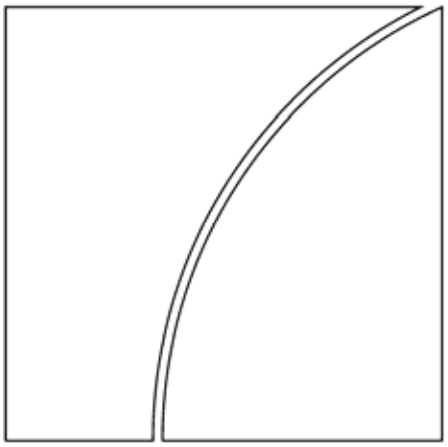
BANK FOR INTERNATIONAL SETTLEMENTS

BIS Quarterly Review

September 2008



International banking and financial market developments

BIS Quarterly Review
Monetary and Economic Department

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Special features

Recent initiatives by Basel-based committees and groups

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.

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Overview: markets adjust to cyclical downturn

During the period from end-May to late August 2008, global financial markets adjusted to growing signs of a broad-based cyclical deterioration. While markets continued to display signs of fragility, worries about the economic outlook and related uncertainties gained prominence, weighing on valuations across asset classes.

Credit markets came under renewed pressure over the period, as spreads widened to reflect the implications of the ongoing cyclical adjustment for loss expectations and financial sector balance sheets. This was despite retreating oil and commodity prices, government action in support of the US housing market and continued recapitalisation efforts by banks and other financial firms. Equity markets reflected similar concerns, as valuations adjusted to reflect disappointing earnings data, including in the financial and other cyclical sectors. Against this background, pressures in interbank money markets persisted, prompting further central bank action to enhance the effectiveness of their liquidity facilities.

As market expectations regarding price levels and monetary policy shifted against the backdrop of changing oil and commodity prices, government bond yields moved to price lower short-term growth prospects and the possibility of higher inflation in the longer run. Worries about inflationary pressures and deteriorating external financing conditions also weighed on emerging market assets, before declining oil and commodity prices seemed to provide temporary relief. With weaker macroeconomic conditions thus moving more clearly into focus, equity prices declined and emerging market spreads increased, although to varying degrees across countries and regions.

Credit markets price cyclical deterioration

Following a period of broadly improving conditions in credit markets after the government-facilitated takeover of Bear Stearns in mid-March, credit spreads came under renewed upward pressure from end-May. With markets trying to assess the implications of cyclical developments for credit quality, attention increasingly turned from a near-exclusive focus on financial sector health to the broader macroeconomic outlook. The emerging environment of higher inflation and lower growth, in particular, suggested that corporate earnings and credit quality were likely to be eroded from the input cost as well as from the demand

side. Credit markets were thus seen as anticipating gradually rising default rates and higher related financial sector losses, though without the environment of disorderly deleveraging witnessed earlier in the year.

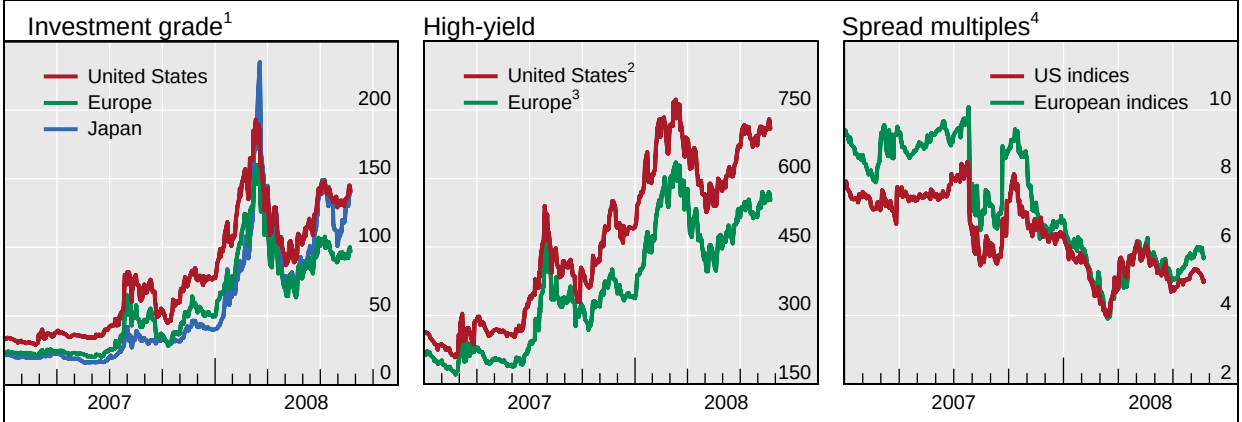
Credit spreads widen once again …

Against this background, benchmark credit default swap (CDS) indices witnessed broadly increasing spreads between end-May and 22 August, while easing somewhat from mid-July. Widening spreads came on the back of revived concerns about financial sector writedowns and weak equity markets, with market sentiment improving in response to easing oil prices and backstop measures by the US authorities targeted at two government-sponsored housing finance agencies. Overall, by the end of the period under review in late August, the US five-year CDX high-yield index spread widened by almost 136 basis points to near 709, while corresponding investment grade spreads rose by 39 basis points to around 141. European and Japanese CDS indices broadly mirrored the performance of their US counterparts, with investment grade spreads rising by some 19 and 58 basis points, respectively. The European five-year iTraxx Crossover credit index, in turn, increased by 106 basis points to 553 (Graph 1).

… following monoline downgrades …

Earlier concerns regarding financial sector balance sheets resurfaced in early June, following negative rating actions on major monoline insurers and deteriorating earnings prospects for financial firms. Moody's decided to place the ratings of MBIA and Ambac on review for downgrade on 4 June, and Standard & Poor's lowered its ratings of the same companies from AAA to AA the next day. Further downgrades of monoline and mortgage insurers followed later in the month, reigniting fears about valuation losses on the securities insured by these companies and related asset disposals. Weak earnings announcements by major investment banks in mid-June added to the negative news, reminding market participants that the cyclical adjustment associated with the financial crisis had not yet run its course. As a result, credit markets repriced on a broad basis, with widening financial sector spreads contributing

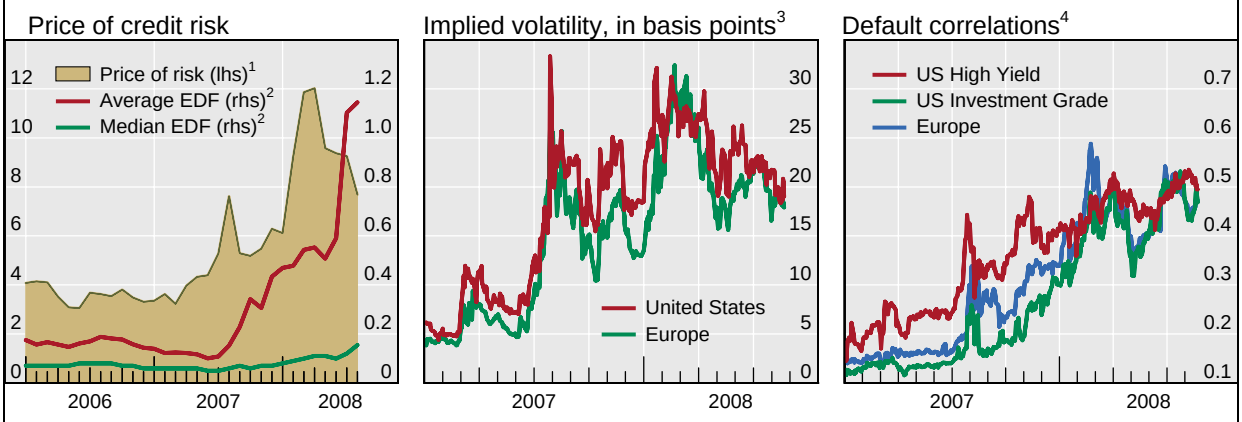
Credit spread indices



[1] Five-year on-the-run CDS mid-spread on index contracts of investment grade quality (DJ CDX IG, iTraxx Europe and iTraxx Japan), in basis points. [2] Five-year on-the-run CDS mid-spread on the DJ CDX HY index, in basis points. [3] Five-year on-the-run CDS mid-spread on the iTraxx Crossover, in basis points. [4] Ratio of the DJ CDX HY over the DJ CDX IG and the iTraxx Crossover over the iTraxx Europe investment grade index, respectively.

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

Price of risk, implied volatilities and default correlations



[1] Ratio of risk neutral to empirical probabilities of default. 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 value for the median name in a large sample of BBB-rated and non-investment grade entities. [2] In per cent. [3] 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. [4] Implied default correlations based on prices for the most junior loss tranches of the DJ CDX HY, DJ CDX IG and iTraxx IG indices.

Sources: JPMorgan Chase; Markit; Moody's KMV; BIS calculations. Graph 2

to an underperformance of investment grade relative to lower-quality debt in June (Graph 1, right-hand panel).

Despite these movements, all five major credit indices remained well below the record highs of March 2008, a sign that concerns about systemic risk had not returned to previous levels. Similar signs emerged from recovering volumes in the international debt securities markets, where gross issuance by financial sector and other investment grade entities surged by some $370 billion in the second quarter (see the highlights section on page 13 for more detail). Risk tolerance also recovered from the depressed levels observed earlier in the year, as suggested by the price of credit risk extracted from credit spread-implied and empirical default probabilities of lower-quality borrowers (Graph 2, left-hand panel). That said, risk premia were still elevated, consistent with implied volatilities from CDS index options, which continued to exceed the levels before the start of the financial crisis in mid-2007 (Graph 2, centre panel). At the same time, default correlations implied by tranched index products remained elevated in both the United States and Europe, indicating that investors were attaching a relatively high weight to cyclical as opposed to firm-specific risk factors (Graph 2, right-hand panel). Observed pricing patterns thus continued to be consistent with expectations of a cyclical increase in default rates.

… and expectations of a cyclical increase in default rates

Negative cyclical expectations were fuelled by further weakness in housing markets. Mortgage delinquencies and foreclosures in the United States rose further, with house price depreciation projected to extend well into the future (Graph 3, left-hand panel). Signs of softening house prices also emerged in key European economies, while bankruptcies in the real estate and construction sectors put pressure on credit spreads in Japan. The broad-based weakness in housing markets, in turn, implied further valuation losses on mortgage-backed securities (MBS). This included the US subprime mortgage

segment, where key indices referencing mortgage loans originated in 2006 suffered their first principal writedowns in June and July (Graph 3, centre panel; see the special feature on page 67 for more detail on these instruments). As the mortgage market deterioration deepened, uncertainty about future losses and associated capital needs triggered fears about banks' ability to add to the $352 billion of new capital raised since the start of the crisis. Despite announcements by their regulator that they remained adequately capitalised, two major US housing agencies were hit by similar concerns. In response, by late June, credit spreads on agency debt (Graph 4, left-hand panel) and on MBS underwritten by these institutions had risen back to levels last seen in March 2008 (Graph 3, right-hand panel).

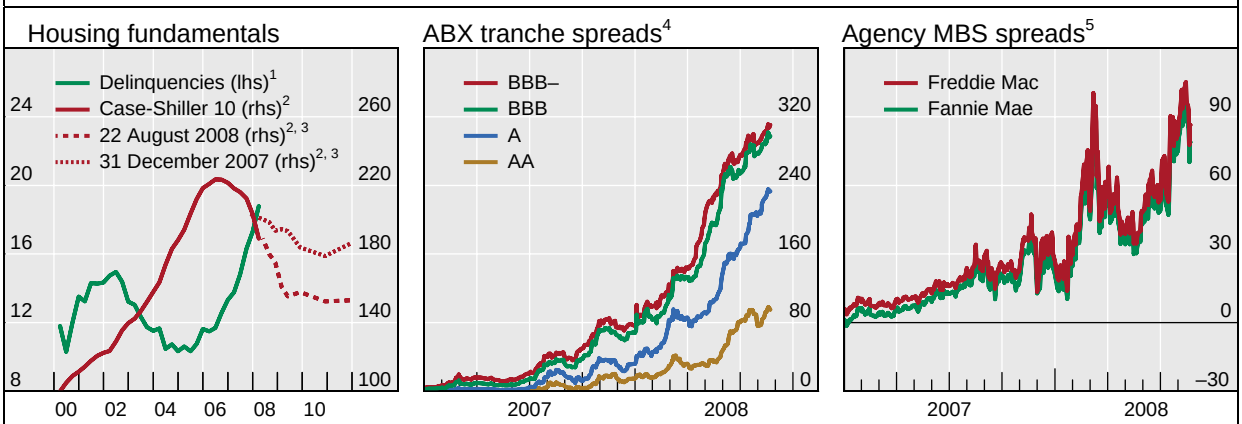
Sentiment improves in July …

Sentiment improved somewhat in July, and credit spreads, particularly in the investment grade segment, reversed part of their previous widening. The proximate trigger of the spread adjustment was an easing in oil prices from a record high on 3 July, combined with better than expected results for a number of US companies at the beginning of the earnings season and government action in support of the US housing market. Agency spreads had risen further in early July and their equity prices plummeted after the 4 July weekend (see the equity market section below). With sentiment regarding the continued viability of the US housing agencies deteriorating and much of the remaining mortgage origination activity dependent on agency securitisation, the authorities stepped in on Sunday 13 July and announced plans for backstop measures. Under the proposed initiative, which was quickly enacted, the US Treasury gained authority to increase its existing line of credit to the housing agencies and to purchase agency stock. In support, the Federal Reserve Board provided temporary authority for the Federal Reserve Bank of New York to lend to the agencies, if necessary.

… aided by backstop measures aimed at US housing agencies

Credit spreads rose during the following days, reflecting in part the takeover by the US Federal Deposit Insurance Corporation of a large California-based mortgage lender, but then tightened for the rest of the month

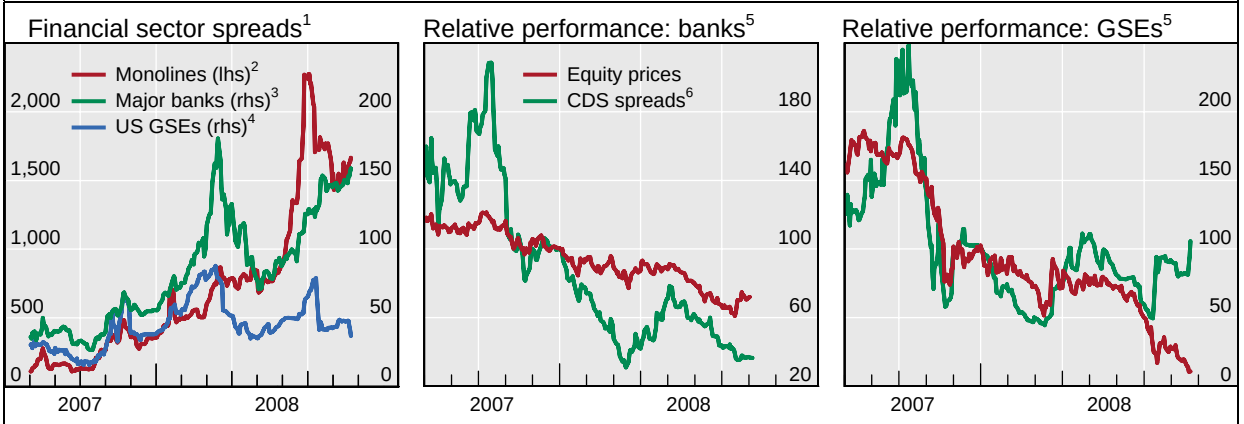
US mortgage markets



[1] Subprime loan delinquencies as a percentage of total subprime loans; seasonally adjusted. [2] House price index; 2000 Q1 = 100. [3] Implied by prices on futures contracts on the Case-Shiller 10 index. [4] Implied index spreads from CDS contracts on subprime mortgage bonds (index series ABX HE 06-2), in per cent. [5] JPMorgan index; option-adjusted spreads over Libor of mortgage-backed securities (MBS), in basis points.

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

Financial sector spreads: relative performance



[1] Equally weighted average spreads, in basis points. [2] Seven monoline financial guarantors. [3] The sample consists of 14 investment and commercial banks headquartered in North America and 11 universal banks headquartered in Europe. [4] US government-sponsored enterprises (GSEs): Fannie Mae and Freddie Mac. [5] Equally weighted average spreads and equity prices; 1 January 2008 = 100. [6] Inverted series.

Sources: Bloomberg; Markit; BIS calculations. Graph 4

(Graph 1). The change in momentum came on the back of the successful completion on 17 July of a $3 billion debt issue by one of the agencies. Agency debt valuations also recovered from their mid-July lows and outperformed corresponding equity prices in the process, as markets seemed to judge that the proposed backstop measures were aimed largely at supporting debt investors. This contrasted with the underperformance of credit spreads relative to equity prices for other major financial institutions (Graph 4, centre and right-hand panels). Spreads on agency MBS, in turn, did not tighten to the same degree as those on the agencies themselves and only with a substantial delay, suggesting a continued lack of institutional and foreign investor demand for US mortgage products (Graph 3, right-hand panel).

Concerns about asset quality are likely to persist

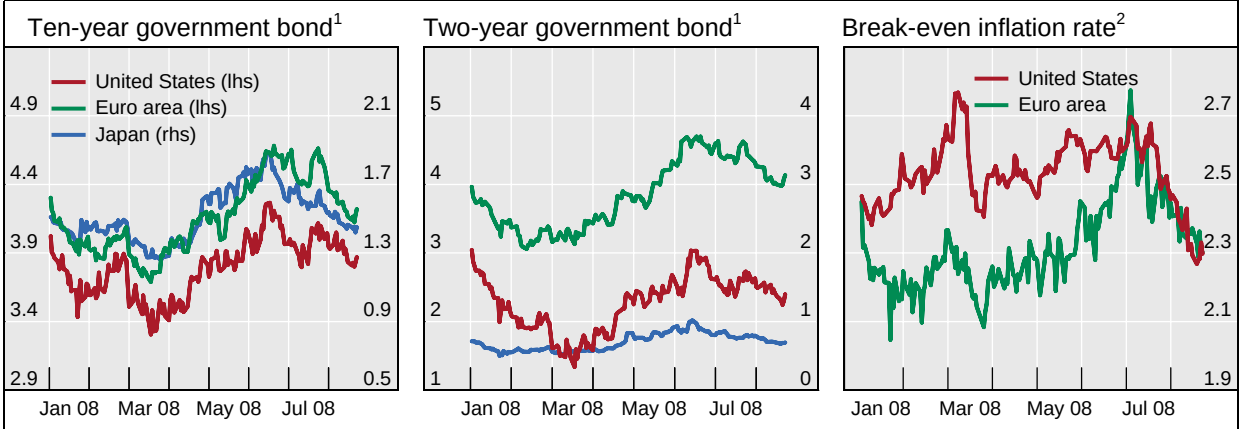
By the end of the period under review in late August, credit spreads had drifted upwards once again. The announcement by a major US bank late on 28 July of an additional writedown of $4.4 billion from the disposal of collateralised debt obligations, and news of larger than expected quarterly losses at both of the large US housing agencies and at major insurance companies in August, served as reminders that concerns about asset quality were likely to persist. Despite an aggregate $503 billion of assets written down by banks and brokerages since the start of the credit crisis in 2007, further writedowns and outright asset disposals were thus seen as continuing over the coming months, adding to existing capital constraints and related funding needs. These developments, in turn, suggested that the combined impact of tighter funding conditions and lower corporate earnings would continue to weigh on credit quality and relative valuations across market segments.

Bond markets reflect changing outlook for growth and inflation

Government bond yields decline …

Government bond yields in the major advanced economies declined over the period under review, reflecting worsening growth expectations, together with an improving near-term inflation outlook. By 22 August 2008, the 10-year US

Government bond yields and break-even inflation rates



[1] In per cent. [2] Nominal minus real 10-year zero coupon bond yields.

Source: Bloomberg. Graph 5

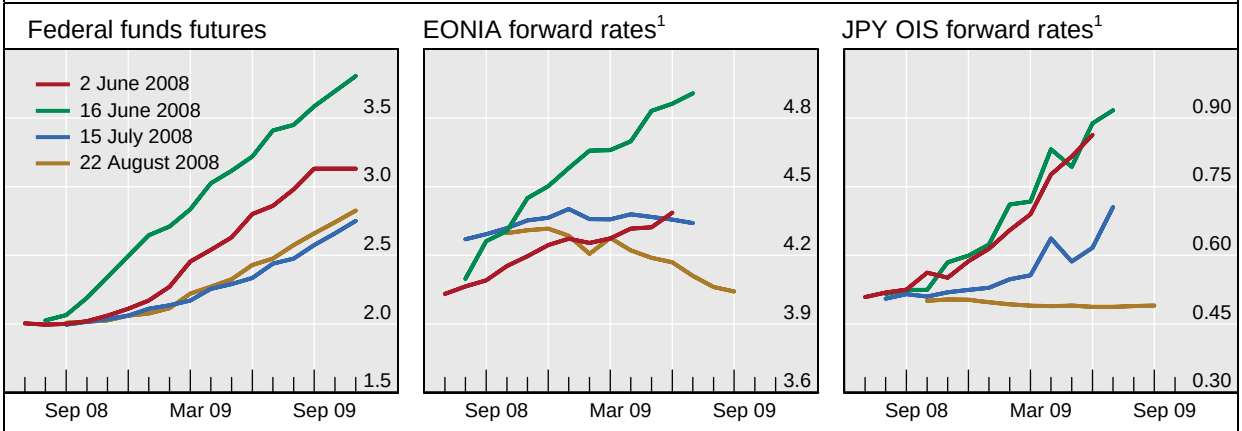
Treasury bond yield was 3.87%, around 20 basis points down from its level in late May. Over the same period, 10-year yields in the euro area and Japan fell by about 20 and 30 basis points, to 4.22% and 1.45%, respectively (Graph 5, left-hand panel). Two-year yields dropped as well, reaching 2.40% in the United States, 4.13% in the euro area and 0.69% in Japan, all lower than their end-May levels by some 20 basis points (Graph 5, centre panel).

… reflecting lower expected growth …

The fall in nominal yields partly reflected changes in growth expectations. All three major markets experienced declining long-term yields between mid-June and mid-July against the background of concerns about the US housing agencies. While there was a modest rebound in yields from mid-July that coincided with measures taken by the US authorities to support the agencies, declines were renewed in late July and into August, reflecting in large part downward revisions of previously released economic indicators as well as surprisingly poor new releases.

Forward curves

In per cent



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

Sources: Bloomberg; BIS calculations. Graph 6

… and anticipated monetary policy responses

Coinciding with these developments, expectations about the path of near-term policy rates were revised downwards. In the case of the United States, federal funds futures prices in late August signalled expectations of a significantly slower pace of rate increases than that indicated a few months earlier (Graph 6, left-hand panel). In the euro area, while mid-June EONIA swap prices had pointed to expectations of policy rate increases by the ECB over the next 12 months, markets in August anticipated a path of lower policy rates (Graph 6, centre panel). In Japan, expectations for 2009 shifted from policy rate increases to unchanged rates (Graph 6, right-hand panel).

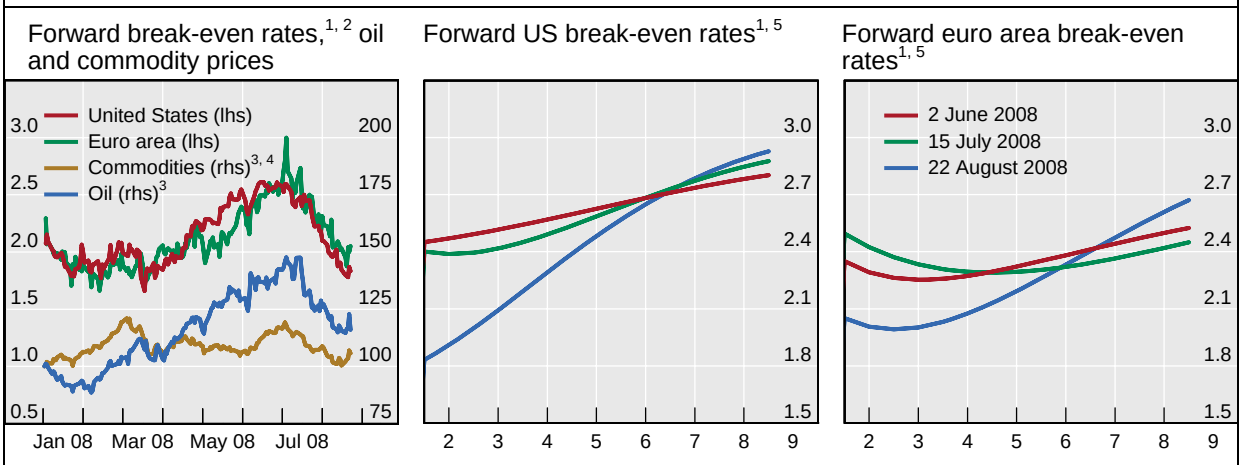
Break-even inflation rates also decline …

Market expectations of inflation moderated in the period under review, at least as proxied by break-even inflation rates, ie the differences in the yields of nominal and inflation-indexed securities.[1] By 22 August, the break-even inflation rates derived from the yields of 10-year securities were 2.30% for both the euro area and the United States, a decline of around 15 and 35 basis points, respectively, since end-May (Graph 5, right-hand panel). The moderation was more marked at shorter ends of the yield curve: for instance, the one-year forward break-even rate at the two-year horizon declined by nearly 70 basis points over the period from end-May for the United States; the corresponding break-even rate in the euro area declined by 35 basis points (Graph 7, left-hand panel). This decline coincided with the fall in oil and other commodity prices from the very high levels observed in early July, which appears to have alleviated concerns about short-term inflationary pressures (Graph 7, right-hand panel).

… even as longer-term inflation concerns persist

At the same time, forward break-even rates painted a very different picture at longer horizons. Between early June and late August, forward break-even inflation rates beyond the six-year horizon rose for both the United States and

Forward break-even inflation rates and commodity prices



[1] In per cent. [2] One-year forward break-even inflation rate two years ahead. [3] 1 January 2008 = 100. [4] Non-Energy CRB Index. [5] One-year forward break-even inflation rate two to nine years ahead (horizontal axis), calculated from US and euro area real and nominal zero coupon yield curves, respectively.

Sources: Federal Reserve; Bloomberg; BIS calculations. Graph 7

[1] Break-even rates reflect not only expectations of inflation, but also risk premia that compensate investors for inflation risk; see the special feature on page 23 for a more detailed discussion.

euro area (Graph 7, centre and right-hand panels). Continued worries about inflation over the longer term were consistent with investors pricing the possibility that key central banks might need to maintain a more accommodative policy stance than normal to contain the risks to economic growth in an environment of stressed financial markets.

Continued funding pressures in interbank money markets

Pressures continue in money markets ...

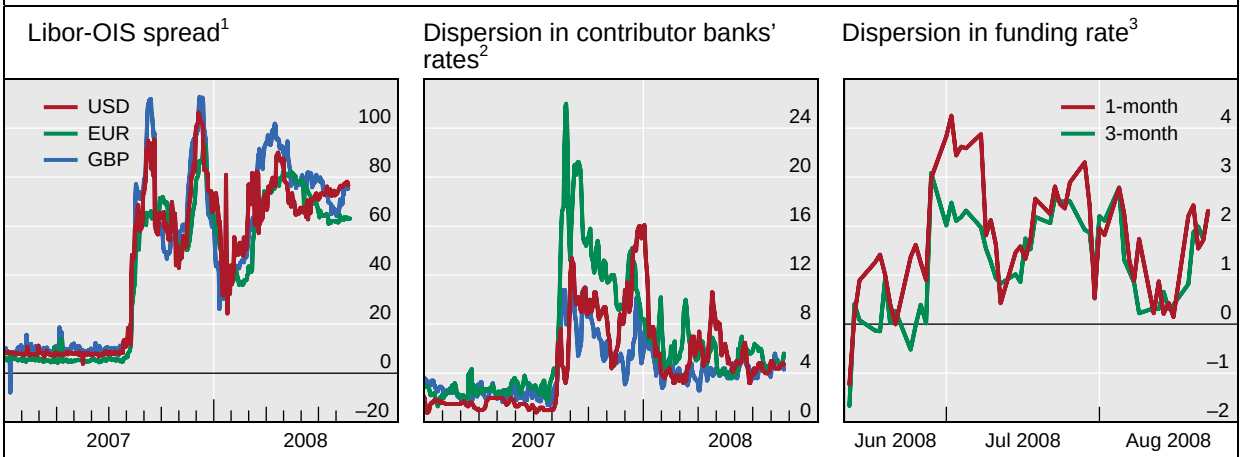
While bond markets over the period as a whole largely reflected expectations regarding growth and inflation, money markets were more directly affected by financial sector concerns. Spreads between Libor and corresponding OIS rates, which reflect a combination of counterparty credit risk and liquidity factors, remained elevated (Graph 8, left-hand panel). At the same time, bids for US dollar funds at auctions conducted by the ECB and the Swiss National Bank (SNB) continued to be high.

... despite new central bank initiatives

Continued pressures in US dollar interbank money markets were also illustrated by the fact that US dollar Libor-OIS spreads did not show any notable reaction to the Federal Reserve's announcement on 30 July of new measures to enhance the effectiveness of existing liquidity facilities. These included an extension of the Primary Dealer Credit and Term Securities Lending Facilities (PDCF and TSLF) until end-January 2009, along with the introduction of an auction mechanism for options on $50 billion worth of TSLF funds to help markets deal with periods of added uncertainty, such as quarter-ends. In addition, to complement the provision of 28-day loans under the existing Term Auction Facility (TAF), new 84-day TAF loans were introduced. Corresponding changes to the maturity profile of available funds were announced by both the ECB and the SNB with regard to their own US dollar funding auctions.

