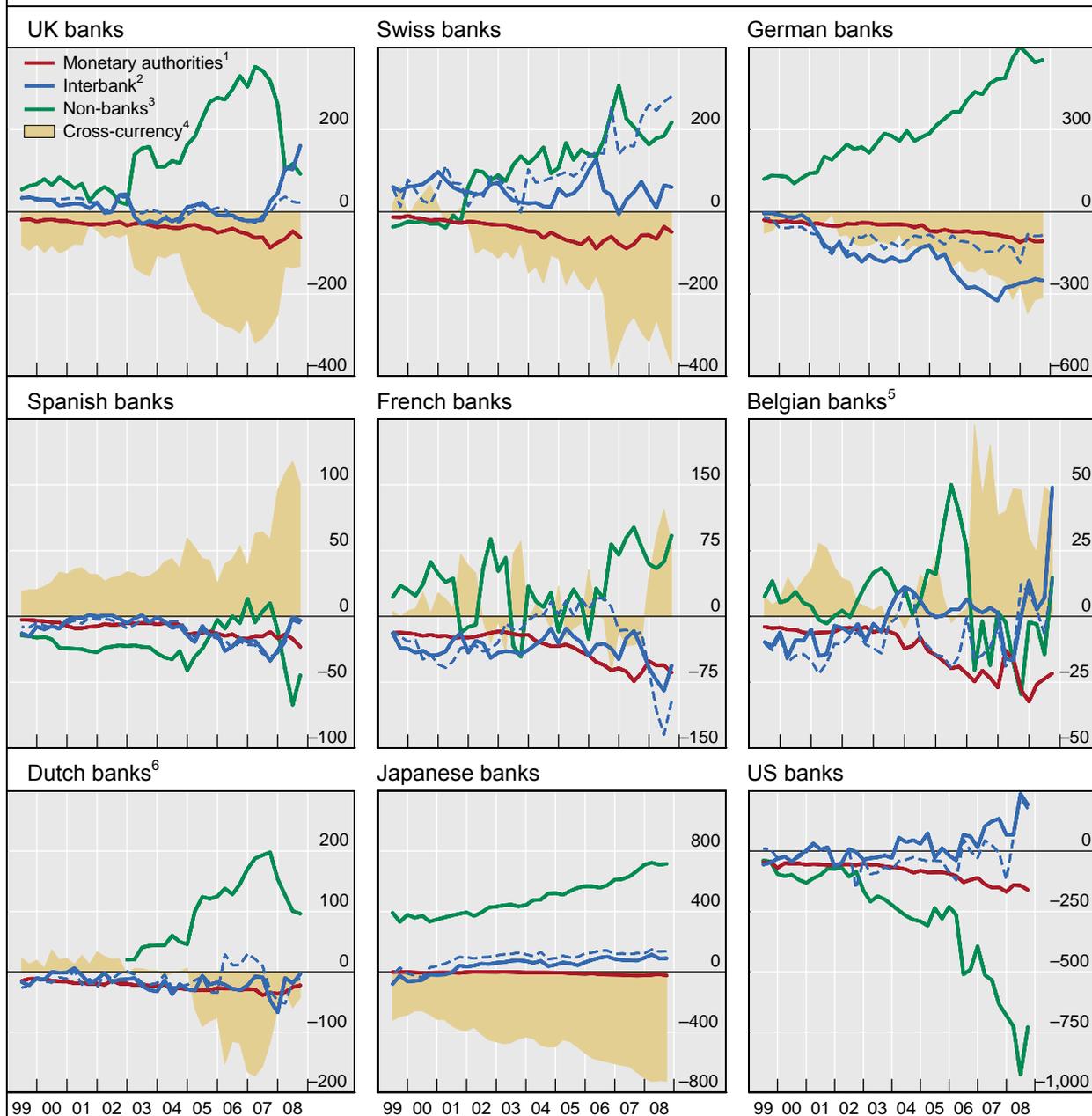
<sup>11</sup> The blue lines in Graphs 4 and 5 depicting net interbank lending to other (unaffiliated) banks should be interpreted with caution, due to incomplete reporting of inter-office positions (see box). This problem is particularly acute for Swiss banks.

<sup>12</sup> If we assume that European banks' estimated liabilities to money market funds (roughly \$1 trillion; see Baba et al in this issue) are also short-term liabilities, then the estimate would be \$2.1–2.3 trillion. Were *all* liabilities to non-banks treated as short-term funding, the upper-bound estimate of their US dollar funding gap would be roughly \$6.5 trillion (Graph 5, top right-hand panel).

<sup>13</sup> In the BIS locational banking statistics, several countries (eg Germany, Japan and the United States) do not report liabilities (in foreign currency) vis-à-vis *domestic* official monetary authorities, which makes it difficult to identify precisely total liabilities to these counterparties. For example, data on foreign exchange reserve holdings reported to the IMF indicate that Japanese monetary authorities held roughly \$118 billion in banks *located in* Japan in mid-2007 (\$26 billion in Japanese banks and \$92 billion in foreign banks in Japan). To the extent that these reserves are US dollar-denominated, the red lines in Graph 4 understate liabilities to official monetary authorities for all those banking systems which have offices in Japan, and which receive deposits from Japanese monetary authorities.

## Net US dollar-denominated foreign positions, by counterparty sector

In billions of US dollars

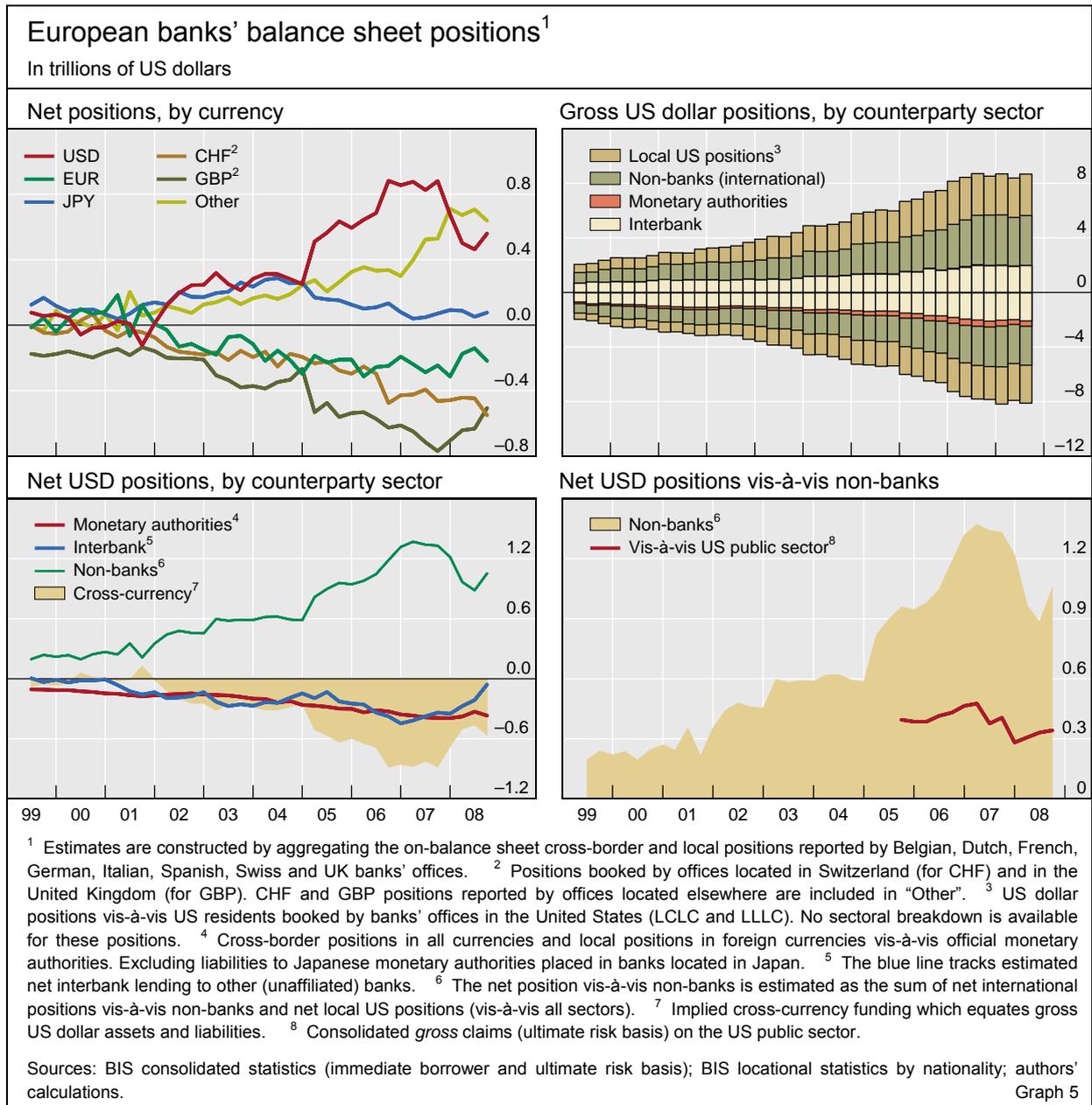


<sup>1</sup> Cross-border positions in all currencies and local positions in foreign currencies vis-à-vis official monetary authorities. Excluding liabilities to Japanese monetary authorities placed in banks located in Japan. <sup>2</sup> The solid blue line tracks net interbank lending to other (unaffiliated) banks. The dashed blue line is an alternative measure of interbank positions which makes use of the available information on inter-office positions (see box). <sup>3</sup> The estimated net position vis-à-vis non-banks is the sum of net international claims on non-banks and net local claims on US residents (vis-à-vis all sectors) booked by the US offices of the reporting bank. See footnote 9 in main text. <sup>4</sup> Implied cross-currency funding (ie FX swaps) which equates gross US dollar assets and liabilities. <sup>5</sup> Prior to Q4 2005, local liabilities in local currency (LLC) vis-à-vis some large European countries are estimated. <sup>6</sup> Local positions (LCLC and LLC) vis-à-vis advanced economies are available from Q4 2002. The contraction in positions in Q3 2008 in part reflects the sale of some business units of ABN AMRO.

Sources: BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations. Graph 4

systems, were skewed towards holdings of US government securities.<sup>14</sup> Japanese banks financed these holdings primarily by borrowing in yen from Japanese residents, although incomplete reporting of liabilities to official monetary authorities makes it difficult to pin these figures down precisely (see footnote 13).

In contrast to Japanese banks, the data show that US banks borrowed roughly \$800 billion internationally by end-2007, and channelled these funds to US residents (as implied by the shaded area in Graph 3). A closer look at the



<sup>14</sup> The BIS consolidated banking statistics (ultimate risk basis) show that Japanese banks' foreign claims on the public sector reached \$627 billion at end-2007, or 29% of their foreign claims. Their claims on the US public sector totalled \$218 billion, or 26% of their foreign claims on the United States. These public sector shares are higher than for any other banking system.

underlying data suggests that a large portion of their international liabilities to non-banks were booked by their offices in Caribbean offshore centres as liabilities to non-bank counterparties *located in* the United States (eg firms or money market mutual funds). This could be regarded as an extension of US banks' domestic activity since it does not reflect (direct) funding from non-banks outside the United States. Netting these positions would imply that their US dollar net borrowing from non-banks in the rest of the world is smaller than the green line in Graph 4 suggests (roughly \$500 billion at end-2007).

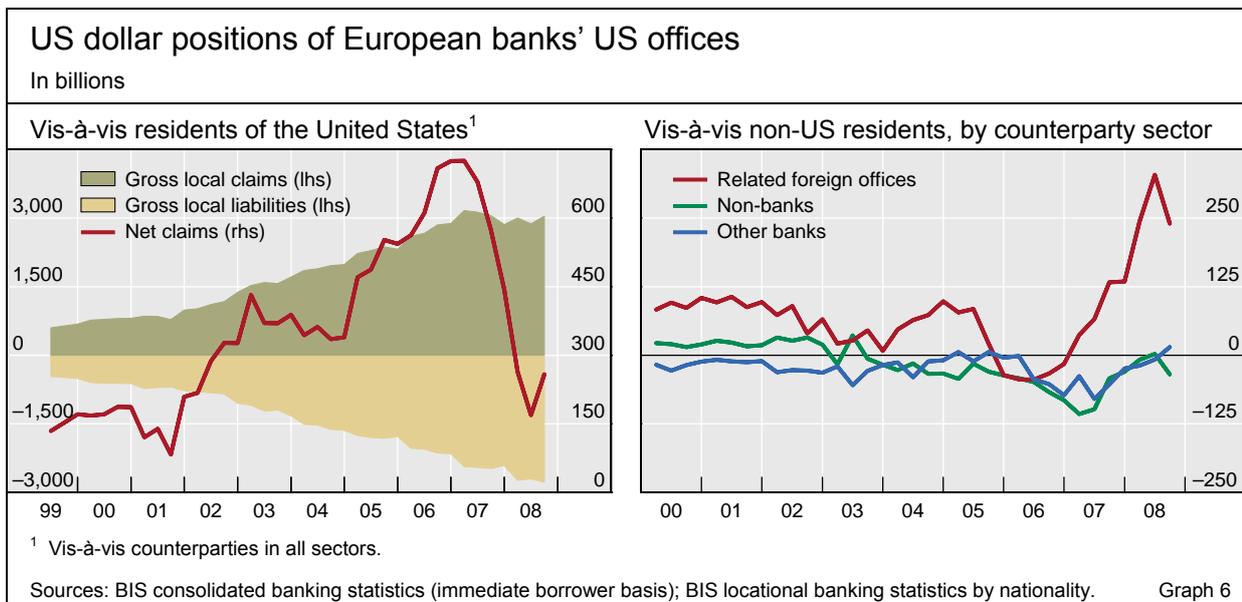
### The shortage of US dollars

Sources of short-term funding ...

The implied maturity transformation in Graph 5 (bottom left-hand panel) became unsustainable as the major sources of short-term funding turned out to be less stable than expected. The disruptions in the interbank market since August 2007 compromised one source of short-term funding, visible in the rise of the blue line in the panel. The related dislocations in FX swap markets made it even more expensive to obtain US dollars via currency swaps (Baba and Packer (2008)), as US dollar funding requirements exceeded similar funding needs in other currencies.

... became unstable during the crisis ...

