

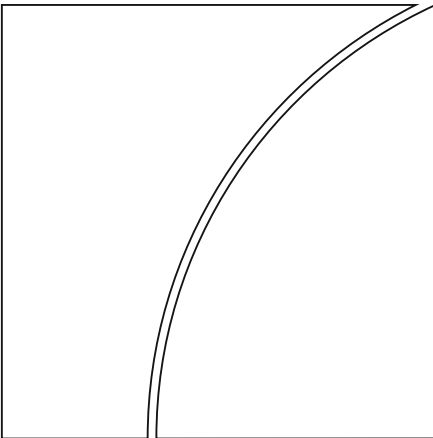


BANK FOR INTERNATIONAL SETTLEMENTS

# **BIS Quarterly Review**

June 2013

International banking  
and financial market  
developments



BIS Quarterly Review  
Monetary and Economic Department

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## Notations used in this Review

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

Differences in totals are due to rounding.

The term “country” as used in this publication also covers territorial entities that are not states as understood by international law and practice but for which data are separately and independently maintained.

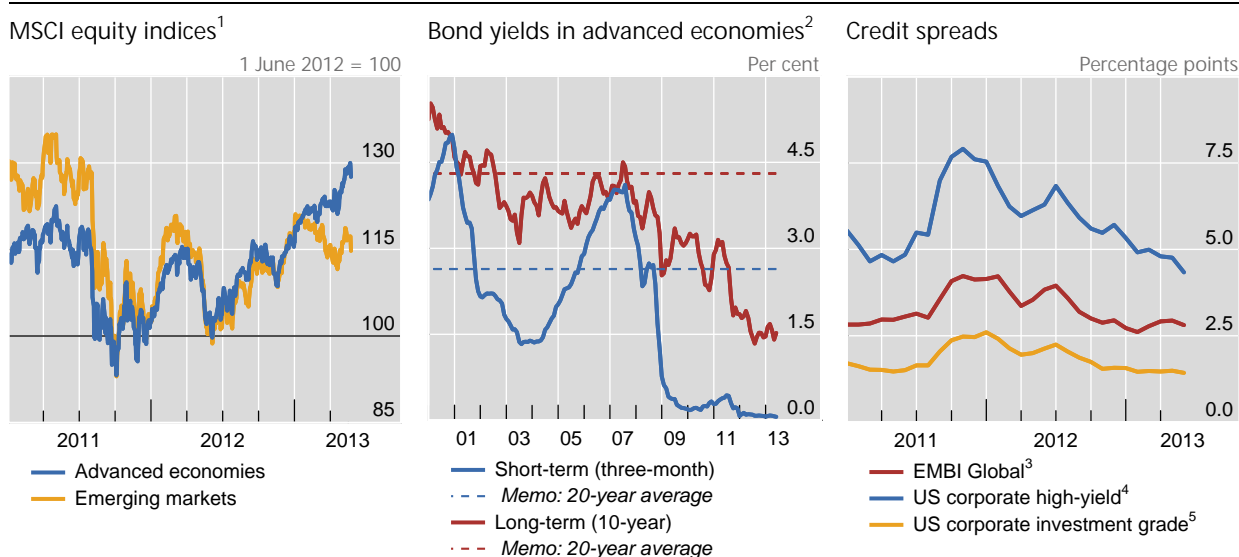
## Markets under the spell of monetary easing<sup>1</sup>

Risk assets extended their rally as further monetary easing helped market participants tune out signs of a global growth slowdown. The spate of negative economic news between mid-March and mid-April did little to interrupt the rise of equity prices in advanced economies. The growth jitters left more of a dent on commodity prices while emerging market equities continued to underperform (Graph 1, left-hand panel). Further policy easing, followed promptly by an improved US outlook in early May, boosted market sentiment and lifted the main equity indices to new highs.

Major central banks further eased their monetary stance from already accommodative levels that had pushed nominal yields to record lows (Graph 1, centre panel). In early May, the ECB cut its policy rate, and the Federal Reserve provided forward guidance while reaffirming its commitment to further asset purchases. The previous month, the Bank of Japan had surprised markets with its ambitious new monetary easing framework. The announcement triggered sharp price movements in the Japanese government bond (JGB) market as investors weighed the yield implications of official purchases against future inflation expectations.

This new phase of monetary policy accommodation in the major currency areas spilled over to financial markets around the world. The prospect of low yields in core bond markets contributed to investors searching for yield in lower-rated European bonds and emerging market paper as well as in corporate debt. This drove spreads even lower while issuance in riskier credit market segments strengthened (Graph 1, right-hand panel). Abundant liquidity and low volatility fostered an environment favouring risk-taking and carry trade activity.

<sup>1</sup> This article was prepared by the BIS Monetary and Economic Department. Questions about the article can be addressed to Andreas Schrimpf ([andreas.schrimpf@bis.org](mailto:andreas.schrimpf@bis.org)), Masazumi Hattori ([masazumi.hattori@bis.org](mailto:masazumi.hattori@bis.org)) and Goetz von Peter ([goetz.von.peter@bis.org](mailto:goetz.von.peter@bis.org)). Questions about data and graphs should be addressed to Agne Subelyte ([agne.subelyte@bis.org](mailto:agne.subelyte@bis.org)) and Jhuvesh Sobrun ([jhuvesh.sobrun@bis.org](mailto:jhuvesh.sobrun@bis.org)).



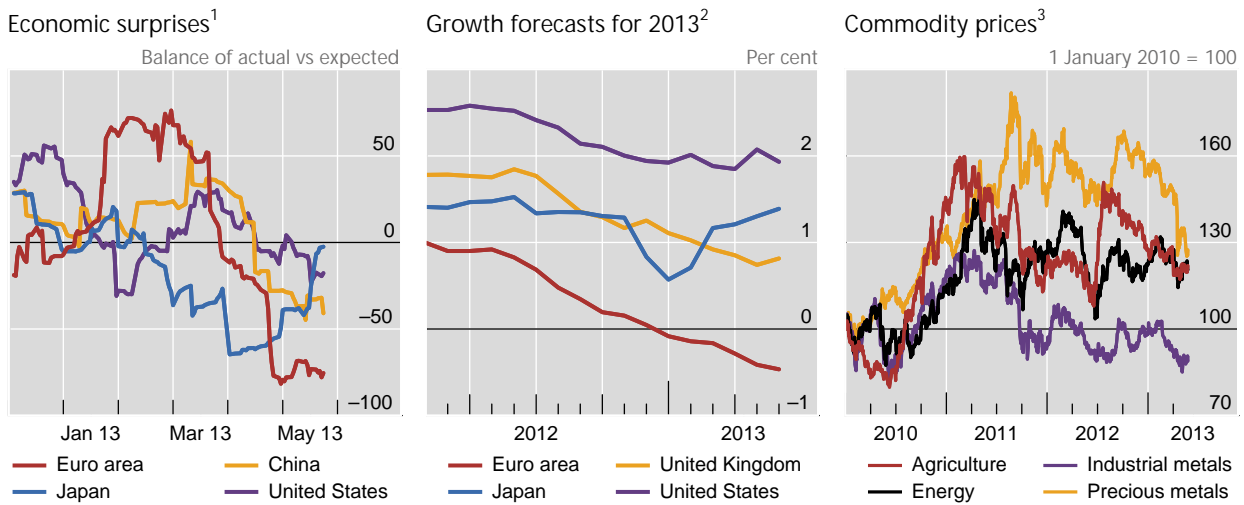
<sup>1</sup> Aggregates are calculated by MSCI. <sup>2</sup> Based on monthly averages of daily nominal rates; weighted average of euro area, Japan, the United Kingdom and the United States, based on 2005 GDP and PPP exchange rates. <sup>3</sup> JPMorgan Chase EMBI Global composite index stripped spreads. <sup>4</sup> Bank of America Merrill Lynch US High Yield Master II index option-adjusted spreads. <sup>5</sup> Bank of America Merrill Lynch US Corporate Master index option-adjusted spreads.

Sources: Bank of America Merrill Lynch; Bloomberg; Datastream; national data; BIS calculations.

## Equity markets rally amidst uncertainty over global growth

Following months of positive sentiment, a series of negative surprises in March led market participants to reassess the prospects for the global economy (Graph 2, left-hand panel). US non-farm payroll data and other indicators suggested a broad deceleration in the world's largest economy. A similar pattern in US data over the past few years had made markets sensitive to even the smallest hint of a slowdown. Weaker purchasing managers' indices (PMIs) led market participants to expect continued contraction in Europe (Graph 2, centre panel). Evidence of a slowdown in the Chinese economy, compounded by a rating downgrade, further added to growth concerns. By early May, these fears were superseded by US data revisions and a string of positive news followed by more mixed signals on global growth later in May.

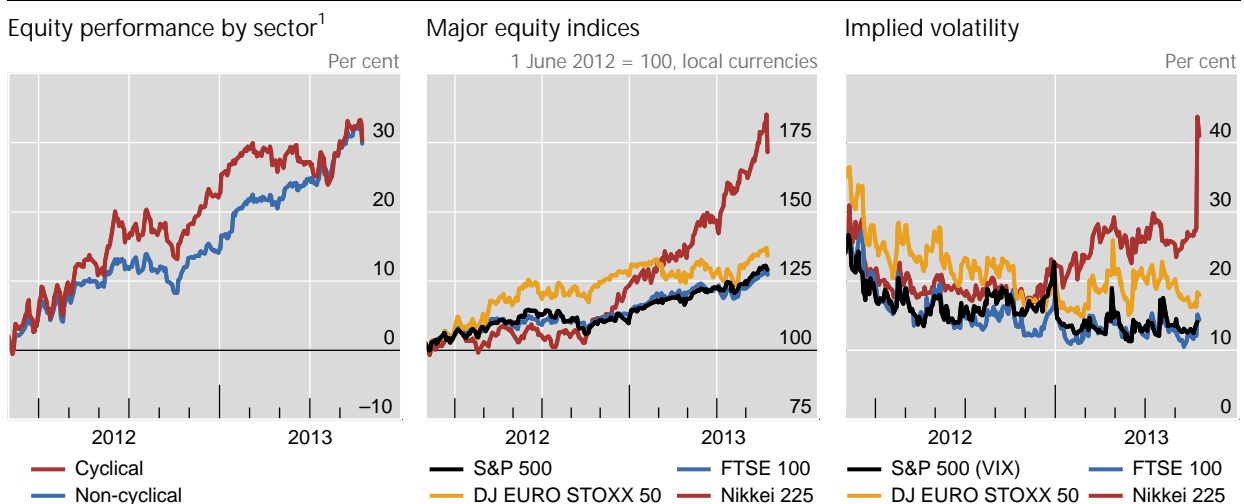
During this period, uncertainty about global growth prospects weighed more on emerging market equities and commodity markets. Commodity prices fell as macroeconomic data mostly surprised on the downside (Graph 2, right-hand panel). The all-commodities index lost 7% in April and oil prices fell below \$100 a barrel for the first time in a year. Copper led the price decline in industrial metals, while among precious metals gold took its sharpest two-day plunge in 30 years. Renewed growth concerns also led to a short-lived correction in some equity market segments. From mid-March to mid-April, equities of cyclical industries, whose earnings tend to be more sensitive to the business cycle, underperformed those of non-cyclical sectors (Graph 3, left-hand panel). Non-cyclical stocks typically deliver a stable dividend stream that many investors value highly in an environment of low yields and uncertain growth.



<sup>1</sup> The Citigroup Economic Surprise Indices are defined as the weighted sum of data surprises (actual releases versus Bloomberg survey median). A positive reading suggests that economic releases have on balance beaten consensus. The indices are calculated daily in a rolling three-month window. <sup>2</sup> Consensus forecasts of real GDP growth in 2013, polled on different dates in the years shown on the horizontal axis. <sup>3</sup> S&P Goldman Sachs Commodity Indices (GSCI).

Sources: Bloomberg; Citigroup; Consensus Economics; Datastream.

Yet equity markets were quick to shrug off the uncertainty and extended their gains as investors expected poor fundamentals to be followed by further policy easing. The S&P 500 posted several all-time highs in rapid succession, first on 11 April and again throughout May. Similarly, European bourses held up well in the face of negative economic news and political uncertainty (Graph 3, centre panel). Throughout this period, the Japanese equity market continued its relentless ascent, fuelled by the prospect of massive monetary stimulus. The rapid gains left equity valuations vulnerable to changes in market sentiment. The 7% drop on 23 May was



<sup>1</sup> Cumulative changes in market capitalisation since 1 June 2012. Cyclical sectors include oil and gas, basic materials, industrials and finance. Non-cyclical sectors include consumer goods, consumer services, telecoms and utilities.

Source: Bloomberg.

one such instance, triggered by a weak Chinese manufacturing PMI and a possible slowdown in Federal Reserve asset purchases. European stock indices lost 2–3% on the same day. Against this background, volatility in many markets remained subdued, given the wide range of possible outcomes for policy and fundamentals in different parts of the world (Graph 3, right-hand panel).

## Monetary policy takes centre stage

Central banks stepped up their expansionary monetary policies from an already accommodative stance. In April, the Bank of Japan (BOJ) outlined its new monetary easing policy framework, and in May the ECB lowered its policy rate to 0.5% while the Federal Reserve reassured markets of continued asset purchases and a low federal funds rate going forward. The United Kingdom and Switzerland left their policy stances unchanged. Partly in response to monetary easing in the major currency areas, a number of central banks subsequently lowered their policy rates, including in Australia, Denmark, India, Israel, Korea, Mexico, Poland and Turkey.

The shift in Japan's monetary policy dominated financial markets during this period. On 4 April, the BOJ announced a new operational framework designed to lift inflation to 2% over about two years (see Box 1). Immediately after the announcement, equity prices rose and the yen depreciated. Meanwhile, the price of JGBs turned extremely volatile, as investors needed to digest the implications of the unexpected scale of future JGB purchases across different portions of the yield curve. On 5 April, the yield on the 10-year benchmark bond dropped to a low of 32 basis points, before rebounding to twice this level in a single trading day. The sharp increase in the volatility of JGBs reflected considerable uncertainty about the future market impact of the policy shift, exacerbated by a drop in market liquidity. In response, the BOJ undertook one-year funding operations to provide a stable funding source for market participants' risk-taking, enhanced communication with market participants and revised its way of conducting JGB purchase operations. This helped ease volatility in the JGB market, at least temporarily (Graph 4, left-hand panel).

The policy shift boosted Japanese equity prices and led to a jump in the volatility of the Nikkei 225 index (Graph 4, centre panel). The stock price increases following the announcement reflected mostly buying pressure from overseas, according to data released by the Tokyo Stock Exchange. The same data indicated that local investors were net sellers, with profit-taking and loss-cutting reported as motives. In the past, net capital inflows into the Japanese equity market had also coincided with episodes of yen depreciation. The effect of inflows on the yen's value was probably more than offset by investors hedging their foreign currency exposure or taking directional bets in derivatives markets.

Starting in mid-May, JGB markets experienced another bout of intense volatility. Yields increased sharply when renewed selling pressure by private investors met with thin trading volume (Graph 4, left-hand panel). After the policy shift, expected inflation derived from bond prices, calculated as the difference between nominal yields and yields on inflation-linked JGBs of similar remaining maturities, started to rise (Graph 4, right-hand panel). Investor caution over potential inflation risk and volatility had reduced trading activity in JGB markets. In



## Monetary policy easing in Japan

On 4 April, the Bank of Japan (BOJ) unveiled a new policy framework aimed at ending deflation, known as Quantitative and Qualitative Monetary Easing (QQE).

The framework changes the central bank's operational target from the overnight rate to the monetary base, and stresses the importance of communication. To enhance clarity and simplicity it gives prominence to the number 2. It sets a 2% price stability target to be reached as soon as possible, with a horizon of about two years. It also calls for doubling the monetary base and the central bank's holdings of JGBs and exchange-traded funds (ETFs) in two years, as well as more than doubling the average maturity of the JGB portfolio.

The BOJ intends to increase the monetary base by ¥60–70 trillion per year to ¥270 trillion by the end of 2014, or nearly 60% of nominal GDP. It also aims to compress interest rates across the yield curve by expanding JGB holdings by ¥50 trillion annually and extending the average remaining maturity of its JGB holdings from the current level of slightly less than three years to about seven years. Moreover, it will increase holdings of risky assets by purchasing ¥1 trillion of ETFs and ¥30 billion of real estate investment trusts (J-REITs) annually (Graph A). According to the central bank, the "qualitative" aspects of monetary easing refer to the effects of the maturity extension putting downward pressure on the entire yield curve, and the expected compression of risk premia on risk assets.

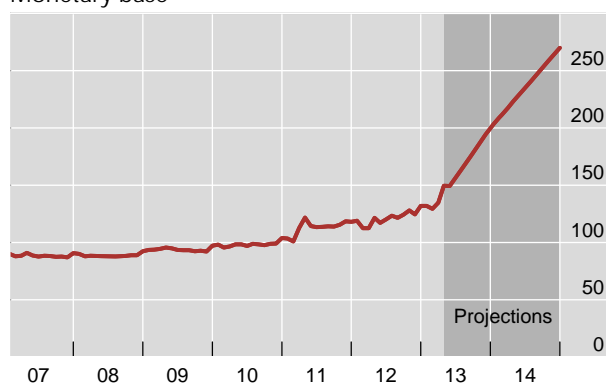
The framework is intended to work through three channels. First, the BOJ expects its purchases of financial assets to lower interest rates across the yield curve and to reduce risk premia in asset prices (the interest rate channel). Second, it expects those changes to encourage financial institutions and institutional investors to rebalance their portfolios towards loans and/or risk assets (the portfolio rebalancing effect). Finally, and strongly emphasised by the BOJ, the new framework represents a clear commitment to achieving the price stability target as soon as possible and to continuing the massive asset purchases that underpin it, in order to help shift economic agents' expectations drastically (the expectations channel) and thus raise inflation expectations, leading to a decrease in real interest rates.

### Bank of Japan balance sheet

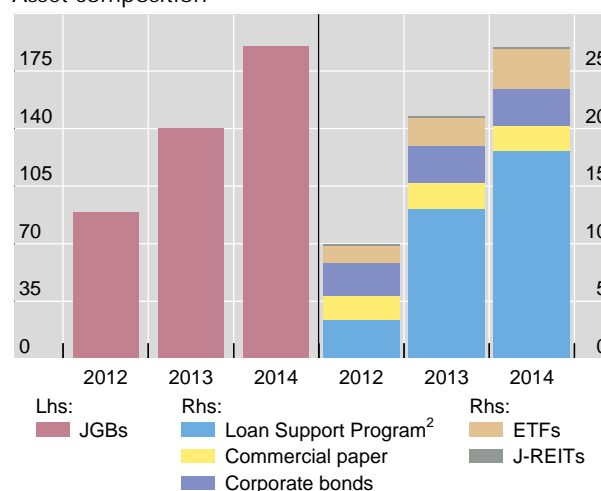
In trillions of yen

Graph A

Monetary base



Asset composition<sup>1</sup>



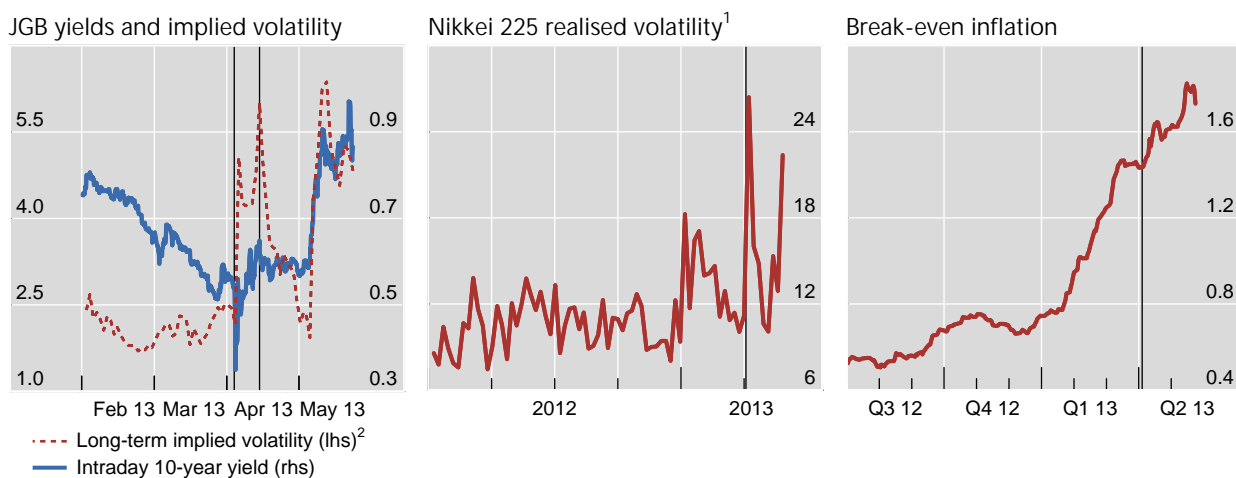
<sup>1</sup> Figures for 2013 and 2014 are projections. <sup>2</sup> A programme established to provide loans made against pooled collateral, with the aim of supporting private financial institutions' efforts to strengthen the foundations for economic growth and stimulating bank lending.

Sources: Bank of Japan; Bloomberg.

## Market impact of Bank of Japan announcement

In per cent

Graph 4



The vertical lines indicate the BOJ's announcements of the new policy framework (4 April 2013, all panels) and of the revision of the Outline of Outright Purchases of Japanese Government Bonds that reflected discussions in meetings with market participants (18 April 2013, left-hand panel).

<sup>1</sup> Weekly averages; realised volatility (pa) estimated from high-frequency returns over five-minute intervals. <sup>2</sup> Implied volatility for option contracts on long-term JGB futures.