Dispersion in money market rates

In basis points

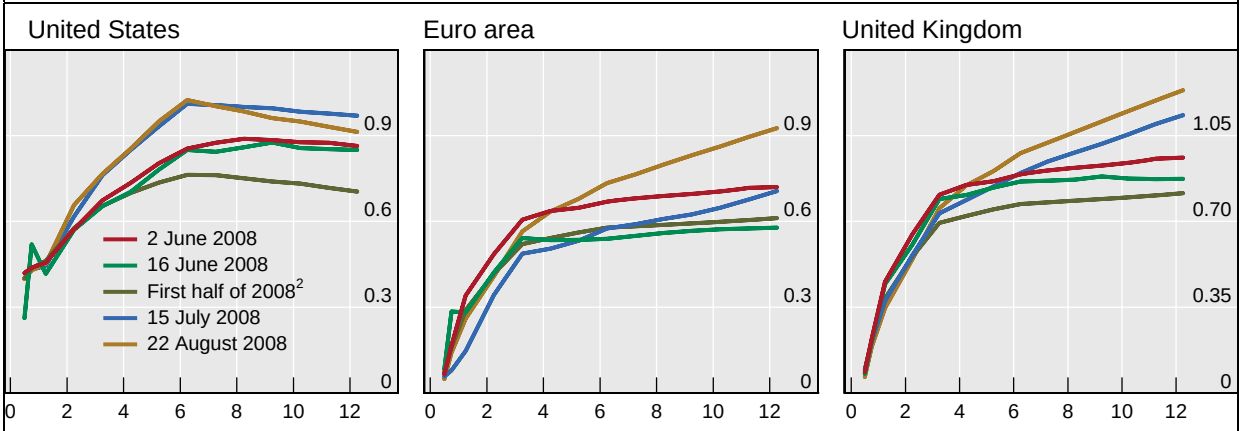


[1] Libor panel, three-month rates. [2] Maximum minus minimum, five-day moving average range. [3] New York funding rate minus Libor.

Sources: Bloomberg; BIS calculations. Graph 8

Term structure of Libor-OIS spreads[1]

In per cent



[1] The horizontal axis measures the maturity in months. For the OIS rates: for the euro area, EONIA; for the United Kingdom, SONIA.
[2] Average spread.

Sources: Bloomberg; BIS calculations. Graph 9

Concerns about the stability and reliability of the Libor interbank rate fixing, however, were less pronounced than before. Variation in Libor panel contributor rates in all three major Libor markets stabilised over the period (Graph 8, centre panel), which may indicate somewhat reduced uncertainty about banks' short-term funding needs. Earlier concerns that Libor panel banks had been reporting rates lower than their actual borrowing costs also appeared to abate. One development that may have helped lessen these concerns was the introduction by a large US brokerage firm of the survey-based New York funding rate (NYFR) on 11 June. Spreads between this measure and Libor remained mostly within a relatively tight band of 2–3 basis points, which seemed to indicate that Libor rates were not skewed downwards during this period (Graph 8, right-hand panel). Nevertheless, the term structure of Libor-OIS spreads suggested that interbank market pressures were expected to continue for some time (Graph 9).

Equity markets decline on growth concerns

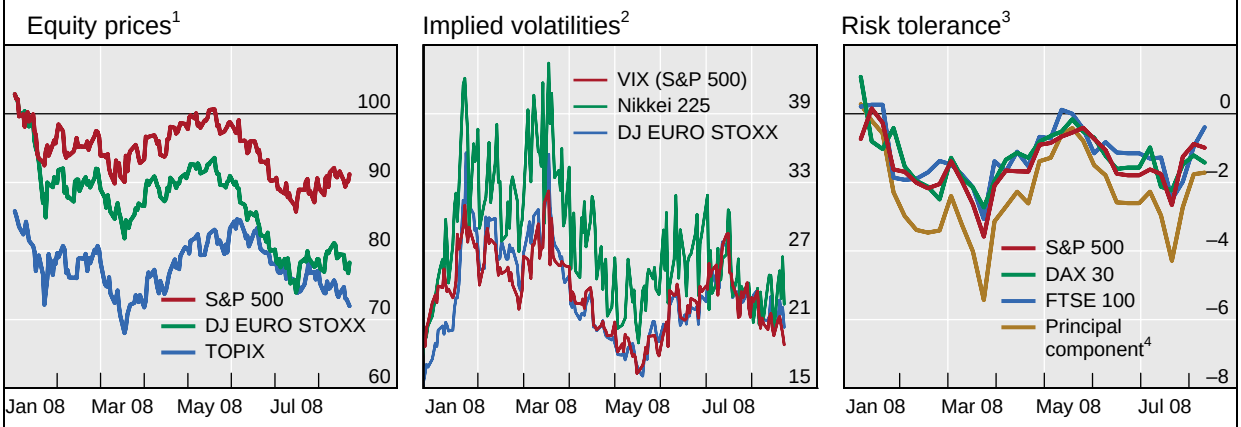
Equity markets decline on negative financial sector news ...

Weighed down by concerns about growth and news of further financial sector losses, equity prices declined to lows not seen since the last quarter of 2005 by mid-July, before recovering somewhat (Graph 10, left-hand panel). By late August, the S&P 500 index had lost almost 8% compared to end-May levels, while markets in Europe and Japan retreated by around 14% over the same period. These declines were consistent with indications of rising risk premia, as apparent from higher implied option volatilities and reduced investor risk tolerance (Graph 10, centre and right-hand panels).

... and growth concerns

The decline in equity markets between end-May and mid-July came on the back of negative news about the health of major financial institutions, rising oil prices and deteriorating earnings. Concerns about the financial sector had been revived in early June, following downgrades of US monoline insurers and signs of continued pressures on bank balance sheets (see the credit market

Equity markets



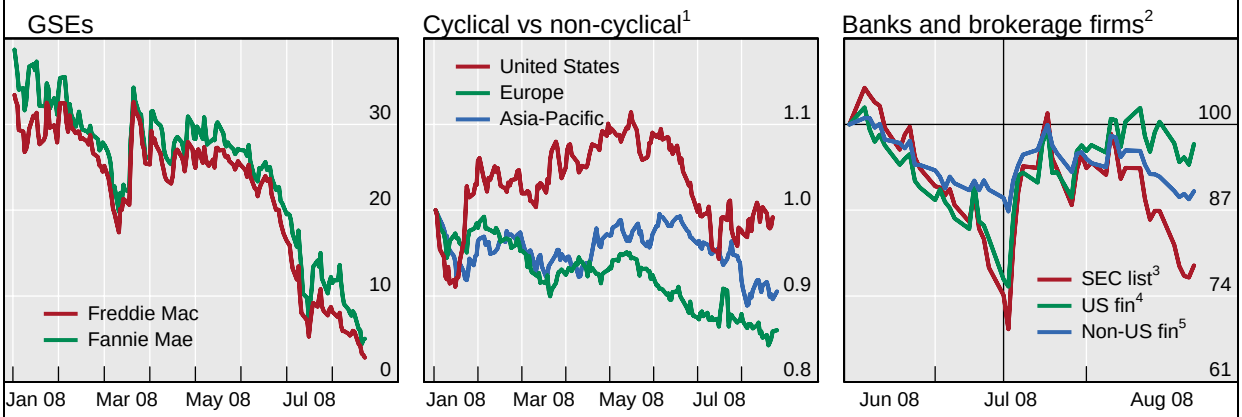
[1] In local currency; 2 January 2007 = 100. [2] Volatility implied by the price of at-the-money call option contracts on stock market indices, in per cent. [3] Derived from the differences between two distributions of returns, one implied by option prices, the other based on actual returns estimated from historical data; weekly averages of daily data. [4] First principal component of risk tolerance indicators estimated for the S&P 500, DAX 30 and FTSE 100.

Sources: Bloomberg; BIS calculations. Graph 10

section above). Sentiment deteriorated further into July, following fears about the capital adequacy of the US housing agencies and weak earnings releases by several financial institutions. Share prices for the US housing agencies plummeted, with Fannie Mae and Freddie Mac declining by about 74% and 79% between end-May and mid-July, respectively. Concerns about weakness in the financial sector were also reflected in commercial bank and brokerage equity prices, which tended to underperform those of other sectors over the same period.

Equity prices recovered part of their earlier losses from mid-July, helped by a combination of supporting factors. These included the announcement of the US housing agency support package, declines in oil and commodity prices and the introduction of new US Securities and Exchange Commission (SEC) emergency measures curbing short selling of stocks in the largest banks and

GSEs and cyclical vs non-cyclical equity prices



[1] Consumer cyclical divided by consumer non-cyclical equity indices. [2] 13 June 2008 = 100. The vertical line marks 15 July (date of the imposition of short selling restrictions by the SEC). [3] A total of 19 banks in the United States. [4] Includes S&P 500 financial firms excluding the 19 banks above. [5] A total of 34 international financial firms excluding the 19 banks above.

Sources: Bloomberg; Markit; BIS calculations. Graph 11

brokerage firms. News of the support package for the US housing agencies helped their share prices up from the lows on 15 July. However, investor uncertainty about the health of the agencies and the need for government intervention remained, with prices eventually plummeting to levels not seen since the late 1980s. Commercial bank and brokerage stocks also saw a mid-July rebound, helped by the unwinding of short positions in these stocks following the SEC's temporary measures regarding uncovered short sales (Graph 11, right-hand panel). Overall, growth concerns, combined with negative earnings surprises, meant that stocks such as consumer cyclicals underperformed non-cyclical equities over the period under review (Graph 11, centre panel). Similarly, despite a temporary upward correction in late August, declining oil and other commodity prices had resulted in lower valuations for energy and commodity-related equities.

Emerging markets face more challenging environment

Emerging market assets …

Emerging markets, which had been relatively resilient during most of 2007 and into 2008, witnessed a dramatically changing environment in recent months. With the credit crisis dragging on and signs of economic weakness emerging in key advanced economies, external funding conditions started to tighten, implying rising risks, particularly for countries with negative current account positions. At the same time, reflecting high food and energy prices, inflation rates remained on the rise, posing a threat to real incomes and corporate profitability. As a result, previous views about emerging market decoupling were increasingly challenged, and changes in macroeconomic conditions and associated economic policies gained increased investor attention.

Emerging market credit spreads, as measured by the EMBIG index, widened from a low near 260 basis points in mid-June to around 324 at the end of the period, close to the highs seen at the peak of the credit sell-off in March. With spreads wider, but 10-year US Treasury yields down about 19 basis points from their levels at end-May (see the bond market section above), EMBIG returns were only slightly negative, at around –0.5% (Graph 12, left-hand panel). While growth forecasts across the emerging markets remained relatively robust, investor sentiment was dampened by inflation concerns and expectations of slower growth in the advanced economies. This tended to put pressure on credit spreads for countries with large current account financing needs, such as those in eastern Europe, given their dependence on foreign direct and portfolio investment flows from the European Union. As average EMBIG member country ratings remained broadly unchanged, spread dispersion increased further, consistent with greater differentiation by investors across issuers (Graph 12, centre panel).

… are weighed down by inflation concerns …

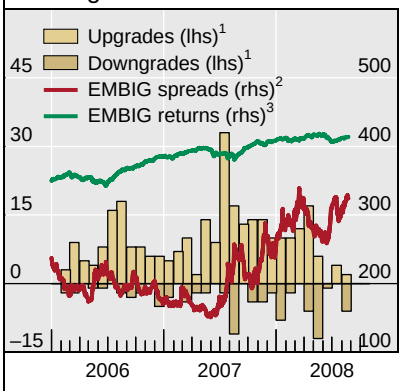
… deteriorating external financing conditions …

… and weaker investor sentiment

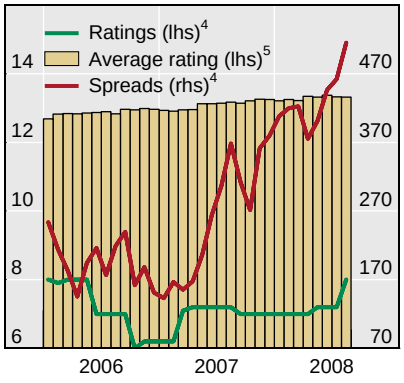
Emerging equity markets suffered from the same set of negative factors, with investor sentiment further depressed by broadly weakening equity prices in the advanced economies up to mid-July (see the equity market section above). Between end-May and late August, the MSCI emerging market index lost some 20% in local currency terms and was down almost 9% from the earlier lows established in mid-March. With the US dollar appreciating on a

Emerging market assets

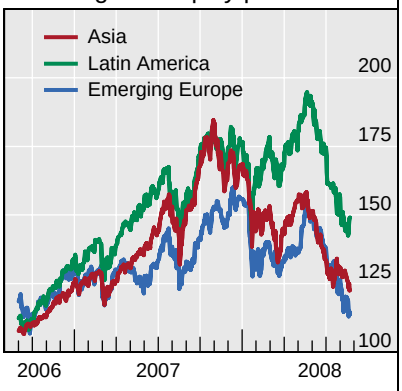
Ratings and EMBIG indices



Dispersion and rating changes



MSCI regional equity prices[6]



[1] Monthly long-term foreign and local currency sovereign rating changes from Fitch, Moody's and Standard & Poor's. [2] EMBI Global index; sovereign spread over government bond yields, in basis points. [3] EMBI Global index; cumulative total returns. [4] Difference between 90th and 10th percentiles; for spreads, in basis points; for ratings, in number of notches. Calculated using identical weights. [5] Average credit rating for all constituents of the JPMorgan Chase EMBI Global index; based on long-term foreign currency ratings from Standard & Poor's. Higher values imply higher ratings. [6] In local currency; 31 December 2005 = 100.

Sources: Bloomberg; Datastream; JPMorgan Chase; Standard & Poor's; BIS calculations. Graph 12

broad basis between mid-July and late August, the effective exchange rate of the US currency vis-à-vis key trading partners in the emerging markets retraced its earlier losses to end the period almost unchanged from its end-May levels. As a result, MSCI performance in dollar terms was broadly similar to the return in local currencies, with the index some 13 percentage points weaker than the S&P 500. Latin American and eastern European markets posted the largest declines, retreating by around 22% and 24%, respectively, over the period. While Asia, at –19%, was also down significantly since end-May, Asian markets appeared to benefit temporarily from declining oil and commodity prices as well as easing inflation concerns in late July. This was in contrast to markets such as Brazil and Russia, where large parts of the local MSCI indices are commodity-related (Graph 12, right-hand panel).

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Highlights of international banking and financial market activity[1]

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 first quarter of 2008. The discussion on international debt securities and exchange-traded derivatives draws on data for the second quarter of 2008.

The international banking market

Growth in international bank claims continued to slow in the first quarter of 2008. BIS reporting banks' gross international claims[2] on non-bank borrowers expanded by $365 billion, the smallest first quarter increase since 2003.[3] This helped to push down the year-on-year growth rate of total international claims from 21% in the previous quarter to 16%. The $1.4 trillion expansion in total international claims (to $40 trillion) mainly reflected greater interbank activity, as banks transferred funds from their offices in the United States to those in the United Kingdom and the euro area.[4]

In the first quarter of 2008, reporting banks continued their net transfer of funds out of the United States, a trend evident since the onset of the financial turmoil in mid-2007. Gross cross-border claims on all sectors in the United States had grown to $5.3 trillion by the second quarter of 2007, outpacing the

[1] Queries concerning the banking statistics should be addressed to Patrick McGuire and Goetz von Peter and queries concerning international debt securities and derivatives statistics to Naohiko Baba.

[2] International claims are comprised of cross-border claims in all currencies plus claims on residents in foreign currencies.

[3] In the BIS locational banking statistics, there is a strong seasonal component in claims on both banks and non-banks, with relatively large expansions in the first quarter of each calendar year.

[4] The BIS consolidated banking statistics on an immediate borrower basis (IB basis) also indicate an increase in international claims in the first quarter of 2008. Total international claims expanded by $1.9 trillion during the quarter, although some of this was the result of the depreciation of the US dollar over the quarter, which tends to boost end-of-period stocks in other currencies when expressed in US dollars.

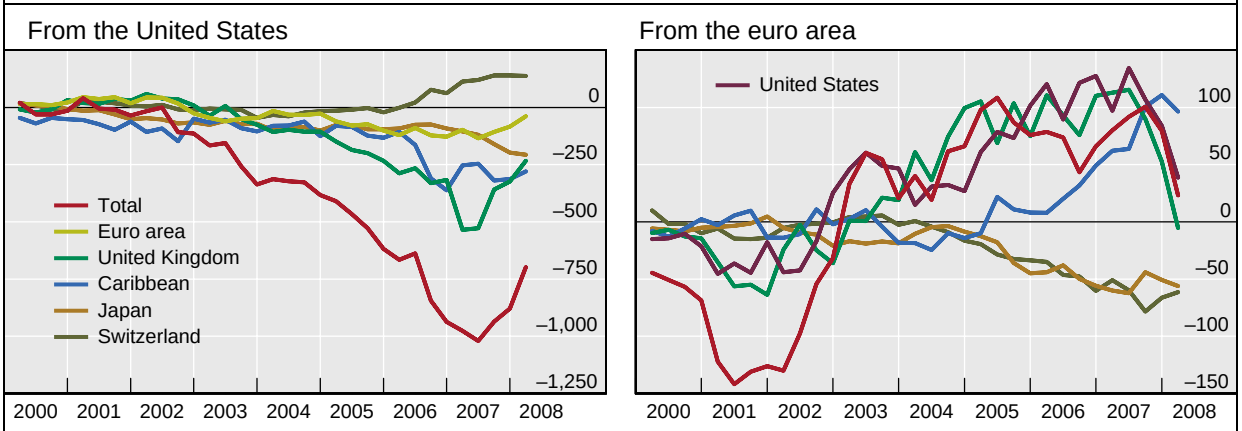
growth in cross-border liabilities to counterparties there. This increase in claims had been behind a cumulative *net* transfer of US dollar-denominated funds into the United States via the international banking system of more than $1 trillion since 2000 (Graph 1, left-hand panel).[5] These net flows reversed in mid-2007; since then, an estimated $321 billion in net US dollar-denominated funds have been transferred out of the United States, much of this the result of interbank activity.[6] Admittedly, in the first quarter of 2008, claims (in all currencies) on all sectors in the United States booked by banks abroad expanded (by $134 billion). However, an even larger increase in these banks' international liabilities to the banking sector in the United States resulted in a $259 billion net outflow from the country during the quarter.

Weak credit to non-banks …

The expansion in international claims on non-bank borrowers worldwide was relatively weak in the first quarter of 2008. Total claims grew by $365 billion, the smallest first quarter expansion since 2003. Banks' outstanding *loans* to non-banks actually increased by more ($530 billion), with greater credit in all major currency segments. Euro-denominated loans to non-banks grew by $247 billion, chiefly the result of lending by banks in the United Kingdom to residents of the United Kingdom ($109 billion) and the euro area ($49 billion), as well as intra-euro area cross-border lending ($31 billion). US dollar-denominated loans to non-banks also increased, by $230 billion, mainly to non-banks in emerging economies ($53 billion), the United States ($51 billion) and the euro area ($43 billion).

Cumulative net claims in US dollars (all sectors)[1]

In billions of US dollars



[1] Panels indicate the total net capital flows via banks from residents of the country/region in the panel heading to residents of the countries/regions in the legend. These flows are calculated by consolidating (across the asset and liability side of the balance sheet, and across sectors) the positions booked by banks inside and outside the country/region in the panel heading. A positive value indicates a flow out of the country/region in the panel heading.

Source: BIS locational banking statistics by residence. Graph 1

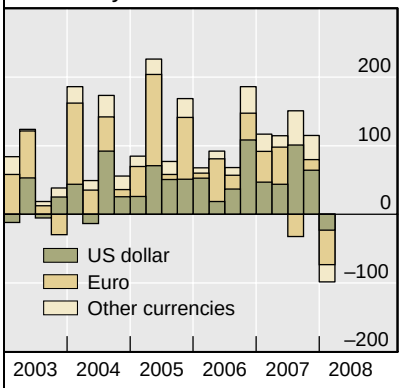
[5] The calculation of the total net transfer of funds via the international banking system takes into account claims and liabilities booked by banks outside the United States, as well as changes in net positions vis-à-vis non-residents booked by banks in the United States. See "Tracking international bank flows", *BIS Quarterly Review*, December 2006, for more discussion on the construction of these net capital flow figures.

[6] See "International banking activity amidst the turmoil" in the *BIS Quarterly Review*, June 2008.

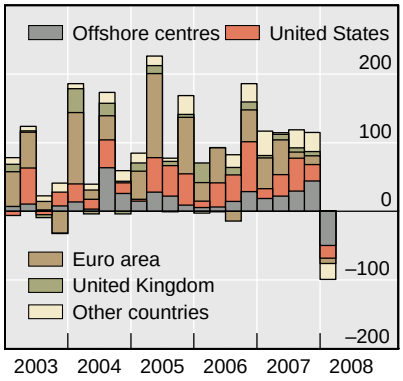
Reporting banks' international debt securities and other positions[1]

In billions of US dollars

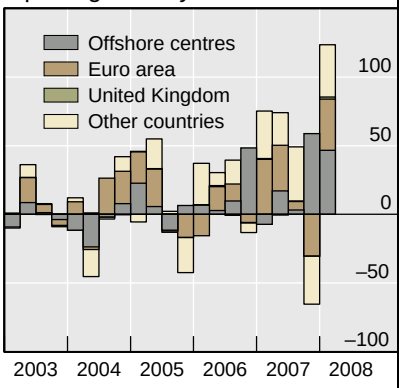
Claims on non-banks, by currency[2]



Claims on non-banks, by vis-à-vis country[2]



Equity and other liabilities, by reporting country[3]



[1] Value-adjusted changes in BIS reporting banks' international positions (cross-border plus local positions in foreign currency). Expressed at contemporaneous exchange rates. Not all reporting countries provide data on these positions. [2] Reporting banks' debt securities claims, including holdings of government securities. [3] The United States does not provide a breakdown of debt securities and other liabilities, and thus is not included here (see footnote 7 in the text).

Source: BIS locational banking statistics by residence. Graph 2

... reflects sales and writedowns of debt securities

Even as loans to non-banks expanded, however, banks' outstanding debt securities claims on non-banks dropped significantly (by $98 billion), the first quarterly decline since the first quarter of 2001 (Graph 2, left-hand panel).[7, 8] While this is suggestive of an unwinding of positions, the decrease also includes writedowns of structured finance products and other securities during the period. Euro-denominated claims dropped the most, with decreases reported by banks in the euro area and the United Kingdom. That said, reporting banks' US dollar-denominated debt securities claims on non-banks also fell markedly (by $23 billion). Banks in the United Kingdom reduced their claims by $39 billion, mostly vis-à-vis borrowers in the United States and offshore centres. Across all reporting countries, reduced holdings of US *government* debt securities did not seem to be the driving factor (see below), suggesting that much of the decrease reflected sales and writedowns of bonds issued by corporate and non-bank financial entities.[9]

Banks shift away from US non-bank private sector ...

This fall in debt securities claims seemed to coincide with a broader shift in bank balance sheets away from the US non-bank private sector, at least for some banking systems. The BIS consolidated banking statistics on an ultimate risk basis (UR basis) indicate that, in absolute terms, gross claims on the non-bank private sector in the United States have remained flat since mid-2007,

[7] Reporting banks' international claim and liability positions are broken down into "loans and deposits", "debt securities" and "other positions". The last category includes equity assets and liabilities, working capital provided by head offices and on-balance sheet derivatives positions, making it impossible to obtain a precise measure of equity positions alone. Moreover, not all reporting countries provide a complete instrument breakdown. In particular, banks in the United States do not separate debt securities positions from equity and other positions.

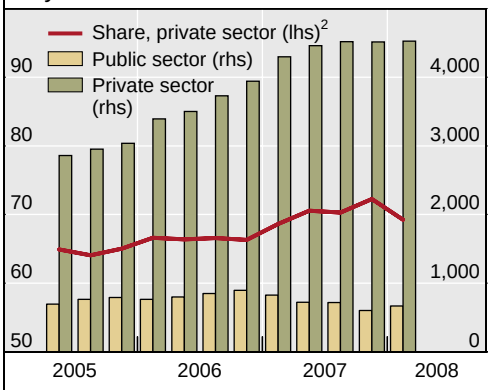
[8] Reporting banks' equity and other securities claims on non-banks fell by a further $90 billion.

[9] The BIS consolidated statistics (IB basis) indicate that international claims on the US public sector actually increased, by $24 billion.

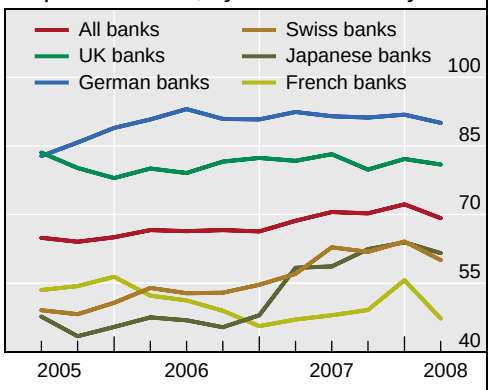
Foreign claims on US non-banks

In billions of US dollars, shares in per cent

By sector[1]



On private sector, by bank nationality[3]



[1] Shaded bars indicate BIS reporting banks' combined foreign claims (on a UR basis) on the US public and non-bank private sectors, respectively. Claims on the US public sector include claims booked by offices outside the United States, plus claims booked by the offices of foreign banks in the United States. Since claims on US borrowers are predominantly denominated in US dollars, valuation effects through exchange rate movements are likely to be small. [2] The share of foreign claims on the US non-bank private sector in total foreign claims on US borrowers. [3] The panel shows those banking systems with the greatest on-balance sheet exposures to US non-bank entities. The lines represent the share of total foreign claims on the US non-bank private sector in total foreign claims on the United States.

Source: BIS consolidated banking statistics on a UR basis. Graph 3

after a steady period of growth since at least 2005 (Graph 3, left-hand panel). In the most recent quarter, the share of claims on the US non-bank private sector dropped below 70% of reporting banks' total foreign claims on the United States, with several major banking systems reporting noticeable shifts (Graph 3, right-hand panel). In absolute terms, total claims on the US non-bank private sector booked by banks headquartered in the euro area (excluding Ireland) and Switzerland fell by a combined $94 billion, with German, Dutch, Spanish and Swiss banks accounting for the bulk of this. In contrast, UK, Belgian and Irish banks' outstanding claims on this sector grew by a combined $88 billion.

… and into public sector debt

At the same time, the BIS data indicate that reporting banks increased their holdings of public sector debt. Across all reporting banking systems, the outstanding stock of claims on the public sector rose by nearly $400 billion (+10% to $4.35 trillion), although this partially reflected exchange rate valuation effects. Assuming that all claims on the euro area public sector are euro-denominated claims, the increase in banks' holdings of euro area public debt (reported at $143 billion) amounted to $21 billion (+1%) at constant exchange rates. Similarly, reporting banks also stocked up on Japanese ($35 billion, +9%) and US ($68 billion, +11%) public sector debt. The general movement towards public debt was particularly evident for French, Swiss, Japanese and German banks, whose stocks grew more than $40 billion in each case (at constant exchange rates).

Banks' cross-border equity and other liabilities surged in the first quarter of 2008, as banks tapped international sources of funds.[10] Total equity and

[10] See footnote 7.

other liabilities rose by $122 billion overall, the largest quarterly increase on record by a considerable margin (Graph 2, right-hand panel). Some $41 billion of this increase was booked by banks in the euro area, and an additional $54 billion by bank offices in offshore financial centres. Banks' debt securities liabilities also grew, by $201 billion, roughly half of which was denominated in US dollars.

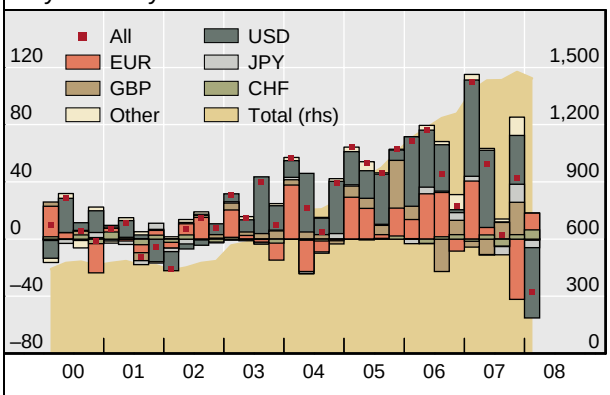
Decline in liabilities vis-à-vis official monetary authorities ...

At the same time, reporting banks' total deposit liabilities vis-à-vis official monetary authorities dropped noticeably in the first quarter (by $38 billion to $1.44 trillion), in part reflecting movements in foreign exchange reserves placed in commercial banks abroad (Graph 4, left-hand panel).[11] US dollar-denominated liabilities dropped the most, lowering the US dollar share of total liabilities vis-à-vis official monetary authorities to 52%, from 54% in the previous quarter. On a residence basis, bank offices in the United Kingdom and the United States and across the euro area reported the largest decreases. By bank nationality, however, the decreases seemed to be concentrated in Swiss, US and German banks (Graph 4, right-hand panel). Identifying with any degree of precision which central banks accounted for these moves is difficult because of incomplete data on the residence of the central bank counterparty. However, data on reserve holdings reported by 63 monetary authorities to the IMF reveal an aggregate decrease of $56 billion in deposits placed in commercial banks in the first quarter of 2008, with relatively large decreases reported by the monetary authorities in Russia ($39 billion), India ($10 billion), Indonesia ($10 billion), Malaysia ($4 billion) and Romania ($5 billion).

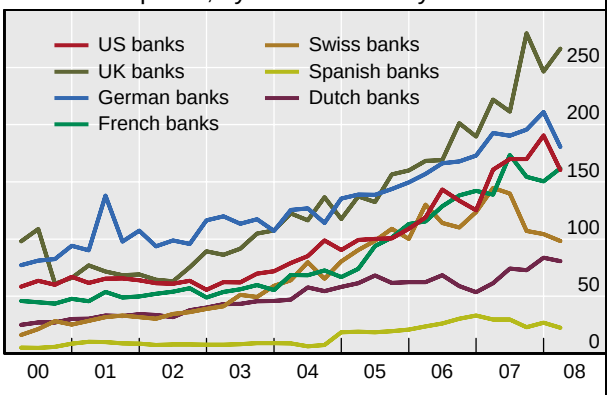
Liabilities to official monetary authorities[1]

In billions of US dollars

By currency[2]



US dollar deposits, by bank nationality[3]



[1] Figures expressed at constant end-Q1 2008 exchange rates. [2] Based on the BIS locational banking statistics by residence. Bars indicate exchange rate adjusted flows; shaded area indicates outstanding stocks. [3] Outstanding stocks, based on the BIS locational banking statistics by nationality.

Source: BIS locational banking statistics. Graph 4

[11] Banks' positions vis-à-vis official monetary authorities are reported as a memo item in the BIS statistics, and thus are not broken down by the country of residence. Reported liabilities will include deposits placed in reporting banks as part of central bank reserve management, reverse repo positions vis-à-vis reporting banks, and any loans which have arisen in the context of central banks' liquidity enhancement operations. There are some differences in the definition of official monetary authorities across reporting countries. For example, positions vis-à-vis central governments and other international organisations are included in this sector in the data reported by the United States.