European banks' funding pressures were compounded by instability in the *non-bank* sources of funds on which they had come to rely. Dollar money market funds, facing large redemptions following the failure of Lehman Brothers, withdrew from bank-issued paper, threatening a wholesale run on banks (see Baba et al in this issue). Less abruptly, a portion of the US dollar foreign exchange reserves that central banks had placed with commercial banks was withdrawn during the course of the crisis.<sup>15</sup> In particular, some



<sup>15</sup> Data compiled from the 63 monetary authorities which report details on their foreign exchange holdings to the IMF indicate that central bank deposits with commercial banks dropped by \$257 billion between mid-2007 and end-2008. This is reflected in the BIS banking statistics, as liabilities to monetary authorities worldwide declined up to the second quarter of 2008. See the Highlights section in the December 2008 *BIS Quarterly Review* for discussion.

monetary authorities in emerging markets reportedly withdrew placements in support of their own banking systems in need of US dollars.

Market conditions made it difficult for banks to respond to these funding pressures by reducing their US dollar assets. While European banks held a sizeable share of their net US dollar investments as (liquid) US government securities (Graph 5, bottom right-hand panel), other claims on non-bank entities – such as structured finance products – were harder to sell into illiquid markets without realising large losses.<sup>16</sup> Other factors also hampered deleveraging of US dollar assets: prearranged credit commitments were drawn, and banks brought off-balance sheet vehicles back onto their balance sheets.<sup>17</sup> Indeed, as shown in Graph 5 (top right-hand panel), the estimated outstanding stock of European banks' US dollar claims actually rose slightly (by \$235 billion or 3%) between Q2 2007 and Q3 2008.<sup>18</sup>

The frequency of rollovers required to support European banks' US dollar investments in non-banks thus became difficult to maintain as suppliers of funds withdrew from the market. The effective holding period of assets lengthened just as the maturity of funding shortened. This endogenous rise in maturity mismatch, difficult to hedge *ex ante*, generated the US dollar shortage.

... leading to a dollar shortage

Banks reacted to this shortage in various ways, supported by actions taken by central banks to alleviate the funding pressures. Since the onset of the crisis, European banks' net US dollar claims on non-banks have declined by more than 30% (Graph 5, bottom left-hand panel). This was primarily driven by greater US dollar *liabilities* booked by European banks' US offices, which include their borrowing from the Federal Reserve lending facilities.<sup>19, 20</sup> Their local liabilities grew by \$329 billion (13%) between Q2 2007 and Q3 2008, while their local assets remained largely unchanged (Graph 6, left-hand panel). This allowed European banks to channel funds out of the United States via inter-office transfers (right-hand panel), presumably to allow their head offices to replace US dollar funding previously obtained from other sources.<sup>21</sup>

In a coordinated policy response, central banks also put in place measures to provide US dollars to banks outside the United States. The

Central banks' swap lines provided support

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<sup>16</sup> Banks may also have held on to their US Treasury securities, a safe haven and a source of (repo) funding during the crisis (Hördahl and King (2008)).

<sup>17</sup> Off-balance sheet (unused) credit commitments reported by European banks declined by \$233 billion (6%) between mid-2007 and Q3 2008, primarily vis-à-vis US entities (down 21%).

<sup>18</sup> This is despite European banks' disclosed credit losses, which totalled \$257 billion at end-September 2008, and reached \$283 billion by end-2008 (data from Bloomberg).

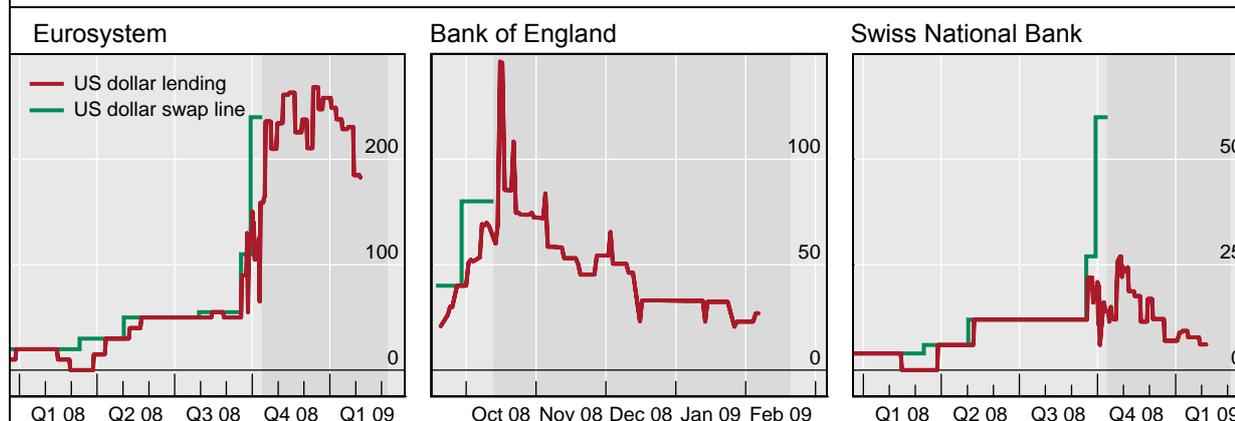
<sup>19</sup> European banks, through their US offices, can borrow against collateral from the Federal Reserve facilities available to depository institutions. A number of European banks have access to additional facilities in their capacity as primary dealers.

<sup>20</sup> The borrowing of US dollars by European banks' US offices from the Federal Reserve is captured in these banks' local liabilities in local currency (LLLC) vis-à-vis the United States. It is not captured in their international liabilities to official monetary authorities (as in Graphs 4 and 5) since there is no cross-border transaction.

<sup>21</sup> Cetorelli and Goldberg (2008) find evidence that US banks often rely on internal markets, ie borrow from foreign affiliates, to smooth liquidity shortages.

## Central banks' US dollar swap lines<sup>1</sup>

In billions



<sup>1</sup> Amounts outstanding are constructed by cumulating auction allotments, taking into account the term to maturity. The shaded area indicates the period of unlimited swap lines (as of 13 October 2008).

Source: Central banks.

Graph 7

Federal Reserve's reciprocal currency arrangements (swap lines) with other, notably European, central banks enabled the latter to channel US dollars to banks in their respective jurisdictions.<sup>22</sup> The quantities of US dollars actually allotted (Graph 7) may provide an indication of European banks' US dollar funding shortfall at any point in time. Following the scramble for US dollars, the Federal Reserve's swap lines with the ECB, the Bank of England and the Swiss National Bank became unlimited in October to accommodate any quantity of US dollar borrowing (against collateral).

### Concluding remarks

The crisis has shown how unstable banks' sources of funding can become. Yet the globalisation of banks over the past decade and the increasing complexity of their balance sheets have made it harder to construct measures of funding vulnerabilities that take into account currency and maturity mismatches. This special feature has shown how the BIS banking statistics can be combined to provide measures of banks' funding positions on a consolidated balance sheet basis. The analysis suggests that many European banking systems built up long US dollar positions vis-à-vis non-banks and funded them by interbank borrowing and via FX swaps, exposing them to funding risk. When heightened credit risk concerns crippled these sources of short-term funding, the chronic US dollar funding needs became acute. The resulting stresses on banks' balance sheets have persisted, resulting in tighter credit standards and reduced lending as banks struggle to repair their balance sheets.

<sup>22</sup> The provision of US dollars via these swap lines will be captured in international liabilities to official monetary authorities in the BIS locational banking statistics by nationality. These liabilities increased noticeably in the third quarter of 2008, after significant declines in the first half of 2008 (see the Highlights section in this review).

## References

Baba, N and F Packer (2008): “Interpreting deviations from covered interest parity during the financial market turmoil of 2007–08”, *BIS Working Papers*, no 267.

Baba, N, R McCauley and S Ramaswamy (2009): “Dollar money market funds and non-US banks”, *BIS Quarterly Review*, March.

Cetorelli, N and L Goldberg (2008): “Banking globalisation, monetary transmission, and the bank lending channel”, *NBER Working Paper* no 14101.

Hördahl, P and M King (2008): “Developments in repo markets during the financial turmoil”, *BIS Quarterly Review*, December.

Lane, P and J Shambaugh (2008): “The long or short of it: determinants of foreign currency exposure in external balance sheets”, *CEPR Discussion Paper*, no 6887.

Stigum, M and A Crescenzi (2007): *Stigum’s Money Market*, fourth edition, New York: McGraw Hill.

## Reconstructing banks' global balance sheets

The analysis in this special feature requires estimates of banks' consolidated asset and liability positions broken down by currency and counterparty sector. This box describes how we construct these estimates, and highlights known data limitations.

### *The BIS banking statistics*

Table A shows the relevant balance sheet components (first column) and how the required breakdowns are captured in the BIS international banking statistics. The underlying data are taken from the *BIS locational banking statistics by nationality* (LBSN) and the *BIS consolidated banking statistics on an immediate borrower basis* (CBS). The CBS are organised on the principle of bank *nationality*. They provide reporting banks' worldwide consolidated foreign claims (FC), which comprise cross-border claims (XBC) and local claims (LC), ie positions booked by banks' foreign offices vis-à-vis residents of the host country. Local claims are denominated in either "local currencies" (LCLC), ie the domestic currency of the host country, or in foreign currencies (LCFC). The statistics record cross-border claims and local claims in foreign currencies as a joint item called international claims (INTC = XBC + LCFC). These claims can be broken down by the country of residence of the counterparty. Therefore, banking system *b*'s foreign claims on borrowers in country *c* are

$$FC_{bc} = LCLC_{bc} + INTC_{bc} \Rightarrow FC_b = \sum_c FC_{bc}.$$

While the counterparty sector (bank, non-bank private sector and public sector) is known for international claims, there is no currency breakdown for these positions nor information about the location of the booking office. Moreover, the CBS data contain no information on *international liabilities* (INTL). In contrast to international positions, both the currency and the location of the booking office are known for LCLC by definition. In addition, banks report their locally booked liabilities in local currencies (LLLC).

In contrast to the CBS data, the LBSN are collected on the principle of bank *residence*. The "reporting unit" in the LBSN is any bank office (head office, branch or subsidiary) in a particular country or jurisdiction – including major offshore financial centres. Each bank office reports its cross-border (XB) claims *and* liabilities, as well as foreign currency claims and liabilities vis-à-vis residents of that country. Importantly, these positions are broken down by *bank nationality* (ie the parent country of the booking office), as well as by *currency* and counterparty sector.<sup>9</sup> For instance,  $XBC_{rb}^{\$}$  represents US dollar cross-border claims booked in reporting country *r* by banks headquartered in parent country *b*. The LBSN, unlike the CBS, do not record the residency of the counterparty, nor the local claims and liabilities (ie vis-à-vis residents) in the domestic currency of the reporting country (LCLC and LLLC).

### *Construction of the dataset*

The two sets of statistics contain *complementary* information on banks' global balance sheets. We merge these statistics to construct the required balance sheet components as shown in Table A. The key step is to aggregate the LBSN data across the 40 reporting countries to obtain total international claims *and international liabilities* for each bank nationality (ie banking system), along with the currency and sector breakdowns that are unavailable in the CBS.

Consider, for example, UK-headquartered banks. Summing across all reporting countries (indexed by *r*) in the LBSN where UK banks have offices gives UK banks' international claims and liabilities on a global consolidated basis, or

$$INTC_b = \sum_r (XBC_{rb} + LCFC_{rb}).$$

This aggregate compares to INTC in the CBS, but now comes with detailed breakdowns by currency and counterparty sector. To match worldwide consolidated foreign claims (FC from the CBS), the only missing balance sheet components are UK banks' local claims and liabilities in the domestic currencies of various host countries (LCLC and LLLC). This information is available in the CBS reported by the United Kingdom. After merging, the only *remaining* missing component in UK banks' global balance sheets is their "strictly domestic" business, ie their claims and liabilities

vis-à-vis UK residents in pounds sterling (DCLC and DLLC in Table A). While their gross domestic positions in pounds are unknown, their *net* position (DCLC – DLLC) can be inferred as a residual from the balance sheet identity (Table A).

### A breakdown of banks' consolidated worldwide positions

Balance sheet positions		Data availability				
		Totals	Breakdowns by			
			Booking office location	Residence of counterparty	Sector of counterparty	Currency of positions
ASSETS	Domestic claims (DC) <sup>1</sup> in foreign currency (DCFC) in local currency (DCLC)	LBSN	LBSN	LBSN	LBSN	LBSN
	Foreign claims (FC)	CBS		CBS		
	Cross-border claims (XBC)	LBSN	LBSN		LBSN	LBSN
	<i>International claims (INTC)</i> <sup>2</sup>	CBS LBSN	LBSN	CBS	CBS LBSN	LBSN
	Local claims (LC) <sup>3</sup> in foreign currency (LCFC)	LBSN	LBSN	LBSN	LBSN	LBSN
	in local currency (LCLC)	CBS	CBS	CBS		CBS
LIABILITIES	Domestic liabilities (DL) <sup>1</sup> in foreign currency (DLFC) in local currency (DLLC)	LBSN	LBSN	LBSN	LBSN	LBSN
	Foreign liabilities (FL)					
	Cross-border liabilities (XBL)	LBSN	LBSN		LBSN	LBSN
	<i>International liabilities (INTL)</i> <sup>2</sup>	LBSN	LBSN		LBSN	LBSN
	Local liabilities (LL) <sup>3</sup> in foreign currency (LLFC)	LBSN	LBSN	LBSN	LBSN	LBSN
	in local currency (LLLC)	CBS	CBS	CBS		CBS

CBS = consolidated banking statistics on an immediate borrower basis; LBSN = locational banking statistics by nationality.

<sup>1</sup> Domestic claims (liabilities) in the home country. <sup>2</sup> International claims INTC ≡ XBC + LCFC, and international liabilities INTL ≡ XBL + LLFC. <sup>3</sup> Local positions booked by banks' foreign offices *outside* the home country. Table A

The combined dataset thus yields foreign claims and liabilities for 19 banking systems on a worldwide consolidated basis, as well as their cross-border and local components, all broken down by both currency and sector. (Only local positions in local currencies are not broken down by sector.) From these, we calculate *net balance sheet positions* (assets minus liabilities) by currency and sector for each banking system, as described in the text.

