

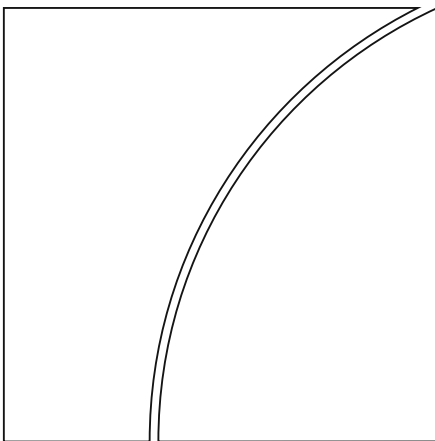


BANK FOR INTERNATIONAL SETTLEMENTS

BIS Quarterly Review

March 2014

International banking
and financial market
developments



BIS Quarterly Review
Monetary and Economic Department

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BIS Quarterly Review

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International banking and financial market developments

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Notations used in this Review

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

Differences in totals are due to rounding.

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

Emerging economies respond to market pressure¹

The retrenchment from emerging market economies resumed in full force around the turn of the year, as their subdued growth outlook continued to diverge from the optimistic sentiment in mature markets and as US monetary policy reduced the flow of easy money. Investors were also unsettled by signs of economic weakening and growing financial risks in China. The upshot was portfolio outflows and declining asset values. In parallel, some emerging market currencies depreciated sharply, prompting authorities to defend them by raising policy rates and intervening in foreign exchange markets.

While the average exchange rate dynamics during the January sell-off were similar to those in mid-2013, the underlying drivers differed. After the unexpected official announcement that the Federal Reserve envisaged tapering its large-scale bond purchases, the large depreciations in the earlier episode tended to be by the currencies of emerging market economies with large external imbalances, high inflation or rapidly growing domestic credit. By contrast, the recent depreciations reflected political uncertainties and differences in growth prospects. Central banks in emerging market economies also intervened much more forcefully this time round, thereby stabilising and in some cases boosting their currencies.

In advanced economies, markets maintained their rally into the first weeks of 2014. Investors there rode on policy commitments to support growth as well as on positive economic surprises, notably in the euro area and the United Kingdom. Thus, they took in their stride the announcement and subsequent start of US tapering. The tightening of credit spreads continued until mid-January, while steady inflows into equity funds maintained upward pressure on stock prices. However, towards the end of January, disappointing data on US job growth and headwinds from emerging market economies led to a sharp, albeit temporary, drop of valuations in all but the safest asset classes.

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 Nikola Tarashev (nikola.tarashev@bis.org). Questions about data and graphs should be addressed to Alan Villegas (alan.villegas@bis.org) and Agne Subelyte (agne.subelyte@bis.org).

Emerging market economies

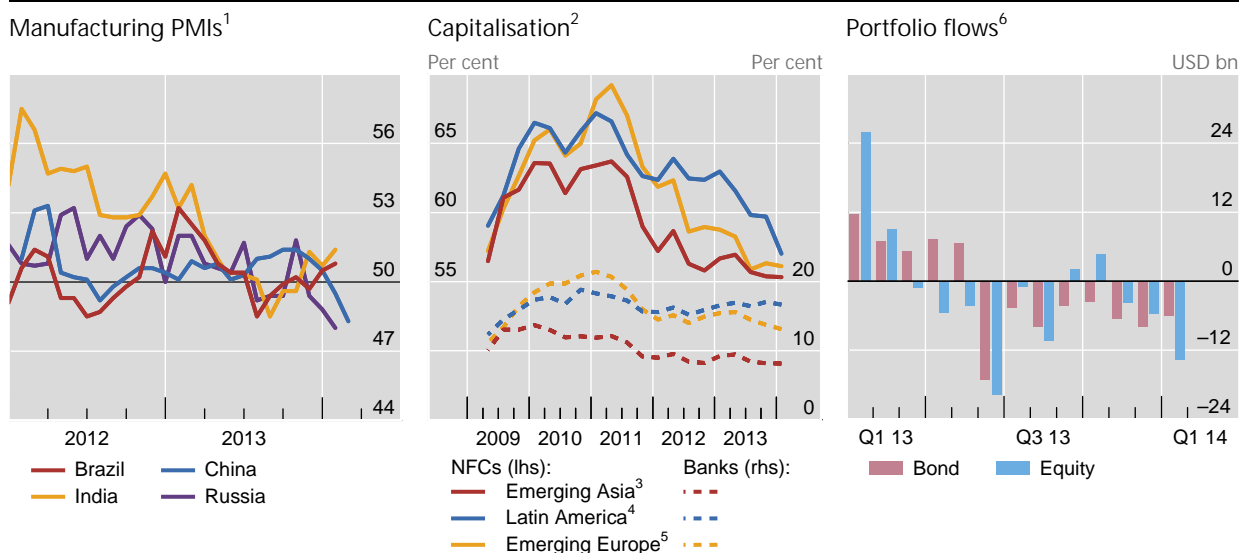
The recent sell-off in emerging market economies occurred against the backdrop of their subdued growth outlook. In January, a survey-based indicator of conditions in China's manufacturing sector dropped into contraction territory for the first time since September 2012, leading market analysts to envisage adverse effects on exporters to China (Graph 1, left-hand panel). In the case of Brazil, India and Russia, the indicator had hovered around its neutral level since mid-2013, signalling minor contractions and expansions. Coupled with a better outlook in advanced economies and a reduction in easy money from the United States, these developments weakened the appeal of emerging markets to international investors.