More broadly, the BIS data also indicate large reductions in liabilities to the *banking sector* of various emerging economies, particularly in the Asia-Pacific region. In some cases, these moves seemed to reflect to some extent the activity of central banks discussed above, since, on a disaggregated basis, these are generally classified as part of the banking sector in the BIS statistics. For example, BIS reporting banks' liabilities to banks in Russia and Romania, countries whose monetary authorities reported significant decreases in deposits in commercial banks, fell by $14 billion and $5 billion, respectively. Elsewhere, reporting banks' liabilities to banks in Asia-Pacific dropped by $50 billion in the first quarter of 2008, the first decrease in more than 10 quarters and the largest on record for this region. Liabilities to banks in China decreased the most (by $28 billion), although the reduction in positions vis-à-vis banks in Korea (–$9 billion), Malaysia (–$6 billion), Thailand (–$6 billion) and the Philippines (–$4 billion) was also noticeable. In addition, liabilities to banks in Hong Kong SAR (classified as an offshore centre in the BIS data) fell by $24 billion.

… and vis-à-vis banks in Asia-Pacific

The international debt securities market

Borrowing in the international debt securities market recovered sharply in the second quarter of 2008 despite the continued turmoil in financial markets. Net issuance of bonds and notes increased to $1,071 billion, up substantially from $371 billion in the first quarter and recovering almost to the level recorded just before the recent turmoil began (the second quarter of 2007). Borrowing through money market instruments remained active, although net issuance declined from the record level of the previous quarter.

Borrowing recovers sharply …

The increase in bond and note issuance stemmed chiefly from the euro-denominated segment (Graph 5, left-hand panel). Net issuance of euro-denominated bonds and notes rose to $464 billion, more than four times the level of the previous quarter. The gain was mostly accounted for by the issuance of private financial institutions. By nationality of issuer, the most substantial growth came from Spanish borrowers, followed by French, Belgian and Irish borrowers.

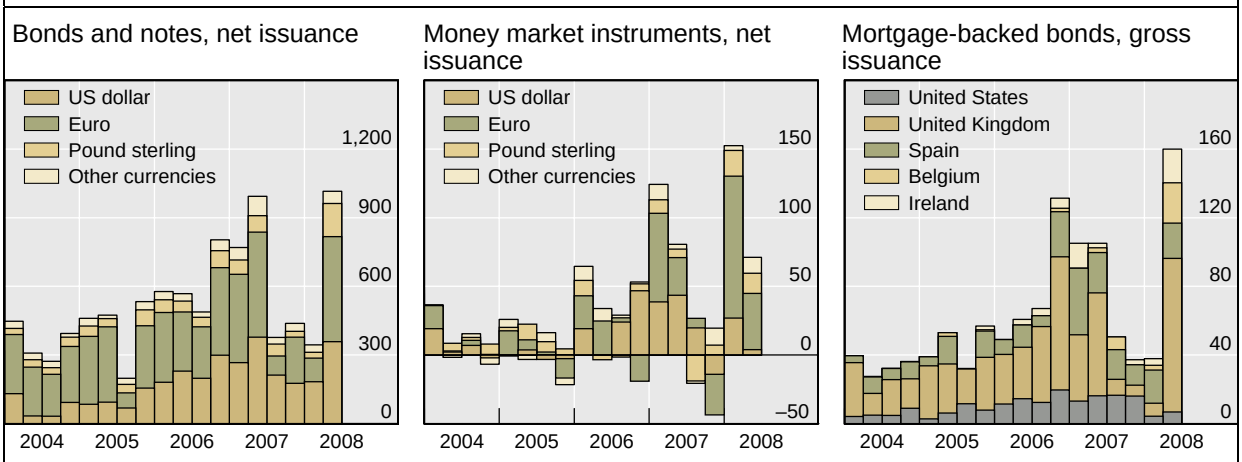
… particularly in euro-denominated bonds and notes

A sharp recovery was also evident across other currency denominations. Net issuance of dollar-denominated bonds and notes increased from $185 billion to $392 billion in the second quarter of 2008, while sterling-denominated bonds and notes rose substantially, from $31 billion to $142 billion, the highest level on record. Yen issuance also rose, from $7 billion to $15 billion. In particular, net issuance of yen-denominated bonds in Japan by non-Japanese issuers in the Japanese local market (samurai bonds) continued to be active at $7 billion in the second quarter of 2008, up from $4 billion the previous quarter.

By sector, private financial institutions showed a remarkable recovery, with net issuance of bonds and notes almost quadrupling in the second quarter of 2008 to $827 billion. Corporate issuance also rebounded, albeit to a lesser degree: net issuance increased to $131 billion, more than double the level of the previous quarter.

International debt securities issuance by developed countries

In billions of US dollars



Sources: Dealogic; Euroclear; Thomson Financial; Xtrakter Ltd; BIS. Graph 5

UK borrowers show the largest growth

The breakdown by nationality of issuer indicates that the largest growth in net issuance was from UK borrowers, up from $12 billion to $186 billion, largely driven by an unprecedented level of activity by UK private financial institutions. A large increase also came from US, Spanish and French borrowers. By contrast, a decline in net issuance was recorded for Australian, Greek, Austrian and German borrowers.

Mortgage-backed bonds recover significantly

The quarter saw a recovery in mortgage-backed bonds (for which only gross figures are available). Gross issuance of mortgage-backed bonds increased from the previous quarter's $52 billion to $188 billion. By nationality, the largest increase was again from UK borrowers, from $8 billion to $90 billion (Graph 5, right-hand panel). Most of the UK issuance followed the Bank of England's announcement in April 2008 of a Special Liquidity Scheme that enables UK banks to swap illiquid assets such as mortgage-backed securities against UK Treasury bills. Belgian and Irish borrowers showed a large increase as well. In particular, Bass Master Issuer in Belgium issued a series of euro-denominated mortgage-backed bonds that totalled more than $23 billion in June 2008. Meanwhile, the US government-sponsored agencies, Fannie Mae in particular, continued to play a large role in the international debt market. Fannie Mae issued $62 billion worth of bonds and notes, its highest quarterly level of issuance ever.

There was a rise in issuance across a wide range of credit classes. In particular, gross issuance of investment grade bonds with ratings less than AAA surged to $691 billion from $368 billion in the previous quarter. This level corresponds to more than double the five-year quarterly average throughout 2007. As for other credit classes, gross issuance of AAA-bonds showed a modest increase to $484 billion from $434 billion, while that of non-investment grade bonds went up to $11 billion from $2 billion.

In the emerging economies, net issuance of bonds and notes grew strongly, rebounding from the previous quarter's decline. This coincided with a significant narrowing of emerging market bond spreads. The increase was most

marked in emerging Europe, followed by Latin America and Africa and the Middle East. By currency of denomination, most of the increase came from US dollar- and euro-denominated bonds and notes, but local currency denominated issuance also showed a recovery.

Borrowing through money market instruments continued to be fairly active, although net issuance of money market instruments decreased to $68 billion in the second quarter of 2008, from the record level of $154 billion in the previous one. The largest decline took place in euro-denominated instruments (Graph 5, centre panel). However, at $993 billion, gross issuance was virtually flat.

Derivatives markets

Turnover of futures and options decreases …

The second quarter of 2008 saw a retreat in activity on the international derivatives exchanges. Total turnover based on notional amounts decreased from the high of $692 trillion recorded in the first quarter to $600 trillion. Most of the contraction was due to derivatives on short-term interest rates, which had contributed most to the record turnover in the first quarter. Turnover also declined in derivatives on long-term interest rates and stock indices. By contrast, turnover in derivatives on foreign exchange gained modestly. Turnover in derivatives on commodities, measured only in terms of the numbers of contracts, dropped, although year-on-year growth remained quite high.

… particularly in derivatives on short-term interest rates

Turnover in derivatives on short-term interest rates contracted to $473 trillion in the second quarter of 2008 from the previous quarter's $548 trillion. The most significant fall was in the US dollar segment, which had surged in the previous quarter, but turnover in the euro, sterling and Australian dollar segments also declined. In particular, turnover in futures and options on three-month eurodollar rates retreated markedly. This coincided with a further deterioration in liquidity conditions in term money markets over the quarter, as evidenced by widening spreads of US dollar Libor over the overnight index swap rate. However, turnover in futures and options on federal funds rates rose, almost reaching the record high of the fourth quarter of 2007.

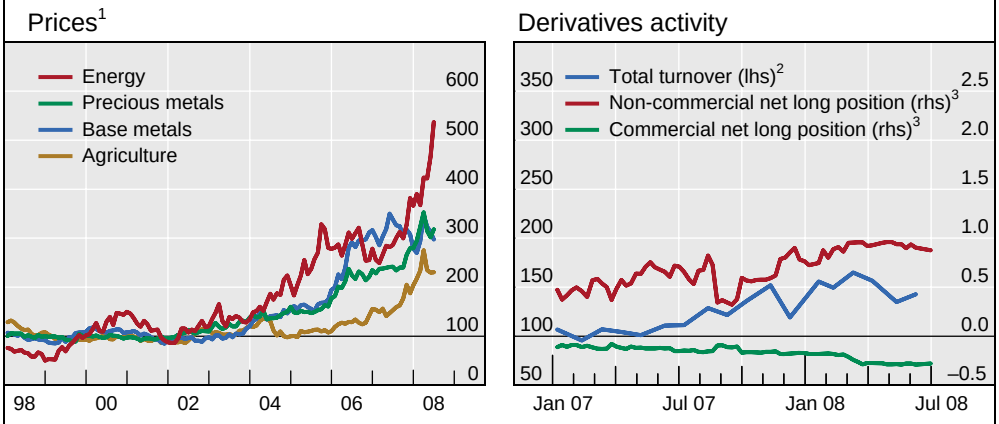
Activity in equity derivatives fell to $67 trillion in the second quarter of 2008 from $73 trillion in the previous one, representing a year-on-year decrease of 3%. By currency of denomination, euro- and US dollar-denominated equity derivatives contracts declined the most. By contrast, the largest increase came from Korean won-denominated contracts.

Trading continued to be robust in the foreign exchange segment of the derivatives exchanges. Turnover grew from $6.7 trillion to $7.5 trillion in the second quarter of 2008, resulting in a year-on-year growth rate of 44%. The increase was attributable mostly to the euro, and offset a decline in currencies such as the yen and Australian dollar.

Trading in commodity derivatives continues to be active

Trading in commodity derivatives declined from the record level of the previous quarter, but continued to be quite active. Global turnover in commodity derivatives measured in numbers of contracts (notional amounts are not available) decreased from 470 million to 434 million, although the year-on-year growth rate remained high at 37%. The largest fall was observed in

Commodity prices and derivatives activity



[1] S&P GSCI Commodity Index subindices, monthly averages; 1998–2002 average = 100. [2] Total exchange-traded commodity derivatives. Number of contracts traded, in millions. [3] Net long position is calculated as long minus short positions on futures and options based on S&P GSCI Commodity Index divided by their sum.

Sources: CFTC; Datastream; BIS. Graph 6

agricultural derivatives, followed by precious metals, non-precious metals and energy products. The decline in turnover in agricultural derivatives came chiefly from Asian exchanges, in particular Chinese ones. This coincided with an easing of price increases in agricultural products over the quarter. Since the beginning of 2007 at least, the rise in commodity derivatives turnover has been largely in line with a significant increase in non-commercial traders' net long positions, amid the relative decline in commercial traders' positions (Graph 6).

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The inflation risk premium in the term structure of interest rates[1]

A dynamic term structure model based on an explicit structural macroeconomic framework is used to estimate inflation risk premia in the United States and the euro area. On average over the past decade, inflation risk premia have been relatively small but positive. They have exhibited an increasing pattern with respect to maturity for the euro area and a flatter one for the United States. Furthermore, the estimates imply that risk premia vary over time, mainly in response to fluctuations in economic growth and inflation.

JEL classification: E43, E44.

As markets for inflation-linked securities have grown in recent years, the prices of these instruments have become an important source of information for both central banks and financial market participants. Index-linked government bonds, for example, provide a means for measuring ex ante real interest rates at different maturities. In combination with yields on nominal government bonds, they can also be used to calculate the implied rate of inflation over the life of the bonds which would equate the real payoff from the two types of bonds. Such break-even inflation rates are commonly taken as a proxy for investors' expectations of future inflation, and are particularly useful because of their timeliness and simplicity. Moreover, implied forward break-even inflation rates for distant horizons are often viewed as providing information about central bank credibility: if the central bank's commitment to maintaining price stability is fully credible, expected inflation in the distant future should remain at a level consistent with the central bank's inflation objective.

Of course, break-even rates do not, in general, reflect expected inflation alone. They also include risk premia that compensate investors for inflation risk, as well as differential liquidity risk in the nominal and index-linked bond

[1] The results and much of the discussion in this article are based on Hördahl and Tristani (2007, 2008). The views expressed are those of the author and do not necessarily reflect those of the BIS. Thanks to Claudio Borio, Stephen Cecchetti, Frank Packer, Oreste Tristani and David Vestin for very helpful comments and suggestions and to Emir Emiray and Garry Tang for providing help with the graphs.

markets.[2] Presence of these risk premia complicates the interpretation of break-even inflation rates, and they should therefore in principle be identified and removed before assessing the information content of the break-even rates. Unfortunately, risk premia are not directly observable, so they must be estimated from data on observable quantities such as prices, yields and macroeconomic variables.

The purpose of this article is to build an empirical model of the inflation risk premium that delivers a "cleaner" measure of investors' inflation expectations embedded in government bond prices.[3] To keep the analysis manageable, liquidity risk premia are not considered explicitly here. However, in order to reduce the risk that the initial limited liquidity of index-linked bond markets might distort the results, information from index-linked bonds is excluded in the early part of the sample. In addition to quantifying the inflation risk premium, this article tries to shed some light on its determinants by explicitly linking prices of real and nominal bonds to macroeconomic fundamentals and to investors' attitudes towards risk. To allow for a comparison across the world's two largest economies, estimates are constructed using data for both the United States and the euro area.

What is the inflation risk premium?

Inflation risk premia arise from the fact that investors holding nominal assets are exposed to unanticipated changes in inflation. In other words, the real payoff – which is what investors ultimately care about – from holding a nominal asset over some time period depends on how inflation evolves over that period, and investors will require a premium to compensate them for the risk associated with inflation fluctuations that they are unable to forecast.

Inflation risk induces premia in bond yields …

Most people tend to think that this compensation, or inflation risk premium, should be positive and possibly increase with the time horizon of the investment. However, economic theory tells us that this need not be the case. For example, in many simple economic models, the price of an asset depends on the covariance of its payoff with real consumption growth. In this type of model, prices of nominal assets, such as nominal bonds, will therefore depend in part on the covariance of consumption and inflation. It is the sign of this covariance that determines the sign of the inflation risk premium: if consumption growth covaries negatively with inflation, so that consumption growth tends to be low when inflation is high, then nominal assets are more risky and investors will demand a positive premium to hold them. If, on the

[2] For example, the daily turnover and the total amounts outstanding are generally considerably lower in index-linked bond markets than in nominal bond markets. This implies that there is a higher risk that investors in index-linked bond markets may encounter problems when trying to quickly exit positions at prevailing market prices, in particular during turbulent conditions, compared to investors in nominal bond markets. Moreover, such liquidity risks are especially high during the first few years after the initial launch of index-linked bonds in a market.

[3] In addition, estimates of the inflation risk premium may be of interest independently of break-even inflation considerations, as they may signal changes in perceived inflation risks or shifts in investors' aversion to inflation risk.

other hand, the covariance is positive, then holding nominal assets will partially hedge negative surprises to consumption, and investors would be willing to do so for a lower expected return, implying a negative inflation premium.[4] To complicate matters, this simple relationship need not hold in more elaborate models.

Irrespective of the sign of the inflation risk premium, from the perspective of the term structure of interest rates, it complicates the decomposition of nominal interest rates into its component parts. Consider, for example, a two-period bond. In somewhat simplified terms, we can express the (continuously compounded) yield on this bond as[5]

$$Ynom = rreal^{e} + RRP + infl^{e} + INFRP \quad (1)$$

The first two components make up the two-period real yield: $rreal^{e}$ denotes the expected average one-period real interest rate during the two periods until the bond matures, and RRP is the real premium due to risk associated with the evolution of the one-period real rate over this period. The third term, $infl^{e}$, is the average expected inflation rate during the two periods, which brings the expected real return of the nominal bond into line with that of the corresponding real bond. The final term, $INFRP$, is the inflation risk premium. The sum of the real risk premium and the inflation risk premium makes up the total term premium (also called the nominal risk premium), which is the quantity that separates the nominal bond yield from the expected average one-period nominal interest rate during the life of the bond.

Looking at equation (1), we can immediately compute the break-even inflation rate as the difference between the nominal yield and the real yield:

$$\begin{aligned} BEI &= Ynom - rreal^{e} - RRP \\ &= infl^{e} + INFRP \end{aligned} \quad (2)$$

... which affect break-even inflation rates

Equation (2) clearly shows that the inflation risk premium introduces a wedge between the break-even rate and investors' inflation expectations.

Available empirical evidence

Because theory provides little guidance with respect to either the sign or the size of inflation risk premia, measuring this important quantity has spawned a large empirical literature. In recent years, a number of studies have used "no-arbitrage" term structure models to estimate inflation risk premia. In this type of model, bonds of different maturities (nominal as well as real) are priced in an internally consistent way, such that any trading strategy based on these prices cannot generate risk-free profits.

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[4] More formally, in standard models with investors exhibiting constant relative risk aversion, the price will depend on the covariance between the ratio of future and current marginal utility of consumption (ie the stochastic discount factor) and the reciprocal of inflation. If this covariance is negative, the inflation risk premium is positive.

[5] As mentioned above, this abstracts from any liquidity premia. For simplicity, it also disregards possible influences due to institutional and technical factors, as well as effects resulting from Jensen's inequality terms (which are in the order of only a few basis points in the cases considered here).

The available empirical evidence on the properties of inflation risk premia is somewhat mixed. Studies that cover very long sample periods and that do not include information from index-linked bonds to help pin down the dynamics of real yields often report sizeable inflation risk premia. For example, using a structural economic model, Buraschi and Jiltsov (2005) find that the 10-year US inflation risk premium averaged 70 basis points from 1960.[6] They also find that the inflation premium was highly time-varying, and that by the end of their sample it had fallen to relatively low levels. Ang et al (2008) estimate a term structure model in which inflation exhibits regime switching using US inflation and nominal yield data, and report a large and time-varying inflation risk premium (on average, around 115 basis points for the five-year maturity over their 1952–2004 sample).

In papers that focus on more recent periods and in those that utilise information embedded in index-linked bonds, inflation risk premium estimates tend to be relatively small, although still mostly positive. Durham (2006) estimates a no-arbitrage model using US Treasury inflation-indexed bond data and finds that the 10-year inflation premium hovered around a slightly positive mean from 2003 onwards.[7] D'Amico et al (2008) apply a similar model to data from 1990 onwards, and report a moderate-sized positive 10-year inflation premium (around 50 basis points on average) that is relatively stable. However, they also find that their results are sensitive to the choice of date from which index-linked bond data are included.

Recent empirical evidence points to small positive inflation premia

The available empirical evidence relating to euro area data is more limited. In fact, apart from the papers on which this article is based, there appears to be only one study focusing on the euro area.[8] García and Werner (2008) apply a term structure model similar to that used by D'Amico et al (2008) on euro real and nominal yields, supplemented with survey data on inflation expectations. Their estimates suggest that the inflation premium at the five-year horizon has averaged around 25 basis points since the introduction of the euro, and that it has fluctuated only mildly over time. Hence, their results seem to be in line with those of Durham (2006) and D'Amico et al (2008), which point to a relatively modest, but positive, long-term inflation risk premium in recent years.

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[6] All quantitative risk premium estimates mentioned are in terms of (annualised) yield, rather than eg holding period returns.

[7] Prior to 2003, Durham (2006) obtains a 10-year inflation premium that was mostly negative. This is probably due to sizeable liquidity premia in this part of the sample period, which would have tended to raise the index-linked bond yield and therefore produce negative inflation premia to fit the resulting low level of break-even inflation rates.

[8] More empirical evidence is available for UK data, as a result of the longer history of index-linked bonds in the UK market. Applying a no-arbitrage model to UK data, Remolona et al (1998) find that the two-year inflation risk premium was relatively stable, averaging around 70 basis points after 1990. Risa (2001) also finds a large and positive UK inflation risk premium, based on a similar model. However, Evans (2003) obtains sizeable negative premia using a model that includes regime switching in the term structure.

A macro-finance approach to modelling the inflation risk premium

Much of the available empirical no-arbitrage term structure literature, including most of the studies mentioned above, has modelled yields and associated premia based on a set of unobservable factors. For example, a standard specification among the most widely used class of models ("affine term structure models") assumes that three unknown factors determine the dynamics of bond yields of all possible maturities. Specifically, given certain assumptions regarding the properties of the unobservable factors, the absence of arbitrage opportunities implies that all yields are "affine" – ie linear plus a constant – functions of the factors. This simplicity has made affine term structure models popular for empirical analysis of bond yields. The fact that such models also seem to successfully capture important features of the data has added to their attractiveness; see eg Dai and Singleton (2000, 2002) and Duffee (2002). The downside is that, since the factors are simply linear combinations of the yields that go into the estimation, these models do not allow us to learn much about the way economic fundamentals drive bond yields and risk premia across various maturities.

Bond yields are modelled jointly with the macroeconomy

In order to overcome this, the direction taken here is to model the dynamics of bond yields jointly with the macroeconomy.[9] Specifically, the approach sets up a small-scale model that describes key macro variables (inflation and real output) and how they interact with monetary policy (see box). The real and nominal interest rate term structures are added in such a way that they are consistent with expected interest rate developments due to central bank policy moves, while at the same time allowing for flexible risk premia linked to macroeconomic risks. In this way, movements in bond yields and in term premia (as well as their decomposition into real and inflation premia) can be explained in terms of developments in macroeconomic variables and monetary policy. The cost is that, as the model is extended to include macroeconomic variables, the estimation process becomes more complex and time-consuming. In addition, the economic structure imposes restrictions on the factors that price bonds in the model, which may make it more challenging to fit bond yields well compared to an approach where the factors are unobservable and hence maximally flexible. On the other hand, insofar as the macro model is able to provide a reasonable characterisation of key features of the economy, the addition of macro information may be useful for accurately pinning down the dynamics of the term structure.

Once the macroeconomic framework is set up to describe the dynamics of output, inflation and the monetary policy rate, as described by (3)–(5) in the box, the model can be solved for the rational expectations equilibrium using standard numerical techniques. As a result, one obtains expressions that describe how the key variables in the economy – the "state variables" – evolve

[9] This approach is a development of the pioneering work by Ang and Piazzesi (2003). The general setup of the model is discussed in some detail in Hördahl et al (2006), while the particular specification used here is described in Hördahl and Tristani (2007, 2008).

Macroeconomic setup

The approach taken here to describe the macroeconomy relies on the so-called "new neo-classical synthesis", which arguably has come to dominate macroeconomic modelling in academia as well as at central banks. This approach combines the real business cycle framework that describes how real variables drive changes in output with the dynamic pricing setup in New Keynesian models. Simple standard versions of this modelling approach boil down to just two equations, which describe the dynamics of output and inflation.[①] Typically, the output gap x_t – ie the deviation of actual output from "potential" (efficient) output – is assumed to depend on expectations of the output gap in the future, on the lagged output gap, and on the next period's expected short-term real interest rate (nominal rate r_t minus expected inflation rate $E_t[\pi_{t+1}]$):

$$x_t = \mu_x E_t[x_{t+}] + (1-\mu_x)x_{t-} + \zeta_r\left(r_t - E_t[\pi_{t+1}]\right) + \varepsilon_t^x \quad (3)$$

The leads and lags of the output gap can be thought of as capturing consumption smoothing behaviour and consumption habits, respectively, among investors (consumption is equal to output in standard simple models). The presence of the expected real rate in (3) allows consumption to shift over time in response to interest rate movements. The last term is a demand shock (eg a preference shock). Inflation is specified in a similar fashion, with expected future inflation as well as lagged inflation included to capture price stickiness and inflation inertia:

$$\pi_t = \mu_\pi E_t[\pi_{t+}] + (1-\mu_\pi)\pi_{t-} + \delta_x x_t + \varepsilon_t^\pi \quad (4)$$

In addition, the output gap enters the inflation equation, so that, for example, positive demand shocks that push output above potential can have inflationary consequences (in a microfounded model, this term would arise because monopolistic competition implies that prices will be set as a markup on marginal cost). Inflation is also assumed to be affected by supply shocks, ε_t^π, such as oil price shocks and other so-called cost push shocks.

With the specification of output and inflation in place, the final building block specifies how monetary policy is conducted. Specifically, it is assumed that a forward-looking Taylor (1993) rule is capable of describing how the central bank sets the short-term nominal interest rate:

$$r_t = \beta\left(E_t[\pi_{t+}] - \pi_t^*\right) + \gamma x_t + \rho r_{t-1} + \varepsilon_t^r \quad (5)$$

According to this rule, the policy rate depends on whether inflation is higher or lower than the level targeted by the central bank (π_t^*), which is allowed to vary over time, as well as on the level of the output gap, x_t. The lagged interest rate is included to account for "interest rate smoothing" behaviour by the central bank, and the last term in (5) denotes a monetary policy shock.[②] The inflation target, which is unobservable, is simply assumed to follow a first-order autoregressive process.

[①] The model is here specified directly at the aggregate level, meaning that the microfoundations, such as the specific preferences of individuals, are not explicitly modelled. However, the specification used is consistent with the setup that would have obtained if the model had been derived from first principles. [②] Like all other shocks in the model, the policy shock is assumed to be normally distributed with constant variance.

over time. This is useful in the context of specifying the term structure of interest rates, because bond yields will depend on expectations of future monetary policy rates, which, in turn, will depend on the way the economy is expected to evolve. Moreover, the law of motion of the state variables implied by the model solution turns out to be of the same form as the assumed dynamics of the unobservable factors in standard affine term structure models, as discussed above.[10] Because the dynamics are identical, the same bond pricing formulae will apply in this setup as in standard affine models, once the

[10] Specifically, both the state variables in our setup and the unobservable factors in an affine term structure model will follow AR(1) processes.

assumption of absence of arbitrage opportunities has been imposed. This means that bond yields (nominal as well as real) will be linear functions of the macroeconomic state variables. In imposing the no-arbitrage assumption, a key element is the specification of the so-called "market prices of risk". As the name suggests, these will determine how risks in the economy are priced as premia in bonds, reflecting investors' aversion to various sources of risks. Here, the market prices of risk are allowed to vary over time, by virtue of being specified as linear functions of the macroeconomic state variables. Specifically, the prices of risk – and by extension bond risk premia – will be linear functions of inflation, the output gap, the inflation target and the policy rate. As a result, the inflation risk premium will also vary with the level of these variables.

Inflation risk premia estimates

Data and estimation considerations

The macro-finance term structure model described above is estimated separately for the United States and for the euro area. In addition to bond yields, the estimation requires data for inflation and the output gap, which effectively limits the frequency of observation. In this article, the data are therefore sampled at a monthly frequency. Inflation is taken to be year-on-year CPI inflation (HICP in the case of the euro area), and the output gap is measured as real GDP (in logs) in deviation from an estimate of potential output.[11] Data revisions are not explicitly taken into account, and the empirical results should therefore be viewed as providing a historical characterisation of the way macroeconomic factors drive movements in bond yields, rather than as a real-time exercise. The period covered in the estimations is January 1990 to July 2008 in the case of the United States. For the euro area, the introduction of the euro provides a natural starting date, so in this case the sample period is limited to January 1999 to July 2008.

In order to estimate the dynamics of the nominal term structure, seven different nominal (zero coupon) yields ranging in maturity from one month to 10 years are included in the estimation. Moreover, because it is important to also accurately pin down the behaviour of the real term structure, four real yields with maturities between three and 10 years enter as well.[12] Although

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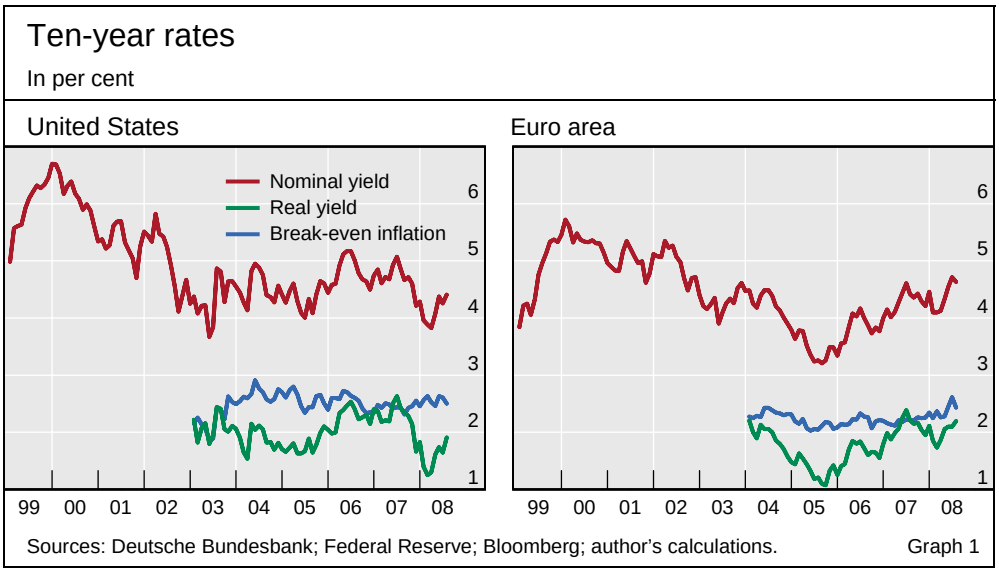
[11] For the United States, the Congressional Budget Office's estimate of potential output is used. Such an official measure is not available for the euro area, so in this case potential output is measured as the quadratic trend of GDP growth, similar to Clarida et al (1998). (Because GDP data are released on a quarterly basis, monthly values are obtained by means of time series forecasts and interpolations.) The results do not appear to be sensitive to the way the output gap is measured. A re-estimation of the model for the United States based on a gap measured with a quadratic trend resulted in only very minor changes to the estimated premia and inflation expectations.