Sources: Bloomberg; Oxford-Man Institute; BIS calculations.

this environment, rising domestic equity prices in the wake of the yen's depreciation beyond the psychologically important threshold of 100 yen per US dollar strengthened expectations of further flows from the JGB market to equity markets.

Markets also closely followed US monetary policy, concentrating on asset purchases and on how long the policy rate would remain near zero. Public statements by Federal Reserve officials pondering the timing of a phase-out of securities purchases repeatedly caused market jitters, illustrating the extent to which sentiment depends on monetary accommodation. On 1 May, the Federal Open Market Committee (FOMC) reaffirmed that it was to continue its purchases of Treasury and agency mortgage-backed securities and keep the federal funds rate at 0–0.25% until the outlook for the labour market improved substantially. While household spending, business investment and housing markets had strengthened, the FOMC saw fiscal policy as a factor restraining economic growth. Following the announcement, the US federal funds futures curve flattened further, with derivatives prices indicating that the federal funds rate was expected to move out of the current band by May 2015 (Graph 5, left-hand panel). With the arrival of better labour market data, this movement had reversed by late May.

Forward guidance and Treasuries purchases continued to contribute to unusually low US long-term rates. A decomposition of 10-year nominal yields suggests that the decline in long-term interest rates can be attributed largely to a drop in the term premium, the compensation for the risk of holding long-duration assets (Graph 5, centre panel). Expected inflation and expected real short-term rates over the 10-year horizon remained stable. Driven by unconventional policies and the flight to quality, the term premium has fallen from roughly +60 to –90 basis points since mid-2011. Looking ahead, a negative term premium could compound

the impact of rising interest rates on bond prices at a time when public holdings of marketable US Treasury securities are at all-time highs.

Long-term US Treasuries repriced again on improved US labour market figures in early May. US 10-year yields surged by some 40 basis points from 2 May to 22 May, inducing a mark-to-market loss of about 3.5% for bond holders. Judging by forward rates in mid-May, the 10-year Treasury yield was expected to approach 3% by late 2015, whereas the short end of the curve remained grounded by forward guidance (Graph 5, right-hand panel). Accordingly, the slope of the yield curve was expected to steepen further over the near term.

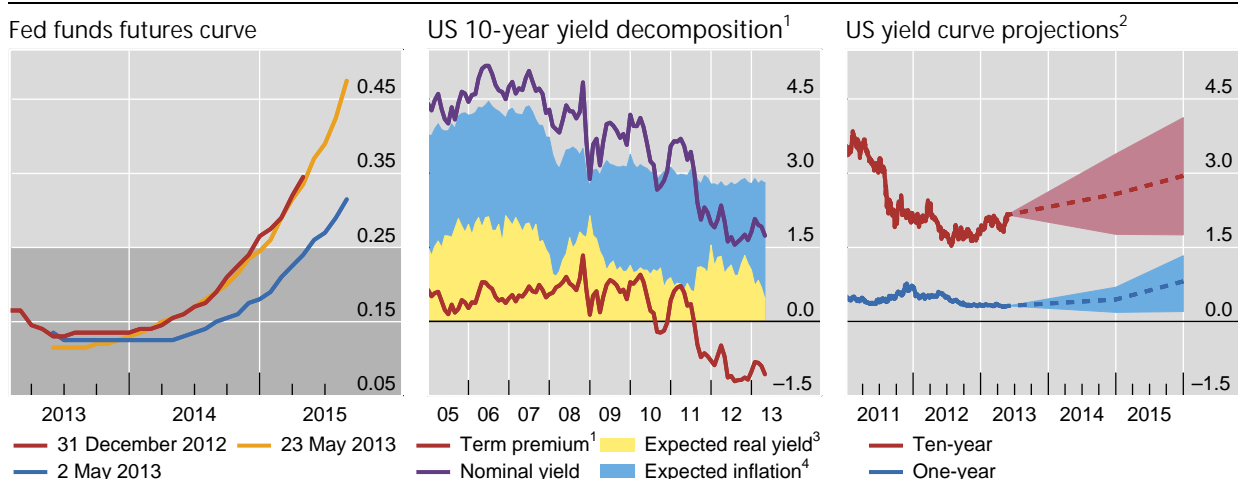
On 2 May, the day after the Federal Reserve announcement, the ECB reduced its policy rate by 25 basis points to 0.50%, after having kept it on hold for 10 months (Graph 6, left-hand panel). The cut had been almost fully priced in ahead of the central bank's move, given poor growth and subdued inflation. With euro area output in decline for five consecutive quarters, annual consumer price inflation slowed to 1.2% in April. The Governing Council also pledged to continue full-allotment refinancing operations for as long as necessary to ensure that a lack of liquidity would not inhibit credit growth, at least through mid-2014.

The fragmentation in credit markets across euro area countries was an important factor behind the ECB's policy action. While the dispersion in funding conditions across euro area banks had decreased since 2012, the central bank considered that the transmission of policy rates to bank lending rates remained impaired in some markets. The costs of household mortgages and loans to non-financial firms in Italy, Spain and smaller peripheral countries remained well above those charged by banks in Germany and France (Graph 6, centre panel). The latest lending survey also indicated that credit standards in the euro area periphery continued to tighten, albeit at a slower rate, and the survey of small and medium-

## Monetary policy expectations and bond yields

In per cent

Graph 5



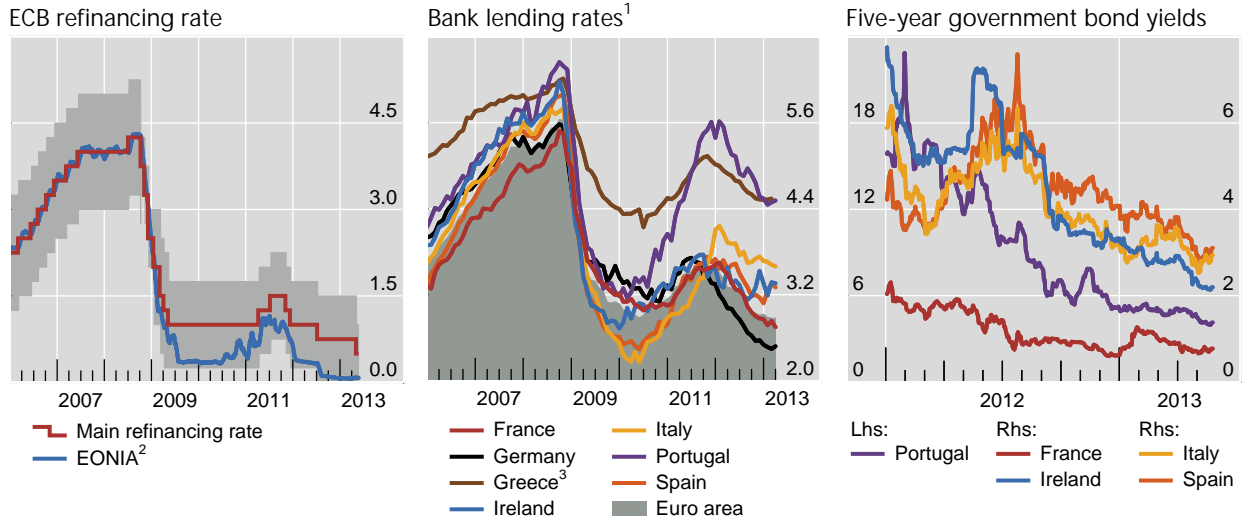
<sup>1</sup> Decomposition based on a joint macroeconomic and term structure model. See P Hörðahl, O Tristani and D Vestin, "A joint econometric model of macroeconomic and term structure dynamics", *Journal of Econometrics*, vol 131, 2006, pp 405–44; and P Hörðahl and O Tristani, "Inflation risk premia in the term structure of interest rates", *BIS Working Papers*, no 228, May 2007. <sup>2</sup> Central projections are based on forward rates, while upper and lower projections are derived from swaption-implied volatilities. <sup>3</sup> Average expected real yield over the maturity of the bond. <sup>4</sup> Average expected inflation over the maturity of the bond.

Sources: Bloomberg; Datastream; BIS calculations.

## Financial conditions in Europe

In per cent

Graph 6



<sup>1</sup> Composite rates on new loans of all maturities and sizes to households for house purchases and to non-financial corporations; non-weighted averages. <sup>2</sup> Thirty-day moving average. <sup>3</sup> For Greece, composite rate on amounts outstanding of loans of all maturities and sizes to households for house purchases and to non-financial corporations; non-weighted average.

Sources: ECB; Markit; BIS calculations.

sized enterprises pointed to a high rejection rate of loan applications. These developments prompted the ECB to consult with the European Investment Bank on possible avenues for promoting a market for asset-backed securities collateralised by loans to non-financial corporations.

## Spillovers to global bond and currency markets

The new phase of monetary policy accommodation in the major currency areas moved financial markets around the world.

Central bank support bolstered financial markets throughout the euro area. Asset prices held up against the flow of negative news that seemed to push the economic recovery further out of reach. Euro area equity prices recovered to their January peak, the highest level since August 2011. Sovereign bond yields continued to drift downward, with Spanish and Italian five-year yields falling below 3% amidst successful bond auctions (Graph 6, right-hand panel). CDS spreads on European corporate debt also declined even as the macroeconomic data surprised on the downside. In this benign environment, the financial crisis in Cyprus produced remarkably little contagion across markets (see Box 2).

European bond markets also benefited from monetary easing abroad. The prospect of depressed yields under Japan's new monetary regime fuelled market expectations that Japanese funds in search for yield would eventually flow into close foreign substitutes for JGBs. Highly rated European sovereign bonds offering a yield pickup against German bunds repriced the most. In particular, 10-year French and Belgian government bonds rallied, with yield spreads tightening by some 20 basis points within days of the BOJ announcement.

## Market reactions to the banking crisis in Cyprus

The insolvency of the two largest banks in Cyprus intensified negotiations between Cypriot and European authorities over official financial assistance in March. The banks had incurred large losses on Greek government debt holdings and on commercial property and mortgage loans extended to borrowers in Greece and Cyprus, while relying to a large extent on offshore deposits. Combined deposits at Bank of Cyprus and Cyprus Popular Bank (Laiki) amounted to €45.5 billion, alongside €0.1 billion in senior debt and €0.5 billion in subordinated convertible debt. The final rescue package prescribed the restructuring of Bank of Cyprus and the resolution of Laiki with 100% losses for shareholders and bondholders, with uninsured deposits above €100,000 also sharing in the burden. The measures were accompanied by a 10-day bank closure of Cypriot banks followed by withdrawal restrictions and capital controls.

The convoluted process of setting the terms led market participants to perceive that euro area bank resolutions could involve greater burden-sharing than had been the case in the past. The initial package of 16 March, and the willingness of political leaders to impose a “one-off stability levy” of 6.75% on *insured* deposits, caused considerable tensions that later subsided when a modified package sparing small deposits was agreed on 25 March. Between these dates, the Stoxx Europe 600 bank index fell by 7.6%, and the bank closure arrested the flight of deposits from Cypriot banks running at €3.9 billion (8%) since January.

Broader contagion from the Cypriot bank bail-in remained limited, however, and liquidity conditions stayed stable across markets. Banks in all euro area countries bar Cyprus recorded deposit inflows in March, totalling €85 billion. The episode led to a modest repricing of bank debt, with yields of euro area bank bond indices edging up for both junior and senior bonds. CDS spreads for senior and subordinated bank debt widened more noticeably, suggesting that participants in derivatives markets may have been more risk-sensitive to recent developments. Even as traders seeking out potentially vulnerable sovereigns pushed Slovenian 10-year bond yields near 7%, other peripheral euro area countries experienced little market pressure.

Several factors may have contributed to this somewhat muted market reaction. The first was a possible perception among market participants that the crisis in Cyprus, and the nature of its bank bail-in, was unique and small in scale. At the same time, perceived tail risk remained contained by continued monetary accommodation and backstop measures, such as the ECB’s longer-term refinancing operations and its readiness to purchase sovereign bonds, if needed, through the Outright Monetary Transactions facility. The resilience of bank debt in the cash market also reflected that a significant share of these securities was being held by institutional investors whose asset allocations tend to be adjusted more gradually. Combined with the fact that net issuance volumes of bank debt in many euro area countries were negative over the last two quarters, this difference in the composition and behaviour of market participants may have contributed to the muted price action observed in the cash market relative to CDS markets.

Renewed monetary stimulus and ample liquidity in the reserve currency areas also helped boost speculative activity in currency markets. A popular trading strategy was the carry trade, in which positions in higher-yielding currencies are funded via positions in lower-yielding ones. Carry-to-risk, a gauge of risk-adjusted *ex ante* returns on foreign currency-denominated investments, was elevated in recent months, in particular for several emerging market currencies (Graph 7, left-hand panel). While global interest rate differentials (carry) have narrowed compared to the 2003–07 episode, they remain relatively high. This environment of persistent interest rate differentials coupled with low foreign exchange volatility fostered the attractiveness of carry trades since mid-2012, especially for leveraged investors (Graph 7, centre panel).

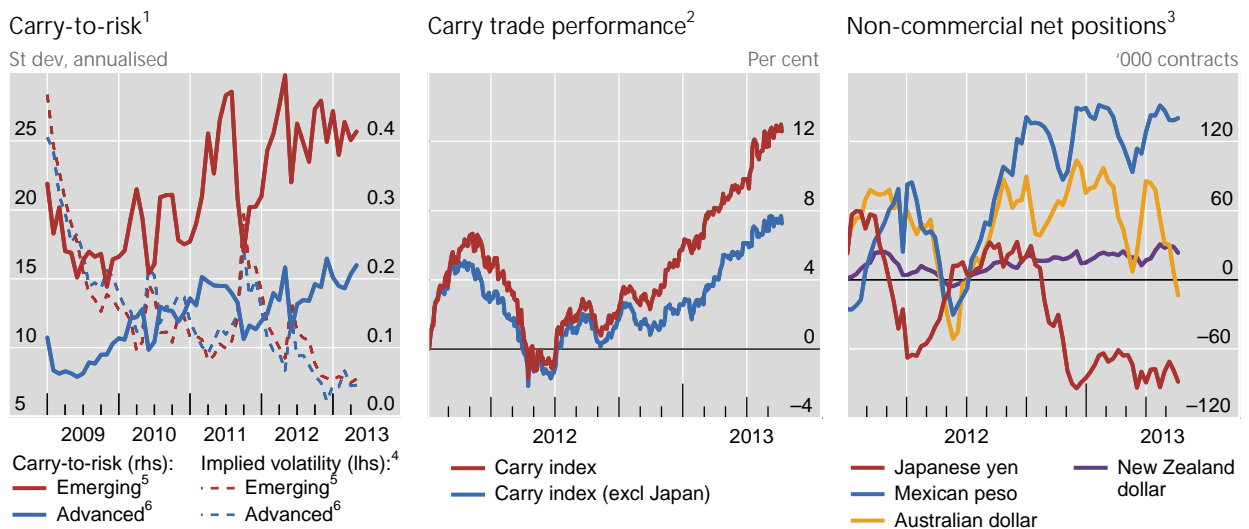
The Japanese yen again became an attractive funding currency, given its recent downward trend. Partly in anticipation of policy action, the falling external value of the yen had already become the central theme in currency markets from the end of last year. After the BOJ unveiled the details of its new monetary policy framework, the yen further depreciated by some 10% against the US dollar until late

May (Graph 8, left-hand panel). Conversely, some emerging market currencies eyed as suitable targets, such as the Mexican peso, experienced significant appreciation pressure vis-à-vis the US dollar (Graph 8, right-hand panel). In line with these incentives, positioning data from futures exchanges showed a sizeable build-up of speculative short positions in the yen, and large long positions in liquid higher-yielding currencies (Graph 7, right-hand panel). There was also a build-up of long positions in the Australian and New Zealand dollars; however, these currencies have not witnessed the same appreciation pressure in recent months, and in Australia's case, these long positions have recently been reversed following the rate cut by the Reserve Bank of Australia in early May.

Monetary authorities outside the US, euro area and Japan cut policy rates in the face of weaker growth and lower inflation, as well as to mitigate appreciation pressures. The main exception was Brazil, where a pickup in inflation prompted the central bank to raise the Selic rate by 25 basis points to 7.5% on 17 April, the first hike in two years. Central banks elsewhere mostly eased their policy stance. On 7 May, the Reserve Bank of Australia lowered its policy rate to 2.75%, a reduction of 25 basis points partly motivated by currency strength. Following the rate cut, the Australian dollar lost ground significantly against the US dollar (Graph 8, centre panel). In response to currency appreciation pressure, the Reserve Bank of New Zealand intervened in the foreign exchange market. In March and April, the central banks of Mexico and Korea cut policy rates by 50 and 25 basis points, respectively. Among other factors, exchange rate developments were explicitly cited as motivations for the policy decisions. In April and May, the Turkish central bank pursued a two-pronged strategy of reducing the policy rate in two steps to 4.5% to

## Carry trade returns and investor positioning

Graph 7



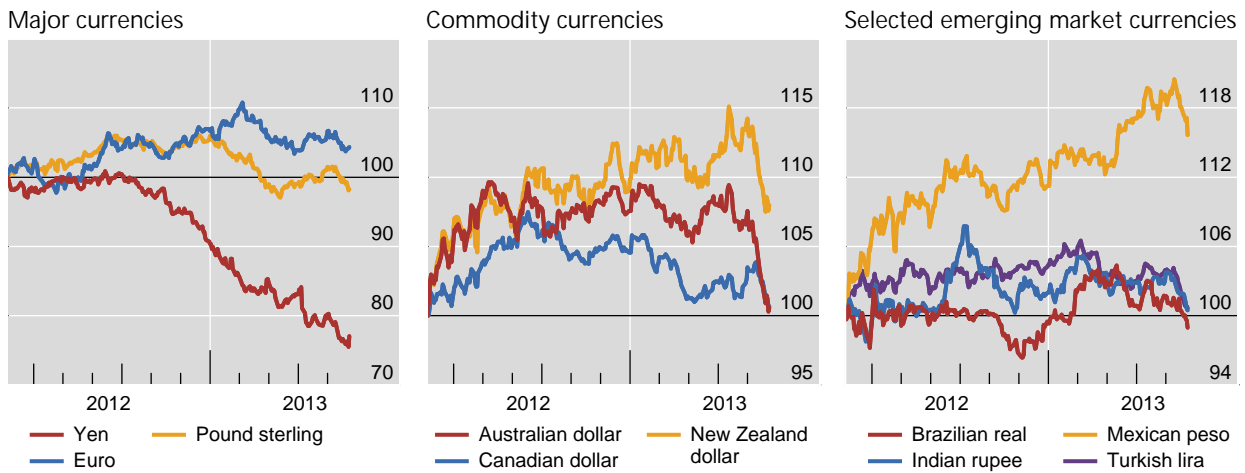
<sup>1</sup> Carry-to-risk is a gauge of the ex ante attractiveness of currency carry trades, and is defined as the interest rate differential (derived from the forward discount) divided by implied FX volatility. The graph shows carry-to-risk averaged across selected advanced economy and emerging market currency pairs. <sup>2</sup> Cumulative changes since 1 January 2012. Performance of a multi-currency carry trade index, where long positions in higher-yielding currencies are funded by short positions in lower-yielding currencies. The index is constructed via a portfolio sorting approach as in J Gyntelberg and A Schrimpf, "FX strategies in periods of distress", *BIS Quarterly Review*, December 2011. The investment universe consists of 30 advanced economy and emerging market currencies (red line), and the same set of currencies excluding the yen (blue line). <sup>3</sup> Positive (negative) indicates net long (short) positions. <sup>4</sup> Implied volatility of one-month FX options. <sup>5</sup> Simple average of carry-to-risk for Brazil, Chile, Israel, Korea, Mexico, the Philippines, Poland, South Africa, Thailand and Turkey. <sup>6</sup> Simple average of carry-to-risk for Australia, Canada, New Zealand, Norway and the United Kingdom.

Sources: Bloomberg; Datastream; US Commodity Futures Trading Commission; BIS calculations.

## Nominal bilateral exchange rates vis-à-vis US dollar<sup>1</sup>

US dollars per unit of local currency; 1 June 2012 = 100

Graph 8



<sup>1</sup> An increase indicates appreciation of the local currency.

Source: Bloomberg.

curb speculative inflows and appreciation pressure, while raising reserve requirements to dampen domestic credit growth. The Reserve Bank of India lowered its policy rate to 7.25%, its third 25 basis point cut in a row, a move motivated by weaker growth dynamics rather than a stronger currency.





## Highlights of the BIS international statistics<sup>1</sup>

*The BIS, in cooperation with central banks and monetary authorities worldwide, compiles and disseminates several data sets on activity in international financial markets. This chapter summarises the latest data for the international banking and OTC derivatives markets, available up to the end of 2012. The box assesses to what extent non-financial corporations have used the low-rate environment of recent years to raise long-term funding.*

During the fourth quarter of 2012, the cross-border claims of BIS reporting banks declined, after remaining broadly unchanged in the previous quarter. The contraction was driven by a sharp reduction in cross-border interbank lending, which more than offset higher cross-border credit to non-bank borrowers. Across reporting areas, cross-border claims on advanced economies declined, while those on emerging market economies and offshore financial centres increased.

Developments in the over-the-counter (OTC) derivatives market in the second half of 2012 were consistent with more central clearing, further monetary expansion and some easing of the euro area sovereign crisis. Although the size of the market was little changed overall, these factors affected particular segments. For instance, the outstanding notional amount of interest rate swaps declined as compression of trades with central counterparties accelerated, while that of forward rate agreements rose as central clearing progressed, mechanically increasing contract volumes. Further monetary easing may help to explain marked declines in the notional amounts of derivatives referencing US dollar and Japanese yen interest rates, as well as the sharp increase in the value of foreign exchange derivatives linked to the yen. Finally, a sharp fall in the market value of credit default swaps was consistent with premia declining from extreme levels towards ones at which contracts were more likely to have been signed.