Perceptions of growing financial risks had also gained momentum. To an extent, these perceptions were fuelled by political tensions in several countries. But the underlying financial conditions played an important role as well. In January, market participants were unsettled by a near default in China's shadow banking sector. The growing importance of this sector had been revealed in a doubling of the volume of credit provided by Chinese non-banks over the past 18 months, to 25% of total credit in the country. More generally, in parallel with expanding balance sheets, the capitalisation of both non-financial corporates and banks in emerging market economies had deteriorated. The region-wide average ratio of equity over total balance sheet size had fallen gradually but steadily from 2010 to the end of 2013 (Graph 1, centre panel).

Economic outlook and investor retrenchment

Emerging market economies

Graph 1



¹ Purchasing managers' index (PMI) derived from monthly surveys of private sector companies. A value above (below) 50 indicates expansion (contraction). ² Region-wide market capitalisation divided by the sum of region-wide market capitalisation and region-wide book value of liabilities; averages over the previous three months. NFCs = non-financial corporates. ³ China, Chinese Taipei, Hong Kong SAR, India, Indonesia, Korea, Malaysia, the Philippines, Singapore and Thailand. ⁴ Argentina, Brazil, Chile, Colombia, Mexico, Peru and Venezuela. ⁵ The Czech Republic, Hungary, Poland, Russia and Turkey. ⁶ Sum across Argentina, Brazil, Chile, China, Chinese Taipei, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa, Thailand, Turkey and Venezuela.

Sources: Bloomberg; Datastream; EPFR; HSBC; Moody's; BIS calculations.

Emerging markets under pressure

After subsiding in September and October, investors' retrenchment from emerging markets gathered speed in November. As a direct manifestation, the outflows from both bond and equity funds intensified and remained sizeable up to end-January (Graph 1, right-hand panel). Retail investors accounted for the bulk of these outflows, while inflows from institutional investors continued. In parallel, and on the heels of a strong two-month rally, a broad equity index lost more than 10% of its value over the three months to end-January (Graph 2, top left-hand panel).

These developments were mirrored in foreign exchange markets, where renewed currency depreciations put pressure on central banks to raise policy rates or tap their reserves. The depreciations started at end-October, maintained their course through the Federal Reserve's tapering decision on 18 December, and accelerated on 23 January (Graph 2, bottom panels). On that date, in an effort to preserve foreign exchange reserves, Argentina's central bank scaled back support for the peso, which immediately lost 10% of its value with respect to the US dollar. This event spilled over, leading to sharp concurrent depreciations of a number of other emerging market currencies and to an upward spike of the credit spreads on a broad domestic currency bond index (Graph 2, top left-hand panel).

Policy interventions in emerging market economies bore fruit in February. These interventions stabilised and in some cases boosted emerging market currencies, providing breathing space to local corporates that had increasingly tapped international markets by issuing foreign currency bonds.² Likewise, stock indices recovered most of their January losses and credit spreads tightened.

Comparing sell-off episodes: mid-2013 and January 2014

Despite similarities in aggregate exchange rate dynamics, the last two emerging markets sell-offs differed in important ways. The episode in mid-2013 was triggered by an unexpected official announcement that the Federal Reserve envisaged tapering its large-scale bond purchases. This announcement had been preceded by a period of relatively stable exchange rates and low and falling interest rates in emerging economies (Graph 2, bottom right-hand panel). In contrast, by end-2013 markets had digested the actual start of US tapering and the macroeconomic outlook had deteriorated in many emerging markets. Thus, during 2013, emerging market exchange rates had already depreciated by around 10% on average vis-à-vis the US dollar. At the same time, interest rates had risen continuously as several emerging market countries, such as India, had already tightened policy rates in response to the sell-off in mid-2013. And when market pressure escalated on 23 January, strong policy responses translated into a much steeper interest rate hike than during the previous episode (Graph 2, bottom right-hand panel).

In addition, foreign exchange risk gradually assumed a dominant role in sovereign credit markets over the second half of 2013. During the first sell-off in June, the yields on domestic currency and US dollar debt went up in sync, driven by perceptions of increased sovereign credit risk (Graph 2, top right-hand panel). By contrast, while the yield on domestic currency debt increased by 80 basis points

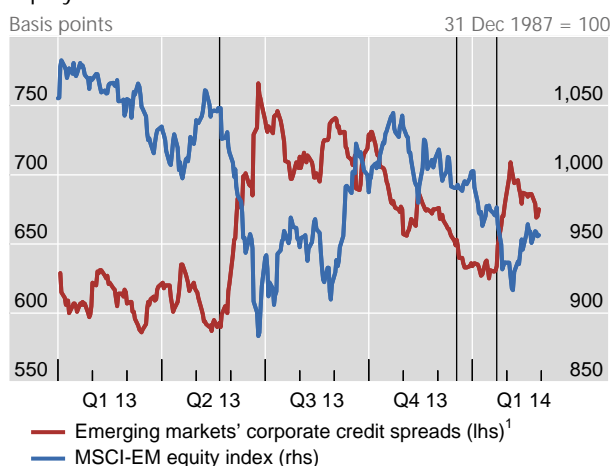
² For a further discussion of potential financial stability implications of foreign currency borrowing by non-bank financials in emerging markets, see P Turner, "The global long-term interest rate, financial risks and policy choices in EMEs", *BIS Working Papers*, no 441, February 2014.