#### Consistency check and data limitations

In principle, the summation of  $INTC_b$  across reporting countries (in LBSN) plus the LCLC positions anywhere (in CBS), should correspond to total foreign claims reported in the CBS. That is,

$$\sum_r (XBC_{rb} + LCFC_{rb}) + \sum_c LCLC_{bc} = FC_b.$$

This serves as a consistency check across the two datasets for the asset side of the balance sheet. There is no corresponding check on the liability side since banks do not report foreign liabilities in the CBS.

In practice, some statistical discrepancies arise because the two sets of statistics are collected in fundamentally different ways. For many banking systems (Belgian, Canadian, Dutch, French, German, Italian, Spanish and UK banks) the match is fairly close. The match is not as satisfactory for Swiss and US banks. Discrepancies arise for three main reasons. First, the set of reporting banks in the CBS differs from that reporting LBSN in various reporting countries.<sup>2</sup> Second, some banking

in the CBS differs from that reporting LBSN in various reporting countries.<sup>①</sup> Second, some banking systems have offices in countries that do not report in the LBSN, yet those offices are included in the worldwide consolidated positions reported in the CBS. In addition, some countries report incomplete positions in the LBSN; the United States, for example, does not report foreign currency positions vis-à-vis US residents.

Third, and most problematic for the analysis, the breakdowns by sector and currency in the LBSN are incomplete. For each banking system  $b$ , total interbank claims ( $IBC$ ) in a particular currency are the sum of claims on other (unaffiliated) banks ( $OTHBC$ ) and inter-office claims ( $IOC$ ). That is,

$$IBC_b = \sum_r IBC_{rb} = \sum_r (OTHBC_{rb} + IOC_{rb}),$$

with a corresponding equation for interbank liabilities. The inter-office asset and liability positions must be stripped out of total foreign claims in order to make the LBSN and CBS data comparable on a gross basis, as in Graphs 2 and 5. Some LBSN-reporting countries, however, do not provide a complete currency breakdown (eg Singapore, Hong Kong SAR and the Channel Islands), while others provide only limited currency information for inter-office positions (eg France, Germany, Italy and Japan split inter-office activity into domestic and foreign currencies). To the extent possible, we estimate the missing inter-office components, although there is still considerable uncertainty in the overall interbank positions for some banking systems. This makes it difficult to pin down the extent of reliance on interbank financing, as shown by the two alternative estimates presented in Graph 4. On a *net* basis (claims minus liabilities), inter-office positions should, in principle, sum to zero across all reporting office locations. This implies that net “interbank” claims ( $IBC - IBL$ ) should equal net claims on “other banks”, both of which are observable in the data.

$$\sum_r (IOC_{rb} - IOL_{rb}) = 0 \Rightarrow \sum_r (IBC_{rb} - IBL_{rb}) = \sum_r (OTHBC_{rb} - OTHBL_{rb})$$

The solid blue line in Graph 4 tracks  $\sum_r (IBC_{rb} - IBL_{rb})$ , or net interbank positions calculated without stripping out inter-office positions, while the dashed blue line tracks  $\sum_r (OTHBC_{rb} - OTHBL_{rb})$ , or the reported positions vis-à-vis unaffiliated banks only. Which estimate is more accurate depends on the relative sizes of observed versus missing inter-office positions, and whether banks have offices with (unobserved) offsetting positions in non-reporting countries.

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① The sectoral breakdown distinguishes positions vis-à-vis non-banks, vis-à-vis official monetary authorities and vis-à-vis banks. The interbank positions are further divided into inter-office positions (within the same bank group) and positions vis-à-vis other (unaffiliated) banks. ② This is problematic in the case of US banks, since the major US investment banks are generally included in the LBSN (reported by all countries), but not in the CBS reported by the United States.



## US dollar money market funds and non-US banks<sup>1</sup>

*The Lehman Brothers failure stressed global interbank and foreign exchange markets because it led to a run on money market funds, the largest suppliers of dollar funding to non-US banks. Policy stopped the run and replaced private with public funding.*

*JEL classification: E58, F34, G28, G29.*

That a loss of confidence in dollar money market funds amplified the financial instability arising from the Lehman Brothers failure in September 2008 is well appreciated. What is less well understood, however, is why the run on these funds coincided with the deterioration in global interbank markets. Similarly unclear is the relationship between policies to stabilise US money markets and those to distribute dollars through cooperating central banks.

How great was the need of non-US banks for dollars and how much did they rely on US dollar money market funds? How did a safe haven become the critical link between Lehman's failure and the seizing-up of interbank markets? Was the run on money market funds indiscriminate? How did policies to calm the US money market fit with policies to provide dollars to non-US banks?

In sum, the run on US dollar money market funds after the Lehman failure stressed global interbank markets because the funds bulked so large as suppliers of US dollars to non-US banks. Public policies stopped the run and replaced the reduced private supply of dollars with public funding.

The rest of this special feature first reviews European banks' need for US dollars. Then it quantifies the role of dollar money market funds as dollar providers. The following two sections trace how money funds played this role up to August 2008 and then how the Lehman failure undid it. The penultimate section reviews policies that responded to the run and associated fund flows.

### European banks' need for US dollar funding

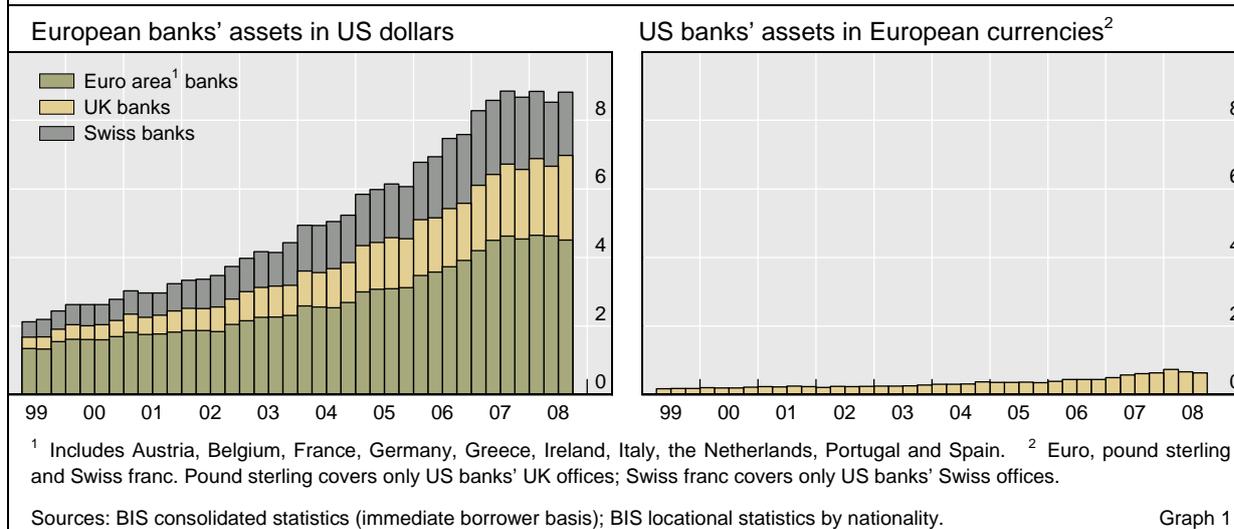
Non-US banks' overall need for US dollar funding provides a useful perspective on their reliance on money market funds. European banks increased their

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<sup>1</sup> The authors thank Steffanie Brady, Peter Crane, Jean-Baptiste de Franssu, Nathan Douglas, Burcu Duygan-Bump, Patrick McCabe, Michael Palumbo, Brian Reid and Asani Sarkar for discussion and comments and Jhuvesh Sobrun for assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

## The transatlantic asymmetry in international banking

In trillions of US dollars



dollar assets sharply in this decade (Graph 1, left-hand panel). Since this growth outran that of their retail dollar deposits, they bid for dollars from non-banks and banks (see McGuire and von Peter in this issue). US banks' need for European currencies is much smaller (Graph 1, right-hand panel) because US banks have leveraged their domestic operations with foreign assets much less. European banks' foreign assets in all currencies topped \$30 trillion in early 2008, 10 times the figure for US banks. (Netting out intra-euro area assets does not alter the order-of-magnitude difference.)

As a result, the effect was not symmetric when, in the second half of 2007, the creditworthiness of major banks on both sides of the Atlantic deteriorated and interbank markets dried up. As European banks relied more on the foreign exchange swap market to obtain dollars against European currencies, they did *not* meet US banks with a complementary need for European currencies. Under these circumstances, this asymmetry led to skewed foreign exchange swap prices that hiked the cost of raising dollars well above an already elevated Libor dollar rate (Baba et al (2008), Baba and Packer (2008)).

Interbank market strains made it critical for non-US banks to retain access to other sources of dollar funding, especially the largest, US dollar money market funds.<sup>2</sup> Originally, these funds invested in US names. Competition to offer investors higher yields, however, led them to buy the paper of non-US-headquartered firms to harvest the "Yankee premium" (Stigum and Crescenzi (2007, Chapter 20)). Most funds that invest in private paper, so-called "prime"

European banks' need for dollars not matched by US banks' need for European currencies ...

<sup>2</sup> This feature concerns US dollar money market funds domiciled in the United States and Europe. It uses the term "US money market funds" to refer to mutual funds in the United States regulated under Rule 2a-7 of the Securities and Exchange Commission. These should be distinguished from "alternative" or "enhanced" cash funds. As noted in the box, most of the US dollar money market funds in Europe are managed under principles similar to those of the SEC adopted by the Institutional Money Market Fund Association.

funds, now invest heavily in non-US names.<sup>3</sup> (So-called “government” funds specialise in Treasury and agency paper – see box.)

Records of the mid-2008 holdings of the 15 largest prime funds (Table 1), accounting for over 40% of prime funds’ assets, show that the funds placed half of their portfolios with non-US banks. Thus, such US money market funds’ investment in non-US banks reached an estimated \$1 trillion in mid-2008 out of total assets of over \$2 trillion. To this can be added one half of the assets of European US dollar funds represented by the Institutional Money Market Fund Association, about \$180 billion out of \$360 billion in early September 2008.

Overall, European banks appear to have relied on money market funds for about an eighth of their \$8 trillion in dollar funding. By contrast, central banks, which invest 10–15% of US dollar reserves in banks (McCauley (2007)), provided only \$500 billion to European banks at the peak of their holdings in the third quarter of 2007. Given these patterns, any run on dollar money market funds was bound to make trouble for European banks.

... leaving  
European banks  
dependent on US  
dollar money  
market funds

Share of US prime money funds’ assets held in non-US/European banks						
As a percentage of each asset class, mid-2008; percentage for non-US banks <sup>1</sup> before slash, European banks after						
Fund	CDs and time deposits	Commercial paper	Corporate notes <sup>2</sup>	Repos	Total	Memo: Net assets, in \$ billions <sup>3</sup>
Fidelity Cash Reserves <sup>c</sup>	91 / 73	28 / 27	54 / 34	70 / 70	63 / 51	128
JPMorgan Prime Money Market <sup>c, d</sup>	98 / 94	35 / 31	57 / 39	73 / 73	67 / 62	120
Vanguard Prime Money Market <sup>c</sup>	94 / 69	39 / 25	0 / 0	68 / 68	33 / 24	106
BlackRock Liquidity Temp <sup>b</sup>	95 / 91	4 / 4	37 / 17	13 / 13	51 / 47	68
Reserve Primary <sup>c, e</sup>	98 / 88	24 / 18	54 / 51	18 / 18	43 / 37	65
Schwab Value Advantage <sup>a</sup>	91 / 64	24 / 19	58 / 48	67 / 67	54 / 40	61
GS FS Prime Obligations <sup>a, f</sup>	0 / 0	0 / 0	0 / 0	2 / 2	0 / 0	56
Dreyfus Inst Cash Advantage <sup>b</sup>	85 / 71	32 / 25	33 / 24	0 / 0	62 / 51	49
Fidelity Inst Money Market <sup>a</sup>	100 / 91	44 / 44	51 / 36	45 / 45	61 / 54	47
Morgan Stanley Inst Liq Prime <sup>b</sup>	4 / 4	19 / 19	0 / 0	91 / 91	37 / 37	34
Dreyfus Cash Management <sup>b</sup>	92 / 75	46 / 30	31 / 31	0 / 0	70 / 56	33
AIM STIT Liquid Assets <sup>c</sup>	95 / 69	25 / 20	27 / 16	84 / 84	57 / 45	32
Barclays Inst Money Market <sup>a, g</sup>	67 / 57	10 / 6	30 / 21	21 / 21	24 / 19	31
Merrill Lynch Premier Inst Portfolio <sup>b, h</sup>	92 / 80	32 / 25	46 / 36	45 / 45	60 / 51	26
Fidelity Inst Money Market: Prime <sup>a</sup>	100 / 90	33 / 33	51 / 34	15 / 15	56 / 47	21
Total	92 / 78	26 / 22	47 / 33	51 / 51	50 / 42	878
Memo: Share of asset class in assets	34	26	13	11	100 <sup>4</sup>	

a: report as of 30 June 2008; b: report as of 31 July 2008; c: report as of 31 August 2008; d: Lehman exposure of 0.2%; e: Lehman exposure of 1.2%; f: Lehman exposure of 0.3%; g: Lehman exposure of 2.7% (all repo); h: Lehman exposure of 0.6%.

<sup>1</sup> Bank classified by ownership; non-US includes US operations. <sup>2</sup> Includes bank notes, master notes, short-term notes, medium-term notes, and variable and floating rate obligations. <sup>3</sup> As of reporting date; funds selected by size at 31 August 2008. <sup>4</sup> Shares add up to 85% owing to the exclusion of Treasury obligations, municipal securities, government agencies and promissory notes.

Sources: Portfolio holding reports; BIS calculations. Table 1

<sup>3</sup> Disproportionate investment in foreign commercial paper by money funds was already evident in the 1980s (McCauley and Hargreaves (1987, pp 26–7)). By the early 1990s, the Yankee premium had declined to a handful of basis points (McCauley and Seth (1992)).

## Money market funds

Money market funds (MMFs) are collective investment schemes that invest in short-term high credit quality debt instruments and provide considerable funding in the overnight and term money markets. In the United States, MMFs are referred to as mutual funds whereas in other countries they are called investment funds. MMFs were introduced in the 1970s in the United States as an alternative to bank deposits to circumvent regulatory caps on bank interest rates. At end-2008, MMFs managed more than \$5 trillion in assets globally. The United States has the largest market for MMFs, with assets under management at end-2008 amounting to \$3.8 trillion, of which \$2.5 trillion accounted for by institutional investor funds and the remainder retail funds. In Europe, assets under management amounted to \$1.3 trillion and more than half of this was denominated in US dollars. The dollar-denominated funds are often managed from offices located in the United States.

