BANK FOR INTERNATIONAL SETTLEMENTS

BIS Quarterly Review

December 2014

International banking and financial market developments

BIS Quarterly Review
Monetary and Economic Department

General queries concerning this commentary should be addressed to Christian Upper (tel +41 61 280 8416, e-mail: christian.upper@bis.org), queries concerning specific parts to the authors, whose details appear at the head of each section, and queries concerning the statistics to Philip Wooldridge (tel +41 61 280 8006, e-mail: philip.wooldridge@bis.org).

This publication is available on the BIS website (www.bis.org/publ/qtrpdf/r_qt1412.htm).

ISSN 1683-0121 (print)
ISSN 1683-013X (online)

BIS Quarterly Review

December 2014

International banking and financial market developments

Special Features

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.

Buoyant yet fragile?[1]

Markets remain buoyant despite mid-October's spike in the volatility of most asset classes. This sharp retreat in risk appetite reflected growing uncertainty about the global economic outlook and monetary policy stance, as well as increased geopolitical tensions. As selling pressure increased, market liquidity temporarily dried up, amplifying market movements.

Markets rebounded quickly as economic concerns faded and some major central banks further eased monetary policy. In particular, the Bank of Japan and the ECB provided further stimulus, while the Federal Reserve ended its QE3 asset purchase programme. These opposing moves unsettled exchange rates, with the dollar appreciating against most other currencies.

These abrupt market movements were even more pronounced than similar developments in August, when a sudden correction in global financial markets was quickly succeeded by renewed buoyant market conditions. This suggests that more than a quantum of fragility underlies the current elevated mood in financial markets.

Growing signs of fragility

Intermitted by volatility spikes, markets have remained buoyant during the period under review. This prolonged a surge in global financial markets over the last two years, occurring against a backdrop of low growth and unusually accommodative monetary policies in advanced economies. Ample monetary stimulus fuelled investors' risk appetite and boosted a search for higher-yielding assets. Stock markets rallied during these two years, in particular in advanced economies (Graph 1, left-hand panel). Yields on high-yield corporate bonds narrowed (centre panel) and record low government bond yields pushed up valuations of risky assets

[1] This article was prepared by the BIS Monetary and Economic Department. Questions about the article can be addressed to Mathias Drehmann (mathias.drehmann@bis.org) and Adrian van Rixtel (adrian.vanrixtel@bis.org). Questions about data and graphs should be addressed to Alan Villegas (alan.villegas@bis.org).

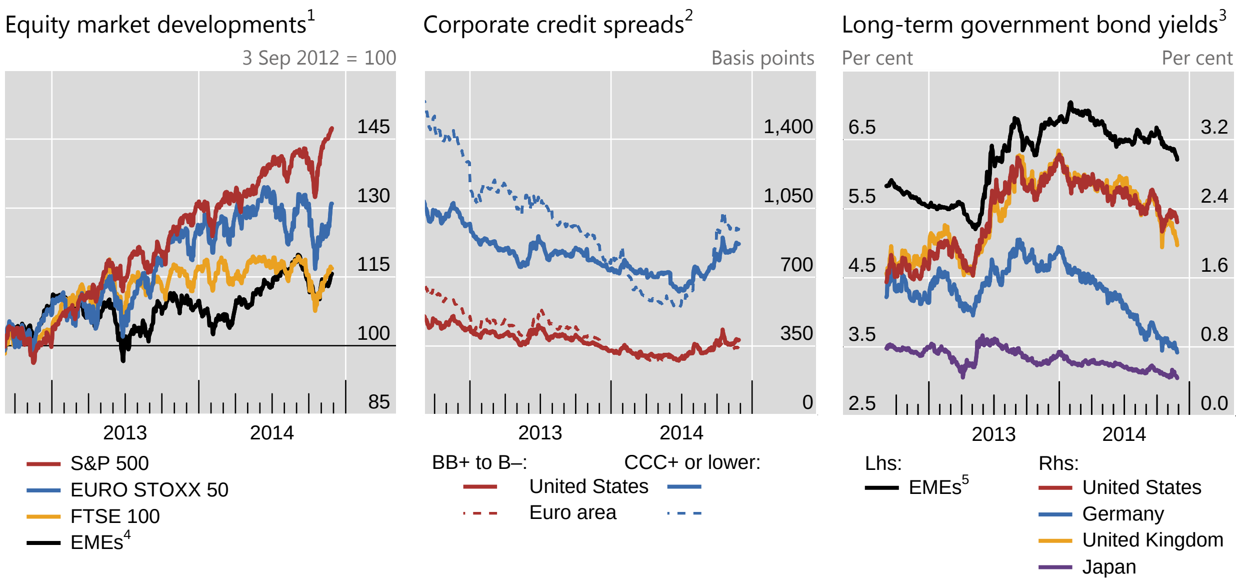
(right-hand panel). The search for yield also revived structured finance and drove leverage loan markets to levels not seen since 2008 (Box 1).

But recent developments suggest that markets are becoming increasingly fragile. Global equity markets plummeted in early August and mid-October (Graph 1, left-hand panel). Mid-October's extreme intraday price movements underscore how sensitive markets have become to even small surprises. On 15 October, the yield on 10-year US Treasury bonds fell almost 37 basis points (Graph 2, left-hand panel), more than the drop on 15 September 2008 when Lehman Brothers filed for bankruptcy. Market movements were particularly sharp during a 20-minute window when yields slipped and then rose by around 20 basis points (Graph 2, centre panel). These fluctuations were large relative to actual economic and policy surprises, as the only notable negative piece of news that day was the release of somewhat weaker than expected retail sales data for the United States one hour before the event.

The initial shock was significantly amplified by deteriorating liquidity conditions. Since the beginning of the year, many leveraged investors (typically hedge funds) had positioned themselves for a rise in long-term rates by holding large net short positions in eurodollar futures (Graph 3, left-hand panel). They began to unwind these positions from late September onwards, yet exposures remained large by mid-October. And as some market participants tried to quickly shed more of these positions, liquidity evaporated, thereby magnifying the bad news (Graph 2, right-hand panel).

But markets rebounded quickly, and some asset classes reached new records by the end of November. Early support was provided by statements of US and UK

Buoyant financial markets | Graph 1

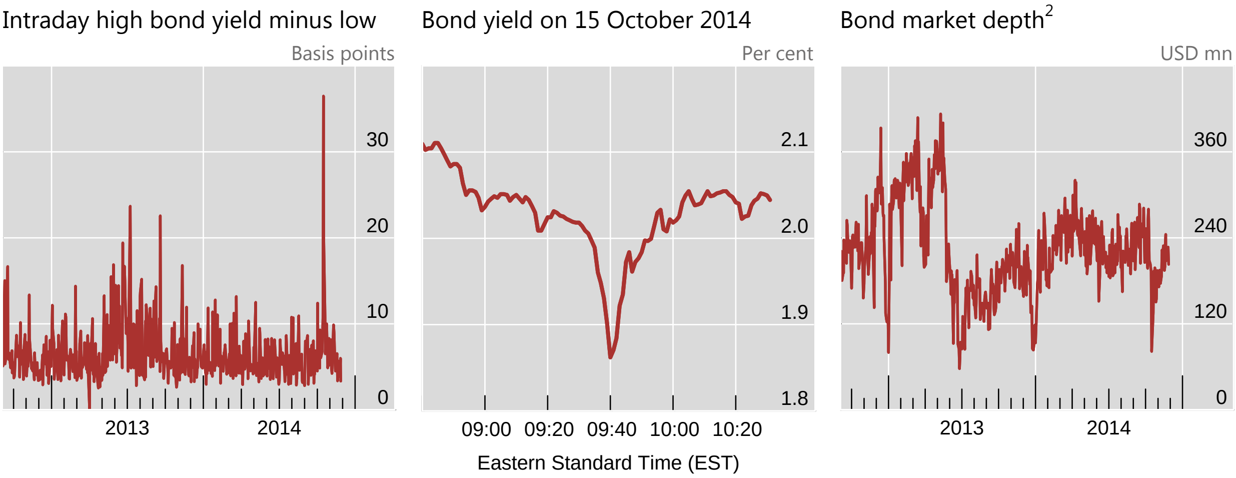


[1] Stock market indices, in local currency terms. [2] Option-adjusted spreads on an index of local currency-denominated bonds issued by financial and non-financial corporates. [3] Ten-year government bond yields. [4] MSCI Emerging Markets equity index. [5] JPMorgan GBI-EM Broad Diversified Index, yield to maturity. This index provides a comprehensive measure of fixed rate government debt issued in emerging market economies (EMEs) in the local currency.

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

Fragilities may be increasing[1]

Graph 2



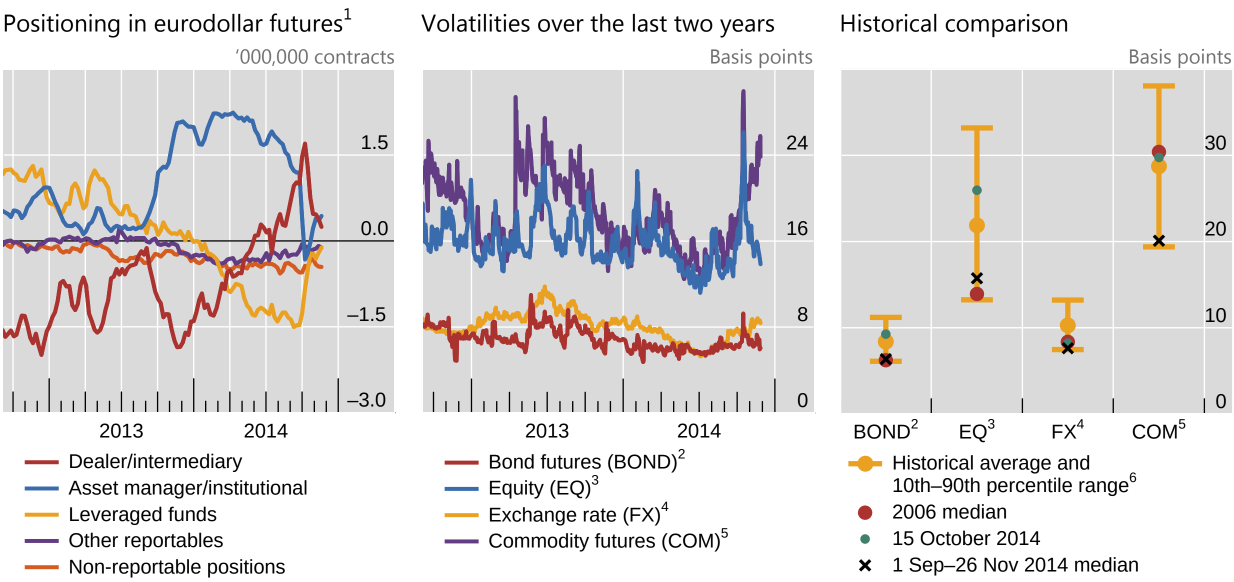
[1] Ten-year generic US government bond. [2] Calculated as the average of the top three bids and offers, daily average between 08:30 and 10:30 EST.

Sources: Bloomberg; JPMorgan Chase; BIS calculations.

central bank officials indicating that quantitative easing could be prolonged. Market confidence was then further bolstered by stronger than expected macroeconomic data, such as for US industrial production. From the end of October

Volatility spikes but remains generally low

Graph 3



[1] From the US Commodity Futures Trading Commission's *Traders in Financial Futures* (TFF) report; a negative number indicates aggregate net short positions in three-month eurodollar futures traded on the Chicago Mercantile Exchange. [2] Weighted average, based on GDP and PPP exchange rates, of the implied volatility of at-the-money options on long-term bond futures of Germany, Japan, the United Kingdom and the United States. [3] Implied volatility of S&P 500, EURO STOXX 50, FTSE 100 and Nikkei 225 equity indices; weighted average based on market capitalisation of the respective indices. [4] JPMorgan VXY Global index, a turnover-weighted index of implied volatility of three-month at-the-money options on 23 USD currency pairs. [5] Simple average of the implied volatility of at-the-money options on commodity futures contracts on oil, gold and copper. [6] Data start in 2001.

Sources: Bloomberg; BIS calculations.

Box 1

Signs of recovery in structured finance and leveraged loan markets

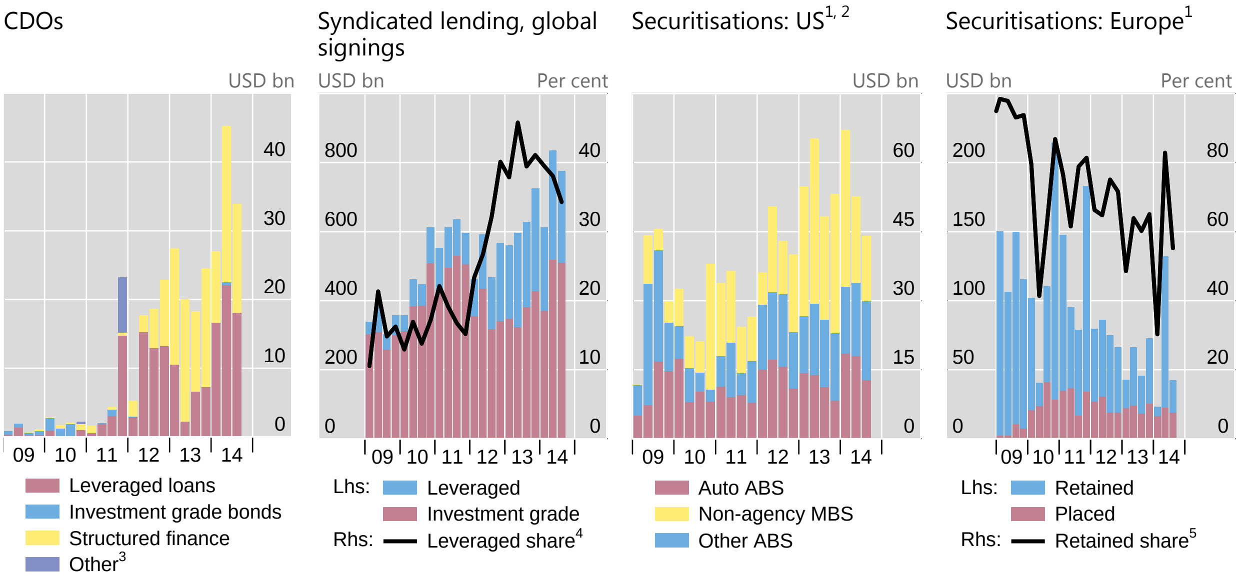
Branimir Gruić, Adrian van Rixtel and Jhuvesh Sobrun

The search for yield revived segments of structured finance markets and drove leveraged loan issuance to unprecedented levels. Issuance of collateralised debt obligations (CDOs) recovered strongly in the first three quarters of 2014 (Graph A, left-hand panel). These instruments package portfolios of assets into a new security, offering higher yields with relatively diversified assets as collateral. Before the crisis, the bulk of CDOs were collateralised by asset-backed securities. Recently, around 55% of CDOs consisted of leveraged loans. Structured finance thus boosted the investor base for these loans, which accounted for approximately 40% of syndicated lending in recent years (Graph A, second panel). Activity in the leveraged loan markets even surpassed the levels recorded before the crisis: average quarterly announcements during the year to end-September 2014 were $250 billion, well above the average of $190 billion during the pre-crisis period from 2005 to mid-2007. In contrast, recent issuance volumes of CDOs remained well below the record high amounts issued in 2006 and 2007.

Securitisation markets have also shown signs of a revival in recent years, especially in the United States (Graph A, third panel). Total US securitisation issuance (excluding agencies) in the first three quarters of 2014 reached $164 billion, well above the levels during similar periods in 2009 and 2010. The increase was the most pronounced for non-agency mortgage-backed securities, reflecting improvements in US housing and mortgage markets. The recovery of securitisation markets has been much more subdued in Europe, where issuance between January and September 2014 increased compared with the same period in 2013, but remained significantly below the amounts issued in earlier years. But there has been an important change in the composition of issuance, as retained securitisations have given way to publicly placed issues (Graph A, right-hand panel). Retained issues are not placed in capital markets, but kept on the issuer's balance sheet for collateral purposes in central bank liquidity operations. The share of retained issues in total issuance fell from 97% in the first three quarters of 2009 to 56% over the same period in 2014, reflecting greater participation of private investors in European securitisation markets.

Issuance in structured finance and leveraged loan markets

Graph A



ABS = asset-backed securities; CDOs = collateralised debt obligations; MBS = mortgage-backed securities.

[1] Excluding cash flow CDOs. [2] Excluding agency MBS. [3] High-yield bonds, mixed collateral, other swaps and other. [4] Share of leveraged loans in total syndicated loan signings. [5] Retained share in total securitisations.

Sources: Association for Financial Markets in Europe (AFME); Dealogic; Securities Industry and Financial Markets Association (SIFMA); BIS calculations.

onwards, monetary policy was eased further in China, Europe and Japan, boosting US equity markets to new all-time highs (Graph 1, left-hand panel) and pushing long-run government bond yields to record lows in many euro area economies. Corporate credit spreads, however, remained above their summer lows (Graph 1, centre panel).

Changes in sentiment were reflected in sharp fluctuations of implied (forward-looking) volatilities of major asset classes. On 15 October, stock market volatility spiked to levels not seen in more than two years. Volatility in credit, commodity and foreign exchange markets also fluctuated markedly (Graph 3, centre panel). But given the rebound in optimism, the jump proved short-lived, so that most of the time volatilities (ie median volatilities) were low relative to historical benchmarks and roughly in line with developments in 2006 (Graph 3, right-hand panel).

Despite signs of heightened fragilities, the release of the ECB's comprehensive assessment on 26 October had little effect in an environment of improved market conditions. Based on their financial positions as of end-2013, the asset quality review and the stress test revealed an aggregate capital shortfall of €25 billion at 25 of the 130 participating institutions. But given the capital injections during this year so far, the current capital shortfall stands at €9.5 billion, distributed among 13 banks. Initial market reactions were neutral to positive. While the majority of banks covered by the ECB exercise witnessed a decline in equity prices on the first trading day after the disclosure of the results, by the end of the week quotes for most banks had recovered, with the exception of banks reporting large capital shortfalls.

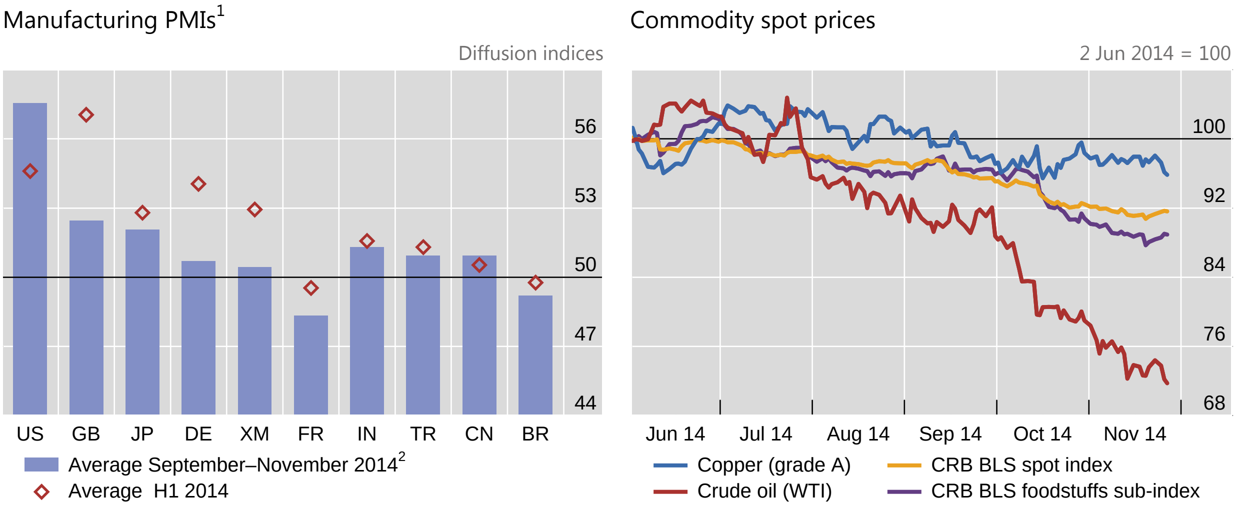
Global divergence may heighten fragilities

The recent bout of volatility in financial markets occurred in an environment of growing uncertainty about the global economic outlook and increasing geopolitical tensions. Manufacturing purchasing managers' indices (PMIs) indicated a loss of economic momentum, especially in Europe (Graph 4, left-hand panel). Markets were particularly surprised by data for Germany, where the widely watched Ifo Business Climate Index fell almost to a two-year low in October. Markets were also affected by the IMF's bleak forecast for the global economy that identified other weak spots, including Japan, China and major emerging market economies (EMEs). One major exception to this softer macroeconomic outlook was the United States, where recent data pointed to a more sustained recovery.

The prices of oil and other commodities continued to fall sharply (Graph 4, right-hand panel). This partly reflected weaker growth, but increasing supply seems to have been the key factor, at least for oil. Several major oil producers significantly increased production in recent months. On balance, the overall impact on the global economy of lower commodity prices is likely to be positive. Net commodity-importing countries in particular will benefit, through improvements in their current accounts and reduced energy subsidies. But commodity-exporting countries, especially those with weaker macroeconomic fundamentals, could be hit, contributing to negative market sentiment for countries like Brazil and Russia.

Diverging macroeconomic developments were reflected in diverging monetary policy actions. The Federal Reserve ended QE3 on 29 October. This programme boosted the Fed's balance sheet by nearly 60% to $4.5 trillion since September

The macroeconomic outlook weakens — Graph 4



BR = Brazil; CN = China; DE = Germany; FR = France; GB = United Kingdom; IN = India; JP = Japan; TR = Turkey; US = United States; XM = euro area.

[1] Purchasing managers' index (PMI) derived from monthly surveys of private sector companies. A value above (below) 50 indicates expansion (contraction). [2] September–October 2014 for Brazil, China, India and Turkey.

Sources: Bloomberg; Datastream; BIS calculations.

2012, an increase of 25% relative to mid-2014 GDP. At the same time, the Fed kept the federal funds rate at the lower zero bound. Given that these policy actions were widely anticipated, they had no marked effect on asset prices, unlike last year's "taper tantrum".

Despite the Federal Reserve's exit from QE3, estimates of the term premium on Treasury yields remained deep in negative territory and even declined further. On the 10-year Treasury bond they fell by more than 10 basis points from September to end-October 2014 (Graph 5, left-hand panel).

Market expectations of future US short-term interest rates also decreased. Forward rates for the end of 2015 fell (Graph 5, second panel), and similar developments were evident across the maturity spectrum. Particularly sharp adjustments occurred on 15 October, and they were not reversed during the actual end of QE3. Throughout the year, primary dealers have consistently and significantly forecasted lower future rates than members of the Federal Open Market Committee (Graph 5, third panel). A future alignment of expectations could raise the risk of abrupt adjustments.

In contrast to the Federal Reserve, the ECB loosened its monetary policy stance further. In early September, it lowered the interest rate on its main refinancing operations by 10 basis points to 0.05% and the rate on the deposit facility to –0.20%. In addition, the Governing Council announced it would purchase asset-backed securities with underlying assets consisting of claims against the euro area non-financial private sector and euro-denominated covered bonds issued by monetary financial institutions (MFIs) domiciled in the euro area. These programmes started in October and in November, respectively. Together with the series of targeted longer-term refinancing operations to be conducted until June 2016, these programmes are expected to bring the ECB's balance sheet back towards its early

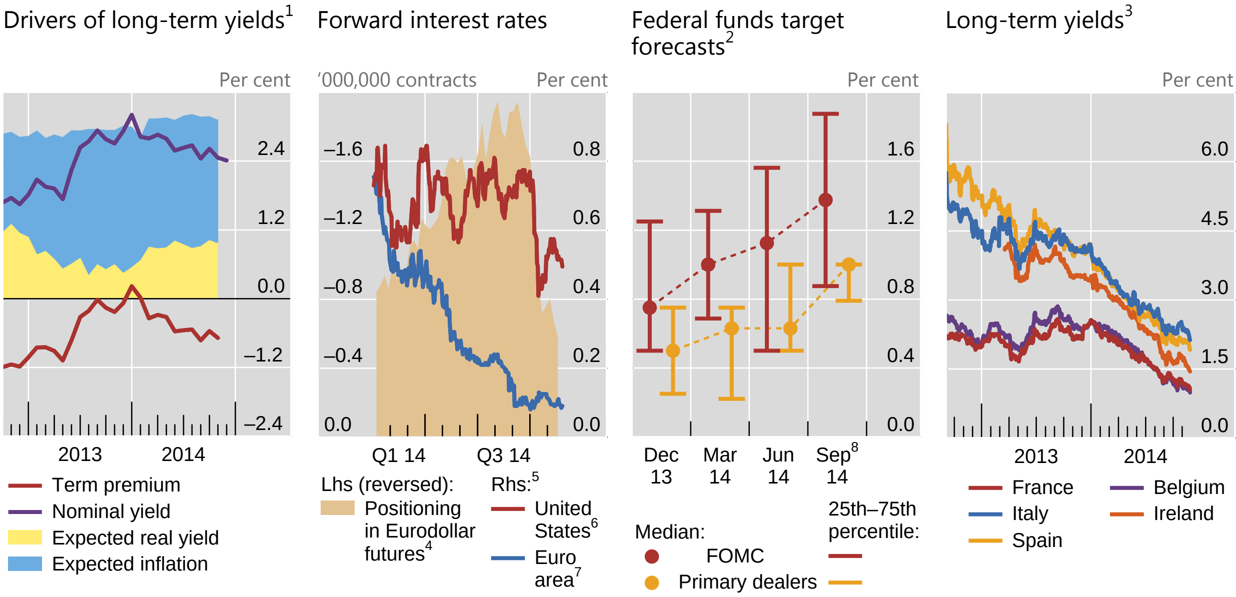
2012 size. The balance sheet could thus increase by around €1 trillion – equivalent to 50% of its current size or around 10% of euro area GDP (as of mid-2014).

The main policy announcements in recent months were anticipated by markets and thus elicited little reaction. But long-term government bond yields fell to record lows for many euro area countries after a speech by ECB President Draghi on 21 November, which stressed that the ECB will do what is required to raise inflation and inflation expectation by adjusting the size, pace and composition of asset purchases, if the currently announced policies prove to be insufficient. This initiated a further decline in 10-year government bond yields, which fell to all-time lows for nine large euro area countries including France, Ireland and Spain by 26 November, the end of the period under review (Graph 5, right-hand panel).

On 31 October, the Bank of Japan surprised markets by stepping up its Quantitative and Qualitative Easing (QQE) programme as it raised the central bank's target for enlarging the monetary base from ¥60–70 trillion to ¥80 trillion a year. If implemented, this will increase the Bank of Japan's balance sheet over the course of the next year by nearly 30%, or more than 16% of mid-2014 GDP. On the same day, the Government Pension Investment Fund (GPIF) announced a rise in domestic equity weights and an increase in foreign asset holdings for its portfolio.

Financial markets reacted strongly to the policy changes in Japan. On the announcement day, Japanese equity prices rose by almost 5% and the yen fell by around 3% against the dollar (Graph 6, left-hand and centre panels). These changes

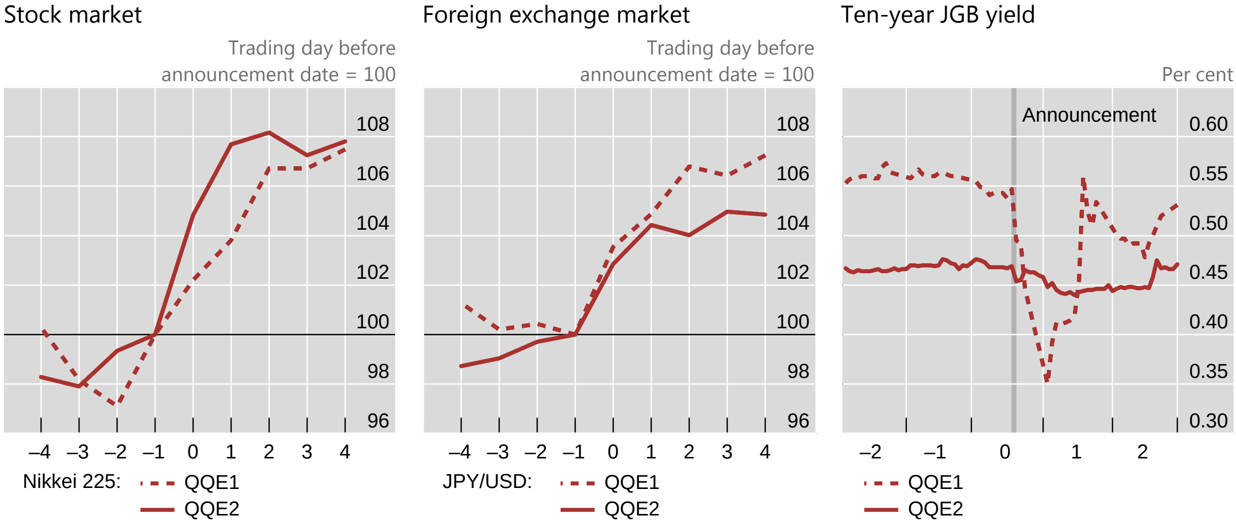
Markets expect low interest rates — Graph 5



[1] Decomposition of the US 10-year nominal yield according to a joint macroeconomic and term structure model. See P Hördahl and O Tristani, "Inflation risk premia in the euro area and the United States", *International Journal of Central Banking*, September 2014. [2] Forecasts for end-2015. The horizontal axis indicates forecast publication dates. From September 2014, the value of FOMC forecasts increased to the nearest ⅛ percentage point (from a ¼ percentage point benchmark previously), while the primary dealers' federal funds target forecasts refer to survey results at the top of the target range. [3] Ten-year generic government bond yield; intraday lows. [4] From the US Commodity Futures Trading Commission's *Commitments of Traders (COT) – Chicago Mercantile Exchange* report; a negative number indicates aggregate net short positions in three-month eurodollar futures taken by non-commercial traders (the report separates reportable traders into "commercial" and "non-commercial" categories). [5] Implied by futures contracts expiring in December 2015. [6] 30-day federal funds rate futures. [7] Three-month Euribor futures. [8] October 2014 for primary dealers.