Declining equity, debt and currency values

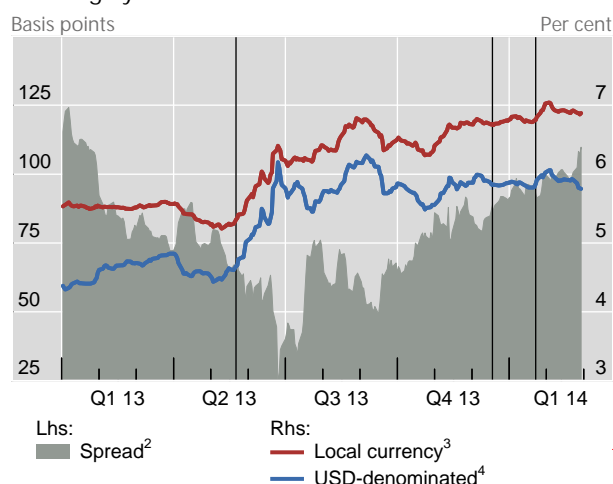
Emerging market economies

Graph 2

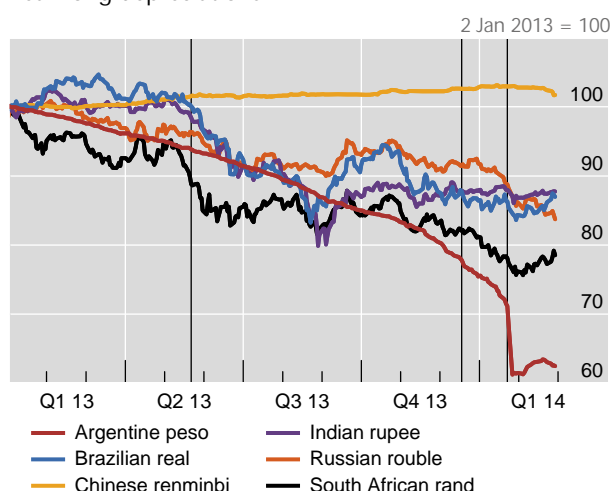
Equity and debt markets



Sovereign yields



Year-long depreciations⁵



Interest and exchange rates⁶



The black vertical lines indicate key tapering announcements on 22 May and 18 December 2013, and the large depreciation of the Argentine peso on 23 January 2014.

¹ High-yield option-adjusted spreads on an index of local currency bonds issued by financial and non-financial corporates. ² Yield on local currency-denominated debt minus yield on US dollar-denominated debt. ³ JPMorgan GBI-EM Broad Diversified index, yield-to-redemption. ⁴ JPMorgan EMBI Global Diversified index, stripped yield-to-maturity. ⁵ US dollars per unit of local currency. ⁶ Simple average across Argentina, Brazil, Chile, Colombia, the Czech Republic, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, South Africa, Thailand and Turkey.

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

from July to January, there was virtually no change in the yield on corresponding US dollar debt over the same period. This suggests that exchange rate risk substituted for credit risk as a key driver of the borrowing costs of emerging market sovereigns.

This provided the backdrop for different developments in foreign exchange markets across the two sell-off episodes. From mid-May to end-July, it was the currencies of emerging market economies with greater external and internal imbalances that depreciated most. For instance, large current account deficits were associated with downward pressure on currency values (Graph 3, top left-hand panel). Foreign exchange investors were also wary of those emerging markets that

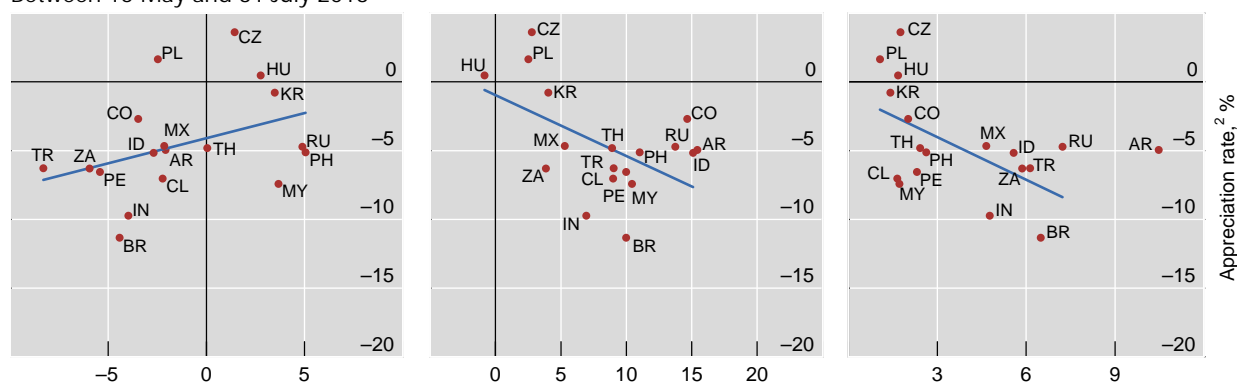
had high inflation rates or had seen rapidly expanding credit to the private non-financial sector (Graph 3, top centre and right-hand panels). Being among the more vulnerable emerging market economies, India and Brazil saw their currencies depreciate by roughly 10% vis-à-vis the US dollar during that episode.

Even though emerging market currencies did depreciate substantially from early 2014 until they stabilised on 3 February, forceful policy actions dampened the effect of market pressure on exchange rates. As the sudden depreciation of the Argentine peso spilled over, markets did penalise countries with large current account deficits. Thus, the Turkish lira and the South African rand were among the currencies that depreciated the most in the following days. In order to contain these developments and their fallout, a number of central banks responded with strong policy rate hikes in late January and early February. This stabilised exchange rates and even brought them into appreciation territory more recently (Graph 2, bottom