<sup>1</sup> This article was prepared by Adrian van Rixtel ([adrian.vanrixtel@bis.org](mailto:adrian.vanrixtel@bis.org)) for the banking statistics, Nicholas Vause ([nick.vause@bis.org](mailto:nick.vause@bis.org)) for the OTC derivatives statistics and Christian Upper ([christian.upper@bis.org](mailto:christian.upper@bis.org)) for the debt securities and syndicated loan statistics. Statistical support was provided by Pablo García, Koon Goh, Serge Grouchko and Branimir Gruić.

## The international banking market in the fourth quarter of 2012

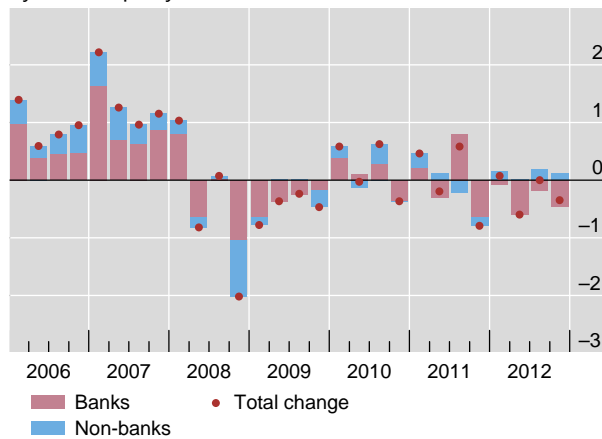
The cross-border claims of BIS reporting banks fell by \$345 billion (1.2%) between end-September 2012 and end-December 2012 (Graph 1, top left-hand panel).<sup>2</sup> With this contraction, total outstanding cross-border credit at end-2012 stood at \$29.3 trillion, 1.9% lower than in the same quarter one year earlier. The decline in cross-border claims was concentrated on those denominated in euros (\$296 billion or 2.9%) (Graph 1, top right-hand panel). Claims in most other main currencies fell modestly, while those in yen increased (by \$14 billion or 1.0%).

### Changes in gross cross-border claims<sup>1</sup>

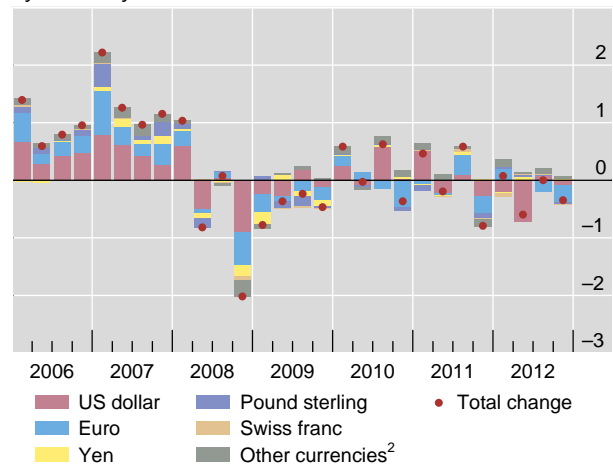
In trillions of US dollars

Graph 1

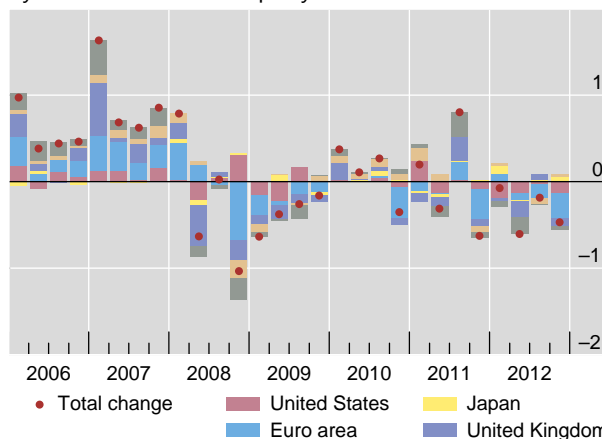
#### By counterparty sector



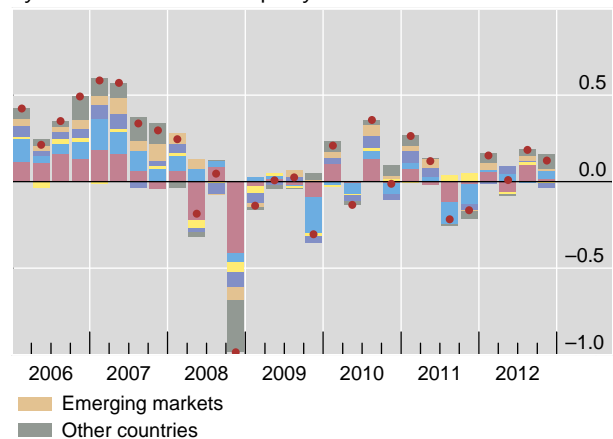
#### By currency



#### By residence of counterparty, banks



#### By residence of counterparty, non-banks



<sup>1</sup> BIS reporting banks' cross-border claims include inter-office claims. <sup>2</sup> Includes unallocated currencies.

Source: BIS locational banking statistics by residence.

<sup>2</sup> The analysis in this section is based on the BIS locational banking statistics by residence, unless stated otherwise. In these statistics, creditors and debtors are classified according to their residence (as in the balance of payments statistics), not according to their nationality. All reported flows in cross-border claims have been adjusted for exchange rate fluctuations and breaks in series.

The overall contraction in credit in the fourth quarter was again driven by reduced *interbank* credit, which has fallen in seven of the last nine quarters of data (Graph 1, top-left hand panel). Cross-border claims on other banks and related offices fell by \$467 billion (2.6%) between end-September and end-December 2012.<sup>3</sup> This large contraction underscored the ongoing trend away from cross-border intermediation, particularly in the euro area (blue stacked bars, lower left-hand panel). This development is also evidenced by the decline, on a consolidated basis, in the share of interbank lending in the total amount outstanding of international claims to a historical low of 38% at end-December 2012.<sup>4</sup> This was down from 40% at end-2011 (and 46% at end-2007).

## Credit to advanced economies

Cross-border claims on advanced economies contracted in the fourth quarter of 2012, by \$472 billion (2.1%). This compares with an increase of \$77 billion (0.4%) in the previous quarter.

Borrowers in Europe and the United States were particularly affected by the retreat in international interbank activity in the fourth quarter. Interbank claims (including inter-office positions) on banks in the euro area fell the most, by \$284 billion (5.2%), the third consecutive quarterly decline (Graph 1, bottom left-hand panel). This resulted from reduced claims on banks in Germany, France, Finland and Luxembourg. Similarly, cross-border interbank credit to UK banks also fell, by \$97 billion (2.6%), after a strong increase in the previous quarter. Elsewhere, cross-border claims on banks in the United States declined for a fifth quarter in a row (by \$132 billion or 5.2%). This trend may be related to regulatory changes that contributed to reducing the reliance of US-chartered banks on wholesale funding raised outside the United States.<sup>5</sup> Claims on banks in Japan, which increased by \$53 billion (7.7%), were the most notable exception to this pattern.

The decline in global cross-border interbank positions was more pronounced in 2012 than in previous years. Cross-border claims on banks and related offices in the euro area fell by about 8% in 2012, compared with 4% in 2011.<sup>6</sup> In the United States and United Kingdom, cross-border interbank activity shrank in 2012 by 16% and 6%, respectively. These declines compared with an increase of 2% for US banks

<sup>3</sup> By contrast, cross-border claims on non-bank borrowers, including governments and non-bank financial intermediaries, increased by \$139 billion (1.2%).

<sup>4</sup> Data according to BIS consolidated international banking statistics on an immediate borrower basis. The consolidated banking statistics exclude positions between affiliates of the same banking group. Banks consolidate their inter-office positions and report only their claims on unrelated borrowers. International claims comprise cross-border claims in all currencies and local claims in foreign currencies, where local claims refer to credit extended by banks' affiliates located in the same country as the borrower.

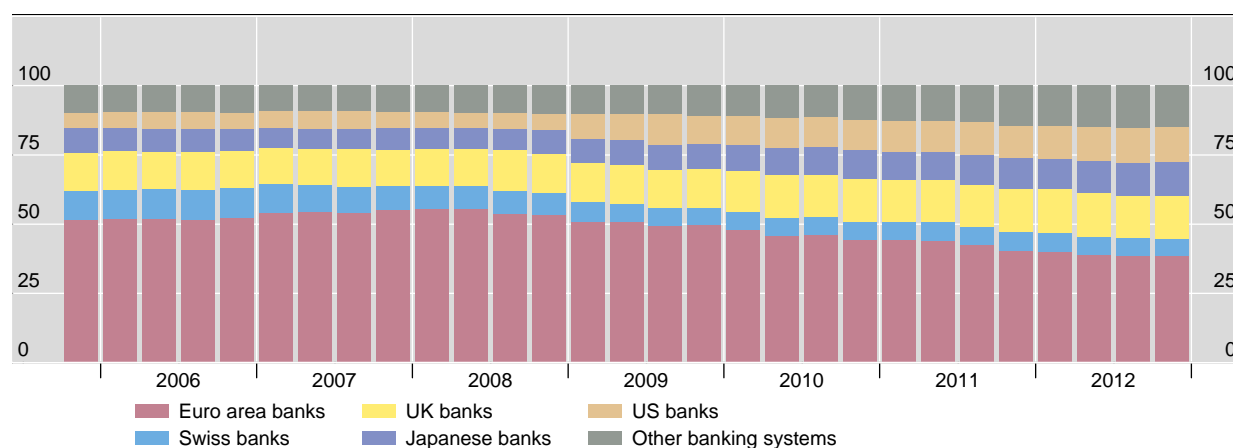
<sup>5</sup> Under the Dodd-Frank Wall Street Reform and Consumer Protection Act, the assessment base for the Federal Deposit Insurance Corporation's reserve fund has widened from insured deposits to assets less tangible equity. This extension has succeeded in reducing the reliance of US-chartered banks on wholesale funding, with domestic deposits replacing wholesale funds raised outside the United States. For more details, see L Kreicher, R McCauley and P McGuire, "The 2011 FDIC assessment on banks' managed liabilities: interest rate and balance sheet responses", *BIS Working Papers*, no 413, May 2013.

<sup>6</sup> Annual percentage changes are calculated as the four-quarter sum of exchange rate- and break-adjusted changes divided by the outstanding stock at the end of the previous year.

## International banking activity

As a percentage of all BIS reporting banks' foreign claims<sup>1</sup>

Graph 2



<sup>1</sup> Foreign claims comprise cross-border claims and local claims of banks' foreign offices on residents of the host country.

Source: BIS consolidated banking statistics (immediate borrower basis).

in 2011, while cross-border interbank activity in the United Kingdom was broadly unchanged in 2011.

The decline in positions booked by banks headquartered in the euro area was particularly noteworthy. On a consolidated basis, their share in the total amount outstanding of BIS reporting banks' foreign claims fell to a historical low of 38% at the end of 2012, from 40% at end-2011 (Graph 2).<sup>7</sup> This share has declined steadily from the record high of 55% in the second quarter of 2008. It stood at 50% at end-2009, before the euro crisis started to develop in the first half of 2010. US and Japanese banks in particular, but also UK and other banks, have filled the gap left by the retreat of euro area banks.<sup>8</sup> Indeed, US and Japanese banks' share of total foreign claims of all BIS reporting banks rose to 13% and 12% at end-2012, up from 10% and 9% at end-2009, respectively (Graph 2).

## Credit to emerging market economies

The BIS locational banking statistics show that reporting banks' cross-border claims on borrowers in emerging market economies expanded by \$43 billion (1.4%) in the fourth quarter of 2012.<sup>9</sup> The increase mostly affected claims on banks (up by \$32 billion or 2.0%); those on non-banks expanded by \$10 billion (0.7%). While the pace of expansion was higher than in the earlier quarters of 2012, it remained well below that of 2010 and 2011. Claims on emerging markets grew by 3% in 2012, as against 8% in 2011 and 17% in 2010.

<sup>7</sup> Foreign claims comprise cross-border claims and local claims (in all currencies) booked by banks' foreign offices.

<sup>8</sup> The international retreat of euro area banks has been analysed for the Asia-Pacific region in P McGuire and A van Rixtel, "Shifting credit patterns in emerging Asia", *BIS Quarterly Review*, December 2012, pp 17–18.

<sup>9</sup> The BIS locational banking statistics by residence are described in footnote 2.

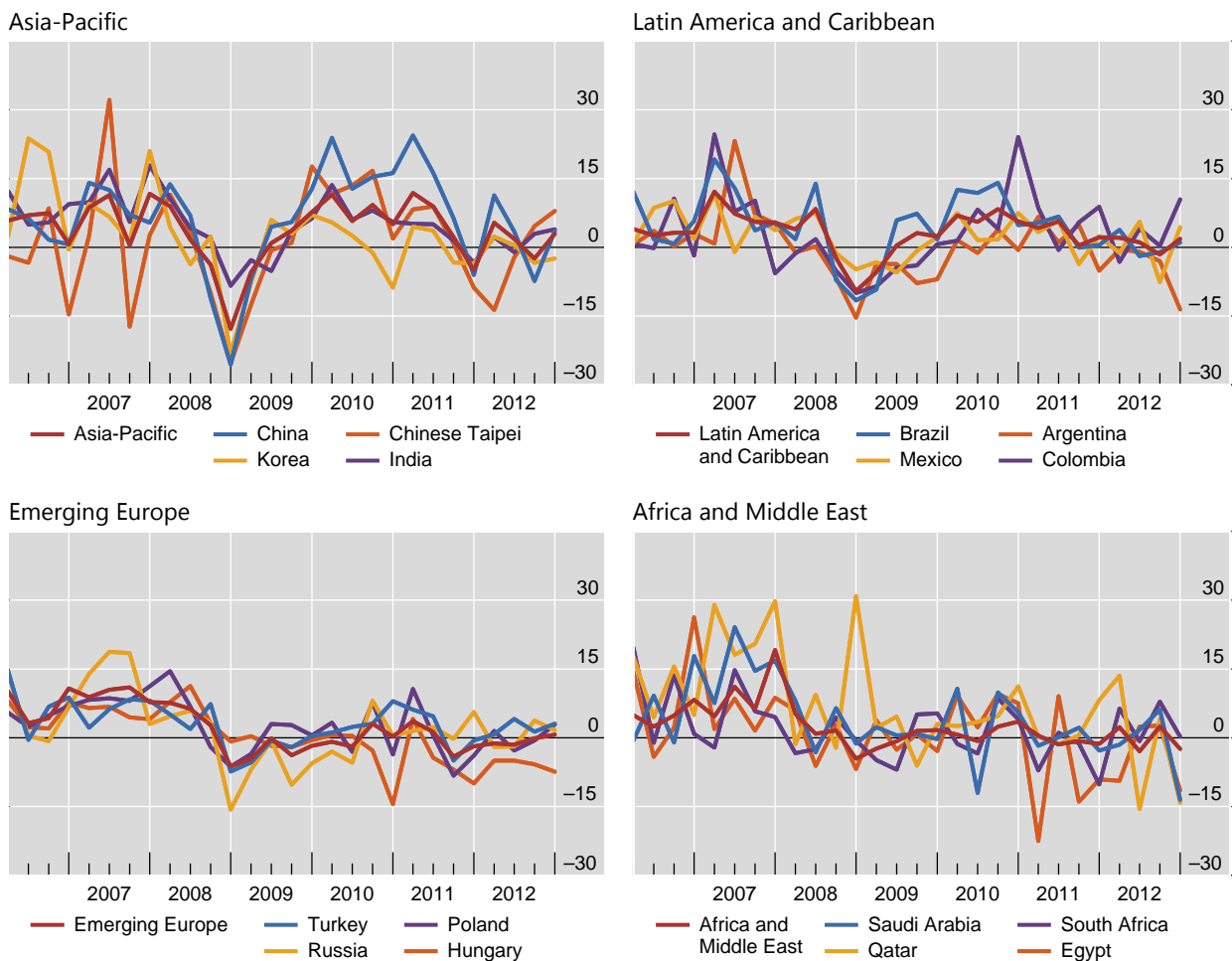
Cross-border claims on the Asia-Pacific region increased the most (by \$39 billion or 2.9%), after a decline in the previous quarter (of \$33 billion or 2.4%) (Graph 3, top left-hand panel). Claims on both banks and non-banks rose, by \$27 billion (3.3%) and \$12 billion (2.3%), respectively. Borrowers in China accounted for around half of the increase in cross-border credit to the region, the majority of them banks (\$13 billion or 3.7%). The remainder of the increase reflected lending to India, Chinese Taipei and Indonesia.

Cross-border credit to borrowers in Latin America and the Caribbean grew (by \$11 billion or 1.8%), while claims on Africa and the Middle East contracted (by \$12 billion or 2.4%) (Graph 3, right-hand panels). The expansion in lending to Latin America and the Caribbean was mainly driven by higher claims on non-banks in the region (\$9 billion or 2.4%), above all in Mexico and Brazil. Cross-border claims on Argentina fell sharply, by \$2.1 billion (14%), representing the fifth consecutive decline. The contraction in cross-border credit to Africa and the Middle East was the second largest since the fourth quarter of 2008. It was concentrated on Saudi Arabia

### Growth rates of cross-border claims on residents of emerging markets<sup>1</sup>

In per cent

Graph 3



<sup>1</sup> Quarterly growth rates of BIS reporting banks' cross-border claims (including inter-office claims) in all currencies.

Source: BIS locational banking statistics by residence.

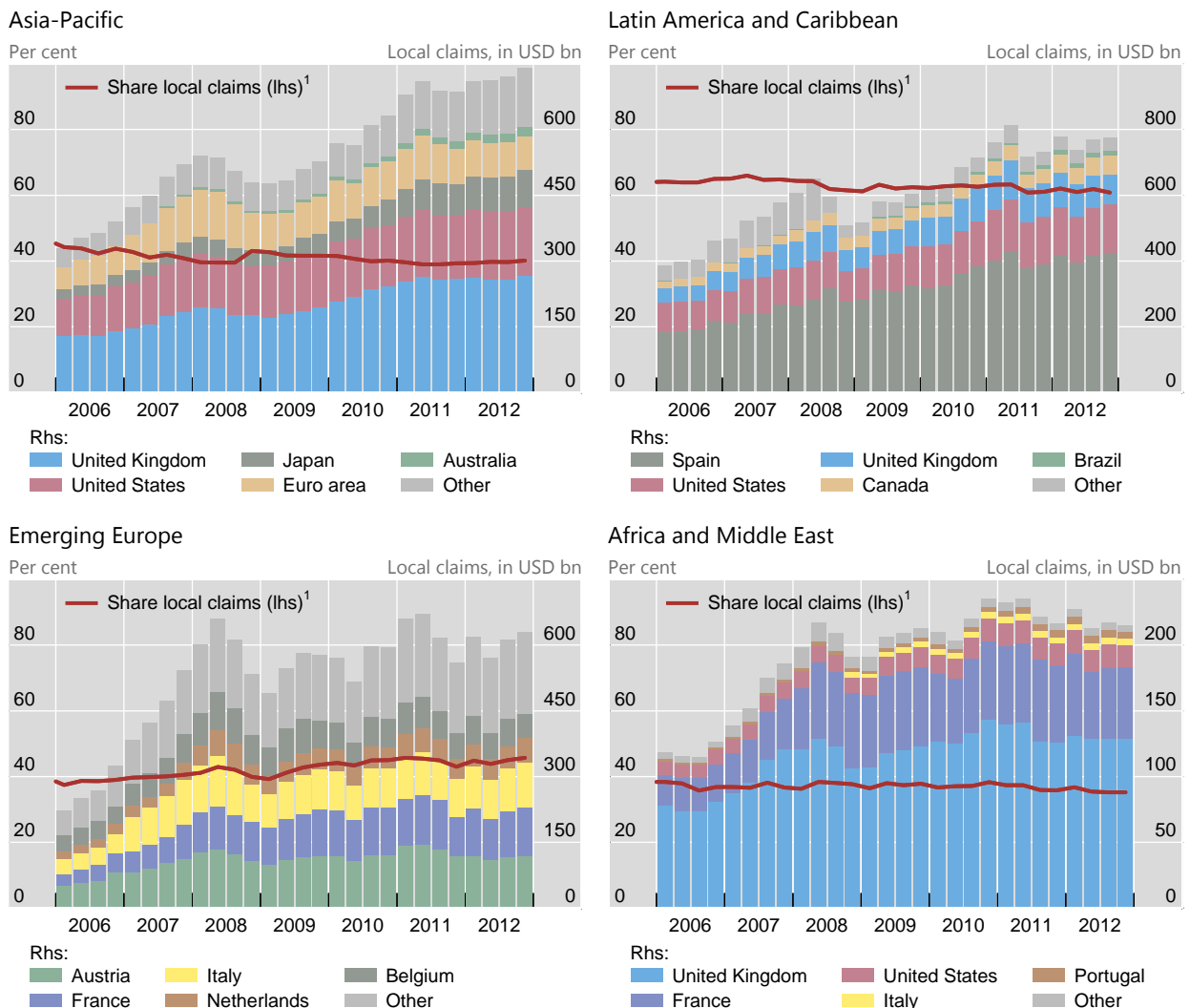
and Qatar (Graph 3, bottom right-hand panel) and affected both bank and non-bank sectors.

Cross-border claims on the emerging economies of Europe increased in the fourth quarter by \$4.9 billion (0.7%), following five quarters of decline (Graph 3, bottom left-hand panel). This turnaround was led by higher claims on Poland and the Czech Republic, while the upward trend in claims on Russia and Turkey continued. At end-2012, Russia and Turkey combined accounted for 47% of the amount outstanding of all cross-border credit to emerging Europe, up from 44% at end-2011. Cross-border claims on Hungary fell again (by \$3.8 billion or 7.4%), bringing the overall contraction in 2012 to 21%. In percentage terms, the drop in

## Local operations in emerging market economies, by region

Ranked by the five largest foreign banking systems in terms of size of local claims

Graph 4



<sup>1</sup> "Share local claims" is measured as claims of banks' foreign offices denominated in local currency on residents of the various regions as a percentage of total foreign claims on that region. Foreign claims comprise cross-border claims and local claims of banks' foreign offices on residents of the host country. The five largest foreign banking systems are the five reporting banking systems with the largest local claims on the regions for which data are publicly available.