[12] The US real and nominal term structure data consist of zero coupon yields based on the Nelson-Siegel-Svensson (NSS) method, which are available from the Federal Reserve Board. The real zeros are made available with a lag of a few months, and the final few months of data are therefore obtained directly using NSS estimates based on available index-linked bond prices (obtained from Bloomberg). For the euro area, the nominal yields are based on the NSS method applied to German data, as reported by the Deutsche Bundesbank. For large



real yield dynamics could in principle be estimated indirectly using only nominal yield data, the inclusion of real yields is likely to result in more accurate estimates. However, while nominal yield data are available from the beginning of the two sample periods, real zero coupon yields are not. Moreover, due to liquidity problems in the US index-linked bond market during the first few years (see eg D'Amico et al (2008)), real yields are included in the US estimation only as of 2003 to reduce the risk of distorting the results. For similar reasons, euro area real yields are included only from 2004. Graph 1 plots nominal and real 10-year yields used in the estimation, along with the break-even inflation rate obtained by taking the difference between these two yields.

In addition to macro and yield information, data on inflation and interest rate expectations from surveys are used in the estimation.[13] As argued by Kim and Orphanides (2005), this is useful to help pin down the dynamics of key variables in the model. Specifically, by including information from survey data, parameter configurations implying model expectations that deviate from survey expectations are penalised in the estimations.

The model is estimated using the maximum likelihood method, based on the Kalman filter (due to the presence of unobservable variables). Because there is a large number of parameters involved in the estimation, it is fruitful to introduce priors and proceed by relying on Bayesian estimation methods. This makes it possible to exploit prior information on structural economic

parts of the maturity spectrum, the German nominal bond market is seen as the benchmark for the euro area. Real euro area zero coupon rates are obtained using the NSS method, based on prices of AAA-rated euro area government bonds linked to the euro area HICP issued by Germany and France (obtained from Bloomberg).

[13] The following survey data are included in the estimations on US data: the expected three-month interest rate two quarters ahead, four quarters ahead and during the coming 10 years, and expected CPI inflation for the same horizons (source: the Philadelphia Fed's quarterly Survey of Professional Forecasters). The euro area survey data consist of forecasts for inflation obtained from the ECB's quarterly Survey of Professional Forecasters, and three-month interest rate forecasts available on a monthly basis from Consensus Economics. The inflation forecasts refer to expectations of HICP inflation one, two and five years ahead. The survey data for the short-term interest rate correspond to forecasts three and 12 months ahead.

relationships available from previous studies. Moreover, the inclusion of prior distributions brings an added advantage in that it tends to make the optimisation of the highly non-linear estimation problem more stable.

Characteristics of inflation risk premia

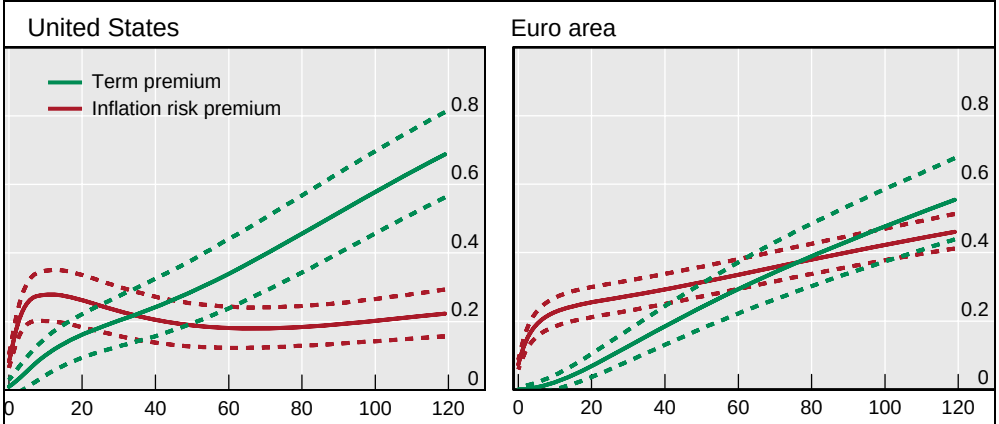
Given the parameter estimates obtained using the approach described above, any possible combination of state variables implies a specific term premium on nominal bonds for any maturity, as well as a decomposition of the term premium into a real risk premium and an inflation risk premium.

Inflation premia are positive on average …

Graph 2 plots the average estimated term premium and inflation risk premium across all maturities up to 10 years. Both premia are positive on average in the United States as well as the euro area.[14] The US term premium is estimated to be slightly larger across all maturities compared to that of the euro area, although the difference is not statistically significant. The inflation premium is found to be somewhat lower on average in the United States than in the euro area, with the difference being significant from a statistical point of view for longer maturities. Moreover, the maturity profile of US inflation premia is estimated to be flatter than that of the euro area. As a result, for long-term maturities most of the US term premium seems to be due to compensation for real rate uncertainty, similar to results reported by Durham (2006) and D'Amico et al (2008), while in the euro area the inflation premium accounts for most of the total average term premium. One possible factor behind a higher US real risk premium compared to the euro area might be the greater variability of US short-term interest rates, which may have resulted in perceptions of higher real

Term structure of average risk premia

In per cent



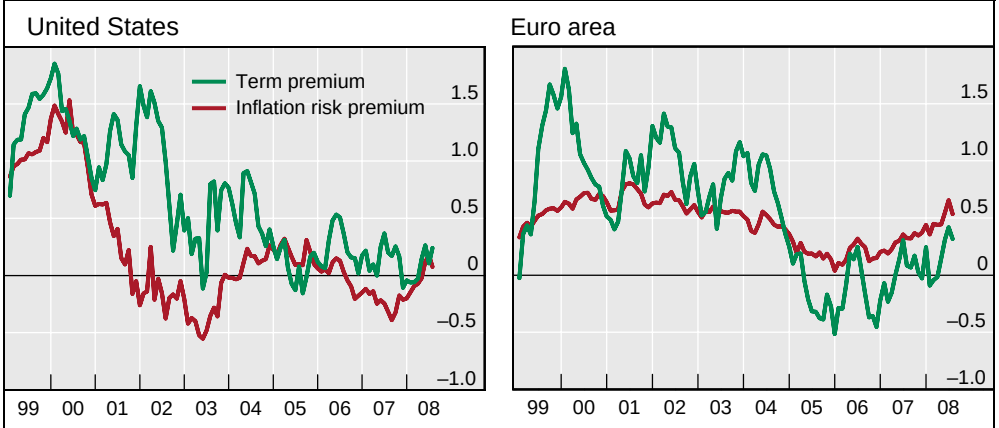
The term premium is the sum of the real risk premium (not shown) and the inflation risk premium. Horizontal axis refers to the horizon in months. The dashed lines show 95% Bayesian confidence intervals around the median (based on 50,000 draws from the posterior distribution).

Source: Author's calculations. Graph 2

[14] While in the case of the United States the data extend back to 1990, the period covered in Graphs 1–4 is 1999 onwards. This is in order to facilitate comparison with results for the euro area.

Estimated 10-year risk premia

In per cent



The term premium is the sum of the real risk premium (not shown) and the inflation risk premium.

Source: Author's calculations.

Graph 3

interest rate risk in the United States and hence higher required compensation to bear this risk.[15]

… and vary over time

The dynamics of the estimated risk premia are displayed in Graph 3, with a focus on the 10-year maturity. The US 10-year term premium has tended to decline during the period covered in the graph, and has remained close to zero in recent years, a feature that has also been found by D'Amico et al (2008), among others. Falling term premia have been seen as an important ingredient in explaining Greenspan's "conundrum" of very low long-term bond yields in the past few years (Greenspan (2005), Kim and Wright (2005), Bernanke (2006)). Our results indicate that the decline in the term premium was due to a fall in both the real premium and the inflation premium.[16] In particular, the US inflation premium displayed a sharp drop in the first couple of years of the new millennium. This coincided with a pronounced fall in US inflation and growing concerns about deflationary pressures in the wake of sharp declines in equity prices and an economic downturn. In such an environment, investors apparently became less concerned about inflation risk, which resulted in lower required return to take on such risk.

The estimates of the 10-year term premium in the euro area show that this has fallen in line with the US term premium. However, much of this has been

[15] For example, since 1999, US one-month nominal interest rates have on average been 80% more volatile than comparable euro area rates. As a result, US ex post one-month real rates have also been more volatile than in the euro area. By contrast, the volatility of US month-on-month inflation has been about the same as in the euro area.

[16] As previously mentioned, the analysis does not take into account institutional or technical factors. Such factors include heavy purchases of government securities by foreign central banks and other state institutions in recent years, which may have influenced government bond prices. To the extent that such factors have exerted downward pressure on bond yields unrelated to fluctuations in macroeconomic variables, this is likely to show up in the results as lower estimated risk premia. Moreover, it has been argued that this type of activity has been particularly pervasive for US Treasuries in recent years, suggesting that the impact may have been especially pronounced on Treasury yields and, by extension, on estimated US risk premia.

attributable to a declining real premium, while the inflation premium has remained relatively more stable around a small positive mean. These estimates of long-term euro area inflation risk premia are broadly in line with those reported by García and Werner (2008), who use an affine model based on unobservable factors. The fact that different models result in similar inflation premia estimates suggests that the results in this dimension may be reasonably robust.

Premium-adjusted break-even rates

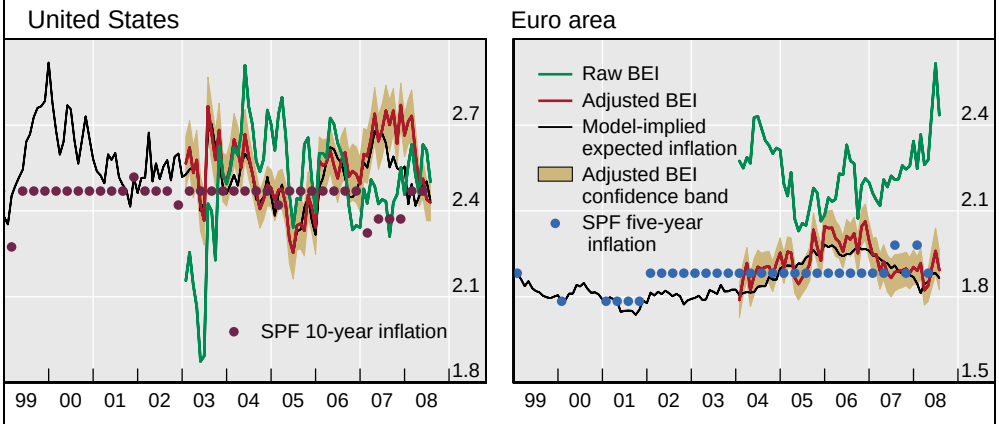
Premium-adjusted break-even rates ...

As mentioned above, inflation risk premia introduce a wedge between break-even inflation rates and actual inflation expectations among investors. Given the inflation risk premium estimates obtained here, it is therefore possible to strip out this component to obtain premium-adjusted break-even inflation rates, which provide a model-consistent measure of average expected inflation during the time to maturity. Graph 4 plots raw and premium-adjusted 10-year break-even inflation rates in the United States and the euro area for the periods during which reliable estimates of zero coupon real rates are available (as discussed above).

Reflecting the small magnitude of the estimated premia, the raw and adjusted break-even rates tend to be relatively close to one another, in particular for the United States. With euro area inflation premia estimated to be somewhat larger than in the United States on average, the euro area adjusted

Ten-year break-even rates and inflation expectations

In per cent per year



BEI denotes break-even inflation rates. The raw BEI is the simple difference between 10-year nominal bond yields and 10-year real yields, while the adjusted BEI subtracts the estimated 10-year inflation risk premium from this quantity. The model-implied expected inflation is the average expected inflation rate over the next 10 years, as implied by the estimated macro dynamics of the model. SPF inflation denotes survey expectations of inflation during the next 10 years (for the United States) and five years ahead (for the euro area), as reported in the Survey of Professional Forecasters of the Federal Reserve Bank of Philadelphia and the ECB, respectively. Adjusted BEI confidence bands show 95% Bayesian confidence intervals around the median premium-adjusted BEI (based on 50,000 draws from the posterior distribution).

Sources: ECB; Federal Reserve; author's calculations. Graph 4

break-even rate is consequently also lower relative to the raw rate.[17] In fact, while the raw euro area break-even rate has been fluctuating consistently above a level of 2% since 2004, the premium-adjusted measure has been close to and mostly below 2%, suggesting long-term euro area inflation expectations more in line with the ECB's price stability objective than would have been the case had the unadjusted break-even rate been taken to represent expected inflation.

Graph 4 also displays the estimated model-implied average expected inflation rate over the next 10 years at each point in time, which is available over the entire sample periods. This is the expected 10-year inflation rate produced by the macro dynamics of the model, which would fully coincide with the premium-adjusted break-even rate if all yield measurement errors were always zero. While this is not the case, the difference is very small, in the order of a few basis points, indicating that the model successfully captures the dynamics of both nominal and real yields. An exception seems to be the last year of the sample in the case of the United States, when a noticeable difference emerges between the two measures. This may have been due to sharp movements in Treasury yields (eg flight to safety) resulting from the outbreak of financial turmoil starting in mid-2007, which the model is ill-equipped to handle.

In addition, Graph 4 reports measures of long-horizon inflation expectations from available survey forecasts: 10-year US inflation expectations from the Federal Reserve's Survey of Professional Forecasters (SPF) and five-year euro area inflation expectations from the ECB's SPF. The results indicate that the model does well in capturing the level and broad movements of investors' long-term inflation survey expectations, which is not surprising given their inclusion in the estimations. In the case of the euro area, where the premium-adjusted break-even rate has differed more from its raw counterpart than in the United States, the adjusted break-even rate is much closer to the survey forecasts than the unadjusted rate. With respect to the US case, the survey data provide some justification for the very low US inflation risk premia estimates obtained. Since 2003, the raw US 10-year break-even rate has been relatively well aligned with the survey measure, suggesting that the inflation premium needs to be small to result in an adjusted break-even rate close to the survey expectations.

… are close to survey inflation expectations

The inflation risk premium and the macroeconomy

In order to gain some insight into what the underlying drivers of inflation risk premia are, it is useful to investigate how they evolve in response to changes in the macroeconomic state variables. Ultimately, all time variation in the estimated premia will be due to movements in these variables. It turns out that two of the state variables are the main drivers of inflation premia in the United

[17] The same result holds for five-year forward break-even rates five years ahead, a common indicator of market inflation expectations for distant horizons. For the United States, the premium-adjusted version of this forward break-even rate has differed little from the raw version, while in the case of the euro area the adjustment has generally resulted in a significantly lower level compared to the raw series (see BIS (2008, pp 112–13)).

Inflation and output movements drive developments in inflation premia …

States as well as in the euro area: the output gap and inflation. Broad movements in the 10-year inflation risk premium largely match those of the output gap, while higher-frequency fluctuations in the premium seem to be aligned with changes in the level of inflation.

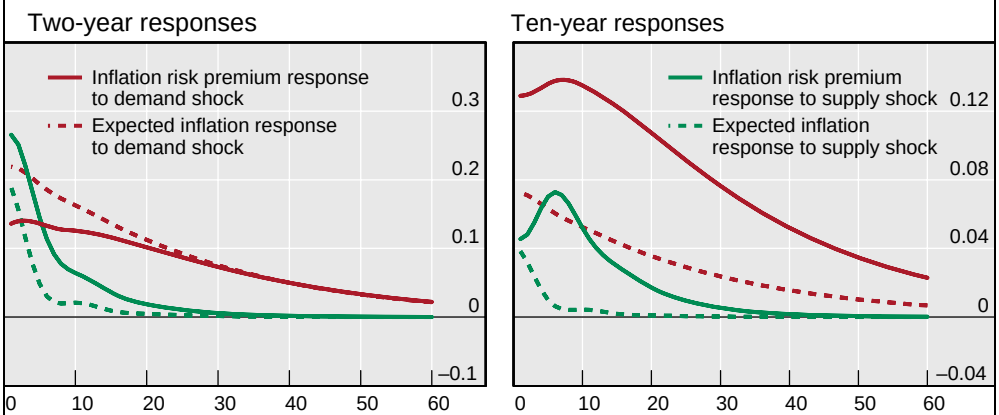
Movements in the output gap and in inflation are due to combinations of the structural shocks in the model, so, to better understand the ultimate determinants of premia, it is necessary to examine their reaction to such shocks. One of the advantages of the modelling strategy adopted here is that it makes it possible to compute impulse response functions of yields and associated premia to the underlying macro shocks. Graphs 5 and 6 show US and euro area responses of inflation risk premia and expected inflation to demand and supply shocks. The left-hand panels refer to a two-year horizon and the right-hand panels to a 10-year horizon. These graphs show that the responses of inflation premia to demand shocks (ie shocks to the output gap in equation (3)) are much more persistent than responses to supply shocks (ie shocks to inflation in equation (4)). Intuitively, this reflects the fact that the effects on inflation and output from demand shocks are substantially longer-lasting than those from supply shocks.

… with demand shocks having persistent effects …

Looking at the results in more detail, a positive shock to US aggregate demand, corresponding to a 1 percentage point increase in the shock to the output gap in equation (3), pushes up the 10-year inflation premium by around 13 basis points (Graph 5, right-hand panel), possibly reflecting perceptions of a higher risk of upside inflation surprises as the output gap widens. A positive demand shock also raises the average expected inflation rate by about 7 basis points, resulting in an overall increase in the 10-year break-even rate (ie the sum of the two responses) of some 20 basis points. At the two-year horizon (Graph 5, left-hand panel), the effect on the break-even rate from a demand shock is even larger, at around 35 basis points on impact, but now the bulk of the response is due to rising inflation expectations, while the inflation premium

US impulse responses

In per cent



The demand shock corresponds to a 1 percentage point increase in the shock to the output gap in equation (3), while the supply shock is a 1 percentage point increase (in annualised terms) in the shock to inflation in equation (4). Horizontal axis measures the horizon of the responses in months.

Source: Author's calculations. Graph 5

response is similar to the 10-year case. Demand shocks therefore seem to induce parallel shifts in the inflation premium, while inflation expectations react much more strongly for short maturities than for long.

… while the impact of supply shocks is short-lived

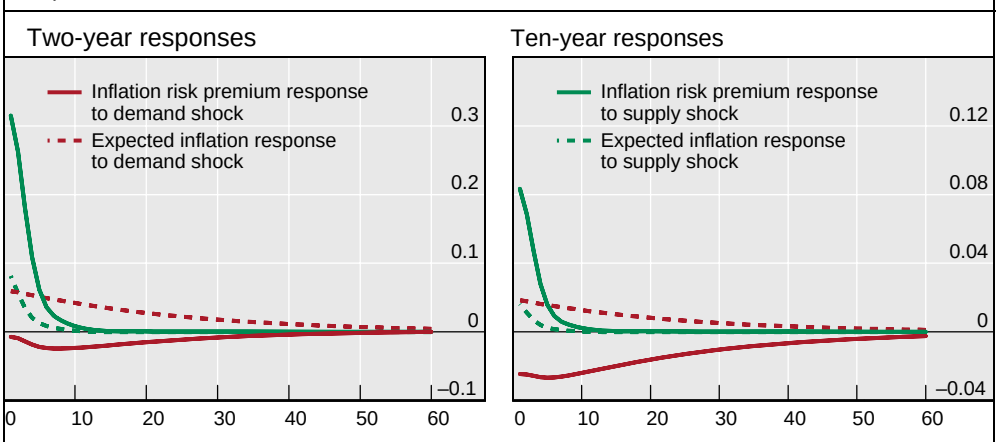
The responses to supply shocks in Graph 5 (corresponding to a 1 percentage point increase in the shock to inflation in equation (4)) are clearly less pronounced and less persistent than for demand shocks. Nonetheless, the short-term reaction of both expected inflation and inflation risk premia at the two-year horizon is sizeable. This suggests that investors become more averse to inflation risk as inflation rises.

As in the United States, a positive demand shock also raises expected inflation in the euro area, and more so at the two-year horizon than at the 10-year horizon (Graph 6). However, in contrast to the US case, the inflation premium response is uniformly negative, albeit small. In terms of the response of euro area break-even inflation to demand shocks, the two effects largely cancel out. Given that the inflation risk premium accounts for a sizeable portion of the overall term premium, this negative response of the inflation premium to demand shocks appears to be in line with evidence from Germany prior to the introduction of the euro, as documented in Hördahl et al (2006), where term premia reacted negatively to positive demand shocks. A possible explanation for this finding could be that investors become more willing to take on risks – including inflation risks – during booms, while they require larger premia during recessions.[18]

With respect to euro area responses to a supply shock, the results in Graph 6 are qualitatively similar to those for the United States. A 1 percentage point upward shock to aggregate supply raises the two-year break-even rate by around 40 basis points on impact, an effect that quickly wears off. Most of this

Euro area impulse responses

In per cent



The demand shock corresponds to a 1 percentage point increase in the shock to the output gap in equation (3), while the supply shock is a 1 percentage point increase (in annualised terms) in the shock to inflation in equation (4). Horizontal axis measures the horizon of the responses in months.

Source: Author's calculations. Graph 6

[18] Such effects have been found elsewhere. Piazzesi and Swanson (2008), for example, report strongly countercyclical risk premia based on estimates on federal funds futures prices.

increase is due to a higher two-year inflation premium (over 30 basis points). At the 10-year horizon, the break-even response is similarly short-lived and substantially smaller at around 10 basis points, predominantly due to the inflation premium.

Conclusion

This article estimates inflation risk premia using a dynamic term structure model based on an explicit structural macroeconomic model. The identification and quantification of such premia are important because they introduce a wedge between break-even inflation rates and investors' expectations of future inflation. In addition, inflation risk premia per se may provide useful information to policymakers with respect to market participants' aversion to inflation risks as well as to their perceptions about such risks.

The results show that inflation risk premia in the United States and in the euro area are on average positive, but relatively small. Moreover, the estimated premia vary over time, mainly in response to changes in economic activity, as measured by the output gap, and inflation. The estimates suggest that fluctuations in output drive much of the cyclical variation in inflation premia, while high-frequency premia fluctuations are mostly due to changes in the level of inflation.

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The development of money markets in Asia[1]

The depth and breadth of money markets in Asia have improved significantly over the past decade, yet many are still characterised by segmentation and a low degree of cross-border integration. Admittedly, the underdevelopment of Asia's money markets worked to the region's advantage during the recent turmoil by insulating it to some degree from the shocks that disrupted more developed money markets. Nonetheless, the turmoil provides authorities and market participants in Asia with an opportunity to learn from experiences elsewhere in their efforts to realise the full benefits offered by well functioning money markets.

JEL classification: E44, E52, E58, F42.

Money markets in much of Asia were not significantly affected by the events that disrupted US dollar and euro money markets beginning in mid-2007. In contrast to the situation in North America and Europe, money markets in Asia functioned normally in the second half of 2007 and first half of 2008, and monetary authorities in Asia had no cause to take special actions to stabilise them.[2]

Although the relative stability of the region's markets was clearly welcome, it stemmed in part from structural weaknesses. The depth and breadth of money markets in Asia have improved significantly over the past decade, yet many of the region's money markets remain characterised by segmentation and a low degree of cross-border integration. These weaknesses helped to insulate the markets from the recent global market turbulence. Nonetheless, the turmoil provides authorities and market participants in Asia with an opportunity to learn from experiences elsewhere in their efforts to realise the full benefits offered by well functioning money markets.

Money markets – conventionally defined as the markets for short-term debt funding of financial and non-financial corporations – perform a number of

[1] The authors are grateful to Claudio Borio, Stephen Cecchetti, Corrinne Ho, Frank Packer, Eli Remolona and Ilhyock Shim for useful discussions and comments. We thank Jhuvesh Sobrun for excellent research assistance. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS.

[2] See Borio (2008), Cecchetti (2008) and Chapter VI of BIS (2008) for overviews of the turbulence in global money markets since mid-2007. Borio and Nelson (2008) and the Committee on the Global Financial System (2008) discuss the impact of the turmoil on the conduct of central bank operations.

vital economic functions. They help banks to match short-term assets and liabilities, securities dealers to finance their positions and non-financial corporations to smooth fluctuations in their working capital needs. Furthermore, the availability of benchmark money market rates is required for the functioning of a wide range of derivatives markets, including interest rate swap markets. Well developed money markets also facilitate central banks' task of implementing their monetary policy objectives, regardless of whether they have formal interest rate targets. Therefore, money markets are integral to the maintenance of macroeconomic and financial stability.

In this special feature, we first provide an overview of money markets in the Asia-Pacific region and then describe how central banks and monetary authorities in the region utilise money markets in the implementation of their policies. We go on to consider why Asian money markets were less disrupted than US and European markets during the global market turmoil of 2007–08. The concluding section outlines possible ways for central banks to help strengthen the resilience of Asian money markets even as these markets become more integrated into the global financial system.

Overview of Asia-Pacific money markets

There is significant heterogeneity in the structures of money markets across the Asia-Pacific region. With only a few exceptions, they are smaller relative to the size of their economies than those in the United States and Europe. Broadly speaking, cash markets for short-term debt securities tend to be the most developed in the region, followed by interbank markets. Repo and foreign exchange (FX) swap markets are, in most economies, the least developed.

Some money markets, including those of Australia and Japan, are closely integrated both with the domestic economy and with international financial markets. Others, such as the Chinese market, are integrated much less. The Australian and New Zealand onshore money markets are among the most internationalised, with significant participation by foreign borrowers and investors; this partly reflects strong demand among foreign investors for securities denominated in higher-yielding currencies. Borrowing in most other markets in the region is dominated by local entities; however, where their participation is not prohibited, foreigners are often important investors.

Markets for short-term securities

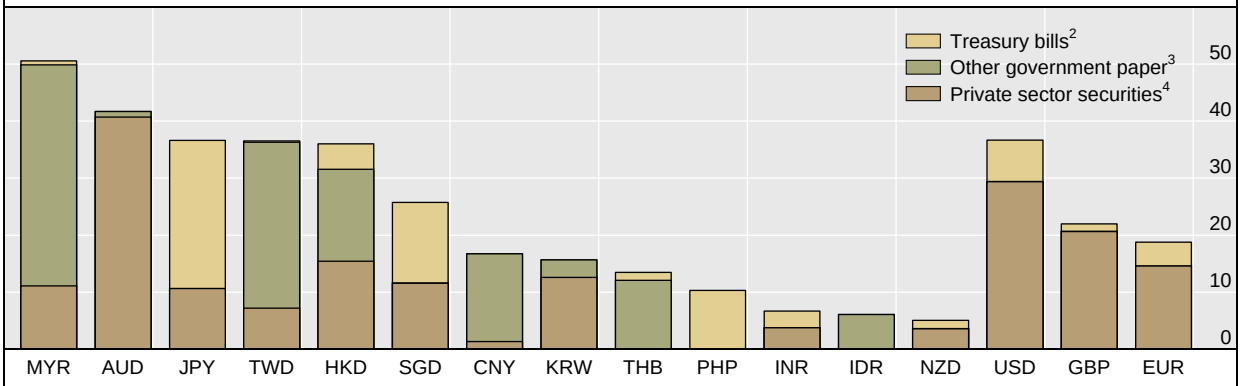
Treasury bill markets in the region are, with the exception of Japan and the Philippines, comparatively small (Graph 1). Governments in a number of Asia-Pacific economies have posted fiscal surpluses for several years and only maintain treasury bill programmes to assist with cash management. Some governments, including that of Singapore, deliberately overfund to support the functioning of other financial markets.

Treasury bill markets are generally small …

Issuance by the monetary authorities themselves, however, has been increasing rapidly. In particular, the monetary authorities of China, Hong Kong SAR, Indonesia, Korea, Malaysia, Taiwan (China) and Thailand have issued large amounts of bills in recent years. In several of these economies,

Outstanding short-term debt securities[1]

As a percentage of nominal GDP, at end-2007



AUD = Australian dollar; CNY = Chinese renminbi; EUR = euro; GBP = sterling; HKD = Hong Kong dollar; IDR = Indonesian rupiah; INR = Indian rupee; JPY = Japanese yen; KRW = Korean won; MYR = Malaysian ringgit; NZD = New Zealand dollar; PHP = Philippine peso; SGD = Singapore dollar; THB = Thai baht; TWD = New Taiwan dollar; USD = US dollar.

[1] Debt securities with an original maturity of one year or less; including securities issued in international markets, with coverage varying across markets. [2] Domestic issues. [3] Domestic and international central bank paper as well as securities issued by sub-national governments; for Hong Kong SAR, Exchange Fund Bills; for Korea, monetary stabilisation bonds; for Malaysia, both conventional and Islamic central bank paper; for Taiwan (China), central bank-issued CDs; for Thailand, Bank of Thailand bonds with remaining maturity less than one year. [4] Securities issued by private sector non-financial and financial institutions.

Sources: Dealogic; Euroclear; ICMA; Thomson Financial; national data; BIS; authors' calculations. Graph 1

the central bank bill market now exceeds in size other segments of the money markets, or even long-term government bond markets. Except for in Hong Kong, the main driver of this growth in recent years has been the sterilisation of foreign exchange operations.

… and private sector CP issuance is widespread

Markets for private sector commercial paper (CP), including asset-backed commercial paper, negotiable certificates of deposit (CDs), and other short-term debt securities such as bills of exchange and various promissory notes, have existed for many years in almost all Asia-Pacific economies. Banks as well as non-financial corporations are active participants in these markets. In Australia, Hong Kong, Singapore and New Zealand, the amounts outstanding in this segment of the money market are as large or larger than those for government or central bank bills, and issuance is dominated by banks and other financial institutions. In Japan, issuance of short-term paper is dominated by non-financial issuers. In China and India, this segment is still small but is growing rapidly, driven mainly by issuance by non-financial corporations. In Korea, the CP market has struggled to recover from the turmoil of 2003, when demand for paper issued by credit card companies collapsed.[3] In Malaysia, the quantity of outstanding Islamic (sharia-compliant) money market paper is about as large as that of conventional (interest-bearing) short-term securities.

Interbank markets

Interbank activity is significant in Hong Kong SAR and Singapore …

Active markets for uncollateralised interbank funding exist across the Asia-Pacific region. These are well developed in Hong Kong and Singapore, where claims against financial institutions exceed 30% of banks' total assets

[3] See Kang and Ma (2007) for an examination of the credit card crisis in Korea.