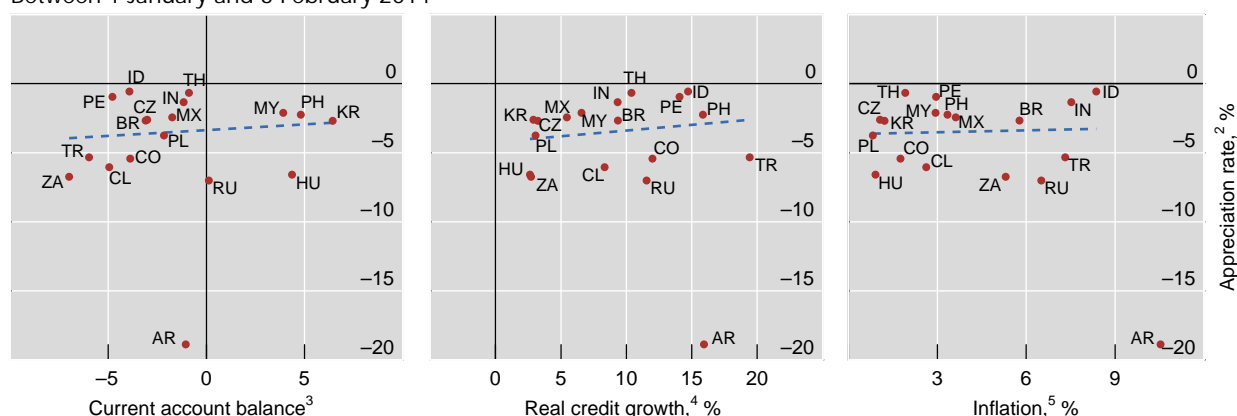
Imbalances and exchange rate depreciations¹

Graph 3

Between 15 May and 31 July 2013



Between 1 January and 3 February 2014



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

¹ Trend lines exclude Argentina. Trend lines are solid (dashed) if the slope estimate is significant (not significant) at the 10% level. This significance level is just missed for the regression of depreciation rates between 15 May and 31 July on current account balances. But this regression is significant if depreciation rates are taken between 15 May and the beginning of September, when emerging market currencies started to appreciate again on average. Extending the horizon does not change the significance levels for the other two variables. ² Percentage change in the exchange rate for the period shown. A negative number indicates a relative depreciation of the local currency vis-à-vis the USD. ³ As a percentage of GDP, Q1 2013 (top panel) and Q3 2013 (bottom panel). ⁴ Year-on-year percentage change in total credit to the private non-financial sector deflated by CPI, Q1 2013 (top panel) and Q3 2013 (bottom panel). ⁵ Year-on-year percentage change in CPI, April 2013 (top panel) and November 2013 (bottom panel).

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

How does US monetary policy affect policy rates in emerging market economies?

Előd Takáts

Monetary policy in advanced economies, especially in the United States, appears to have a significant influence on the conduct of monetary policies in many emerging market economies (EMEs). During the global “search for yield”, many EMEs were concerned that large interest rate differentials vis-à-vis advanced economies would lead to destabilising capital inflows and overvalued exchange rates. In recent years, this seems to have kept EME policy rates lower than what purely domestic conditions would have implied. Conversely, the beginning of the normalisation of US monetary policy has already started to induce upward adjustments in policy rates, amplified by a turn in investor sentiment, a reversal of capital flows and strong downward pressure on exchange rates.

One way to assess the factors driving EME policy rates is to estimate a Taylor equation. The standard Taylor equation uses two domestic variables to explain policy rates: inflation (or its deviation from the target) and the output gap. The intuition is straightforward: countercyclical monetary policy should raise rates if inflation is rising or the economy is overheating – and lower rates if inflation is declining or output falls short of its potential. We augment this standard Taylor equation with an additional term in order to assess the impact of US monetary policy.^① Formally, we estimate the equation below for each EME:

$$r_{t,EME} = c + \alpha\pi_{t,EME} + \beta y_{t,EME} + \gamma r_{t,US} + \varepsilon_t$$

where r_{EME} denotes the monetary policy rate of the EME in question, π the inflation rate and y the output gap; r_{US} denotes the “shadow” policy rate of the United States.^② As usual, ε denotes the error term and t is the quarterly time index. The sample covers 20 EMEs over the Q1 2000–Q3 2013 period.

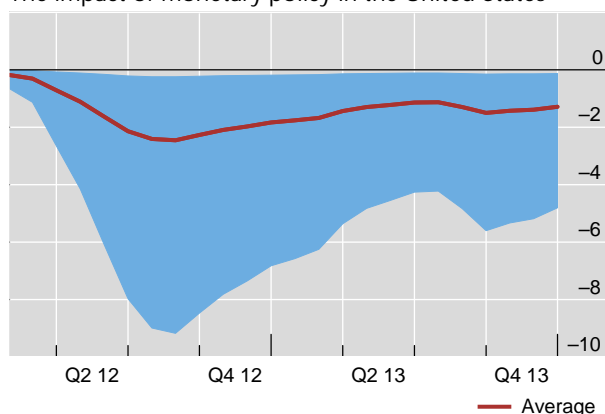
The results confirm that the augmented Taylor equation is broadly consistent with the evolution of EME policy rate setting, ie the regression fits the observed policy rates well. They confirm that US monetary policy has a significant effect over and above domestic conditions: US monetary policy, captured by parameter γ , is statistically significant for most emerging markets (16 out of 20). More specifically, the results indicate that in these economies US monetary policy is associated with on average 150 basis points lower policy rates since 2012 (Graph A, left-hand panel, red line), albeit with substantial heterogeneity across countries and time (blue shaded band). This is consistent with recent findings suggesting that EME monetary policy tended to be more accommodative than the Taylor rule prescription.^③ For example, even at the end of 2013, after the adjustments induced by the May sell-off,