US MMFs are categorised on the basis of their investment objectives and the type of investors in the fund. For example, prime MMFs invest predominantly in non-government paper as opposed to government funds. If government MMFs are restricted to investing only in US Treasuries, they are referred to as Treasury funds. Depending on whether the funds are marketed to institutional or retail investors, these MMFs may be further classified into institutional prime funds or retail prime funds. Some MMFs invest in tax-exempt US municipal securities, which provide the basis for another categorisation of MMFs as taxable and tax-free funds.

MMFs operate under different regulatory regimes in the United States and Europe. The Securities and Exchange Commission regulates the credit quality, issuer concentration and maturity of assets that US MMFs can hold in their portfolios under Rule 2a-7. Under this rule, MMFs are not permitted to hold more than 5% of investments in second tier (A2-P2) paper, or to hold more than a 5% exposure to any single issuer (other than the government and agencies). Weighted average maturity of the portfolio is also restricted to 90 days or fewer. MMFs in Europe, which are dominated by institutional investor funds, are authorised under the Undertakings for Collective Investments in Transferable Securities (UCITS) Directive. The UCITS Directive allows a fund to be sold throughout the European Union subject to regulation by its home country regulator. Dollar funds domiciled in Europe generally adopt voluntarily the code of practice published by the Institutional Money Market Funds Association (IMMFA) for their investment guidelines. These guidelines are in spirit very similar to the investment restrictions under Rule 2a-7, and the weighted average maturity of portfolio holdings is even capped at a more restrictive 60 days. This is a noteworthy case of an offshore financial market adopting an onshore regulation. Many MMFs are rated by credit rating agencies, which may in turn impose additional investment restrictions.

All US and a majority of European MMFs are structured to maintain a stable net asset value (NAV) of \$1 (or \$10), and portfolio holdings are accounted for under amortised cost to compute NAV. Funds charge fees between 25 and 50 basis points of the NAV, and monthly dividends are paid to shareholders that reflect the average accrual income on the fund investments net of fee. As investments in MMFs can be withdrawn on the same day, these funds need to maintain a strong liquidity position to meet potential investor redemptions. Unlike bank deposits, however, investments in MMFs do not carry an official guarantee, nor are they insured or guaranteed by the fund's sponsor.<sup>6</sup>

While amortised cost provides the basis for computation of dividend payments, fund sponsors are required by regulation to also compute a shadow price for the portfolio holdings. Shadow price is the current NAV per share of the fund calculated using available market prices. Applicable regulations require that the shadow price does not materially deviate from \$1. Under Rule 2a-7, this deviation is limited to 50 basis points. For Dublin-domiciled funds regulated by the Irish Financial Services Authority, the deviation limit is 30 basis points. In circumstances where the shadow price falls below this limit, fund managers are required to take corrective action. An inability to do this would result in the fund "breaking the buck", that is, valuing shares at less than \$1.

The reason why MMFs did not "break the buck" in 30 years, with one exception in 1994, is that fund sponsors have provided financial support when the market value of a share threatened to fall substantially below \$1. While there is no legal obligation to provide support, fund sponsors have done so to preserve their business franchise. Available evidence on parental support suggests that around 145 funds received sponsor support up until July 2007. Since then, about one third of the top 100 US MMFs have received financial support from management companies through various means (Crane Data Archives (2008)). Such support has also been extended recently by US

sponsors to European-domiciled funds, which were subject to runs in September 2008. Recognising the importance of the ability and willingness of a fund sponsor to support its fund, credit agencies factor these into their fund rating decisions (Moody's (2008)). Fitch (2009) gives new emphasis to its evaluation of support and its interaction with concentration and liquidity.

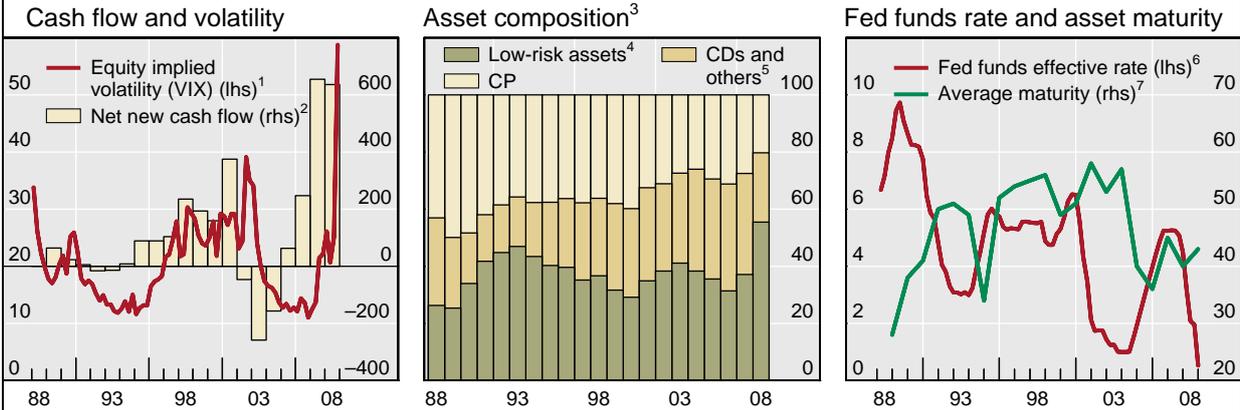
Support can take various forms. The fund sponsor can purchase the security that has experienced a credit event from the fund at par or can provide the fund with an A1-P1 letter of credit or guarantee covering the par amount of the security. A blanket guarantee of the NAV could lead to the consolidation of the MMF into the sponsor's balance sheet, but support for individual securities has thus far been interpreted as not requiring such consolidation (SEC (2008)).

Considering that MMFs invest in short-term and high credit quality securities and are structured to provide principal protection, inflows into these funds usually rise during periods of heightened investor risk aversion (Graph A, left-hand panel). During the current financial market crisis, MMFs have been important beneficiaries, with assets under management rising by more than 20% in 2008. In fact, end-2008 holdings in MMFs exceeded those in equity mutual funds in the United States for the first time in the last 15 years. As net inflows into MMFs have grown rapidly since 2007, competition between funds to gain market share has increased. This competition has been further intensified by the growth in money fund portals, which offer institutional investors and corporate treasuries not only a wider range of funds to invest in, but also greater flexibility in switching among them.

As investors in short-term debt, MMFs are important providers of liquidity to financial intermediaries through purchases of certificates of deposit (CDs) and commercial paper (CP) issued by banks, and through repo transactions. For example, MMFs held nearly 40% of the outstanding volume of CP in the first half of 2008. Consequently, when MMFs shift away from these assets into safer ones, funding liquidity for financial institutions can be affected. The shifts in the asset composition and maturity, however, tend to be influenced by credit market conditions, market liquidity and level of interest rates. Interpreting falling interest rates as periods of weaker credit market conditions, aggregate portfolio holdings of MMFs have shifted to low-risk assets in such periods (Graph A, centre and right-hand panels). To maintain yield in a falling interest rate environment, the shift to safer assets is usually accompanied by maturity extension.

© Following the Lehman bankruptcy, the US Treasury unveiled a temporary guarantee programme for investments held in MMFs.

**US money market funds**



<sup>1</sup> The Chicago Board Option Exchange Volatility Index (VIX) is a measure of market expectations of near-term volatility, as conveyed by the S&P 500 stock index option prices; quarterly averages. <sup>2</sup> In billions of US dollars; taxable and tax-exempt funds; end-of-year observation. <sup>3</sup> As a percentage of total net assets of taxable funds; end-of-year observation. <sup>4</sup> Treasury bills, other Treasury securities, government agency issues and repurchase agreements. <sup>5</sup> CDs, eurodollar CDs, bank notes, corporate notes and other assets. <sup>6</sup> Quarterly averages, in per cent. <sup>7</sup> Average maturity in days of taxable funds; end-of-year observation.

Sources: Bloomberg; Investment Company Institute.

Graph A

## US money market funds from August 2007 to August 2008

US money market funds appear to have increased their outright investment in non-US banks in the August 2007–August 2008 period. Their stepped-up funding of non-US banks reflected the cross-currents set in motion by investors' and fund managers' response to heightened risk in various corners of the money market. Amid concerns over risk, however, competition for assets under management through relatively high yields continued.

Assets at US money market funds grew strongly (Graph 2, left-hand panel) as investors withdrew funds from less safe short-term investments. Such investments included alternative “cash” funds, auction-rate preferred instruments and extendible asset-backed commercial paper (ABCP), sold as short-term instruments but revealed as less liquid in strained markets.

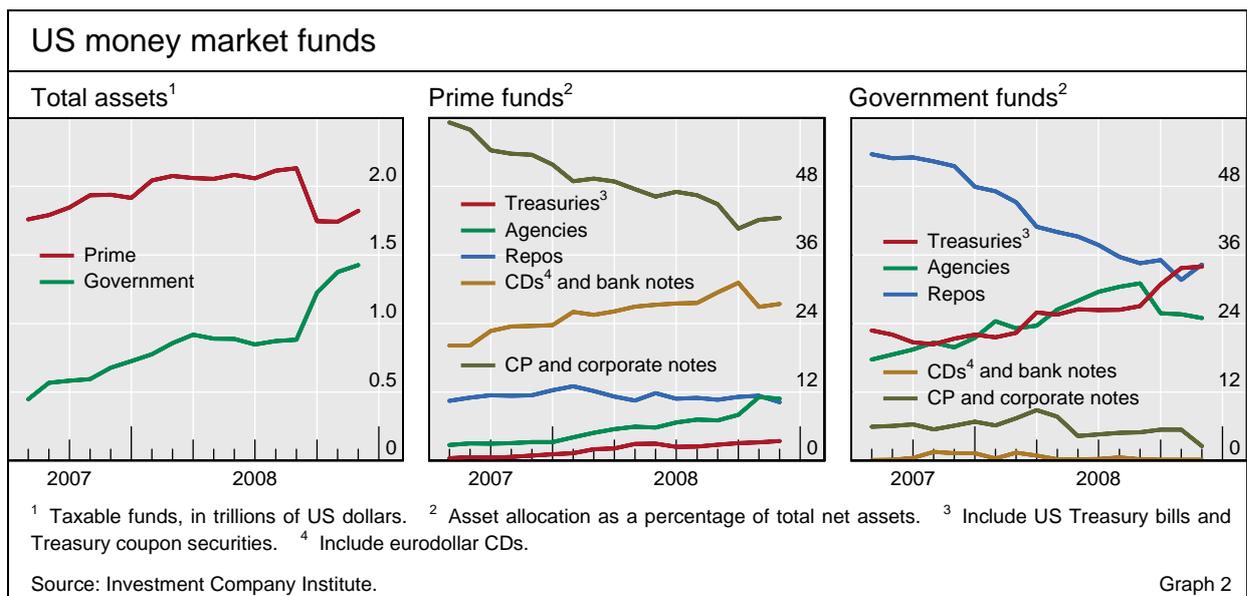
From late 2007 to April 2008, investors strongly favoured government funds, invested in agency and Treasury paper, over prime funds. This followed recognition in August 2007 that prime funds held ABCP of vehicles that held securities backed by shaky mortgages and other debts (Fender and Hördahl (2007)). By October, some prime fund managers found it necessary to promise investors that they would make good any losses on such paper (Table 2), especially ABCP issued by vehicles without a bank sponsor. This support, however, did not prevent inflows from favouring government funds (Graph 2).<sup>4</sup>

Non-US banks did benefit as prime fund managers took their cue from investors and adopted a less risky investment mix. Prime funds shifted their portfolios away from problematic commercial paper (CP) towards certificates of deposit (CDs) – seen as intermediate in risk between CP and government paper – and agency and Treasury issues (Graph 2, centre panel). This shift from CP to CDs suggests that prime funds enlarged their role as providers of unsecured dollar funding to non-US banks, given the much larger share of non-

Up to August 2008, US money market funds increase dollar funding of non-US banks ...

... despite investors' shift from “prime” funds to government funds ...

... as “prime” fund managers shift from commercial paper to safer certificates of deposit ...



<sup>4</sup> Dudley (2007) highlights a two-week portfolio shift of \$30–40 billion from prime funds to Treasury funds in August 2007 as a source of pressure on the ABCP market.

## Asset growth of the largest money market fund managers in the year to August 2008

Bank-owned <sup>1</sup>				Others			
Manager	Asset growth <sup>2</sup>	Assets <sup>3</sup>	Support?	Manager	Asset growth <sup>2</sup>	Assets <sup>3</sup>	Support?
Dreyfus (BoNY Mellon)	75.9	199.1	Sep 08	Reserve	113.0	84.0	
HSBC	57.4	32.8	Jan, Jun 08	Goldman	54.1	183.6	
UBS	53.5	56.7		BlackRock	50.2	259.8	
SSgA (State Street)	36.4	43.6		Fidelity	32.9	425.7	
TDAM (Toronto Dominion)	36.2	22.6	Dec 07	Federated	29.7	231.1	
JPMorgan	31.7	267.9		AIM	30.0	70.9	
First American (US Bancorp)	27.2	59.8	Nov 07	Morgan Stanley	29.2	112.6	Sep–Nov 08
Wells Fargo	21.8	103.9	Feb 08	Schwab	22.8	194.5	
Barclays	21.2	21.4	2008	Western	21.3	110.6	Jun, Sep, Dec 08
DWS (Deutsche)	20.7	64.9		Vanguard	12.3	191.5	
Northern (Northern Trust)	19.3	63.4	Feb, Jul 08	Lehman	0.3	21.0	Apr 08
Evergreen (Wachovia)	15.6	56.1	Sep 08				
Ridgeworth (SunTrust)	6.5	23.5	Oct 07, Jan, Sep 08				
Columbia (BofA)	-0.3	146.8	Nov 07, Oct 08				

<sup>1</sup> The chi-squared statistic to test the null hypothesis of independence of bank ownership and support (for the 24 cases excluding Reserve) is 4.0, allowing a rejection at the 0.05 level. <sup>2</sup> In per cent over the 12 months to 31 August 2008. <sup>3</sup> In billions of US dollars, 31 August 2008.