(Graph 2, left-hand panel). In these two centres, a large foreign currency denominated money market coexists with the local currency market.

In other Asian banking systems, interbank claims account for a substantially smaller proportion of assets. Moreover, interbank borrowing and lending are concentrated in the overnight segment to a far greater extent than is the case in more developed interbank markets. Interbank rates are often quoted for maturities as long as 12 months, but in most markets hardly any transactions take place beyond a few weeks.

… while term interbank lending in many economies is limited

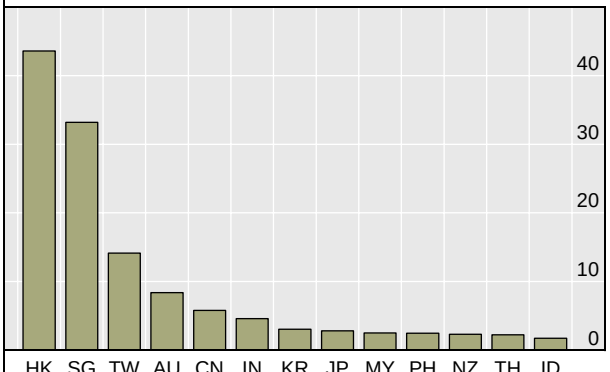
An indication of the lack of depth in some of the term interbank markets in the region is the use of very short-term or even swap-implied interest rates as the reference floating rate leg in interest rate swap (IRS) contracts, instead of the three- or six-month interbank rates typically employed in the US dollar, euro and yen markets. For instance, the floating rate leg of renminbi IRS is linked to the seven-day repo rate because repo markets are more active than term interbank markets in China. For a similar reason, Philippine peso IRS are referenced to interest rates implied by FX swaps.

One explanation for why term interbank markets have failed to develop in many Asia-Pacific economies is that, in recent years, their banking systems have been well supplied overall with liquid local currency assets. An indicator of this feature is that, with the exception of Australia and Korea, deposits exceed outstanding loans in banking systems across the region (Graph 2, right-hand panel).

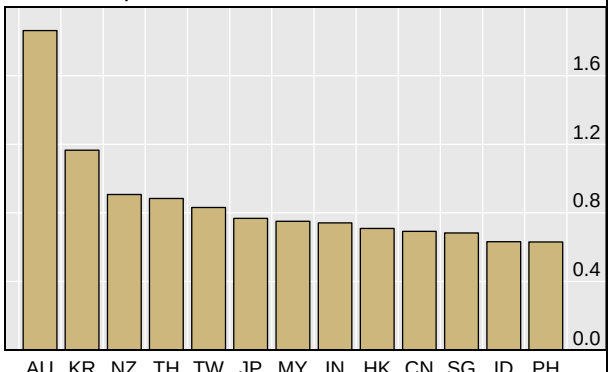
Despite ample liquidity in the aggregate, banks facing a funding gap often report difficulties obtaining sufficient funds in the uncollateralised interbank market. Banks with surplus cash frequently prefer to deposit it with the central bank or buy government securities rather than lend it out in the interbank market. Such credit rationing is, in some circumstances, appropriate. Even in the most developed markets for short-term credit, rationing rather than repricing is the common response to uncertainty regarding credit quality, perhaps because of the heightened importance of adverse selection during

Selected bank balance sheet indicators

Interbank claims[1]



Loan-to-deposit ratio[2]



AU = Australia; CN = China; HK = Hong Kong SAR; ID = Indonesia; IN = India; JP = Japan; KR = Korea; MY = Malaysia; NZ = New Zealand; PH = Philippines; SG = Singapore; TH = Thailand; TW = Taiwan, China.

[1] As a percentage of total banking system assets, at end-2007; national definitions. [2] Late to end-2007 data; national definitions.

Sources: Bankscope; CEIC; IMF; national data; authors' calculations. Graph 2

periods of uncertainty. However, in Asian interbank markets, creditworthiness is not necessarily the main constraint on banks' access to funding. Foreign banks, many of which have higher credit ratings than locally headquartered ones, are prominent among those that report having difficulty accessing local interbank markets.

Institutional impediments make some money market participants either unwilling or unable to transact with other participants at prevailing interest rates. These impediments include controls on lending to or borrowing from offshore entities and rules governing the use of the central bank's standing facilities. In some cases, segmentation also arises from anticompetitive practices: for example, established banks might seek to undermine the growth of rivals by declining to place surplus funds with them.

Repo and FX swap markets

The growth of collateralised markets in Asia and the Pacific lags well behind improvements in uncollateralised money markets. Repo markets, where loans are secured against securities, are among the most important markets for collateralised short-term financing, particularly for securities dealers, which tend to hold large stocks of eligible collateral.[4] Australia and Japan have large, active repo markets. In several other economies in the region, participation in repo markets by private financial institutions is limited to transacting with the central bank.

Repo activity is impeded by the lack of an appropriate legal framework

One impediment to the development of repo markets in the region may be the lack of an appropriate legal framework. To the extent that private financial institutions conduct repos with each other, lenders at times behave as if such transactions were not truly secured, as they reportedly impose unusually strict credit limits on their counterparties. This may be due in part to settlement risk, but may also stem from untested legal frameworks or master agreements that fail to provide certainty about which counterparty owns the collateral in the event of default.

Restrictions on short selling of securities also inhibit repo market activity. In well developed markets, it is common for financial institutions to position for changes in interest rates by first borrowing certain securities in the repo market and then short selling them. Corporate bond dealers commonly hedge their inventories of newly issued bonds through short sales of government securities with comparable duration characteristics. Restrictions on short selling are gradually being eased, but in many Asia-Pacific economies there are still limits on the types of institutions that are allowed to short sell securities, as well as outright prohibitions on the short selling of securities which the institution has not yet borrowed.

Another obstacle to the development of repo markets in some economies in the region is a lack of arrangements that would allow the use of a wider

[4] The term "repo" is used in this article in a broad sense, to denote "ordinary" reverse purchase transactions as well as reverse repos, matched sale-purchases and reverse matched sale-purchases, where collateral is denominated in domestic currency and frequently (though not necessarily) made up of government or sub-government securities.

range of assets that could serve as collateral. For now, securities issued by the central government typically constitute the preferred base of suitable collateral. This is in part because such securities are often seen as being virtually free of credit risk, and so disagreements over the required haircut are minimised. The fact that such securities also tend to be held in custody at the central bank as book entry securities facilitates the settlement of repo transactions. In some Asia-Pacific economies, the availability of such low-risk collateral is declining because of fiscal surpluses. To the extent that the central bank itself has been running out of such assets on its balance sheet, it has often issued its own paper, which may in turn serve as collateral in repo transactions.

FX swap markets are an alternative source of secured financing. FX swaps can be thought of as loans secured with foreign currency. They tend to be an especially important source of short-term financing for foreign financial institutions with limited access to retail deposits or the interbank market.

FX swaps are actively traded in only a few economies in the region

The use of FX swap contracts as money market instruments varies widely across the region. In Australia, Hong Kong, Japan, New Zealand and Singpore, they are an integral part of the domestic money markets, and the turnover of FX swaps referencing these four currencies is large (Table 1). In other Asia-Pacific economies, activity in FX swap markets is quite limited, reflecting both controls on capital flows and restrictions on the participation of non-resident investors in the local money markets.

Turnover in derivatives markets

Average daily trading volume in April 2007, in millions of US dollars

	FX swaps[1]	Interest rate derivatives		
		Money market futures[2]	Forward rate agreements[1]	Options[1]
AUD	131,998	123,613	3,195	1,480
CNY	1,078	0	0	34
HKD	63,895	128	49	366
IDR	560	0	0	1
INR	6,303	0	0	165
JPY	242,319	135,873	3,882	23,121
KRW	8,812	0	253	602
MYR	1,190	235	0	101
NZD	34,828	5,700	1,046	43
PHP	1,053	0	0	0
SGD	26,209	12	346	1,056
THB	4,325	0	14	38
TWD	1,438	0	0	391
Memo:				
USD	*1,580,594*	*2,097,927*	*97,903*	*112,857*
EUR	*581,977*	*952,718*	*66,492*	*61,795*
GBP	*264,593*	*373,099*	*41,606*	*6,184*

Refer to Graph 1 for an explanation of the currency abbreviations.

[1] Turnover in over-the-counter derivatives markets, adjusted for local and cross-border inter-dealer double-counting. [2] Turnover on organised exchanges worldwide of contracts on short-term interest rates.

Sources: FOW TRADEdata; Futures Industry Association; national data; BIS. Table 1

Interest rate derivatives

Money market futures and forwards are in their infancy

Interest rate derivatives markets in much of the Asia-Pacific region are in their infancy, constrained by some of the same impediments affecting repo markets. Futures contracts on short-term interest rates are listed on exchanges in several of the region's economies. However, aside from yen, Australian dollar and New Zealand dollar contracts, they are not widely traded (Table 1). Among the other Asia-Pacific currencies, the only money market futures contracts for which turnover has increased in recent years are those on the Malaysian ringgit. In contrast to most other interest rate futures contracts in the region, ringgit futures reference the same rate as ringgit IRS – the onshore three-month interbank rate – and thus futures market activity is boosted by the ability to hedge or position in either instrument.

Forward rate agreements (FRAs) are the over-the-counter equivalent of money market futures. There is significant activity in yen and Australian dollar FRAs (Table 1). Singapore dollar interest rate derivatives are also relatively widely traded, especially options contracts. In other Asia-Pacific currencies, OTC interest rate derivatives activity is negligible.

Central bank operations in money markets

The development and functioning of money markets are influenced in part by central banks' monetary policy operations. The very fact that a central bank chooses to operate in one segment of money markets rather than another – or indeed chooses to operate in money markets rather than rely on non-market instruments such as credit controls – gives rise to trading activity and thereby influences the depth and overall development of money markets.

Central banks in the region rely increasingly on money markets ...

In recent years, central banks in the Asia-Pacific region have increasingly come to conduct the operations that implement their policy objectives in money markets. Many have also begun to specify their policy targets in terms of money market rates. In the 10 economies in the region where the monetary authority at present has a short-term interest rate target, there is considerable diversity in the ways these targets are specified and how monetary operations are conducted (Table 2).[5] Many specify their target in terms of an unsecured interbank rate, yet operate in a different market. In New Zealand, for example, the official cash rate is set in the interbank market while operations are conducted largely in the FX swap market. One exception is Malaysia, where both the policy target and the central bank's main operations are in the interbank market.

... especially repo markets

Central banks in the region are making greater use of repo markets. In India and the Philippines, the central bank announces a corridor or target range

[5] The three monetary authorities in the region that do not implement policy primarily through money market targets and operations are those of China, Hong Kong and Singapore. The Chinese authorities announce targets for one-year deposit and lending reference rates and also influence banks' minimum required reserve ratios. Hong Kong has a currency board system based on a target for the nominal HKD/USD spot rate. The Monetary Authority of Singapore announces targets and rates of adjustment for the nominal effective exchange rate of the Singapore dollar.

Key policy rates and main operating instruments

	Key policy rate	Type	Main operating instruments
Australia	Target cash rate	Interbank	RPs
India	Repo and reverse repo rates	Repo	RPs
Indonesia	Overnight rate	Interbank	SBI auctions, RPs
Japan	Call money rate	Interbank	RPs
Korea	Repo rate	Repo	MSB sales
Malaysia	Overnight policy rate	Interbank	Interbank transactions
New Zealand	Official cash rate	Interbank	FX swaps
Philippines	Overnight repo rates	Repo	RPs
Taiwan, China	Discount rate	Interbank	CDs and NCDs
Thailand	Repo rate	Repo	RPs

CDs = certificates of deposit; MSBs = monetary stabilisation bonds; NCDs = negotiable certificates of deposit; RPs = repos and reverse repos; SBI = Sertifikat Bank Indonesia (one- to six-month Bank Indonesia bills).

Sources: Ho (2008); authors' updates. Table 2

for repo rates and also conducts its operations in the repo market. In June 2008, Bank Indonesia switched to targeting the overnight call rate and conducting repo operations. Balance sheet considerations may limit the ability of a monetary authority to achieve its operational targets by means of reverse repos and outright sales of securities, if such actions are deemed necessary to drain a sufficient amount of reserves from the financial system. However, it is possible to circumvent this obstacle by letting the central bank issue its own debt securities – a path that has been taken by several of the central banks in the region, including those of China, Malaysia and Thailand.

Many central banks in the region also operate in the FX swap market. Often these operations are designed to offset changes in aggregate reserves that would result from foreign exchange intervention operations (which are generally carried out in the spot FX markets). In some cases, they are a key operating instrument. The Reserve Bank of Australia used to operate primarily in the domestic repo market to achieve its target for the interbank rate but since the early 2000s has made greater use of FX swaps.

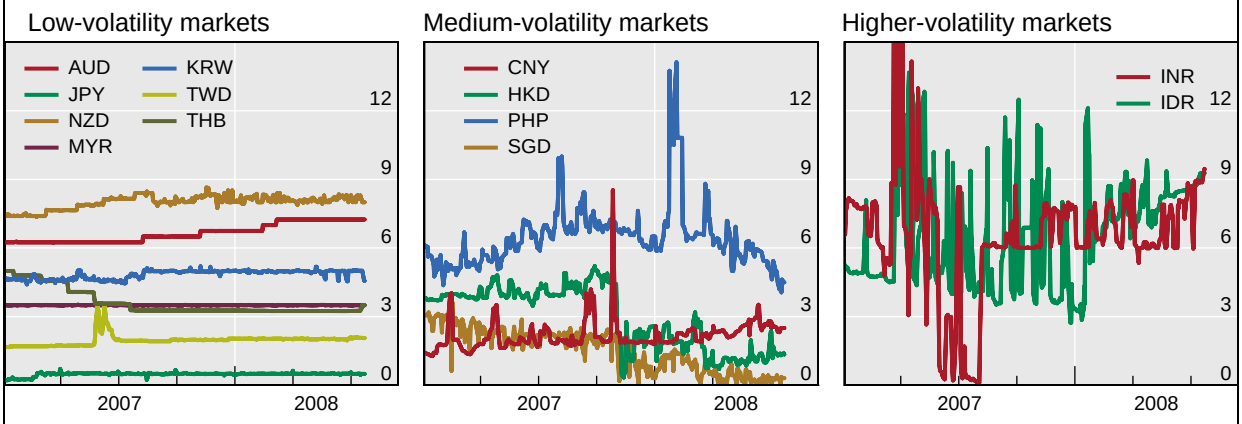
Central banks' presence can stifle activity among private sector participants

Although the participation of the central bank in a given market segment tends to boost activity, there can be costs. If the central bank is the dominant participant in the market, its presence may actually stifle transactions between private financial institutions. For instance, in Thailand the active role of the central bank in the repo market was perceived as contributing to a crowding out of other participants. To counteract this problem, in November 2007 the Bank of Thailand announced measures intended to reduce its own role in the repo market and to encourage increased activity among private sector participants.

Differences in monetary regimes and operations contribute to significant differences in the volatility of overnight interbank rates in the region (Graph 3).[6] The monetary authorities of Hong Kong SAR and Singapore do not

[6] We focus here on the volatility of overnight interbank rates because activity in the term interbank markets is limited in most economies in the region.

Interbank interest rates[1]



Refer to Graph 1 for an explanation of the currency abbreviations.

[1] Overnight uncollateralised rates, in per cent; for PHP, one-week rate.

Source: CEIC. Graph 3

have interest rates as their operating targets and so accept greater volatility in overnight rates. In contrast, where the central bank targets a money market rate, overnight rates tend to be less volatile. Structural weaknesses in liquidity management practices in the Indian and Indonesian money markets have, at times, exacerbated volatility in rupee and rupiah overnight rates.[7] Since June 2008, when Bank Indonesia switched to targeting the overnight call rate, the volatility of the overnight rupiah rate has declined markedly.

Resilience of Asian money markets to the global turmoil

Problems in credit markets led to severe strains in some of the most developed money markets in the world in the second half of 2007 and the first half of 2008. The spread between interbank rates and overnight index swap (OIS) rates – a measure of credit and liquidity premia in interbank markets – illustrates the severity of the situation: in US dollar, euro and sterling money markets, this spread widened sharply in August 2007 and was both unusually high and volatile for many months afterwards (Graph 4, left-hand panel).

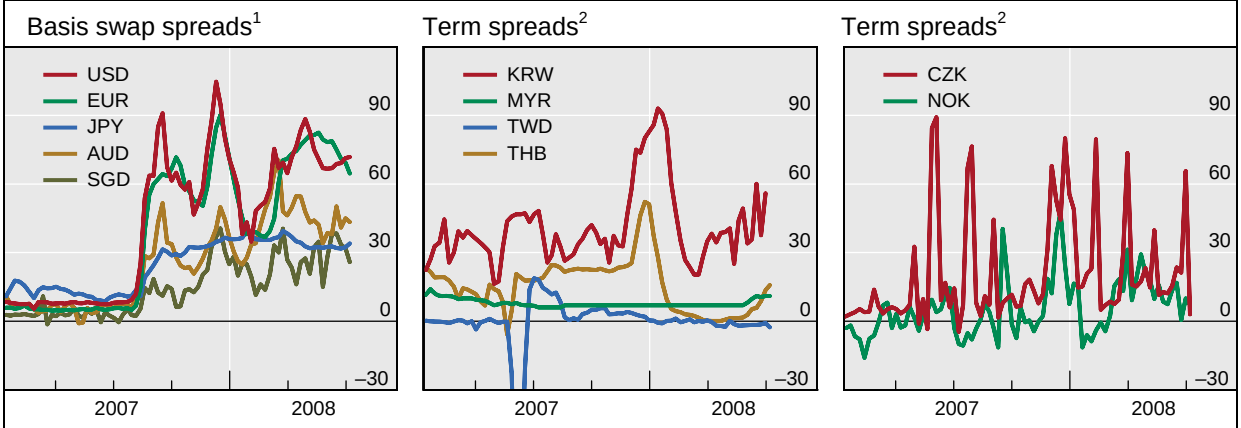
Asian money markets remained relatively stable despite disruptions elsewhere …

In contrast to developments in US and European money markets, Asia-Pacific money markets remained relatively stable. In the few places where there was both a three-month interbank market and a market for overnight index swaps, the interbank-OIS spread widened modestly (Graph 4, left-hand panel). In many others, there was little or no change in the relationship between different short-term interest rates. For example, the term spread

[7] For instance, in late March 2007 a calendar-related temporary increase in demand for central bank reserves in India coincided with a dip in the supply of reserves, and as a result the overnight rupee rate spiked up briefly to about 60%. The overnight rate subsequently fell back to within the interest rate corridor maintained by the Reserve Bank of India. In the second quarter of 2007, the Reserve Bank temporarily suspended its reverse repo operations. As a result – and because of continued heavy capital inflows – the overnight rupee interbank rate fell to near zero. Overnight rates rose again after reverse repos resumed early in the third quarter of 2007.

Money market spreads

Weekly average, in basis points



AUD = Australian dollar; CZK = Czech koruna; EUR = euro; JPY = Japanese yen; KRW = Korean won; MYR = Malaysian ringgit; NOK = Norwegian krona; SGD = Singapore dollar; THB = Thai baht; TWD = New Taiwan dollar; USD = US dollar.

[1] Three-month interbank rate minus three-month overnight index swap rate. [2] One-month onshore interbank rate minus overnight rate; for KRW, three-month deposit rate minus overnight rate.

Sources: Bloomberg; authors' calculations. Graph 4

between one-month and overnight interbank rates in the Thai baht and Taiwanese dollar markets was relatively stable until December 2007 and deteriorated only moderately, if at all, in the first half of 2008 (Graph 4, centre panel). Term spreads in the Korean won market widened towards the end of 2007. However, this move was driven by the Korean authorities' efforts to slow the growth of short-term foreign currency borrowing rather than by spillovers from abroad.

Restrictions on cross-border financial activity in some Asian emerging economies were one reason for the resilience of their money markets to shocks in the major markets. Capital mobility is lower in Asia than in most other emerging markets (García-Herrero and Wooldridge (2007)). Those Asia-Pacific markets that were most disrupted tended to be the ones most closely integrated with international markets, in particular the Australian dollar, yen, New Zealand dollar and Singapore dollar markets.

However, weak cross-border ties do not fully explain the relative lack of contagion to Asia-Pacific money markets. Some highly integrated and open financial systems, such as those of the Czech Republic and Norway, were also not affected strongly by the recent turmoil in major markets (Graph 4, right-hand panel).[8] This indicates that other features of the financial system may have been as important as capital controls in insulating Asian markets from the turmoil.

[8] In both the Czech Republic and Norway, capital accounts are liberalised and foreign entities are active in the domestic financial markets. Even though foreign banks tapped the koruna and krone markets for funding and local banks refinanced maturing foreign currency obligations in the local market, these activities did not cause serious disruptions. Norwegian krone and Czech koruna term spreads were relatively stable in August and September 2007 during the early phases of the turmoil; they widened on a prolonged basis only towards the end of 2007, and fell back after the turn of the calendar year. So far in 2008, they have also shown little sign of marked widening.

… thanks to features of Asian financial systems …

One such feature is the greater reliance of Asian banking systems on deposits rather than interbank or capital markets for funds. Banks in Malaysia, the Philippines and Thailand, for example, are net creditors in the international banking system (McCauley and Zukunft (2008)). Consequently, the structure of their liabilities was less vulnerable to the global repricing of risk than those banks dependent on wholesale funding.

Furthermore, Asia-Pacific banks had limited exposure to structured credit products and other assets which were behind large losses at international banks. Admittedly, some Asian banks announced larger than expected losses or writedowns. Nevertheless, unlike in the case of some US and European banks, the size of these exposures was not large.[9] For example, in June 2007, the notional principal of synthetic collateralised debt obligations held by banks headquartered in non-Japan Asia equalled a mere 0.1% of these banks' total assets, compared to about 40% of assets for G10 banks collectively.[10]

Similarly, the vast majority of Asian banks did not sponsor CP conduits or follow the originate-to-distribute business model of many international banks. Therefore, Asian banks did not face the risk of being called upon to refinance the conduits' maturing short-term obligations that could no longer be rolled over after asset-backed CP markets seized up, and they were not left holding assets that they had expected to securitise and move off their balance sheets. Securing financing for an unexpected expansion of assets was correspondingly less of a worry among Asian banks.

… and the shallowness of Asian money markets

Finally, the shallowness of many Asian money markets limited their attractiveness as a source of financing for foreign financial institutions. The FX swap market was an important channel through which shocks in the US dollar market were transmitted to other markets (Baba et al (2008)). However, as discussed earlier, foreign banks tend to have difficulty borrowing in Asian interbank markets, so tapping local markets to fund assets denominated in US dollars was unlikely to be a viable alternative. For most economies in non-Japan Asia, BIS data on foreign banks' local currency positions give no indication that these banks either scaled back their local assets or shifted financing from foreign markets to local ones in the second half of 2007 or the first part of 2008.

Conclusions

The underdevelopment of money markets arguably worked to Asia's advantage during the recent turmoil by insulating Asian financial systems and economies to some degree. That said, well functioning money markets bring many

[9] Even though international banks announced far larger losses and writedowns than Asian banks, CDS spreads for Asian banks widened by as much as those of international banks. Changes in the risk appetite of global investors appear to explain this high degree of co-movement (Remolona and Shim (2008)).

[10] Exposures arising from multi-name CDS portfolios are substantially smaller than the notional outstanding value of such portfolios. Such exposures are better approximated by market values. For G10 banks, gross market values at end-June 2007 equalled 1.7% of notional amounts outstanding.

economic and financial benefits, so it is in Asia's long-term self-interest to promote further development of these markets. Closer integration with foreign markets is an important part of this process.

If accompanied by appropriate policy and market reforms, integration need not increase Asian money markets' vulnerability to external shocks. The continued development of repo and FX swap markets is especially important, considering that activity in collateralised funding markets is usually the most resilient in the face of disruptions to other segments of the financial system. The turmoil has, however, demonstrated that even collateralised markets can be vulnerable to disruptions when trading conditions in related markets deteriorate. This highlights the dependence of money markets on the proper functioning of other segments of financial markets, including bond, equity and foreign exchange markets.

Asia could learn from the experiences of central banks faced with impaired markets

A recent report from the Committee on the Global Financial System (2008) recommends ways in which central banks could modify their monetary policy operations to cope flexibly and effectively with episodes of impaired money market functioning. These include having systems in place that allow central banks to conduct operations with an extensive set of counterparties and against a broad range of collateral, redesigning standing facilities in ways that reduce any stigma associated with borrowing directly from a central bank, establishing swap lines among central banks and other mechanisms that facilitate the international distribution of funds, and enhancing communications with market participants and the media. The resilience of money markets everywhere, Asia included, would be enhanced through the implementation of these recommendations.

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Reducing foreign exchange settlement risk[1]

Much progress has been made in reducing settlement risk in foreign exchange markets, particularly through use of CLS Bank. However, the remaining exposures are sometimes still significantly large and not always well managed, creating the potential for systemic risk. To address this problem, it is particularly important that prudential regulators promote effective management of the risk by market participants.

JEL classification: G15, G18, G2, G21, G28, G32.

Foreign exchange settlement risk has proved to be a persistent and problematic issue in financial markets. Despite much discussion and even a significant amount of action, the size and nature of the risk mean that it could still disrupt the stability of global financial markets.

This special feature examines the results of a survey that took place in April 2006 to assess the degree of risk. The survey was carried out for the Committee on Payment and Settlement Systems (CPSS) by 27 central banks and involved 109 institutions (both banks and non-banks) that were selected to cover 80% of the foreign exchange (FX) market in 15 currency areas (CPSS (2008)). This feature first sets out the background to the survey, and then summarises the survey's key findings. Next it explains why there is still a problem with FX settlement risk, and finally it suggests that there are two key actions which need to be taken if the problem is to be addressed effectively.

The nature of FX settlement risk

Trading in financial markets typically requires settlement – delivery of the asset by the seller and payment for it by the buyer. The market for foreign exchange is no different, except that settlement involves two payments – ie the exchange of one currency for another. Although FX settlement is often regarded as a routine activity that is less interesting than the trading itself, it deserves close attention because of the risk that can be involved, namely the risk that one party to an FX trade pays the currency it has sold but fails to receive the currency it has bought. The risk arises because, using the traditional method of

[1] The author thanks Jimmy Shek and Marcus Jellinghaus for their technical assistance. The views expressed in this feature are those of the author and do not necessarily reflect those of the BIS, the CPSS or the central banks involved in the survey.

settling trades, there is no mechanism to ensure that you pay only if you are paid (a mechanism called payment versus payment or PVP). Both counterparties to the trade therefore commit themselves to paying away the currency they are selling before they are certain that they will receive the currency they are buying. Moreover, the traditional settlement process can be a relatively slow one, meaning that the counterparties can be exposed to this risk for a significant period, often more than a day (see Box 1 for more on how the risk arises).

FX settlement risk is a significant counterparty risk

FX settlement risk (sometimes also known as Herstatt risk[2]) is therefore primarily a counterparty risk. It is equivalent to the risk of making an unsecured loan to the counterparty: you have paid money to the counterparty with no guarantee that you will be paid back. As such it involves both principal risk (you may not get paid at all, so you may lose the full value of the trade) and liquidity risk (in this context, the risk that, even if the counterparty does pay you, the payment comes at the wrong time and/or in the wrong currency, leaving you without the currency you need when you need it).[3] Given the size of the FX market – estimated to involve daily turnover equivalent to $3.2 trillion in April 2007 – the potential risk is significant.[4]

Central banks have a strategy to reduce it

Because of this, in 1996 the G10 central banks launched a comprehensive strategy to contain FX settlement risk. At the time, the duration and size of FX settlement exposures tended to be underestimated by banks, while their risk management measures were often inadequate. Indeed, the scale of exposures arising from settling FX trades was such that the failure of a single participant in the FX market could have caused systemic risk to materialise – ie it could have caused the failure of other participants (CPSS (1996)). The strategy to address the problem involved three tracks: action by individual banks to control their FX settlement exposures; action by industry groups to provide risk-reducing services for settling FX trades; and action by central banks to induce private sector progress on the previous two tracks.[5]

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[2] The collapse of Bankhaus Herstatt was one of the earliest cases where FX settlement risk crystallised. The bank, a medium-sized bank that was active in the FX markets, was closed by the German authorities on 26 June 1974. Some of its FX counterparties had already paid Deutsche marks to the bank but had not yet received the US dollars that they were buying in exchange. For more about this and other cases where settlement problems have arisen, see CPSS (1996) and Galati (2002).

[3] Thus although the main concern is with outright default by the counterparty (eg because of insolvency), even technical fails that are corrected on a subsequent day (eg when there are temporary operational difficulties) have the potential to cause liquidity problems.

[4] For estimates of the size of the FX market, see BIS (2007).

[5] For more information about the 1996 strategy, see CPSS (1996).

Box 1: How FX settlement risk arises

An example of how settlement risk arises when using traditional correspondent banking

In this example, Bank A has a spot trade with Bank B in which it is selling yen for US dollars. The trade is executed on Day *V*–2 for settlement on Day *V* (value day).

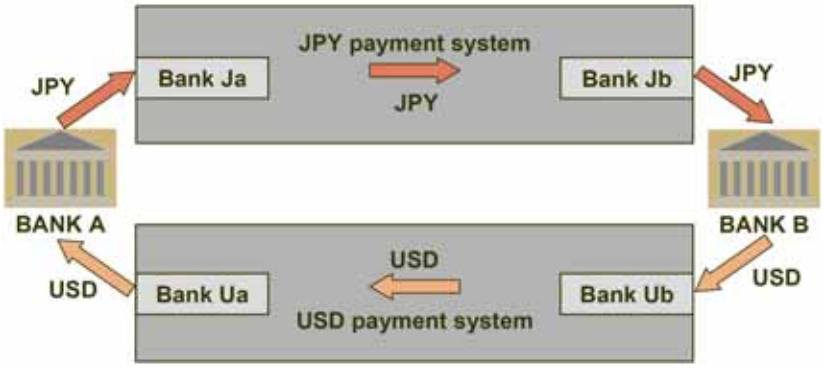
After the trade has been struck, Bank A sends an instruction to its correspondent in Japan (Bank Ja), asking the latter to send the yen to Bank B's correspondent there (Bank Jb) on Day *V*. Bank Ja executes this instruction sometime during Day *V* by debiting the account that Bank A holds with it and sending the yen to Bank Jb via the relevant payment system. After Bank Jb has received the funds, it credits them to Bank B's account and informs Bank B that they have arrived.