EME policy rate setting

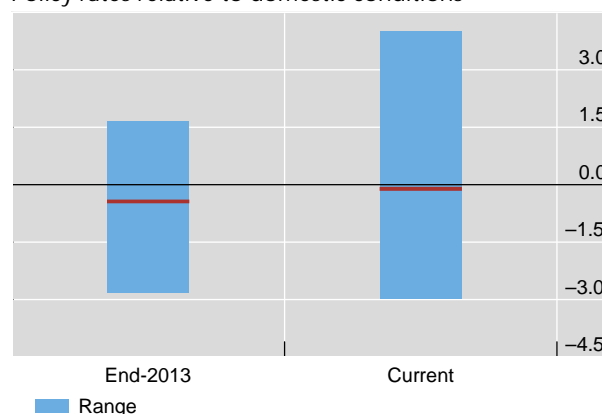
In percentage points

Graph A

The impact of monetary policy in the United States¹



Policy rates relative to domestic conditions²



¹ The shadow US policy rate-driven component of the augmented Taylor equation for countries where γ is significant at the 5% level: Brazil, China, Colombia, the Czech Republic, Hungary, India, Indonesia, Israel, Korea, Mexico, Peru, the Philippines, Poland, Singapore (overnight rate), South Africa and Turkey. ² Difference between policy rates implied by the domestic components (inflation and output gap) of the augmented Taylor equation and actual rates for the same set of countries as above.

Sources: IMF; Datastream; national data; authors' calculations.

EME policy rates tended to be lower by an average of 50 basis points than the levels suggested by the domestic components of the Taylor equation estimates (Graph A, right-hand panel, red line on the first column). The recent policy tightening in EMEs helped to eliminate this gap on average (red line on the second column). However, these averages hide a substantial increase in dispersion (blue bars), which reflects some sudden and concentrated shifts as opposed to a broad-based realignment of policy rates

Of course, a comparison of policy rates with a simple benchmark should be interpreted with caution. Measuring unobservable variables, such as the output gap, is fraught with difficulties. Even the policy rate might not be an accurate measure of monetary conditions, because EMEs have increasingly used non-interest rate monetary policy measures and macroprudential tools to affect monetary conditions. And the results, even if representative for EMEs as a group, should not be seen to apply to all individual EMEs. That said, the finding of unusually accommodative conditions in EMEs seems rather robust. It would survive the use of other benchmarks, such as the growth rate of the economies. And it is consistent with the presence of strong credit and asset price booms in several countries. In particular, recent evidence suggests that potential output tends to be overestimated when such booms are under way.^④

① For more details on the estimation, see E Takáts and A Vela, "International monetary policy transmission", *BIS Papers*, 2014 (forthcoming), available upon request. The paper shows that the standard Taylor rule does not fully capture the development of policy rates in most EMEs, and that including a measure of the US policy rate improves the estimates significantly. ② The shadow policy rate was developed in M Lombardi and F Zhu, "Filling the gap: a factor based shadow rate to gauge monetary policy", 2014 (mimeo), in order to account for the impact of unconventional US monetary policies once the zero lower bound was reached. Naturally, this shadow rate can be negative. ③ See further in B Hofmann and B Bogdanova, "Taylor rules and monetary policy: a global 'Great Deviation'?", *BIS Quarterly Review*, September 2012. ④ C Borio, P Disyatat and M Juselius, "Rethinking potential output: embedding information about the financial cycle", *BIS Working Papers*, no 404, February 2013.

right-hand panel). For their part, the Russian authorities defended the rouble by drawing on their substantial foreign exchange reserves. The Russian central bank sold \$7.8 billion in January, compared to a combined \$7 billion in June and July. Such actions – as well as the increasing importance of political tensions as a differentiating risk factor – blurred the relationship between depreciations of emerging market currencies and the above indicators of economic imbalances (Graph 3, bottom panels).

In raising interest rates to defend their currencies, policymakers face a trade-off. On the one hand, higher rates can stabilise the exchange rate. On the other hand, they could undermine the macroeconomy. At the current juncture, assessing the appropriate monetary stance in many emerging market economies is further complicated by the fact that monetary policy conditions have been extremely accommodative in past years (see box). Tightening could thus normalise the stance of policy, better aligning interest rates with underlying domestic macroeconomic conditions. Yet the prolonged period of low interest rates has fuelled the rapid build-up of debt in several countries. Coupled with a weakening economic outlook, raising rates in such an environment could precipitate a disorderly unwinding of financial imbalances by increasing the debt servicing costs of overextended borrowers.

Advanced economies

In recent months, investors in advanced economies acted on perceptions of a favourable growth outlook and in an environment of extraordinary monetary accommodation. The upbeat sentiment manifested itself in substantial gains in equity markets, sizeable inflows into equity funds and unabated tightening of credit spreads. This strong performance was tested at end-January by the emerging

market sell-off and weaker than expected macroeconomic data from the United States.