Sources: Bloomberg; Datastream; national data; BIS calculations.

Policy changes in Japan affect financial markets[1] Graph 6



[1] The horizontal axis represents the trading days before and after the announcement dates. Zero represents the announcement dates: 4 April 2013 for the Quantitative and Qualitative Easing programme 1 (QQE1); 31 October 2014 for the Quantitative and Qualitative Easing programme 2 (QQE2) and the decision by the Government Pension Investment Fund to raise domestic equity weights and increase foreign asset holdings. Closing prices for stock market and foreign exchange market; intraday yields for 10-year Japanese government bonds.

Sources: Bloomberg; BIS calculations.

were either greater than or nearly at par with those on 4 April 2013 when QQE was introduced. In contrast, the impact on already low Japanese government bond yields was modest, perhaps reflecting market confidence that the extreme volatility in bond markets after the initial introductions of QQE would not be repeated (Graph 6, right-hand panel). Expectations that sales of Japanese government bonds by the GPIF would partially offset bond purchases by the Bank of Japan also played a role.

Against the backdrop of a slowdown in economic growth, the People's Bank of China cut its benchmark policy rates on 21 November after local markets had closed – the first such move since July 2012. The one-year benchmark lending rate was cut by 40 basis points to 5.6%, and the one-year benchmark deposit rate by 25 basis points to 2.75%. Rates for loans and deposits at different maturities were also lowered accordingly. Global markets responded positively to the news. Spot prices for crude oil immediately increased by 1.1%. On the following Monday, the CSI300 index – the equity index for the largest Chinese companies listed in Shanghai and Shenzhen – rose by 1.2%.

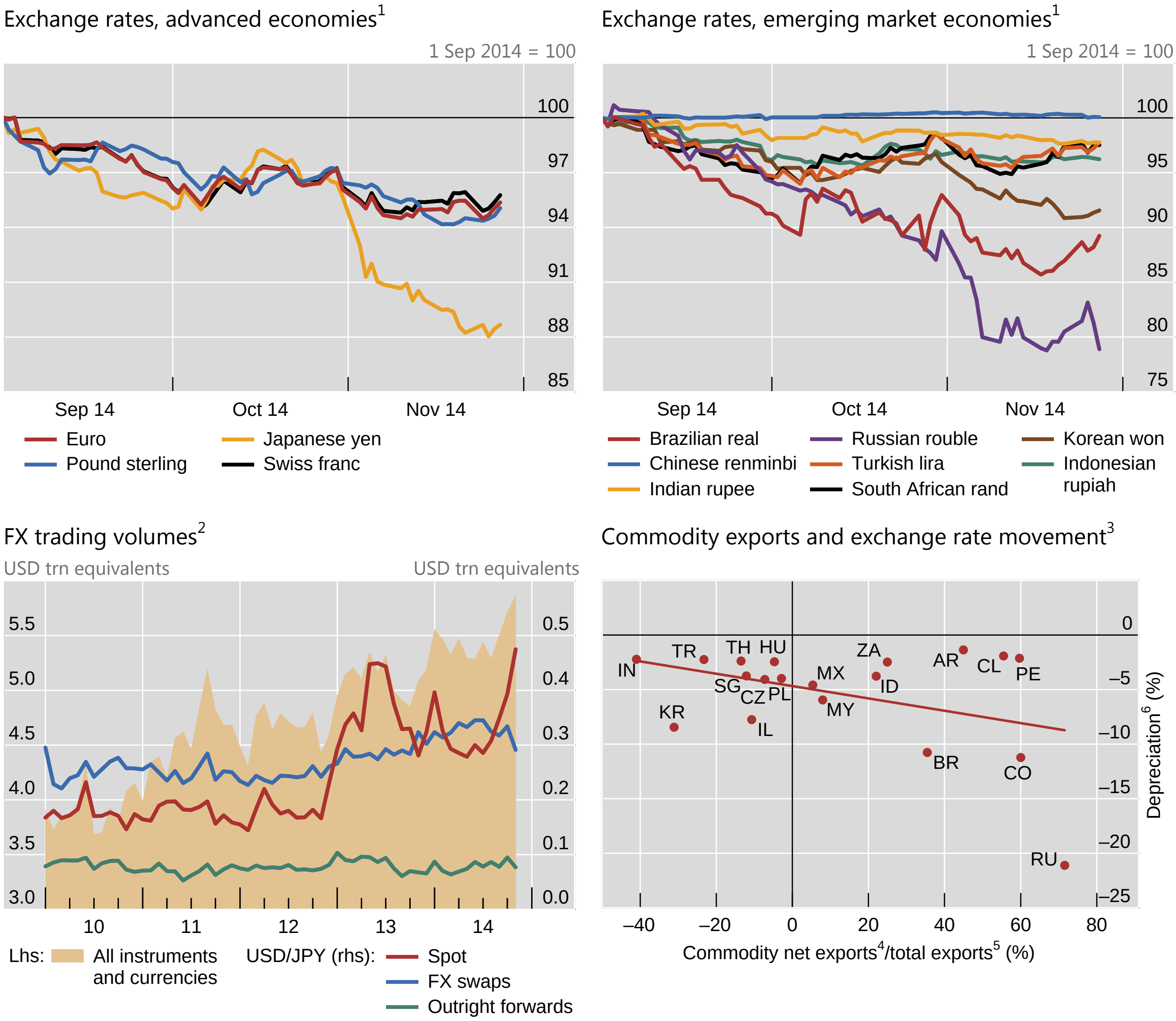
Opposing moves by the world's major central banks resulted in sharp exchange rate movements. The dollar appreciated against most currencies (Graph 7, top panels). Amongst advanced economy currencies, the yen was especially affected, not only on 31 October but throughout the period under review. This led to a sharp increase in the activity in the dollar/yen spot market, resulting in record turnover in global foreign exchange markets (Graph 7, bottom left-hand panel).

Most EME currencies also fell against the dollar, with the currencies of commodity importers depreciating less than those of commodity exporters (Graph 7, bottom right-hand panel). The Turkish lira, Indian rupee and Thai baht depreciated by less than 3% vis-à-vis the dollar over the last three months. The Korean won fell slightly further.

The combination of a strong dollar and weak commodity prices led to sizeable depreciations of the currencies of net commodity exporters. In some cases, these global factors interacted with country-specific vulnerabilities. For example, the Brazilian real depreciated amidst uncertainty associated with the presidential election and a general weak economic outlook. Economic sanctions against Russia and a worsening of the conflict in Ukraine led the rouble to plummet by more than 13% during September and October. To shore up its currency, the Russian central

The US dollar appreciates

Graph 7



AR = Argentina; BR = Brazil; CL = Chile; CO = Colombia; CZ = Czech Republic; HU = Hungary; ID = Indonesia; IL = Israel; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PL = Poland; RU = Russia; SG = Singapore; TH = Thailand; TR = Turkey; ZA = South Africa.

[1] US dollars per unit of local currency. A decline indicates a depreciation of the local currency. [2] Benchmarked series, calculated using the proportional Denton technique. The CLS data are seasonally adjusted before the benchmarking technique is applied. See M Bech and J Sobrun, "FX market trends before, between and beyond Triennial Surveys", *BIS Quarterly Review*, December 2013, pp 45–53. [3] The red line represents predicted values from a linear regression of the depreciation of local currency on the relative importance of commodity net exports, R^2 = 0.16. [4] 2013 commodity exports minus commodity imports. Commodity sectors comprise the Standard International Trade Classification codes 0, 1, 2, 3, 4, 68, 667 and 971. [5] Total exports of goods, 2013. [6] Change in exchange rate, in US dollars per unit of local currency, from 1 September to 26 November 2014. A negative value represents a depreciation of the local currency.

Sources: Bloomberg; CLS; Datastream; FXC surveys; UN Commodity Trade Statistics database; BIS 2013 Triennial Survey; BIS calculations.

Box 2

The Shanghai-Hong Kong Stock Connect programme

Feng Zhu

On 10 April 2014, the China Securities Regulatory Commission (CSRC) and the Securities and Futures Commission (SFC) of Hong Kong SAR announced Shanghai-Hong Kong Stock Connect, a pilot programme aimed at establishing mutual stock market access between mainland China and Hong Kong. On 17 October, the CSRC and SFC signed a memorandum of understanding (MoU) and agreed on the principles and arrangements for cross-boundary regulatory and enforcement cooperation under the programme. On 10 November, the CSRC and SFC approved the launch of the Stock Connect on 17 November 2014.

The Stock Connect – also known as the "Through Train" – will allow trading of shares between the Shanghai Stock Exchange (SSE) and Stock Exchange of Hong Kong Limited (SEHK). In the Shanghai-to-Hong Kong "southbound trading link", mainland investors can trade in up to 266 eligible stocks listed in Hong Kong, up to a daily quota for (net) purchases of RMB 10.5 billion, and an aggregate quota of RMB 250 billion. The shares qualified for trading represent 82% of the SEHK's market capitalisation.① In the Hong Kong-to-Shanghai "northbound trading link", global investors can trade in up to 568 eligible stocks listed in Shanghai, up to a daily quota for (net) purchases of RMB 13 billion, and an aggregate quota of RMB 300 billion, with the shares qualified for trading representing 90% of the SSE's market capitalisation. The quotas constrain only buy orders; sell orders are always allowed. The quotas are open to future adjustments.

The programme needs to ensure that brokers comply with the rules and regulations in two very different markets. Preparing and streamlining operations for the Stock Connect brought significant challenges and required extensive cooperation by the respective regulators. One major issue was taxation. On 14 November, China's Finance Ministry, State Administration of Taxation and the CSRC announced that capital gains levies would be waived for an unspecified period for northbound investors, and for three years for southbound individual investors. Investors on both sides would be exempt from the business taxes on stock trading.

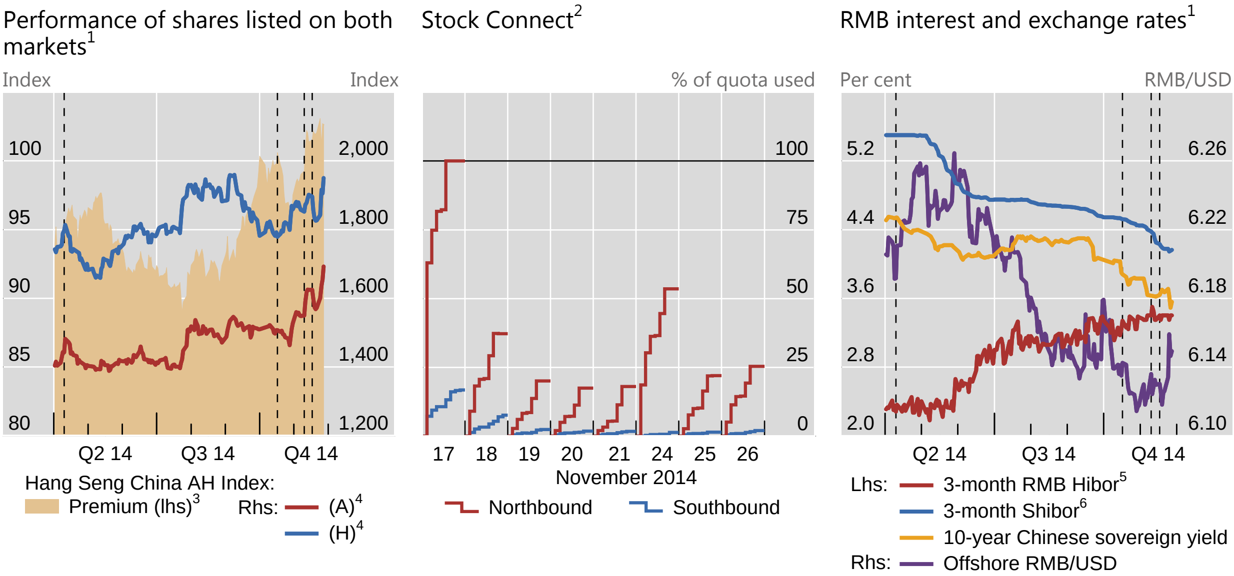
The Stock Connect can be an important landmark for China's capital account liberalisation process. The SSE has the seventh highest market capitalisation in the world, with $2.96 trillion at the end of October 2014, yet it remains relatively closed. Foreign institutional investors could only access China through the Qualified Foreign Institutional Investor (QFII) and RMB QFII (RQFII) programmes under an existing MoU between the firm's home nation and China; these require regulatory approval and are subject to strict, individually granted trading quotas. The Stock Connect represents a significant addition to the existing programmes, and opens up China's capital markets to an unprecedented degree:

- While the existing schemes focus on one-way flows, the Stock Connect relaxes restrictions on capital flows in both directions: northbound trading is open to all investors, and southbound trading to mainland institutional investors and individual investors with securities and cash balances of at least RMB 500,000.
- Northbound trading will be quoted in renminbi but settled in offshore renminbi, and southbound trading will be quoted in Hong Kong dollars but settled in onshore renminbi. Trading and settlement in renminbi will encourage its further use.
- At RMB 1.1 trillion, Hong Kong's liquidity pool consisted of renminbi deposits and certificates of deposit, and was large enough to meet the projected demand under the Stock Connect. Yet the People's Bank of China moved to abolish the daily RMB 20,000 per person conversion cap for Hong Kong residents, effective on 17 November. This would facilitate their participation and encourage local financial institutions to introduce more renminbi investment products. But renminbi transfers to onshore bank accounts remain subject to a daily limit of RMB 80,000 per person, limiting the likely impact on cross-boundary capital flows.
- Mainland firms not participating in the Qualified Domestic Institutional Investor programme can now raise funds globally, as their shares become accessible to global investors under the new programme.
- Compared to the QFII and RQFII programmes, trading via the Stock Connect has no lockup or repatriation restrictions.

The Stock Connect has been expected to narrow the price differences for shares of Chinese companies listed in both markets, ie the A shares listed on mainland exchanges, and the H shares listed in Hong Kong. The shares are traded separately, with heavy restrictions on foreign access to A shares, and investors' ability to arbitrage the two

Market reaction to the launch of Shanghai-Hong Kong Stock Connect

Graph B



[1] The dashed lines indicate the key dates of Shanghai-Hong Kong Stock Connect: 10 April, 17 October, 10 and 17 November. [2] Ratio of purchases to daily quotas. [3] The Hang Seng China AH Premium Index indicates the absolute price premium (or discount) of A shares over H shares for the Chinese companies included in the AH (A) and AH (H) indices. A value above 100 suggests that A shares trade at a premium to H shares. [4] The Hang Seng China AH (A) and AH (H) indices track the stock price of 57 large and liquid Chinese companies with shares listed in both the mainland (A shares) and Hong Kong SAR (H shares) markets, respectively. [5] RMB Hong Kong Interbank Offered Rate (Hibor). [6] Shanghai Interbank Offered Rate (Shibor).

Sources: Bloomberg; Hang Seng Indexes Company Limited; BIS calculations.

markets was limited. As the widely anticipated launch of the Stock Connect neared, the price differences between the A and H shares narrowed significantly over the third quarter of 2014, briefly achieving parity in early October (Graph B, left-hand panel). When the launch date was confirmed on 10 November, the price discount on A shares quickly turned into a premium, reflecting investors' strong demand for those shares. Indeed, initial trading was lopsided, with the northbound trading volume hitting the daily quota limit by 14:00 local time on the first day, while southbound trading ended the day reaching RMB 1.768 billion, just 17% of the quota (Graph B, centre panel). Trading volumes declined in the following days; the daily quota used by northbound investors dropped to 17.5% on 20 November, but stabilised towards 25% on day 26 after a strong rebound on day 24. Several factors might have contributed to weak trading, eg investors' unfamiliarity with the new system, lack of expertise on A and H shares, and concerns over adequate investor protection.

The effects of the Stock Connect may spill over to other assets, despite the fact that both funds and securities stay in the "closed loop" of the two settlement systems: once a northbound investor sells her A shares bought through the Stock Connect, the resulting funds go back to her bank account in Hong Kong. She will not be able to use the proceeds to invest in other types of mainland assets. Even so, QFII and RQFII investors can now free up part of their quotas originally destined for equities to invest in eg fixed income assets. In fact, the 10-year Chinese government bond yield fell following the major announcements (Graph B, right-hand panel). In addition, the gap between onshore and offshore renminbi interest rates has narrowed since May 2014. Yet initial weak Stock Connect trading contributed to a rise in the offshore RMB/USD rate as renminbi enthusiasm waned.

So far, the Stock Connect has operated smoothly. As currently designed, it applies only to equities traded on the two exchanges, although in principle trading quotas could be increased and the programme expanded to other exchanges, instruments and asset classes. Ultimately, the Stock Connect may encourage a convergence of market rules, accounting and information disclosure standards between the SEHK and mainland exchanges. The Stock Connect is also expected to bring greater transparency to the mainland market and enhance corporate governance at Chinese firms.

① Figures quoted in this paragraph are as of March 2014.

bank increased policy rates by 150 basis points on 31 October. But the downward pressure continued. The 5 November decision to reduce foreign exchange interventions to support the currency was followed by a 4% depreciation the next day. On 10 November, the central bank abandoned the rouble's trading corridor, allowing the currency to float freely, stabilising the exchange rate.

The appreciation of the dollar against the backdrop of divergent monetary policies may, if persistent, have a profound impact on the global economy, in particular on EMEs. For example, it may expose financial vulnerabilities as many firms in emerging markets have large US dollar-denominated liabilities.[2] A continued depreciation of the domestic currency against the dollar could reduce the creditworthiness of many firms, potentially inducing a tightening of financial conditions.

2 M Chui, I Fender and V Sushko, "Risks related to EME corporate balance sheets: the role of leverage and currency mismatch", *BIS Quarterly Review*, September 2014, pp 35–47.

Highlights of the BIS international financial statistics[1]

The BIS, in cooperation with central banks and monetary authorities worldwide, compiles and disseminates data on activity in international financial markets. This chapter summarises the latest data for the international banking and OTC derivatives markets, available up to mid-2014. A box looks at the sectoral composition of offshore borrowing of EME non-financial corporations.

Takeaways

- International banking activity expanded for a second consecutive quarter between end-March and end-June 2014, partially reversing the sustained contraction experienced in 2012 and 2013. The annual growth rate of cross-border claims went up to 1.2% in the year to end-June 2014, its first move into positive territory since late 2011.
- Banks' cross-border claims on emerging market economies (EMEs) continued their recovery from the "taper tantrum" of mid-2013.
- Increases in the second quarter of 2014 were concentrated in Asia, with China again receiving substantial inflows.
- Claims on China continued to grow at annual rates of close to 50%. The latest increase took the outstanding stock of cross-border claims on China to $1.1 trillion, by far the largest in the emerging market world and the seventh largest overall.
- Cross-border claims on emerging Europe declined, with credit to Russia, Hungary and Ukraine contracting the most.
- Positions in over-the-counter (OTC) derivatives retreated slightly in the first half of 2014. The notional amount of outstanding contracts fell to $691 trillion at end-June 2014, from $711 trillion at end-2013.
- Central clearing by market participants advanced further, reaching 27% of notional credit default swaps (CDS) outstanding at end-June 2014, up from 23% one year earlier. In addition, bilateral netting agreements reduced the

[1] This article was prepared by Stefan Avdjiev (stefan.avdjiev@bis.org) and Cathérine Koch (catherine.koch@bis.org). Statistical support was provided by Jeff Slee. The section on the OTC derivatives statistics was prepared by Andreas Schrimpf (andreas.schrimpf@bis.org), with statistical support by Denis Pêtre.

net market value of outstanding CDS contracts, which provides a measure of exposure to counterparty credit risk, to 23% of their gross market value.

- The classification by sector of foreign affiliates of EME non-financial corporations sheds light on the risk profile of their offshore debt. Non-financial affiliates are presumably more likely than financial affiliates to be engaged in activities other than providing funding for the parent. The split between financial and non-financial subsidiaries varies greatly across countries and industries.

Recent developments in the international banking market

Between end-March and end-June 2014, international banking activity expanded for a second consecutive quarter following the sustained contraction of 2012 and 2013. The cross-border claims of BIS reporting banks rose by $401 billion to $30.0 trillion. At 1.2% in the year to end-June 2014, this was the first increase in the annual growth rate of cross-border claims since late 2011 (Graph 1, left-hand panel). The modest recovery in international lending during the second quarter appears to have coincided with a continued strengthening of risk appetite; nevertheless, international credit flows through banks remained smaller than the respective flows through the bond market.[2]

The strongest component of cross-border banking activity was claims on non-bank borrowers. They rose by $207 billion between end-March and end-June 2014, taking the year-on-year growth rate to 3% (Graph 1, left-hand panel). Cross-border claims on banking offices, which in the locational banking statistics[3] include banks' own offices, also increased (by $194 billion) during the second quarter of 2014, continuing the pickup that had started in the first. Outstanding cross-border claims on non-bank borrowers thus totalled $12.3 trillion at end-June 2014, near their pre-crisis peak in 2008. By contrast, at $17.7 trillion, the outstanding stock of interbank claims remained about 22% below its pre-crisis peak.

The consolidated banking statistics[4] provide a more detailed sectoral breakdown of counterparties than the locational statistics and yield further insights into the sectors receiving credit. The recent increases in cross-border claims on non-bank borrowers went mainly to non-bank financial institutions, non-financial corporations and households, grouped together as the non-bank private sector. This is a departure from the post-2008 pattern of lending to governments. The outstanding stock of consolidated international claims (on an immediate borrower basis) on the non-bank private sector rose by $139 billion to $9.5 trillion at end-

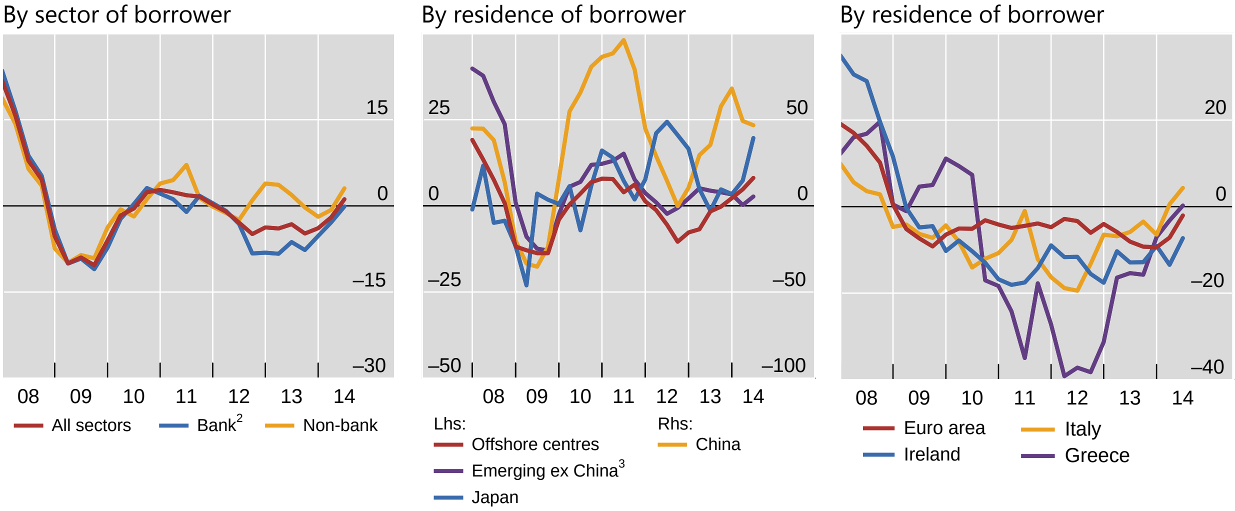
2 See BIS, "Global liquidity: selected indicators", memorandum, 8 October 2014.

3 The locational banking statistics are structured according to the location of banking offices and capture the activity of all internationally active banking offices in the reporting country regardless of the nationality of the parent bank. Banks record their positions on an unconsolidated basis, including those vis-à-vis their own offices in other countries.

4 The consolidated banking statistics are structured according to the nationality of reporting banks and are reported on a worldwide consolidated basis, ie excluding positions between affiliates of the same banking group. Banks consolidate their inter-office positions and report only their claims on unrelated borrowers.

Cross-border claims of BIS reporting banks

Annual percentage changes[1] Graph 1



[1] Calculated as the sum of exchange rate- and break-adjusted changes over the preceding four quarters divided by the amount outstanding one year earlier. [2] Including banks' positions vis-à-vis their own offices. Claims on banks are calculated as total claims minus claims on non-banks; consequently, they include claims unallocated by sector of counterparty. [3] Claims on emerging market economies excluding claims on China.

Source: BIS locational banking statistics by residence (Tables 6A and 6B).

June 2014.[5] By comparison, claims on public sector borrowers increased by $61 billion to $3.1 trillion.

The growth in claims on non-bank borrowers was especially strong for offshore financial centres. The locational banking statistics indicate that, between end-March and end-June 2014, BIS reporting banks increased cross-border lending to non-bank borrowers in offshore centres by $62 billion. The latest quarterly expansion raised the annual growth rate to 10% and took the outstanding stock of claims on non-bank entities in offshore centres to $1.8 trillion as of end-June 2014. Most of the funds were channelled to entities in the Cayman Islands – where many international investment funds, especially hedge funds, are domiciled – with smaller amounts flowing to non-banks in Hong Kong SAR and Singapore.

The increase in total cross-border claims was well spread across borrowing countries in the second quarter of 2014. Claims on Japan rose by $32 billion, resulting in a growth rate of 20% in the year to end-June 2014 (Graph 1, centre panel). This took the outstanding stock of claims on Japan to $1.1 trillion, including banks' positions vis-à-vis their own offices. Claims on borrowers in the euro area, including cross-border claims between countries within the currency zone, rose by $225 billion. This was the largest quarterly expansion since 2008. It slowed the

[5] The consolidated banking statistics do not contain a currency breakdown, which precludes the calculation of exchange rate-adjusted changes that is possible for the locational banking statistics. For example, the depreciation of the euro against the US dollar between end-March and end-June 2014 resulted in a decline in the reported US dollar value of the outstanding stock of claims denominated in euros. Conversely, the appreciation of the yen against the US dollar over the same period resulted in an increase in the reported US dollar value of the outstanding stock of claims denominated in yen.

annual rate of contraction in cross-border claims on the euro area from –7% as of end-March 2014 to –2% as of end-June 2014 (Graph 1, right-hand panel).

Inflows were recorded by some euro area members that had previously experienced substantial drops in cross-border credit. Cross-border claims on Italy rose by $35 billion, resulting in a 4% increase in claims compared with a year earlier (Graph 1, right-hand panel). Ireland saw inflows of $11 billion, which slowed the annual pace of contraction to –7%.

Credit to emerging market economies

International lending to emerging market economies also expanded during the second quarter of 2014, continuing the recovery from the taper tantrum of mid-2013.[6] The $98 billion increase took the annual growth rate to 12%.

China again dominated inflows to EMEs. Cross-border claims on the country increased by $65 billion during Q2 2014 and were up by 47% in the year to end-June 2014 (Graph 1, centre panel). Owing to such rapid growth, China has become by far the largest EME borrower for BIS reporting banks. Outstanding cross-border claims on residents of China totalled $1.1 trillion at end-June 2014, compared with $311 billion on Brazil and slightly more than $200 billion each on India and Korea (Graph 2, left-hand panel). Globally, China ranked seventh overall, just behind the Netherlands, but immediately ahead of Japan. A key factor behind the surge was transactions between mainland and overseas offices of Chinese banks. Yet even on a consolidated basis – that is, after excluding inter-office transactions – and taking account of foreign banks' claims booked via their affiliates in China, BIS reporting banks' exposure to China was almost twice as large as that to any other emerging market economy (Graph 2, centre panel). At end-June 2014, it stood at $813 billion, compared with $456 billion vis-à-vis Brazil and $381 billion vis-à-vis Mexico (for consolidated foreign claims on an ultimate risk basis). As recently as 2009, China was not even among BIS reporting banks' top five foreign EME exposures.

The current status of China as the premier EME international bank lending destination is the result of a remarkable evolution that has taken place largely since the financial crisis (Graph 2, right-hand panel). On an unconsolidated basis, as recently as at end-2008, China accounted for 6% of cross-border claims on all EMEs and for 21% of those on emerging Asia. By mid-2014, those two shares had risen to 28% and 53%, respectively. On a consolidated basis, similar dynamics have played out. Namely, China's share of BIS reporting banks' foreign claims on all EMEs has grown from 5% at end-2008 to 16% at mid-2014. During the same period, China's share in foreign claims on emerging Asia has risen from 17% to 38%.