In parallel, Bank B settles its side of the trade by a similar process in which it instructs its correspondent in the United States (Bank Ub) to send US dollars to Bank A's correspondent there.

Settlement risk arises because each counterparty may pay the currency it is selling but not receive the currency it is buying. The underlying cause is the lack of any "link" between the two payment processes (in yen and dollars) to ensure that one payment takes place only if the other also does.

- Looking at the trade from Bank A's point of view, its exposure to settlement risk starts when it can no longer be certain that it can cancel its instruction to pay Bank B. This depends primarily on any agreement between Banks A and Ja about cancellation. In the absence of a specific agreement, Bank A cannot be certain whether it can cancel or not and so its exposure begins immediately it has sent the payment instruction to Bank Ja, which is likely to be on Day *V*–1 or even *V*–2. Even if there is a specific agreement, Bank Ja may need some time to process a cancellation request by Bank A, so the exposure may start at least several hours before the yen payment system opens on Day *V*. The effective cancellation deadline may therefore be very early on *V* or even on *V*–1 in Japanese local time, which, if Bank A is located in (say) Europe, will be even earlier in Bank A's local time because of time zone differences.
- Bank A's exposure ends when Bank Ua credits its account with the dollars received from Bank Ub. Bank Ua may not receive the funds until just before the close of the relevant payment system, and it may be some time after that that the funds are credited to Bank A's account. This could be relatively late on Day *V* in US local time, and even later on Day *V* or even on Day *V*+1 in the local time of Bank A. Bank A's actual exposure to this trade could therefore last more than 24 hours.

Bank B also faces settlement risk. Its exposure period will differ from that of Bank A to the extent that Banks B, Ub and Jb have different arrangements compared to those of Banks A, Ja and Ua, and the relevant US and Japanese payment systems have different opening hours. Time zone differences are also important. In this trade, time zones work against Bank A because it is selling a currency that settles in an early time zone (so it is committed to selling its currency relatively early) and buying one that settles in a late time zone (so it will receive the currency it is buying relatively late), which extends the duration of its exposure. Conversely, the time zone difference works in Bank B's favour. However, it is important to note that the problem does not arise solely because of time zone differences.



Settlement methods

Progress has been made …

The 2006 survey found that much progress has been made since 1996, particularly on the provision of risk-reducing services by industry groups, the second track of the strategy. Most significant was CLS Bank (CLS),[6] which started operating in 2002. CLS provides a PVP service that almost completely eliminates the principal risk associated with settling FX trades. (Box 2 provides a simple example of how CLS works. For more detail, see CPSS (2008) and Galati (2002).) Although there are seasonal fluctuations, use of CLS has grown steadily (Graph 1) and the service is now a well established and critical part of the global financial infrastructure.

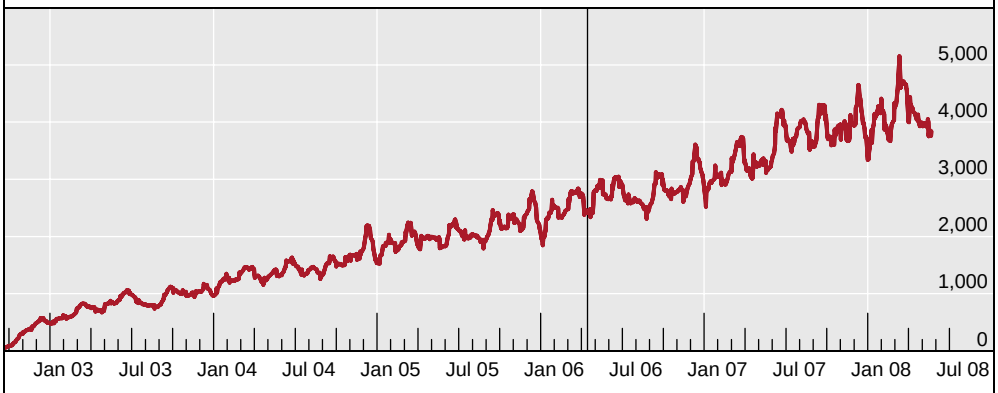
Indeed, the 2006 survey showed that CLS has become the primary settlement method for FX trades, with 55% of trades being settled this way (Graph 2). A further 8% was settled by bilateral netting, where two market participants agree that the settlement obligations resulting from all the trades between them due to settle on a given day will be netted against each other so that only the smaller netted amount in each currency needs to be settled.[7] Various other methods accounted for another 5%. However, the key survey finding was that 32% of trades were still settled by traditional correspondent banking – the major source of FX settlement risk.

… but risk remains

This compares to a previous survey in 1997, before CLS was available, when 85% of FX trades were settled by traditional correspondent banking with the remainder settled by other methods including netting. However, although it

Growth of CLS

Daily value settled, in billions of US dollars (15-day moving average)[1]



[1] The value settled is a multiple of the value traded, depending on the number of currency legs that trades have – ie a spot or forward deal has two currency legs, one for each currency, while a swap has four, two for the spot trade and two for the forward trade. The vertical line indicates when the survey took place.

Graph 1

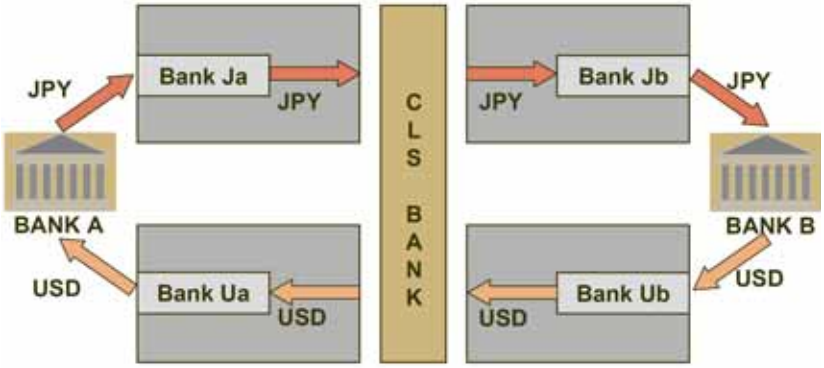
[6] The name "CLS Bank" is derived from "Continuous Linked Settlement", the brand name of the service provided.

[7] The 8% refers to the size of the reduction achieved. The smaller netted amount will then be settled by another method, typically traditional correspondent banking. (In the survey results, the 32% share of traditional correspondent banking includes any netted amounts settled this way.)

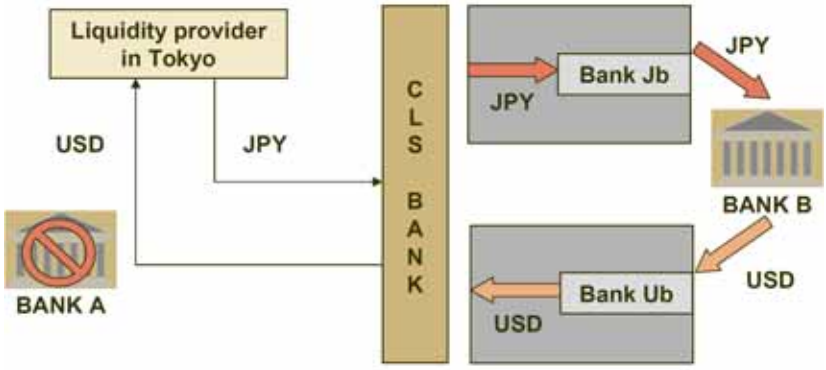
Box 2: How CLS works – a simplified example

CLS Bank (CLS) is a limited purpose bank for settling FX, based in New York with its main operations in London. It is owned by 69 financial institutions which are significant players in the FX market. It currently settles trades in 17 currencies, three in North America (Canadian dollar, Mexican peso and US dollar), two in Africa and the Middle East (Israeli shekel and South African rand), six in Europe (Danish krone, euro, Norwegian krone, Swedish krona, Swiss franc and pound sterling) and six in the Asia-Pacific region (Australian dollar, Hong Kong dollar, Japanese yen, Korean won, New Zealand dollar and Singapore dollar).

The simple example below, which uses the same yen/US dollar trade as in the previous box, is designed to show the essence of the CLS mechanism in the case of a single trade. In reality, CLS settles a large number of trades between multiple counterparties and has complex risk control mechanisms to enable it to do this safely.



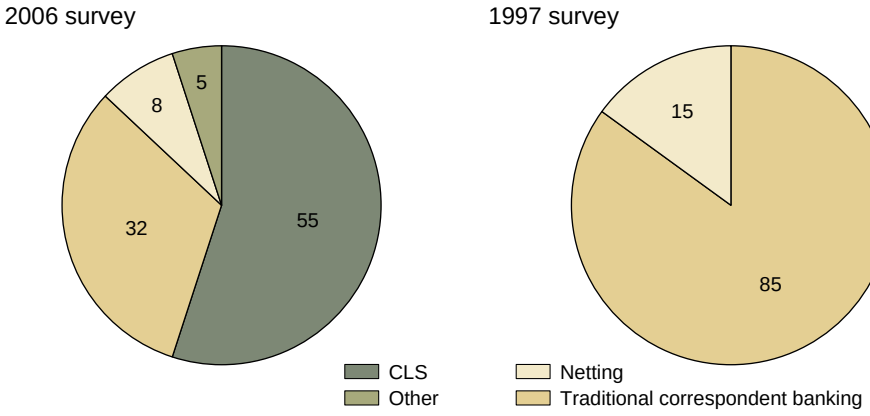
CLS removes principal risk by using PVP – you get paid only if you pay. On settlement day, each counterparty to the trade pays to CLS the currency it is selling – eg by using a correspondent bank, as with the example in the previous box. However, unlike the previous example, CLS pays out the bought currency only if the sold currency is received. In effect, CLS acts as a trusted third party in the settlement process. (However, note that CLS is not a central counterparty – in the example shown, the trade remains between Banks A and B.)



CLS could have been designed so that, if one of the counterparties fails, CLS simply returns the principal amount to the surviving counterparty – in the example, it could return the US dollars to Bank B. However, in practice CLS has committed standby lines of credit with major banks in each of the currencies it settles. In this case, Bank B was buying yen, so CLS will swap the US dollars for yen with its yen liquidity provider in Tokyo, and then give the yen to Bank B. In this way, CLS not only removes principal risk but also reduces liquidity risk. However, the standby liquidity facilities cannot completely remove liquidity risk. The main underlying reason for this is that the liquidity facilities are finite while there is no limit on the total value of the trades that you can attempt to settle via CLS.

Breakdown of total settlement obligations according to settlement method

In per cent



Graph 2

is a big reduction from 85%, 32% remains a significant share. Moreover, the values involved are also significant relative to the size of the institutions concerned – on average, equivalent to approximately 70% of their total capital.

Assessing the remaining exposures

Given that traditional correspondent banking remains a significant method of settling FX trades, the key issue is whether the resulting exposures pose an unacceptable degree of risk. To assess this, the survey asked about the duration and size of survey institutions' total exposures (ie to all their counterparties) and largest bilateral exposures (ie to a single counterparty). It also asked how these exposures were managed.

Total exposures

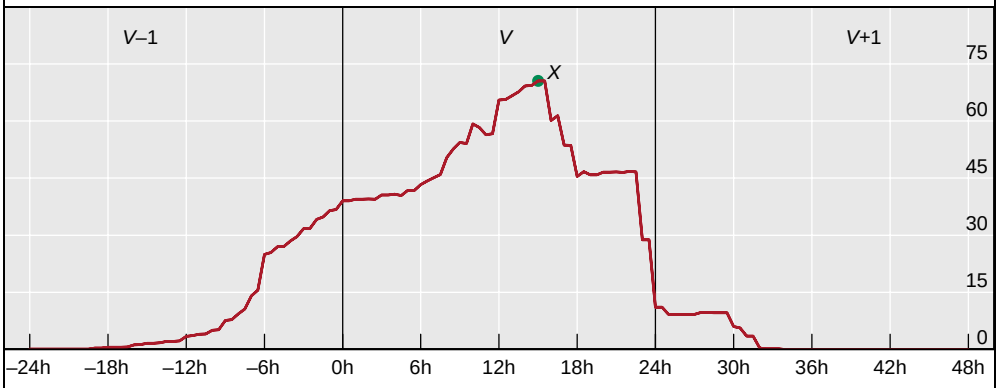
Total exposures can be large and long-lasting …

The survey showed that the duration and size of total FX settlement exposures can still be significant (Graph 3). Given that, as noted above, FX settlement risk is the risk of paying without being paid, an institution's exposure starts when it becomes irrevocably committed to paying away one of the currencies it is selling. As the graph shows, on average this is at about 06:00 on the day before settlement. As it becomes committed to paying more currencies, its exposure increases. Then at some point, the institution will start to receive the currencies it is buying, causing its exposure to decrease. For a period, its overall exposure may fluctuate as it becomes committed to paying some currencies and receives others. On average, the peak exposure (*X*) is reached at around 16:00 on settlement day, and the exposure ends when the last currency is received, on average at around 08:00 on the day after settlement.[8]

[8] Box 1 explains this process in more detail.

Exposure profile of an average survey institution (single day's trades)

Shown as a percentage of trades settled by traditional correspondent banking on Day *V*



X = time of peak exposure. Graph 3

On average, therefore, an institution's exposure to trades due to settle on a particular day actually starts on the day before settlement and continues until the day after settlement – ie the duration is more than 24 hours. This means that an institution using traditional correspondent banking to settle its trades typically always has some FX settlement exposure, overnight as well as intraday. In addition, it means that, for at least part of the day, an institution is exposed to more than one day's trades. Graph 4 shows average exposure during the day allowing for this simultaneous exposure to trades settling on multiple days.[9]

... including overnight

During the period the exposure lasts, the size of an institution's total exposure to all its counterparties varies, as the graphs show, but, on average, peaks at an amount equal to about 70% of the value settled by traditional correspondent banking allowing for one day's trades (ie point *X* on Graph 3) or at about 80% allowing for simultaneous exposure to multiple days' trades (point *Y* on Graph 4).[10] Moreover, on the latter, multiple day basis, the exposure is never less than about 50% – even during the night.

Translating these percentages into values for the survey participants overall, the aggregate amount at risk never falls below $0.5 trillion and peaks at about $1.1 trillion.[11]

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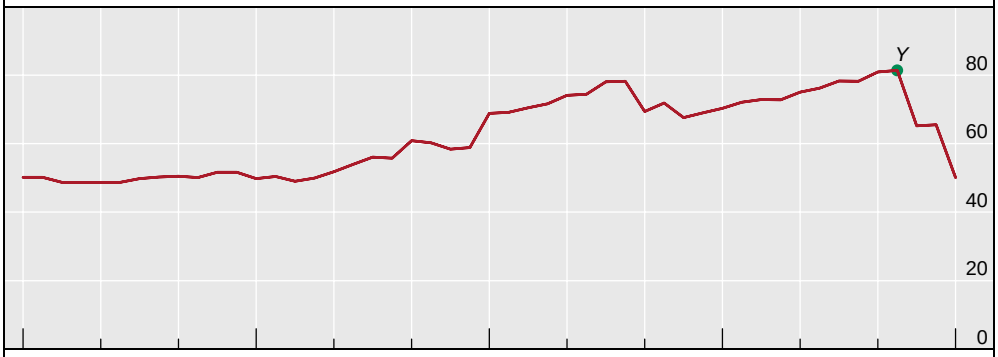
[9] Note that the survey results were daily averages for the survey period. Graph 3 thus shows the exposure profile for the trades settling on one average day (Day *V* in the graph), while Graph 4 is created by superimposing that exposure profile with identical profiles for trades due to settle on earlier and later average days. In reality, an institution's profile for each day would vary according to the value and type of trades due to settle that day.

[10] The maximum exposures are less than 100% of the value settled primarily because of time zone differences, which mean that (a) some currency pairs generate no exposure (the bought currency is received in an eastern time zone before the sold currency is irrevocably paid away in a western time zone) and (b) the exposure period generated by one currency pair does not always overlap with that of another currency pair (the exposure period for a trade in two eastern currencies may not overlap with that for a trade in two western ones).

[11] The size of the range of the average institution's position in percentage terms (ie 50 to 80%) is different from the range of all survey institutions' aggregate value (ie $0.5 trillion to $1.1 trillion) because the exposure profile of the average institution is expressed in its local

Exposure profile of an average survey institution (multiple days' trades)

Shown as a percentage of the average daily value of the trades settled by traditional correspondent banking



Y = time of peak exposure. Graph 4

An alternative way to judge the size of the total exposures is to scale them by the institution's capital, rather than by the value of the settled transactions themselves. By this measure, an institution's total exposure peaks at 47% and 57% of its total capital on average (single day and multiple day, respectively). In other words, if such exposures were to be shown on an institution's balance sheet (which in practice they are not), they would be a significant item.

Institutions' exposures to FX settlement risk vary for many reasons. For a given institution, exposure can vary substantially from day to day depending on the value and currency composition of the trades. And comparing institutions, the internal procedures of each institution and its correspondents also have a significant effect, particularly on the time at which an institution's settlement exposure in a currency starts.[12] Not surprisingly, therefore, there was very wide variation about the averages just mentioned, with some institutions having negligible exposures while others had exposures as large as six times the size of their capital.

Bilateral exposures

As noted above, FX settlement risk arises because of the possibility that an individual counterparty will fail to pay. Thus although an institution's aggregate exposure to all its counterparties (its total exposure) is interesting in order to get an idea of the overall scale of the potential problem, more relevant from the point of view of assessing risk are an institution's settlement exposures to its individual counterparties (its bilateral exposures).

Unfortunately, the survey data do not include direct information about the size of bilateral exposures. Nor was it possible to come up with robust *point*

time, which has to be translated into a standardised time (eg GMT) when aggregating across institutions.

[12] That is, there is variation in the cancellation deadlines, the point at which the institution can no longer cancel the instruction to pay the currency it is selling (Box 1). If an institution and its correspondent bank improve their procedures, they may be able to move back the time at which the exposure starts.

estimates of what those exposures might be. However, in most cases it was possible to produce a robust estimate of the *range* within which an institution's largest bilateral exposure was likely to lie.[13] The results are shown in Graph 5 for the 81 institutions in the survey for which sufficient data were available.

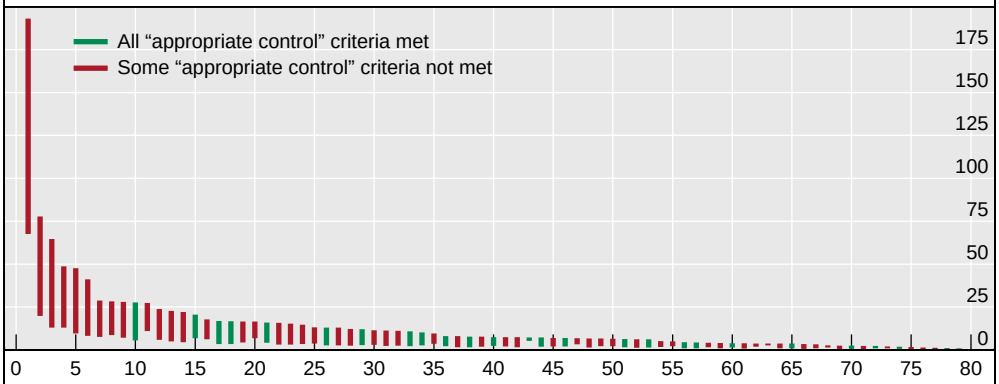
Thus, for example, the largest bilateral exposure of Institution 1, on the left of the graph, is estimated to have been, on average, somewhere between about 70 and 190% of its capital. However, that is an extreme case. For most institutions the range was much lower – for a majority it was entirely under the 10% level. Nevertheless, making some additional assumptions about where within the possible range the actual exposure was most likely to be, more than one in four of the institutions may have had an exposure to a single counterparty greater than 5% of capital, with one in eight being over 10%.[14]

Exposures to single counterparties can also be significant

Moreover, these are estimates for an average day; on a peak day, the exposures may have been substantially higher. And in order to get a complete picture of an institution's counterparty exposure, this FX settlement exposure needs to be added to other types of exposure it has to the same counterparty (eg as a result of interbank lending). Given that it would normally be regarded as prudent for a bank to keep its exposure to a single counterparty to no more than a rather small percentage of its capital, the estimates suggest that many institutions continue to have significant bilateral FX settlement exposures which they need to control prudently.

Largest bilateral exposure (daily average range)[1]

Range of largest bilateral exposure, as a percentage of total capital



[1] Exposure to multiple days' trades. Institutions ranked by upper end of range. Graph 5

[13] The survey had data on the aggregate value of an institution's settlement obligations to its five largest and 10 largest trading counterparties and on the breakdown of this value between the various settlement methods. Taking the portion of this aggregate value that was settled by traditional correspondent banking, the ranges were based on estimates of how much or how little of the portion could be accounted for by a single counterparty. More information about the method used to calculate the ranges is given in Annex 3 of CPSS (2008).

[14] These calculations used additional data provided by CLS about the relative sizes of institutions' five largest counterparties, where "largest" was judged by trades settled using CLS, and assumed that the same relative sizes applied to trades settled using traditional correspondent banking.

Control of exposures

However, judged according to three specific criteria, there was a mixed picture about whether the exposures were in practice controlled "appropriately". The three criteria were whether the institution (1) had established clear senior-level responsibility for managing the exposures, (2) had appropriate daily management procedures (including the use of the same counterparty limits as were applied to other types of similar exposures) and (3) measured the risk in a way that did not lead to underestimation.[15] Although most institutions in the survey met the first two criteria – ie they had established clear senior-level responsibility and many had appropriate daily management procedures – there was still a significant minority (8% and 23%, respectively) that did not. Moreover, most (73%) surveyed institutions failed to meet the third criterion – ie they measured their exposures in a way that at least to some extent underestimated the amounts they had at risk.[16] Indeed, judged overall by these criteria, 66% of the surveyed institutions did not appropriately control their FX settlement exposures – ie only 34% met all three criteria. And as Graph 5 shows, among the institutions with the highest bilateral exposures, the percentage is even lower. For example, of the 10 institutions with the highest exposure, only one was judged to control its exposures appropriately.

Also the exposures are not always appropriately controlled

Evaluation of the risk

Overall, the survey shows that the situation of individual institutions varies considerably. There are some institutions – both large and small – that use PVP services such as CLS as much as they can given the limitations that exist (these limitations are that some trades, including trades in non-CLS currencies and many same day trades, are ineligible for CLS settlement and that CLS cannot be used to settle trades with counterparties that are not themselves CLS users). Some of these institutions also appropriately control any exposures that result from the remaining trades that are settled using traditional correspondent banking – ie they meet the three criteria discussed above. They therefore do all that they can to reduce risk. However, at the other end of the range are institutions that make little or no use of PVP settlement and have significant exposures that are not always well controlled.

The lack of appropriate control is clearly an issue. Financial institutions naturally take many types of risks and this is generally acceptable as long as those risks are well managed – ie understood, properly measured and subject to appropriate controls, such as counterparty limits. From this perspective, the problem is the lack of appropriate management rather than the size of the exposures themselves. There is therefore a choice of solutions. One is for such

One view is that the risk is acceptable as long as it is well managed

[15] The three criteria were formulated as objectives. The means by which the objectives were met were not assessed.

[16] Most institutions did not attempt to measure their exposure exactly (as in Graphs 4 and 5) but instead used an approximation method. For example, a common method would be to assume that the exposure existed only on the settlement day. For institutions whose exposures could last for more than one day, this could lead to underestimation of the true position.

institutions to use PVP services such as CLS so that the exposures are avoided. But it is also acceptable for them to continue to use traditional correspondent banking and incur the exposures provided they manage those exposures in an appropriate way.

However, from a different perspective, FX settlement exposures can be seen as intrinsically undesirable, even when they are well managed, because of their possible effects during financial crises. If there is increased market uncertainty – about the financial strength of a counterparty, for example – institutions may prudently decide to reduce their trading limits to that counterparty in order to reduce settlement risk. And, in doing so, they may deprive the counterparty of the market access it needs and thus inadvertently cause it to fail. In contrast, if it was possible to make settlement risk-free, institutions could prudently continue to trade, even in uncertain circumstances. In economic terms, the argument is that the private costs to market participants of removing the risks are outweighed by the social benefits of risk-free settlement.

Another view is that settlement should be risk-free

It is true that, in practice, settlement of any transaction – including FX trades – is rarely, if ever, completely risk-free. This is because even though principal risk can usually be removed by good system design, some liquidity risk typically remains, as is the case with CLS (as noted in Box 2, the reason for this is that, even with the principal amount of the trade being protected in the event of a counterparty failure, CLS cannot fully guarantee that you will receive that amount in the currency you were trying to buy). So the ideal state of risk-free settlement can never be fully achieved. Nevertheless, from this perspective, the risk should be reduced as far as possible. Accordingly, the survey results are of more concern because even well managed FX settlement exposures are not ideal and it would be better if PVP services such as CLS were always used.

Solutions

Whichever perspective of settlement risk is held, there seem to be two main weaknesses with the current situation which need to be addressed.

The first is that the existing *risk-reducing services* for settling FX trades are not sufficiently comprehensive. The survey showed that over a third of the trades subject to settlement risk were between CLS users but involved types of trades that they currently cannot settle using CLS. As noted above, such trades include same day trades (where the difficulty is that the CLS settlement process takes place too early in the day) and trades in non-CLS currencies. To reduce settlement risk on these trades, either the CLS service needs to be modified or a new settlement service introduced.

There need to be new services …

The second and perhaps more important weakness is the lack of *incentives* for individual institutions to take action to better manage FX settlement risk. Discussions with survey participants suggest that many FX market participants who have not already taken the necessary action are unlikely to do so unless they are given stronger incentives or compelled to do so by regulatory authorities. The problem is that taking action costs the

institutions money. But at the same time, it seems that the risk is not well understood or is perceived as less serious than equivalent counterparty risks that arise from other activities. Why this should be so is not completely clear – it is perhaps because the exposures are not very transparent. More fundamentally, even if individual institutions were fully aware of the risk to themselves, they would not necessarily take into account the social benefits to the market as a whole of the reduced systemic risk that would result from using safe settlement methods. In any event, there is often a reluctance to spend the necessary money, suggesting that there is a need for incentives or regulatory inducements, both of which are lacking at the moment.

… and stronger incentives to act …

As far as use of CLS is concerned, certain market-based incentives that some had hoped for (such as smaller spreads on FX trades settled through CLS, recognising the reduced risk involved) have apparently failed to materialise. And although existing CLS users can point to operational savings from the standardised and automated procedures for using CLS, these seem to be outweighed in the minds of many non-CLS users by the size of the fee for using the CLS service. Incentives for addressing the problem through better management of the exposures from traditional correspondent banking are equally lacking. Given this, it is not surprising that many institutions felt that further improvements to the management of FX settlement risk are unlikely unless there is a clear regulatory requirement for them. Particularly important here is action by the banking supervisors. In 2000, the Basel Committee on Banking Supervision (BCBS) issued guidance on managing FX settlement risk. The BCBS and CPSS have recently agreed to work together to review and update the guidance with the aim of setting a higher standard for how banks manage FX settlement risk.

… including regulatory requirements

When publishing the survey results, the CPSS recommended a series of actions to bring about further progress in addressing FX settlement risk (CPSS (2008)). Given the analysis above, two of these actions seem particularly important. One is that CLS or other industry groups should continue to develop services to reduce FX settlement risk, particularly services for same day trades and trades involving additional currencies. The other is that central banks should work with banking supervisors and other regulators to explore ways to encourage market participants to manage their settlement risks better. For example, regulators could require FX settlement risk to be managed and controlled in the same way as other formal short-term credit extensions of similar size and duration (eg unsecured overnight interbank loans).[17] Success in implementing these two actions will be key to determining whether the potential threat of FX settlement risk to the stability of the global financial system can finally be removed.

[17] Another possibility that is sometimes proposed is to put a capital charge on the exposures.

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The ABX: how do the markets price subprime mortgage risk?[1]

The ABX family of indices has become a key barometer of subprime mortgage market conditions during the recent financial crisis. Simple regression analysis illustrates the relationship between observed index returns and proxies of default risk, interest rates, market liquidity and risk appetite. The results suggest that declining risk appetite and heightened concerns about market illiquidity have provided a sizeable contribution to the observed collapse in ABX prices since the summer of 2007.

JEL classification: E43, G12, G13, G14.

The evolution of derivatives products based on indices of credit market exposures has allowed market participants to trade standardised contracts on pools of a variety of underlying instruments. This, in turn, has added a degree of transparency and liquidity to market segments as diverse as leveraged loans or mortgage-backed securities (MBS). For instance, the so-called ABX indices, which are based on credit derivatives written on MBS backed by subprime mortgage loans, track the price of credit default insurance on a basket of such deals. Since the start of the recent financial turmoil in the summer of 2007, the ABX index family has served as a widely followed barometer of the collapsing valuations in the US subprime mortgage market, which have been at the core of observed credit market developments. Despite some shortcomings, ABX price information also seems to have been widely used by banks and other investors as a tool for hedging and trading as well as for gauging valuation effects on subprime mortgage portfolios more generally.[2]

[1] The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS or the ECB. Any errors and omissions also remain those of the authors, who would like to thank Patrick McGuire, Nikola Tarashev and Haibin Zhu for useful comments as well as Emir Emiray and Jhuvesh Sobrun for assistance with the data and graphs.

[2] According to *The Wall Street Journal* (2007), when Swiss bank UBS wrote down its subprime mortgage investments by $10 billion in December 2007, it looked to the ABX as a guidepost in determining values for its holdings. Likewise, Morgan Stanley and Citigroup reportedly cited the ABX as a factor in the sizeable writedowns announced in late 2007.

Understanding the specific factors driving the variation of ABX prices is important for market participants and policymakers because changes in the weight of credit- and non-credit-related elements may have different implications. For instance, indications of changes in risk appetite with regard to subprime mortgage risk may help explain any discrepancies between observed ABX prices and projections of default-related losses on the underlying pool of subprime MBS. These discrepancies, in turn, can have consequences for investors, for example when ABX quotes are used to value existing holdings of subprime MBS. Yet despite the importance of these issues, empirical work on the ABX indices has so far been scarce.[3]

In what follows, ABX prices are analysed to establish the importance of different pricing factors and how they have changed over time. For this purpose, the first section provides a brief overview of the ABX indices and how they work. The second section applies simple regression analysis to investigate the determinants of ABX index returns, illustrating the relationship between ABX pricing and macroeconomic news as well as market-based proxies of default risk, interest rates, market liquidity and risk appetite. The final section concludes.