Source: BIS consolidated banking statistics (immediate borrower basis).

claims on that country was second only in Europe to the 31% fall experienced by Greece in 2012.

In addition to greater cross-border lending, BIS reporting banks also expanded their local operations in emerging market economies in 2012. On a consolidated basis, credit provided by foreign banks' offices in emerging markets increased to \$2.4 trillion at end-2012, from \$2.2 trillion at end-2011 (unadjusted for exchange rate movements). This expansion was mainly driven by higher local claims in Asia-Pacific and emerging Europe (Graph 4, left-hand panels).

The growth of both cross-border and local positions left the share of locally extended credit in total foreign claims on emerging market economies relatively unchanged at 46% overall, although the relative importance of local claims varied considerably across regions. It was stable at around 60% in Latin America and the Caribbean and increased to around 46% in emerging Europe (Graph 4, top right-hand and bottom left-hand panels). In contrast, Asia-Pacific and Africa and the Middle East saw modest reductions to around 40% and 35%, respectively.

The pattern of local claims on residents of emerging market economies also varied greatly from the perspective of the reporting banking systems. At the end of 2012, UK banks provided the bulk of local credit in Africa and the Middle East (60%), as did Spanish banks in Latin America and the Caribbean (55%) (Graph 4, right-hand panels). Emerging Europe and the Asia-Pacific region displayed a more varied pattern in terms of foreign banks' local activities, with the largest players holding smaller market shares (19% for Austrian banks and 36% for UK banks, respectively). Banks headquartered in emerging markets have gained importance in local banking operations in countries of the same region. For example, Brazilian banks were among the five largest foreign banking systems as measured by the size of local operations in Latin America and the Caribbean in the fourth quarter of 2012.

## The OTC derivatives market in the second half of 2012

The over-the-counter (OTC) derivatives market shrank slightly in the second half of 2012. The notional principal of outstanding contracts fell by 1% to \$633 trillion, while the cost of replacing them at prevailing market prices (their gross market value) declined by 3% to a little under \$25 trillion.<sup>10</sup> Credit exposures related to these contracts (after legally enforceable netting but before collateral) were fairly steady, ending the period at 14.7% of gross market value.

In the important interest rate segment of the market, offsetting changes in swaps and forward rate agreements (FRAs) that related to different aspects of central clearing left outstanding notional amounts little changed overall (-1%). Swap positions fell by \$9 trillion to \$370 trillion, as compression of trades with central counterparties (CCPs) accelerated.<sup>11</sup> Meanwhile, FRA positions rose by \$7 trillion to \$71 trillion, as more of these derivatives were cleared centrally, which

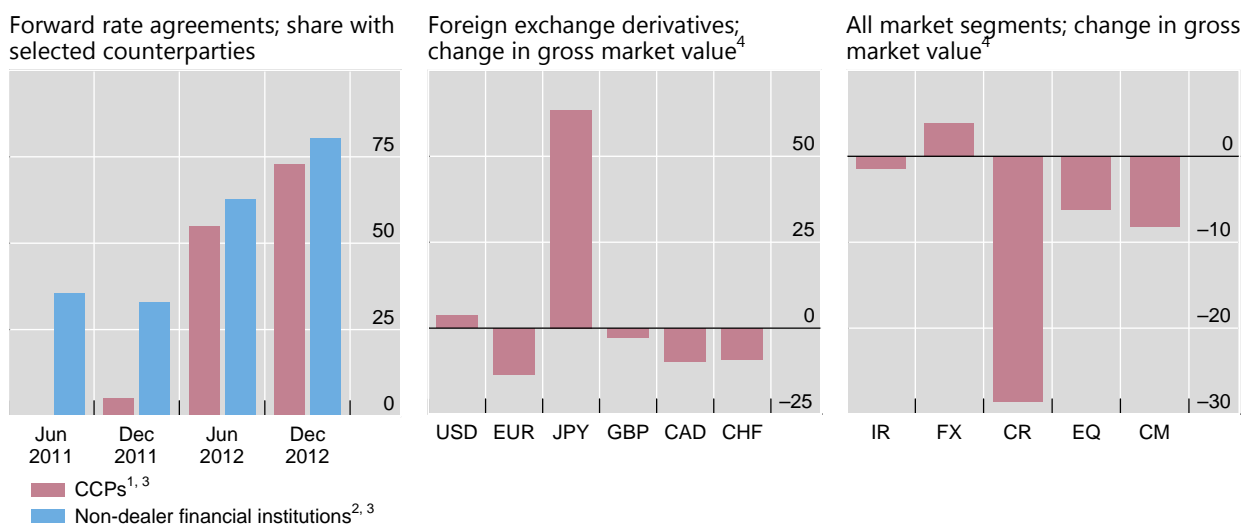
<sup>10</sup> As the US dollar depreciated against other currencies on average during this period – by 3% on a trade-weighted basis – reporting in this currency slightly understates the underlying contraction in both volume and value terms.

<sup>11</sup> See <http://www.trioptima.co.uk/resource-center/statistics/triReduce.html>.

## OTC derivatives

In per cent

Graph 5



CAD = Canadian dollar; CHF = Swiss franc; EUR = euro; GBP = sterling; JPY = yen; USD = US dollar. CM = commodity contracts; CR = credit default swaps; EQ = equity-linked contracts; FX = foreign exchange contracts; IR = interest rate contracts.

<sup>1</sup> Share of notional amounts reported to the Global Trade Repository that are with central counterparties. <sup>2</sup> Share of notional amounts reported to the BIS that are with non-dealer financial institutions (including CCPs). <sup>3</sup> Not adjusted for the doubling of contract volumes when bilateral positions are moved to CCPs. <sup>4</sup> Change between end-June 2012 and end-December 2012.

Sources: Central banks of the G10 countries, Australia and Spain; DTCC; TriOptima; BIS.

mechanically increases contract volumes.<sup>12</sup> This was reflected in a \$17 trillion increase in FRA positions with non-dealer financial institutions – the counterparty category that includes CCPs (Graph 5, left-hand panel).

Despite the stability of positions in interest rate derivatives overall, there were significant reductions in certain currencies and maturity ranges, possibly reflecting lower hedging demand. Notably, positions referencing US dollar and Japanese yen interest rates each declined by 9%, while those maturing within a year fell by 8%. It may be that market participants allowed many of their dollar and yen interest rate hedges to mature, as they perceived little risk to the outlook for short-dated interest rates in these currencies. During the period, the Federal Reserve announced that it expected to keep its policy rate at exceptionally low levels for an extended time and the Bank of Japan expanded its asset-buying plans on three occasions, which was also consistent with an extended period of near zero policy rates.

Positions in foreign exchange derivatives were also little changed overall (+1%), even though those referencing Swiss francs continued to fall. Swiss franc positions decreased by 5% during the period, taking to 21% the cumulative decline since shortly before the Swiss National Bank started to cap the value of the franc relative to the euro. The cumulative decline in option positions on the Swiss franc was particularly large, at 46%.

In contrast, the market value of foreign exchange derivatives rose somewhat overall (by 4%), reflecting strong growth in contracts referencing Japanese yen. The

<sup>12</sup> See "Central clearing and OTC derivatives statistics", *BIS Quarterly Review*, June 2011, p 26.



## Have corporations used low interest rates to lock in cheap funding?

Non-financial firms significantly stepped up their bond issuance after the global financial crisis. Net sales of bonds and notes by non-financial corporations increased from an average of under \$30 billion per year between 2001 and 2006 to almost \$70 billion in 2010–12 (Graph A, blue line in the left-hand panel).<sup>①</sup> At the end of March 2013, 12-month cumulative net issuance fell just short of \$100 billion, the highest level on record. A significant proportion of non-financial corporate issuance is by firms below investment grade. In the 12 months to end-March 2013, firms rated BBB– or below raised \$29 billion (gross) in the bond market (Graph A, shaded areas in left-hand panel), or 19% of total non-financial corporate gross issuance. In absolute amount this is the most ever, but in relative terms it falls short of the 25% share taken by high-yield debt in late 2006–early 2007 and the 23% in early 2011.

The surge in non-financial issuance mirrored a decline in financial issuance. Net sales of bonds and notes by financial institutions worldwide peaked at just over \$400 billion in the 12 months ending in May 2006 and then fell to a range of \$150–200 billion annually between 2008 and 2012. In the 12 months up to March 2013, net issuance by financial institutions stood at a mere \$32 billion, the lowest level in more than a decade.

The rise in bond issuance by non-financial companies during and shortly after the financial crisis was, at least in part, a reaction to the reduced availability of bank finance, but this factor appears to have lessened in importance more recently. Syndicated lending, a close substitute for bond issuance, contracted sharply in 2008 and 2009 but began to increase again in late 2010 (Graph A, right-hand panel). The number of newly signed facilities peaked in late 2011, but the continued growth in lending to lower-rated firms suggests that this is likely to be the result of lower demand for such funding by investment grade corporates rather than a lower supply of funds.

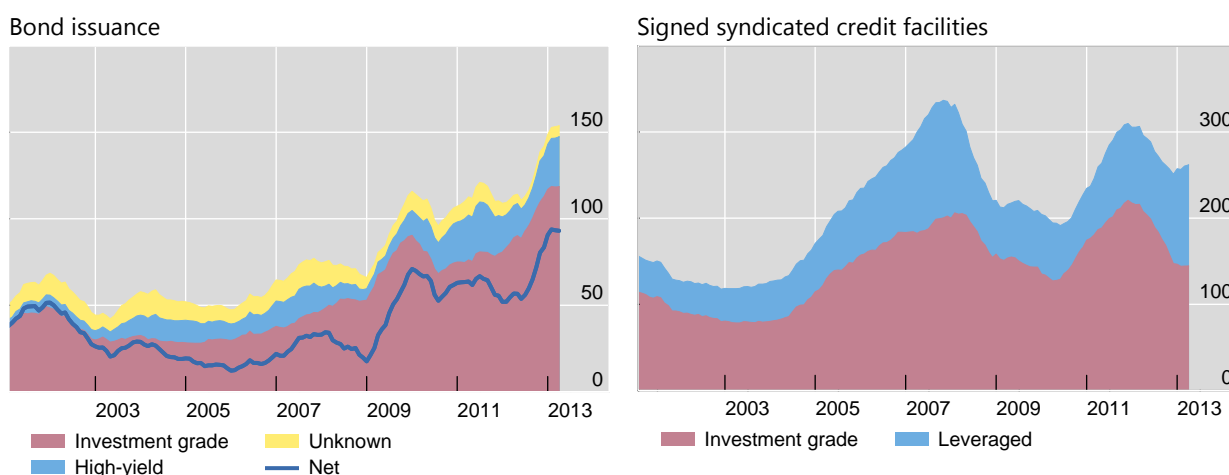
Although firms borrowing in the syndicated loan market tend to be smaller than firms issuing corporate bonds, there is some overlap between the two markets. Hence, a possible reason for the shift from syndicated lending to bond issuance could be that firms are taking advantage of low interest rates to lock in favourable funding conditions. Corporate bond yields shot up during the crisis but quickly fell back to unprecedentedly low levels (Graph B). Syndicated loans tend to pay floating rates, whereas coupons on corporate bonds are mostly fixed, allowing issuers to lock in low rates. The bulk of non-financial issuance was long-term, which is in line with this hypothesis. Well over one third of all bonds issued in 2010 and thereafter carried original maturities of 10 years or more, and almost one half had maturities from five to 10 years. That said, this maturity distribution is by no means

<sup>①</sup> Data on volumes cover both international and domestic issues syndicated by international banks.

### Financing of non-financial corporations<sup>1</sup>

In billions of US dollars

Graph A



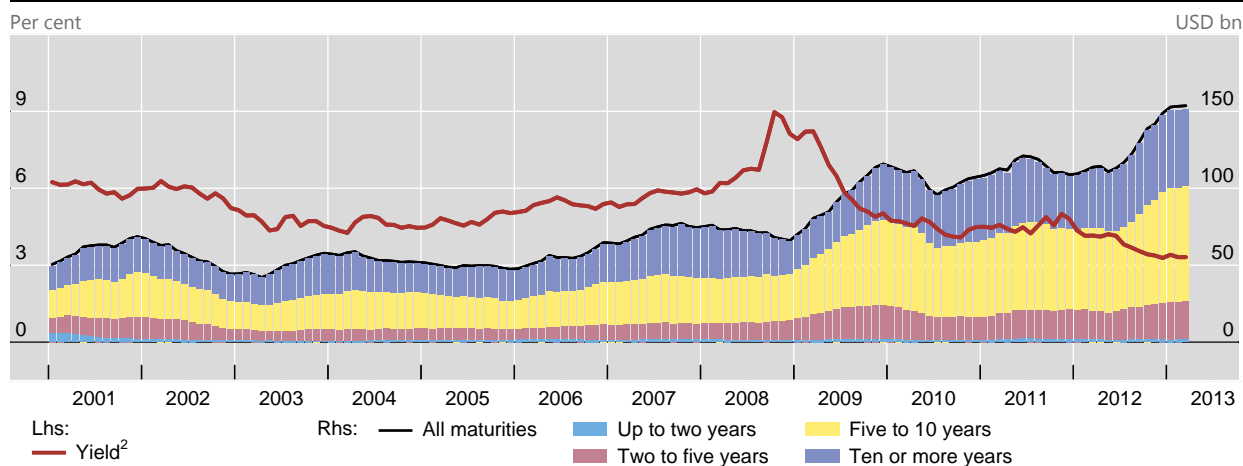
<sup>1</sup> Twelve-month moving average.

Sources: Dealogic; BIS calculations.

unusual, and the proportion of very long-term corporate bonds is actually lower than it was in the years shortly before the crisis, when it fluctuated around 40%. This gives only partial support to the hypothesis that the non-financial corporate sector has taken advantage of the low interest rates to lock in cheap long-term funding.

Bond issuance by original maturity<sup>1</sup>

Graph B



<sup>1</sup> Issued by non-financial corporations on any market; 12-month moving average. <sup>2</sup> Yield to maturity; Bank of America Merrill Lynch Global Broad Market Corporate High Yield Index.

Sources: Bank of America Merrill Lynch; Dealogic; BIS calculations.

gross market value of contracts linked to the yen increased by 63%, mainly due to the revaluation of forwards and swaps (Graph 5, centre panel). This coincided with the yen depreciating by 9% against the dollar and 8% on average against trade partner currencies as market participants increasingly anticipated the end-year change of government and Japan's subsequent monetary expansion.

In the credit default swap (CDS) market, outstanding contract volumes continued to decline. They fell by 7% to \$25 trillion – far below the end-2007 peak of \$58 trillion. Trade compression continued to eliminate redundant contracts, and fewer new trades were signed than in the previous half-year. Single-name positions fell by 8%, while those referencing multiple names declined by 5%. Outstanding credit protection on financial and non-financial debt as well as mortgage and other asset-backed securities dropped, while it was relatively steady on sovereign debt.

The market value of outstanding CDS contracts fell even more sharply than for notional amounts. It declined by 29% overall, with similar reductions across single-name and multi-name contracts (Graph 5, right-hand panel). CDS premia for many euro area debtors fell towards historical averages in the second half of 2012 as the severity of the sovereign debt crisis in the region eased. This suggests that, in many cases, default risk expectations returned towards those prevailing when contracts were signed, reducing the market value of these contracts.

The share of CDS cleared centrally remained low. It inched up from 14% to 15% for multi-name contracts, while staying at 8% for single-name contracts.<sup>13</sup> This was

<sup>13</sup> Calculated as  $0.5x/(y-0.5x)$ , where  $x$  is the volume of contracts with CCPs and  $y$  is the total volume of contracts, since central clearing has the effect of doubling contract volumes.

despite a G20 target for all standardised OTC derivatives to have been cleared centrally by the end of 2012.

In the equity segment of the market, notional amounts changed little (-1%). Here, positions in forwards and swaps rose by 9%, while those in options declined by 5%. Options with dealers as buyers accounted for the vast majority of the fall in option positions. In contrast, dealers maintained their sold-option volume and, hence, the corresponding premium income. The market value of outstanding option contracts also declined (by 10%), but rose for forwards and swaps (by 6%).

Both the notional amount and market value of outstanding commodity derivatives declined. The notional amount fell by 14% and the gross market value by 8%.



## A template for recapitalising too-big-to-fail banks<sup>1</sup>

*A proposed creditor-funded recapitalisation mechanism for too-big-to-fail banks that reach the point of failure ensures that shareholders and uninsured private sector creditors of such banks, rather than taxpayers, bear the cost of resolution. The template is simple, fully respects the existing creditor hierarchy and can be applied to any failing entity within a banking group. The mechanism partially writes off creditors to recapitalise the bank over a weekend, providing them with immediate certainty on their maximum loss. The bank is subsequently sold in a manner that enables the market to determine the ultimate losses to creditors. As such, the mechanism can eliminate moral hazard throughout a banking group in a cost-efficient way that also limits the risk to financial stability. The creditor-funded mechanism is contrasted with other recapitalisation approaches, including bail-in and “single point of entry” strategies.*

*JEL classification: G21, G28.*

During the financial crisis, a number of financial institutions reached the point of failure or failed outright. The stated capital levels of these institutions typically exceeded minimum regulatory requirements, but the market doubted that those levels were enough to cover potential future losses. The suspicions of future insolvency brought these institutions down through a lack of current liquidity: depositors and other creditors demanded immediate repayment, and the institutions ran out of funds to satisfy the demands.

Governments considered many of the institutions that reached the point of failure to be “too big to fail” (TBTF). That is, they were so big, complex and interconnected with the rest of the financial system that the public cost of allowing them simply to go out of business was judged to be too high. In the absence of any alternative mechanism to restore their viability, governments themselves recapitalised these TBTF entities – using taxpayers’ funds.

Besides imposing direct costs on taxpayers, publicly funded bailouts generate significant moral hazard. Expectations of government support can amplify risk-taking, reduce market discipline and create competitive distortions, further increasing the probability of distress. These concerns have prompted efforts to reduce the likelihood that TBTF institutions will fail, mainly through requirements for them to maintain higher levels of capital and liquidity and through greater

<sup>1</sup> The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS or those of the Basel Committee on Banking Supervision. The authors would like to thank Wayne Byres and Neil Esho for their support of this article, and Stephen Cecchetti, Claudio Borio and Christian Upper for their helpful comments and edits.

supervisory attention. But these measures do not answer the question of how to pay for recapitalisation if such entities reach the point of failure. If taxpayers are to avoid this cost, the shareholders and creditors of the failed institutions must bear it, but how?

In recent years, authorities have made significant efforts to improve resolution schemes. Their initial efforts have focused on obtaining legal authority to resolve domestic and global TBTF financial entities without the use of taxpayers' funds. These efforts include the requirements of the Basel Committee on Banking Supervision regarding the loss absorbency of capital "at the point of non-viability" and the key attributes of effective resolution schemes developed by the Financial Stability Board.<sup>2</sup> Resolution powers alone, however, are not enough. Indeed, uncertainty regarding their use may itself pose a threat to financial stability.

What has yet to be sufficiently developed is clarity on the rights of private sector claimants in the resolution of a failing TBTF bank: depositors and creditors must have a guarantee that, in any attempt to recapitalise a TBTF bank by imposing losses on shareholders and creditors, the hierarchy of claims will be respected. Depositors insured prior to resolution must continue to be insured afterwards; likewise, creditors whose claims were senior or ranked equally to other claims prior to resolution must be treated accordingly in resolution. In short, a resolution scheme for a TBTF bank must respect the hierarchy of claims that existed before the institution reached the point of failure.<sup>3</sup>

This article proposes a template for a simple approach – which we term a creditor-funded recapitalisation mechanism – that national authorities could employ to clarify the allocation of losses when a TBTF bank needs to be recapitalised. The proposed approach enables recapitalisation over the course of a weekend without the use of taxpayers' money. It uses a *temporary* holding company to ensure that these losses are allocated in a way that strictly follows the creditor hierarchy, and it uses the market itself to determine the losses creditors need to bear to recapitalise the bank.

The proposed mechanism includes elements of other resolution methods, such as bail-in and holding company resolution (described below). As such, it is offered not necessarily as a replacement for these other methods but as an additional approach that provides clear direction on the central issue of recapitalisation for TBTF banks that reach the point of failure. As with other approaches, various detailed operational and legal questions need to be answered before the creditor-funded recapitalisation mechanism could be implemented; this article focuses on the benefits of the proposed mechanism's overall structure and suggests a staged approach to settling the operational and legal issues.

<sup>2</sup> See Basel Committee, *Minimum requirements to ensure loss absorbency at the point of non-viability*, January 2011; and Financial Stability Board, *Key attributes of effective resolution regimes for financial institutions*, October 2011.

<sup>3</sup> In response to events in Cyprus, ECB President Mario Draghi commented, "What makes a bail-in a problem? A bail-in in itself is not a problem: it is the lack of ex ante rules known to all parties [...] that may make a bail-in a disorderly event" (ECB, press conference, 4 April 2013, [www.ecb.int/press/pressconf/2013/html/is130404.en.html%20](http://www.ecb.int/press/pressconf/2013/html/is130404.en.html%20)).