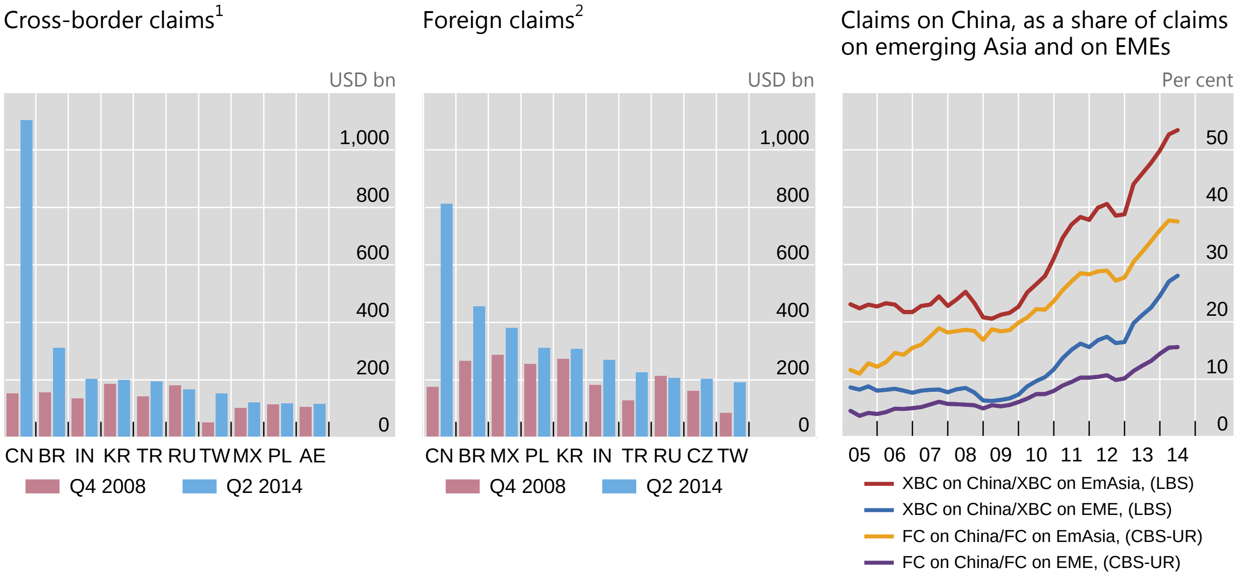
Excluding China, cross-border claims on emerging market economies rose by $33 billion between end-March and end-June 2014, up 2.7% year on year (Graph 1, centre panel). Increases were concentrated in Asia. Claims on Korea grew by $13 billion in Q2 2014 and 6% over the year, while those on Indonesia increased by $5 billion and 18%, respectively. Claims on Latin America rose modestly ($3 billion, 2%).

Emerging Europe was an exception to the general pattern of increases in cross-border claims in the second quarter. Cross-border lending to the region contracted

[6] See S Avdjiev and E Takáts, "Cross-border bank lending during the taper tantrum: the role of emerging market fundamentals", *BIS Quarterly Review*, September 2014, pp 49–60.

The rise of China as an international bank lending destination

Claims of BIS reporting banks on emerging market economies, outstanding end-of-period stocks — Graph 2



AE = United Arab Emirates; BR = Brazil; CN = China; CZ = Czech Republic; IN = India; KR = Korea; MX = Mexico; PL = Poland; RU = Russia; TR = Turkey; TW = Chinese Taipei; EmAsia = emerging Asia-Pacific; EME = emerging market economies; XBC = cross-border claims; FC = foreign claims; LBS = locational banking statistics; CBS-UR = consolidated banking statistics on an ultimate risk basis.

[1] All reporting banks' cross-border claims (including banks' positions vis-à-vis their own offices) on the 10 largest EME borrowers as of end-Q2 2014. [2] All domestic banks' foreign consolidated claims (ultimate risk basis) on the 10 largest EME borrowers as of end-Q2 2014.

Sources: BIS locational banking statistics by residence (Table 6A); BIS consolidated banking statistics (Table 9D).

by $2.1 billion during the quarter, and by 5% year on year. Credit to a few countries grew, notably to Turkey (up by $7 billion during the quarter, 0% year on year). However, these increases were offset by declines vis-à-vis Russia (–$6 billion, –10%), Hungary (–$3 billion, –13%) and Ukraine (–$2 billion, –18%).

In Russia and Ukraine, foreign banks' claims booked via local affiliates, which tend to be locally funded, held up better than cross-border claims. Adjusted for exchange rate movements, local claims in local currency on Russian residents went up about 5% at end-June 2014 compared with a year earlier. Those on residents of Ukraine fell by about 3%. Consequently, those foreign banks with sizeable local operations in Russia and Ukraine, particularly Austrian, French and Italian banks, saw smaller declines in their total foreign claims – cross-border plus local claims – than banks with predominantly cross-border claims, such as German, Japanese, UK and US banks.

In addition to their foreign claims, BIS reporting banks had other potential exposures – comprising derivatives contracts, guarantees extended and credit commitments – to residents of Russia and Ukraine totalling $156 billion and $17 billion, respectively. The majority ($130 billion and $16 billion) of these exposures were in the form of guarantees extended, which primarily represent the contingent liabilities of CDS protection sellers (at notional values). Importantly, such CDS-related contingent liabilities are usually reported on a gross basis, without taking account of netting agreements or collateral. They thus represent a ceiling on banks' CDS-related exposures to a given country. While other potential exposures to Russia did not change much between end-2013 and end-June 2014, those to

Ukraine declined by about $2 billion owing to a reduction in banks' credit commitments.

The OTC derivatives market in the first half of 2014

Activity in over-the-counter derivatives markets contracted slightly in the first half of 2014. Notional amounts of outstanding OTC derivatives contracts fell by 3% to $691 trillion at end-June 2014 (Graph 3, left-hand panel). The gross market value of contracts, which measures the cost of replacing outstanding contracts at market prices, fell by 7% to $17 trillion at end-June 2014 (Graph 3, centre panel). Gross credit exposures – a measure of dealers' exposure after accounting for legally enforceable netting agreements but before collateral – remained roughly unchanged. Amounting to $2.8 trillion at end-June 2014, this gauge of counterparty risk stood at 16.3% of gross market values, about the same as half a year earlier (Graph 3, centre panel).

The contraction in aggregate notional derivatives positions was largely driven by the interest rate segment. Notional amounts of interest rate derivatives contracts stood at $563 trillion at mid-2014, about $20 trillion below the volume recorded at end-2013. Outstanding volumes of interest rate swaps fell by 8% to $421 trillion. An important driver of the fall in notional values has been the elimination of redundant swap contracts via trade compression, which has expanded significantly in 2014.[7] The contraction in swap positions was partly offset by rising activity in the forward rate agreement segment, where notional contract volumes expanded by 17% to $93 trillion. Outstanding amounts of fixed income options, by contrast, remained largely unchanged.

Gross market values of interest rate derivatives have declined by 5% since late 2013 and hence by slightly more than the notional amounts. At $13 trillion, the market values of outstanding interest rate derivatives positions at end-June 2014 were one third below their recent peak at end-2011. Such declines can generally be traced to a narrowing of the gap between market interest rates on the reporting date and the rates prevailing at contract inception.[8] In the first half of 2014, the drop in market value was largely confined to contracts denominated in US dollars. For euro- and yen-denominated contracts, gross market values increased between end-2013 and end-June 2014, to $7.4 trillion and $0.8 trillion, respectively. These movements probably reflect the divergence in market interest rates, which declined by more in euro and yen markets in the first half of 2014 than in the US dollar market.[9]

The distribution of interest rate derivatives by counterparty points to a continued shift in activity towards financial institutions other than dealers (Graph 3,

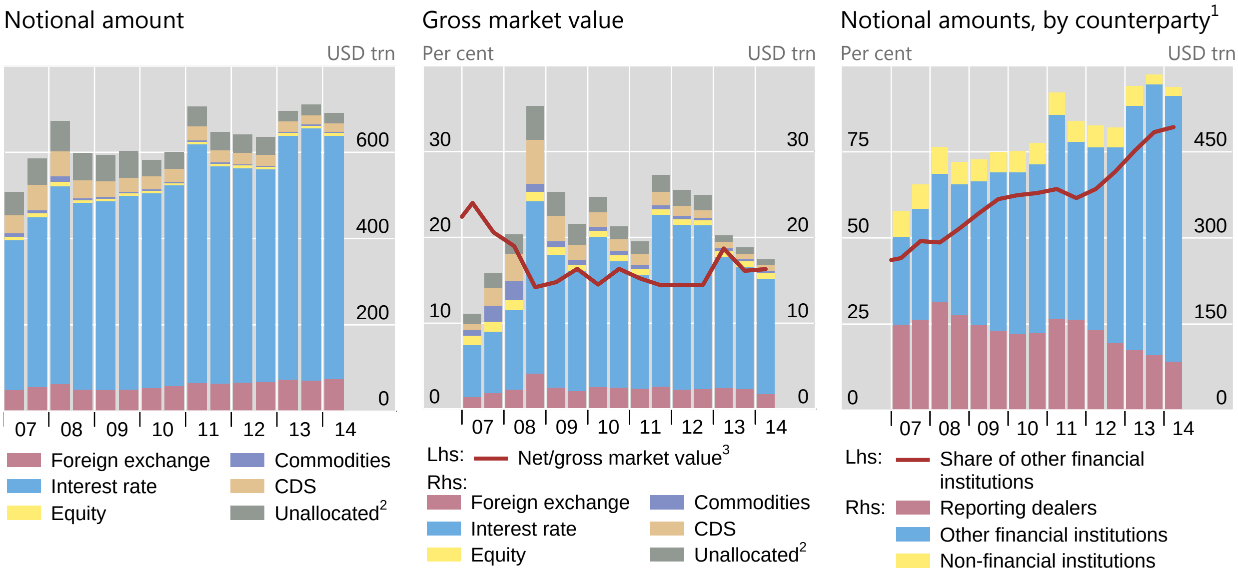
[7] Compression is a process for tearing up trades, which enables economically redundant derivatives trades to be terminated early without changing the net position of each participant. For statistics on multilateral compressions, see TriOptima, www.trioptima.com/resource-center/statistics/triReduce.html.

[8] At the inception of an interest rate swap contract, the market value is zero, ie the expected value of fixed interest rate cash flows over the life of the swap is equal to the expected value of floating interest rate cash flows.

[9] See BIS, "Volatility stirs, markets unshaken", *BIS Quarterly Review*, September 2014, pp 1–11.

Global OTC derivatives market

Outstanding positions, by data type, risk category and counterparty — Graph 3



[1] Interest rate derivatives. [2] Outstanding OTC derivatives positions of dealers that do not participate in the BIS's semiannual survey. Estimated by the BIS based on the Triennial Central Bank Survey of foreign exchange and derivatives market activity. [3] Gross credit exposure as share of gross market value.

Source: BIS OTC derivatives statistics.

right-hand panel). Contracts between dealers and other financial institutions stood at $463 trillion at end-June 2014, or 82% of all contracts, up from about one half at end-2008. A potential driver could be the increased use of derivatives by asset management firms and a general shift away from the traditional dealer-centric market structure.[10] That said, the trend towards central clearing of OTC contracts also plays an important role, as it may overstate growth in notional amounts for other financial institutions. Once a trade between a dealer and its counterparty is novated to the central counterparty (CCP), it becomes two outstanding contracts with the CCP.[11]

Notional amounts of outstanding foreign exchange (FX) contracts moved up by 6% to $75 trillion at mid-2014. The pickup in FX OTC derivatives volumes was fairly evenly distributed across the main instruments (forwards and FX swaps, currency swaps and options). At the same time, the market values of outstanding FX derivatives plunged by 25% to the lowest level (as a share of notionals) in several years (Graph 4, left-hand panel). The market value declined to $1.7 trillion at

[10] See D Rime and A Schrimpf, "The anatomy of the global FX market through the lens of the 2013 Triennial Survey", *BIS Quarterly Review*, December 2013, pp 27–43, for a characterisation of the evolving market structure in foreign exchange OTC markets, which has become less dealer-centric in recent years and features a greater participation by other financial institutions (eg smaller banks, asset managers, hedge funds and proprietary trading firms). K Miyajima and I Shim, "Asset managers in emerging market economies", *BIS Quarterly Review*, September 2014, pp 19–34, discusses the behaviour of asset managers of emerging market asset portfolios and their use of derivatives.

[11] See N Vause, "Central clearing and OTC derivatives statistics", *BIS Quarterly Review*, June 2011, p 26.

What does the sectoral classification of offshore affiliates tell us about risks?

Branimir Gruić, Christian Upper and Agustín Villar

Around one half of the outstanding international debt securities of non-financial corporations headquartered in major EMEs was issued through subsidiaries abroad, albeit with significant variation between countries (Graph A, left-hand panel). This debt does not show up in the residence-based external debt statistics, which therefore paint an overly benign picture of the non-financial corporate sector's indebtedness.① But the risk profile of offshore debt is likely to be very different depending on whether the issuing affiliate is a fully fledged firm with significant operations in the country of residence or if it is merely a conduit channelling funds to the parent.② Unfortunately, information on the full set of activities of offshore subsidiaries is not available at the aggregate level. That said, the sectoral classification of affiliates can help. Specifically, the non-financial affiliates of non-financial corporations are presumably more likely than purely financial affiliates to engage in activities other than providing funding for the parent. If so, the sector of the issuing entity could shed at least some light on the risk profile of offshore debt.③

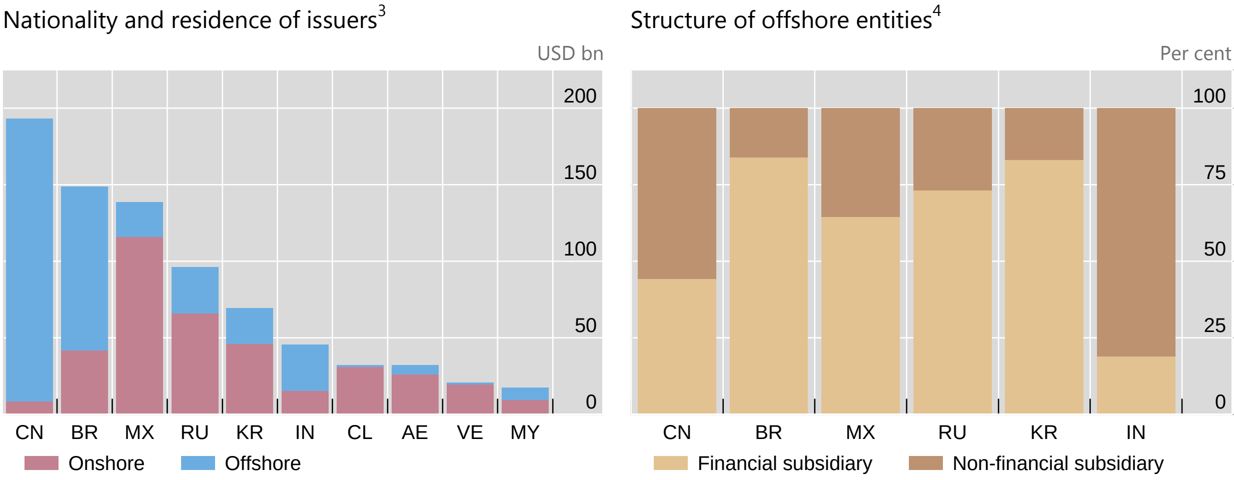
The sector classification of offshore affiliates shows considerable variation between countries, even in the case of those with similar offshore shares. More than 80% of offshore issuance by firms headquartered in India is by non-financial subsidiaries (Graph A, right-hand panel). Much of this debt is raised by firms in the Metal & Steel sector with large operations around the world. Chinese firms also issue heavily through non-financial subsidiaries abroad, which account for well over one half of issuance abroad by firms headquartered in China. By contrast, Brazilian and Korean firms issue primarily through financial subsidiaries.

The split between financial and non-financial subsidiary also varies between industries. For instance, firms operating in the Oil & Gas sector overwhelmingly issue through financial subsidiaries (Graph B), suggesting that most of the funding is being channelled to the parent. For most other sectors, the proportion of debt issued by financial and non-financial subsidiaries is roughly similar.

Using the sectoral split as a proxy for risk profiles does have its limits. This is illustrated by the Real Estate/Property sector. The bulk of issuance from this sector is by firms headquartered in China, which issue mostly

International issuance of EME based non-financial groups[1]

Outstanding amounts[2] Graph A



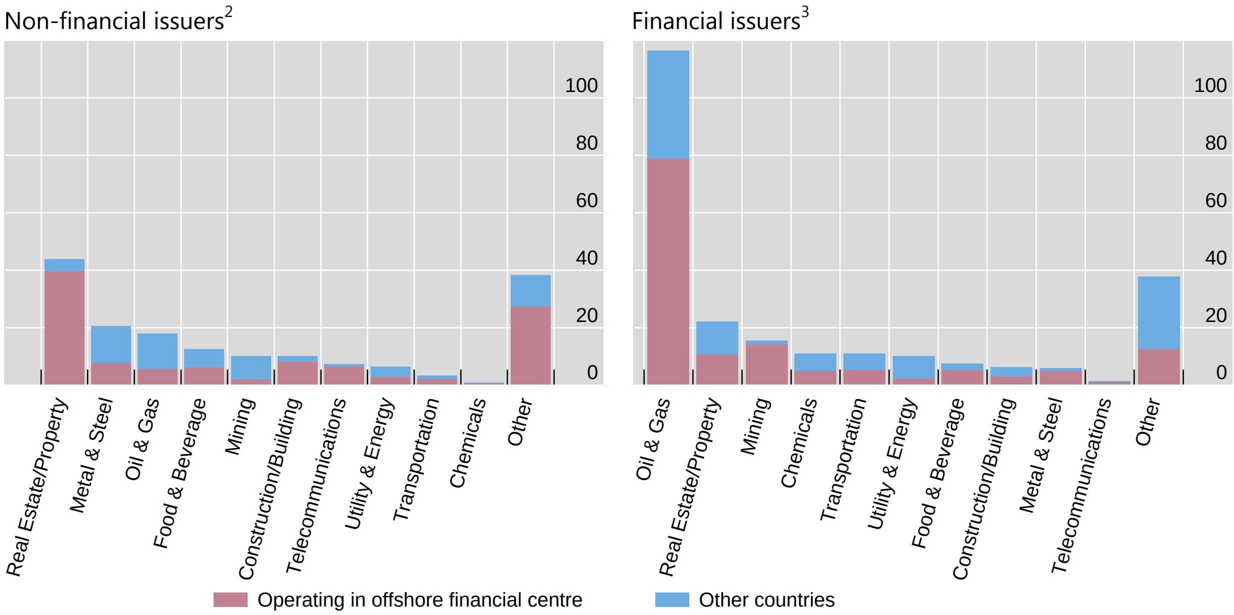
AE = United Arab Emirates; BR = Brazil; CL = Chile; CN = China; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; RU = Russia; VE = Venezuela.

[1] Non-financial corporations headquartered in one of the selected countries, with issuing entities operating in any country. Bonds in this selection were issued offshore (ie in international markets). [2] End-September 2014. [3] Nationality denotes residence of non-financial headquarters; residence denotes country of issuer. Residence is the same as nationality for onshore issuers, but differs for offshore issuers. [4] The main activities of financial subsidiaries are in financial services.

Sources: Dealogic; BIS calculations.

Industry classification of non-financial corporations

Outstanding amounts, in billions of US dollars[1] Graph B



[1] End-September 2014. Selected nationalities combined. [2] Industry classification of issuing non-financial subsidiaries by residence. If there is no indication of issuer's industry, non-resident owner's industry is used. [3] Industry classification of issuer's non-resident owners by residence of issuing financial subsidiaries.

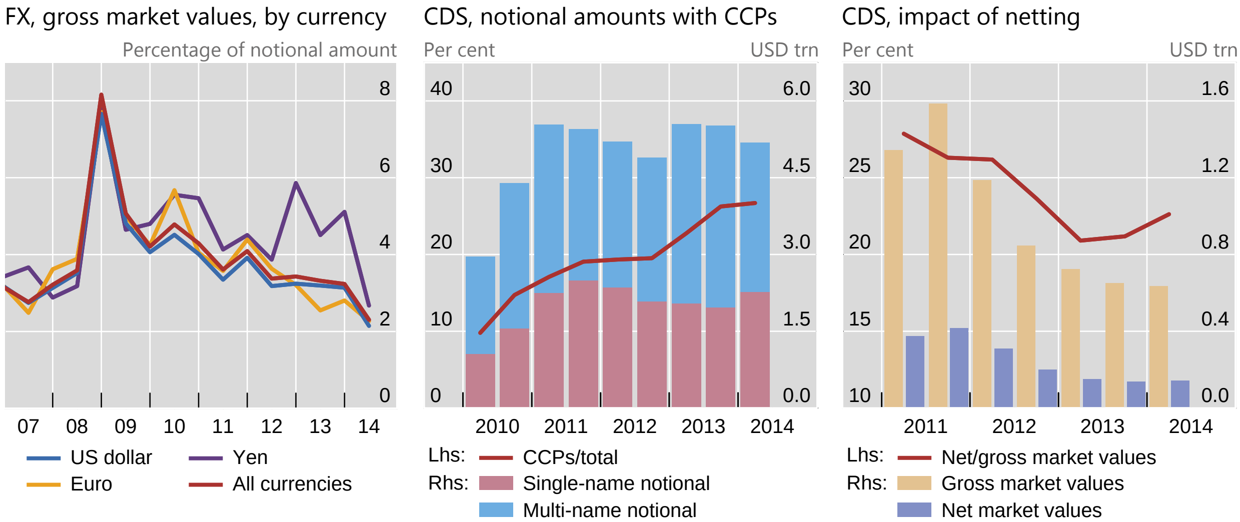
Sources: Dealogic; BIS calculations.

through non-financial affiliates. A possible reason is that non-financial affiliates can hold property that may serve as collateral. But this property need not be located in the country of issuance; it could equally well be situated in China or a third country. In fact, the vast majority of immediate (offshore) issuers belonging to this sector are resident in offshore financial centres (Graph B) such as the Cayman Islands that have tiny property markets compared with the volume of bonds outstanding.

① International debt securities are those issued in a country other than the one in which the issuer resides. This analysis ignores local issuance, ie in the country of the issuer. For previous discussions of offshore borrowing, see R McCauley, C Upper and A Villar, "Emerging market debt securities issuance in offshore centres", *BIS Quarterly Review*, September 2013, pp 22–23; and B Gruić, M Hattori and H S Shin, "Recent changes in global credit intermediation and potential risks", *BIS Quarterly Review*, September 2014, pp 17–18. For a discussion of how the repatriation of such funds shows up in balance of payments statistics, see S Avdjiev, M Chui and H S Shin, "Non-financial corporations from emerging market economies and capital flows", *BIS Quarterly Review*, December 2014, pp 67–77. ② See M Chui, I Fender and V Sushko, "Risks related to EME corporate balance sheets: the role of leverage and currency mismatch", *BIS Quarterly Review*, September 2014, pp 35–47, for a discussion of the risks associated with international debt issuance. ③ In some cases, foreign-registered financial subsidiaries pool funding for a global business across different national markets. Aggregating funding for different business units in this way can help achieve economies of scale in issuance while the proceeds can be distributed across different national markets. Foreign investors' holdings of such securities do not affect the external debt statistics of the parent's country.

end-June 2014 from $2.3 trillion at end-2013 and $2.4 trillion at end-June 2013. Contracts against the US dollar represented 87% of the notional amount outstanding at end-June 2014 and accounted for most of the decline in gross market values. The market values of FX swaps, forwards and options linked to the yen declined by more than 50% in the first half of 2014, a period when the main yen exchange rate movements stabilised and FX volatility receded from the elevated levels seen in 2013.

Foreign exchange derivatives and credit default swaps Graph 4



Source: BIS OTC derivatives statistics.

Outstanding volumes of CDS contracts continued to decline, dropping to \$19 trillion at end-June 2014, mostly due to a fall in inter-dealer positions and the continued elimination of redundant contracts. This means that aggregate positions in credit derivatives are now much smaller than before the crisis, when volumes peaked at \$58 trillion at end-2007. The notional amount for contracts between reporting dealers fell to \$10 trillion at end-June 2014. By contrast, notional amounts outstanding with banks and securities firms picked up to \$2 trillion. While trade compression continued to eliminate redundant contracts, the volume of compressions in the CDS segment has slowed since peaking in 2008–09. That said, trade compression made further inroads into other OTC market segments, particularly CCP-cleared interest rate swaps.

Central clearing remained an important theme in OTC derivatives markets during the first half of 2014. It is high on the global regulatory agenda for reforming OTC derivatives markets with a view to reducing systemic risks. Contracts with CCPs rose to account for 27% of all CDS contracts at end-June 2014, up from 23% one year earlier. The share of CCPs was highest for multi-name credit derivatives, at 34% (Graph 4, centre panel). Contracts on CDS indices in the multi-name segment tend to be more standardised, making them more amenable to central clearing than single-name contracts.

Owing in part to the shift towards central clearing, the CDS market has seen an increase in netting. Netting enables market participants to reduce their counterparty exposure by offsetting contracts with negative market values against those with positive ones. A comparison of net market values with gross market values indicates the prevalence of netting agreements. As a result of the increased use of such agreements, net market values as a percentage of gross market values fell to 21% at end-2013. Recently, this share has ticked up again, to 23% at end-June 2014 (Graph 4, right-hand panel). The prevalence of netting is greatest for CDS contracts with other dealers and CCPs, where it reduced the ratio of net to gross market values to 15% and 16%, respectively, at end-June 2014. It is lowest for contracts with insurance companies (85%) and non-financial customers (75%).

Robert McCauley
robert.mccauley@bis.org

Tracy Chan
tracy.chan@bis.org

Currency movements drive reserve composition[1]

A long-standing puzzle in international finance is the durability of the dollar's share of foreign exchange reserves – which remains above 60%, while the weight of the US economy in global output has fallen to less than a quarter. We argue that the dollar's role may reflect instead the share of global output produced in countries with relatively stable dollar exchange rates – the "dollar zone". If a currency varies less against the dollar than against other major currencies, then a reserve portfolio with a substantial dollar share poses less risk when returns are measured in domestic currency. Time series and cross-sectional evidence supports the link between currency movements and the currency composition of reserves.

JEL classification: E58, F31, F33.

Observers of international finance have long puzzled over the durability of the dollar's predominance in official foreign exchange reserves. Heller and Knight (1978) found that "on average, the countries in our sample tend to hold 66% of their foreign-exchange reserves in dollars". Some 36 years later, the IMF reports that 61% of allocated aggregate reserves are held in dollars. This is despite the dollar's 18% decline against major currencies and its 62% and 52% depreciations against the Deutsche mark/euro and the yen, respectively. Moreover, the US economy's share of global GDP has shrunk by 6% since 1978. If one takes the size of the US economy to explain the dollar's share, then one might infer that this share would decline only slowly unless and until another economy surpasses the US economy in size.[2]

This special feature proposes an alternative interpretation based on the size not of the US economy but rather of the "dollar zone". Despite the dollar's decline and the shrinking share of the US economy, the dollar zone still accounts for more than half of the global economy. In countries whose currencies are more stable against the dollar than against the euro, a reserve composition that favours the dollar produces more stable returns in terms of the domestic currency. This alternative interpretation implies that currency shares could shift rapidly, as happened between the world wars (Eichengreen and Flandreau (2010)).

[1] The authors thank Claudio Borio, Michael Dooley, Marc Flandreau, Guonan Ma, Madhu Mohanty, Denis Pêtre, Catherine Schenk, Jimmy Shek, Hyun Song Shin and Christian Upper for their discussions. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

[2] Chinn and Frankel (2007, 2008) ascribe the dollar's high share of reserves to the size of the US economy in an inductively non-linear relationship. This allows reserves in dollars to amount to more than twice those held in euros while the economy of the United States is only a third larger than that of the euro area.

This special feature argues in five sections that currency movements drive the currency composition of reserves. The first section sets out the main explanations that have been put forward for the currency composition of reserves. The second discusses time series evidence, both historically around currencies joining or quitting the sterling zone and since 1990. The third examines current cross-sectional evidence for two dozen economies. Our hypothesis competes with other hypotheses in the fourth section, and the fifth concludes.

Explanations for the currency composition of forex reserves

How should reserve managers choose the currency composition of their reserves? The numeraire that is used to measure risks and returns has a very strong influence on calculated optimal currency allocations (Papaioannou et al (2006), Borio et al (2008a)). Its choice depends on the intended uses of the reserves. If reserves are held mainly to intervene in the currency market, then a plausible numeraire would be the currency against which the domestic currency trades most heavily, especially in the spot market where most central banks operate. If reserves are held mainly to insure purchases of foreign goods and services, then an import basket would be plausible. Or, if reserves are held mainly as a hedge against (or to pay) debt service, the currency composition of outstanding debt would be a plausible choice.

The domestic currency may serve as the numeraire for economic or institutional reasons. Where reserves exceed transaction or insurance needs, their value as domestic wealth can be measured in terms of domestic currency. Or, the domestic currency may be used as numeraire owing to its use in valuing foreign exchange reserves in striking the central bank's accounting profit and reported capital. These may affect a central bank's reputation or even its operational independence.

A survey found a considerable range of choice (Borio et al (2008b)). About a third of central banks used the domestic currency, a fifth a basket of foreign currencies and the rest a single foreign currency. One third used the US dollar. Some central banks used different numeraires for different tranches, which themselves were distinguished by use (eg liquidity versus investment).

The next two sections provide evidence consistent with the use of the domestic currency as numeraire. The share of the dollar in reserves is higher where the domestic currency varies less against the dollar than other major currencies.