Sources: Barclays 2008 interim and full-year reports; Crane Data; Morgan Stanley 2007 10-K, p 55; SEC; Standard & Poor's (2008).  
Table 2

US banks as issuers of CDs than of CP held by those funds (Table 1).<sup>5</sup>

While both investors and managers broadly shifted away from risk, US money market funds continued to compete keenly under pressure from shareholders for yield. Financial investors, including securities lenders, led the growth of money fund assets as they shifted from CP, and many sought higher yields. As in previous periods of easing policy interest rates (see box), money market funds competed by extending the maturity of their portfolios.

... amid yield competition for funds

Competition produced strikingly different growth rates of assets under management for fund families (Table 2) and thus changes in market share. Support announcements in 2007 and early 2008 acted as a drag on the growth of some fund families, with concern over risk management outweighing the reassurance of support. Bank-owned fund managers were over-represented among support providers. But the credit loss that would pose the greatest challenge to the industry would strike a fast growing independent fund family.

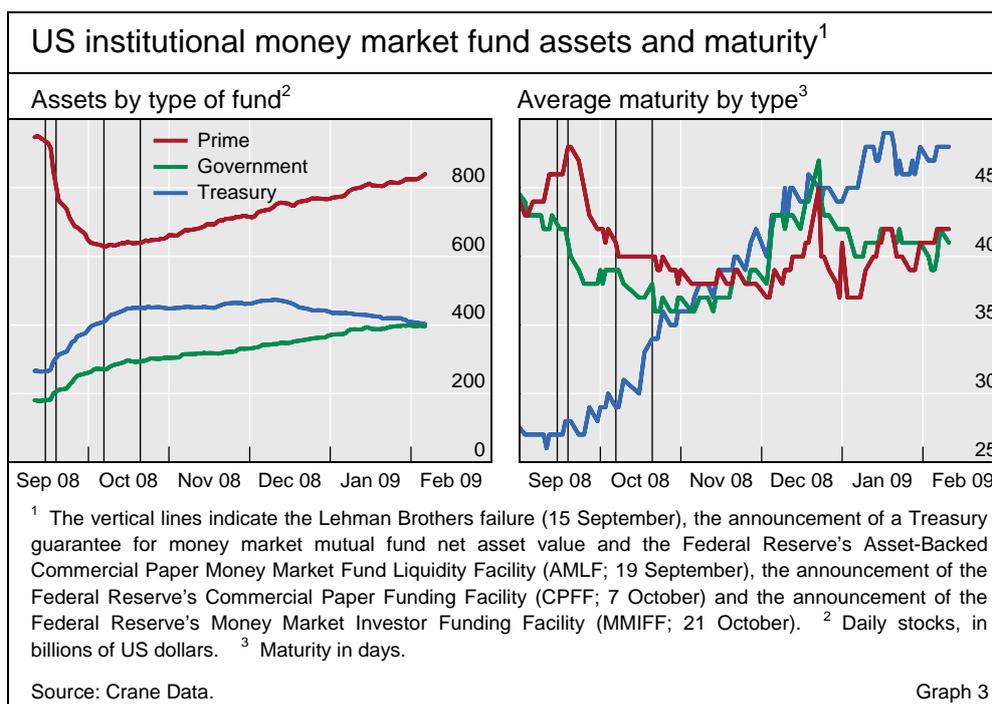
<sup>5</sup> Government money market funds also responded to heightened counterparty risk by reducing their repos (Graph 2, right-hand panel), before and after Bear Stearns' collapse. To what extent this reduction squeezed secured lending to non-US banks by such funds is not known.

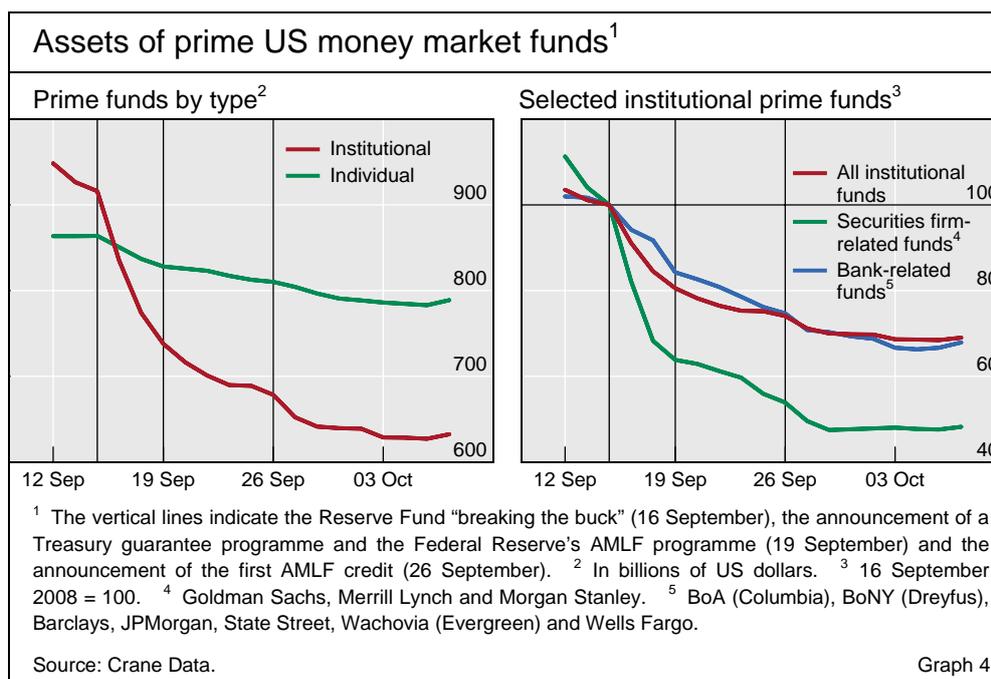
## The run on money market funds

On 16 September, the day after Lehman's failure, the fastest growing fund family over the previous several years, Reserve, announced that shares in its flagship fund were worth 97 cents and those in its Caribbean fund 91 cents. The flagship Primary Fund, the industry's oldest and still independently managed by its founder, had gained market share by buying higher-yielding paper, including Lehman notes (Stecklow and Gullapalli (2008)). A deep-pocketed parent, such as Bank of New York Mellon, made good the Lehman losses in money funds managed by Dreyfus (the second fastest growing fund family in Table 2). Reserve, however, had shallow pockets and "broke the buck", an event without precedent for a major fund. This set off broad-based but selective shareholder redemptions, like a bank run (Fender et al (2008)).

Data by fund show three aspects of this run. First, punishment: the buck breaker did "suffer massive withdrawals", as expected (Stigum and Crescenzi (2007)). The Primary Fund had \$25 billion of redemption orders on 15 September (Commonwealth (2009)) and by 19 September another \$35 billion, for a total of \$60 billion out of \$62 billion. Although reporting an unbroken buck, Reserve's \$10 billion US Government Fund received \$6 billion in sell orders. Second, contagion and flight to safety: other prime funds also suffered redemptions; meanwhile, government funds received inflows (Graph 3, left-hand panel, which distinguishes Treasury-only funds from agency-holding government funds). Third, the who's who: if institutional investors ran, then individual investors walked. On the Wednesday and Thursday following Tuesday's breaking of the buck, institutional investors liquidated \$142 billion in 102 prime institutional funds, 16% of their holdings (Graph 4, left-hand panel). On the same days, they purchased \$54 billion in government funds, a similar percentage increase. Individuals sold a more modest \$27 billion from prime funds (3%), and bought a net \$34 billion in government funds.

A selective run:  
some funds hit ...





... with focus on funds with managers not seen as source of support

The largest redemptions occurred at institutional prime funds managed by the remaining securities firms and small independent managers, which investors doubted could support their funds. Two-day redemptions at the largest institutional prime fund managed by the three largest securities firms were 20%, 36% and 38% of assets, well above the 16% average. By contrast, the largest such funds managed by affiliates of seven large banks met two-day calls of 2%, 5%, 5%, 7%, 10%, 10% and 17% of assets (Graph 4, right-hand panel). On 21 September, Goldman Sachs and Morgan Stanley announced plans to become bank holding companies; Bank of America had announced its purchase of Merrill Lynch on 15 September. American Beacon, an independent money fund spun off by American Airlines, faced two-day redemptions of 46% of its assets and resorted to in-kind redemption.

Run leads to less demand for commercial paper and certificates of deposit

The immediate effect of investors’ shifts of funds can be seen in the differing portfolios of prime and government funds (Graph 2). The flight to safety represented new demand for Treasuries, agency securities and repos as well as less demand for CP and bank CDs. Prime funds’ holdings of repos at 11% of portfolio (Table 1) could not meet even the first two days’ redemptions at many funds. Liquidating repos forced up average maturities (Graph 3, right-hand panel) and led funds to reinvest only at the very short term.

Investors also shifted from prime money market funds into bank deposits. If US banks received the deposits while European banks repurchased their CP or CDs, then the latter needed to bid in the already strained interbank market.<sup>6</sup>

In sum, the run on money market funds threatened a run first on the CP market and then on the CD market and thereby on non-US banks. A run on the money market funds destabilised already strained global bank funding markets.

<sup>6</sup> The Federal Reserve’s H.8 release showed that demand deposits jumped \$37.4 billion (6.5%) and deposits jumped \$238 billion (4.1% seasonally adjusted) in the week to 17 September. In Table 13A, US dollar “other instruments”, mostly CDs, fell 18% in the fourth quarter of 2008.

## Policy responses

Policy responses to the run on the money market funds had two complementary but different purposes. They sought to stop the withdrawal of funds from money market funds by restoring confidence in their liquidity and solvency. And they sought to accommodate or offset the withdrawals by providing public funds so as to reduce asset sales at distress prices. With this distinction in mind, we consider the measures taken in September and October: the Treasury's money market fund guarantee and the Federal Reserve's ABCP money market fund liquidity facility (AMLF), expanded central bank swaps and the CP funding facility (CPFF).<sup>7</sup>

### *Treasury guarantee and the Federal Reserve's AMLF*

On Friday 19 September, the US President described a wide-ranging package of measures to support the financial system. In addition to proposed legislation to authorise official purchases of financial assets, there was a Treasury guarantee for money market funds' net asset value: "For every dollar invested in an insured fund, you will be able to take a dollar out." Earlier that day, the Federal Reserve had announced the AMLF to help MMFs meet demands for redemptions by investors and to foster liquidity in the money markets.

Drawing on the above distinction, the Treasury guarantee sought to stop the run by taking on risk from money market fund shareholders. The AMLF sought to stop the run by granting MMFs indirect access to Federal Reserve funding and to finance it by exchanging cash for theretofore illiquid assets.

The Treasury guarantee gained definition over the weekend and opened for business a week later on 28 September. MMFs could sign up for net asset value insurance on shares outstanding as of 19 September for three months (subsequently extended to 30 April 2009). The cost would be either 1 or 1½ basis points for three months, depending on the gap between the market value of holdings (the "shadow price") and the \$1 (1.5/2.2 basis points for the extension up to end-April). This offer was compelling: the opportunity cost of holding 5% of the portfolio in Treasury bills rather than bank CDs exceeded the insurance cost. And only those who bought insurance in the first instance were invited to participate in the extension. Industry participation reached over 98%, with just a handful of Treasury-only money funds not opting in.

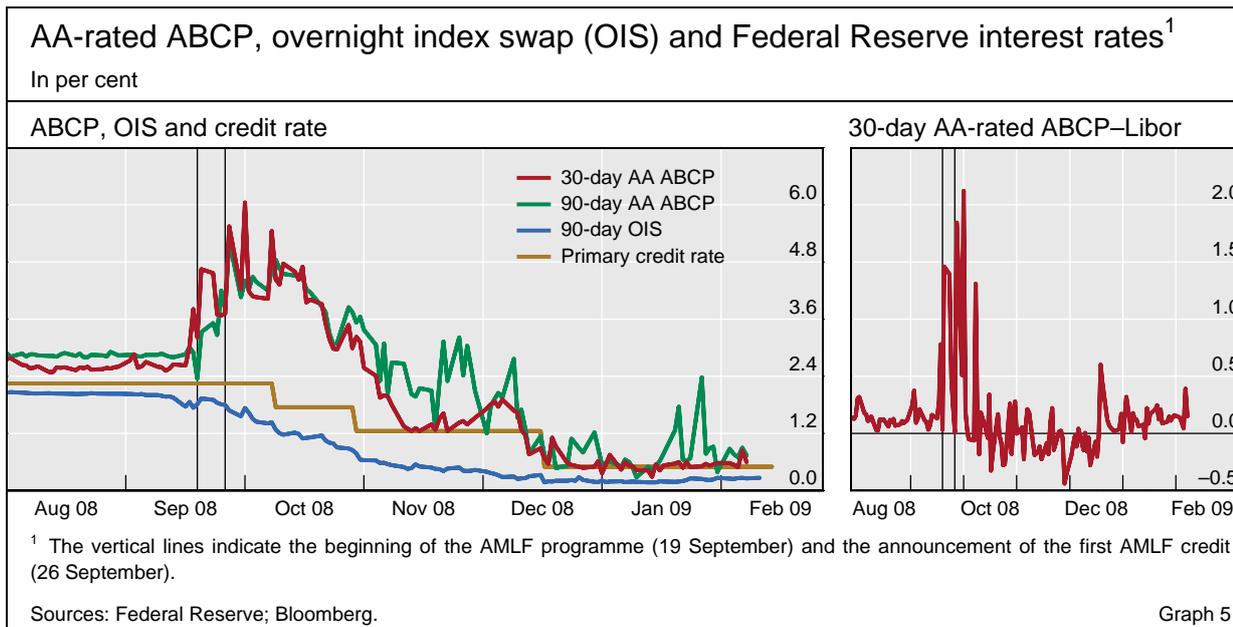
The Federal Reserve began making AMLF loans as early as Monday 22 September (Rosengren (2008)) through the adaptation of its operating procedures. Banks that bought ABCP with a top rating from two rating

US Treasury guarantees the net asset value of US money market funds ...

... Federal Reserve funds ABCP ...