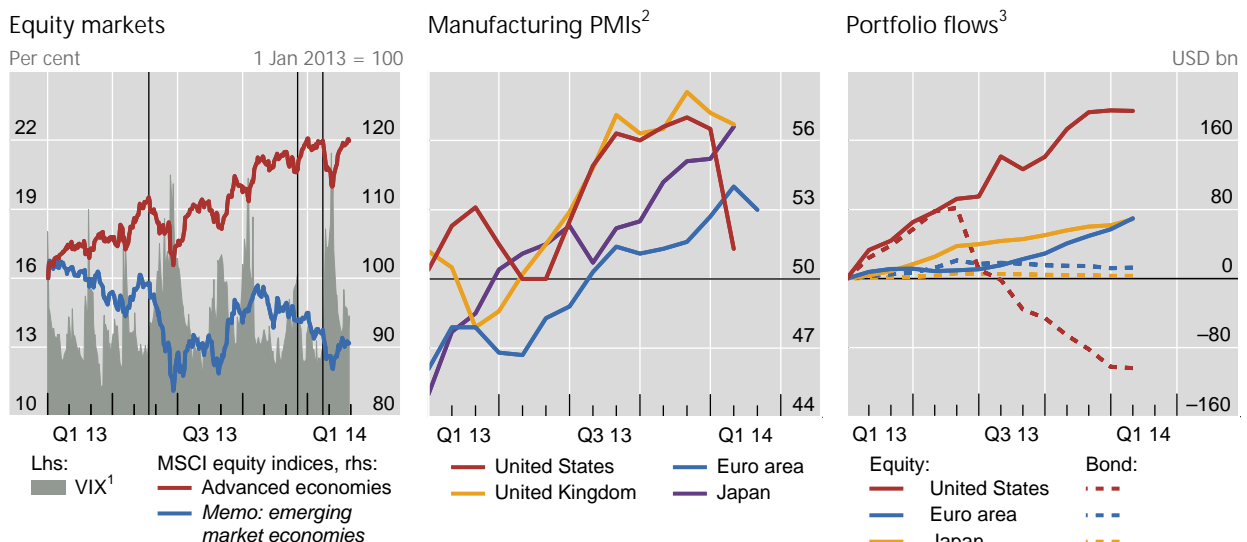
From November to mid-January, stock prices in advanced economies maintained their upward trend, in contrast to those in emerging markets (Graph 4, left-hand panel). On the back of a positive growth outlook (Graph 4, centre panel), the broad stock indices in the United States, the euro area and Japan gained 5%, 4% and 10%, respectively, between 1 November and 22 January. In the process, markets took in their stride the 18 December announcement of US tapering. The rise in valuations went hand in hand with strong inflows into equity funds, especially in the euro area (Graph 4, right-hand panel).

In line with their appetite for equities, investors searched for yield in advanced economies' bond markets. As a result, high-yield spreads continued to narrow towards their pre-crisis lows. The spreads on broad corporate bond indices in the United States, euro area and United Kingdom decreased steadily up to mid-January to reach their lowest levels since October 2007 (Graph 5, left-hand panel). In parallel, there was a similar squeeze of the spreads on investment grade corporate bond indices, while the yields on debt issued by sovereigns in the euro area periphery remained flat at lower levels than in mid-2013. Coupled with an improved growth outlook and expectations of monetary policy tightening, the appeal of relatively risky debt contributed to a repricing of assets in the safest part of the spectrum. US and UK 10-year sovereign yields rose by roughly 40 basis points over the last two months of 2013, while the corresponding German bund yields edged up by 25 basis points. At the same time, there were outflows from bond funds (Graph 4, right-hand panel). These outflows were particularly sizeable in the United States, where the Federal Reserve started tapering its bond purchases.

Growth outlook, equity markets and investor repositioning

Advanced economies

Graph 4



The black vertical lines indicate key tapering announcements on 22 May and 18 December 2013, and the large depreciation of the Argentine peso on 23 January 2014.

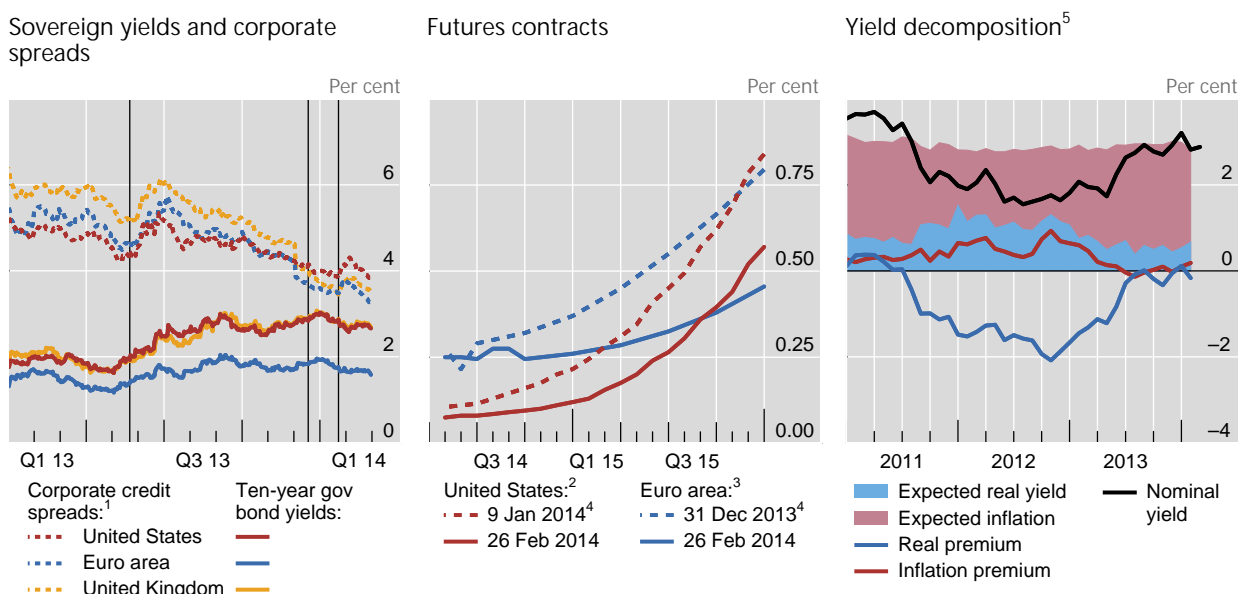
¹ Chicago Board Options Exchange volatility index. ² Purchasing managers' index (PMI) derived from monthly surveys of private sector companies. A value above (below) 50 indicates expansion (contraction). ³ Cumulative net flows.