The time series evidence

The historical record of changes in the composition of reserves is quite telling. Looking back to the interwar period and the 1960s and 1970s: as economies joined (or left) the sterling area, their reserve composition shifted towards (or away from) sterling. In the period since 1990, the relative stability of the dollar share of reserves reflects the stability of the dollar zone at more than half of global output. In both cases, we observe that reserves are held in the major currencies that move less against the domestic currency.

Entering and leaving the sterling area

Historically, reserve shifts by those authorities whose currencies entered or left the sterling area show this logic at work. After the Scandinavian currencies joined the sterling area in the wake of the UK currency's 1931 floating (Drummond (2008)), central banks shifted their reserves into sterling.[3] Similarly, after the yen was pegged to sterling in 1934, sterling's share of Japanese reserves reached 90% in 1935, from just 15% in 1932 (Hatase and Ohnuki (2009), Figure 3).

Conversely, after leaving the sterling area, monetary authorities cut their holdings of sterling. For instance, in the 1968 Basel sterling agreement, the Bank of England guaranteed the dollar value of the 99% of Hong Kong's reserves that were invested in sterling (Schenk (2010), pp 295–6). After Hong Kong replaced its peg to sterling with its first dollar peg in July 1972, the proportion of Hong Kong's reserves held in dollars rose to 20% by September 1974 (Schenk (2009)) – and to 75% now, 31 years after the subsequent peg to the dollar in 1983.

Similar observations hold for less extreme reserve portfolios in the sterling area. In 1968, the Bank of England guaranteed the dollar value of the 70%, 45% and 40% of their reserves that were invested in sterling by New Zealand, Iceland and Australia, respectively. After the Australian and New Zealand dollars were pegged to the US dollar in the Smithsonian Agreement of December 1971, and then both to baskets by July 1973, the sterling share fell to about 20% by 1974 for Australia and by 1977 for New Zealand (Schenk and Singleton (forthcoming)). Today, New Zealand, Iceland and Australia hold 15%, 15% and 0% of their reserves in sterling and 25%, 40% and 55% in dollars, as described below.

The dollar zone and the dollar share of reserves since 1990

The dollar's role as reference for other countries' exchange rates ranges from dollar pegs, at one end, to largely market-driven co-movements under free-floating regimes as influenced by interest rate policies, at the other. By examining the degree of co-movements, and predefining the set of key currencies, we derive a measure of each such currency's zone of influence using simple regression techniques (see Annex for details). We use the euro (before 1999, the Deutsche mark) and yen as the other candidate reference currencies, consistent with their status as the second and third most transacted currencies in the Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity.

We then define not a tightly linked dollar bloc, but rather a fuzzier dollar zone. A given country's GDP contributes to this zone in proportion to its currency's dollar weight. So defined, the dollar zone accounts for more than half of global GDP.[4]

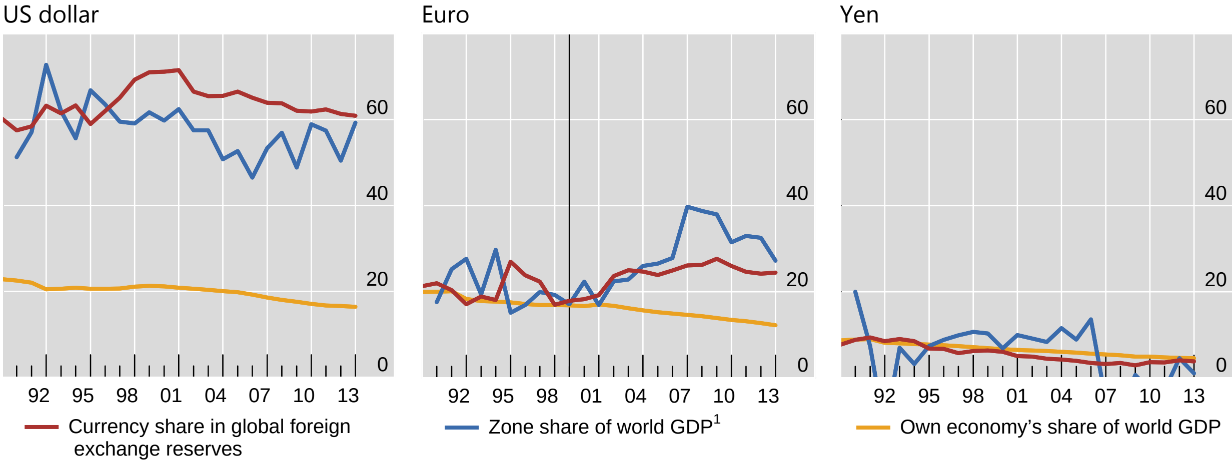
By this measure, the US dollar's pre-eminent influence as a reference currency lines up with its relative role as store of value for official reserves. The dollar zone has been close to 60% of global GDP and has shown little trend since 1990 (Graph 1, blue line in the left-hand panel). This 60% is much closer to the dollar share of reserves than the global share of the US economy (here measured in PPP terms, but the point would still hold at market values). The euro zone share of

[3] Personal communication with Marc Flandreau.

[4] Cf Kawai and Akiyama (1998), Bénassy-Quéré et al (2006) and Bracke and Bunda (2011).

Size of currency zones and global reserve composition

In per cent Graph 1



[1] Zone share estimated as own economy's share of PPP GDP, plus the elasticity-weighted share of all other economies' PPP GDPs. The elasticities are derived from a regression of weekly changes in the domestic currency/US dollar rate against a constant, and changes in the euro/dollar (prior to 1999, Deutsche mark/dollar) and yen/dollar rates, during the corresponding year. Negative values of the yen bloc arise from negative coefficients on the yen, which can be interpreted as reflecting the use of the yen as the funding currency in carry trades.

Sources: IMF; Datastream; national data; BIS calculations.

global GDP is now around 25%, just above the euro's (reduced) share of reserves. The yen trails.

A stable dollar zone share of global GDP is at first puzzling, given that the euro's influence has extended east in Europe (ECB (2014)), to commodity currencies and even as far as emerging Asia. However, Asia's fast growth has offset the euro's wider influence, given the diminished yet still strong dollar linkage of Asian currencies.

In sum, the dollar's share in global forex reserves tracks over time the share of the dollar zone in global output. Together with the cross-sectional evidence to which we now turn, this evidence suggests the importance of portfolio considerations and the domestic currency numeraire.

Cross-sectional evidence

The insight that the way a currency trades against the major currencies guides the choice of the currency denomination of reserves has found only limited use in previous cross-sectional studies. IMF studies of confidential data, whether Heller and Knight (1978), Dooley et al (1989) or Eichengreen and Mathieson (2000), use dummies for pegs. They thus restrict to only extreme cases a test of the connection between currency anchoring and reserve composition.

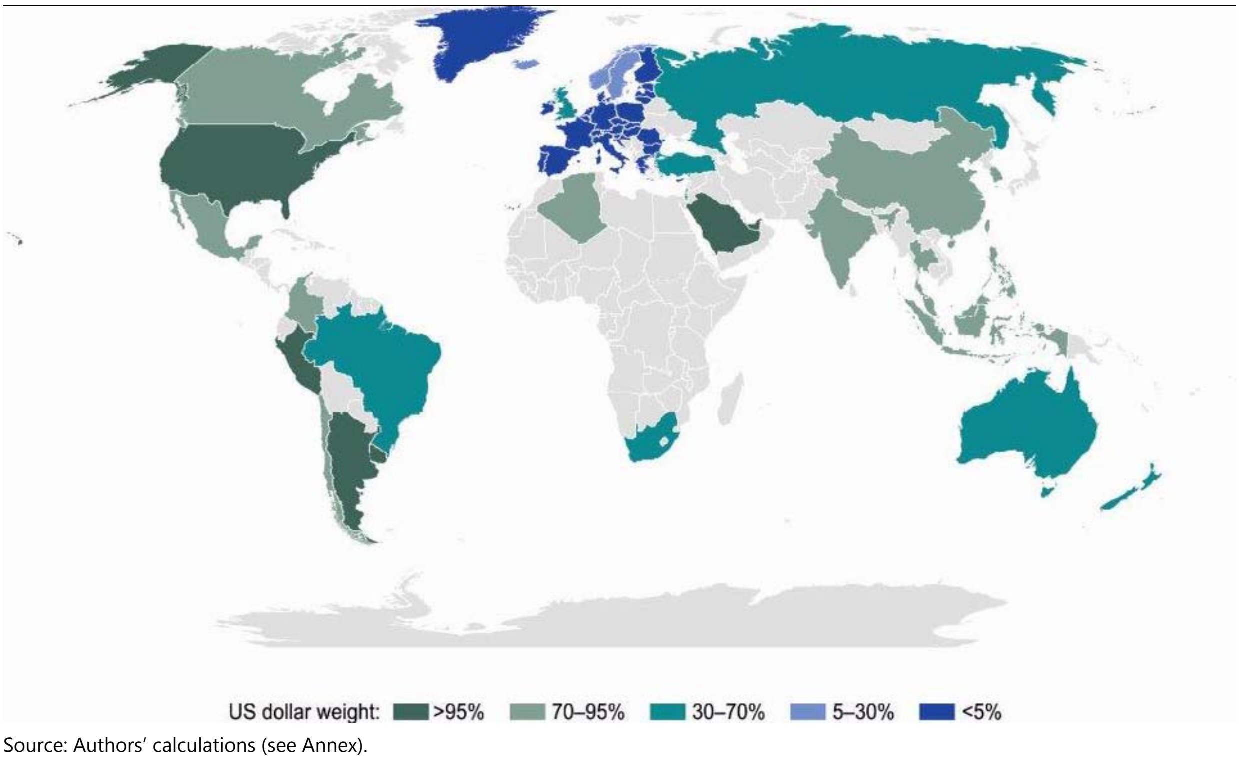
The less restrictive approach sketched above provides quite a different picture. Graph 2 shows the dollar share based on weekly changes over the calendar years 2010–13. Most economies outside the United States, the euro area and Japan are intermediate cases, with dollar zone weights of less than 95% and above 5%.

Intermediate status derives from explicit management or from a combination of policy and market responses. For example, the Central Bank of the Russian Federation (2013, p 75; ECB (2014), p 67) has managed the Russian rouble against a basket of €0.45 and $0.55. And indeed, we compute its weight on the dollar at 0.55. Another intermediate case, the free-floating pound sterling, has a dollar weight of 0.45, as Haldane and Hall (1991) find for the late 1970s.[5]

The calculation summarised in Graph 2 questions the widespread view that western hemisphere currencies are all firmly attached to the dollar. Other than the currencies of highly dollarised Peru and Uruguay, the co-movement with the euro of the Chilean, Colombian and Mexican pesos, or especially the Brazilian real, contradicts the long-standing notion of a solid dollar zone in the western hemisphere. Similarly, the co-movement of the Australian, New Zealand and, to a lesser extent, Canadian dollars with the euro against the dollar suggests that the "dollar bloc" label, still used by many asset managers, has outlasted its sell-by date.[6]

Does a currency's dollar weight influence the share of the US dollar in the corresponding country's official reserves? Yes, the limited cross-sectional evidence strongly suggests (Graph 3). Broadly, central banks in the Americas heavily weight the dollar, which remains the most important influence on their currencies despite

Dollar zone weights | Graph 2



Source: Authors' calculations (see Annex).

[5] If most shocks to the euro/dollar exchange rate do not imply a change in the pound's effective exchange rate, then one would expect the dollar zone weight to match the weight of the US and other dollar zone economies in the pound's trade-weighted basket. In fact, the dollar zone weight is close to leaving the effective pound exchange rate unchanged with changes in the euro/dollar rate. Thus dollar zone weights for floating currencies may be grounded in trade shares, and hence the gravity model.

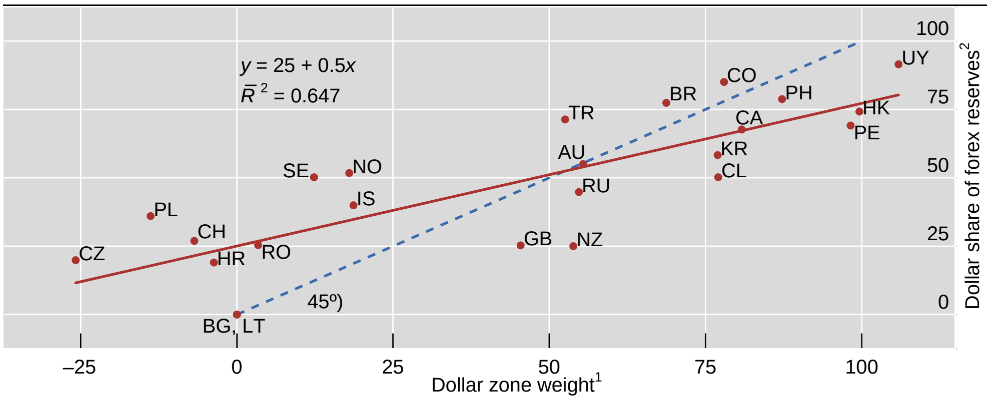
[6] Indeed, the recent appeal to reserve managers of the Australian dollar (its IMF-reported share in global reserves was 1.9% in June 2014) might have arisen from its euro co-movement and yield.

the rising importance of the euro. Most European central banks do not hold such a high share of dollars, and Russia, Turkey, the United Kingdom, Australia and New Zealand are in between. Two thirds of the cross-sectional variation in the dollar share in foreign exchange reserves can be accounted for by the currencies' average dollar zone weight in 2010–13.

The slope of the least squares line (in red in Graph 3) is not 1 (dashed blue line), as would be the case if reserve managers on average chose the dollar weight to minimise the variance of their portfolios in domestic currency.[7] Instead, the estimate of the slope of one half points to some departure from the minimum variance portfolio, perhaps in some cases to raise expected funds.

The necessary caveat to this strong finding is that the sample may not be representative. At the end of 2013, the 24 economies in Graph 3 accounted for $2.8 trillion of reserves, just 28% of the global total not held by the United States, the euro area and Japan.[8] The 24 clearly oversample small and advanced economies. Among the top 20 holders of reserves, emerging market economies Brazil, Hong Kong SAR, Korea, Russia, and Turkey are included, but eight are not: China, Saudi Arabia, Chinese Taipei, India, Singapore, Mexico, Algeria and Thailand.

Dollar zone weight and dollar share of forex reserves, 2013 — Graph 3



AU = Australia; BG = Bulgaria; BR = Brazil; CA = Canada; CH = Switzerland; CL = Chile; CO = Colombia; CZ = Czech Republic; GB = United Kingdom; HK = Hong Kong SAR; HR = Croatia; IS = Iceland; KR = Korea; LT = Lithuania; NO = Norway; NZ = New Zealand; PE = Peru; PH = Philippines; PL = Poland; RO = Romania; RU = Russia; SE = Sweden; TR = Turkey; UY = Uruguay.

[1] Average over four years. [2] For Australia, June 2013; Colombia, March 2011; Brazil, Croatia and Turkey, 2012; New Zealand, September2010.

Sources: National data; BIS calculations.

[7] The biggest outlier is New Zealand, which, like Canada and the United Kingdom, borrows most of its reserves. The currency denomination of borrowed reserves can be matched to the corresponding liabilities to avoid currency exposure. Thus, the domestic currency numeraire may be irrelevant to the choice of the currency composition. However, Graph 3 plots New Zealand's 25% weight on the dollar for the portion of reserves that is "unhedged" (owned outright against the New Zealand dollar), so it really is an outlier. In cash terms, 60% of New Zealand's reserves are held in the US dollar, because "the NZD/USD cross rate is the main traded market [and] intervention aims to influence the value of the NZD through operations in the NZD/USD market" (Eckhold (2010), p 40). Forward sales of 35% of the US dollars against other currencies including the Australian dollar reconcile the 60% cash holding and the 25% ultimate dollar weight. Thus, the need to hold the US dollar as an intervention currency does not determine the ultimate currency composition of reserves.

[8] Since the G3 countries cannot hold their own currencies in their reserves, they face a different set of choices from other reserve holders.

Given that previous work has used currency pegs, but not behavioural anchors, to explain the currency composition of reserves, it strengthens our result to note that it does not depend on pegs. In particular, if we exclude Bulgaria, Hong Kong and Lithuania, the estimated relationship is indistinguishable statistically from that in Graph 3. Furthermore, if we exclude currencies that the IMF (2013, pp 5–6) characterises as having a "crawl-like" (Croatia) or "other managed arrangement" (Russia and Switzerland), the result does not change much.[9] All in all, the relationship does not depend on economies where the currency is heavily managed.

Where might the largest reserve holder, China, place on Graph 3? If its reserve composition was at the average for emerging market economies reported to the IMF (Bénétrix et al (forthcoming)), then China would be the largest outlier: with only 60% of reserves held in the dollar on the vertical axis but a calculated dollar zone weight of 93% on the horizontal axis.[10] If market estimates of a lower dollar share are given credence, China would be a larger outlier. But if the medium-term management of the renminbi is interpreted as an upward crawl against China's trade-weighted basket (Ma et al (2012)), then the dollar zone share would be about half, lower than our estimate based on weekly changes.[11]

Private asset and debt managers also align their portfolios with their home currency's dollar zone weights. This is interesting in its own right and also gives us more confidence in the small-sample relationship between currency movements and the official foreign currency portfolio. Moreover, the tendency of the private sector to denominate its debt in the major currency that is more stable against the domestic currency reinforces the reserve managers' rationale for investing in it.[12]

Graph 4 (left-hand panel) relates the share of cross-border dollar deposits by country to the dollar zone share. The blue-circled dots indicate Graph 3's sample of 24 economies; the red dots, an additional 15 economies. Offshore bank deposits include some official holdings, but would usually be dominated by holdings of banks, firms and some households. The relationship is remarkably similar to that between the dollar zone weight and official reserve composition. The dollar share of deposits is somewhat higher (larger estimated intercept) and responds more strongly to the dollar zone share (steeper estimated slope), and overall is more tightly related to the dollar zone weight, with 81% of its variance accounted for.

Corresponding considerations bear on banks and firms – and, in some countries, households – in choosing the currency composition of their foreign currency liabilities. Graph 4 (centre panel) shows the relationship between the dollar share of cross-border bank loans to domestic residents and the dollar zone share, with blue-circled dots again showing Graph 3's sample of 24 countries. The

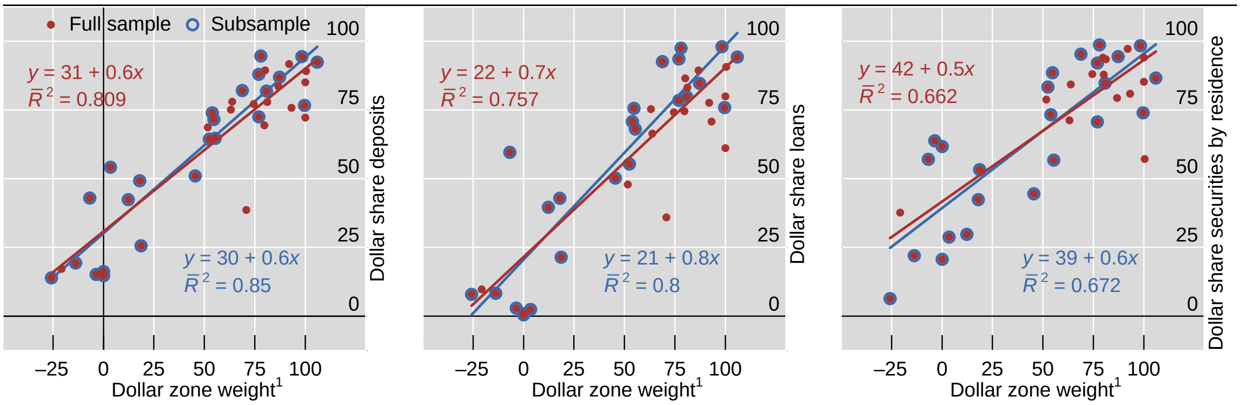
9 The slope is slightly flatter at 0.4 and the adjusted R^2 falls by little (0.555). If we further exclude the nine currencies classified as merely "floating", and run the regression for only the eight currencies classified as "free-floating", then the slope flattens to 0.3 and the adjusted R^2 falls to 0.344. In this sample, the problem of borrowed reserves (Canada and the United Kingdom) is acute (see footnote 7).

10 China could be a still bigger outlier if the dollar zone estimates were based on higher-frequency (daily or intraday) data; see Frankel and Wei (2007) and Frankel (2009). However, it would be a smaller outlier if Setser and Pandey (2009, p 1) were and continue to be correct in their conclusion that "dollar assets constitute at least 65 percent of China's aggregate portfolio", and the reserve portfolio resembled and continues to resemble the aggregate portfolio.

11 The BIS effective renminbi exchange rate features equal one sixth weights for the dollar, euro and yen, with most of the balance accounted for by regional currencies.

12 Dooley (1986) analyses net currency positions.

The dollar zone weights and the dollar share of country assets and liabilities Graph 4



[1] Average over four years.

Sources: National data; BIS international debt securities; BIS locational banking statistics; BIS calculations.

relationship is very strong. The right-hand panel plots the dollar share of outstanding issues of international debt securities by residents against the dollar zone weight. Here, the relationship is similar to that in Graph 3 for official reserves.

Thus, although our sample of disclosed currency compositions of reserves is limited, larger samples measuring the dollar share of economy-wide stocks of assets and liabilities bolster the small-sample results. The co-movement of a currency with the dollar is strongly associated with the dollar share of private assets and liabilities. While Dooley et al (1989) and Eichengreen and Mathieson (2000) use the currency composition of broad external debt stocks to explain the currency composition of official reserves, we consider that both respond to currency movements. In any case, any notion that official reserves hedge or provide for the servicing of foreign currency debt only reinforces the rationale for matching the reserve composition to the dollar zone share.

The dollar share of foreign exchange trading?

While the various functions of an international money mutually reinforce each other,[13] this section allows the dollar's means of exchange function to compete with currency movements in accounting for the dollar share of reserves in the cross section. Particularly if reserves are not large, the share of trading of the domestic currency against the dollar in the foreign exchange market could constrain the choice of the dollar share of reserves. Our measure of the share of dollar trading is

[13] Dollar trade invoicing encourages exporters (especially commodity exporters) to borrow dollars to hedge and importers to borrow dollars for working capital. Servicing dollar debts tilts trading towards the dollar, encouraging reserve managers to hold dollars. Using the limited evidence on the invoicing of imports by 11 of the 24 economies from Ito and Chinn (2014), we found an anomalous negative relationship between the dollar share of trade invoicing and the dollar share of reserves. Following Eichengreen and Mathieson (2000), we tried trade with the United States as a share of trade, but it never entered significantly in the presence of the dollar zone weight.

Regression analysis of dollar share of portfolios and forex trading and US trade[1] — Table 1

	1 (n=24)	2 (n=21)	3 (n=21)	4 (n=34)	5 (n=34)
Dependent variable: Dollar share of forex reserves					
Dollar zone	0.52 (0.00)	0.50 (0.00)	0.37 (0.01)		
Dollar trading, spot			0.18 (0.35)		
R^2 adjusted	0.647	0.583	0.577		
Dependent variable: Dollar deposit share					
Dollar zone	0.64 (0.00)	0.62 (0.00)	0.48 (0.00)	0.59 (0.00)	0.51 (0.00)
Dollar trading, spot			0.20 (0.17)		0.12 (0.11)
R^2 adjusted	0.850	0.845	0.856	0.864	0.871
Dependent variable: Dollar loan share					
Dollar zone	0.78 (0.00)	0.76 (0.00)	0.36 (0.06)	0.68 (0.00)	0.44 (0.00)
Dollar trading, spot			0.57 (0.01)		0.38 (0.00)
R^2 adjusted	0.800	0.777	0.862	0.764	0.828
Dependent variable: Dollar share in international bonds by residence of issuer					
Dollar zone	0.56 (0.00)	063 (0.00)	0.39 (0.02)	0.56 (0.00)	0.50 (0.00)
Dollar trading, spot			0.34 (0.08)		0.10 (0.39)
R^2 adjusted	0.672	0.721	0.751	0.687	0.684

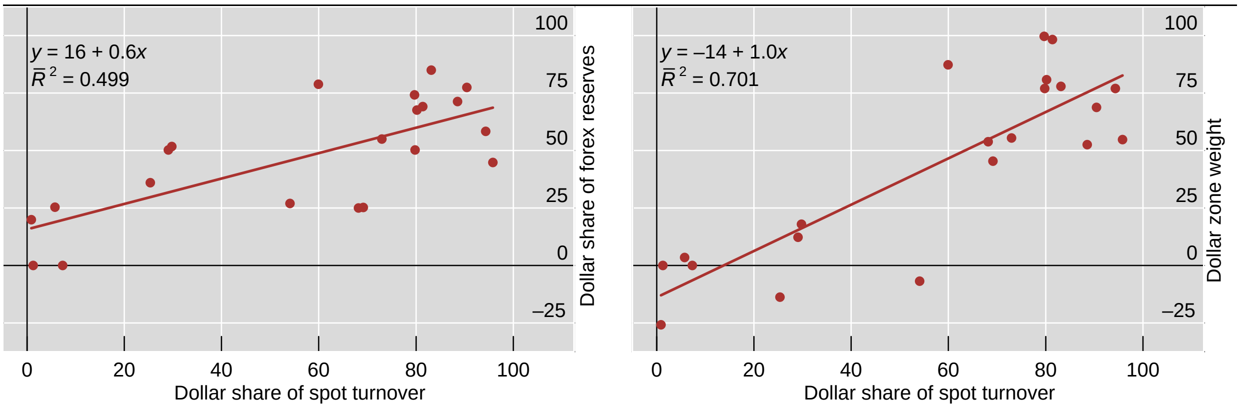
[1] P-values in brackets.

Source: BIS calculations.

derived from the results for spot trading in the Triennial Survey of April 2013, which improved on reporting on a range of emerging market currencies.[14]

On a bivariate basis, the share of dollar trading in the spot market does fall into line with the share of dollar reserves (Graph 5, left-hand panel). This is not surprising because the share of dollar trading is quite highly correlated with the dollar zone

The dollar share of spot forex turnover and reserves and the dollar zone weight — Graph 5



Sources: National data; BIS Triennial Survey; BIS calculations.

[14] Despite the improvements in the 2013 survey, reporting on the eight smaller currencies among our 24 was less complete. When we exclude the data for BG, CL, CO, CZ, LT, PE, PH and RO (Graph 3), the relationships in Graph 5 are weaker, but the results in Table 1 (top panel) are similar, albeit the R^2 is lower.

share (Graph 5, right-hand panel). But in a multivariate analysis of the dollar share of reserves, the dollar zone weight dominates the dollar share of trading in the currency market (Table 1, top panel). Portfolio considerations seem more important than trading in the spot market.

For completeness, and as a complementary test given the small size of our sample, the bottom three panels of Table 1 report regressions of the broader stocks of mostly private assets and liabilities on the same factors. Only the dollar zone weight seems to matter for the dollar deposit share (second panel). Alongside the dollar zone weight, the proportion of dollar trading emerges as a significant factor in the dollar share of loans and international bonds (third and fourth panels). However, these wider debt aggregates may themselves give rise to sufficient foreign exchange transactions as to explain the dollar trading share (reverse causation).

All in all, a currency's co-movement with the dollar bears a robust relationship to the dollar share of assets and liabilities. Currency geography is portfolio destiny.

Conclusions

We find that the higher the co-movement of a given currency with the dollar, the higher the economy's dollar share of official reserves. Two thirds of the variation in the dollar share of foreign exchange reserves is related to the respective currency's dollar zone weight.

This association is supported by the currency composition of broader economy-wide balance sheets including the private sector. After all, our sample of official reserves is limited to only 24 economies representing $2.8 trillion or 28% of official foreign exchange reserves outside the G3. As a sort of robustness check, we assess the same relationship between currency movements and portfolio choices for $6 trillion, $6 trillion and $7 trillion in bank deposits, bank loans and international bonds outstanding, respectively. We find – if anything – stronger relationships.

The logic underlying both private and official behaviour is straightforward. The dollar looks less risky as an investment or a borrowing currency the more closely the domestic currency moves with the dollar.

Looking forward, our findings also have implications for the possible evolution of the currency composition of official reserves. They suggest that changes in the co-movement of currencies could result in more rapid than commonly thought shifts in the composition of reserves, potentially eroding the weight of the dollar. By the same token, they indicate that country size alone may be less relevant.

If correct, these findings have implications for the future of the renminbi. The continued relatively rapid growth of the Chinese economy, even if accompanied by developing money and bond markets, opening of the capital account and floating of the renminbi, might not be sufficient for the currency to eclipse the dollar in official reserve holdings. By contrast, if the renminbi at some point showed substantial independent movement against the major currencies *and* if its neighbours' and trading partners' currencies shared that movement, then it might be said that "the renminbi bloc [ie zone] is here" (Subramanian and Kessler (2013), but see also Kawai and Pontines (2014) and Shu et al (2014)). In that case, official reserve managers might hold a substantial share of renminbi, perhaps not too far from their currencies' renminbi zone weights.

References

Bénassy-Quéré, A, B Cœuré and V Mignon (2006): "On the identification of de facto currency pegs", *Journal of the Japanese and International Economies*, vol 20, pp 112–27.

Bénétrix, A, P Lane and J Shambaugh (forthcoming): "International currency exposures, valuation effects and the global financial crisis", *Journal of International Economics*.

Borio, C, J Ebbesen, G Galati and A Heath (2008a): "FX reserve management: elements of a framework", *BIS Papers*, no 38, March.

Borio, C, G Galati and A Heath (2008b): "FX reserve management: trends and challenges", *BIS Papers*, no 40, May.

Bracke, T and I Bunda (2011): "Exchange-rate anchoring: is there still a de facto dollar standard?", *ECB Working Paper Series*, no 1353, June.