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<sup>7</sup> Two additional policies may have helped to stabilise MMFs. On 10 October, the Securities and Exchange Commission allowed money market funds for 90 days to use amortised cost to measure the market value of holdings of high-quality securities of less than 60 days' maturity for the purpose of determining whether they had "broken the buck" (Plaze (2008)). Since such "shadow pricing" is not reported to shareholders, it is unknown how many trustees used this option, which expired on 12 January 2009. Industry sources suggest that the permitted accounting was not critical to other funds' not breaking the buck, perhaps because rating agencies monitored mark to market valuations. On 21 October, the Federal Reserve announced a facility to lend to special vehicles to which money market funds would sell CP. At the time of writing, this facility has not been used. These measures are not further discussed.



agencies<sup>8</sup> from MMFs at amortised cost could obtain “non-recourse” Federal Reserve funding at the Fed’s primary credit rate for the paper’s life. In other words, funds could sell paper at the purchase price, adjusted for interest, and banks could lock in a spread and transfer any credit risk to the Federal Reserve (which would have no call on the seller in case of default). Since the primary credit rate then stood well below ABCP yields (Graph 5), the custodian bank was by design a willing buyer.<sup>9</sup> By selling ABCP, the money market fund could raise funds without suffering a loss and possibly breaking the buck. Assured of such a market, funds had an incentive to buy and to hold ABCP.

... and the run stops

In the days following these measures, the institutional run on prime funds abated, as indeed it had already on Thursday 18 September, the day before the announcement, amid discussions of a guarantee.<sup>10</sup> By the end of the month the institutional run had slowed to a crawl, and the retail “walk” halted in early October. And no other fund broke the buck.

Since the two measures were announced simultaneously, market participants continue to debate their respective effects. Clearly, the mere initial announcement of both these measures did not halt the run on the institutional prime funds in its tracks. At \$36 billion, US redemptions on Friday 19 September were as large as the day before. They slowed further on the following Monday, but dropped to \$1 billion only on Thursday 25 September.

<sup>8</sup> Or a top rating from one agency if there was only one. See Estrella (2000) for issues arising from such use of single or multiple ratings.

<sup>9</sup> This was all the more the case in that the non-recourse nature of the loan from the Federal Reserve allowed the bank’s holding to be assigned a zero weight for regulatory capital purposes (*Federal Register*, vol 73, no 188, 26 September 2008, p 55706). In economic substance, the Federal Reserve was subject to downgrade and default risk and received the difference between the primary credit and the federal funds rates, then 25 basis points.

<sup>10</sup> The ICI (2008) timeline for 18 September reads: “Consults with Treasury on proposal by Secretary Henry M. Paulson for a money market fund guarantee program.”

Those who emphasise the effect of Federal Reserve funding point to the timing of the announcement of the first AMLF usage (Graph 5). As noted, the Federal Reserve began to make AMLF loans on Monday 22 September, but this was only confirmed and quantified (\$22 billion average for the week and \$73 billion outstanding on Wednesday) on Thursday 25 September. In the six working days between 16 September and this announcement, prime funds tracked by Crane (other than Reserve) had met redemptions of \$272 billion.

It may be misplaced to ask which of the two policies stopped the run. Despite their benefiting from neither the Treasury guarantee nor any AMLF funding, European-domiciled dollar MMFs generally experienced runs not much worse than those on similar US prime institutional funds with the same manager. Variation in the run by fund family, more than by domicile, highlights the role of perceptions of the need, and capacity, for support. A wide range of policies bolstering financial firms left them more able to offer support.

Money market funds not only benefited from immediate AMLF funding but also rather quickly responded to its incentives to buy ABCP once the run ended. AMLF credit peaked on 1 October at \$152 billion, no more than 21% of the ABCP market, and perhaps 30–40% of MMFs' ABCP. Notwithstanding this sale, prime funds' proportion of CP holdings stabilised in the fourth quarter after a drop in September (Graph 2). Of the top 15 prime funds, four separately identify ABCP and in two cases report that ABCP holdings actually rose to end-October from end-July, despite overall portfolio shrinkage. In all four cases, ABCP rose over the three months including September as a share of assets (by 8–14 percentage points) and as a share of CP holdings. However representative these funds were, Federal Reserve data show that private ABCP holdings bottomed out very rapidly on 8 October. For their part, 30-day ABCP yields peaked in absolute terms and relative to Libor around the end of September (Graph 5). By early 2009, AMLF credit was only 2% of ABCP.

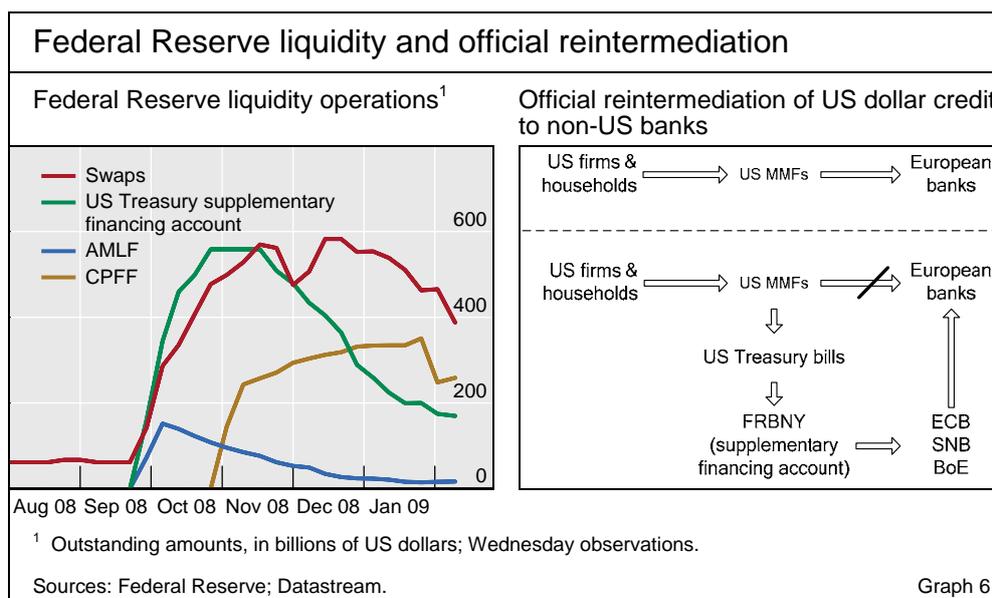
Run on US dollar money market funds in Europe offers a clue

AMLF allows money market funds to sell, and later spurs holding of, ABCP

### *The expansion of the central bank swap lines*

The run on money market funds made it almost inevitable that they cut back on their funding of non-US banks. An update of Table 1 based on end-September to end-November portfolios shows that the funds still held half of their assets in non-US banks in aggregate, with assets down by 14%.

In response to these and other pressures on non-US banks' dollar funding, central banks ramped up their transatlantic dollar funding of non-US banks. On 18 September, the Federal Reserve agreed to increase its existing swap lines with the ECB and the Swiss National Bank (SNB) to \$110 billion and \$27 billion, respectively. It also agreed new swap lines with the Bank of Japan (\$60 billion), Bank of England (\$40 billion) and Bank of Canada (\$10 billion). On 29 September, the above swap lines were at least doubled. On 13 October came an unprecedented announcement: "sizes of the reciprocal currency arrangements (swap lines) between the Federal Reserve and the BoE, the ECB, and the SNB will be increased to accommodate whatever quantity of US dollar funding is demanded [at fixed rates]".



Central banks provide US dollars to European banks and offset cutbacks by money market funds

Whereas the Treasury guarantee provided an incentive not to withdraw funds, the expansion of the swap lines between the Federal Reserve and European central banks, inter alia, offset withdrawals that resulted in less credit to European banks from US money market funds (Graph 6). Even as money funds and others shifted to safer assets, the Treasury “overfunded” its immediate cash needs and placed the proceeds in the Federal Reserve. These funds were the counterpart of the expansion of Federal Reserve funding to European central banks which in turn funded their banks. In quantity terms, the accommodation was more than complete in the last two weeks of September. Redemptions of prime funds amounted to \$350 billion in the 11 business days 16 September to 1 October. Given the allocation in Table 1, this implied an eventual loss of funding for non-US banks of \$175 billion. In the two weeks ending on 1 October, the Federal Reserve’s swaps rose by \$225 billion.<sup>11</sup>

#### *The Federal Reserve’s Commercial Paper Funding Facility (CPFF)*

On 7 October, the Federal Reserve announced a facility to restore liquidity to the CP market<sup>12</sup> and to encourage issuance of longer-term paper. Money market funds received no direct support from this facility and could not sell paper into it. As holders of 40% of US CP, however, they benefited from an assurance that eligible issuers could roll over maturing CP at a certain spread.

Until 30 April 2009 (just extended to 31 October), issuers could sell three-month CP directly to the Federal Reserve up to a level set by the shortfall of their paper currently outstanding from the maximum outstanding from January to August 2008. Similar to the AMLF, paper was to be top-rated. The price was

<sup>11</sup> Non-US banks may have also obtained Federal Reserve Term Auction credit, particularly through the Second District (New York). There, funding rose by \$17 billion on 1 October and by \$45 billion on 15 October.

<sup>12</sup> The Federal Reserve responded to a rapid decline in outstanding CP after the failure of Penn Central in 1970 by welcoming banks that lent to CP issuers at the discount window (Timlen (1977)). At the time, the banking system was healthy.

set at the three-month OIS, basically tracking the expected average federal funds rate over the period, plus 200 basis points for unsecured CP.<sup>13</sup>

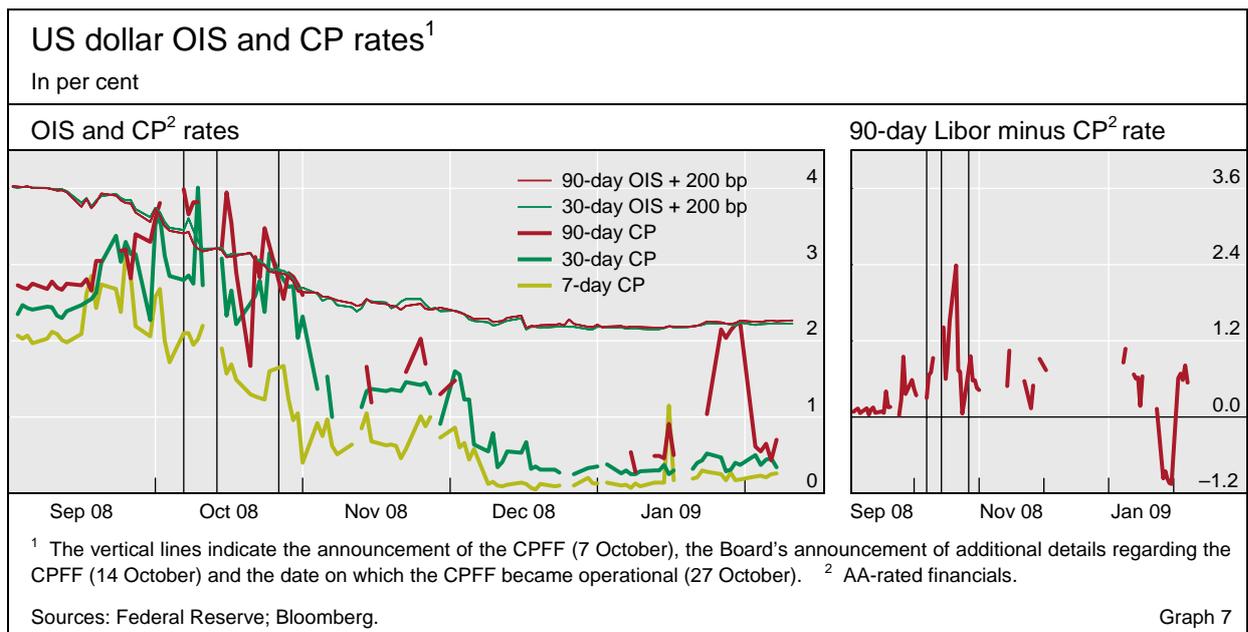
Official purchases financed repayments of maturing CP that the holder opted not to roll over, including CP of non-US banks held by money funds. While this facility thus financed a portfolio reallocation, it also gave MMFs incentives to hold CP. General Electric announced its willingness to repurchase its paper, given GE's stated eligibility for \$98 billion in Federal Reserve funding. A ready market for the *issuer* could thus encourage money market fund *investors* to purchase longer-term issues. As noted, MMFs showed no discontinuous reduction in CP holdings in late 2008. And prime funds stopped reducing their portfolio maturity in November (Graph 3, right-hand panel).

Money market funds benefit from CP issuers' access to Federal Reserve funding

In terms of pricing, the facility provided a backstop that benefited any CP buyer constrained by market prices. Term paper spreads over OIS exceeded the 200 basis point facility spread at times between the facility's announcement and its first purchases. Once purchases began, three-month yields – admittedly a market so thin that no yields were collected on many days in this period – fell under the facility's ceiling (Graph 7, left-hand panel). The denser observations on one-month yields reinforce the impression that the facility capped yields.

The gap between three-month Libor and financial CP yields (Graph 7, right-hand panel) also suggests that Federal Reserve purchases held down CP yields. Libor rose to 4.5% in October, well above the peak in CP rates. Indeed, this spread widened well beyond any experience since the Federal Reserve reduced reserve requirements on large domestic CDs and net eurodollar borrowing to zero in December 1990. In sum, the CP facility both financed repayments to MMFs and reduced their risk in continuing to hold CP.

At the first opportunity, CPFF credit has shrunk, as money market funds, inter alia, have bought CP at lower yields. Overall, seasonally adjusted CP held



<sup>13</sup> The yield would be 100 basis points less if the borrower could post acceptable collateral or obtain an acceptable guarantee. For ABCP, the yield was set at OIS plus 300 basis points.

outside the Federal Reserve recovered from a post-Lehman low of \$1.269 trillion on 12 November by \$56 billion by end-January 2009. Late January's \$100 billion decline in CPFF credit showed, however, that issuers had found credit elsewhere as well, including by sale of bonds, some with official guarantees.

## Conclusions and prospects

Money flowed into money market funds in 2007–08 in search of a safe haven. But these funds were ill-designed to serve as such in times of extreme market strains, given a business model of not “breaking the buck” while competing on yield. Non-US banks' funding benefited from these inflows initially but subsequently suffered when losses on Lehman securities set off a run. Global interbank and foreign exchange markets felt the strain. Policies succeeded in stopping the run, thereby stabilising money market funds' assets and their holdings of non-US banks' paper. Policies also more than replaced the funding to non-US banks previously provided by money market funds.