## Overview of the proposed recapitalisation mechanism

By definition, a TBTF bank that reaches the point of failure must be recapitalised because the authorities have judged that the financial stability risks of liquidating the bank are unacceptably high. The creditor-funded recapitalisation mechanism proposed here provides for a forced recapitalisation of a TBTF bank *by its creditors* when the bank reaches the point of failure. It enables a TBTF bank to be recapitalised over a weekend without taxpayer support and to remain open for business. The mechanism is not designed to replace liquidation for non-TBTF banks that fail; instead, it is an alternative that is similar to liquidation in terms of its allocation of losses.<sup>4</sup>

The ownership of the bank is transferred to a newly created temporary holding company. The bank is immediately recapitalised by writing off sufficient claims of creditors over a weekend. The holding company then sells the recapitalised bank at market prices and distributes the proceeds from the sale to the written-off creditors by strictly following the hierarchy of their claims as it existed before the point of failure was reached. In the period between the recapitalisation and the sale of the bank, the management and board members responsible for the failure of the bank can be replaced, as appropriate. Insured deposits are fully protected from the effects of the write-off; instead, a charge is directly levied on the relevant national deposit insurance scheme.

### Basic illustration of the mechanism: no insured deposits

The treatment of insured deposits is fundamentally important to any resolution mechanism that applies to banks. However, the essential features of the creditor-funded resolution mechanism can best be highlighted by first assuming that the bank has no insured deposits. The treatment of insured deposits set out below in the section “Extended illustration of the mechanism: with insured deposits”, is in effect an extension of the basic approach described here.

The balance sheets of the bank shown in the graphs and tables below are their accounting balance sheets. As noted in the introduction, many banks that reached the point of failure during the financial crisis had positive amounts of accounting equity. The problem was that the amount of equity was insufficient to cover market expectations of future losses. As such, the markets were not willing to lend to such banks; if the authorities were also unwilling, those banks failed. The following illustration does not show the actual occurrence of losses at the recapitalised bank because they are unknown at the point of recapitalisation. But the illustration does show that the proposed mechanism delivers an increase in equity to the level that is viewed as sufficient to cover anticipated losses.

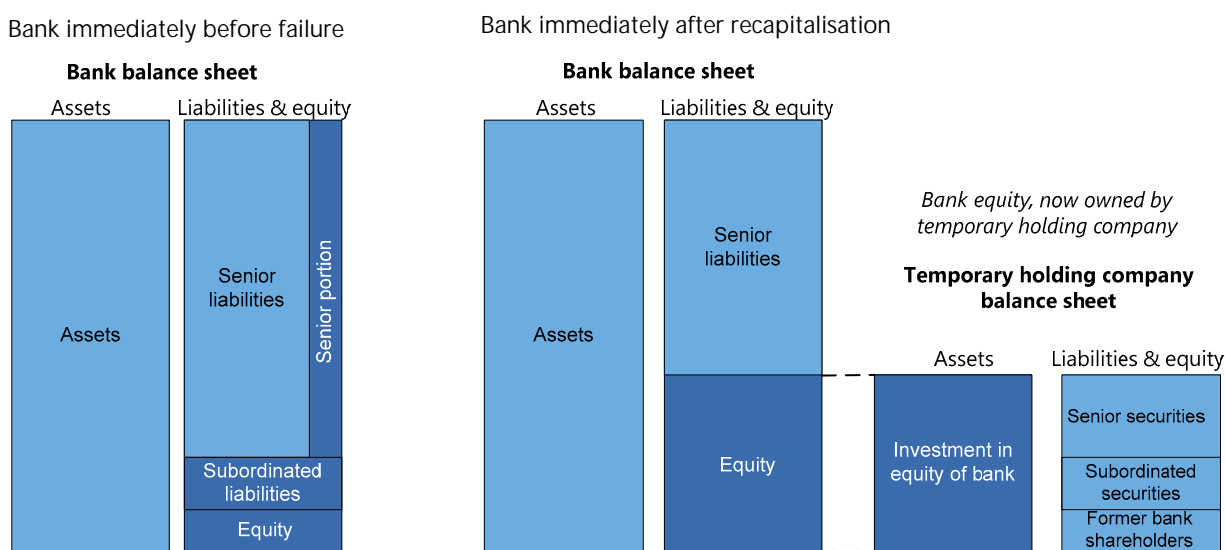
#### Step 1: Recapitalisation of the bank over the weekend

When a TBTF bank reaches the point of failure, over the weekend national authorities initiate an immediate forced transfer of its ownership to a newly created

<sup>4</sup> The mechanism in principle could be applied to any bank at the point of failure, but the liquidation of a failed bank may remain the first choice of authorities when this can occur without severe financial stability consequences; however, to avoid any prospect of taxpayer support, authorities need to have in place the mechanisms that enable a forced creditor-funded recapitalisation should this become necessary.

Operation of the mechanism, no insured deposits: recapitalisation over the weekend

Graph 1



temporary holding company (ie the common shares of the bank become the assets of the holding company). In compensation, the former shareholders of the bank are given a residual claim on the holding company. The resolution authority is given the voting rights of the holding company.

To recapitalise the bank over the weekend, the resolution authority simultaneously writes off all of the subordinated liabilities together with a proportion of all senior unsecured uninsured liabilities. Because equity is the difference between assets and liabilities, the decrease in liabilities correspondingly increases equity (Graph 1, left-hand and middle pairs of bars). At this stage, there has been no adjustment to the assets of the bank and so the size of the balance sheet remains unchanged; only the mix of liabilities and equity has changed.

The resolution authority will determine the proportion of senior liabilities written off. Their determination must be based on a generous estimate of the amount of equity that must be created if the bank is to sustain the full range of potential losses that it may still be expected to incur. That is, the authorities need to give both themselves and market participants comfort that the bank will remain sufficiently well capitalised as actual losses materialise. As explained later, the authorities can make a generous estimate because the size of the write-off does not determine the ultimate losses suffered by creditors.

The investors affected by the write-offs are given claims on the temporary holding company (in the form of securities) that are equal in size and rank to their written-off claims on the bank (Graph 1, right-hand pair of bars, "Senior securities" and "Subordinated securities").

The impact of step 1 can be shown with a numerical example. Assume that immediately before the point of failure (Graph 1, left-hand pair of bars) the balance sheet of the bank is as follows:



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#### Bank balance sheet immediately before failure

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Assets: \$100	Senior liabilities: \$91 Subordinated liabilities: \$5 Equity: \$4
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Although the bank has \$4 of accounting equity, the market does not believe that this amount is sufficient to cover potential future losses given the riskiness of this bank's assets. To resolve those doubts in the process of recapitalisation, the authorities estimate that the bank needs \$16 of equity to support itself as a going concern. To achieve this level of equity, \$7 of senior liabilities and all subordinated liabilities (\$5) are written off. After these write-offs (Graph 1, middle pair of bars), the balance sheet of the bank is as follows:

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#### Bank balance sheet immediately after recapitalisation

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Assets: \$100	Senior liabilities: \$84 Equity: \$16
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Step 1 also transfers ownership of the bank to a newly created holding company and includes the issuance of holding company securities to senior and subordinated investors and former bank shareholders in the amount of the write-offs they incurred. Therefore, the balance sheet of the holding company after step 1 is as follows:

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#### Holding company balance sheet immediately after recapitalisation

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Assets (the bank's equity): \$16	Senior securities: \$7 Subordinated securities: \$5 Former bank shareholders: \$4
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#### Step 2: Bank reopens for business after the weekend

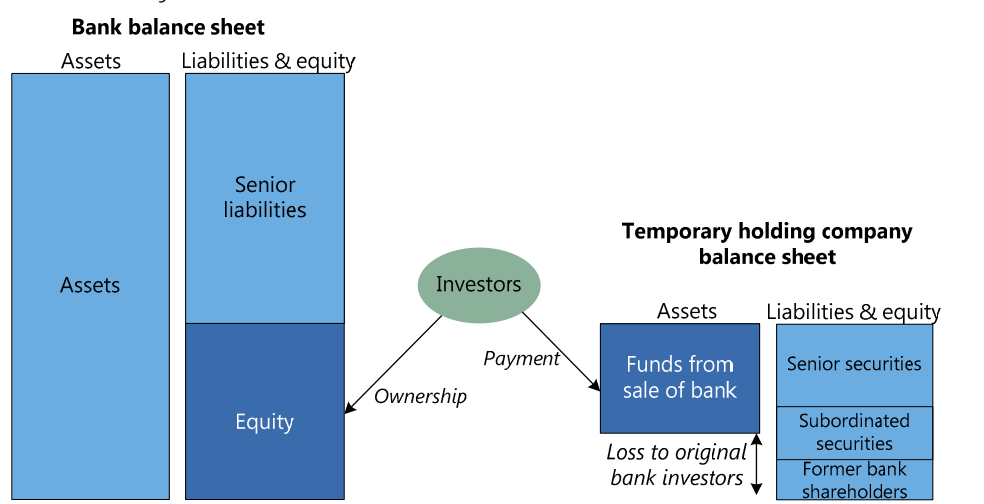
At the end of the weekend, the authorities announce that recapitalisation has provided the bank with substantial capital to protect the holders of the liabilities that remain on the bank's balance sheet. On Monday morning, the authorities reopen the bank and can provide it with any necessary and appropriate liquidity assistance because it is now well capitalised, that is, its equity is sufficient to cover expected future losses. Management and board members can be replaced as appropriate. Any overstated assets and understated liabilities can be revalued if necessary (revaluations not shown in graphs).

#### Step 3: Sale of the recapitalised bank

The temporary holding company is required to sell the bank in the months following its recapitalisation. After the sale, the holding company is liquidated by distributing the proceeds from the sale to the former investors in the bank according to the hierarchy of their claims.

Graph 2 illustrates a sale in which investors acquire the bank for an amount that is less than the value of the equity on its balance sheet. This amount reflects the investors' estimate of the bank's future profits and losses, which are not yet recognised on the accounting balance sheet. The difference between the payment

*Sale by the holding company and distribution of proceeds to former creditors strictly according to the hierarchy of their claims*



from the investors and the equity of the bank is the loss that will be suffered by former shareholders and written-off bank creditors.

The above numerical example is continued to illustrate the impact of Step 3. Assume that investors pay the holding company only \$10 to acquire all of the shares of the bank, which is less than the accounting value of the bank's equity of \$16.

The holding company is then liquidated and distributes its assets – the \$10 received from the sale of the bank – to its creditors and shareholders strictly according to the hierarchy of their claims. But the assets are insufficient to repay all of those claims. In this example, \$7 is given to the senior security holders (ie they are repaid in full), the remaining \$3 is given to the subordinated security holders (ie they get back only \$3 of their \$5 claim), and the former shareholders of the bank get nothing.<sup>5</sup> The result can be seen in the following balance sheet:

Holding company balance sheet immediately after sale of the bank

Assets (cash from bank sale): \$10	Senior securities: \$7 (paid \$7)
	Subordinated securities: \$5 (paid \$3)
	Former bank shareholders: \$4 (paid \$0)

Extended illustration of the mechanism: with insured deposits

In reality, a bank's balance sheet includes both insured and uninsured deposits. However, the addition of insured deposits to the illustration does not alter the operation of the proposed mechanism. It treats *uninsured* deposits exactly as it did other senior liabilities in the above basic illustration: it subjects them to the same partial write-off that it applies to other senior creditors that have a claim of equal

<sup>5</sup> Senior creditors would have suffered a loss only if the amount paid for the bank by the new investors had been less than the senior creditors' claims on the holding company.

rank and compensates them with securities issued by the holding company.<sup>6</sup> However, authorities must provide unequivocal assurance that *insured* deposits are fully protected during the forced recapitalisation of a TBTF bank to avoid a bank run and to promote financial stability.

Such unequivocal assurance will not be forthcoming from a plan that first allocates some of the losses to insured depositors and then asks those depositors to reclaim their loss from the deposit insurance scheme. While consistent with the creditor hierarchy, that roundabout approach would reduce trust in the financial system and trigger withdrawals. It is also unnecessary. A more effective approach to maintaining the confidence of insured depositors in a creditor-funded recapitalisation plan is also a much simpler one: require deposit insurance schemes to bear losses directly, leaving insured deposits intact.

This approach works as follows. Rather than writing off some amount of insured deposits as part of the process of creating equity, the required equity would be obtained instead with a direct payment from the deposit insurance scheme to the bank (thereby increasing the bank's assets). The deposit insurance scheme would then have a claim on the holding company under step 3 of the basic illustration, along with the written-down uninsured creditors.

The three steps of the basic illustration are recapitulated here, but now in the context of a TBTF bank with insured deposits.

#### Step 1 with insured deposits: Recapitalisation of the bank over the weekend

This step is essentially the same as that described in the case without insured deposits. However, rather than writing off a portion of insured deposits to create equity, the deposit insurance scheme (DIS) is required to make a payment of equal size to the bank in lieu of this amount. Insured depositors are therefore completely unaffected by the write-off. However, along with other senior claimants, the DIS is given the most senior securities issued by the holding company<sup>7</sup> (Graph 3). The DIS holds an amount of these securities equal to the portion of insured deposits of the bank which would have otherwise been written off.

#### Step 2 with insured deposits: Bank reopens for business after the weekend

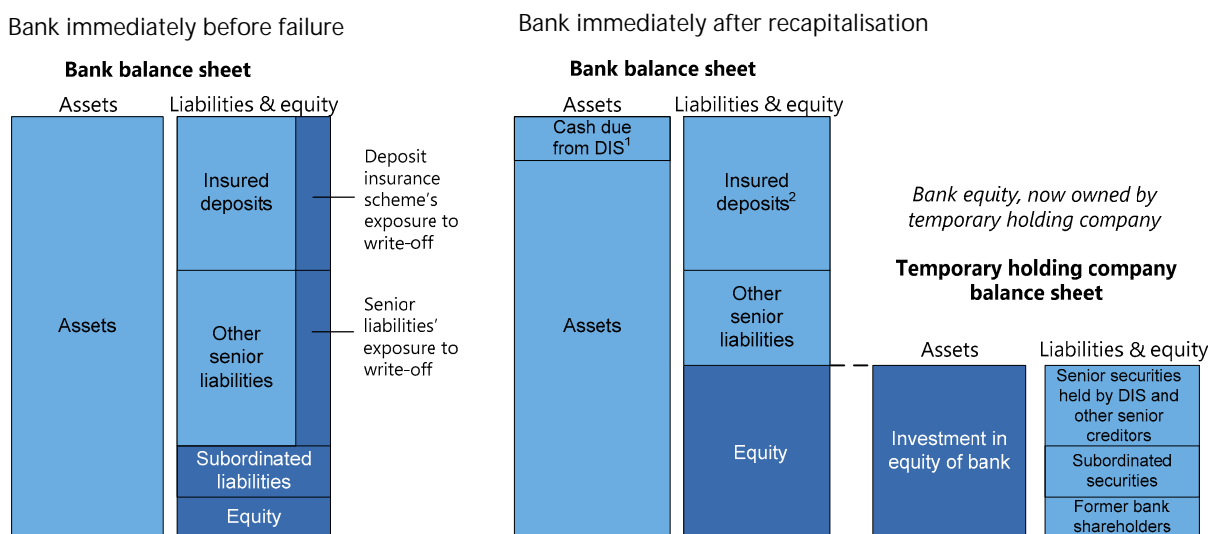
This step is essentially the same as that described in the case without insured deposits. However, in their communication, the authorities would also announce that insured deposits have been safeguarded by the DIS and that insured depositors' funds are unaffected.

#### Step 3 with insured deposits: Sale of the recapitalised bank

This step is essentially the same as that described in the case without insured deposits. However, the proceeds from the sale of the bank will be paid to the DIS

<sup>6</sup> For the sake of simplicity, this illustration assumes that there is no "depositor preference" in the jurisdiction in which the mechanism is being applied. That is, there is no legal requirement that makes depositors' claims senior to other senior claims in liquidation. If depositor preference were in place, then uninsured depositors' funds, and the deposit insurance scheme in respect of insured depositors' funds, should not suffer the effects of a write-off under the proposed mechanism unless all junior ranking claims have first been completely written off.

<sup>7</sup> If a jurisdiction had depositor preference, only the DIS and uninsured depositors would receive the most senior securities of the holding company. Other senior bank creditors would receive securities which rank just below.



<sup>1</sup> Deposit insurance scheme (DIS) payment to bank to cover losses from depositors' share of write-off. <sup>2</sup> Unaffected by write-off because of payment from DIS.

and to the holders of other equally ranking senior claims ahead of all other investors.

### Treatment of secured funding under recapitalisation

For a resolution plan to be consistent with prior investor agreements, funding provided to a bank on a secured basis must remain protected. But the protection should extend only as far as the collateral covers the investors' claims. Any amounts of such funding that are unsecured because of insufficient collateral at the point of failure should be written down together with other unsecured claims.

### Comparison with other recapitalisation approaches

The proposed mechanism includes elements of two broad types of established or contemplated recapitalisation approaches – bail-in and certain holding company resolution schemes – that aim to quickly recapitalise a failed bank or banking group (eg over a weekend):

- *Bail-in schemes.* These aim to achieve recapitalisation through a direct conversion of a bank's creditors' claims into newly issued common shares.<sup>8</sup> Bail-in regimes that immediately issue common shares to bank creditors at the point of failure according to some predetermined formula are referred to here as direct bail-in schemes.

<sup>8</sup> For details, see International Monetary Fund, "From bail-out to bail-in: mandatory debt restructuring of systemic financial institutions", *Staff Discussion Note 12/03*, Washington, April 2012.

- *Holding company resolution schemes (certain “single point of entry” schemes).*<sup>9</sup> These generally apply to banks that, before reaching the point of failure, are owned by a non-operating holding company that has issued debt. If the banking group as a whole needs to be recapitalised, the holding company can be required to sell the bank or transfer it to the resolution authority, which has the effect of recapitalising the group by relieving it of the liabilities at the holding company level.

In practice, many other recapitalisation mechanisms exist, each with many potential variants. More particularly, some seek recapitalisation over a more extended period to allow national authorities the time necessary to make a detailed assessment of the failed bank’s recapitalisation needs; these are collectively referred to here as phased recapitalisation approaches. An example of a phased recapitalisation approach consists of a modified bail-in scheme that delays the conversion of a bank’s creditors’ claims pending the official assessment of its recapitalisation needs. A phased approach can also take the form of a “bridge bank” approach that splits the institution into a “good bank” and a “bad bank” on the basis of a detailed assessment of the capital needs of the good bank.

Although the mechanism proposed in this article includes elements of the above existing or contemplated recapitalisation approaches, it has been designed to avoid their main pitfalls. It may, therefore, represent the *only* approach which can simultaneously (i) respect the creditor hierarchy (maximising cost efficiency); (ii) achieve a recapitalisation over the weekend providing investors with immediate certainty on their maximum loss (limiting risks to financial stability); and (iii) be applied to all uninsured creditors throughout a TBTF group (fully addressing moral hazard).

## Comparison with bail-in schemes

### Respect for the creditor hierarchy

When a company is liquidated, the liquidator sells the company’s assets and returns the proceeds to senior creditors, subordinated creditors, and shareholders, in that strict order (ie according to their priority in the liability structure). The implication here for the shareholders is that they will receive nothing whenever a creditor takes a loss. Similarly, subordinated creditors will be wiped out if senior creditors take a loss.

Direct bail-in schemes, however, do not fully respect this creditor hierarchy. They work by converting a bank’s creditors’ claims directly to shares, which dilutes the claims of existing shareholders, but it does not wipe out shareholders even as it inflicts losses on existing creditors.<sup>10</sup> This violation of the hierarchy does not occur

<sup>9</sup> For the purposes of this article, holding company resolution refers to “single point of entry” as contemplated by the US authorities. The US approach to single point of entry focuses on recapitalising the banking group as a whole through the allocation of losses at the parent company level, where that parent company is a non-operating holding company of a TBTF banking group. For details on this and the Bank of England’s approach to “single point of entry” recapitalisation, see Federal Deposit Insurance Corporation and Bank of England, *Resolving globally active, systemically important, financial institutions*, December 2012.

<sup>10</sup> Creditors will suffer a loss if the value of the shares they receive is less than the amount by which their former claims are reduced, an outcome which will be unavoidable if the recapitalisation needs of the bank are significant. It could be argued that if creditors agree to the possibility of suffering a loss before the shareholders of the bank are wiped out (eg by purchasing a debt instrument in

under the proposed creditor-funded recapitalisation mechanism because shareholders will receive some compensation only if creditors are repaid in full. Similarly, subordinated creditors will receive some compensation only if senior creditors are repaid in full.

### Compensation of creditors

Any mechanism that involves writing off creditors in order to recapitalise a failed bank puts the authorities in a difficult position. On the one hand, write-offs should be large enough to ensure that the recapitalised bank is able to survive without taxpayer support. On the other hand, to treat creditors fairly and limit financial instability, the authorities do not want to allocate larger losses to creditors than is necessary. Furthermore, any delay in the decision on the level of the write-off perpetuates uncertainty on the losses that may be borne by creditors and may have serious repercussions on financial stability.

The recapitalisation mechanism proposed here allows authorities to strike a good balance between stability and fairness. They can take a prudent and timely approach to the size of the creditor write-off needed to recapitalise the bank over the weekend. This provides *immediate* certainty to creditors on their *maximum* loss – thus limiting risks to financial stability. Creditors also remain assured that, regardless of the amount of this write-off, they will ultimately be compensated fairly. This is because the amount received from the market for the sale of the recapitalised bank in step 3 of the process supersedes the amount written off in step 1.<sup>11</sup>

To illustrate this point, imagine that the authorities decide to write off a significant proportion of the claims of senior creditors to ensure that the bank is left very well capitalised and unquestionably able to honour the claims of all its remaining creditors. This would increase the value of the recapitalised bank and thus lead to a higher price paid when the bank is sold. The higher price in turn means that there are more funds to distribute to those same senior creditors to compensate them for the write-off that they have suffered. This self-correcting dynamic delivers market value to the creditors and protects the authorities from accusations of penalising (or favouring) creditors in their pursuit of restoring financial stability in short order.