Central Bank of the Russian Federation (2013): *Annual Report*, Moscow, May.

Chinn, M and J Frankel (2007): "Will the euro surpass the dollar as a reserve currency?", in R Clarida (ed), *G7 current account imbalances*, University of Chicago Press, pp 285–322.

——— (2008): "Why the euro will rival the dollar", *International Finance*, vol 11, pp 49–73.

Dooley, M (1986): "An analysis of the management of the currency composition of reserve assets and external liabilities of developing countries", in R Aliber (ed), *The reconstruction of international monetary arrangements*, Macmillan, pp 262–80.

Dooley, M, S Lizondo and D Mathieson (1989): "The currency composition of foreign exchange reserves", *IMF Staff Papers*, vol 36, pp 385–434.

Drummond, I (2008): *The floating pound and the sterling area: 1931–1939*, Cambridge University Press.

Eckhold, K (2010): "The currency denomination of New Zealand's unhedged foreign reserves", *Reserve Bank of New Zealand Bulletin*, vol 73, no 3, September, pp 37–46.

Eichengreen, B and M Flandreau (2010): "The Federal Reserve, the Bank of England and the rise of the dollar as an international currency, 1914–39", *BIS Working Papers*, no 328, November.

Eichengreen, B and D Mathieson (2000): "The currency composition of foreign exchange reserves: retrospect and prospect", *IMF Working Papers*, no 00/131, July.

European Central Bank (2014): *The international role of the euro*, July.

Frankel, J (2009): "New estimates of China's exchange rate regime", *Pacific Economic Review*, no 14 (3), pp 346–60.

Frankel, J and S-J Wei (1996): "Yen bloc or dollar bloc? Exchange rate policies in East Asian economies", in T Ito and A Krueger (eds), *Macroeconomic linkage: savings, exchange rates, and capital flows*, University of Chicago Press, pp 295–329.

——— (2007): "Assessing China's exchange rate regime", *Economic Policy*, July, pp 577–627.

Haldane, A and S Hall (1991): "Sterling's relationship with the dollar and the Deutschemark: 1976–89", *Economic Journal*, vol 101, no 406, May.

Hatase, M and M Ohnuki (2009): "Did the structure of trade and foreign debt affect reserve currency composition? Evidence from interwar Japan", Bank of Japan Institute for Monetary and Economic Studies, *Discussion Paper Series*, 2009-E-15.

Heller, H and M Knight (1978): "Reserve currency preferences of central banks", *Princeton Essays in International Finance*, no 131, December.

International Monetary Fund (2013): *Annual Report on exchange arrangements and exchange restrictions*, October.

Ito, H and M Chinn (2014): "The rise of the 'redback'", *Asian Development Bank Institute Working Paper Series*, no 473.

Kawai, M and S Akiyama (1998): "The role of nominal anchor currencies in exchange rate arrangements", *Journal of the Japanese and International Economies*, vol 12, pp 334–87.

Kawai, M and V Pontines (2014): "Is there really a renminbi bloc in Asia?", *Asian Development Bank Institute Working Paper Series*, no 467, February.

Ma, G and R McCauley (2011): "The evolving renminbi regime and implications for Asian currency stability", *Journal of the Japanese and International Economies*, vol 25, no 1, pp 23–38.

Ma, G, R McCauley and L lam (2012): "Narrowing China's current account surplus: the role of saving, investment and the renminbi", in H McKay and L Song (eds), *Rebalancing and sustaining growth in China*, ANU Press and Social Sciences Research Press (China), pp 65–91.

Papaioannou, E, R Portes and G Siourounis (2006): "Optimal currency shares in international reserves", *Journal of the Japanese and International Economies*, vol 20(4), December, pp 508–47.

Schenk, C (2009): "The evolution of the Hong Kong currency board during global exchange rate instability, 1967–1973", *Financial History Review*, vol 16, pp 129–56.

——— (2010): *The decline of sterling: managing the retreat of an international currency, 1945–1992*, Cambridge University Press.

Schenk, C and J Singleton (forthcoming): "The shift from sterling to the dollar 1965–76: evidence from Australia and New Zealand", *Economic History Review*.

Setser, B and A Pandey (2009): "China's $1.5 trillion bet: understanding China's external portfolio", *Council on Foreign Relations Working Paper*, May.

Shu, C, D He and X Cheng (2014): "One currency, two markets: the renminbi's growing influence in Asia-Pacific", *BIS Working Papers*, no 446, April.

Subramanian, A and M Kessler (2013): "The renminbi bloc is here", *Peterson Institute for International Economics Working Paper Series*, WP 12-19, August.

Annex: Estimating the US dollar, euro and yen zones

The size of, say, the dollar zone is measured using variants of the methodology developed by Haldane and Hall (1991) and Frankel and Wei (1996). Kawai and Akiyama (1998) and Bénassy-Quéré et al (2006) have similarly applied this method.

The dollar share is calculated in two steps. First, for a given currency, its weekly percentage change against the dollar is regressed on the weekly percentage change of the euro/dollar and yen/dollar rates. The dollar zone weight is calculated as 1 minus the corresponding regression coefficients. For example, for sterling in 2013 the pound's estimated coefficient on the euro/dollar rate is 0.60 and on the yen/dollar is 0.09. So, the dollar weight for the pound is (1 – 0.60 – 0.09), or 0.31. For the Hong Kong dollar, the coefficients would be zero; and hence the dollar zone weight, 1.

Second, across currencies, the dollar share is then calculated using (PPP) GDP weights. Each of the 39 economies' (49 before the euro) dollar zone weight is multiplied by the respective GDP, and the product is added to the US GDP. This sum is then expressed as a share of the total GDP of the 42 major economies analysed, including those of the United States, the euro area and Japan. This analysis produces dollar zone weights of 1 for Hong Kong SAR and Saudi Arabia, and zero for Bulgaria.

There are four issues: three concern the technique and one the results. First, the selection of major currencies is a prior choice. It is grounded in the Triennial Survey finding of the three most traded currencies.[15]

Second, as regards the choice of numeraire, many analysts seek to avoid a major currency and use the SDR or Swiss franc. Our approach, which uses the dollar, assigns a given currency to the dollar zone if its movements against the dollar have nothing in common with those of the euro or the yen. But, as long as the coefficients are interpreted correctly, the results do not depend on the choice of numeraire (Ma and McCauley (2011), Table 1). Moreover, as a practical matter, use of the SDR may make it more difficult to collect simultaneous observations for the three currencies, which become econometrically more crucial the higher the frequency. Nevertheless, we have re-computed the dollar zone by regressing weekly percentage changes in a given currency's SDR exchange rate on percentage changes in the dollar/SDR, euro/SDR and yen/SDR rates. Except for the polar cases, the dollar weights thus derived tend to be lower, but the correlation is 0.85. As a result, however, the goodness of fit of Graph 2 using these alternative dollar zone estimates is only a bit lower, with an adjusted R^2 of 0.56 rather than 0.65.

Third, there is a question of data frequency. Our use of weekly data, as opposed to higher-frequency data, strikes an appropriate balance between estimation precision and reducing the downward bias from non-simultaneous observation of the three exchange rates used. In addition, it may work better with managed exchange rates if the authorities limit daily dollar movements but track a basket over lower frequencies (Frankel and Wei (2011), Ma and McCauley (2011)).

And fourth, the estimation for the last 10 years has often produced negative coefficients on the yen for a range of commodity currencies. For example, these

[15] Subramanian and Kessler (2013) find evidence for the existence of a renminbi bloc in Asia, but this is questioned by Kawai and Pontines (2014) and Shu et al (2014).

indicate that the Brazilian real falls against the US dollar when the yen rises against the dollar. Thus, in Graph 1, the yen zone becomes negative in some years, as portions of commodity currencies' (that load on the yen) GDPs outweigh Japanese GDP. One way of interpreting these observations is that they reflect carry trades in which the yen is a funding currency. These observations highlight the possibility that conventional measures understate the yen's role in international finance, because hard-to-measure derivatives transactions are important in its use as a funding currency.

Adonis Antoniades
adonis.antoniades@bis.org

Nikola Tarashev
nikola.tarashev@bis.org

Securitisations: tranching concentrates uncertainty[1]

Even when securitised assets are simple, transparent and of high quality, risk assessments will be uncertain. This will call for safeguards against potential undercapitalisation. Since the uncertainty concentrates mainly in securitisation tranches of intermediate seniority, the safeguards applied to these tranches should be substantial, proportionately much larger than those for the underlying pool of assets.

JEL classification: G24, G32.

The past decade has witnessed the spectacular rise of the securitisation market, its dramatic fall and, recently, its timid revival. Much of this evolution reflected the changing fortunes of securitisations that were split into tranches of different seniority. Initially, such securitisations appealed strongly to investors searching for yield, as well as to banks seeking to reduce regulatory capital through the sale of judiciously selected tranches.[2] Then, the financial crisis exposed widespread underestimation of tranche riskiness and illustrated that even sound risk assessments were not immune to substantial uncertainty.

The crisis sharpened policymakers' awareness that addressing the uncertainty in risk assessments is a precondition for a sustainable revival of the securitisation market. Admittedly, constructing simple and transparent asset pools would be a step towards reducing some of this uncertainty. That said, substantial uncertainty would remain and would concentrate in particular securitisation tranches. Despite the simplicity and transparency of the underlying assets, these tranches would not be simple.

We focus on the uncertainty inherent in estimating the risk parameters of a securitised pool and study how it translates into uncertainty about the distribution of losses across tranches of different seniority. The uncertainty could be small for junior tranches, which are the first to be wiped out following even small adverse shocks, or for tranches that are senior enough to enjoy substantial credit protection. In the middle of a securitisation's capital structure, however, mezzanine tranches would be subject to considerable uncertainty because of the so-called *cliff effect*: a

[1] The authors thank Magdalena Erdem for excellent research assistance, and Claudio Borio, Dietrich Domanski, Neil Esho, Marc Farag, Ingo Fender, Raquel Lago, Hyun Song Shin, Kostas Tsatsaronis and Christian Upper for useful comments. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

[2] For discussions of key drivers of the pre-crisis securitisation markets, see Jones (2000), CGFS (2005) and Hull and White (2012).

small estimation error could mean that the risk of such a tranche is as low as that of a senior tranche or as high as that of a junior tranche.

Pool-wide uncertainty concentrates in tranches in the vicinity of the cliff and, if ignored, raises the possibility of severe undercapitalisation for these tranches. Based on a stylised example, our analysis reveals that this possibility is substantial even for extremely simple and transparent underlying assets. And while regulatory capital tends to increase with assets' riskiness, ignoring uncertainty results in a similarly elevated degree of undercapitalisation throughout. Safeguards are thus needed to address this issue head-on. Since the issue pertains mainly to mezzanine tranches, the safeguards applied to them should be proportionately much larger than those for the underlying asset pool. The revisions to the regulatory framework for securitisations – as proposed in a recent consultative document of the Basel Committee (BCBS (2014)) – are a welcome step in this direction.[3]

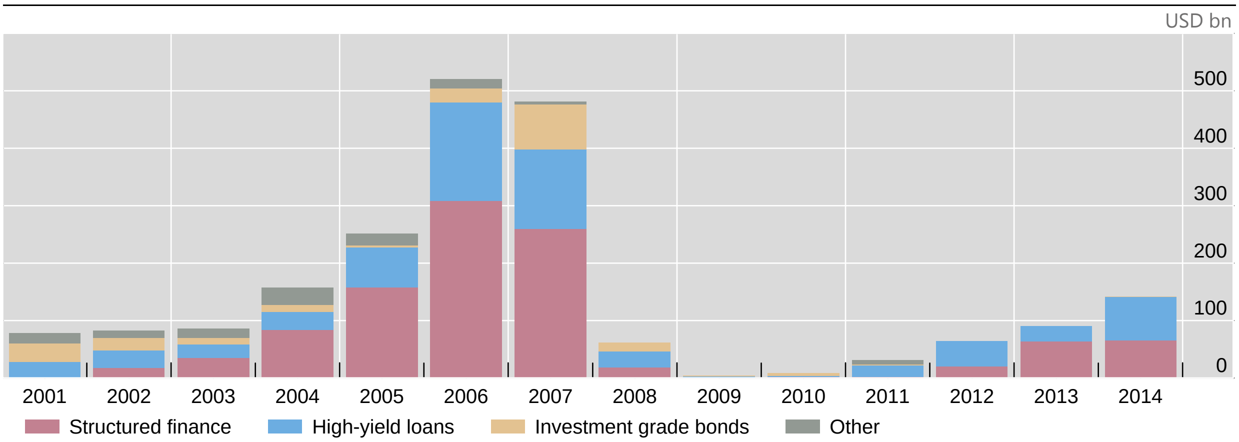
The article proceeds as follows. The first section reviews briefly the issuance and rating performance of securitisation tranches. Abstracting from uncertainty and adopting the benchmark credit risk model that underlies the Basel capital framework, the second and third sections compare capital requirements across different types of securitisation exposures. Finally, considering an extremely simple and transparent securitisation, the fourth section studies the potential undercapitalisation of tranches when model parameters are uncertain but treated as known, ie when no allowance is made for estimation error.

Historical experience with securitisation tranches

Extremely popular before the global financial crisis, structured securitisations underperformed subsequently. The issuance of such instruments grew strongly between 2003 and 2007 (Graph 1). As the crisis unfolded, however, outsize and

Issuance of collateralised debt obligations

By collateral type | Graph 1



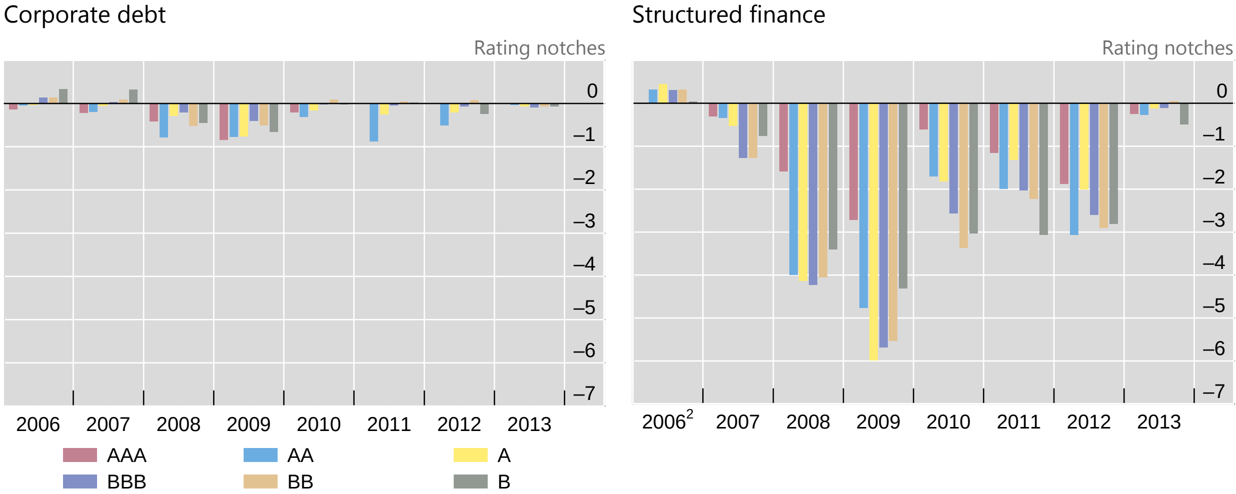
Source: Securities Industry and Financial Markets Association (SIFMA).

[3] These proposals address various types of uncertainty, including model uncertainty, while our analysis focuses exclusively on estimation uncertainty.

Evolution of credit risk assessments[1]

Average one-year rating migrations

Graph 2



[1] Based on Fitch's entire rating universe. A bar's colour corresponds to a rating at the beginning of the year, and its height to the average migration over the year. A positive (negative) number indicates an upgrade (downgrade). [2] US instruments only.

Sources: Fitch; authors' calculations.

widespread downgrades forced banks to quickly raise capital for unshed securitisation exposures.[4] While the average rating of corporate bonds was revised downwards by roughly one notch in 2009, the corresponding revision was three to six notches for tranches with different seniority in securitisations' capital structure (Graph 2).[5] And while the wave of downgrades quickly receded for corporate bonds, it persisted until 2012 for both low- and highly rated tranches.

This relative rating performance underscored previously underappreciated features of structured securitisations and brought their issuance to a halt (Graph 1). Fender et al (2008) explained tranches' relative performance with the high sensitivity of their credit rating to changing economic conditions. In turn, the argument below points to an explanation of why tranche downgrades caught markets by surprise: market participants ignored substantial uncertainty in risk assessments.

Regulatory capital: from total portfolio to tranche exposures

A key function of capital is to protect against failure by absorbing losses. The internal ratings-based approach in the current regulatory capital framework for the banking book evaluates the probability distribution of portfolio credit losses on the basis of a stylised model. And it sets regulatory capital to a level that these losses could only exceed with a sufficiently small probability.

[4] The crisis revealed that certain banks were exposed both to tranches on their balance sheets and, through explicit or implicit guarantees, to tranches held by off-balance sheet conduits. This article does not address the distinction between on- and off-balance sheet exposures and assumes that a bank sheds an exposure through an outright sale to an unrelated entity.

[5] For an extensive review of securitisation markets at the crisis outset, see BIS (2008), Chapter VI.

Assuming that the regulatory model is correct and its parameters are known with certainty, we outline in this section the calculation of capital at the level of the overall bank portfolio and the allocation of this capital to individual exposures. The ultimate goal of the section is to highlight the sensitivity of exposure-level regulatory capital to risk parameters. Awareness of this sensitivity – and how it differs across exposure types – leads us naturally to explore the implications of parameter uncertainty in the next section.

Regulatory capital for a credit portfolio

The regulatory model for portfolio credit risk is a stylised description of a bank's future losses. It aims to specify the average level of losses – which can be determined in advance – as well as possible deviations from the average. These unknown, random deviations are the credit risk against which the bank builds a capital cushion. The regulatory model's distinguishing feature – a single source of risk for the aggregate portfolio – stems from two assumptions.

The first assumption is that the portfolio comprises a very large number of small assets, ie the portfolio is *asymptotic*. When there are many assets, an adverse shock in one place – eg a personal tragedy of an uninsured homeowner – is sure to go hand in hand with a favourable shock elsewhere – eg a successful patent sale by an indebted enterprise. And when the assets are of comparably small size, such *idiosyncratic* shocks balance each other: asset-specific risks are diversified away at the portfolio level. If the portfolio were subject only to such idiosyncratic risk, actual losses would be known for sure, ie there would be losses but no credit risk at the level of the portfolio as a whole.

The second modelling assumption is that there is a single additional source of risk and it cannot be diversified away. This *common risk factor* is interpreted as relating to general economic conditions. For example, it may capture unexpected swings in energy prices or natural catastrophes that affect *all assets* in the portfolio. It thus generates *correlation* of losses and maintains portfolio credit risk.

The two assumptions are the reason why the regulatory model is referred to as the Asymptotic Single Risk Factor (ASRF) model. The parameters of this model – such as individual probabilities of default (PD), loss-given-default (LGD) and dependence on the common factor – shape the mapping from the common factor to portfolio losses. Provided that these parameters are known with certainty, the mapping is one-to-one: if the trajectory of the common factor were known, so would be aggregate portfolio losses.

The regulatory target is to limit the one-year likelihood of bank failure to 0.1%. This requires setting regulatory capital to a critical level of one-year portfolio losses that can be exceeded only with 0.1% probability. Under the ASRF model, these losses conveniently correspond to a critical level of the common factor: its 0.1 percentile. Thus, the bank's regulatory capital is equal to *the portfolio losses that would materialise if the common factor were at its critical level* (see Annex 1 for further details).

Exposure-level regulatory capital

In turn, the capital allocated to a particular exposure is equal to the exposure's contribution to the critical level of portfolio losses. Namely, it is equal to the expected losses on the exposure – roughly, the product of its PD and LGD – conditional on the common factor being at the chosen critical level (henceforth, "conditional expected losses"). This holds irrespective of the exposure type, eg a loan, a securitisation of loans or a securitisation tranche.

Even though exposure-level capital is always based on the same risk metric – conditional expected losses – its actual value would depend on the exposure type and the risk characteristics of the underlying assets. To focus on the importance of the exposure type, we keep risk characteristics as simple as possible. Namely, we focus on homogeneous loans – which have the same size and risk parameters – and on only one risk parameter – the unconditional PD – keeping LGD and common-factor dependence in the background at benchmark levels (see Annex 1). We treat these loans as underpinning exposures that are infinitesimally small parts of the bank's overall ASRF portfolio.

Exposures underpinned by a simple aggregation of homogeneous loans would face proportionately the same regulatory capital. For instance, if the PD of a loan is 3%,[6] the capital allocated to this loan would be $0.10 per $1 of exposure. Pooling many such loans in a securitisation would then call for summing up the individual requirements, resulting again in regulatory capital of $0.10 per $1 of exposure.

Likewise, the same regulatory capital would apply to a composite exposure that consists of an equal fraction of each underlying loan, often referred to as a *vertical* tranche. An increase in the capital requirements for a loan would trivially translate *one-to-one* into an increase in the requirements for the pool of loans or for a vertical tranche from this pool. Across all these exposure types, the *structure* of the underlying risks does not change from the point of view of the metric used for regulatory capital, ie they all feature the same conditional expected losses per unit of exposure.

The picture changes dramatically when the securitisation is sliced into tranches of *different* seniority, which absorb pool losses sequentially. In this case, conditional expected losses are no longer distributed uniformly across tranches but are mostly concentrated in only some of them. And so is regulatory capital. We next show that the high concentration makes the regulatory capital for tranches of intermediate seniority substantially more sensitive to risk parameter values than the capital for a vertical tranche.

Regulatory capital for tranches of different seniority

Unlike vertical tranches, tranches that absorb losses sequentially offer a spectrum of risk characteristics and, thus, appeal to a broader investor base. Such tranches are defined by an attachment and a detachment point. The attachment point indicates the minimum of pool-level losses at which a given tranche begins to suffer losses. In turn, the detachment point corresponds to the amount of pool losses that completely wipe out the tranche.

The riskiness of a tranche decreases with the tranche's seniority in the securitisation's capital structure. A junior tranche, for example, could have

[6] We choose this specific PD level in order to work with easy-to-read graphs. The article's takeaways remain unchanged in qualitative terms under more realistic, lower PDs.

attachment and detachment points equal to 0% and 10%, respectively, of the pool exposure. Such a tranche would be intact if there are no losses but would be partly eroded with the first losses. The erosion will be complete when losses reach 10% of the pool exposure. By contrast, a mezzanine tranche with attachment and detachment points of 10% and 20%, respectively, is initially protected but would be affected as soon as losses exceed 10% of the pool size. Finally, a senior tranche with attachment and detachment points of 20% and 100% respectively will be the most protected, starting to incur losses only when both the junior and mezzanine tranches are wiped out.

For given attachment and detachment points, the risk of a tranche would depend on the risk characteristics of the underlying pool. Our main focus is on the underlying assets' PD, which we first study in an ASRF pool. Besides this PD, however, the proposed revisions to the regulatory framework for securitisations take explicit account of several additional risk characteristics, such as the number of assets in the pool (ie the pool's granularity) and the correlation of associated losses (BCBS (2014), pp 10 and 31). In line with these proposals, we relax the ASRF assumptions at the level of the pool and study the robustness of our findings to the presence of idiosyncratic risk and to a second, pool-specific risk factor. In each case, we calculate "regulatory" capital as the expected loss on a tranche, conditional on the critical level of the global common factor.[7]

Perfectly diversified pool with a single common risk factor

We first study an ASRF pool, which possesses the two key properties of the bank's overall portfolio: full diversification of idiosyncratic risk and exposure to a single common risk factor. Paralleling the bank's portfolio, knowledge of the critical level of the common factor implies knowledge of the critical level of pool-wide losses. Given a loan PD of 3%, this level – and, thus, pool-wide capital – is equal to $0.10 per $1 of exposure.

Knowledge of the conditional pool losses translates into knowledge of the conditional losses on each tranche. By construction, a tranche with a detachment point below 10% of the pool size is sure to be fully wiped out when the common risk factor is at its critical level. Thus, the regulatory capital for such a tranche is $1 per $1 of exposure. By contrast, a tranche with an attachment point above 10% is fully shielded from losses when the common factor is at its critical level. The regulatory capital for this tranche is thus $0.

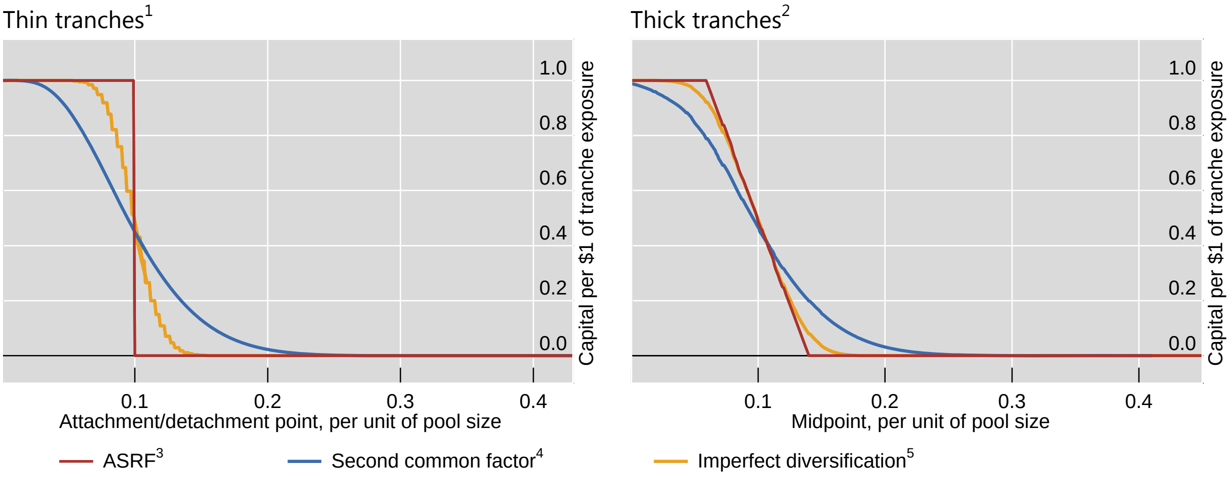
This story is depicted with the red line in Graph 3 (left-hand panel), which plots the dependence of regulatory capital on the seniority of a tranche from the ASRF pool. The height of this line shows the regulatory capital per unit of exposure to an infinitesimally thin tranche, whose attachment and detachment points coincide. As the pool's conditional losses are entirely concentrated in the most junior 10% of the tranches, so is the pool's capital. And the vertical segment of the red line at 0.1 illustrates the extreme version of the so-called *cliff effect*.

The cliff effect is less dramatic for a thick tranche (Graph 3, right-hand panel, red line). The regulatory capital for such a tranche, which has different attachment and detachment points, is equal to the aggregate capital for the thin tranches

[7] As we abstract from uncertainty, our capital calculations do not incorporate the proposals in BCBS (2014).

Regulatory capital for securitisation tranches

Under alternative underlying pools — Graph 3



Each line extends trivially from 0.4 to 1.

[1] Each point X on the horizontal axis corresponds to an infinitesimally thin tranche, with attachment and detachment points coinciding at X. The shaded areas correspond to adjacent thick tranches. [2] Overlapping tranches. Each point X on the horizontal axis corresponds to a tranche with attachment point X – 0.04 and detachment point X + 0.04. [3] Perfect diversification of idiosyncratic risk and a single global risk factor. [4] Perfect diversification of idiosyncratic risk and a global and a pool-specific risk factor. [5] Imperfect diversification of idiosyncratic risk (125 assets in the pool) and a single global risk factor.

Source: Authors' calculations.

between these points. Aggregating across thin tranches on the two sides of the cliff dampens the effect of thick tranche seniority on regulatory capital (the red line is less steep in the right-hand than in the left-hand panel of Graph 3).

The cliff effect shapes the sensitivity of a tranche's regulatory capital to risk parameters. To see this, suppose that an increase in the PD of the underlying assets raises the ASRF pool's regulatory capital from $0.10 to $0.12 per $1 of exposure. Being subject to the extreme version of the cliff effect, a thin tranche with attachment/detachment points at 11% would see its regulatory capital rise by the maximum possible amount: from $0 to $1 per $1 of exposure. Given the less pronounced version of the cliff effect in the context of thick tranches, the corresponding rise for a 7%–15% tranche would be lower, albeit still substantial: from $0.38 to $0.63. By comparison, a vertical tranche, which is not subject to the cliff effect, would see its regulatory capital rise only as much as that for the overall pool: from $0.10 to $0.12 per $1 of exposure.

Imperfectly diversified pool or second common factor

The two assumptions that give rise to the extreme version of the cliff effect – full diversification of idiosyncratic risk and a single common risk factor – may be too strong. If either of these assumptions is violated within a securitised pool, knowledge of the global common factor would no longer imply knowledge of pool-wide losses. Conditional on the critical level of the global factor, there would be residual risk, which we study in the context of two different pools.