The future of the money market fund industry is not clear. Those in the industry tend to take the view that too much should not be made of one fund that tried to shoot the moon. According to them, events have shown that money market funds can survive much stress if they get the credit analysis right.

Some former policymakers and current market participants, however, have called for money market funds that offer transaction services, withdrawal on demand and a stable net asset value to be organised and supervised as banks with access to last resort lending (Group of 30 (2009)). Further, they would require any short-term funds that were not thus organised and supervised to have a floating net asset value.

US securities firms' becoming bank holding companies points in this direction. They could seek deposits and follow the lead of Merrill Lynch, which, well before its funding risks became evident or it was acquired by Bank of America, shifted retail “cash management accounts” from a money market fund to its own bank. In contrast, banks have moved strategically to manage money market funds, but their heavy support to them over the last two years raises questions.

Such proposals and developments leave open the future allocation of the current \$3.4 trillion portfolio of US taxable money market mutual funds. In particular, their ultimate importance as providers of dollars to non-US banks remains to be seen. For now, flows from low-yielding Treasury funds to prime funds could provide a near-term boost to non-US banks' funding in US dollars.

## References

Baba, N and F Packer (2008): “Interpreting deviations from covered interest parity during the financial market turmoil of 2007–08”, *BIS Working Papers*, no 267.

Baba, N, F Packer and T Nagano (2008): “The spillover of money market turbulence to FX and cross-currency swap markets”, *BIS Quarterly Review*, March, pp 73–86.

Commonwealth of Massachusetts, Office of the Secretary, Securities Division (2009): “Administrative complaint in the matter of Reserve Management Company Inc, Reserve Partners, Inc., Reserve Funds Trust and Bruce Bent II”, docket number 2008-0079, 17 January.

Crane Data Archives (2008): “News archives, December 2008”.

Dudley, W C (2007): “May you live in interesting times”, remarks at the Federal Reserve Bank of Philadelphia, 17 October.

Estrella, A et al (2000): “Credit ratings and complementary sources of credit quality information”, *Basel Committee on Banking Supervision Working Papers*, no 2, August.

Fender, I, A Frankel and J Gyntelberg (2008): “Three market implications of the Lehman bankruptcy”, *BIS Quarterly Review*, December, pp 6–7.

Fender, I and P Hördahl (2007): “Overview: Markets hit by renewed credit woes”, *BIS Quarterly Review*, December, pp 1–17.

Fitch Investors (2009): “Global money market fund rating criteria”, January.

Group of 30, Working Group on Financial Reform (2009): *Financial reform: a framework for financial stability*, 15 January.

Investment Company Institute (2008): Annual Report (November).

McCauley, R (2007): “The evolving instrument composition of official holdings of US dollars”, *BIS Quarterly Review*, December, pp 27–8.

McCauley, R and L Hargreaves (1987): “Eurocommercial paper and US commercial paper: converging money markets?”, Federal Reserve Bank of New York *Quarterly Review*, Autumn, pp 24–35.

McCauley, R and R Seth (1992): “Foreign bank credit to US corporations: the implications of offshore loans”, Federal Reserve Bank of New York *Quarterly Review*, vol 17, Spring, pp 52–65.

McGuire, P and G von Peter (2009): “The US dollar shortage in global banking”, *BIS Quarterly Review*, March.

Moody’s Investors Services (2008): “Parental support in money market funds: Moody’s perspective”, November.

Plaze, R E (2008): “No-action letter to Karrie McMillan, General Counsel, Investment Company Institute”, Securities and Exchange Commission, 25 September and 10 October.

Rosengren, E (2008): “The impact of financial institutions and financial markets on the real economy: implications of a ‘liquidity lock’”, speech at the University of Wisconsin, Madison, 9 October.

Securities and Exchange Commission (2008): “SEC issues clarification on accounting issues relating to bank support for money market mutual funds”, 2008–205, 17 September.

Standard & Poor’s (2008): “Money-market fund support weighs on fund managers and bank sponsors”, 4 December.

Stecklow, S and D Gullapalli (2008): “How money-fund manager’s shift in course ‘broke the buck’”, *The Wall Street Journal*, 9 December, pp 16–17.

Stigum, M and A Crescenzi (2007): *Stigum’s money market*, 4th edition, New York: McGraw Hill.

Timlen, T (1977): “Commercial paper – Penn Central and others”, in E J Altman and A W Sametz (eds), *Financial crises: institutions and markets in a fragile environment*, New York: John Wiley and Sons, pp 220–5.



## Execution methods in foreign exchange markets<sup>1</sup>

*Over the past decade or so, the spread of electronic trading has brought about significant changes in the structure of the interbank foreign exchange markets and the relationship between foreign exchange dealers and their clients. This article looks at the way foreign exchange transactions are executed based on the BIS triennial survey data, and provides some quantitative estimates of the importance of electronic trading across transaction types, counterparties and economies.*

*JEL classification: F31, G15.*

One of the most significant developments in the foreign exchange market over recent decades has been the introduction and growth of new electronic trading technologies. In addition to increasing the efficiency of foreign exchange markets, the diffusion of this technology has allowed new market segments to develop. As a result, the distinction between the interbank and other markets has blurred.

The 2007 BIS Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity (BIS (2007))<sup>2</sup> asked participating central banks for information on the way foreign exchange transactions were executed in April 2007. This was the first time these data were published, and provides an opportunity to examine the extent to which electronic trading methods are used across economies. Based on these data, we make three main observations. First, electronic means of execution are more commonly used for spot transactions, which are more homogeneous and therefore more readily automated. Second, although electronic methods are more likely to be used in the interbank market, their prevalence has increased rapidly to similar levels for transactions between foreign exchange dealers, typically banks, and financial customers, such as hedge funds or pension funds. Finally, the take-up of electronic execution methods varies considerably across economies. In

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<sup>1</sup> The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS or the Reserve Bank of Australia. We would like to thank Carlos Mallo, Jhuvesh Sobrun and Andrew Zurawski for their help in preparing this article.

<sup>2</sup> The final triennial survey publication is available on the BIS website at [www.bis.org/publ/rpfx07t.htm](http://www.bis.org/publ/rpfx07t.htm).

general, industrialised economies have the highest diffusion of electronic methods while smaller financial centres have relatively low shares.

The following section describes the evolution of electronic trading in the foreign exchange market and discusses the implications this has had for its structure. Next, the feature presents the triennial survey data by transaction type, counterparty and location and highlights some stylised facts. The final section summarises the conclusions.

## The evolution of electronic execution methods

Until the late 1980s foreign exchange transactions depended mostly on phone-based technologies. A dealer needing to enter into a foreign exchange transaction would call a counterparty to get both the bid and offer rates for a specific transaction size. The size of the deal would typically influence the prices received. This “two-sided” price quoting was standard practice in foreign exchange markets as it limited market-makers’ ability to adjust quoted prices in order to take advantage of information about the counterparty’s intentions to buy or sell foreign exchange. At the same time, these phone calls were the only way to get direct bank prices, so frequent calls were required to keep up to date on the latest price developments (“price discovery”) (Galati (2001)). Although most transactions took place directly between banks, indirect dealing could also occur through brokers. Dealers would phone a voice broker, who would search for matching interest among their clients to complete a transaction. Voice brokers were beneficial in terms of both saving time on price discovery and the convenience of only needing to show a bid or an offer rate.

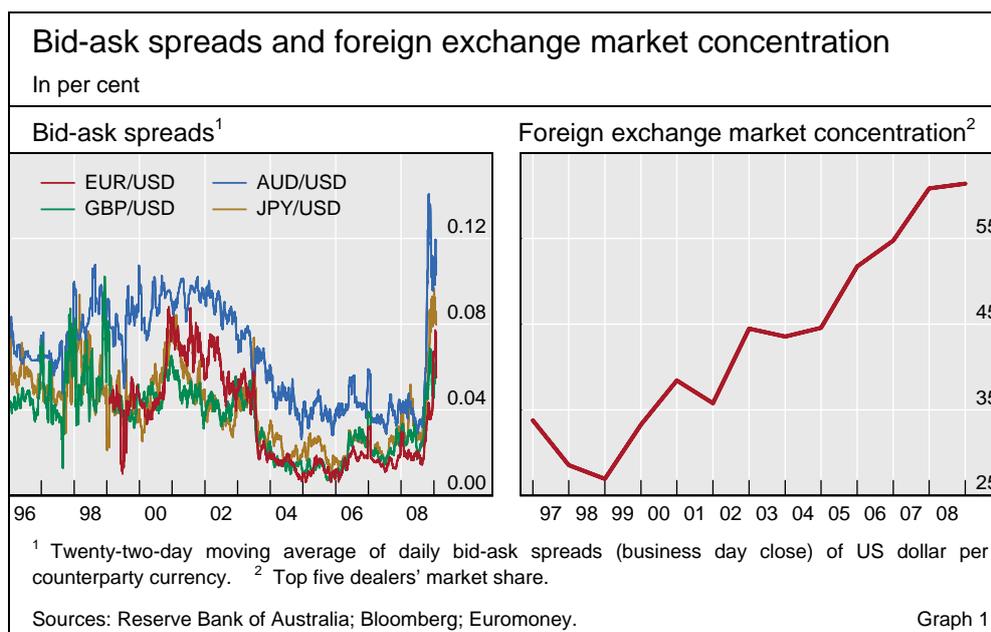
Traditionally, foreign exchange trades were mainly done directly by phone

Given advances in technology and the relatively simple structure of some foreign exchange deals, it was only a matter of time before electronic technologies were implemented in foreign exchange markets. In 1989 Reuters began offering participants in the interbank market a so-called electronic broking service, whereby trading is carried out through a network of computer terminals linked among participating users, and new orders are matched with outstanding orders already in the system. In the early 1990s a consortium of banks launched EBS to provide a similar service.<sup>3</sup> Electronic broking systems allow banks to make a “one-way” price quote and, in addition to the best bid and offer prices, display information about the closest bids and offers in the system. The resulting transparency of prices obviates the need to spend resources on price discovery activities, as interbank price quotes are now available at all times to participating interbank dealers. Another important feature of these systems is that a large order can be matched with several small ones, which allows banks to make a one-way price quote for smaller amounts. Access to these systems therefore enabled smaller institutions to deal at more favourable spreads that had previously been available only to large institutions. Reuters Matching and EBS continue to dominate in the inter-dealer market, although they cover somewhat different currencies: while

Electronic broking systems evolved in the 1990s

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<sup>3</sup> EBS has subsequently been bought by ICAP to complement its other broking services.



Reuters Matching specialises in major Commonwealth currencies, EBS has much more trading in the US dollar, euro, yen and Swiss franc.

As a result of the increased penetration of electronic broking systems, the efficiency of interbank foreign exchange markets has improved significantly. This can be observed in the decrease in the bid-ask spreads quoted in the interbank market over the 1990s and early 2000s (Barker (2007); see also Graph 1, left-hand panel). One consequence of the associated sharp fall in margins has been a shift by market participants towards a business model that focuses on high volumes of low-margin transactions (Barker (2007)). The high fixed costs of making the investment required to put in place and maintain the systems that can handle high volumes of transactions have been one of the factors behind the increased concentration of liquidity provision and market-making in the interbank market (ECB (2003); see also Graph 1, right-hand panel).

The downward trend in bid-ask spreads had levelled off by the mid-2000s but increased significantly following the failure of Lehman Brothers in September 2008. As volatility in foreign exchange markets spiked to nearly three times normal levels (Reserve Bank of Australia (2009)), bid-ask spreads for many major currency pairs more than doubled between September and December (Graph 1, left-hand panel).

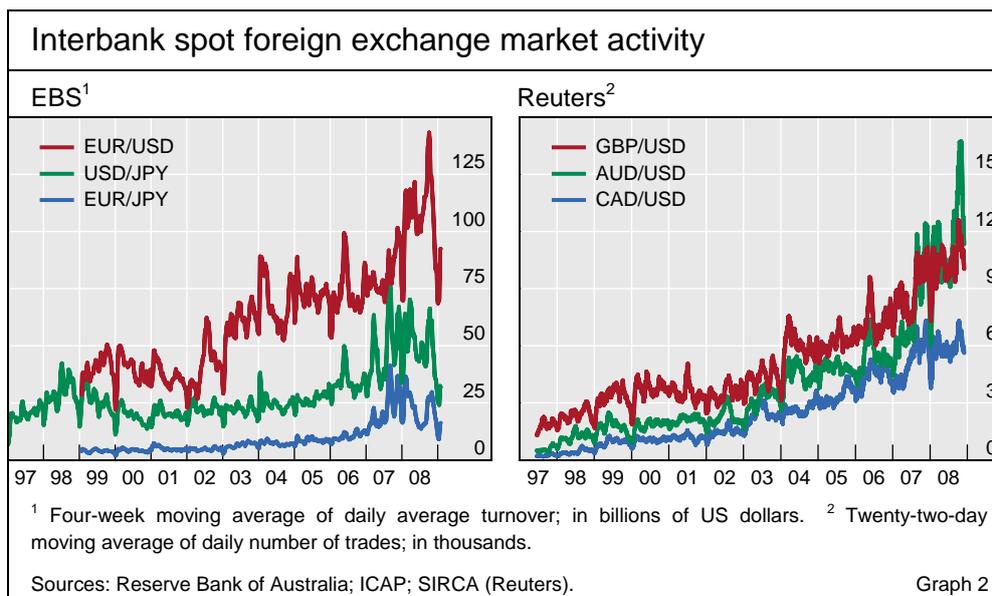
Turnover on EBS and Reuters, which grew rapidly over most of the past decade, also reversed course in late 2008 (Graph 2). Though activity in interbank markets in many currency pairs levelled off in mid-2007, growth resumed in some major currency pairs, such as the euro/US dollar, in 2008. But in late 2008, activity levels dropped sharply across the board: turnover for the three most traded currency pairs in EBS roughly halved between the end of September and the end of the year.

Although aggregate turnover could be expected to fall in extremely volatile conditions, there are several reasons why recent market volatility may have disproportionately affected electronic trading turnover. First, the general

Electronic broking has increased the efficiency of interbank markets ...

... although the downward trend in bid-ask spreads has recently reversed ...