The ABX: an introduction

Index mechanics

The ABX allows trading of subprime mortgage risk …

The ABX family of indices, which started trading on 19 January 2006, consists of a series of equally weighted, static portfolios of credit default swaps (CDS) referencing 20 subprime MBS transactions.[4] The ABX indices were introduced on the back of strong issuance activity in subprime MBS markets (Graph 1, left-hand panel) and the successful launch of MBS-based CDS contracts in 2005. These contracts, which allow investors to buy and sell protection against the default risk of subprime mortgages, had seen particularly strong growth due to their inclusion in synthetic collateralised debt obligations. Growing volumes, in turn, eventually triggered demands for a tradable benchmark index that would make it easier for investors to establish and adjust subprime MBS exposures.

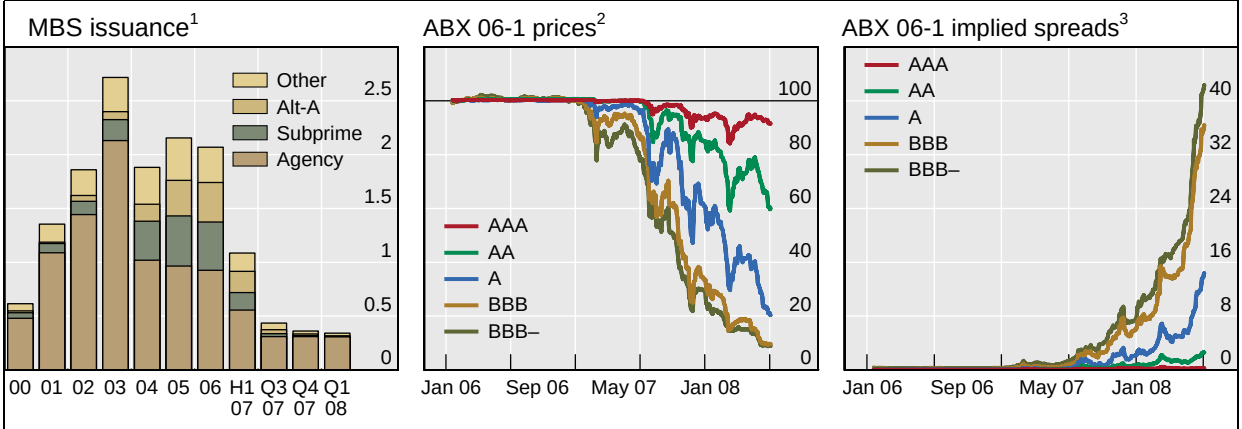
The mechanics of the ABX indices, which are offered for trading by a consortium of major credit derivatives dealers, are determined by vintage- and credit rating-related considerations. New on-the-run ABX series are introduced every six months,[5] and each of these index vintages references 20 completely

[3] Related research includes Mizrach (2008), who analyses the jump risk in ABX prices and its determinants. Perraudin and Wu (2008) examine the determinants of prices for asset-backed securities in two distinct crisis periods.

[4] Mortgage-backed securities are based on large pools of individual mortgage loans that are financed through the issuance of bonds (tranches) at different levels of seniority. The most senior tranches of the resulting liabilities structure are the first to receive any cash flows generated by the asset pool and are protected against default until the more junior tranches are depleted. See, for example, Ashcraft and Schuermann (2008).

[5] Four such vintages have been initiated since January 2006, before the scheduled index "roll" into a new set of underlying MBS deals in January 2008 had to be postponed due to a lack of eligible collateral – a direct consequence of collapsing subprime issuance volumes.

Subprime MBS: issuance and pricing



[1] In trillions of US dollars. [2] As a percentage of par. [3] Over Libor, in thousands of basis points.

Sources: JPMorgan Chase; UBS; authors' calculations. Graph 1

new subprime MBS deals issued during a six-month period prior to index initiation. Trade documentation excludes any form of physical settlement, thus decoupling ABX trading from the availability of the underlying cash instruments. This has aided market development, supporting the adoption of ABX index contracts as a tool for trading and hedging. However, with markets reportedly overwhelmed by large speculative short positions, market liquidity in the ABX indices has been impaired during the recent turmoil even as trading continued throughout the crisis.

… across vintages and rating levels …

Each index vintage consists of five individual subindices, each referencing exposures to the same 20 underlying subprime mortgage securitisations, though at different levels of the liability structure. The ABX 06-1 AAA index, for example, represents tranches with an original rating of AAA from a pool of MBS originated in the latter half of 2005. The other subindices, in turn, are backed by tranches of the same securitisations at the AA, A, BBB and BBB– levels of credit quality.[6] Underlying MBS are selected on the basis of set criteria, targeting large and liquid structures with at least $500 million of deal size at issuance. Concentration limits apply, among other things, to the number of deals with the same originator, and each underlying obligation is required to carry ratings at a corresponding level by both Moody's and Standard & Poor's. Once created, index composition remains static, implying that underlying credit quality can migrate to ratings that are lower than indicated by the index name. The maturity of each ABX contract corresponds to the longest legal maturity among the individual CDS contracts backing the index, which results in exposures that are very similar to those of the underlying MBS tranches. Trading is conducted in price terms, where prices are quoted as a percentage of par for each individual index of a given vintage.[7]

[6] Supplementary indices, called ABX PENAAA, were introduced in May 2008 to provide additional pricing information for all four existing index vintages. See the box in Fender and Hördahl (2008).

[7] See, for example, Lehman Brothers (2006).

… but for only part of the MBS universe

Importantly, the combined ABX indices capture only part of the underlying universe of subprime MBS. For all four index vintages taken together, the original outstanding balance has averaged about $31 billion at issuance (an average of $1.54 billion per underlying MBS deal). This compares to average monthly MBS issuance amounts of about $36 billion over the 10 quarters up to mid-2007 or almost a month's worth of MBS issuance per ABX vintage (Graph 1, left-hand panel).[8] Coverage of actual MBS transactions, however, is lower than these numbers suggest. This is because only parts of the capital structure of the underlying deals are actually referenced by the various indices of a given series. Of the 15 or so tranches per MBS deal, only five were originally included in the ABX indices of the respective series (one AAA, AA, A, BBB and BBB– quality tranche each). This is particularly relevant at the AAA level, which accounts for around 80% of the outstanding balance at issuance, as the AAA tranches referenced by the corresponding ABX indices are not the most senior pieces in the capital structure of their constituent MBS deals.[9] As a result, limited deal coverage makes it difficult to translate price data for, say, the ABX 07-1 AAA index into information on how other AAA subprime bonds originated in the second half of 2006 have or should have performed.

Pricing basics

ABX prices reflect the willingness of investors to buy or sell default protection on the basis of their views about the risk of the underlying subprime loans. With the terms and coupon payments of the respective CDS contracts fixed, premia or discounts relative to par indicate the amount that is to be exchanged upfront. This amount, in turn, reflects the present value of the difference between any expected payments due to principal writedowns or interest rate shortfalls and the fixed coupon of the index plus accrued interest (see box). Spreads can be calculated from observed prices on the basis of duration assumptions. These implied spreads are then broadly comparable to the basis point spreads quoted on other credit products (Graph 1, centre and right-hand panels).

ABX pricing is a complex task

Reflecting the nature of the underlying MBS instruments, ABX pricing involves the use of cash flow models to project payments, delinquencies, defaults and losses. Modelling is based on collateral characteristics (such as FICO scores,[10] loan-to-value ratios and loan size), as well as assumptions about house price appreciation. These, in turn, result in cash flow projections across various house price paths, which can then be aggregated to derive the

[8] Limited market coverage has raised questions about whether the ABX indices are representative of the overall subprime MBS market. See eg *The Wall Street Journal* (2007).

[9] This implies that the AAA bonds referenced by the ABX AAA index have longer durations (expected average lives) than other AAA bonds from the same subprime securitisations, which makes them riskier. See the box in Fender and Hördahl (2008) for details.

[10] FICO (Fair Isaac Corporation) scores measure the credit risk of individual borrowers based on a statistical analysis of their credit files. FICO scores range between 300 and 850, and subprime loans are often defined as those to borrowers with limited income and/or a score of 620 or below. See Frankel (2006) for details.

ABX pricing mechanics

Prices for ABX index instruments are determined by two payment legs.[1] The first leg, which is paid by the protection buyer, is based on the index coupon,[2] which, in turn, is fixed as a percentage of notional over the life of the index on the day of the index roll (ie on initiation of a new on-the-run index vintage). As payments are made on a pay-as-you-go basis, the fixed valuation leg can be approximated by the present value of the monthly stream of fixed, default-free coupon payments, adjusted for any prepayments on the underlying bonds.[3] The second, floating leg is paid by the protection seller, who makes conditional payments equivalent to any principal writedowns or interest rate shortfalls as determined by Markit, the administration and calculation agent for the ABX indices.

In simplified terms, ABX prices can therefore be written as:

$$price = 100 + PV(coupons) - PV(writedowns, shortfalls)$$

where the PV expressions denote the present values of the fixed (coupons) and floating (writedowns, shortfalls) payment legs, respectively.

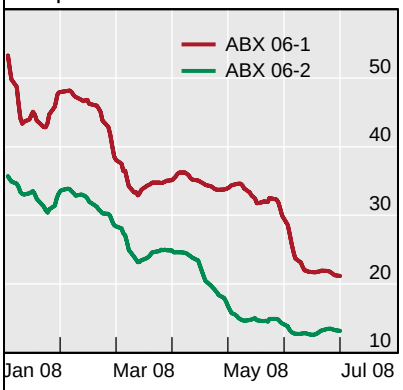
On this basis, market participants' expectations regarding future writedowns of tranche principal are key factors in determining ABX prices. These, in turn, depend on information such as prepayments and delinquencies, while writedown timing assumptions and discount rates are important parameters in calculating present values. Specifically, if writedowns are assumed to occur immediately (zero months to default) and with coupon payments given, prices will be determined by the number of bonds written down. Broadly put, 10 immediate writedowns (ie half of the underlying MBS tranches) will result in a price of 50, whereas 15 writedowns (75% of all tranches) imply a price of 25.[4] Alternatively, if all tranches are assumed to be written down, expectations about writedown timing, combined with any risk premia, will translate directly into ABX prices.

Recent ABX pricing can be used to illustrate the interaction of different pricing factors. While house prices had been weakening and delinquencies on the rise for some time, 2007 particularly saw very severe deterioration in the subprime mortgage segment. As mortgage delinquencies ramped up, so did loss projections on subprime mortgage bonds, implying loss rates far exceeding historical precedents?[5] As a result, the most junior indices of the more recent ABX series (which are backed by lower-quality exposures than the original 06-1 index vintage) quickly started to trade on an interest-only basis, ie at levels essentially pricing complete principal writedowns of all 20 underlying MBS tranches. The 06-1 BBB– index, in turn, began to follow the same pattern during the first quarter of 2008, suggesting that writedown expectations were approaching 100%.

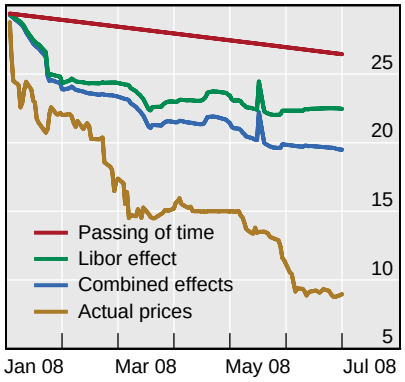
With total loss of principal seen as increasingly certain, observed prices (abstracting from any risk premia) thus turned into a broad reflection of traders' expectations as to when tranche

ABX index analytics

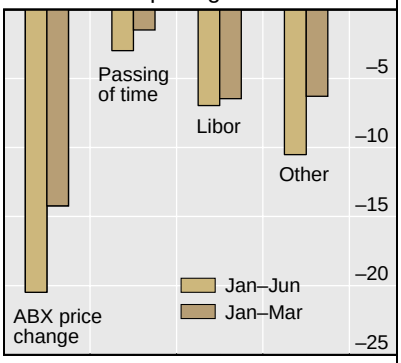
Implied time-to-writedown[1]



ABX price decomposition[2]



Effect of ABX pricing factors[2]



[1] Implied time to full writedown of tranche principal in months; calculated from prices for the ABX 06-1 and 06-2 BBB– index series, assuming that all underlying bonds are completely written down; five-day moving averages. [2] Actual and implied ABX 06-1 price changes over the January–March and January–June 2008 periods; actual change decomposed on the basis of end-December 2007 implied time-to-writedown and one-month Libor rates; assumes full writedown of tranche principal.

Sources: JPMorgan Chase; UBS; authors' calculations. Graph A

writedowns would take place.[⑥] After an initial adjustment during the first quarter of 2008, these implied times-to-writedown declined markedly up to June 2008 for the 06-1 and 06-2 BBB– indices (Graph A, left-hand panel). Part of the underlying decrease in prices was attributable solely to the passage of time and its effect on the discounted value of the (large) floating leg of the respective ABX contracts. The impact of declining Libor rates, however, turns out to have been a more important price determinant, particularly during the first quarter. Under the assumption of total principal writedowns (ie a writedown rate of 100%, discounted over the assumed time-to-writedown), lower Libor rates contributed about half of the price decline for the most junior ABX 06-1 exposures between early January and end-March 2008. Other factors, which would include any risk premia, accounted for the rest of the price movement (Graph A, centre and right-hand panels).

[①] A second fixed leg may be paid to reimburse the protection seller for reversed writedowns and interest rate shortfalls. [②] The 2006-1 AAA index is quoted with a coupon of 18 basis points, whereas the corresponding BBB– index has a coupon of 267 basis points. [③] See, for example, Lehman Brothers (2006). [④] See UBS (2007); calculation of writedowns requires deal-level knowledge about the effective attachment and detachment points of the various tranches of ABX constituent deals, which will depend on the amount of overcollateralisation and accumulated excess spread. [⑤] See Box 1 in Fender and Hördahl (2007) for an illustration. [⑥] See UBS (2008) for methodological details; cash flows are discounted using one-month Libor; the calculation abstracts from any interest rate shortfalls and payment reversals as these will be dominated by the assumed principal writedown event.

appropriate price, given probability assumptions for the various scenarios. Other price determinants will include interest rates (both via discounting and in determining prepayments, defaults and effective subordination)[11] as well as factors such as market liquidity and risk appetite (which will influence any risk premia). Time is another factor in that, for given expected writedowns and writedown timing, ABX prices will tend to fall as the projected losses draw closer. Similarly, as default as well as prepayment performance are known to have strong seasoning effects, average loan age (which grows over time) will feed into prices.

What drives ABX prices?

Econometric setup and data

Regression analysis is used to …

Econometric methods in the analytical literature on credit spreads have been applied to address some of the complexities described above.[12] An advantage of such a regression-based approach is that the analysis is not constrained by any particular pricing model, and allows for a wide set of explanatory variables to be used. A disadvantage is the reliance on rather indirect proxies for factors such as market liquidity and risk tolerance, which suggests that any results will have to be interpreted with care.

The specific approach adopted below proceeds in three steps. First, ABX returns will be analysed by way of a factor decomposition, to illustrate broad

[11] Sensitivities for assets (ie mortgage loans) and liabilities (ie issued tranches) in MBS transactions will be different in that interest payments on liabilities will tend to reset faster. Abstracting from any hedges that may be in place, declining interest rates will thus translate into higher "excess spread" earned on the assets relative to what is paid out on the liabilities. Excess spread, in turn, offers additional protection for investors. See UBS (2007).

[12] For the regression-based approach to analysing the determinants of credit spreads. see eg Collin-Dufresne et al (2001). Scheicher (2008) performs similar analyses of the market pricing of CDX and iTraxx index tranches.

correlation patterns between ABX prices and other financial market variables. Second, simple panel regressions are used to establish the effect of these variables on ABX returns for the ABX 06-1 vintage in more detail. Finally, blockwise regressions of individual ABX indices are employed to investigate changes in the importance of different pricing factors over time. In implementing these three steps, the various pricing factors will be proxied by macroeconomic and financial market variables combined with, where available, survey information and publication dates to capture any announcement effects. Specifically, the following variables are used:

... explain the response of ABX returns to ...

Dependent variables. The analysis focuses on the ABX 06-1 index, which is the oldest of the four available vintages, offering the longest time series. While trading in subsequent index vintages, especially the latest so-called on-the-run series, is likely to have diminished some of the activity in the 06-1 market, index underlyings are different from series to series. This should help limit any adverse effects on activity in the 06-1 index from the trading of other index vintages. At the same time, the underlying credit quality of the 06-1 series is known to be better than that of subsequent vintages, as mortgages originated in the second half of 2005 have benefited from the tail end of the strong house price appreciation that was observed in the United States until 2006 (and the associated build-up in home equity values). This will have to be taken into account when interpreting any results on the basis of 06-1 prices.

Casual inspection of ABX price data yields a number of interesting observations. One is the steep decline in prices (massive increase in implied spreads) observed since June 2007, following an initial price correction early in 2007 (Graph 1, centre and right-hand panels).[13] The developing subprime crisis then caused price deterioration across the entire liability structure of the various ABX indices, with prices up to the A index plummeting to very low levels. A closer comparison of three pricing snapshots (Table 1) for the first two ABX vintages shows that the AAA tranches were quoted close to par in June 2007, whereas they were quoted at around 93 and 87, respectively, at end-December 2007. By end-June 2008, valuations had deteriorated further, illustrating how the market had started to differentiate between the two adjacent vintages, particularly for the higher-rated indices. In total, the strongest price declines were observed in the BBB segment, where prices dropped from levels around 94 to near 9.6 for the 2006-1 BBB index, which is close to the price of the originally A-rated index of the 2006-2 vintage.

Correlation patterns also offer some insights into how the market perceives the riskiness of different ABX tranches. For example, rolling 90-day correlations between AAA and BBB– index prices show a pronounced increase during the onset of the subprime crisis in the summer of 2007. This followed a brief spike in January–February 2007, consistent with the initial subprime jitters during that period, and correlations around 0.3 throughout much of 2006. These observations are broadly consistent with observed correlation patterns between senior ABX and investment grade CDS prices, which suggests that

[13] See BIS (2008, Chapter VI) for a description of market developments during the unfolding financial crisis.

The pricing of subprime mortgage risk: three snapshots

Observed market prices (as a percentage of par) for the ABX 06-1 and 06-2 index series, by original rating

Price series	1 June 2007	31 December 2007	30 June 2008
ABX 06-1 AAA	100.1	93.5	91.8
ABX 06-2 AAA	99.6	86.8	69.3
ABX 06-1 AA	100.1	85.0	60.6
ABX 06-2 AA	99.5	62.2	20.5
ABX 06-1 A	98.7	61.0	21.2
ABX 06-2 A	96.2	39.5	9.3
ABX 06-1 BBB	94.5	33.5	9.7
ABX 06-2 BBB	82.7	20.5	5.5
ABX 06-1 BBB–	88.2	29.4	9.0
ABX 06-2 BBB–	73.1	19.3	5.2

Source: JPMorgan Chase. Table 1

factors other than the risk of mortgage default may have played an important role in driving ABX returns (Graph 2, left-hand panel).

… mortgage market fundamentals …

Housing and other mortgage market fundamentals. Detailed data on the subprime mortgage market are scarce, which makes it difficult to come up with appropriate proxies for fundamental drivers of mortgage default. Three groups of housing-related indicators were considered for inclusion. The first of these consists of contemporaneous indicators, such as macroeconomic data releases, which tend to be available at a weekly or monthly frequency. The second group contains daily pricing factors with forward-looking information, such as those derived from prices for financial products. The third group is based on ABX-specific performance data.

Contemporaneous data. From a modelling perspective, the inclusion of most lower-frequency measures of market fundamentals in the regression setup is challenging, as precise announcement dates and estimates of analysts' forecasts are required in order to properly test the reaction of daily market prices to these fundamental factors.[14] Only four such variables turned out to be significant drivers of ABX prices, proxying the overall state of the US economy and related mortgage market developments: building permits, an indicator of private residential real estate activity; new home sales, which track sales of new one-family houses; and the RPX residential property composite index, which is based on daily transaction prices per square foot paid for US residential real estate in 25 regional markets. The RPX property price series enters the analysis both in levels and in terms of observed volatilities over a moving 20-day window to capture housing market trends as well as associated uncertainties. The fourth proxy is the surprise component in the monthly net

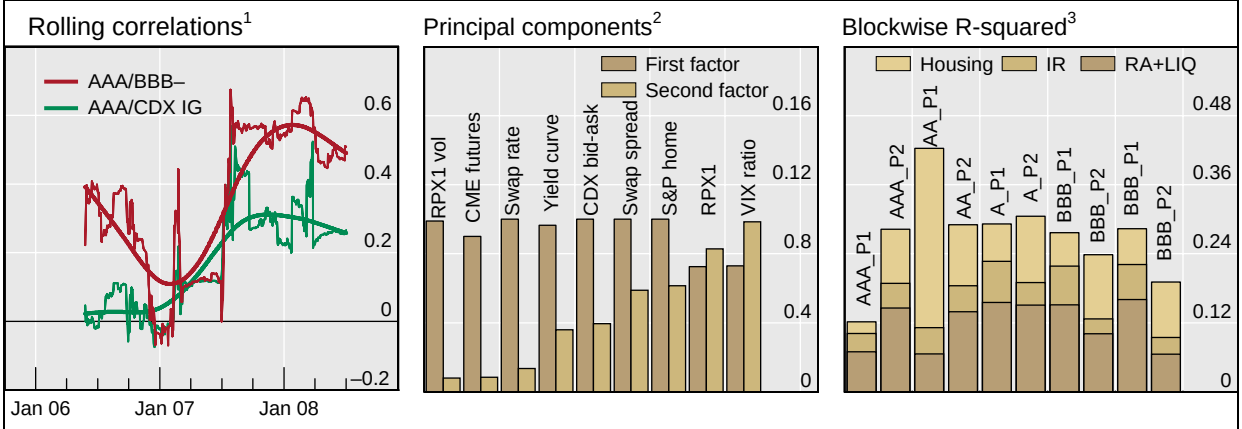
[14] Asset pricing theory suggests that observed prices reflect publicly available information about the state of the economy. Therefore, it is not the published level of a macroeconomic variable that affects the prices of securities or derivatives, but the unexpected component of the new information (see eg Fleming and Remolona (1997)). On this basis, whenever possible, survey data are used to calculate the surprise component of economic data releases. If no such survey information is available, changes from the previous release are employed as an, admittedly crude, proxy for the surprise effect.

change in US employees on non-farm payrolls, which serves as the key macroeconomic control variable.

Forward-looking information. Expected developments in the housing sector are captured by the daily logarithmic excess return of the homebuilders subindex over the S&P 500 equity index and daily average price changes for futures contracts on the Case-Shiller composite index, which is based on recorded changes in home values in 10 geographical areas in the United States. These futures, which are traded on the Chicago Mercantile Exchange, are available for the contract months of February, May, August and November, and are cash-settled on the day the Case-Shiller index is released.

ABX-specific data. Deal-specific news for each of the constituent MBS bonds of the ABX indices is proxied by information on rating downgrades by the three major rating agencies and delinquency data from the monthly so-called remittance reports. For the first of these ABX-specific indicators, downgrade events by Moody's, Standard & Poor's and Fitch for the underlyings of the 06-1 ABX indices are coded by date and ABX rating category.[15] The second indicator summarises underlying deal performance on the basis of observed changes in average 60-day-plus delinquencies for the same set of MBS instruments.

ABX 06-1 pricing



[1] Rolling 90-day correlations of observed daily changes in AAA and BBB– ABX 06-1 and CDX investment grade index prices. Thin lines indicate the HP-filtered trend. [2] Significance (1 minus p-value) of the estimated correlation between the two principal components of daily ABX 06-1 log returns and selected explanatory variables: 20-day rolling volatility in the RPX1 housing index (RPX1 vol), average price of housing index futures (CME futures), one-year swap rate (swap rate), difference between 10-year and three-month Treasury yield (yield curve), average bid-ask spreads for CDX index tranches (CDX bid-ask), spread on 10-year US dollar interest rate swaps (swap spread), daily excess log return of the homebuilders subindex over the S&P 500 (S&P home), RPX one-day US residential property prices (RPX1) and the ratio of the VIX volatility index over realised S&P 500 index volatility (VIX ratio). [3] R-squared goodness of fit measures from bivariate regressions of ABX 06-1 returns by rating category. The three blocks of explanatory variables are housing market fundamentals (housing), interest rates (IR) and risk appetite and liquidity (RA+LIQ). Values marked P1 and P2 indicate estimates over two different subperiods; cutoff date is 9 August 2007.

Sources: Bloomberg; JPMorgan Chase; authors' calculations. Graph 2

[15] The resulting downgrade counts, aggregated into an index covering all five rating categories, identify 35 days with downgrades on at least one underlying instrument. The maximum count for the 06-1 vintage is 14 downgrades per day on 8 April 2008. With 100 MBS bonds referenced by each individual ABX vintage, individual index readings can be interpreted as the percentage of underlyings downgraded (in numbers of bonds).

Interest rates. The series that is commonly seen as market participants' preferred discount rate is Libor and, by extension, the rate on US dollar swaps. In addition to its impact on the present values of the two payment legs via the discount factor, as argued above, interest rates are also going to influence the effective subordination of the various ABX tranches. Finally, the slope of the yield curve of interest rates will capture expectations of monetary policy and the economic climate, including those regarding mortgage prepayment behaviour. In the econometric setup, these interest rate effects are going to be proxied by the one-year US swap rate[16] and by the spread between 10-year and three-month US Treasury yields.

… interest rates …

Investor risk appetite and liquidity. Spreads for credit-risky products are known to compensate investors for more than pure expected losses from default (see eg Berndt et al (2005)). That is, they include various risk premia, which are typically assumed to correlate with investor risk appetite.[17] Given its forward-looking character, the VIX implied volatility index derived from option prices on the S&P 500 equity index is a common measure used to capture these effects. Here, risk appetite is proxied by the ratio of the VIX and realised S&P volatility over a leading 20-day window, where higher readings of the VIX ratio (ie positive forecast errors of the VIX relative to realised volatility) correspond to declining risk appetite. In addition, specific market liquidity proxies are included to better gauge associated risk premia. As bid-ask spreads or other direct market liquidity measures for the ABX indices are not readily available, two more indirect indicators are used in the empirical analysis. First, bid-ask spreads are proxied by the average of observed bid-ask spreads across tranched CDX investment grade contracts (ie credit derivatives drawn on portfolios of US corporate credit exposures). Second, US dollar 10-year swap spreads are used. These are known to contain a liquidity premium, along with a premium reflecting the default risk embedded in the Libor rate, due to banks' funding operations in the interbank market.[18]

… and risk appetite as well as …

… market liquidity measures

The sample period extends from 19 January 2006, the first trading date of the ABX 06-1 series, to end-June 2008. Price and interest rate observations are daily, enhanced with macroeconomic and financial data releases at a monthly or weekly frequency. Regressions are based on pooled ordinary least squares (OLS) with cross-sectional fixed effects and White period-robust covariance matrices to account for heteroscedasticity-induced bias in the estimated standard errors. A time trend is included to capture maturity effects. All right-hand side variables except the surprises and S&P excess returns are

[16] Part of the observed movement in the swap rate is going to reflect changes in counterparty credit and liquidity premia; see below.

[17] Risk appetite is generally defined as a measure of the degree to which investors dislike uncertainty surrounding the future consumption implied by their asset holdings as well as the level of that uncertainty. See Gai and Vause (2006).

[18] Longstaff et al (2005) show that the non-default component in credit spreads is positively related to average bid-ask spreads, which, in turn, capture changes in market liquidity. See Huang and Neftci (2003) for details on the importance of liquidity premia in swap spreads.

specified as first differences, and the left-hand side variables are logarithmic ABX price changes.

Factor analysis

As a first step, the information content of observed ABX index returns for the 06-1 vintage is analysed by way of a simple factor analysis.[19] The results of this decomposition suggest that the correlation structure of logarithmic ABX returns can be explained by only two separate factors.

The first of these, which accounts for a variance share of some 86%, is strongly related to a number of financial market variables. This is apparent from highly significant correlations with indicators such as homebuilder excess returns, interest rates or bid-ask spreads. Changes in the last of these variables, for example, have a contemporaneous correlation of –0.27 with the first ABX return factor. The second factor, in turn, accounts for a much smaller share of the overall return variance and appears to be correlated significantly with measures of risk appetite, such as the ratio of the VIX volatility index over realised 20-day S&P index volatility (Graph 2, centre panel). These patterns suggest that variation in ABX returns may be due not only to changes in house prices and other drivers of fundamental mortgage risk, but also to more general pricing factors, such as liquidity and investor risk attitudes.

Factors other than mortgage risk …

Baseline results

In order to analyse these results in more detail, panel regressions are run to shed light on the effect of key explanatory variables on contemporaneous ABX returns.[20] The impact of the financial crisis is captured through interactions of the explanatory variables with a "crisis" dummy that takes values of one from 9 August 2007 onwards.[21] The same approach is taken to account for possible interactions of rating downgrades with other pricing factors. Bearing in mind the indirect nature of many of the proxies used to capture pricing fundamentals, several results are worth highlighting (Table 2).

First, the surprise components of non-farm payrolls and building permits have a positive, statistically significant effect on ABX returns over the sample period. As expected, ABX valuations tend to rise in response to news suggesting better than expected economic and housing market activity. The surprise component of new home sales, in contrast, is negatively related to ABX pricing, perhaps due to the effects of data revisions or other concurrent data releases (such as regional sales, houses for sale or sales prices). While

[19] The factor decomposition uses maximum likelihood estimation and determines the overall number of factors on the basis of their shares in total observed variance.

[20] Use of the panel approach, though somewhat restrictive, allows estimation of a system of equations with ABX returns as dependent variables and identical explanatory variables. An alternative setup on the basis of lagged explanatory variables (to account for potential endogeneity issues) yields broadly similar results at comparable levels of significance, though with a reduced R-squared. Further robustness tests allowing for non-linear relationships and the possibility of heterogeneous responses across indices are reserved for future research.

[21] This corresponds to the spilling-over of the subprime sell-off into interbank money markets, which first gave market participants a true sense of crisis. See BIS (2008, Chapter VI).