Illusory AAA tranches: the case of resecuritisations

Instead of comprising individual bonds or loans, the pool underlying a securitisation may itself comprise other securitisations or tranches of securitisations. For instance, the run-up to the global financial crisis witnessed the rise of securitisations of mezzanine tranches, or mezzanine resecuritisations. From 2005 to 2007, the senior tranches of mezzanine resecuritisations could rely on a wide investor base thanks to perceptions that they were virtually risk-free. Such perceptions turned out to be wrong. This box argues that the poor performance of senior tranches of mezzanine resecuritisations during the crisis can be explained with an overlooked inherent feature of these resecuritisations: high correlation of the underlying assets.[1]

The box uses an illustrative example of a two-stage securitisation. In the first stage, 1 million homogeneous loans are split equally into 1,000 pools and then each pool is securitised. All first-stage securitisations are divided in the same way into junior, mezzanine and senior tranches. In the second stage, the 1,000 first-stage mezzanine tranches are all pooled together and securitised: this is a mezzanine resecuritisation (Graph A). The goal of the second-stage securitisation is to create a senior tranche that is subject to so little risk that it merits a AAA rating.

The risk characteristics of a first-stage mezzanine tranche would differ from those of an individual loan. Such a tranche is shielded by the corresponding junior tranche from the first losses on the underlying pool, ie from the losses triggered mainly by loan-specific, idiosyncratic shocks. Nevertheless, the mezzanine tranche is exposed to widespread, systematic shocks that are strong enough to completely wipe out the junior tranche. And the same systematic shocks would also dominate in mezzanine tranches from other first-stage securitisations. In turn, the greater relative role of systematic shocks in the mezzanine tranches than in the individual underlying loans implies that the losses on these tranches would be more strongly correlated than loan losses.

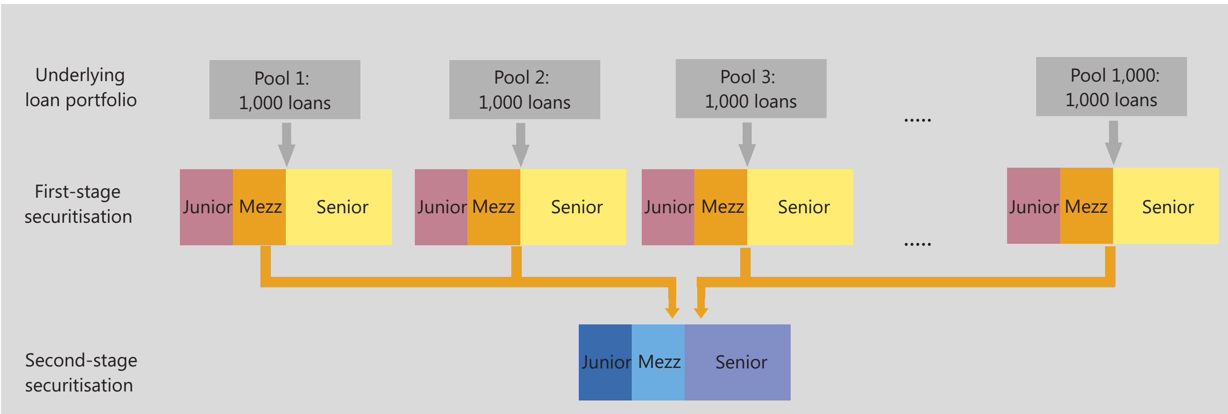
For a numerical illustration of this argument, let expression (A.1) in Annex 1 govern the credit risk of each securitised loan, and let the attachment and detachment points of each first-stage mezzanine tranche be equal to 3% and 7% of the respective pool. For a given homogeneous loan-level PD, the regulatory capital formula provides a common-factor loading that governs the correlation of defaults. Over a range of PDs from 0.3% to 2%, losses on first-stage mezzanine tranches are substantially more correlated than loan defaults. For any pair of loans, if there is at least one default, the likelihood of two defaults is lower than 3%. In the context of mezzanine tranches, the corresponding likelihood is 20 times larger. Namely, if at least one of two first-stage mezzanine tranches is subject to default losses, the other is as well with likelihood greater than 60%.

The strong correlation of losses on first-stage mezzanine tranches undermines the benefits of pooling these tranches together at the second securitisation stage. The higher this correlation, the smaller is the scope for diversification and the higher is the probability of large losses on the mezzanine resecuritisation. In fact, for the mezzanine resecuritisations implied by the stylised example in this box, the highest rating of a senior tranche with a realistic attachment point is A, several notches below the desired AAA rating (Table A). This is true even if the risk of the resecuritisation's junior tranche is quite low, corresponding to a BBB rating (last row in the table).

This can explain why senior tranches of mezzanine resecuritisations did not live up to their AAA ratings during the crisis. The admittedly stylised example above brings to the fore a key feature of first-stage mezzanine tranches

Mezzanine resecuritisation

Graph A



that rating agencies underappreciated prior to the crisis: since these tranches are largely protected from idiosyncratic shocks, their losses are highly correlated. And it is thus unrealistic to expect that securitising such tranches could generate diversification benefits that give rise to low-risk securities.

Tranches of mezzanine resecuritisations[1]

Default probabilities and ratings[2] — Table A

Attachment	Detachment	Probability of asset-level default			
		0.30%	0.50%	1%	2%
10%	100%	*0.02% (A)*	*0.04% (A)*	*0.16% (BBB)*	*0.59% (BBB)*
20%	100%	*0.02% (A)*	*0.05% (A)*	*0.18% (BBB)*	*0.76% (BB)*
30%	100%	*0.02% (A)*	*0.07% (A)*	*0.22% (BBB)*	*0.98% (BB)*
0%	10%	*0.10% (BBB)*	*0.28% (BBB)*	*1.00% (BB)*	*4.37% (B)*

[1] Tranche seniority changes across rows. Attachment/Detachment = tranche's attachment/detachment point, per unit of pool size. [2] Each italicised entry indicates the probability that a tranche is affected by defaults over one year and, in parentheses, the corresponding rating per Moody's "idealised" default rates (Moody's (2006)).

Source: Authors' calculations.

① For a study that reaches similar conclusions, see Hull and White (2010).

In the first pool, there is residual idiosyncratic risk (Fender et al (2008)). This arises when there is a small number of underlying assets and, thus, idiosyncratic risk cannot be diversified at the level of the pool. In line with standardised and liquid credit default swap indices – such as Dow Jones CDX North America and Markit iTraxx® Europe – we assume that the pool comprises 125 assets.

In the other pool, the source of residual risk is a second, pool-specific factor. This second factor could arise when the loans in the pool are to obligors in the same industry, and are thus more strongly correlated with each other than with loans in the overall bank portfolio (Pykhtin and Dev (2002)). In line with Duponcheele et al (2013), we assume that, conditional on the global risk factor, the intra-pool asset correlation is equal to 10% (see Annex 1).

Conditional on the critical level of the global factor, residual risk maintains the randomness of pool losses and it is now their *expected* – or average – level that delivers pool-wide regulatory capital. Continuing with a loan PD of 3%, this capital is again \$0.10 per \$1 of exposure.

Residual risk has a direct bearing on the allocation of regulatory capital across tranches. Take, for instance, a thin tranche with an attachment/detachment point to the left of 10% of the pool size. There would be cases when conditional pool-wide losses are below this level, implying the tranche is unaffected, and other cases in which they are above, implying that the tranche is wiped out. Aggregation across all alternative outcomes results in regulatory capital below \$1 per \$1 of exposure to this tranche (Graph 3, left-hand panel, blue and orange lines). Symmetrically, for a thin tranche with an attachment point above 10%, the regulatory capital is greater than zero. In other words, there is a less extreme version of the cliff effect than under the ASRF pool.

The differences relative to the ASRF pool are less pronounced in the context of thick tranches. This is illustrated by the red and blue/orange lines in Graph 3, which are closer to each other for thick tranches (right-hand panel) than for thin tranches (left-hand panel). The reason for the similarity of "thick tranche" lines is the following. On the one hand, the reduced slope of the capital schedule for thick tranches from the ASRF pool stems from aggregating capital across thin tranches. On the other hand, the residual risk in the other two pools requires similar aggregation already for thin tranches' capital and leaves little scope for further aggregation at the level of thick tranches.

How does residual risk affect the sensitivity of tranches to risk parameters? As for the ASRF pool above, we assume that an increase in the PD of the underlying assets raises regulatory capital from \$0.10 to \$0.12 per \$1 of exposure to either of the two pools studied in this subsection. A thin tranche with attachment/detachment points at 11% would see its regulatory capital rise from \$0.37 to \$0.55 per \$1 of exposure (for the pool with a second risk factor) or from \$0.27 to \$0.72 (for the pool with a small number of assets). The corresponding changes for a 7%–15% tranche would be from \$0.39 to \$0.55 and from \$0.37 to \$0.62, respectively.

A comparison with the results for the ASRF pool above reveals that residual risk reduces substantially the sensitivity of thin tranches to the asset PD but only marginally the sensitivity of thick tranches. As these sensitivities are substantial in each case, we study their implications more systematically in the next section.

Uncertainty about tranche riskiness

Risk assessments are inevitably subject to uncertainty. Initially ignored, this uncertainty came to the fore during the 2007–09 crisis and destabilised the already distressed financial markets. Resecuritisations (discussed in the box) were particularly affected, but so were less exotic securitisations, such as those that are the main focus of this article. As seen above, the regulatory capital for mezzanine tranches of these securitisations can be quite sensitive to risk parameters. This sensitivity implies that ignoring potential errors in risk parameter estimates can lead to large errors in regulatory capital calculations.[8]

In this section, we quantify the impact of estimation errors on the calculation of regulatory capital in a stylised setting. As in previous sections, we consider a pool of homogeneous assets. For simplicity, we assume that the model used to measure credit risk is correct and that all but one of its parameters are known. The exception is the asset-level PD, which is estimated from data. The PD estimator is unbiased – ie would be correct on average – but inevitably generates errors.

8 For a different perspective on uncertainty in the realm of securitisations, see Fender and Mitchell (2009). They argue that, when a securitisation originator's uncertainty about tranche riskiness differs from that of an investor, the credibility of the securitisation process is at stake. To support this credibility, it is thus necessary to impose specific retention requirements on originators.

Deriving expected undercapitalisation: methodology and stylised data

As in previous sections, we study the dependence of regulatory capital on a single risk parameter: the one-year PD of the underlying homogeneous assets. In this and the following subsections, we assume that regulatory capital is calculated on the basis of a PD estimate, denoted by $\widehat{PD}$, which could differ from the true but unknown PD, denoted by PD^*. If the true PD^* is higher than the estimated $\widehat{PD}$, regulatory capital would be too low relative to the level consistent with the target probability of bank failure.

To summarise the severity and probability of potential capital shortfalls, we calculate the "expected undercapitalisation" of a securitisation tranche. This statistic reflects two pieces of information: first, the extent of the shortfall for each value of the true PD^* above the estimated $\widehat{PD}$; and second, the probability of each PD^*, given the estimated $\widehat{PD}$ (derived as in Tarashev (2010)). Concretely, expected undercapitalisation is equal to the weighted sum of potential capital shortfalls, using the corresponding probabilities as weights (see Annex 2).

The next subsection will give specific numerical examples of the expected undercapitalisation of tranches from the three underlying pools studied above. These pools are simple, as they comprise homogeneous assets with a single uncertain risk parameter: PD. We also assume that they are extremely transparent, as the PD can be estimated from an exceptionally rich data set, comprising 10 yearly default rates.[9] Each of these default rates is generated by a cohort of 1,000 homogeneous obligors that start the year with the same true 〚PD〛^* as that underlying the securitised pool. In the light of standard bank practice, which is to barely meet regulatory requirements for five years of data, this is an exceptionally rich data set.

Expected undercapitalisation across tranches: findings

If regulatory capital treats a PD estimate as error-free, the expected undercapitalisation would reflect the seniority of the tranche, as well as the type and riskiness of the underlying pool. This subsection revisits the pool types discussed above: one in accordance with the ASRF model, one subject to a second risk factor and one comprising 125 assets and thus featuring incomplete diversification of idiosyncratic risk. In each case, we derive the expected undercapitalisation of various tranches for different PD estimates.

In the absence of regulatory safeguards for estimation error, there is a high likelihood of severe undercapitalisation of mezzanine tranches. We first show this in the context of an ASRF pool and for a PD estimate that is equal to 3%, which results in a pool-wide regulatory capital of $0.10 per $1 of exposure. The expected undercapitalisation across thin tranches from this pool is plotted by the red line in Graph 4 (left-hand panel). Tranches with detachment points below the pool-wide regulatory capital are fully capitalised, at $1 per $1 of exposure, and thus can never experience a capital shortfall. For tranches most vulnerable to the cliff effect –

9 A discussion paper, EBA (2014), has published a list of proposed criteria that simple and transparent securitisations should satisfy. These criteria include: homogeneous underlying assets, well defined capital structures, enforceable repayment schedules and long performance history of the underlying assets.

ie with attachment points slightly above the pool-wide regulatory capital – expected undercapitalisation is extremely high: $0.60 per $1 of exposure. Of course, expected undercapitalisation declines with the seniority of the thin tranche, ie as it becomes less likely that the true PD is sufficiently high to matter.

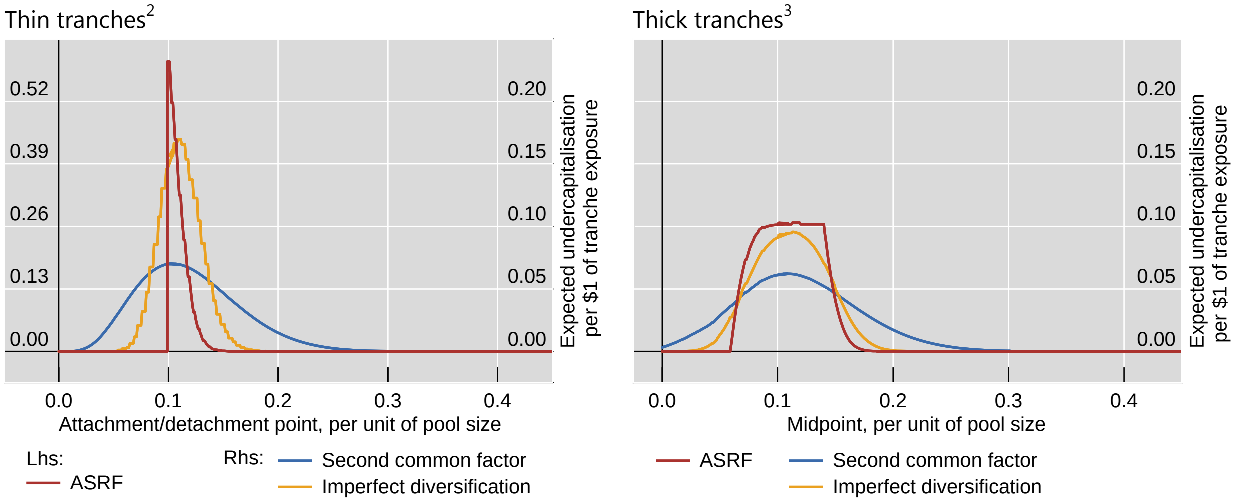
Expected undercapitalisation is also substantial in the other two pools (Graph 4, left-hand panel, blue and orange lines). As discussed earlier, residual risk in these pools' conditional losses weakens the cliff effect and results in regulatory capital being more evenly spread across tranches than in the ASRF pool (recall Graph 3, left-hand panel). As a result, capital shortfalls are also more evenly spread out. This is why expected undercapitalisation has a lower peak but affects a wider range of thin tranches.

In practice, attachment and detachment points differ, ie tranches are thick. As explained above, taking the PD estimate at face value leads to quite similar capital requirements for thick tranches across the three pool types (recall Graph 3, right-hand panel). Expected undercapitalisations are thus also similar: between $0.06 and $0.10 per $1 of exposure to mezzanine tranches with a thickness of 8 percentage points (Graph 4, right-hand panel).

To underscore the large magnitude of expected undercapitalisation for mezzanine tranches, we refer to vertical tranches from the same underlying asset pools. As such tranches are not subject to the cliff effect, the impact of estimation error on their regulatory capital is much smaller. Namely, the expected undercapitalisation is roughly $0.01 per $1 of exposure to a vertical tranche. If the pool were sliced into tranches of different seniority, this undercapitalisation would

Effect of estimation uncertainty[1]

Low PD estimate — Graph 4



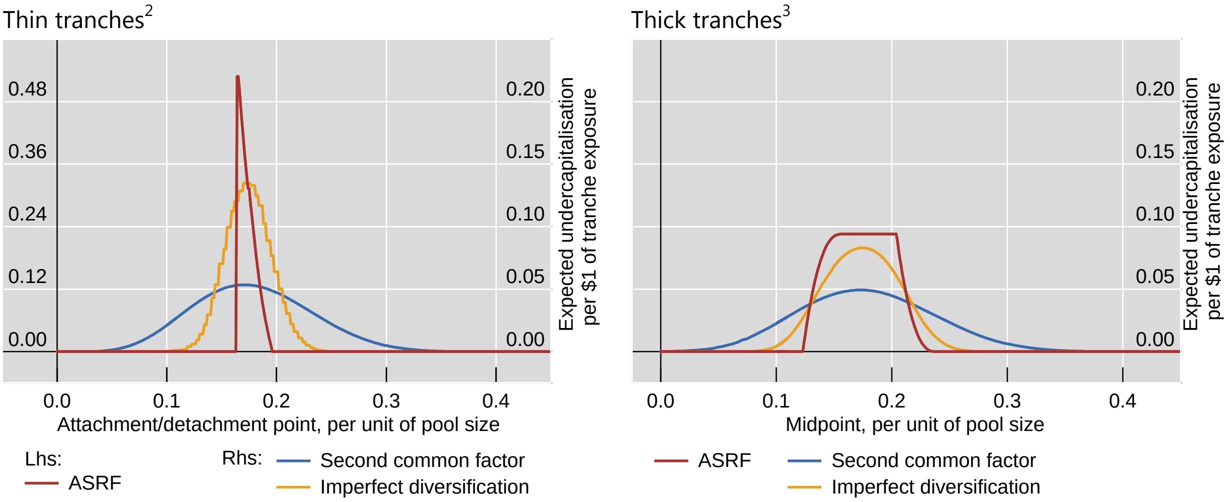
Each line extends trivially from 0.4 to 1.

[1] Regulatory capital relies on an estimated one-year asset-level PD of 3%, based on 10 observations of one-year default rates on 1,000 homogeneous assets. The true PD can equally take on any value between 0.1% and 11% at 0.1 percentage point increments. There is undercapitalisation whenever the true PD is higher than the estimated PD. [2] Each point X on the horizontal axis corresponds to an infinitesimally thin tranche, with attachment and detachment points coinciding at X. [3] Overlapping tranches. Each point X on the horizontal axis corresponds to a tranche with attachment point X – 0.04 and detachment point X + 0.04.

Source: Authors' calculations.

Effect of estimation uncertainty[1]

High PD estimate | Graph 5



Each line extends trivially from 0.4 to 1.

[1] Regulatory capital relies on an estimated one-year asset-level PD of 8%, based on 10 observations of one-year default rates on 1,000 homogeneous assets. The true PD can equally take on any value between 0.1% and 11% at 0.1 percentage point increments. There is undercapitalisation whenever the true PD is higher than the estimated PD. [2] Each point X on the horizontal axis corresponds to an infinitesimally thin tranche, with attachment and detachment points coinciding at X. [3] Overlapping tranches. Each point X on the horizontal axis corresponds to a tranche with attachment point X – 0.04 and detachment point X + 0.04.

Source: Authors' calculations.

be concentrated in mezzanine tranches. This is shown by the area under any of the lines in the left-hand panel of Graph 4, which is also equal to $0.01.

These results are robust to changes in the riskiness of the underlying portfolio. To gain intuition, note that an increase in the asset-level PD sets three forces in motion. First, all else the same, a higher asset-level PD is estimated with more noise, implying higher likelihood and severity of undercapitalisation. Second, in line with the regulatory model outlined in Annex 1, our setting accounts for an empirical regularity that a higher PD goes hand in hand with a lower default correlation.[10] And the lower the default correlation, the lower the noise in PD estimates, all else the same.[11] Third, regulatory capital is less sensitive to noise around high PD estimates than around low PD estimates (BCBS (2006), p 64). The second and third forces reduce the likelihood and severity of undercapitalisation and, in our stylised setting, roughly balance the effect of the first force.

A comparison between Graphs 4 and 5 – based on PD estimates of 3% and 8%, respectively – illustrates the weak dependence of tranches' expected undercapitalisation on the PD of the underlying assets. Indicating that a higher PD

[10] A likely explanation of this regularity is that, in order to attain a low PD, obligors diversify away their exposure to idiosyncratic risks. But the flip side of reduced idiosyncratic risks is greater relative exposure to non-diversifiable, common risk factors. This means that the default of a low-PD obligor would tend to stem from a risk factor that is likely to adversely affect other obligors as well. Low-PD obligors would thus be more likely to default together than high-PD ones.

[11] A higher default correlation implies that observed default rates are more likely to be either very large or very small, irrespective of the true underlying PD. Thus, the higher the default correlation, the less informative are the default rates and, ultimately, the noisier is the PD estimate.

estimate translates into higher pool-level regulatory capital, the spike of the red line in the left-hand panel in Graph 5 occurs for a higher attachment/detachment point than the corresponding spike in Graph 4. Nevertheless the level of expected undercapitalisation – indicated by the heights of the lines – is remarkably similar across graphs.. This similarity remains for a wide range of PDs, including PDs as low as the regulatory target for banks, 0.1%.

Conclusion

Financial losses are uncertain. Banks and regulators rely on risk models to assess potential losses and set capital accordingly. However, not only are models simplifications of reality, but they also take as inputs parameters that are themselves estimated with uncertainty. The true value of a parameter can differ from the one that the bank or regulators based capital calculations on. This opens the door to uncertainty-driven undercapitalisation

We have shown in this article that the uncertainty inherent in estimating asset-level PDs will concentrate in mezzanine tranches and, if ignored, can lead to substantial undercapitalisation of these tranches. Our result is remarkable because it is obtained in the context of extremely simple and transparent asset pools, which should bring to a minimum the scope for estimation uncertainty. In other words, the result shows that the simplicity and transparency of the asset pool would not translate into simple-to-assess mezzanine tranches.

It is thus important to prevent the uncertainty inherent in risk assessments from raising the spectre of undercapitalisation and ultimately impairing the functioning of the securitisation market. Proposed changes to the regulatory framework for securitisations, which impose substantial capital safeguards on mezzanine tranches, would help avoid such an outcome (BCBS (2014)).

References

Bank for International Settlements (2008): *78th Annual Report*, June.

Basel Committee on Banking Supervision (2006): Basel II: *International convergence of capital measurement and capital standards: a revised framework – comprehensive version*, June.

——— (2014): *Revisions to the securitisation framework, consultative document*, March.

Committee on the Global Financial System (2005): "The role of ratings in structured finance: issues and implications", *CGFS Papers*, no 23, January.

Duponcheele, G, W Perraudin and D Totouom-Tangho (2013): "A principles-based approach to regulatory capital for securitisations", *Risk Control Working Paper*.

European Banking Authority (2014): "EBA Discussion Paper on simple standard and transparent securitisations", EBA/DP/2014/02, October.

Fender, I and J Mitchell (2009): "The future of securitisation: how to align incentives", *BIS Quarterly Review*, September, pp 27–43.

Fender, I, N Tarashev and H Zhu (2008): "Credit fundamentals, ratings and value-at-risk: CDOs versus corporate exposures", *BIS Quarterly Review*, March, pp 87–101.

Gordy, M (2003): "A risk-factor model foundation for ratings-based bank capital rules", *Journal of Financial Intermediation*, vol 12, pp 199–232.

Hull, J and A White (2010): "The risk of tranches created from mortgages", *Financial Analysts Journal*, vol 66, no 5, pp 54–67.

——— (2012): "Ratings, mortgage securitizations, and the apparent creation of value", in A Blinder, A Lo and B Solow (eds), *Rethinking the financial system*, Chapter 7, Russell Sage Foundation.

Jones, D (2000): "Emerging problems with the Basel Capital Accord: regulatory capital arbitrage and related issues", *Journal of Banking and Finance*, no 24, pp 35–58.

Moody's Investors Service (2006): "Measuring corporate default rates", Special Comment, November.

Pykhtin, M and A Dev (2002): "Credit risk in asset securitisations: analytical model", *Risk*, vol 15(5), May, pp S16–S20.

Tarashev, N (2010): "Measuring portfolio credit risk correctly: why parameter uncertainty matters", *Journal of Banking and Finance*, no 34, September, pp 2065–76.

Annex 1: The ASRF model and securitisation tranches

Relying on the so-called Asymptotic Single Risk Factor (ASRF) model of credit losses (Gordy (2003)), the regulatory framework allows banks to calculate capital requirements at the level of individual exposures. Here, we outline the rationale behind such requirements when the exposure is to a securitisation or a securitisation tranche.

The ASRF model rests on two key assumptions. The first is that the bank's portfolio comprises infinitely many assets, each of negligible size. The second assumption is that a single common risk factor, Y, drives defaults. Concretely, focusing on asset i and denoting its idiosyncratic risk factor by Z_i, the loss per unit of exposure to this asset, L_i, is equal to:

$$L_i = LGD_i * I_i \text{ where } I_i = \begin{cases} 1 \; if \; \sqrt{\rho_i}Y + \sqrt{1-\rho_i}Z_i < DP_i \\ 0 \qquad\qquad\qquad\qquad otherwise \end{cases} \qquad \text{(A.1)}$$

In this expression, LGD_i is loss-given-default, DP_i is the default point, I_i indicates the default status, and the common factor loading ρ_i governs asset correlations. The benchmark horizon is one year.

A bank's regulatory capital is set equal to the highest level of portfolio losses that can be exceeded with a probability of 0.1%. Two key properties of the ASRF model facilitate the calculation of this level. First, all idiosyncratic risk is diversified away. This implies that the sum of asset-specific losses is a *known* decreasing function of the common risk factor: $\sum_i L_i = f(Y)$. Then, denoting the 0.1 percentile of Y by $y^{0.1}$, portfolio-wide regulatory capital is $K = f(y^{0.1})$. Second, this capital can be allocated to individual assets, as it equals the sum of *expected asset-level losses* conditional on $Y = y^{0.1}$: ie $K = f(y^{0.1}) = \sum_i K_i = \sum_i E(f_i(y^{0.1}))$, where $K_i = E(f_i(y^{0.1}))$ is the asset-specific capital requirement.

To minimise the data burden on banks, the regulatory framework allows for further simplifying assumptions. Namely, it is assumed that the two risk factors affecting each asset are independent standard normal variables, that $LGD_i = 45\%$ and that the common factor loading is a decreasing function of the corporate obligor's probability of default: $\rho_i = \rho(PD_i)$. The last assumption reflects the stylised fact that better creditworthiness rests on diversification on the obligor's side and, thus, on higher relative exposure to non-diversifiable, common risk factors. The upshot is that, abstracting from maturity adjustments, the only free parameters in the regulatory capital formula are the one-year probabilities of default of individual assets (BCBS (2006), p 64).

When an infinitesimally small exposure is a securitisation, the calculation of capital requirements involves two steps. First, denoting an asset in the securitised pool by j, the pool's overall regulatory capital is calculated as $K^{pool} = \sum_j E\left(f_j(y^{0.1})\right)$. This sum is the expected pool-wide loss when the common risk factor is at its 0.1 percentile, ie when $Y = y^{0.1}$. Second, K^{pool} is allocated across tranches of different seniority according to the associated expected loss when $Y = y^{0.1}$. For the same attachment and detachment points of a tranche, this expected loss would change with the risk profile of the securitised pool.

Let the securitised pool itself satisfy the two key assumptions that the ASRF model requires from the bank's overall portfolio. In this case, conditional on $Y = y^{0.1}$, pool-wide losses are known to be equal to K^{pool}. By construction, these conditional losses are sure to wipe out any tranche with a detachment point below

K^{pool}. Thus, the regulatory capital per $1 exposure to such a tranche should be $1. Symmetrically, if the attachment point of a tranche is higher than K^{pool}, then this tranche is completely shielded from the pool's conditional losses and its regulatory capital should be $0.

Alternatively, let the pool still comprise a large number of small assets but allow for a second, pool-specific risk factor, Z^{pool}. This is the setting in Pykhtin and Dev (2002), who assume that, for asset j in the securitised pool, $Z_j = \sqrt{\rho^*}Z^{pool} + \sqrt{1-\rho^*}\varepsilon_j$, where ε_j is an idiosyncratic shock. Duponcheele et al (2013) argue that a reasonable value for ρ^* is 10%. Because of the pool-level uncertainty generated by Z^{pool}, conditional on $Y = y^{0.1}$, the expected loss on a tranche with a detachment point below K^{pool} will now be less than $1 per $1 exposure. And so will be the tranche's regulatory capital. Symmetrically, the regulatory capital will be above $0 for a tranche with an attachment point above K^{pool}.

Annex 2: Conditional probability of the true PD

In this Annex, we accomplish two tasks. First, we derive the probability distribution of the true probability of default PD^* conditional on a particular estimate, $\widehat{PD}$. Second, on the basis of this distribution, we define expected undercapitalisation when regulatory capital is based on $\widehat{PD}$.

To compute the conditional distribution of PD^*, $Pr(PD^*|\widehat{PD})$, we need two pieces of information. The first is the prior distribution of PD^*. To be unrestrictive, we assume that PD^* can equally take on any of the values at 0.1 percentage point increments between 0.1% (which is the regulatory target for a bank PD) and 11% (which corresponds to a distressed entity). The second is the data-generating process, given by expression (A.1) in the previous Annex for $PD = PD^*$, which delivers the empirical default rates used to derive $\widehat{PD}$. We assume that there are 10 one-year default rates each underpinned by 1,000 obligors.