... as has the uptrend in turnover



reduction in risk appetite may have had a larger adverse effect on the activities of market participants that are more active users of electronic methods, such as proprietary and prime brokerage accounts. Second, market-makers may have been less willing to quote on electronic platforms to avoid being caught by adverse price movements, thereby driving activity through phone transactions. In addition, some forms of trading activity, such as automated trading, which rely on electronic execution methods and are based on rules designed to work in normal conditions, may be abandoned at times of unusually high volatility.

Some time after the development of electronic broking systems became established in the interbank market, some foreign exchange providers developed electronic trading systems that allowed them to transact electronically with their customers. This opened electronic execution methods to counterparties that had not had access to electronic broking systems (Christodoulou and O'Connor (2007)). Initially, some large foreign exchange trading banks provided electronic execution to their customers through "single-bank" platforms. These largely internet-based systems allow a client to deal directly with their bank and, generally, to automate trading processes. Banks were motivated to develop these proprietary platforms both to create new opportunities as the profitability of the interbank market decreased and to meet demand for foreign exchange services from a range of clients, from smaller corporate customers to sophisticated financial institutions, such as hedge funds (ECB (2003)). Subsequently, demand from clients for prices from several sources led to the development of multibank electronic trading systems, such as Currenex, FX Connect and FXall, established between 1999 and 2002. These systems allow different market-makers to quote prices in competition with one another. In contrast to electronic broking systems in the interbank market, there are a large number of electronic trading systems that allow clients to execute foreign exchange transactions with banks. A dominant business model has yet to emerge. For example, some multibank electronic trading systems provide prices in response to requests for quotes, while others stream quotes with a limit order book (Celent (2007)).

Electronic trading between banks and their clients evolved later ...

... allowing new market segments to emerge

The developments described above have significantly changed the relationship between banks and their customers. In particular, as larger banks have invested in technology to handle large volumes of transactions executed electronically with their clients, a number of new market segments have emerged, such as white labelling, prime brokerage, algorithmic trading and retail margin trading.<sup>4</sup>

### A snapshot of execution methods used in April 2007

The 2007 triennial survey is the first dataset that contains information on execution methods used in foreign exchange markets across economies. The survey asked banks to provide information on whether foreign exchange transactions were executed directly with another bank that deals in foreign exchange, directly with a customer, indirectly through a voice broker or indirectly through electronic means, categorised as electronic broking systems, multibank trading systems or single-bank trading systems. The survey also collected data by execution method broken down by transaction type and counterparty. The transactions distinguished were: spot transactions, outright forwards, foreign exchange swaps and options. The counterparty categories reported comprised: reporting dealers, which are typically banks; other financial institutions, which include hedge funds, pension funds and smaller banks; and non-financial customers.

Incidence of electronic methods is highest for spot market transactions ...

In total, around one third of all foreign exchange transactions are executed electronically.<sup>5</sup> Disaggregating the triennial survey by transaction type shows that electronic execution methods are most prevalent in the spot market, accounting for over half of turnover on a global basis (Table 1). Electronic broking systems, such as Reuters Matching or EBS, account for around 32% of all spot market transactions, while single- and multibank electronic trading platforms represent 17% and 8%, respectively. Among non-electronic methods, the most important way of executing spot transactions is directly between banks and their customers (“customer direct”).

... and lower for more complex instruments

Electronic execution methods are used less frequently for more complex instruments. Around 30% of outright forward transactions take place electronically, predominantly through electronic trading systems. In contrast to

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<sup>4</sup> White labelling is an arrangement whereby a smaller bank outsources the provision of foreign exchange services for its clients to a larger bank (Barker (2007)). Prime brokerage allows large banks to provide sophisticated clients, such as hedge funds, with the ability to trade foreign exchange in the bank’s name using the bank’s credit rating (Foreign Exchange Committee (2005)). Algorithmic trading strategies fully automate the process of entering data, applying decision rules and executing the chosen trades (Pelham (2006)). Margin trading for retail customers has become increasingly important in recent years, particularly in Japan (Terada et al (2008)). This has contributed to the blurring of the distinction between wholesale and retail customers.

<sup>5</sup> Data were collected on a “gross-gross” basis, meaning that there is double-counting of local and cross-border inter-dealer transactions. Data on the size of this effect for each transaction type and counterparty appear in Table E.1 of the triennial survey. The turnover data used in Tables 1 and 2 are scaled by this adjustment, and are therefore net of local and cross-border double-counting.

Foreign exchange market turnover by execution method <sup>1</sup>							
Daily averages in April 2007, percentage share by transaction type							
	Inter-dealer direct	Voice broker	Customer direct	Electronic methods			
				Broking systems	Multibank trading systems	Single-bank trading systems	Total
Spot transactions	13	2	28	32	8	17	57
Outright forwards	17	8	45	7	11	12	30
FX swaps	22	27	25	13	6	6	25
OTC FX options	26	16	51	4	2	2	8
Total	19	17	30	17	7	10	34

<sup>1</sup> Adjusted for local and cross-border inter-dealer double-counting, "net-net".  
Source: BIS Triennial Survey. Table 1

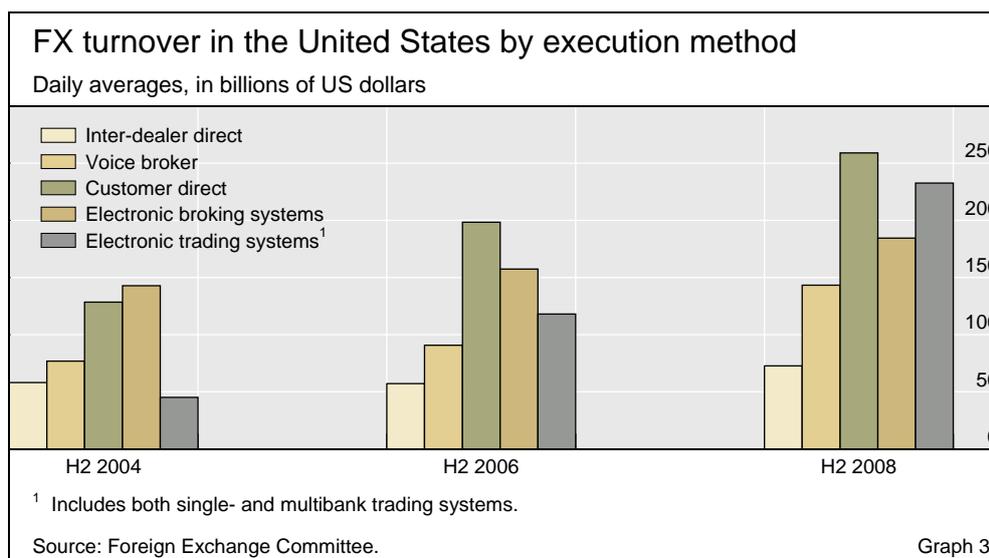
spot transactions, most outright forwards are conducted directly between banks and their customers. Electronic execution is used for around one quarter of all foreign exchange swap transactions. Unlike outright forwards, electronic broking systems are employed relatively frequently in foreign exchange swap transactions, which, in comparison with other transactions, also appear to use voice brokers more frequently. A relatively small percentage of foreign exchange options is traded electronically, which is compatible with their more complex and less homogeneous nature.

Electronic execution methods are extensively used across all counterparties. Around 35% of interbank transactions are executed electronically, with almost two thirds of this accounted for by electronic broking systems (Table 2). Almost half of all interbank transactions occur directly between dealers (the category "inter-dealer direct"), and voice brokers execute the remainder. A similar share of transactions between banks and other financial institutions is done electronically, although electronic broking systems are less important. More than 30% of transactions between banks and their

Electronic execution is common for all counterparties

Foreign exchange market turnover by counterparty <sup>1</sup>							
Daily averages in April 2007, percentage share by counterparty							
	Inter-dealer direct	Voice broker	Customer direct	Electronic methods			
				Broking systems	Multibank trading systems	Single-bank trading systems	Total
Reporting dealers (interbank)	45	20	–	23	5	7	35
Other financial institutions (non-bank)	–	18	48	15	8	11	34
Non-financial customers	–	7	62	9	8	14	31
Total	19	17	30	17	7	10	34

<sup>1</sup> Adjusted for local and cross-border inter-dealer double-counting, "net-net".  
Source: BIS Triennial Survey. Table 2



non-financial customers take place electronically (with around half of this share accounted for by single-bank trading systems), while almost two thirds occur directly between the reporting bank and the customer.

Given the relatively rapid growth in turnover between banks and other financial institutions as well as non-financial customers (BIS (2007)), and the importance of multibank and single-bank trading systems for these counterparty categories, these data suggest that turnover through these trading systems has increased significantly faster than that executed on electronic broking systems. Data from the Foreign Exchange Committee on foreign exchange turnover in the United States, which show that turnover through electronic trading systems (both multibank and single-bank) has grown at an exceptionally rapid pace, support this conjecture (Graph 3).

The importance of electronic execution in foreign exchange markets across different economies varies widely (Table 3).<sup>6</sup> In a number of cases, the share of electronic methods is consistently high (or low) across all instruments and counterparties. For example, it is consistently high across all market segments for Switzerland and Germany, but consistently low for Denmark, Latin America and smaller financial centres in Asia. In other instances, the aggregate numbers reflect differences in the composition of turnover and in the predominance of electronic methods. For example, both Australia and Hong Kong SAR have relatively low incidence of electronic methods in their interbank markets. However, the interbank market makes up a much more significant share of total turnover in Hong Kong, resulting in a lower incidence of electronic methods in aggregate.

Importance of electronic execution varies by location

<sup>6</sup> Data by economy can only be adjusted for local dealer double-counting. In Table 3, the level of turnover is scaled by estimates of local dealer double-counting, which are available in Tables E.9 to E.11 and Table E.28 of the triennial survey. This adjustment typically has only small effects on the reported shares because the share of turnover between local reporting dealers is generally small, particularly in the larger financial centres.

Global foreign exchange market turnover by execution method <sup>1</sup>					
Daily averages in April 2007, percentage share by location					
	Inter-dealer direct	Voice	Customer direct	Electronic methods	Economy share <sup>2</sup>
United Kingdom	22.9	18.8	27.9	30.4	34.1
United States	12.2	15.7	31.9	40.2	16.6
Switzerland	8.9	22.4	14.5	54.2	6.1
Japan	31.5	18.8	17.4	32.3	6.0
Singapore	34.4	17.5	12.4	35.6	5.8
Hong Kong SAR	45.5	19.5	9.9	25.0	4.4
Australia	33.0	20.2	15.2	31.6	4.3
France	16.6	33.3	16.7	33.4	3.0
Germany	22.6	2.2	12.4	63.7	2.5
Denmark	67.2	1.4	17.2	14.1	2.2
Canada	29.2	11.3	26.7	32.8	1.5
Russia	28.1	9.5	27.6	34.8	1.3
Other industrialised <sup>3, 4</sup>	35.0	8.4	22.2	34.4	6.7
Other Asia <sup>3, 5</sup>	29.8	17.2	26.2	26.8	2.4
Latin America <sup>3, 6</sup>	24.3	14.3	36.7	24.7	0.6
Central and eastern Europe <sup>3, 7</sup>	40.7	6.9	25.0	27.5	0.8
Other <sup>3, 8</sup>	32.1	5.4	18.6	43.8	0.5
Average <sup>3</sup>	32.8	11.5	23.8	31.8	–
Aggregate	19.1	16.7	30.2	34.0	–

<sup>1</sup> Adjusted for local double-counting, "net-gross". <sup>2</sup> Total country turnover as a share of global turnover. <sup>3</sup> Average of component shares. <sup>4</sup> Austria, Belgium, Finland, Greece, Ireland, Italy, Luxembourg, the Netherlands, New Zealand, Norway, Portugal, Spain and Sweden. <sup>5</sup> Chinese Taipei, India, Indonesia, Korea, Malaysia, the Philippines and Thailand. <sup>6</sup> Brazil, Chile, Colombia, Mexico and Peru. <sup>7</sup> Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovenia and Turkey. <sup>8</sup> Bahrain, Saudi Arabia and South Africa.

Source: BIS Triennial Survey. Table 3

## Conclusion

The development of electronic broking and trading systems represents one of the most significant catalysts of structural change in foreign exchange markets over the past decade or so. Although there has been substantial commentary about the increased penetration of electronic execution methods for foreign exchange and the changes in business models and strategies it has enabled, little has been produced in the way of comprehensive data that allow the importance of the trend to be quantified.

Data from the triennial survey provide an opportunity to look at the importance of electronic execution methods across economies for different foreign exchange transactions and counterparties. The survey confirms that the prevalence of electronic execution methods declines as the complexity of the instrument increases. More than half of foreign exchange spot turnover worldwide is executed electronically, whereas less than one tenth of foreign exchange options are. The results presented by counterparty show that although the development of execution methods started with electronic broking systems in the interbank market, the use of electronic methods to execute

transactions between banks and financial customers, such as hedge funds or pension funds, has expanded rapidly and has captured a similar market share. The survey results also indicate that the use of electronic execution methods varies widely across economies. Some economies, notably Germany and Switzerland, have a consistently high share of electronic execution methods across market segments, while in other economies, particularly smaller financial centres, electronic execution methods are less important.

## References

Bank for International Settlements (2007): *Triennial central bank survey of foreign exchange and derivatives market activity in 2007*, December.

Barker, W (2007): "The global foreign exchange market: growth and transformation", *Bank of Canada Review*, autumn, pp 3–12.

Celent (2007): *Electronic platforms in foreign exchange trading*, January.

Christodoulou, G and P O'Connor (2007): "The foreign exchange and over-the-counter derivatives markets in the United Kingdom", *Bank of England Quarterly Bulletin*, Q4, pp 548–63.

ECB (2003): *Review of the foreign exchange market structure*, March.

Foreign Exchange Committee (2005): *2005 Annual Report*.

Galati, G (2001): "Why has global FX turnover declined? Explaining the 2001 triennial survey", *BIS Quarterly Review*, December, pp 39–47.

Pelham, M (2006): "Automation creates level playing field for FX traders", *The Banker*, August, pp 30–3.

Reserve Bank of Australia (2009): "Box A: Volatility in global financial markets", *Statement on Monetary Policy*, February, pp 29–30.

Terada, T, N Higashio and J Iwasaki (2008): "Recent trends in Japanese foreign-exchange margin trading", *Bank of Japan Review*, 2008-E-3, September.