Sources: Bloomberg; Datastream; EPFR.

Bond markets and policy expectations

Advanced economies

Graph 5



The black vertical lines indicate key tapering announcements on 22 May and 18 December 2013, and the large depreciation of the Argentine peso on 23 January 2014.

¹ High-yield option-adjusted spreads on an index of local currency bonds issued by financial and non-financial corporates. ² Thirty-day federal funds rate futures. ³ Three-month Euribor futures. ⁴ The date witnessing the highest yields between 1 December 2013 and 26 February 2014. ⁵ Decomposition of the 10-year Treasury yield, based on a joint macroeconomic and term structure model. See P Hördahl, O Tristani and D Vestin, "A joint econometric model of macroeconomic and term structure dynamics", *Journal of Econometrics*, vol 131, 2006, pp 405–44; and P Hördahl and O Tristani, "Inflation risk premia in the term structure of interest rates", *BIS Working Papers*, no 228, May 2007.

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

Market tensions surfaced briefly in advanced economies at end-January but dissipated by mid-February. Data revealing disappointing job growth in the United States, coupled with a sell-off of emerging market assets, led to a sharp drop in valuations and a rise in equity market volatility (Graph 4, left-hand panel) as well as in high-yield credit spreads (Graph 5, left-hand panel). In parallel, the yields on 10-year core sovereign bonds dropped, as did sovereign yields in the euro area periphery, where investor sentiment had been improving.

Authorities in advanced economies maintained their support of the economic recovery. Central banks on both sides of the Atlantic had committed explicitly and repeatedly to keep policy rates at ultra-low levels until recovery is well entrenched (see previous issues of this Review). More recently, the US and UK central banks revised their forward guidance to emphasise that the monetary stance would remain accommodative despite a faster than expected reduction in the unemployment rate. Consistent with this, markets pushed back the expected date of policy rate hikes by several months (Graph 5, centre panel). Futures curves at end-February imply that markets did not expect US or euro area policy rates to rise before late 2015. Likewise, little uncertainty about monetary policy and its impact on inflation, as well as perceptions that markets would absorb the decline in official demand for long-term paper, kept the risk premium of the US 10-year Treasury yield close to zero over the past eight months (Graph 5, right-hand panel).

Highlights of the BIS international statistics¹

BIS reporting banks reduced their cross-border claims in the third quarter of 2013, especially claims on banks, which contracted the most since the second quarter of 2012. Adjustments of inter-office positions accounted for most of the retreat in interbank lending. Cross-border credit to non-banks declined as well, especially to borrowers in the United States and the euro area. Among the main reporting regions, only emerging market economies and Japan saw an increase in cross-border credit to their residents. Claims on offshore centres remained virtually unchanged. This article contains two boxes. The first analyses recent changes in international interbank activity. The second discusses the role of cross-border investment in the global securities market.

The international banking market in the third quarter of 2013

The cross-border claims of BIS reporting banks fell by \$500 billion (1.8%) between end-June and end-September 2013 (Graph 1, top left-hand panel).² As a result, total outstanding cross-border credit stood at \$28.5 trillion at end-September 2013, compared with \$29.5 trillion one year earlier. Cross-border claims denominated in euros fell by \$308 billion or 3.2%, and those in US dollars by \$295 billion or 2.5%, while claims in Japanese yen and Swiss francs increased by \$43 billion (3.3%) and \$18 billion (4.5%), respectively (Graph 1, top right-hand panel).

Cross-border credit developments differed across regions. Claims on advanced economies fell by \$554 billion (2.6%), the largest decline in almost two years. The main exception was claims on Japan, which increased by \$90 billion (10%). Claims on offshore centres remained virtually unchanged, registering a decline of just

¹ This article was prepared by Adrian van Rixtel (adrian.vanrixtel@bis.org). Statistical support was provided by Jeff Slee (jeff.slee@bis.org).

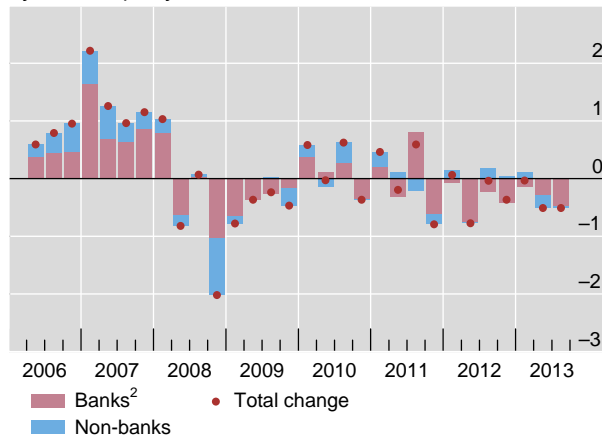
² The analysis in this section is based on the BIS locational banking statistics by residence, unless stated otherwise. In these statistics, creditors and debtors are classified according to their residence (as in the balance of payments statistics), not according to their nationality. All reported flows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

Changes in cross-border claims¹

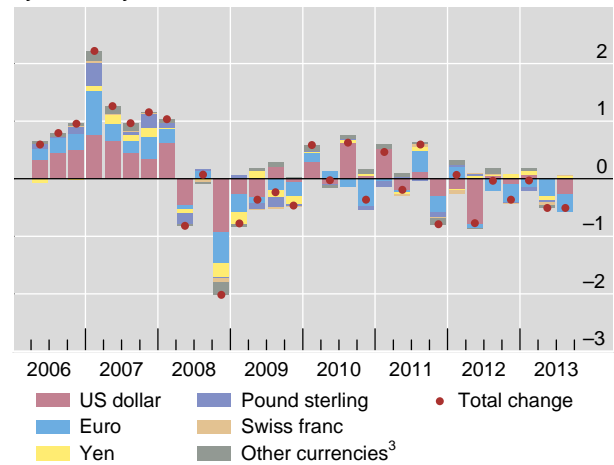
Exchange rate- and break-adjusted changes, in trillions of US dollars