Given these two pieces of information, the derivation of $Pr(PD^*|\widehat{PD})$ involves four steps. First, the prior distribution of PD^* provides directly the unconditional $Pr(PD^*)$. Second, given a PD^*, Monte Carlo simulations of the available data deliver $Pr(\widehat{PD}|PD^*)$. Third, the weighted average of $Pr(\widehat{PD}|PD^*)$ across different values of PD^*, using $Pr(PD^*)$ as weights, delivers the unconditional $Pr(\widehat{PD})$. Fourth, by Bayes' rule, $Pr(PD^*|\widehat{PD}) = Pr(\widehat{PD}|PD^*) * Pr(PD^*)/Pr(\widehat{PD})$.

We can now compute the expected undercapitalisation of a securitisation tranche. Let the calculated capital for the tranche be $K(\widehat{PD})$ and the desired capital be $K(PD^*)$. Then, expected undercapitalisation is the weighted sum of $K(PD^*) - K(\widehat{PD})$ across all values of PD^* above $\widehat{PD}$, using $Pr(PD^*|\widehat{PD})$ as weights.

Rungporn Roengpitya
rungporr@bot.or.th

Nikola Tarashev
nikola.tarashev@bis.org

Kostas Tsatsaronis
ktsatsaronis@bis.org

Bank business models[1]

We identify three business models using balance sheet characteristics of 222 international banks and a data-driven procedure. We find that institutions engaging mainly in commercial banking activities have lower costs and more stable profits than those more heavily involved in capital market activities, mainly trading. We also find that retail banking has gained ground post-crisis, reversing a pre-crisis trend.

JEL classification: D20, G21, L21, L25.

Banks choose to be different from one another. They engage strategically in different intermediation activities and select their balance sheet structure to fit their business objectives. In a competitive pursuit of growth opportunities, banks choose a business model to leverage the strengths of their organisation.

This article has three objectives. The first is to define and characterise banks' business models. We identify a small set of key ratios that differentiate banks' business profiles and use a broader set of variables to provide a more complete characterisation of these profiles. The second objective is to analyse the performance of these business models in terms of profitability and operating costs. The final objective is to track how banks changed their business models before and after the recent crisis.

We identify three business models: a retail-funded commercial bank, a wholesale-funded commercial bank and a capital markets-oriented bank. The first two models differ mainly in terms of banks' funding mix, while the third category stands out primarily because of banks' greater engagement in trading activities. On average, retail-focused commercial banks exhibit the least volatile earnings, while wholesale funded commercial banks are the most efficient. On the other hand, trading banks struggle to consistently outperform the other two business types.

Banks' profiles evolve over time in response to changes in the economic environment and to new rules and regulations. We find that transition patterns changed around the recent financial crisis. While several banks increased their

[1] The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank of Thailand or the Bank for International Settlements. We would like to thank Michela Scatigna for outstanding work and valuable advice in the construction of the data on banks. We also acknowledge, without implication, very helpful comments by Claudio Borio, Christian Upper and Hyun Song Shin. All errors remain our responsibility.

reliance on wholesale funding prior to the crisis, in its wake more banks have adopted more traditional business profiles geared towards commercial banking.

The rest of this article is organised in four sections. In the first section, we lay out the methodology we employ to classify banks into distinct business models. In the second section, we characterise the three business models in terms of banks' balance sheet composition, while in the third we highlight systematic differences in the performance of banks in different business model groups. In the last section, we look into the transitions of banks across the three groups.

Classifying banks: the methodology

The procedure we use to classify banks into distinct business models is primarily driven by data but incorporates judgmental elements. It shares many technical aspects with the procedure employed by Ayadi and de Groen (2014), but differs in terms of the judgmental elements and the data used. In contrast to their analysis, which focuses exclusively on European banks, we use annual data for 222 individual banks from 34 countries, covering the period between 2005 and 2013. The unit of our analysis (ie a data point) is a bank in a given year (bank/year pair). Given that the available data do not cover the entire period for each bank, we work with 1,299 bank/year observations. By focusing on bank/year pairs our approach allows institutions to switch between business models at any point in the period of analysis (an aspect that we explore in the last section). In this section we provide a description of the classification methodology, leaving the more technical details for the box.

The inputs to the classification are bank characteristics. These are balance sheet ratios, which we interpret as reflecting strategic management *choices*. We use eight ratios expressed in terms of balance sheet size and evenly split between the asset and liability sides of the ledger. They relate to the share of loans, traded securities, deposits and wholesale debt, as well as the interbank activity of the firm.[2] We distinguish this set of variables from other variables that we use in the third section to characterise the performance of different business models. We view these other variables, which capture profitability, income composition, leverage and cost efficiency, as reflecting the interaction between banks' strategic choices and the market environment. We thus treat them as variables that relate to *outcomes* as opposed to choices.

The core of the methodology is a statistical clustering algorithm. Based on a pre-specified set of input variables, the algorithm partitions the 1,299 bank/year observations into distinct groups. We select inputs from the set of choice variables. The idea is that banks with similar business model strategies have made similar choices regarding the composition of their assets and liabilities. We make no a priori decisions as to which choice variables are more important in defining business models or as to the general profile of these models. In that sense, the methodology is data-driven. We rely on the repeated use of the clustering algorithm and a goodness-of-fit metric (the F-index, which is described in the box) to guide the

2 This is another aspect where our approach differs from that of Ayadi and de Groen (2014). They classify banks using interbank loans, trading assets, interbank liabilities, customer deposits, debt liabilities and derivative exposures.

Using statistical clustering to identify business models

This box more precisely defines the variables used as inputs and discusses the more technical aspects of the statistical classification (clustering) procedure.

The eight input variables from which we selected the key characteristics of the business models are evenly split between the asset and liability sides of the balance sheet. All ratios are expressed as a share of total assets net of derivatives positions. The reason for this is to avoid distortions of the metrics related by differences in the applicable accounting standards in different jurisdictions. The asset side ratios relate to: (i) total loans; (ii) securities (measured as the sum of trading assets and liabilities net of derivatives); (iii) the size of the trading book (measured as the sum of trading securities and fair value through income book); and (iv) interbank lending (measured as the sum of loans and advances to banks, reverse repos and cash collateral). The liability side ratios relate to: (i) customer deposits; (ii) wholesale debt (measured as the sum of other deposits, short-term borrowing and long-term funding); (iii) stable funding (measured as the sum of total customer deposits and long-term funding); and (iv) interbank borrowing (measured as deposits from banks plus repos and cash collateral).

We employ the statistical classification algorithm proposed by Ward (1963). The algorithm is a hierarchical classification method that can be applied to a universe of individual observations (in our case, these are the bank/year pairs). Each observation is described by a set of scores (in our case, the balance sheet ratios). This is an agglomerative algorithm, which starts from individual observations and successively builds up groups (clusters) by joining observations that are closest to each other. It proceeds by forming progressively larger groups (ie partitioning the universe of observations more coarsely), maximising the similarities of any two observations within each group and maximising the differences across groups. The algorithm measures the distance between two observations by the sum of squared differences of their scores. One could present the results of the hierarchical classification in the form of the roots of a tree. The single observations would be automatically the most homogeneous groups at the bottom of the hierarchy. The algorithm first groups individual observations on the basis of the closeness of their scores. These small groups are successively merged with each other, forming fewer and larger groups at higher levels of the hierarchy, with the universe being a single group at the very top.

Which partition (ie step in the hierarchy) represents a good compromise between the homogeneity within each group and the number of groups? There are no hard rules for determining this. We use the pseudo F-index proposed by Caliński and Harabasz (1974) to help us decide. The index balances parsimony (ie a small number of groups) with the ability to discriminate (ie the groups have sufficiently distinct characteristics from each other). It increases when observations are more alike within a group (ie their scores are closer together) but more distinct across groups, and decreases as the number of groups gets larger. The closeness of observations is measured by the ratio of the average distance between bank/years that belong to different groups to the corresponding average of observations that belong to the same group. The number of groups is penalised based on the ratio of the total number of observations to that of groups in the particular partition. The criterion is similar in spirit to the Akaike and Schwarz information criteria that are often used to select the appropriate number of lags in time series regressions.

The clustering algorithm is run for all combinations of at least three choice variables from the set of eight. If we had considered all their combinations, there would have been 325 runs. We reduce this number by ignoring subsets that include two choice variables that are highly correlated because the simultaneous presence of these variables provides little additional information. We impose a threshold for the correlation coefficient of 60% (in absolute value), which means that we do not examine sets of input variables that include *simultaneously* the securities and trading book variables, or the wholesale debt and stable funding variables.

selection of the most appropriate partitioning of the observations universe into a small number of distinct business model groups.

At various stages, our approach incorporates judgmental elements in order to help narrow down the search for a robust, intuitive and parsimonious classification of banks into distinct business models. The general strategy is as follows. We run the clustering algorithm for each subset of at least three choice variables, ignoring all subsets that include simultaneously pairs of variables that are very highly correlated with each other, hence providing little independent information. The clustering algorithm produces a hierarchy of partitions ranging from the very coarse (ie few groups) to the very fine (ie many small groups). We select the partition in this hierarchy with the highest F-index. This becomes the candidate partition for this run (ie this subset of choice variables).

We use judgmental criteria to eliminate candidates that do not represent clear and easily interpretable groups (ie distinct bank business models). One such criterion is to eliminate candidates that produce fewer than three or more than five groups as fewer than three do not allow for a meaningful differentiation of banks and more than five are difficult to interpret. The other criterion is to focus only on partitions that are "clear winners" among all other partitions based on the same set of choice variables. To this effect we require that the top scoring partition has an associated F-index score at least 15% higher than that of the partition with the second highest score within the same hierarchy (ie the same set of input variables). We dropped candidates that failed this test. This elimination procedure leaves us with five partitions (ie five different sets of groups) based on five different subsets of the choice variables.

To these five groups we apply a final judgmental criterion that seeks to capture the stability of outcomes over time. For each of the five combinations of choice variables we create two partitions of the banks in the universe. We first partition banks using only data up to 2012, and then using all available data. We then calculate the share of observations that are classified in the same group in both partitions over the overlapping period. We select the partition with the highest overlap ratio, which is 85%. This partition classifies the 1,299 bank/year observations into three groups, which we refer to as bank business models. We next characterise these models in terms of the whole set of eight choice variables.

Three distinct business models: the characteristics that matter

The classification process identifies three distinct business models and selects three ratios as the key differentiating choice variables: the share of loans, the share of non-deposit debt and the share of interbank liabilities to total assets (net of derivatives exposures). This partition satisfies our criteria of robustness, parsimony and stability. The share of gross loans is the only variable relating to the composition of the banks' assets. The other two ratios differentiate banks in terms of their funding structure.

Table 1 characterises the three business model profiles in terms of all eight choice variables (rows). The cells report the average ratio for all banks that were classified in the corresponding business model (columns). For comparison, the last column provides the average value of the corresponding ratio for the universe of observations.

The first business model group we label commercial "retail-funded", and it is characterised by a high share of loans on the balance sheet and high reliance on stable funding sources including deposits. In fact, customer deposits are about two thirds of the overall liabilities of the average bank in this group. This is the largest group in our universe with 737 bank/year observations over the entire period.

The second business model group we label commercial "wholesale-funded". The average bank in this group has an asset profile that is remarkably similar to the profile of the retail funded banks in the first group. The main differences between the two relate to the funding mix. Wholesale-funded banks have a higher share of interbank liabilities (13.8% versus 7.8%) and a much higher share of wholesale debt

Business model profiles

Average values of ratios to total assets[1] (in per cent) Table 1

Choice variable[2]	Retail-funded	Wholesale-funded	Trading	All banks
Gross loans	62.2	65.2	25.5	57.5
Trade	22.4	20.7	51.2	26.5
Trading book	5.1	7.1	17.3	7.1
Interbank lending	8.5	8.2	21.8	10.5
Interbank borrowing	7.8	13.8	19.1	11.2
Wholesale debt	10.8	36.7	18.2	19.1
Stable funding	73.8	63.1	48.6	66.9
Deposits	66.7	35.6	38.0	53.6
Memo: number of bank/years	*737*	*359*	*203*	*1,299*

Trade = trading assets plus liabilities, net of derivatives; trading book = trading securities plus fair value through income book; interbank lending = loans and advances to banks plus reverse repos and cash collateral; wholesale debt = other deposits plus short-term borrowing plus long-term funding; stable funding = total customer deposits plus long-term funding; interbank borrowing = deposits from banks plus repos and cash collateral.

[1] Total assets are net of derivatives. [2] Variables in **bold** are those that were selected as the key drivers in defining the partition.

Sources: Bankscope; authors' calculations.

(36.7% versus 10.8%), with the balance being a lower reliance on customer deposits (35.6% versus 66.7%). There are half as many observations in the wholesale-funded group compared to the retail-funded group.

The third group is more capital markets-oriented. Banks in this category hold half of their assets in the form of tradable securities and are predominately funded in wholesale markets. In fact, the average bank in this group is most active in the interbank market, with related assets and liabilities accounting for about one fifth of the balance sheet. We label this business model "trading bank". It is the smallest group in terms of observations (203 bank/years) in our sample.

By comparison, Ayadi and de Groen (2014) classify European banks into four business models, which they label as investment banks, wholesale banks, diversified retail and focused retail. Drawing rough parallels with the classification in this paper, which involves a more global universe of banks, their investment bank model corresponds to our trading model, the two wholesale models correspond to each other, and the diversified and focused retail models together correspond to our retail-funded model. That said, an exact comparison would require comparing individual banks in the two universes.

We find that the popularity of business models differs with banks' nationality (Table 2). Looking only at the last year of our data (2013), the North American banks in our universe had either a retail-funded or trading profile; none belonged to the wholesale-funded group. At the same time, one third of the European banks had a wholesale-funded model. In turn, banks domiciled in emerging market economies (EMEs) clearly preferred the retail-funded model (90%).

We also look at the distribution of global systemically important banks (G-SIBs) across business models (Table 2). Our data for 2013 cover 28 firms that were part of the banking organisations designated as G-SIBs by international policymakers

Distribution of business models in 2013

Table 2

	Retail-funded	Wholesale-funded	Trading	Total
North America	16	–	6	22
Europe	36	22	9	67
Advanced Asia-Pacific[1]	11	3	3	17
Emerging market economies	45	2	3	50
G-SIBs	14	2	12	28
Non-G-SIBs	94	25	9	128

[1] Australia and Japan.

Source: Authors' calculations.

(Financial Stability Board (2014)).[3] The list – which includes institutions from both advanced and emerging market economies – was roughly equally split between the retail-funded and trading models.

Business models and bank performance

Are there systematic differences in the performance of banks with different business models? The question is pertinent for understanding the impact of banks' choices on shareholder value but also on financial stability, which depends on sustainable performance by financial intermediaries. In this section we examine the performance of banks in the different business model categories both in a cross section and over time.

In analysing the performance of different bank models, we use what we label "outcome" variables. In contrast to the choice variables that we used to define the business models, we interpret outcome variables as the result of the interaction between the strategic choices made by the bank in terms of business area focus and the market environment. Examples of such variables are indicators of profitability, (for example, banks' return-on-equity (RoE)), the composition of bank earnings (for instance, the share of interest income in total income) and indicators of efficiency (for example, the cost-to-income ratio).

Profitability and efficiency have varied markedly across models as well as over time (Graph 1). The outbreak of the recent crisis marked a steep drop in advanced economy banks' RoE across all business models (Graph 1, left-hand panel). But while RoE stabilised for retail banks after 2009, it remained volatile for trading and wholesale-funded banks. In fact, trading banks as a group show the highest volatility of RoE across the three groups, swinging repeatedly between the top and bottom of the relative ranking. The story is qualitatively similar in terms of return-

[3] The list of G-SIBs refers to consolidated entities. In our data we have at times more than one firm that belongs to a consolidated group. The reason for this is that in order to use bank/year observations with relatively pure business profiles in some cases we avoided using conglomerate firms. When possible for the largest institutions we opted instead to use individual subsidiaries (banks and securities firms) and not the holding company.

on-assets (RoA, not reported here), an alternative metric of profitability that is insensitive to leverage (see also Table 3).

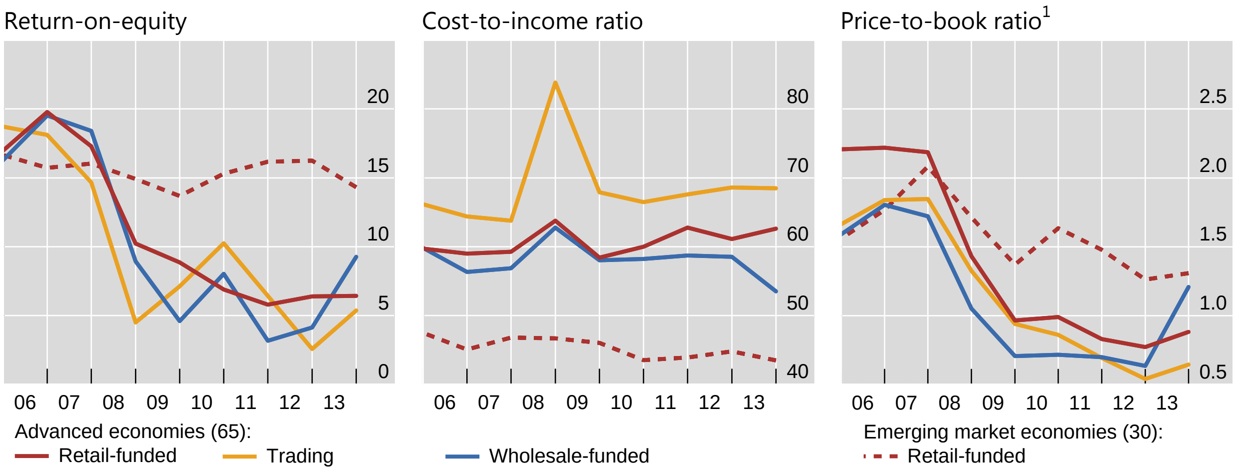
All three business models show relatively stable costs in relation to income (Graph 1, centre panel). A spike in the cost-to-income ratio around 2008 is readily explained by the drop in earnings in the midst of the crisis. Compared to the other two business models, trading banks had a persistently high cost base throughout the period of analysis, despite their more mixed record in terms of profitability. Interestingly, high costs relative to income have persisted post-crisis despite the decline in these banks' profitability. A possible explanation can be found in staff remuneration rates, although this would be difficult to decipher from our data.

Post-crisis markets appear rather sceptical about the prospects of all three business models, judging from the price-to-book ratio of banks in advanced economies (Graph 1, right-hand panel). This ratio relates the banks' stock market capitalisation to the equity they report in their financial accounts. A value higher than unity suggests that the equity market has a more positive view on the franchise value of the bank than what is recorded on the basis of accounting rules. A value below unity suggests the opposite. The ratio declined dramatically around the crisis for banks in all three business models. In fact, it has been persistently below unity since 2009 for most advanced economy banks, reflecting market scepticism about their prospects.

Banks domiciled in EMEs (dashed lines in Graph 1) remained largely unscathed by the 2007–09 crisis. These lenders are almost exclusively classified in the retail-funded model. But even compared to their advanced economy peers with a similar business model, they achieved a more stable performance. And while a more favourable macroeconomic environment has certainly contributed to their higher profitability in recent years, the overall stability of their performance is underpinned by greater cost efficiency, ie a lower cost-to-income ratio. In line with these results,

Efficiency and earnings stability go hand in hand

In per cent | Graph 1



Number of banks in brackets.

[1] The data refer to 50 advanced economy and 20 EME banks.

Sources: Bankscope; authors' estimates.

Characteristics of business models

Average values of ratios in per cent (unless otherwise indicated) Table 3

	Retail-funded	Wholesale-funded	Trading	All banks
Return-on-assets (RoA)	1.16	0.45	0.98	0.94
Risk-adjusted RoA	0.68	0.09	0.57	0.48
Return-on-equity (RoE)	12.49	5.81	8.08	9.95
Risk-adjusted RoE	8.76	2.57	-9.55	4.29
Share of fee income	22.11	23.28	44.30	25.84
Capital adequacy	14.56	12.23	17.29	14.27
Cost of equity[1]	12	3	11	9
Total assets (in USD bn)	361.5	321.6	787.8	417.1
Memo: number of bank/years	*737*	*359*	*203*	*1299*

[1] Reflects the systematic relationship between the rate of return on bank stocks in excess of the risk-free rate and the excess return on the corresponding broad market price index.

Source: Authors' calculations.

market valuations are quite generous for EME banks with price-to-book ratios persistently higher than unity, although they are on a declining trend.

Table 3 compares the three business models in terms of a number of other outcome variables across the entire sample period. Besides RoA and RoE, which confirm the ranking from Graph 1, we also calculate *risk-adjusted* versions of these profitability statistics, which subtract from the earnings variable (the numerator of the ratio) the cost of capital that is necessary to cover for the risk inherent to the activity of the bank. The approach follows closely the rationale of standard industry approaches to calculate the risk-adjusted return on capital (or RAROC).[4] More specifically, we subtract from the bank's gross earnings the associated operational expenses and losses (including credit losses and provisions) as well as the cost of capital set aside to cover possible future losses. This last component is the product of the quantity of capital held by the bank (proxied by the regulatory capital requirement linked to risk-weighted assets) multiplied by the cost of equity capital (estimated by a standard capital asset pricing model).[5]

Regardless of the profitability metric, the retail-funded model is the top performer. This is true in almost every year in our sample (not reported here).[6] Trading banks come in second place, with the exception of the risk-adjusted RoE, which penalises the volatility of their earnings base. Trading banks differ very significantly from their commercial bank peers in terms of the source of revenue. They collect about 44% of their total profit through fees, a share that is almost double that of the average other bank.

4 RAROC is a commonly used approach for measuring investment performance and comparing the profitability of different business lines. See, for instance, Zaik et al (1996).

5 The cost of equity here is measured in terms of the systematic relationship between the rate of return on the stock of the bank in excess of the risk-free rate and the excess return on the corresponding broad market price index. The parameter was estimated using monthly data.

6 The top performance of retail-funded banks is consistent with the findings in Altunbas et al (2011), who document that banks with a greater share of deposits in their funding mix fared significantly better in the crisis than their peers.

Wholesale-funded banks have the thinnest capital buffers among the three business models, while they also have the lowest cost of equity. Somewhat surprisingly, trading banks do not seem to be too different from retail-funded banks in terms of these yardsticks. However, they do stand out in terms of total asset size. The average trading bank is more than twice as large as the average commercial bank, even those that are primarily funded in the wholesale markets.

Shifting popularity of bank business models

The crisis-driven reshaping of the banking sector has affected its concentration and business model mix. A number of institutions failed or were absorbed by others, thus increasing the concentration in the sector despite tighter regulatory constraints on banks with a large systemic footprint. And many of the surviving banks adjusted their strategies in line with the business models' relative performance.

Table 4 presents a summary of banks' shifts across different business models before and after the crisis. Each cell reports the number of banks that started the period in the model identified by the row heading and finished it in the model named in the column heading. The large numbers along the diagonal indicate that there is considerable persistence in the classification of banks, as the majority of institutions remain in the same business model group over time.

In recent years, most of the transitions have been between the retail- and wholesale-funded models of commercial banks. The group of trading-oriented banks is fairly constant throughout the period. The direction of change in bank business models, however, is very different post-crisis from that prevailing prior to 2007. During the boom period, market forces favoured wholesale funding, as

Business models: traditional banking regains popularity

Number of banks[1] Table 4

		Business model in 2007			
		Retail-funded	Wholesale-funded	Trading	*Total*
Business	Retail-funded	53	10	0	*63*
model	Wholesale-funded	3	25	2	*30*
in 2005	Trading	2	0	13	*15*
	Total	*58*	*35*	*15*	*108*
		Business model in 2013			
		Retail-funded	Wholesale-funded	Trading	*Total*
Business	Retail-funded	57	1	0	*58*
model	Wholesale-funded	16	16	3	*35*
in 2007	Trading	3	1	11	*15*
	Total	*76*	*18*	*14*	*108*

[1] A non-italicised entry indicates the number of banks that started a period with the business model indicated in the row heading and finished the period with the business model indicated in the column heading. Based on a sample of 108 banks from advanced and emerging market economies.

Sources: Bankscope; BIS calculations.

bankers tapped debt and interbank market sources of finance. About one in six retail banks in our 2005 universe increased their capital market funding share to the point that they could be reclassified as wholesale-funded by 2007 (first row of Table 4).

The opposite trend characterises the post-crisis period. About two fifths of the banks that entered the crisis in 2007 as wholesale-funded or trading banks (ie 19 out of 50 institutions) ended up with a retail-funded business model in 2013. Meanwhile, only one bank switched from retail-funded to another business model post-crisis, confirming the relative appeal of stable income and funding sources.

While we observe transformations of banks in ways that result in their reclassification under a different business model, we cannot pinpoint the underlying economic drivers. We can, however, look at performance statistics to examine whether bank shifts correlate with a turnaround of the firm. We find that a change in bank business model actually hurts profitability, but improves efficiency relative to the firm's peer group.

To do this, we select all the banks in our sample that switched models and for which we have data for at least two years before and two years after the switch. We focus on two performance ratios: RoE and cost-to-income. We benchmark the performance of the bank against a comparator group that comprises all banks that belonged to the same business model as the switching bank prior to the switch and remained in that model. We determine that the switching bank outperformed its old peers if the difference between its average post-switch and average pre-switch RoE is greater than the difference between the corresponding averages in the comparator group. On the basis of this criterion, we find that only a third of the banks that switched their business model outperformed their old peers in terms of profitability. The remaining two thirds underperformed. However, applying the same criterion to the cost-to-income ratio reveals that, among the banks that switched business model, two thirds registered post-switch efficiency gains relative to their peers.

Conclusions

We identified bank business models that have had different experiences over the past decade. Given the consistently stable performance of retail-funded banks engaging in traditional activities, it comes as little surprise that their model has recently gained in popularity. More surprising is the stability of the group of trading banks, which exhibited sub-par return-on-equity over most of the sample, both in absolute and risk-adjusted terms. While further analysis is needed to uncover the clear benefits to these banks' shareholders, high cost-to-income ratios suggest outsize benefits to their managers.

References

Altunbas, Y, S Manganelli and D Marques-Ibanez (2011): "Bank risk during the financial crisis: do business models matter?", *ECB Working Paper Series*, no 1394, November.

Ayadi, R and W de Groen (2014): *Banking business models monitor 2014 – Europe*, Centre for European Policy Studies and International Observatory on Financial Services Cooperatives.

Caliński, T and J Harabasz (1974): "A dendrite method for cluster analysis", *Communications in Statistics*, no 3, pp 1–27.

Financial Stability Board (2014): "2014 update of list of global systemically important banks (G-SIBs)", www.financialstabilityboard.org/2014/11/2014-update-of-list-of-global-systemically-important-banks.

Ward, J H Jr (1963): "Hierarchical grouping to optimise an objective function" *Journal of the American Statistical Association*, no 58, pp 236–44.

Zaik, E, J Walter, G Kelling and C James (1996): "RAROC at the Bank of America: from theory to practice", *Journal of Applied Corporate Finance*, vol 9, no 2, pp 83–93.

Stefan Avdjiev
stefan.avdjiev@bis.org

Michael Chui
michael.chui@bis.org

Hyun Song Shin
hyunsong.shin@bis.org

Non-financial corporations from emerging market economies and capital flows[1]

Non-financial corporations from emerging market economies (EMEs) have increased their external borrowing significantly through the offshore issuance of debt securities. Having obtained funds abroad, the foreign affiliate of a non-financial corporation could transfer funds to its home country via three channels: it could lend directly to its headquarters (within-company flows), extend credit to unrelated companies (between-company flows) or make a cross-border deposit in a bank (corporate deposit flows). Cross-border capital flows to EMEs associated with all three of the above channels have grown considerably over the past few years, as balance of payments data reveal. To the extent that these flows are driven by financial operations rather than real activities, they could give rise to financial stability concerns.

JEL classification: D21, F31, G32.

The pattern of cross-border financial intermediation has undergone far-reaching changes in recent years, from one that relied overwhelmingly on bank-intermediated finance to one that places a greater weight on direct financing through the bond market. In the process, non-financial firms have taken on a prominent role in cross-border financial flows. They have increased their external borrowing significantly through the issuance of debt securities, with a significant part of the issuance taking place offshore. Between 2009 and 2013, emerging market non-bank private corporations issued $554 billion of international debt securities. Nearly half of that amount ($252 billion) was issued by their offshore affiliates (Chui et al (2014)).[2] An important question is whether this increased corporate external borrowing can be a source of wider financial instability for emerging market economies and, if so, which channels of financing flows give rise to concerns.[3]

The large increase in issuance by their overseas affiliates shows that EME firms' financing activities straddle national borders. Hence, measurement of external debts

1 The authors would like to thank Claudio Borio, Dietrich Domanski, Branimir Gruić, Pablo García-Luna, Robert McCauley, Patrick McGuire, Christian Upper and Philip Wooldridge for their discussions. Deimantė Kupčiūnienė provided excellent research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

2 For further evidence of increased offshore bond issuance by EME non-financial corporations, see Gruić et al (2014b).

3 Chui et al (2014) outline the potential risks related to EME corporate balance sheets, focusing on the role of leverage and currency mismatch.

based on the residence principle can be problematic.[4] In particular, external debt based on the residence principle may understate the true economic exposures of a firm that has borrowed through its affiliates abroad. If the firm's headquarters has guaranteed the debt taken on by its affiliate, then the affiliate's debt should rightly be seen as part of the firm's overall debt exposure. Even in the absence of an explicit guarantee, the firm's consolidated balance sheet will be of relevance in understanding the firm's actions. While this point has been well recognised in the realm of international banking (Cecchetti et al (2010)), it had not received much attention in the context of non-financial corporates until recently (Gruić et al (2014a)).