The use of market valuation to determine the allocation of losses to creditors contrasts sharply with the approach to loss allocation under a *direct* bail-in scheme. Direct bail-in schemes seek to provide clarity on the loss that will be suffered by creditors by converting debt to equity in short order. But in doing so, they set the number of shares issued to creditors before the post-recapitalisation market value

which this possibility is mentioned in its terms and conditions – so-called “contractual bail-in”), then a new creditor hierarchy has been created. However, this article considers whether resolution approaches respect the *existing* established creditor hierarchy that applies in liquidation. It argues that respect for this hierarchy is key in limiting uncertainty and attracting the significant existing pool of debt investors (see the section “Depth of market access and liquidity” below).

<sup>11</sup> The use of the market valuation of the bank and its respect for the creditor hierarchy make the mechanism very similar to a standard liquidation procedure in terms of the allocation of losses. When a company fails and enters liquidation, the normal rights of shareholders and creditors are replaced by claims on the sale of the company's assets. When the proposed mechanism is used to recapitalise a bank, the temporary holding company is effectively acting as the liquidator; however, instead of selling the individual assets of the bank, it sells the bank as a whole as a going concern. Because maintenance of the going-concern status of the bank retains its franchise value, the sale of the whole bank should generally preserve more value for creditors than liquidation.

of the bank is known. Therefore, a direct bail-in scheme distributes an unknown amount of value to creditors and, as a consequence, is likely to either over- or undercompensate them for the loss of their prior claims. When buying bail-in debt, investors will want to be paid for taking on this uncertainty, and so direct bail-in debt has a cost that is not present in the recapitalisation mechanism proposed here. (Certain modified bail-in schemes, however, do attempt to address this compensation issue by delaying the conversion of a bank's creditors' claims. These are covered in the section "Comparison with phased recapitalisation approaches" below.)

### Depth of market access and liquidity

An important additional factor in the cost of funding for a bank is the depth and liquidity of markets for the debt instruments that it issues. In practice, many investors in bank debt have mandates forbidding them from investing in shares. As a result, bail-in debt, which has the potential to be converted into shares (without certainty on the adequacy of compensation received), is less likely to be acceptable to current debt investors and therefore is likely to be less liquid than a pure debt instrument.

In contrast, debt subject to the proposed recapitalisation mechanism does not require investors to be capable of receiving shares and ensures adequacy of compensation in full accordance with the hierarchy of claims. Debt investors receive cash from the sale of the bank in much the same way they would receive cash from the sale of a bank's assets in liquidation. Such debt is therefore more likely to be liquid because it is more likely to be rated like debt, be incorporated into bond indices, and be appropriate for existing domestic and global debt investors.

In other words, relative to direct bail-in, the proposed mechanism is likely to maximise depth of credit market access and liquidity by respecting the structure of *existing* investment markets rather than by attempting to alter them to create new markets for significant amounts of hybrid debt-equity instruments.

### Shareholder base

Under direct bail-in schemes, the post-bail-in shareholders of the bank are a mixture of the pre-bail-in shareholders and creditors. By contrast, under the recapitalisation mechanism, the shareholders are new and willing equity investors that have actively chosen to acquire the recapitalised bank. The proposed mechanism therefore avoids the situation in which credit investors can unexpectedly become shareholders and thus be unprepared to perform key duties such as voting for new management to run the bank. Also, under the recapitalisation mechanism the new investors in the shares of the bank can be subject to all the usual screening procedures regulatory authorities apply to potential new owners of banks, which may not be possible under a direct bail-in scheme that immediately issues shares to converted creditors.

## Comparison with holding company ("single point of entry") resolution

### Cost efficiency

The proposed recapitalisation mechanism focuses on loss absorption at the bank level (ie the operating company level), but can also be applied to any entity in a banking group. This contrasts with a scheme focusing on allocating losses to debt

issued by a pre-existing holding company that owns the bank. The latter is likely to entail an unnecessary cost arising from “structural subordination”. In essence, debt issued by the holding company is de facto junior in the credit hierarchy to any debt issued by the operating bank subsidiary – and is therefore more expensive.

By way of a simple example, consider a banking group that consists of a holding company that owns just one bank subsidiary. Assume that, to improve the resolvability of this group, the authorities require the issuance of a large amount of debt capable of absorbing losses in resolution. Is it most efficient to issue this large amount of debt from the holding company or from the operating bank subsidiary? The answer is, from the subsidiary.

Debt issued at the holding company level is “structurally subordinated” to debt issued at the operating bank level because it depends on the common dividends paid by the bank to the holding company for the payment of accrued interest. The operating bank’s board or management has the ability to halt the payment of share dividends; moreover, under stress conditions, regulatory authorities also have the ability to reduce or halt such dividends. Therefore, structural subordination brings management and regulatory discretion into the picture; it creates uncertainty that will put upward pressure both on the cost of debt issued at the holding company level and on the banking group’s overall cost of funding.<sup>12</sup>

By contrast, debt issued at the bank level is not reliant on the payment of discretionary dividends. It is dependent only on the bank avoiding failure. Furthermore, a reduction in dividends to rebuild common equity actually improves the protection of debt issued by the bank, as this debt now has a greater cushion of common equity to protect it. In practice, rating agencies, including the two largest global rating agencies for banks, have historically rated debt issued by a non-operating holding company at least one notch lower than debt issued by its operating bank because of structural subordination and other considerations. For poorly rated groups or groups under stress, the relative down-rating can be even lower. Furthermore, these long-established practices have recently been reconfirmed in the context of the Dodd-Frank Act and holding company resolution strategies.<sup>13</sup>

## Moral hazard

The proposed recapitalisation mechanism is designed to address moral hazard more fully than a holding company (or “single point of entry”) resolution approach. It does this by allocating losses to *all* uninsured creditors of the bank rather than to only a subset of debt securities issued by the holding company.

One obvious problem with limiting the allocation of losses to only holding company creditors (or to only certain classes of operating bank creditors) is that the total amount that may be written down may prove to be insufficient to recapitalise the bank. In addition, the remaining creditors may believe that they continue to be

<sup>12</sup> Structural subordination is independent of jurisdiction, but its impact can be magnified when the regulator of the holding company is different from the regulator of the operating bank subsidiary, and even more so when the two regulators are from different jurisdictions.

<sup>13</sup> For rating agency methodologies, see eg Standard & Poor’s, *Reassessing US non-operating financial holding company creditworthiness under the Dodd-Frank Act*, 10 December 2012; Standard & Poor’s, *Criteria: financial institutions: general: analytical approach to assessing non-operating holding companies*, 17 March 2009; and Moody’s Investors Service, *Reassessing systemic support in US bank ratings – an update and FAQs*, 27 March 2013.



guaranteed if there is no mechanism by which they can be allocated losses if a recapitalisation becomes necessary.

Wider problems also exist when debt issued by a holding company, or certain limited categories of debt issued by the bank, are earmarked to be the primary source of funding that bears the cost of recapitalisation. Because it is much easier to allocate losses to simpler senior creditor claims (eg debt securities issued to external investors) than to more complex ones (eg derivatives), resolution strategies seeking to ensure a sufficient amount of funding to cover feasible losses gravitate towards allocating losses to the simple claims first. A similar situation may also occur when authorities seek to protect short-term funding from bearing a loss in resolution or recapitalisation. The downside of such approaches is that the creditor hierarchy is not respected and the most complex and shortest-duration senior claims are effectively subsidised by those that are less complex and longer in duration. This outcome can counter recent regulatory efforts to reduce complexity and increase funding duration, and it thus risks reducing the resilience of the global financial system over time.

The proposed recapitalisation mechanism is applicable to any uninsured creditor of any legal entity that is part of a financial group (eg whether a banking, broker-dealer, insurance or other group) for which authorities wish to have an alternative to a taxpayer-funded bailout. It can be targeted at the specific TBTF operating entity that is failing within the group, whether that is the holding company or a subsidiary. This universal applicability is attributable to the fact that the temporary holding company is established only when the recapitalisation mechanism is triggered. As the temporary holding company is external to the existing group's structure, it can be used to recapitalise any entity of a TBTF group. This contrasts with using a single point of entry, which by design relies solely on allocating losses to debt issued by the parent entity of the group, limiting that approach's capacity to address moral hazard across group entities.

### Market signalling

Aside from moral hazard issues, using a single point of entry may also suffer from a market signalling problem. Consider a large banking group – consisting of a holding company and many international bank subsidiaries – that market participants judge to be too big to fail. Under a holding company resolution model, the debt issued by the holding company is the source of funding that will bear a loss if the group needs to be recapitalised. This debt, therefore, effectively acts as a source of capital to protect the creditors of the subsidiary banks. This means that if a particular subsidiary takes excessive risks, the cost of the holding company's debt should increase, acting as a market signal and imposing some market discipline on the group. However, under this model it is not possible, with any certainty, to attribute this increased cost of funding at the holding company level to the risks taken by a particular subsidiary: the source of the market signal is hidden.

Under the proposed recapitalisation mechanism, the creditors of the banking subsidiaries themselves will bear the cost of recapitalisation. This means that if a subsidiary takes excessive risks, the funding cost of that specific subsidiary should increase. In turn, the source of the market signal is clear and market discipline is imposed on the legal entity actually taking the excessive risks. These clearer market signals under the proposed mechanism should enable supervisors, risk managers and management to more accurately track sources of market concerns about risk-

taking across a complex group. This in turn should help with the efficient allocation of capital across the group.

## Comparison with phased recapitalisation approaches

Phased recapitalisation approaches, which as defined above include modified bail-in schemes and bridge bank structures, delay the decision on the amount and, potentially, the allocation of losses to creditors pending the outcome of a detailed valuation of the failed bank. This valuation may be conducted by the authorities themselves or by independent consultants. The authorities use this valuation to determine the level of losses to be allocated to shareholders and creditors to recapitalise the bank. The aim is a more accurate assessment of the value of the bank than is possible to achieve over a weekend and an allocation of losses to creditors that attempts to respect the hierarchy of their claims.

However, aside from the problem of the significant subjectivity of any valuation assessment, a downside of phased recapitalisation approaches is that they do not provide creditors with immediate certainty on their maximum loss. They instead extend the period of uncertainty to the *full amount* of all creditors' funds that may ultimately be allocated a loss as a result of the assessment. This extended uncertainty has the potential to magnify financial instability, exacerbate negative news flow, and damage the franchise value of the bank, ultimately leading to unnecessary further losses to creditors. In contrast, the proposed recapitalisation mechanism enables authorities to rapidly cap the uncertainty, through limiting creditor losses to the amount of creditors' funds that is immediately written off in step 1. This should achieve the critical financial stability goal of ending the significant uncertainty which exists prior to the announcement of the bank's recapitalisation.

In summary, direct bail-in tends to limit risks to financial stability (through rapidly allocating losses to creditors to achieve recapitalisation) whereas phased recapitalisation seeks to allocate losses to creditors in a way that respects the creditor hierarchy by more accurately taking account of the value of the recapitalised bank. The proposed recapitalisation mechanism is designed to achieve *both* benefits simultaneously.

## Implementation

This article has focused on the high-level design benefits of its proposed recapitalisation mechanism. However, as with other recapitalisation approaches, various operational and legal aspects of this proposal would need to be detailed and clearly communicated to stakeholders before its implementation could begin; these include the detailed treatment of various types of senior creditor claims, including all those that are complex. Therefore a pragmatic, staged approach to implementation is recommended.

In its first stage, the proposed creditor-funded recapitalisation mechanism would be applied to all shareholders' and subordinated creditors' claims. Authorities would require large banks to maintain sufficient amounts of subordinated debt outstanding to cover most recapitalisation needs (a requirement that could be relaxed following the completion of the second stage).

After the detailed treatment of senior claims has been set out, and the significant legal and operational issues addressed, the second stage would then apply the write-off mechanism in a proportionate way to all uninsured senior claims simultaneously, no matter how complex these claims may be. The potential for uninsured depositors to suffer a loss in this stage means that authorities would need to think carefully about the appropriate level of deposit insurance and the issue of depositor preference (ie whether legislation is used to give depositors seniority relative to other senior claims).

## Conclusions

This article proposes a simple recapitalisation mechanism that is consistent with the rights of creditors and enables recapitalisation of a TBTF bank over a weekend without the use of taxpayers' money. It includes elements of existing recapitalisation strategies in a way that retains their respective advantages and avoids their main pitfalls. It uses the market itself to determine the losses that creditors need to bear to recapitalise the bank and uses a temporary holding company to ensure that these losses are allocated in a way that strictly follows the creditor hierarchy. Compared with other approaches, the proposed mechanism may be the *only* approach that can simultaneously (i) respect the existing creditor hierarchy (maximising cost efficiency); (ii) achieve a recapitalisation over the weekend providing investors with immediate certainty on their maximum loss (limiting risks to financial stability); and (iii) be applied to all uninsured creditors throughout a TBTF group (fully addressing moral hazard).



## Total credit as an early warning indicator for systemic banking crises<sup>1</sup>

*Credit-to-GDP gaps are valuable early warning indicators for systemic banking crises. As such, they are useful for identifying vulnerabilities and can help guide the deployment of macroprudential tools such as the build-up of countercyclical capital buffers. In line with Basel III recommendations, credit-to-GDP gaps can be further improved by taking account of all sources of credit to the private non-financial sector, rather than just bank credit. Drawing on a new BIS database, this special feature finds that total credit developments predict the risk of systemic crises better than indicators based solely on bank credit.*

*JEL classification: E44, G01.*

Financial crises are usually preceded by private sector credit booms.<sup>2</sup> This insight can be used to construct early warning indicators for crises. Yet much of the work on such indicators is based only on credit granted by domestic banks, even though this aggregate excludes lending from non-banks or foreigners. However, such lending can be significant. A new BIS database reveals, for example, that banks may provide as little as 30% of total credit to the private non-financial sector, as is currently the case in the United States.

This special feature assesses whether credit from all sources (ie total credit) has different early warning properties than bank credit. It extends previous BIS work (eg Borio and Lowe (2002), Borio and Drehmann (2009)) which finds that credit booms can be successfully captured by the so-called credit-to-GDP gap.<sup>3</sup> In particular, the analysis draws on the new BIS database covering bank and total credit to the private non-financial sector (Dembiermont et al (2013)). The sample comprises 39 emerging market and advanced economies, starting at the earliest in 1970 and capturing 33 crises.<sup>4</sup>

<sup>1</sup> The views expressed are the author's and do not necessarily reflect those of the BIS. I would like to thank Claudio Borio and Christian Upper for helpful comments.

<sup>2</sup> See eg Borio and Lowe (2002), Borio and Drehmann (2009), Reinhart and Rogoff (2009), Gourinchas and Obstfeld (2012) or Jorda et al (2011).

<sup>3</sup> Credit-to-GDP gaps in these earlier BIS papers are based on bank credit series, except for the United States, where total credit is used.

<sup>4</sup> The new database is available on the BIS website ([www.bis.org/statistics/credtopriv.htm](http://www.bis.org/statistics/credtopriv.htm)). For the empirical implementation, a homogenous sample is used, where both bank and total credit are observed. Crisis dates are the same as in Drehmann et al (2011).

The analysis has practical implications. In particular, the credit-to-GDP gap was adopted as a common reference point under Basel III to guide the build-up of countercyclical capital buffers (BCBS (2010)). For calculating the gap, the Basel III guidelines suggest that “ideally the definition of credit should include all credit extended to households and other non-financial private entities in an economy independent of its form and the identity of the supplier of funds” (p 10), ie that total credit should be used.<sup>5</sup> The findings are consistent with this recommendation.

## The early warning properties of total and bank credit

Credit series are defined by several characteristics, including, most importantly, the borrower, the lender and the financial instrument(s). Both total and bank credit series used here capture borrowing by the private non-financial sector (ie households and non-financial corporations) and cover the same set of financial instruments, including loans and debt securities such as bonds or securitised loans. But they differ in terms of lenders. The total credit series provided by the new BIS database capture, as much as possible, all sources of credit, independent of the country of origin or type of lender. This goes well beyond the provision of credit by domestic depository corporations – such as commercial banks, savings banks or credit unions that are covered by traditional bank credit series – to include eg securitised credits held by the non-bank financial sector and cross-border lending (Dembiermont et al (2013)).

For both credit series, credit-to-GDP gaps are derived, in line with the Basel III guidelines for the countercyclical capital buffer, as the deviations of the credit-to-GDP ratios from their one-sided (real-time) long-term trend.<sup>6</sup> Trends are calculated using a one-sided Hodrick-Prescott filter with a smoothing factor lambda of 400,000, taking account only of information up to each point in time.<sup>7</sup>

Graph 1 shows that the total and bank credit-to-GDP gaps (or, for convenience, the “total gap” and the “bank gap”) can give different signals about credit developments. For instance, in the United Kingdom (Graph 1, left-hand panel), the bank gap did not signal any large credit build-up ahead of the recent crisis. In contrast, the total gap clearly captured the run-up in credit from the early 2000s onwards. This reflects the part played by non-bank funding, eg via securitisation, as the boom’s main driver. And different signals also emerge from the total and bank gaps even for highly bank-based systems such as Germany’s, at least in certain periods (Graph 1, centre panel). If we look more specifically at the years ahead of the 33 crises in the sample, the right-hand panel shows that both gaps are generally elevated during this phase. But the total gap is on average higher and rises more strongly than the bank gap, suggesting that it may be the better indicator.

<sup>5</sup> The guidance document gives two reasons for using total credit. First, banks can suffer the consequences of a period of excess credit, even if their own lending did not expand significantly. Second, using a broad definition of credit may also limit the scope for unintended consequences such as incentivising banks to divert the supply of credit to other parts of the financial system.

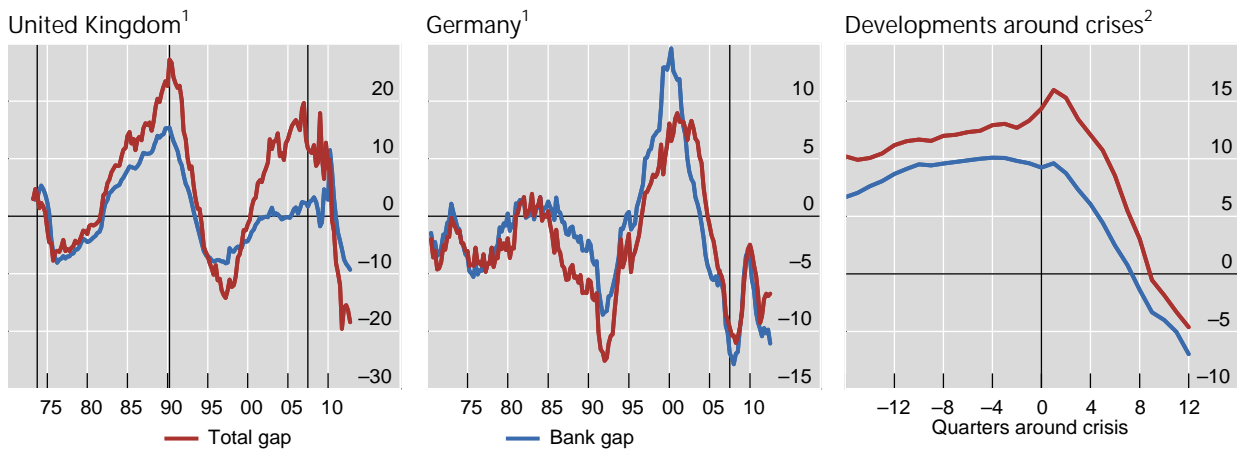
<sup>6</sup> More precisely, trends are calculated in a quasi-real-time fashion, as they are not based on data that would have been available at each point in time. Research for the United States suggests that this is not a problem because data revisions do not alter the credit-to-GDP gap in any significant way (Edge and Meisenzahl (2011)).

<sup>7</sup> The rationale for using this approach is discussed in detail by Drehmann et al (2011).

## Development of total and bank gaps

In percentage points

Graph 1



<sup>1</sup> The vertical lines indicate the beginning of systemic crises. <sup>2</sup> The total/bank gap corresponds to the respective averages across all observations in a particular quarter.

Sources: National data; author's calculations.

To formally assess the early warning properties of the different credit-to-GDP gaps, this paper follows the methodological approach used by previous BIS studies (Borio and Lowe (2002), Borio and Drehmann (2009) and Drehmann et al (2011)). These studies have, in turn, built on work by Kaminsky and Reinhart (1999). The method is simple: for each period and country, a signal is calculated. The signal takes the value of 1 (is "on") if the credit-to-GDP gap exceeds a critical threshold; it is 0 ("off") otherwise. A signal of 1 (or 0) is judged to be correct if a crisis occurs (or does not occur) at any time within the next three years, allowing the fraction of correctly predicted crises as well as incorrect calls (type II errors) to be calculated. The noise-to-signal ratio provides a useful summary statistic, as it is the ratio of type II errors to one minus the fraction of crises that were not called (type I errors). The classification ability of both credit gaps is estimated for thresholds between two and 10. These correspond to the respective thresholds set out in the Basel III guidelines that suggest when countercyclical capital buffers should start to be built up and raised to their maximum level.

Both the total gap and the bank gap provide useful early warning signals (Table 1), but the total gap is the more informative.<sup>8</sup> For each threshold, it predicts a greater proportion of crises without providing significantly more false alarms, as evidenced by the similar noise-to-signal ratios. Differences are particularly stark for the upper thresholds. In these cases, the bank gap captures fewer than two thirds of the crises. Borio and Drehmann (2009) suggest that a two-thirds level of accuracy is a minimum requirement (in the absence of any concrete information about policymakers' loss functions) as it represents an acceptable trade-off between the costs of missing a crisis and those of false alarms. That said, the performance of both types of credit gap is very good compared with other potential indicators of systemic crises (Drehmann et al (2011)).