Regression results: ABX 06-1 pricing

Pooled least squares with cross-sectional fixed effects[1, 2, 3]

Variable	Coefficient (t-value)					
	Variable		Interaction with:			
			crisis dummy		ABX 06-1 rating changes	
Non-farm payrolls	**0.009**	(3.602)				
Building permits	**0.006**	(2.576)				
New home sales	**–0.004**	(–2.922)				
RPX house prices	0.007	(1.633)	**0.025**	(3.541)	**–0.022**	(–3.311)
RPX 20-day volatility	**0.065**	(2.178)	**–0.275**	(–3.690)	**0.233**	(4.328)
ABX 06-1 delinquencies	**–0.335**	(–3.416)				
ABX 06-1 rating changes	**–0.098**	(–4.015)				
CME housing futures	0.001	(0.128)	**0.146**	(3.524)	**1.516**	(4.311)
Homebuilder returns	**3.100**	(4.529)	**5.992**	(3.180)	**–1.384**	(–3.532)
Interest rates	**4.544**	(4.190)	**–1.661**	(–2.414)	**2.502**	(5.057)
Yield curve slope	0.716	(1.475)	**–1.867**	(–2.665)	**0.882**	(4.099)
VIX volatility ratio	*–0.297*	(–1.931)	0.323	(0.863)	*–0.167*	(–1.753)
Swap spreads	**–24.340**	(–3.203)	–3.486	(–0.713)	**4.186**	(5.751)
CDX bid-ask spreads	**–0.384**	(–2.945)	**–0.497**	(–3.067)	0.091	(1.278)

[1] Sample (adjusted): 22 May 2006 to 10 June 2008; pooled regressions of logarithmic ABX 06-1 returns on an identical set of explanatory variables as specified above; the crisis dummy is set at a value of one from 9 August 2007 to the end of the sample; the setup includes a constant and time trend (not reported). [2] Bold (italicised) values are significant at the 5% (10%) level; coefficient estimates have been multiplied by 100 for ease of presentation; standard errors are calculated using the White period-robust coefficient variance estimator. [3] The adjusted R-squared is 19.9%.

Source: Authors' calculations. Table 2

insignificant, changes in both current and CME futures-implied house price index values correlate positively with ABX returns when estimated over the entire sample. These positive effects appear to be even stronger during the latter part of the sample, as suggested by the highly significant positive coefficients found in conjunction with the crisis dummy. The same is true for homebuilder excess returns, whose positive influence on ABX prices is found to increase in the crisis period. Uncertainty around daily house prices, which would not necessarily be expected to have any particular directional effect, has a negative coefficient during the latter part of the sample. This is consistent with heightened market attention to such credit quality proxies in-crisis.

Second, delinquency rates and rating downgrades on the securities referenced by the ABX 06-1 indices are found to have a negative effect on subprime mortgage pricing, as expected. In addition, the ratings variable is significant when interacted with some of the other factors, suggesting market sentiment effects associated with negative rating actions. RPX house prices, for example, are found to correlate negatively with ABX returns on days with rating downgrades, implying that the effects of any positive news from the RPX measure are broadly offset by ratings-related market technicals. A similar effect is found for homebuilder excess returns, though not for other variables.

Third, there are signs that decreasing risk appetite and rising market illiquidity lower the value of ABX instruments. Swap and bid-ask spreads, while

… such as risk appetite and liquidity …

being only indirect proxies of ABX liquidity, are found to negatively affect ABX prices over the sample period, with the estimated coefficient for the latter indicator rising during the crisis period. The VIX-based measure of investor risk appetite has the expected negative sign, although no significant additional effects are found in-crisis. Interest rate effects, in turn, are significant, with rising yield curve slopes associated with negative ABX returns during the latter part of the sample, perhaps reflecting the impact of interest rate expectations on projected prepayments.

Finally, the results are consistent with a considerable unexplained component in the variation of ABX prices, as the R-squared is only about 20%.[22] In line with the results of the principal component analysis of ABX 06-1 returns reported above (Graph 2, centre panel), this points to the existence of a sizeable unobservable driver of subprime mortgage risk that is not captured satisfactorily by any of the explanatory variables in the econometric setup.[23]

One possible interpretation of this finding is in terms of a broad version of the so-called "credit spread puzzle" (eg Amato and Remolona (2003)), which describes the observation that fundamental factors are usually found to explain only a small fraction of the level of observed credit spreads. These findings are also applicable to the present case if the unexplained component is time-varying, implying similar effects in terms of observed returns.

Blockwise regression results

The third and final step of the analysis focuses more closely on the impact of the recent financial turmoil on ABX pricing and the effects of heterogeneity across the various 06-1 indices. To illustrate changes in the weight of the different pricing factors over time (ie pre- and in-crisis, where the cutoff is again set at 9 August 2007) and across individual indices, the relative contributions of partial R-squared "goodness of fit" measures are compared on the basis of blockwise regressions of ABX 06-1 index returns. Following the description of the various data series above, the different blocks are: housing and other fundamentals; interest rates; and risk appetite and liquidity.

… are found to explain part of ABX variation …

Results are reported in Graph 2 (right-hand panel) and suggest some important changes in the relative explanatory power across the three sets of pricing factors. Importantly, for the entire sample, risk appetite and market liquidity factors seem to account for a sizeable part of the observed variation in ABX returns. Patterns, however, differ quite substantially across the various rating categories. Specifically, while risk appetite and liquidity risk appear to have grown in importance for the AAA and AA indices, they have tended to diminish in importance for the lower-quality indices. For the BBB– index, for

[22] Results for the 2006-2 vintage are broadly similar but omitted to conserve space.

[23] This value is somewhat lower than those documented elsewhere for corporate bonds, eg Collin-Dufresne et al (2001). A principal component analysis of the residuals of the baseline regression finds that correlations between the residuals are substantially smaller than those for the dependent variables, but that the remaining interdependence is still consistent with a sizeable unobserved common component in the regressions. Alternatively, the regression setup may be inappropriately specified.

example, the combined housing and interest rate factors seem to have become more important in relative terms, as risk appetite and liquidity became less of a factor. This reduced role of risk appetite and liquidity proxies for BBB– pricing may be consistent with an increasing likelihood for all underlying MBS bonds to be written down completely – that is, a transition to interest-only pricing for the BBB– index in 2008 (see box and Graph A, centre and right-hand panels). The increased importance of risk appetite and liquidity for the most senior ABX 06-1 indices, in turn, is consistent with the sort of technical market factors typically associated with times of crisis – that is, the use of these senior indices as a macro hedge or to express negative trading views on the US housing market, even as those indices remain less likely than their subordinated counterparts to take sizeable losses in the wake of a deteriorating housing market.

... though with differences across rating categories

Concluding remarks

The results presented above suggest that declining risk appetite and rising concerns about market illiquidity have provided a sizeable contribution to the observed collapse in ABX prices since the summer of 2007. While proxies for fundamental drivers of subprime mortgage risk, such as indicators of housing market activity, have continued to exert a strong influence on the subordinated ABX indices, the AA and AAA indices have tended to react more to the general deterioration of the financial market environment.

These results underline the well established view that risk premia are important components of observed prices for default-risky products, and that the relative importance of non-default-related risk factors will tend to increase in periods of strong repricing of risk. This suggests that theoretical pricing models that do not sufficiently account for these factors may be inappropriate, particularly in periods of heightened market pressure.

A related set of findings concerns the use of ABX price information by market participants and policymakers for the valuation of positions in US subprime instruments. Importantly, the empirical results provide tentative evidence suggesting that observed ABX prices are unlikely to be good predictors of future default-related cash flow shortfalls on outstanding subprime MBS, especially for tranches at the higher end of the capital structure. This is in part because coverage of the ABX indices extends only to a small fraction of the outstanding subprime MBS universe, which can lead to significant price divergence across like-rated products even in the absence of sizeable risk premia.

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Recent initiatives by the Basel-based committees and groups

During the period under review, the Basel Committee on Banking Supervision (BCBS) released a report on fair value measurement, as well as consultative documents on sound liquidity risk management and supervision, and on an incremental risk capital charge. The Committee on the Global Financial System (CGFS) issued three reports analysing important issues pertinent to the financial market turmoil that broke out in mid-2007. The Committee on Payment and Settlement Systems (CPSS) published reports on foreign exchange settlement risk and on the interdependencies of payment and settlement systems. Thanks to these initiatives and others at the national and international levels, good progress was made on implementing the recommendations made by the Financial Stability Forum (FSF) in April 2008. Table 1 provides an overview of these and other developments.

Basel Committee on Banking Supervision

BCBS releases publication on fair value measurement and modelling …

On 12 June, the BCBS released a publication on *Fair value measurement and modelling: an assessment of challenges and lessons learned from the market stress*. Drawing on the work of the Committee's Accounting Task Force and Risk Management and Modelling Group, the paper summarises the Committee's initial assessment of valuation practices. It identifies four key areas in which practices can be improved: governance and controls; risk management and measurement; valuation adjustments and uncertainty; and financial reporting.

… and is undertaking further work on the subject

To strengthen practices and promote greater transparency regarding valuation processes, the Committee is undertaking further work to develop guidance that supervisors can use to assess the rigour of banks' valuation processes and promote improvements in risk management and control practices. The Committee will also work with accounting and auditing standard setters and auditors to promote standards and practices that enhance the reliability, verifiability and transparency of fair value estimates. These initiatives will build on existing BCBS and industry guidance. They are also part of a broader effort by the Committee and national supervisors to strengthen firm-wide risk management practices.

Initiatives by Basel-based committees and groups

Press releases and publications over the period under review

Body	Initiative	Thematic focus	Release date
BCBS	*Fair value measurement and modelling: An assessment of challenges and lessons learned from the market stress*	• Summary of Committee's initial assessment of valuation practices • Identification of areas for improvement of practices • Steps forward	June 2008
	Principles for sound liquidity management and supervision	• Revision of earlier sound practices published in 2000 • Proposals to raise standards in the areas of governance and firm-wide risk tolerance, liquidity risk measurement, risk-taking incentives for individual business units, stress testing, intraday liquidity risks and collateral, the establishment of liquidity cushions, public disclosures and supervision	
	Guidelines on an incremental risk charge and accompanying revisions to the Basel II Framework	• Aligning regulatory capital requirements with the risk exposure of banks' trading book positions	July 2008
CGFS	*Private equity and leveraged finance markets*	• Trends during the period of rapid growth • Performance since mid-2007 • Short-, medium- and long-term risks	July 2008
	Ratings in structured finance: what went wrong and what can be done to address shortcomings?	• Recommendations on improving the information provided on ratings of structured finance products • Summary of the feedback received during consultation with credit rating agencies and investors	
	Central bank operations in response to the financial market turmoil	• Summary of central bank actions • Assessment of the outcome • Policy recommendations	
CPSS	*Reducing foreign exchange settlement risk*	• Assessment of progress made • Recommendations to reduce and control remaining large and long-lasting exposures	May 2008
	Interdependencies of payment and settlement systems	• Various interdependencies among the systems of CPSS countries • Risk implications of these interdependencies; associated risk management challenges	June 2008
FSF	*Report by the FSF Chairman to the G8 Finance Minsters*	• Current situation of the financial system • Implementation of the recommendations of the FSF *Report on enhancing market and institutional resilience* • Future work of the FSF	June 2008

Source: Relevant bodies' websites (www.bis.org, www.fsforum.org). Table 1

BCBS publishes consultative document on sound liquidity management and supervision …

On 17 June, the Committee released for public comment a consultative document on *Principles for sound liquidity management and supervision*. The enhanced global standards reflect the lessons of the financial market turmoil and represent a substantial revision of the Committee's *Sound practices for managing liquidity in banking organisations* that were published in 2000. The principles draw on recent and ongoing work on liquidity risk[1] by the public and private sectors and are intended to strengthen banks' liquidity risk management and improve global supervisory practices. They support one of the key recommendations for strengthening prudential oversight set out in the *Report of the Financial Stability Forum on enhancing market and institutional resilience*, which was presented to G7 Finance Ministers and central bank Governors in April 2008.

… outlining the importance of a robust, bank-wide risk management process …

The principles underscore the importance of establishing a robust liquidity risk management framework that is well integrated into the bank-wide risk management process. The primary objective of this guidance is to raise banks' resilience to liquidity stress (impairment of secured or unsecured funding, the source of which can be market- or bank-specific). The principles seek to raise standards in the following areas:

- governance and the articulation of a firm-wide liquidity risk tolerance;
- liquidity risk measurement, including the capture of off-balance sheet exposures, securitisation activities, and other contingent liquidity risks that were not well managed during the financial market turmoil;
- aligning the risk-taking incentives of individual business units with the liquidity risk exposures their activities create for the bank;
- stress tests that cover a variety of institution-specific and market-wide scenarios, with a link to the development of effective contingency funding plans;

… and seeking to raise standards in specific areas

- strong management of intraday liquidity risks and collateral positions;
- maintenance of a robust cushion of unencumbered, high-quality liquid assets to be in a position to survive protracted periods of liquidity stress;
- regular public disclosures, both quantitative and qualitative, of a bank's liquidity risk profile and management;
- supervisory approaches to periodic and ongoing assessment of a bank's liquidity position[2] and risk management framework, as well as the utilisation of remedial action when necessary.

The document was open for comment until 29 July 2008.

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[1] In this context, liquidity is the ability of a bank to fund increases in assets and meet obligations without incurring unacceptable losses. Liquidity risk thus means the risk of not being able to obtain such funding or meet obligations.

[2] A bank's liquidity position is a point-in-time measure of its ability to fund increases in assets and meet obligations as they come due, without incurring unacceptable losses. Determining a bank's liquidity position therefore requires an understanding of a number of factors that affect its liquidity at the relevant point in time, such as the bank's cash flow mismatch, the size of its cushion of unencumbered, highly liquid assets, the market liquidity of its assets and the certainty of its access to various sources of funds, among others.

On 17 July, the BCBS released for public comment its preliminary views on supervisory expectations relating to *due diligence and transparency regarding cover payment messages related to cross-border wire transfers*.

BCBS invites comments on due diligence and transparency principles in the area of cross-border wire transfers

The processing of cross-border wire transfers frequently involves several financial institutions. In addition to the originator's bank and the beneficiary's bank, other banks are often involved. This paper examines the circumstances where one or more of these intermediary banks is located in a jurisdiction other than the jurisdictions where the bank of the originator and the bank of the beneficiary are located. It describes the supervisory expectations, pursuant to the current initiatives supported by the Basel Committee to enhance transparency in payment messages, about information that must be included in payment messages related to cover payments, the various mechanisms that must be used to ensure that complete and accurate information has been included in such messages, and the use that should be made of the information for AML/CFT purposes.

The document is open for comment until 16 September 2008.

On 22 July, the Committee released for comment *Guidelines for computing capital for incremental risk in the trading book*. This followed the consultation paper released in October 2007 on proposed guidelines for computing capital for incremental default risk, or the risk that is incremental to the default risk already reflected in a bank's value-at-risk (VaR) model. Reflecting comments received and the experience of the recent turmoil, the Committee has expanded the scope of the capital charge to more fully capture the sources of recent losses in CDOs of ABS and other resecuritisations held in the trading book, which arose not from actual defaults but from credit migrations combined with widening of credit spreads and the loss of liquidity.[3] The proposed incremental risk charge (IRC) would capture price changes due to defaults as well as other sources of price risk, such as those reflecting credit migrations and significant moves of credit spreads and equity prices.

BCBS issues for comment guidelines for computing capital for incremental risk in the trading book …

In its *Proposed revisions to the Basel II market risk framework*, the BCBS also proposes improvements concerning internal VaR models. It has further aligned the language with respect to prudent valuation for positions subject to market risk with existing accounting guidance. In addition, it has clarified that regulators will retain the ability to require adjustments to current value beyond those required by financial reporting standards, in particular where there is uncertainty around the current realisable value of a position due to (market) illiquidity.

… together with improvements to Basel II regarding internal VaR models

The guidance would become effective for implementation by 1 January 2010 for default and migration risk and by 1 January 2011 for all remaining price risks. It was developed jointly by the Basel Committee and the International Organization of Securities Commissions (IOSCO). In conjunction with the proposed guidelines, the Committee will conduct a two-stage quantitative impact study of the IRC on firms' capital requirements. In the first

[3] Market liquidity, or the ability to trade on short notice without incurring unacceptable losses.

stage, the Committee plans to rely largely on data collected in connection with the 2007 incremental default risk proposal to examine the impact of incorporating default and migration risk into the IRC. In stage two, additional data will be collected to examine the impact of incorporating other risks.

The consultative documents are open for comment until 15 October 2008.

Committee on the Global Financial System

On 4 July, the CGFS published three reports analysing important issues pertinent to the financial turmoil that broke out in mid-2007, in the areas of private equity and leveraged finance markets, ratings in structured finance and central bank operations in response to the financial turmoil.

CGFS releases report on private equity and leveraged finance markets …

The report on *Private equity and leveraged finance markets* was prepared amidst rapidly deteriorating conditions in leveraged finance[4] markets. Against this backdrop, the report addresses two broad questions. First, what have been the important trends during the period of rapid growth in the markets for leveraged finance, private equity and leveraged buyouts (LBOs), and how has market growth affected financing patterns? Second, how have leveraged finance markets performed since mid-2007, which risks have surfaced, and what preliminary lessons can be drawn for financial stability?

… summarising development trends …

On the first question, the report finds evidence of more rapid growth in leveraged loan issuance in recent years than issuance of high-yield bonds. At the same time, institutional investors have replaced banks as the main investors. Collateralised loan obligation[5] (CLO) vehicles have emerged as loan securitisers and intermediaries. Increased ratings coverage of the loans has further attracted institutional investors. There has been increased secondary market trading of leveraged loans, and bank business models have shifted from "buy and hold" to "originate to distribute" (OTD).

… highlighting risks that have arisen since mid-2007 …

… in particular, warehousing risk …

On the second question, the report notes that conditions in the leveraged loan market deteriorated in the second half of 2007 and demand for leveraged finance declined sharply. The contraction in demand for leveraged loans, especially by securitisation vehicles,[6] revealed substantial exposure of arranger banks to warehousing risk. Undistributed loans, in conjunction with other off-balance sheet products that banks have been forced to move onto their balance sheets during the credit market turmoil, have contributed to increased funding costs and capital requirements.

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[4] Financing, typically for takeovers, ensuing in a high level of leverage for the borrower.

[5] Bonds backed by the cash flow on a pool of loans. Structured finance consists in issuing securities backed by the cash flows on a pool of homogeneous assets. The securities are often divided into tranches, each corresponding to a particular riskiness, depending on guarantees attached to each tranche and on their seniority for the collection of payment (interest and principal) streams.

[6] Such vehicles, which had become major investors in leveraged loans in recent years, had influenced the characteristics of leveraged loans through their sustained demand for covenant-lite and long-maturity loans.

The report highlights a number of risks. In the short term, there are risks associated with an unwanted expansion of bank balance sheets from undistributed leveraged loans. This may impair banks' ability to provide liquidity (ie short-term funding) and bridge financing, in a period when the high-yield bond market may not be able to act as a "spare tyre" for corporate funding. In the medium term, a tightening of financing conditions may lead to substantially higher refinancing risks for highly leveraged firms. This, together with the expected pressure on firms' future cash flows stemming from a weakening economy, will further increase the default risk of firms dependent on leveraged finance. In the long term, the terms and availability of leveraged finance and the capacity of private equity participants to fund LBO deals will depend on modifications to the OTD model. Finally, the greater diversity of investors in the leveraged finance market may raise the duration and cost of the debt restructuring process, with potential implications for default risk and the dynamics of the corporate credit cycle.

… a tightening of financing conditions …

… and developments related to changes in the OTD model

Ratings in structured finance: what went wrong and what can be done to address shortcomings? revisits a topic the Committee discussed in its 2005 working group report *The role of ratings in structured finance: issues and implications.* The current report draws on the lessons learnt during the turmoil about the vulnerabilities of ratings of structured finance (SF) products. It highlights the risk factors that are likely to have contributed to the poor rating performance of SF products backed by US subprime mortgages. These include credit rating agencies (CRAs) underestimating the severity of the housing market downturn, model risk (the risk of using a wrong model) aggravated by limited historical data, and CRAs underestimating the originator risk factor.

CGFS revisits ratings in structured finance

The report highlights several lessons. First, credit rating information should support, not replace, investor due diligence. Second, better information on the key risk factors of SF ratings is needed. Third, CRAs should take system-wide risk into account.[7] Based on these lessons, it provides a number of specific recommendations on how the information provided on ratings of SF products can be improved. Key recommendations include the need for more user-friendly access to CRA SF models, including the sensitivity of SF tranche ratings to change central assumptions regarding default rates, recovery rates and correlations, and the need for CRAs to consider how to incorporate additionnal information on the risk properties of SF products into the rating framework.

Lessons and recommendations

The report also includes a summary of the feedback received during a consultation process with CRAs and investors. Although investors were critical of CRAs' technical failings and inadequate resources, the need for CRAs to repair their reputation was seen as a powerful force for improvements. Indeed,

[7] CRAs should periodically consider the wider systemic implications of a rapid growth of similar instruments or vehicles, or of new business undertaken by existing vehicles, for the continued robustness of their original ratings criteria. Such growth may lead to a concentration of market and other risks that may not have been anticipated at the time the CRA's minimum requirements were formulated. As illustrated by the recent experience of structured investment vehicles (SIVs), the consequences of exposure to a common shock can be amplified when several vehicles sharing common ratings rules are simultaneously affected. This is particularly the case when market-based triggers are incorporated in the rating.

investors noted that CRAs' recent shortcomings in risk evaluation had been shared by many market participants. A number of initiatives to enhance the information provided on SF ratings are already under way. In the light of these initiatives, the CGFS will follow up with CRAs and investors on the recommendations made in the report.

CGFS issues report on central bank operations in response to the financial market turmoil

Central bank operations in response to the financial market turmoil examines how central banks have adapted their liquidity operations (the provision of central bank money to eligible financial institutions) in response to the money market tensions that emerged during the turbulence. The report was prepared by a study group convened by the CGFS in cooperation with the Markets Committee. It discusses the various measures taken by central banks,[8] assesses the outcome of these measures and sets out a number of recommendations for central bank liquidity operations.

Central banks have reduced, though not resolved, tensions in money markets

Based on the experience up to end-April 2008, the report suggests that the various central bank actions have reduced, though not resolved, tensions in the money markets. In turn, this was judged to have mitigated the potential damage to the economy from the broader financial market turmoil. Overall, the most tangible result was that central banks were able to keep short-term market rates close to their policy rate targets, notwithstanding the more volatile market conditions, as well as the stigma associated with standing lending facilities, which might have, in some cases, complicated central banks' efforts. Addressing funding market pressures in the broader sense, particularly in term unsecured markets, proved to be more difficult. This was because funding market pressures could come not only from liquidity concerns (eg due to asset market dislocations or unanticipated payment obligations affecting individual institutions), which are amenable to central bank action, but also from counterparty risk or other concerns, which are not readily addressable by central bank operations. Central bank communication during the turmoil was judged largely successful, especially in distinguishing liquidity management actions from monetary policy changes. Nonetheless, given that there were still some instances of misunderstanding about the details of policy implementation, there could be room for improvement.

Policy recommendations

The report concludes with a number of recommendations that pertain to central banks' ability to achieve their policy rate targets in times of turmoil, problems in the domestic distribution of reserves, illiquidity of financial markets or of institutions, problems in the international distribution of liquidity, risks of misinformation and misunderstanding, financial institutions' reluctance to use standing facilities (stigma) and costs associated with central bank interventions, including moral hazard. While making these recommendations, the study group emphasises that the specific ways that central banks may choose to implement them should depend upon the circumstances and the individual central bank's situation. In any event, the report reflects the study group's awareness that the recommendations it identified cannot deal with the

[8] A detailed chronology of selected central bank actions is presented in the annex of the report.

root causes and pervasive effects of the market turmoil, which go beyond the sphere of central bank actions.

The report was drafted during a time when central banks were closely monitoring market developments and, more or less simultaneously, needed to respond to the evolving challenges. Some of the specific recommendations discussed by the study group had already been implemented during the drafting period. Beyond this report, which reflects the study group's experience and assessment only up to end-April 2008, central banks will continue to draw lessons from the turmoil and to examine how their liquidity operations can be made more effective. In particular, central banks are further exploring the steps they might take to facilitate mobilising liquidity across national borders.

Committee on Payment and Settlement Systems

CPSS releases study on progress in reducing FX settlement risk …

On 14 May, the CPSS released a report on *Progress in reducing foreign exchange settlement risk*. The report was prepared for the Committee on Payment and Settlement Systems by its Sub-Group on Foreign Exchange Settlement Risk, and was first published as a consultative document in July 2007.[9] In 1996 the G10 central banks endorsed a strategy to reduce the systemic risk arising from the settlement of foreign exchange trades. The strategy was motivated by the finding that banks' foreign exchange settlement exposures[10] to their counterparties were in many cases extremely large relative to their capital, lasted overnight or longer and were poorly understood and controlled. The report analyses the progress that has been made over the past 10 years and concludes that the central bank strategy has achieved significant success, evidenced most visibly by the establishment and growth of CLS Bank, which settles on average more than $3 trillion each day in FX-related payment obligations. However, at the same time, a notable share of FX transactions is settled in ways that still generate significant potential risk across the global financial system and so further action is needed. The report therefore recommends specific actions by individual institutions, industry groups and central banks to reduce and control remaining large and long-lasting exposures and to guard against a risk of reversing the important progress already made. The special feature article on page 53 of this issue discusses the report in more detail.

… and issues report on interdependencies of payment and settlement systems …

On 4 June, the CPSS released a report on *The interdependencies of payment and settlement systems.* The report was prepared by the Working Group on System Interdependencies, in order to identify the various interdependencies that exist among the systems of CPSS countries, analyse the risk implications of these interdependencies, and assess any associated risk management challenges.

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[9] See "Recent initiatives by the Basel-based committees and groups", *BIS Quarterly Review*, September 2007, pp 95–101.

[10] The CPSS defines FX settlement risk as "the risk that one party to a foreign exchange transaction will pay the currency it sold but not receive the currency it bought"; see *A glossary of terms used in payments and settlement systems*, CPSS, March 2003.

The report concludes that interdependencies have important implications for the safety and efficiency of the global payment and settlement infrastructure. Tighter interdependencies among systems have contributed to strengthening the global infrastructure by reducing several sources of settlement costs and risks. At the same time, interdependencies have increased the potential for disruptions to spread quickly and widely across multiple systems.

… suggesting policy actions to reduce the potential of a disruption to spread quickly

To address the potential for a disruption to spread quickly to many systems, the report suggests that system operators, financial institutions and service providers take several actions in order to adapt their existing risk management practices to the more complex, integrated environment resulting from tighter interdependencies. To that end the report underlines the importance of broad risk management perspectives, risk management controls that are commensurate with the role played in the global payment and settlement infrastructure, and wide coordination among interdependent stakeholders. The report also suggests that central banks and other authorities review and, where necessary, adjust their policies in the light of the challenges posed by interdependencies. In this context, the CPSS will pursue a number of objectives to increase the resilience of the global payment and settlement infrastructure.

Financial Stability Forum

FSF chairman updates G8 Finance Ministers …

In his *report* made on 14 June to the G8 Finance Ministers, the Chairman of the FSF assessed the current situation in the financial system and gave an update on the implementation of the recommendations of the FSF's *Report on enhancing market and institutional resilience*. He also outlined the FSF's future work plans.

… on implementing recommendations of FSF report on market and institutional resilience

Implementation is on track for the recommendations of the FSF report identified by the G7 in April as immediate priorities. Supervisors and national authorities have strongly encouraged their internationally active financial institutions to use for mid-year 2008 financial reports the risk disclosure framework set out in the FSF report. The International Accounting Standards Board (IASB) is accelerating its work to enhance the accounting and disclosure of off-balance sheet entities; it has set up an expert advisory panel which has started assisting it in (a) reviewing best practices in the area of valuation techniques and (b) formulating any necessary additional guidance on valuation methods for financial instruments and related disclosures when markets are no longer active. On 16 April, the BCBS announced a series of steps to make the banking system more resilient to financial shocks, including quidance to strengthen risk management and supervisory practices.[11] It also issued for public consultation global sound practice guidance on the management and supervision of liquidity risks (see above). Lastly, IOSCO finalised the revision

[11] See *BIS Quarterly Review*, June 2008, pp 81–4.

to its Code of Conduct Fundamentals for Credit Rating Agencies (CRAs), and released the revised Code on 28 May.[12]

Good progress is also being made by FSF member institutions and bodies as well as the FSF Working Group on further recommendations from the April report. The Basel Committee announced that it will publish later this year proposals for establishing higher capital requirements for complex structured credit products; strengthening the capital treatment of liquidity facilities extended to off-balance sheet vehicles; and strengthening the capital requirements in the trading book (see the above discussion on the incremental risk charge). The BCBS is also in the process of developing guidance to enhance the supervisory assessment of banks' valuation processes (see above). IOSCO decided in May to monitor the implementation by CRAs of the revised Code of Conduct Fundamentals for CRAs; it aims to have the results later this year. The Joint Forum has launched a stocktaking of the uses of credit ratings by its member authorities in the banking, securities and insurance sectors; it plans to finalise the work by end-2008. The FSF Working Group on Market and Institutional Resilience has formed a small group of supervisors to develop the protocols needed for the establishment of supervisory colleges for the major global financial institutions. Finally, at a meeting convened by the Federal Reserve Bank of New York on 9 June, major market participants and their supervisors reviewed industry strategy and agreed an agenda for addressing weaknesses in the operational infrastructure of the over-the-counter (OTC) derivatives market.[13]

Enhanced capital treatment of complex structured products, of liquidity facilities extended to off-balance sheet vehicles, and of the trading book

Agenda for addressing weaknesses in the operational infrastructure for OTC derivatives

The FSF Working Group continues to assess progress in taking forward the above and other recommendations. It is also setting in train an examination of the forces that contribute to procyclicality in the financial system and possible options for mitigating it.

[12] The Code sets out materially enhanced expectations for quality and integrity of the rating process; CRA independence and avoidance of conflicts of interest; and CRA responsibilities to the investing public and issuers.

[13] The agenda includes the establishment of a central clearing house for credit default swaps (CDS); bilateral and multilateral netting of contracts; protocol for managing defaults; and targets for greater automation of trading and settlement.