The practice of using overseas affiliates as financing vehicles has a long history. Borio et al (2014) describe how in the 1920s German industrial companies used their Swiss and Dutch subsidiaries as financing arms of the firm to borrow in local markets and then repatriate the funds to Germany.[5] As old as such practices are, they have become the centre of attention again in recent years due to the increasingly common practice of EME non-financial corporates borrowing abroad through debt securities issued by their affiliates abroad. If the proceeds of the bond issuance are used for acquiring foreign assets, the money stays outside and there are no cross-border capital movements. However, we will be focusing on the case where the firm transfers the proceeds of the bond issuance back to its home country, either to finance a local (headquarters) project, or to be held as a financial claim on an unrelated home resident – say, by being deposited in a bank or by being lent to another non-bank entity. If the overseas bond proceeds are repatriated onshore to invest in domestic projects with little foreign currency revenue, the firm will face currency risk. If the proceeds are first swapped into local currency, then the firm's activities are likely to have an impact on financial conditions (Box 1). In either case, the economic risks may be underestimated if external exposures are measured according to the conventional residence basis.

Having obtained funds abroad (by issuing bonds offshore), the foreign affiliate of a non-financial corporation could act as a surrogate intermediary by repatriating funds (Chung et al (2014), Shin and Zhao (2013)). It can do that via thee main channels (Graph 1). First, it could lend directly to its headquarters (*within*-company flows). Second, it could extend credit to unrelated companies (*between*-company flows). Finally, it could make a cross-border deposit in a bank (corporate deposit flows).

A practical question is how best to monitor these non-bank capital flows under the existing measurement framework organised according to the residence principle. The balance of payments (BoP) accounting framework lists broad categories such as foreign direct investment (FDI) and portfolio flows, but it does not separate out the

4 In international finance, the statistical convention is to identify the border as the boundary of the national income area, so that what is "external" or "internal" is defined by reference to that boundary. This statistical convention gives rise to the *residence principle*. A firm is resident in a particular national income area (or "economic territory") if it conducts its business activities mostly within the boundaries of that economic territory.

5 Even to this day, Germany is one of the few developed countries where non-financial firms are still generating large within-company capital flows across borders. During the past five years, gross direct investment flows to Germany totalled $185 billion, $73 billion of which were for equity acquisitions and the rest were debt transfers between a firm's headquarters and its affiliates.

Box 1

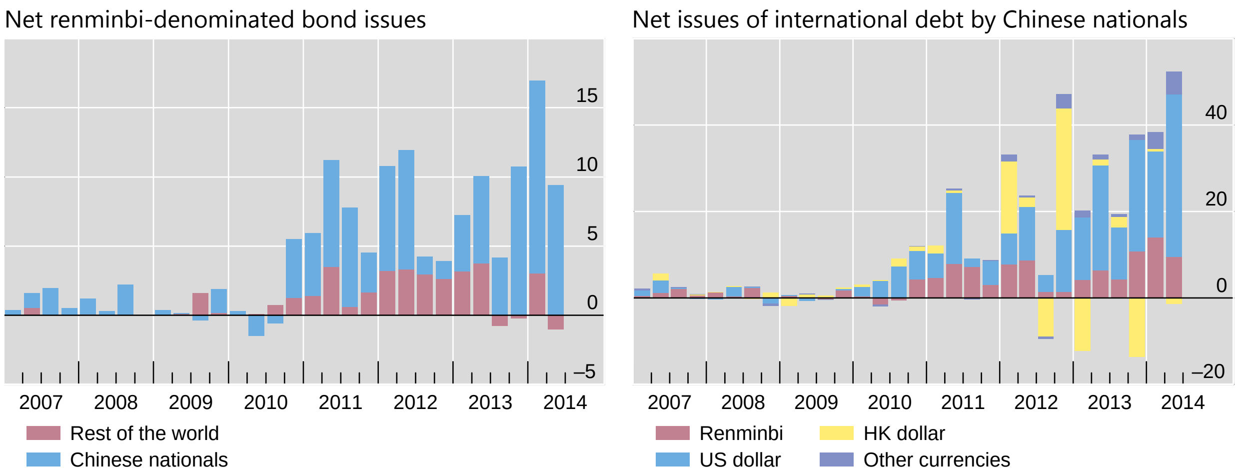
International bond issuance, cross-currency swaps and capital flows

When an EME company issues a US dollar-denominated bond in overseas capital markets and then repatriates the proceeds, one would expect that to show up as capital inflows in US dollars. However, this need not always be the case. The company or its overseas subsidiary can issue the bond and swap the proceeds into domestic currency before transferring the funds back to the headquarters. Obviously, there will be a similar increase in the headquarters' liabilities, but only the company's consolidated balance sheet would show an increase in foreign currency liabilities.

For instance, Chinese firms have primarily issued US dollar-denominated bonds abroad, whereas non-Chinese companies account for a sizeable proportion of offshore renminbi bond (CNH) issuance (Graph A). Very often, these non-Chinese entities will swap their CNH proceeds into US dollars. In doing so, they are taking advantage of the cross-currency swap markets to obtain US dollar funding at lower costs than by issuing US dollar bonds (HKMA (2014)). Similarly, cross-currency swaps offer Chinese firms a channel to get around the tight liquidity conditions in China by swapping their US dollar proceeds from bond issuance into renminbi and remitting to their headquarters.

International debt securities issuance

In billions of US dollars — Graph A



Source: BIS international securities statistics.

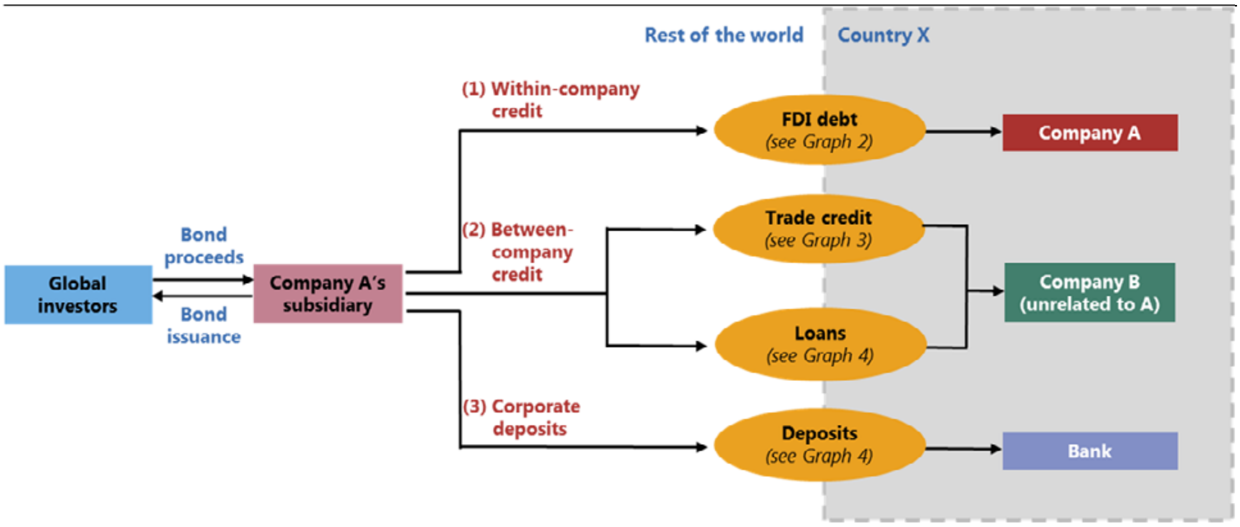
flows associated with corporate activity from those of the financial sector.[6] However, a little detective work can reveal a wealth of information. This article explores how the BoP data and some key items buried deep within the broad categories of direct investment and other investment can be used to shed light on cross-border capital flows through non-financial corporate activities (Table 1).

In the rest of this article, we present evidence that capital flows to EMEs associated with non-financial corporations have indeed increased markedly over the

[6] Reporting of sectoral data, however, is included in the sixth edition of the IMF's *Balance of Payments and International Investment Position Manual* (BPM6) published in 2009 and last updated in November 2013. The IMF will only accept data submitted under this new template from January 2015 (Box 2). However, only a small number of EMEs are expected to submit granular sectoral data in the near term.

Non-financial corporations and capital flows

Graph 1



Source: BIS.

past few years through three different channels. First, we demonstrate that transfers between firms' headquarters and their offshore affiliates have surged. Next, we show that "non-bank" trade credit flows to EMEs have increased significantly. Finally, we demonstrate that the amount of external loan and deposit financing to EMEs provided by non-banks has grown considerably.

Within-company credit

An accounting convention in the balance of payments deems borrowing and lending between affiliated entities of the same non-financial corporate to be "direct investment". Specifically, such transactions are classified under the "debt instruments" sub-item of direct investment. In contrast, borrowing and lending between unrelated parties are classified as either a portfolio investment or under the "other" category.[7] The rationale behind treating within-firm transactions as direct investment is that the overall profitability of a multinational corporation depends on advantages gained by deploying available resources efficiently to each unit in the group. For example, tax considerations could drive the choice between equity and within-company debt, and behaviourally such debt can be, and often is, written down in adverse circumstances.

Classifying the transfer onshore of funds obtained offshore as FDI raises questions about the traditional view that FDI is a stable or "good" form of capital flow (CGFS (2009)). This may be true for FDI in the form of large equity stakes associated with greenfield investment or foreign acquisitions. But within-company loans, especially if invested in the domestic financial sector, could turn out to be "hot money", which can be withdrawn at short notice. Thus, to the extent that

[7] Lending and borrowing between affiliated deposit-taking corporations (ie intrabank flows) are an exception to the above rule. They are classified not as FDI (debt), but as "other investment" (loans and deposits, respectively).

Balance of payments financial accounts[1] Table 1

Gross inflows		
	Direct investment	
		Equity
		Debt instruments (**within-company credit**)
	Portfolio investment	
		Equity
		Debt
	Financial derivatives	
	Other investments	
		Currency and deposits (**corporate deposits**)
		Loans (**between-company credit**)
		Trade credit (**between-company credit**)
		Other payables (**between-company credit**)

[1] Possible modes of capital flow generated by non-financial companies are in bold.

Source: IMF, *Balance of Payments Manual*.

within-company loans are financed through the offshore issuance of debt securities, they could be viewed as portfolio flows masked as FDI.

Quantitatively, for most EMEs, within-company lending has been modest when compared with purchases of stakes in other companies (Graph 2, left-hand panel). However, there have been sizeable increases in within-company flows in Brazil, China and Russia, amounting to more than $20 billion per quarter for these three countries combined (Graph 2, right-hand panel), which was broadly similar to the size of total portfolio inflows to the three countries during this period.

Between-company trade credit

The second mode of capital flow generated by non-financial firms' activities is through trade credit. The term "trade credit" has a narrower meaning in the balance of payments than in everyday use. Instead of encompassing trade financing more broadly such as guarantees through banks and letters of credit, the trade credit category under the BoP accounts refers only to claims or liabilities arising from the direct extension of credit by suppliers for transactions in goods and services, under a residual item known as "other investment". Bank-provided trade financing, such as letters of credit, is recorded separately under "loans".[8]

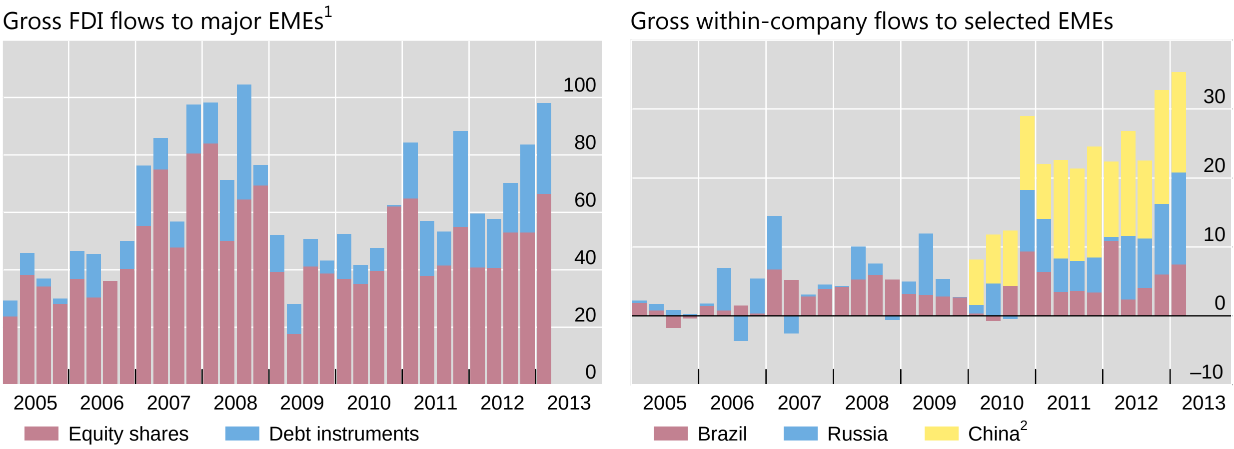
Typically, trade credit flows between companies are small and account for a small proportion of total other investment flows in most instances. Direct credit extension between exporters and importers could be seen as much riskier than arranging trade financing through banks. However, trade credit flows to EMEs have increased since the global financial crisis (Graph 3, left-hand panel), and the increase

8 Other firm-to-firm cross-border transactions such as account payables/receivables are simply recorded under "other" in "other investment".

FDI: equity and debt flows to major EMEs

In billions of US dollars

Graph 2



[1] Brazil, Chile, the Czech Republic, Hungary, India, Indonesia, Korea, Mexico, the Philippines, Poland, Russia, South Africa, Thailand and Venezuela. [2] Data for China start from 2010.

Source: IMF.

was driven, to a certain extent, by China (Graph 3, right-hand panel). In fact, the share of trade credit inflows in total other investment in China in recent years has been much larger than that in other EMEs. While these trade credit flows to China may reflect Chinese companies' growing importance and credibility in world trade, trade credit could be another route through which the proceeds of offshore funding can be transferred to headquarters and/or unrelated companies onshore.

Between-company loans and corporate deposits

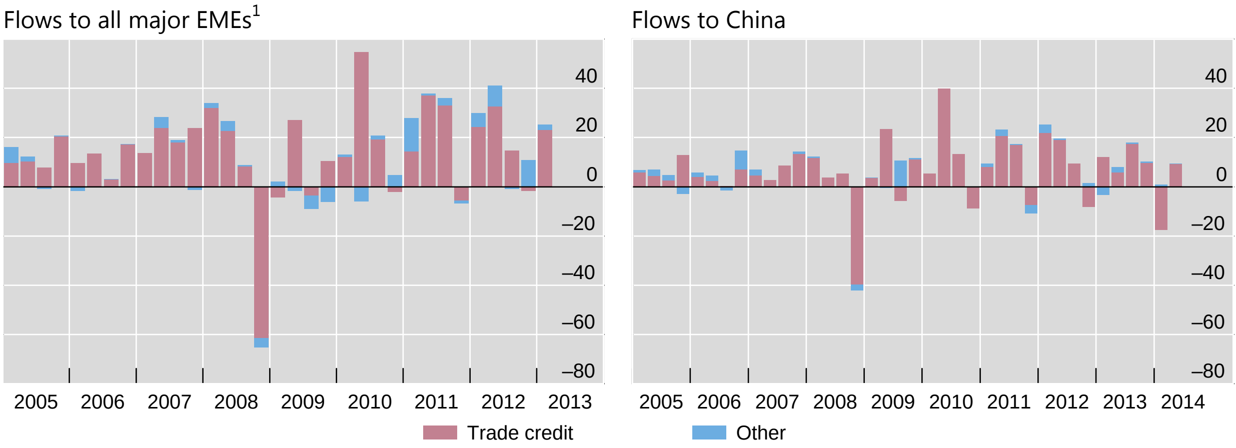
Despite the limitations of the existing data frameworks discussed above, it is possible to combine BoP statistics with the BIS international banking statistics (IBS) to shed some light on the growing importance of non-bank corporates in providing cross-border loans and deposits to EMEs.

From the *lender* perspective, the IBS capture the cross-border positions of internationally active banks. As a consequence, the IBS could be used to measure the amount of cross-border loans that banks provide to residents (both banks and non-banks) of a given country.

From the *borrower* perspective, a couple of (liability) categories in the BoP data provide information on the amount of cross-border financing that the residents of a given country obtain in the form of deposits and loans. More specifically, "deposit liabilities" capture the standard contract liabilities of all deposit-taking institutions in a given reporting jurisdiction to both banks (interbank positions) and non-banks (transferable accounts and deposits). Meanwhile, "loan liabilities" cover liabilities that are created when a creditor lends funds directly to a debtor, and are documented by claims that are not negotiable.

Between-company flows to EMEs

Inflows of trade credit and other account payables, in billions of US dollars — Graph 3



[1] Includes Argentina, Brazil, Chile, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Korea, Peru, the Philippines, Poland, Russia, South Africa, Thailand, Turkey and Venezuela; Malaysia and Mexico are excluded due to data availability.

Sources: IMF; State Administration of Foreign Exchange, China.

Table 2 illustrates how BoP and IBS can be brought together to estimate the amount of non-bank finance to EME residents.[9] The two BoP categories discussed above capture the cross-border liabilities of (bank and non-bank) residents of a given country to all (bank and non-bank) creditors (represented by cells A, B, C and D).[10] By contrast, the IBS capture solely the cross-border liabilities to offshore banks (cells A and B).[11] Thus, in principle, the difference between the two series could be used as a rough proxy for the amount of non-bank external financing to the residents of a country (cells C and D).[12]

This difference used to be small but has been increasing rapidly in recent years (Graph 4, left-hand panel).[13] Up until 2007, the two series moved fairly in sync, suggesting that BoP deposits and loan flows were dominated by banks. However, the gap between the two series has been steadily growing and currently stands at approximately $270 billion (which amounts to 17% of cumulative BoP flows since Q1 2005). The growing gap between the BoP and IBS series could be interpreted as evidence of the increasing weight of non-banks in providing external loan and deposit financing to residents of emerging market economies.

[9] Using a slightly different approach, Domanski et al (2011) decompose total (domestic and cross-border) credit to a number of advanced economies by creditor sector (bank and non-bank).

[10] In the context of our discussion, the category "non-banks" includes both non-financial firms and non-bank financial firms. That said, in the case of EMEs, a large part of the latter group is accounted for by the non-bank financial vehicles of non-financial corporates.

[11] Note that intrabank flows are included in both the IBS series on cross-border bank lending and the BoP series on external deposit liabilities (see footnote 7 for additional details).

[12] In theory, the variation between the BIS and the BoP data could also be due to residents' cross-border liabilities to banks located in countries which do not report data for the IBS. In practice, given the fairly comprehensive coverage of the IBS (which captures approximately $30 trillion worth of cross-border claims that belong to banks located in 44 jurisdictions), it is reasonable to assume that the above accounts for a negligible part of the overall wedge between the two series.

[13] The data used to construct the IBS series are available in BIS Statistical Table 7A.

Coverage of external loans and deposits in the BoP and IBS data

Table 2

		Borrowing country	
		Banks	Non-banks
Lending country	Banks	**A**	**B**
	Non-banks	**C**	**D**

Green: Captured by both BoP and IBS data. Red: Captured solely by BoP data.

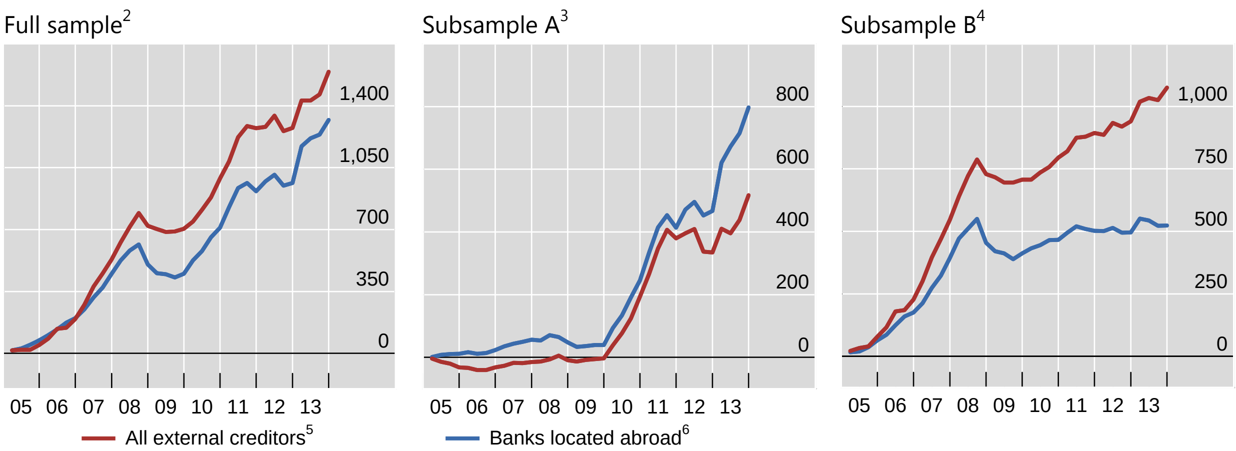
Sources: IMF, *Balance of Payments Manual*; BIS, *Guidelines for reporting the BIS international banking statistics.*

A more detailed examination of the data suggests that the role of non-banks might be even greater than the above estimates imply. Assuming positive gross inflows from non-banks, the BoP external loan and deposit estimates should exceed the respective IBS estimates for each country in our sample (since, as discussed above, the former include external lending by non-banks, whereas the latter do not). However, we find that the exact opposite is true for several EMEs, such as Brazil, China, Indonesia, the Philippines and Thailand (Graph 4, centre panel).[14] In theory, this finding could be explained by negative cumulative non-bank flows to each of those countries. In practice, it is highly unlikely that this was the case during

Cumulative cross-border deposit and loan gross flows to major EMEs[1]

By creditor sector, in billions of US dollars

Graph 4



[1] Cumulative flows starting from Q1 2005. Data for China start from Q1 2010. [2] Full sample = subsample A + subsample B. [3] Brazil, China, Indonesia, the Philippines and Thailand. [4] Chile, the Czech Republic, Hungary, India, Korea, Mexico, Poland, Russia, South Africa and Turkey. [5] Sum of "BoP other liabilities: currency and deposits" and "BoP other liabilities: loans" for each listed country. [6] Cross-border claims of BIS reporting banks on each listed country.

Sources: IMF; BIS locational banking statistics by residence (Table 7A).

[14] McCauley and Seth (1992) and Borio et al (2013) find that, for the United States, figures from the IBS data on external bank loans considerably exceed those based on the respective flow of funds data.

Box 2

Interpreting FDI flows under the new balance of payments template

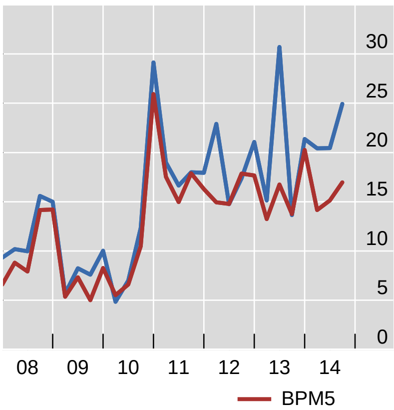
The rapid pace of financial globalisation over the past few decades has changed many aspects of international capital flows. To improve the understanding of these capital movements, in 2009 the IMF and its members agreed on a new template for collecting international financial transactions data: the sixth edition of the IMF's *Balance of Payments and International Investment Position Manual* (BPM6). From January 2015, the IMF will only accept data submissions under BPM6. In the transition period, some countries will still be publishing their BoP data under the previous template (BPM5, introduced in 1993) and the IMF will simply convert those "old" data to the new standard. Using Brazil as an example, this box illustrates how the conversion between BPM5 and BPM6 affects the interpretation of FDI flows.

Data published under the two formats reflect somewhat different treatments of within-company loans, resulting in differences in reported gross FDI inflows and outflows (Graph B, left-hand and centre panels), even though net FDI flows remain unchanged. This is because, under BPM5, FDI transactions between affiliates are recorded on a residence versus non-residence basis, whereas BPM6 differentiates between the net acquisition of assets and the net incurrence of liabilities. Simply put, under BPM5, both headquarter lending to affiliates (which increases claims) and borrowing from affiliates (which increases liabilities) are counted as gross outflows, albeit with opposite signs. Under BPM6, by contrast, the two activities will fall into different categories. While headquarter lending to affiliates will continue to count as capital outflow, borrowing from affiliates will be counted as net incurrence of liabilities (capital inflow). Using the notation in Graph B (right-hand panel), net acquisition of debt claims under BPM6 (item 6.1.2) will be the sum of items 5.1.2 and 5.2.2 under BPM5.

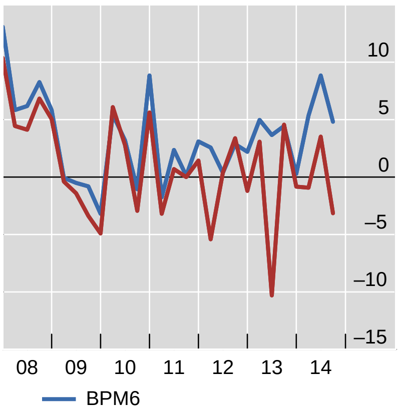
Brazilian FDI flows

Graph B

Gross FDI inflows



Gross FDI outflows



Direct investment flows

BPM 5	**BPM 6**
Gross outflows	
5.1 Direct investment abroad	**6.1 Net acquisition of assets**
5.1.1 Equity	6.1.1 Equity claims
5.1.2 Claims on affiliates	6.1.2 Debt claims
5.1.3 Liabilities to affiliates	
Gross inflows	
5.2 Direct investment in reporting country	**6.2 Net incurrence of liabilities**
5.2.1 Equity	6.2.1 Equity liabilities
5.2.2 Claims on direct investors	6.2.2 Debt liabilities
5.2.3 Liabilities to direct investors	

Sources: Central Bank of Brazil; IMF; BIS calculations.

the time period we examine. A much more plausible explanation could be related to inconsistencies in the reporting of external liabilities.[15]

While the above finding is intriguing in its own right, it also has important implications for the main question that we examine in this article. Namely, it suggests that, for the remaining EMEs in our sample, the aggregate size of the gap between the BoP and IBS series is considerably larger than the one implied by the

[15] Potential data reporting-related sources of discrepancy include the coverage of the reporting population, the treatment of bank-supported trade credit and the exchange rate valuation adjustment methodology.

estimates for the full sample. Indeed, as the right-hand panel of Graph 4 illustrates, the wedge between the BoP and IBS series is considerably larger for the latter set of EMEs (ie Chile, the Czech Republic, Hungary, India, Korea, Mexico, Poland, Russia, South Africa and Turkey). At the end of 2013, the BoP-implied external loan and deposit series for that group of countries exceeded its IBS counterpart by over $550 billion (51% of cumulative BoP flows since Q1 2005). This presents further evidence of the importance of non-banks in providing external loan and deposit financing to EMEs.

Conclusion

The shift away from bank-intermediated financing to market financing over the past few years has coincided with a sharp increase in international bond issuance by EME non-financial corporations. This trend could have important financial stability implications. Yet, analysis of it is hindered by conceptual difficulties associated with statistical conventions on the measurement of cross-border flows.

In this article, we utilise several key BoP data items to shed light on cross-border capital flows through non-financial corporate activities. We find that capital flows associated with non-financial corporations have indeed increased markedly over the past few years through three different channels. First, within-firm transfers have surged. Second, trade credit flows to EMEs have increased significantly. Finally, the amount of external loan and deposit financing to EMEs provided by non-banks has grown considerably. We interpret those findings as evidence that the offshore subsidiaries of EME non-financial corporates are increasingly acting as surrogate intermediaries, obtaining funds from global investors through bond issuance and repatriating the proceeds to their home country through the above three channels.

References

Borio, C, H James and H S Shin (2014): "The international monetary and financial system: a capital account historical perspective", *BIS Working Papers*, no 457, September.

Borio, C, R McCauley and P McGuire (2013): "Global liquidity and credit booms", in B Winkler, A van Riet and P Bull (eds), *A flow of funds perspective on the financial crisis*, Palgrave Macmillan, November, pp 94–124.

Cecchetti, S, I Fender and P McGuire (2010): "Toward a global risk map", in *Central bank statistics: what did the financial crisis change?*, proceedings from the Fifth ECB Conference on Statistics.

Chui, M, I Fender and V Sushko (2014): "Risks related to EME corporate balance sheets: the role of leverage and currency mismatch", *BIS Quarterly Review*, September, pp 35–47.

Chung, K, J Lee, E Loukoianova, H Park and H S Shin (2014): "Global liquidity through the lens of monetary aggregates", *IMF Working Paper*, January.

Committee on the Global Financial System (2009): "Capital flows and emerging market economies", *CGFS Papers*, no 33, January.

Domanski, D, I Fender and P McGuire (2011): "Assessing global liquidity", *BIS Quarterly Review*, December, pp 57–71.

Gruić, B, M Hattori and H S Shin (2014a): "Recent changes in global credit intermediation and potential risks", *BIS Quarterly Review*, September, pp 17–18.

Gruić, B, C Upper and A Villar (2014b): "What does the sectoral classification of offshore affiliates tell us about risks?", *BIS Quarterly Review*, December, pp 20–1.

Hong Kong Monetary Authority (2014): *Half-yearly monetary & financial stability report*, March.

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

Shin, H S and L Zhao (2013): "Firms as surrogate intermediaries: evidence from emerging economies", working paper, December.