<sup>8</sup> This is in line with the findings of Avdjiev et al (2012), who show that international credit – a potentially important component of total credit – is a key determinant of credit booms in emerging markets.

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## The performance of various credit-to-GDP gaps as early warning indicators

In per cent

Table 1

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Threshold	Bank gap		Total gap	
	Predicted <sup>1</sup>	Noise-to-signal ratio <sup>2</sup>	Predicted <sup>1</sup>	Noise-to-signal ratio <sup>2</sup>
2	85	46	91	48
4	76	36	85	41
6	73	26	82	33
8	58	24	79	26
10	48	21	70	22

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<sup>1</sup> Fraction of correctly predicted crises. <sup>2</sup> Ratio of type II errors (crisis signal issued, but no crisis occurred) to the fraction of predicted crises.

Sources: National data, author's calculations.

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While Table 1 shows the good statistical performance of both credit-to-GDP gaps, judgment is likely to play an important role in practice (BCBS (2010)). Obviously, neither indicator is perfect, ie both issue some wrong signals. Even so, errors in the statistical sense are not necessarily errors from a policy perspective. First, indicators may signal crises “too early”. In several cases, credit-to-GDP gaps issued warning signals four, five or even more years before a crisis, as in the United Kingdom before the last two crises (Graph 1, left-hand panel). Given the three-year forecast horizon, these signals are classified as type II errors, even though they ultimately proved to be correct. Second, not all vulnerabilities identified by the gaps necessarily end in a crisis. This was the case for Germany, for example, around the turn of the century (Graph 1, centre panel). Even though no crisis eventuated, the German banking sector experienced sufficient stress in the early 2000s to have warranted the build-up and subsequent release of macroprudential instruments (CGFS (2012)). Finally, crises can be triggered by banks’ international exposures rather than by domestic vulnerabilities as measured by the gaps. Again, Germany is a good example, in that the recent crisis was fuelled by losses stemming mainly from exposures in the United States and Ireland.<sup>9</sup>

## Conclusion

This article finds that both the bank and the total credit-to-GDP gaps provide powerful early warning indicators for systemic banking crises. As such, both types of indicator can help to identify vulnerabilities or guide the deployment of macroprudential tools such as countercyclical capital buffers. But, as suggested in the Basel III guidelines, gaps based on all sources of credit are likely to provide a more accurate indication of impending systemic crises.

<sup>9</sup> Omitting crises that were driven by international exposures (Germany, Sweden and Switzerland in 2007 and 2008) slightly improves the statistical performance of both gaps for all thresholds.



## References

Avdjiev, S, R McCauley and P McGuire (2012): "Rapid credit growth and international credit: challenges for Asia", *BIS Working Papers*, no 377.

Basel Committee on Banking Supervision (2010): *Guidance for national authorities operating the countercyclical capital buffer*.

Borio, C and M Drehmann (2009): "Assessing the risk of banking crises – revisited", *BIS Quarterly Review*, March, pp 29–46.

Borio, C and P Lowe (2002): "Assessing the risk of banking crises", *BIS Quarterly Review*, December, pp 43–54.

Committee on the Global Financial System (2012): "Operationalising the selection and application of macroprudential instruments", *CGFS Publications*, no 48.

Dembiermont, C, M Drehmann and S Muksakunratana (2013): "How much does the private sector really borrow? A new database for total credit to the private non-financial sector", *BIS Quarterly Review*, March, pp 65–81.

Drehmann, M, C Borio and K Tsatsaronis (2011): "Anchoring countercyclical capital buffers: the role of credit aggregates", *International Journal of Central Banking*, vol 7, no 4, pp 189–240.

Edge, R and R Meisenzahl (2011): "The unreliability of credit-to-GDP ratio gaps in real time: implications for countercyclical capital buffers", *International Journal of Central Banking*, vol 7, no 4, pp 261–98.

Gourinchas, P and M Obstfeld (2012): "Stories of the twentieth century for the twenty-first", *American Economic Journal: Macroeconomics*, vol 4, no 1, pp 226–65.

Jorda, O, M Schularick and A Taylor (2011): "Financial crises, credit booms and external imbalances: 140 years of lessons", *IMF Economic Review*, vol 59, no 2, pp 340–78.

Kaminsky, G and C Reinhart (1999): "The twin crises: the causes of banking and balance-of-payments problems", *American Economic Review*, vol 89, no 3, pp 473–500.

Reinhart, C and K Rogoff (2009): *This time is different: eight centuries of financial folly*, Princeton University Press.



## Looking at the tail: price-based measures of systemic importance<sup>1</sup>

*We use tools of extreme value theory to extract information about rare events from market prices. We find that such information contributes materially to measures of banks' systemic importance. These measures exhibit strong and intuitive relationships with simple characteristics of banks' balance sheets and income statements.*

*JEL classification: G20, G28, C14.*

The more systemically important a financial institution, the stricter its regulatory requirements should be, all else the same. A Basel III capital surcharge is one manifestation of this macroprudential philosophy (BCBS (2011)). To apply the philosophy, policymakers need to measure systemic importance – that is, an institution's potential contribution to rare but extreme system-wide losses that damage the real economy (Drehmann and Tarashev (2011), Tarashev et al (2010)).

Analysing rare, extreme losses is always challenging because they relate to the tail of the probability distributions of financial shocks, about which data are scarce. In this article, we present an empirical method that addresses this challenge head on and thus provides a potentially useful input to policy discussions.

To illustrate the empirical method, we measure the systemic importance of banks by analysing *explicitly* the tail properties of financial shocks. Two components of this measure are bank size, which we obtain from balance sheet data, and probability of default (PD), for which we rely on commercial estimates. For the other two components – a bank's loss-given-default (LGD) and tendency to default with other banks – we resort to changes in CDS spreads, which reflect shocks to banks' creditworthiness (Jorion and Zhang (2007)). It is tail realisations of such shocks that drive rare but extreme losses in the banking system.

For the analysis of shocks to banks' creditworthiness, we use tools from extreme value theory (EVT). The fundamental idea behind EVT is to focus exclusively on extreme observations in the data, evaluate them and attribute their properties to the *unobserved* tail of shocks' probability distribution. EVT has been applied in

<sup>1</sup> The views expressed in this article are those of the authors and do not necessarily reflect those of the Netherlands Bank or the BIS. We thank Angelika Donaubaue for excellent help with the graphs and tables, and Claudio Borio, Stephen Cecchetti, Kostas Tsatsaronis and Christian Upper for useful comments on earlier drafts.

analyses of natural disasters and, since the 1990s, financial crises. The contribution of this article is to employ EVT tools in estimating banks' LGD and tendency to default with others as components of a measure of systemic importance.

By focusing on extreme observations, EVT tools should extract better information about unobserved tail events than alternative approaches that fit *typical* observations to well known probability distributions. But do these tools deliver materially different conclusions? We argue that they do. We find that the EVT-based method and a popular alternative approach disagree substantially on the ranking of banks according to systemic importance.

To further assess the value added of EVT in our context, we examine the extent to which changes in banks' size, PD, LGD and tendency to default with others alter measured systemic importance. We find that the impact of the last two components, which we estimate with EVT tools, is economically significant and similar to that of the first two components, which we obtain directly from the data. In addition, the impact of size, PD and LGD is statistically significant at a high confidence level.

Finally, we examine whether simple balance sheet and income statement characteristics, which are manifestations of banks' business models, can help explain EVT-based measures of systemic importance. We find that the more systemically important banks in our sample tend to be larger, more leveraged and more active in the interbank market than their peers. By contrast, the banks of lesser systemic importance tend to have a higher share of net interest income in total income, resort more to stable sources of funding and exhibit greater operational efficiency.

In the rest of this article, we first define our measure of systemic importance and outline its derivation, paying particular attention to alternative approaches to assessing the tail properties of financial shocks. We then evaluate the extent to which different drivers contribute to the evolution of banks' relative systemic importance over time. Finally, we investigate whether simple bank characteristics can help explain banks' relative systemic importance at particular points in time.

## Measuring systemic importance

Before we measure the systemic importance of individual institutions, we need to measure system-wide risk. We equate this risk with the expected credit losses on banks' debt in systemic events, in which losses are large enough to impair financial intermediation and potentially damage the real economy. Concretely, we define a systemic event as one in which the aggregate credit losses exceed a certain fraction of banks' aggregate debt. We abstract from the risks faced by banks' equity holders on the assumption that equity is loss-absorbing and, unless fully depleted, ensures a bank's proper functioning.

Systemic importance is a bank's share in system-wide risk. We define this share to be equal to the expected losses of the bank's creditors in a systemic event. According to this definition, the sum of systemic importance measures across banks is exactly equal to the measure of system-wide risk.

Systemic importance increases with the magnitude of the losses that a defaulting bank gives rise to and with the likelihood that it defaults in a systemic event. Concretely, the larger a bank's debt, the greater the losses it imposes on

creditors and the greater the likelihood that its default leads to a systemic event. Henceforth, we refer to the size of a bank's debt as the bank's size. Thus, a bank of a larger size would be of greater systemic importance, all else the same. For similar reasons, the larger the portion of a bank's debt lost in default – ie the larger the *LGD* – the greater the bank's systemic importance. In turn, a bank with a higher (unconditional) probability of default, or *PD*, is more likely to default in a systemic event, all else the same. And this likelihood increases further with the probability that extreme adverse shocks affect the bank at the same time as other banks, or as the *tendency to default with others* increases. Thus, a bank's systemic importance increases with its PD and tendency to default with others.

In the appendix, we derive that the systemic importance of bank *i*, or  $SI_i$ , is the product of three terms:

$$SI_i = size_i \cdot LGD_i \cdot Pr(\text{bank } i \text{ defaults} \mid \text{systemic event}) \quad (1)$$

The last term is the probability of default given a systemic event, or *PDS*. Each of the systemic importance components discussed above – size, PD, LGD and tendency to default with others – affects PDS.

## Data and methodology

Our sample consists of 50 large banks headquartered in different parts of the world. Specifically, these are the top 50 banks in terms of total assets (as reported by Bankscope for 2011) for which, in addition to balance sheet data, there are also CDS data (from Markit) and data on expected default frequencies (EDFs, from Moody's KMV). These institutions include 24 European, eight US, five Japanese and four Australian banks, as well as nine banks from emerging market economies.

We think of the 50 banks as forming a system and calculate yearly measures of systemic importance for each one from 2007 to 2011. For these measures, we use the data as follows. First, constrained by data limitations, we set size to be equal to the bank's total non-equity liabilities, net of derivative liabilities, at the end of the year in focus. Ideally, however, the measure of size would have incorporated derivatives positions, as they provide important information about the repercussions of bank defaults.<sup>2</sup> Second, we use one-year EDFs as estimates of banks' unconditional PDs. Third, we combine such PDs with data on CDS spreads, observed over a two-year period ending at the end of the year in focus, to estimate a bank's LGD and its tendency to default with other banks (see below).

Once we have estimates of the four components – size, LGD, PD and tendency to default with others – we proceed as follows. We use the size and LGD estimates as the first two terms of a bank's systemic importance in equation (1). Then, following Huang et al (2009), we define systemic events to be those in which the aggregate default-related losses (eg writedowns) on banks' debt exceed 15% of the

<sup>2</sup> Our methodology would accommodate such a measure of size. In this article, however, we abstract from derivatives as they are reported differently by banks following different accounting rules. Since our analysis focuses exclusively on banks' *relative* systemic importance, the conclusions are affected to the extent that the share of derivatives positions in total non-equity liabilities differs materially across banks.

overall size of this debt in the system.<sup>3</sup> On the basis of this definition, we use banks' sizes and LGDs to identify the systemic events. Next, using the estimates of PDs and tendencies to default with others, we derive the probability of the systemic events in which a particular bank defaults and the probability of all systemic events. The ratio of the first to the second probability is the bank's probability of default in a systemic event, which is the third term in equation (1). Finally, the product of the three terms is our measure of systemic importance.

We next outline the estimation of banks' LGD and tendency to default with others. To fix ideas, we start with the ideal case of plenty of observations from the tail of financial shocks' distribution, which prompts a straightforward estimation procedure. We then turn to the realistic case of no such observations, which calls for using EVT tools.

### Ideal case: observations in the tail of interest

Suppose that we observe daily shocks affecting the creditworthiness of each bank in the system. A standard expositional device of the credit risk literature is to identify a bank-specific threshold value for these shocks, beyond which the bank is in default. If we assume that there are plenty of observations of shocks' exceeding the default threshold of each bank in the system, then a PD estimate for a given bank helps to locate the corresponding default threshold. Namely, the location needs to be such that the PD estimate is equal to the share of shocks exceeding the threshold in the total number of shocks affecting the bank.

We think of LGD as reflecting a bank's distress when in default. This makes it natural to estimate LGD as the average distance between adverse shocks that exceed the default threshold and the threshold itself. Since LGD is the share of a bank's debt lost in default, its estimate should be roughly zero if shocks barely exceed the threshold, and should approach 100% for very large shocks. To implement this idea, we would focus on the observed shocks that exceed the threshold. Then we would measure LGD as the average difference between each of these shocks and the threshold, divided by the average value of the same shocks.

To estimate the tendency of a bank to default with a group of other banks, we would need to consider the cases in which all banks concerned experience extreme adverse shocks. Specifically, we would first obtain the number of days for which the shocks affecting *each* bank in the group surpass the corresponding default threshold. Then, focusing on the same days, we would obtain the number of days when the shocks affecting the bank we are interested in also exceed the corresponding threshold. The ratio of the second to the first number of days would be our estimate of the tendency of a bank to default with others.

<sup>3</sup> In practice, policymakers would need to determine the level of system-wide losses beyond which an event would be considered systemic. Given our parameterisation, the default of the eight largest banks in the sample would constitute a systemic event. Admittedly, the most recent financial crisis featured fewer outright defaults by large banks, but this was essentially the result of massive public sector interventions that kept many distressed institutions afloat. Policymakers need to factor out such interventions in assessing banks' systemic importance.

## Real-world case: no observations in the tail of interest

Since the shocks affecting banks' creditworthiness are unobservable, we approximate them with daily *changes* in banks' CDS spreads (Jorion and Zhang (2007)). Markets' appetite for risk, which introduces noise in risk estimates, affects such high-frequency changes to CDS spreads to a lesser degree than the spreads' *levels*. Provided that risk appetite evolves slowly over time, we further limit its role by using a short, two-year sample period for CDS spread changes.

However, this sample period is too short to reveal any direct information about shocks that exceed default thresholds, ie about the tail of interest. The highest PD in our sample implies that, if shocks are daily and independent over time, they would surpass the corresponding default threshold with a probability of 0.13%. The two years of daily CDS spread changes we use provide us with roughly 520 observations of such shocks. Since these observations do not reveal direct information about events occurring with probability of less than 0.2% ( $= 1 / 520$ ), extrapolation is unavoidable. We now compare and contrast two alternative extrapolation methods.

One of the methods is based on extreme value theory (EVT). The fundamental idea underlying EVT is that extreme observations are representative of the tails of the underlying probability distribution (de Haan and Sinha (1999)). We combine EVT-based tools with PD estimates to select *observed* thresholds of CDS spread changes, beyond which the data points are representative of the shocks exceeding the *unobserved* default thresholds for financial shocks. At an intuitive level, the lower the PD, the fewer and more extreme the selected data points.<sup>4</sup> In Graph 1 (left-hand panel), where we plot the daily CDS spread changes for two banks over two years, EVT tools indicate that the observations in red carry information about the tail of interest.

Once we have identified the observed thresholds and the data points that exceed them, we implement the estimation algorithm outlined in the previous subsection. Thus, large differences between the selected data points and the corresponding threshold would lead to a high LGD estimate, as they imply a high likelihood that the losses on the bank's debt would be severe.<sup>5</sup> Likewise, selected data points that have a strong positive correlation across banks would result in high estimates of banks' tendency to default with others.

The alternative approach we consider assumes that the shocks driving banks into default are normal random variables (Li (2000)). It calls for estimating the sample mean and variance-covariance matrix of the CDS spread changes. These two estimates, which reflect mainly information about typical shocks, pin down a normal distribution. The approach uses the analytic formulas characterising this distribution to extrapolate as far into the tail as desired.

To compare the implications of the two approaches, we simulate two years of data from a normal distribution that has the same mean and variance-covariance matrix as the actual CDS spread changes for the two banks in Graph 1. We plot the

<sup>4</sup> Choosing more data points reduces the random noise in our tail estimate but also brings in more information about the centre of the distribution, thus introducing a bias in the tail estimate. To obtain an optimal mix between random estimation noise and bias, we rely on the selection methodology developed in de Haan and de Ronde (1998).

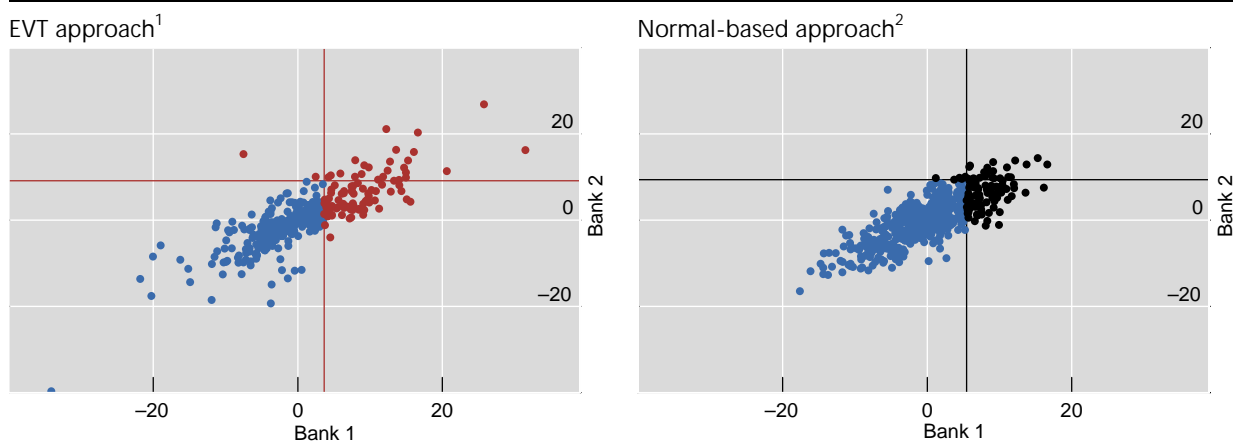
<sup>5</sup> We rescale our LGD estimates so that they average 50% across banks and years. This is a frequently used value in the credit risk literature. The higher the average LGD, the lower the number of defaulting banks that would generate a systemic event, all else the same.

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## Two approaches to estimating the tail

In basis points

Graph 1



The red and black dots correspond to the same percentiles of the respective distributions. The vertical (horizontal) reference lines correspond to the observed thresholds for bank 1 (bank 2).

<sup>1</sup> Daily changes in CDS spreads between 1 January 2010 and 31 December 2011, for two banks in the sample. The red dots indicate the data used by the EVT approach. <sup>2</sup> Simulated data, drawn from a normal distribution that has the same mean and variance-covariance matrix as the data in the left-hand panel.

Sources: Markit; authors' calculations.

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outcome in the right-hand panel and flag extreme observations with black dots. A casual comparison between the two panels reveals that the black dots associated with the normal distribution are clustered more closely to the default thresholds and are less synchronised across the two banks than the red dots associated with the actual data. In the light of the above discussion, it then comes as no surprise that the normal distribution leads to an estimated probability of the two banks defaulting together that is less than two thirds of the corresponding estimate under the EVT approach. This is a general phenomenon. The ratios between the normal-based and EVT estimates of the probability of joint defaults average about one third across all pairs of banks in our sample and are smaller than unity for 95% of the pairs.

In contrast to approaches that rely on the analytical formulas describing *entire* distributions, the EVT approach focuses exclusively on the tails of interest. Of course, it could happen that typical shocks describe these tails well and, thus, the EVT and normal-based approaches lead to similar conclusions. In other cases, the EVT approach could agree with an approach based on a distribution that implies a high probability of extreme shocks and high degree of synchronisation of such shocks across institutions, such as a Student's *t*-distribution. What sets EVT apart is that it is flexible enough to seamlessly account for tail properties that differ across banks and change over time.

## Empirical results on systemic importance

Our analysis of the measures of systemic importance has four takeaways. First, the conclusions reached by applying the EVT approach differ materially from those obtained on the assumption that shocks have a normal distribution. Second, even



though we can confidently differentiate many banks according to their EVT-based measures of systemic importance, substantial uncertainty remains. Third, each component of these measures – size, PD, LGD and the tendency to default with others – materially affects the evolution of banks' relative systemic importance over time. Fourth, simple bank characteristics help to explain the variation of EVT-based measures of systemic importance in the cross section.

We focus the analysis on the way in which the price-based measures of systemic importance differentiate banks, either through their ranking or their *relative* systemic importance. Our choice reflects existing evidence that markets have done a reasonable job in differentiating banks *ex ante* with respect to their losses in a financial crisis (Acharya et al (2009)). This contrasts with markets' failure to accurately assess the actual level of system-wide risk and, thus, the *level* of individual institutions' systemic importance (BIS (2011), Chapter VI).

### EVT versus normal-based ranking of banks

Do different empirical approaches to evaluating the tail properties of the data rank banks differently in terms of their systemic importance? To answer this question, we compare banks' rankings under the normal-based approach to those under the EVT approach. In a given year, we obtain the absolute difference between the two alternative rankings for each bank and then take an average in the cross section. The resulting average ranking change (ARC) is substantial. For the entire sample of 50 banks over five years, ARC ranges from roughly five positions in 2011 to seven positions in 2008. Similarly, for the 25 most systemically important banks according to the EVT approach, ARC varies between roughly five positions in 2007 and seven positions in 2009.

Given that the EVT- and normal-based approaches estimate an *unobservable* tail of the shocks' probability distribution, it is not possible to test which approach delivers more accurate results. A priori, however, the extreme observations on which the EVT approach focuses provide better information about the tail properties of financial shocks than the typical observations that strongly affect the conclusions of the normal-based approach. Thus, we analyse only EVT-based measures in the rest of this article.

### Uncertainty around banks' rankings

Can we confidently rank banks with respect to measured systemic importance? To address this question, we quantify the estimation noise around each point estimate and the correlation of this noise across banks (see Hartmann et al (2004)). Then, considering one bank at a time, we determine how many other banks are of statistically higher or lower systemic importance. Graph 2 reports the results for 2011, ordering banks from high to low systemic importance.

Graph 2 provides four pieces of information about each bank. First, the black dots indicate each bank's ranking according to the point estimate of its systemic importance. Second, the height of the white bar corresponds to the number of other banks whose systemic importance is statistically indistinguishable, with 95% confidence, from that of the bank in focus. Third, the height of the blue bar denotes the number of other banks that have significantly lower systemic importance. Fourth, the height of the red bar indicates the number of other banks with significantly higher systemic importance. In the absence of estimation noise, the

blue bars would reach up to the corresponding black dots, the red bars would extend down to these dots and the white bars would disappear.

Reassuringly, we can differentiate many banks with a high level of confidence. For instance, the systemic importance of all but one of the banks in the sample is statistically different from that of 28 or more other banks. That is, virtually every bank can be differentiated from more than half of the others in the sample.

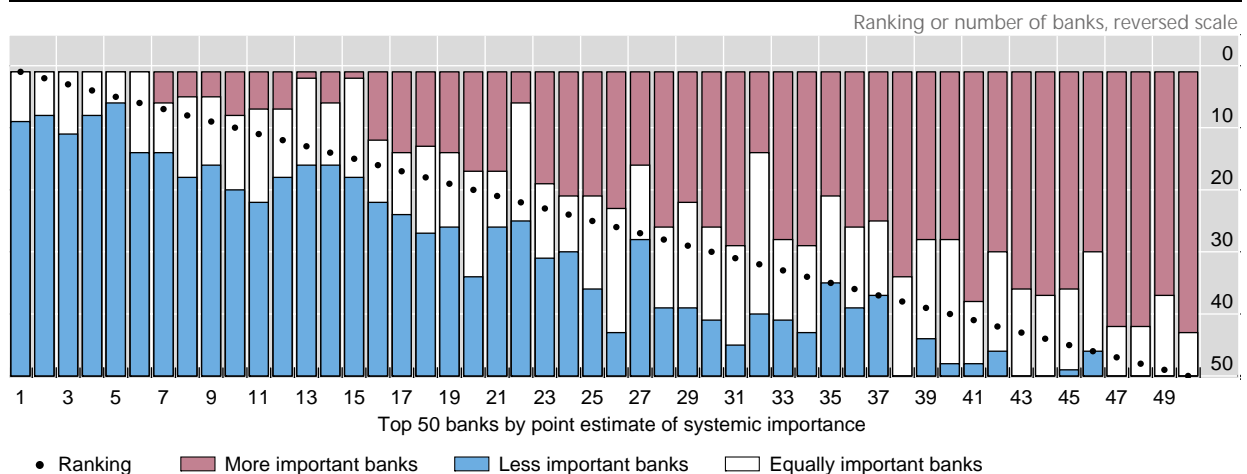
Admittedly, however, the differentiation across banks is far from perfect. For example, the banks ranked 13 and 15 can be confidently distinguished from only one other bank with a higher point estimate of systemic importance (see the corresponding red bars). In other words, the systemic importance of banks 13 and 15 is potentially much higher than what point estimates indicate. Conversely, bank 11 may be ranked too high, as 21 other banks could in fact be of greater systemic importance (see the combined height of the corresponding red and white bars). Thus, when interpreting results on systemic importance, careful attention must be paid to estimation noise.

Finally, putting estimation noise in the background, we find that banks' relative systemic importance varies considerably over time. To illustrate this, we calculate the systemic importance as a share in system-wide risk for the top 10 banks in 2011 (Graph 3). The most stable of these shares, that of bank 3, varies between 0.033 in 2007 and 0.053 in 2011, a range that amounts to almost 50% of the average share of this bank over the sample period. At the other extreme, bank 9 saw its share in system-wide risk range between 0.015 in 2008 and 0.084 in 2010, which amounts to 150% of the bank's average share over the sample period. This variability prompts us to examine the relative strength of the four components of our systemic importance measure – the two we obtain directly from the data and the two we estimate with EVT tools – as drivers of the measure's evolution over time. We do this in the next subsection.

## Differentiating banks according to systemic importance

With 95% confidence<sup>1</sup>

Graph 2



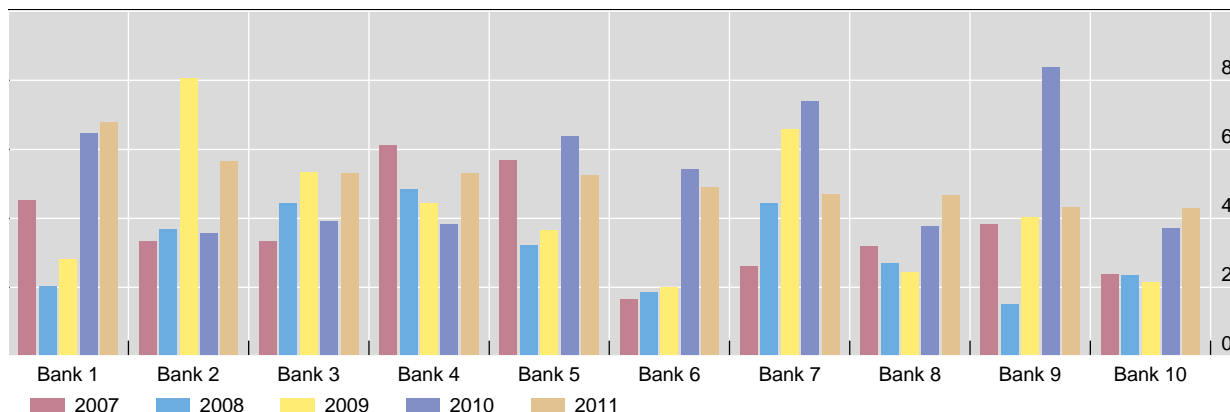
<sup>1</sup> Based on bootstrapped confidence intervals around point estimates for 2011. The height of the red (blue) bars corresponds to the number of significantly more (less) important banks. The height of the white bars corresponds to the number of other banks whose systemic importance cannot be distinguished from that of the particular bank at the chosen confidence level.

Sources: Bankscope; Markit; Moody's KVM; authors' calculations.

## Systemic importance over time<sup>1</sup>

Shares in system-wide risk, in per cent

Graph 3



<sup>1</sup> Banks' numbers correspond to their 2011 rankings in terms of systemic importance.

Source: Authors' calculations.

## Drivers of banks' relative systemic importance

We examine the extent to which the four components – a bank's size, PD, LGD and tendency to default with others – drive changes in banks' relative systemic importance from 2009 to 2011.<sup>6</sup> To this end, we derive what the estimates of banks' systemic importance would have been had one of the drivers remained as in 2009 while the other three changed to their 2011 levels. In Graph 4, we use diamonds to plot these hypothetical estimates for five banks, holding a different driver fixed in each panel. For instance, the diamond for bank 1 in the left-hand panel shows what this bank's systemic importance would have been in 2011 had it kept its 2009 size. In addition, we plot the corresponding *actual* estimates of systemic importance for 2009 (red dots) and 2011 (blue dots), which do not change across panels. In each case, we express systemic importance as a share in system-wide risk.

We find that each driver has a strong impact on the evolution of the point estimates of banks' relative systemic importance. This result reflects a comparison between two sets of rankings: one based on the actual measures for 2011, and one on the hypothetical measures. For each driver, we calculate the average ranking change (ARC) between the two sets of rankings and report the results in Table 1 (left-hand columns). Keeping any of the drivers as in 2009 leads to an ARC of seven to eight positions (first column). And this effect remains strong for the 25 most systemically important banks in 2011, for which the ARC is six to seven positions (second column).

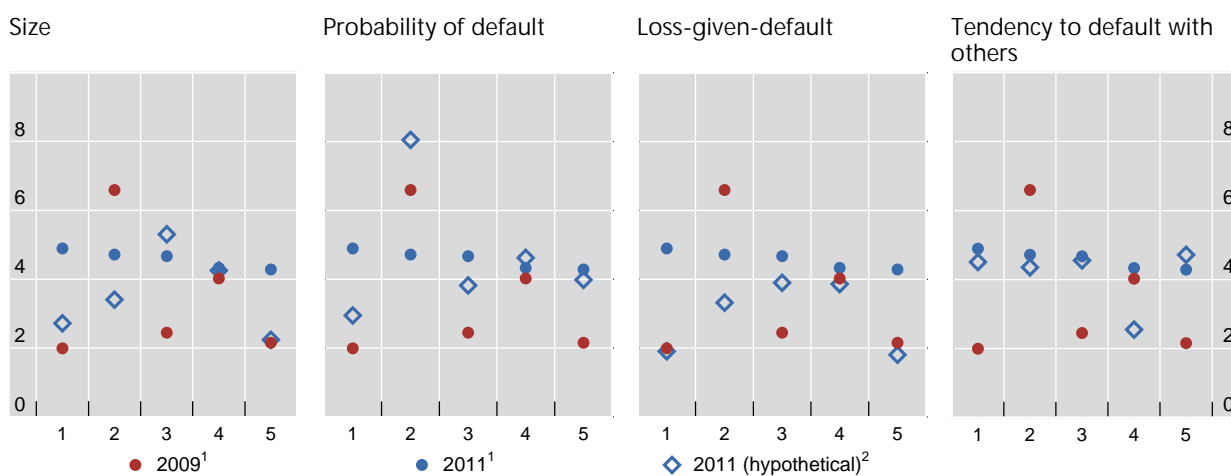
The general message is similar when we examine the statistical significance of the drivers' impact. For this exercise, we analyse the noise around the actual point estimates of relative systemic importance in 2009 and 2011 and the hypothetical point estimates. We say that a driver has a strong impact on a bank if the actual and hypothetical estimates for 2011 (the blue dots and diamonds in Graph 4) are

<sup>6</sup> The 2009 and 2011 estimates of systemic importance are based on *non-overlapping* two-year samples of CDS data.

## Strength of different drivers

In per cent

Graph 4



<sup>1</sup> Systemic importance, as a share in system-wide risk, for five banks in the sample. <sup>2</sup> Systemic importance, as a share in system-wide risk, when the driver indicated in the panel heading is held as in 2009 and the other three drivers are as in 2011.

Source: Authors' calculations.

statistically different at the 95% confidence level. As reported in Table 1 (third column), three of the four drivers – size, PD and LGD – have a statistically significant impact for at least half of the banks. And for 21 banks (= 7 + 12 + 2), size, PD or LGD is the only driver to have a statistically significant impact on measured systemic importance (fourth column).<sup>7</sup>

The analysis in this subsection underscores the strength of the drivers we obtained with EVT tools, ie banks' LGD and tendency to default with others. Each of these drivers has a material impact on the point estimates of banks' ranking according to systemic importance. And while the tendency to default with others comes with much estimation noise, LGD has a statistically significant impact on the relative systemic importance of half of the banks in the sample.

### Simple bank characteristics and systemic importance

Is there a relationship between our price-based measures of systemic importance and bank characteristics derived from balance sheets and income statements? If a relationship does exist, then it would shed light on which aspects of banks' business

<sup>7</sup> For a driver to qualify as the only one with a significant impact on a particular bank, three criteria must be satisfied. First, the actual estimate of the bank's relative systemic importance in 2011 has to be significantly different from the corresponding hypothetical estimate for which this driver is held as in 2009; ie the driver should have a statistically significant impact. Second, the same hypothetical estimate has to be statistically indistinguishable from the actual 2009 estimate for the bank. Third, the individual impact of each of the other three drivers on the bank should not be statistically significant.

## Drivers of systemic importance

Table 1

	Average rank change <sup>1</sup>		Impact on relative systemic importance <sup>2</sup>	
	All 50 banks	Top 25 banks	Significant impact <sup>3</sup>	Only significant driver <sup>4</sup>
Size	8	6	29	7
Probability of default	7	7	39	12
Loss-given-default	8	6	25	2
Tendency to default with others	8	7	1	0

<sup>1</sup> Average of the absolute differences between banks' rankings in 2011 and the corresponding rankings when the driver in the row heading is kept as in 2009 and all other drivers are as in 2011; rounded to a whole number. <sup>2</sup> Number of affected banks, at the 95% confidence level. Based on bootstrapped confidence intervals, expressing systemic importance as a share in system-wide risk. <sup>3</sup> The following condition must be satisfied: keeping the driver indicated in the row heading as in 2009 but letting all other drivers change to their 2011 levels leads to a measure of relative systemic importance that is statistically different from the actual measure for 2011. <sup>4</sup> Three conditions must be satisfied: (i) the driver indicated in the row heading has a significant impact on measured systemic importance; (ii) keeping this driver as in 2009 but letting all other drivers change to their in 2011 levels leads to a measure of relative systemic importance that is not statistically different from the actual measure for 2009; and (iii) the individual impact of each of the other drivers on measured systemic importance is not statistically significant.

Source: Authors' calculations.

models shape markets' perception of systemic importance.<sup>8</sup> We now look for such a relationship in the cross section of banks at each year in the sample.

To pursue our analysis, we focus on banks' probability of default in a systemic event (PDS), the third term of systemic importance in equation (1). There are two reasons for this choice. First, we find that LGD has a negligible impact through the second term on the variation of systemic importance in the cross section of banks. This is despite the key role of LGD as a driver of the evolution of banks' relative systemic importance over time (as described in the previous subsection). Second, the first term – bank size – is directly related to a balance sheet feature by construction, ie non-equity liability net of derivative liabilities.

We investigate the relationship between PDS and six bank characteristics. The first is bank *size*, as defined above, which we consider because a systemic event is more likely to feature defaults by larger banks. The second characteristic is *leverage*, or assets divided by equity, which is a proxy for a bank's credit riskiness and, thus, for its unconditional PD. The third is the *stable funding ratio* – defined as customer deposits and long-term debt over total liabilities – which reflects the extent of funding liquidity risk to which a bank is exposed. The fourth characteristic is the ratio of interbank to total assets and captures *interbank links* that affect the tendency to default with others. The fifth variable is *net interest income* as a share in total net income. Interest income tends to be the most robust income type, thus contributing to banks' resilience at a time of general distress (BIS (2012), Chapter VI). Finally, the *cost-to-income ratio* is inversely related to a bank's efficiency and, by extension, to the capacity to cut costs in order to stay afloat at a time of widespread difficulties. We would expect size, leverage, interbank links and cost-to-income to be positively related to PDS, and the stable funding ratio and net interest income to be negatively related to PDS.

<sup>8</sup> See Ayadi et al (2012) for a broad analysis of business models in banking. Building on that paper, Blundell-Wignall and Roulet (2012) use business model indicators to explain banks' distance-to-default, a measure akin to an unconditional PD.

Simple bank characteristics and probability of default in a systemic event<sup>1</sup>

Table 2

	Bivariate relationships <sup>2</sup>					Multivariate regression: decomposing the goodness of fit <sup>3</sup>				
	2007	2008	2009	2010	2011	2007	2008	2009	2010	2011
Size	0.29**	0.19	0.25*	0.47***	0.36**	0.03	0.03	0.05	0.18***	0.08**
Leverage	0.41***	0.07	0.18	0.33**	0.41***	0.09	0.00	0.03	0.07*	0.13***
Cost-to-income	0.41***	0.25*	0.33**	0.43***	0.50***	0.12**	0.06*	0.09**	0.14***	0.21***
Interest income	-0.28*	-0.06	-0.09	-0.24*	-0.26*					
Stable funding	-0.01	-0.21	-0.18	-0.20	-0.33**					
Interbank links	0.18	0.36**	0.13	0.31**	0.30**					
<i>Total R-squared</i>						<i>0.24</i>	<i>0.09</i>	<i>0.17</i>	<i>0.39</i>	<i>0.42</i>

\*\*\*, \*\* and \* indicate significance at the 99%, 95% and 90% confidence levels, respectively.

<sup>1</sup> Size = total non-equity liabilities minus derivative liabilities; leverage = total assets minus derivative assets divided by total equity; cost-to-income = operating expenses divided by total net income; interest income = net interest income, as a share in total net income; stable funding = customer deposits plus long-term debt as a share in total liabilities; interbank links = interbank assets as a share in total assets minus derivative assets. <sup>2</sup> Cross-sectional correlation between the variable in the row heading and the probability of default in a systemic event. <sup>3</sup> Obtained from a linear regression of the probability of default in a systemic event on size, leverage and cost-to-income. The top three numbers in each column add up exactly to the fourth.

Source: Authors' calculations.

Table 2 (left-hand columns) reveals that *all* bivariate relationships are of the expected sign, in each year of the sample. In terms of statistical significance, these relationships weaken during the crisis years, 2008 and 2009, but are in general quite strong both before and after. Interestingly, the cost-to-income ratio is the characteristic that most consistently helps to differentiate banks with respect to PDS. By extension, this finding suggests that, when evaluating the likelihood that a bank will fail in a systemic event, markets appear to pay closer attention to efficiency than to size or leverage. Less surprisingly, stronger interbank links and less reliance on interest income tend to be associated with a high PDS.

We also explore the extent to which several bank characteristics can *simultaneously* explain PDS. Unfortunately, because different characteristics tend to go hand in hand, using them simultaneously in regression analysis makes it hard to distinguish their separate relevance. This leads us to a parsimonious specification in which we explain PDS on the basis of bank size, leverage and cost-to-income ratio, in each of the five years in the sample.

The resulting goodness-of-fit measures (Table 2, right-hand panel) confirm the general message from the bivariate analysis: simple bank characteristics can explain PDS quite well before and especially after the peak of the crisis, but fare quite poorly in 2008 and 2009. The characteristic with the strongest and most robust explanatory power is again the cost-to-income ratio.

## Conclusions

Measuring systemic importance involves analysis of rare, tail events, about which relevant data are scarce. In trying to address this issue, we employ tools of extreme value theory to infer the tail properties of financial shocks from market prices. We find that exploiting these properties enhances our understanding of systemic

importance and delivers measures that exhibit strong and intuitive relationships with simple bank characteristics.

Of course, the measures of systemic importance we derive paint only part of the picture. They reflect prices from only one market and are limited to publicly available data on banks' balance sheets and credit risk. Thus, they need to be complemented by information from other financial markets and supervisory assessments of banks' riskiness and interconnectedness.

## References

Acharya, V, L Pedersen, T Philippon and M Richardson (2009): "Measuring systemic risk", New York University, mimeo.

Ayadi, R, E Arbak and W P de Groen (2012): "Regulation of European banks and business models: towards a new paradigm?", Centre for European Policy Studies.

Bank for International Settlements (2011): *81st Annual Report*.

——— (2012): *82nd Annual Report*.

Basel Committee on Banking Supervision (2011): *Global systemically important banks: assessment methodology and the additional loss absorbency requirement*, consultative document, July.

Blundell-Wignall, A and C Roulet (2012): "Business models of banks, leverage and the distance-to-default", *OECD Journal: Financial Market Trends*, vol 2012, issue 2.

de Haan, L and J de Ronde (1998): "Sea and wind: multivariate extremes at work", *Extremes*, vol 1, no 1, pp 7–45.

de Haan, L and AK Sinha (1999): "Estimating the probability of a rare event", *The Annals of Statistics*, vol 27, no 2, pp 732–59.

Drehmann, M and N Tarashev (2011): "Measuring the systemic importance of interconnected banks", *BIS Working Papers*, no 342.

Hartmann, P, S Straetmans and C de Vries (2004): "Asset market linkages in crisis periods", *Review of Economics and Statistics*, vol 86, no 1, pp 313–26.

Huang, X, H Zhou and H Zhu (2009): "A framework for assessing the systemic risk of major financial institutions", *Journal of Banking and Finance*, vol 33, no 11, pp 2036–49.

Li, D (2000): "On default correlation: a copula function approach", *Journal of Fixed Income*, vol 9, no 4, pp 43–54.

Jorion, P and G Zhang (2007): "Good and bad credit contagion: evidence from credit default swaps", *Journal of Financial Economics*, vol 84, no 3, pp 860–83.

Tarashev, N, C Borio and K Tsatsaronis (2010): "Attributing systemic risk to individual institutions", *BIS Working Papers*, no 308.



## Annex: Defining systemic importance

In this annex, we present a formal definition of our measure of systemic importance. In our analysis we define a systemic event as an event in which the aggregate losses on the debt of all banks in the system exceed some fraction,  $\alpha$ , of the size of this debt. Concretely, a systemic event occurs when  $\sum_{j=1}^N L_j > \alpha \sum_{j=1}^N Size_j$ . In this expression, an index  $j$  refers to a particular bank,  $L_j$  is the loss on this bank's debt,  $Size_j$  denotes the size of this debt, and  $N$  is the total number of banks in the system.

We equate the systemic importance of bank  $i$ , or  $SI_i$ , with the expected loss on this bank's debt in systemic events:  $SI_i = E(L_i | \sum_{j=1}^N L_j > \alpha \sum_{j=1}^N Size_j)$ . Then, we write the loss  $L_i$  as the product of the bank's debt, the fraction of this debt that is lost at default, and an indicator that is equal to one if the bank is in default and zero otherwise:  $L_i = Size_i \cdot LGD_i \cdot I_i$ . Finally, treating size and loss-given-default (LGD) as parameters, we obtain an explicit version of equation (1) in the main text:

$$SI_i = Size_i \cdot LGD_i \cdot Pr(I_i = 1 | \sum_{j=1}^N L_j > \alpha \sum_{j=1}^N Size_j).$$