Graph 1

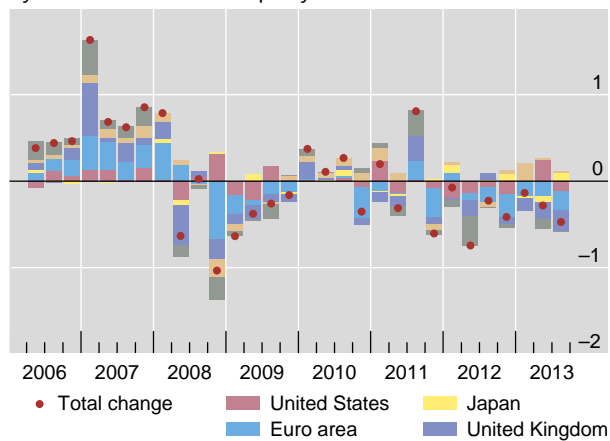
By counterparty sector



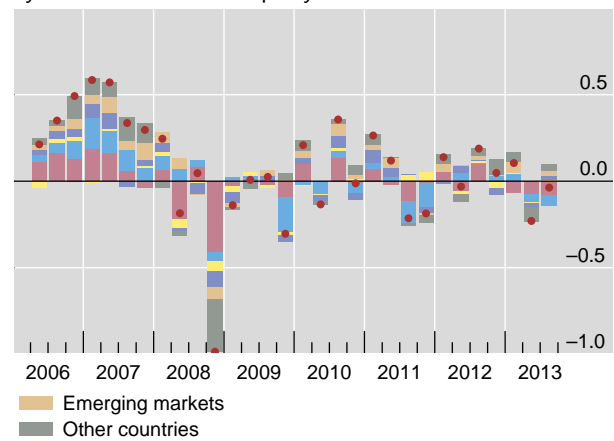
By currency



By residence of counterparty, banks²



By residence of counterparty, non-banks



¹ BIS reporting banks' cross-border claims include inter-office claims. ² Includes claims unallocated by counterparty sector. ³ Includes unallocated currencies.

Source: BIS locational banking statistics by residence.

\$4.4 billion (0.1%). In contrast, cross-border claims on emerging market economies increased by \$60 billion (1.7%). Nevertheless, excluding China these claims actually fell.

International banking activity was characterised by lower credit to both banks and non-banks in the third quarter of 2013, mirroring developments in the previous quarter. Cross-border claims on banks fell by \$466 billion (2.7%) (Graph 1, bottom left-hand panel). Inter-office positions accounted for most of this contraction, continuing the steady decline that began in late 2011. The retreat in cross-border interbank activity was most pronounced for claims on banks in the euro area (\$205 billion or 4.2%), United Kingdom (\$250 billion or 7.8%) and offshore centres (\$35 billion or 1.7%).

Cross-border claims on non-bank borrowers – mainly non-bank financial institutions, governments and corporations – fell by \$34 billion (0.3%) (Graph 1,

bottom right-hand panel). While the fall was small, it was the second consecutive quarterly decline and partially reversed the modest increase seen in 2012.

Credit to non-bank entities

The decrease in cross-border claims on non-bank borrowers in the third quarter of 2013 was concentrated on the United States (\$80 billion or 3.2%) and the euro area (\$58 billion or 1.6%). Notwithstanding this decline, the consolidated banking statistics, which have a finer sectoral breakdown than the locational banking statistics, indicate that the sharp fall in claims on the US public sector recorded in the first half of 2013 was partially reversed in the third quarter. Consolidated international claims³ on the US public sector rose from \$534 billion at end-June to \$580 billion at end-September 2013. At the same time, the decline in international claims on the US non-bank private sector – mainly non-bank financial institutions and non-financial firms – continued in the third quarter of 2013, when they fell to \$1.3 trillion.

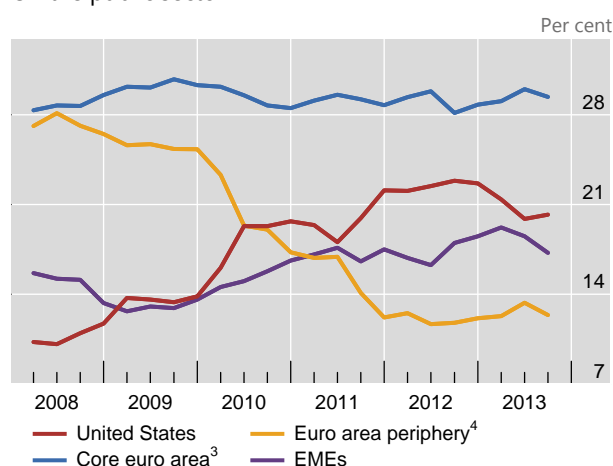
In the euro area, France (–\$24 billion or –4.5%) and Germany (–\$22 billion or –3.7%) led the decline in credit to non-bank borrowers in the third quarter. At the same time, some euro area economies that had experienced sharp reductions in cross-border credit in recent years saw lending stabilise in 2013. Consolidated claims on the non-bank sectors of southern European countries and Ireland, both the public and non-bank private sectors, were more or less unchanged between end-June and end-September 2013, although at a fraction of their amount outstanding in 2009.

BIS reporting banks' share of international claims^{1, 2}

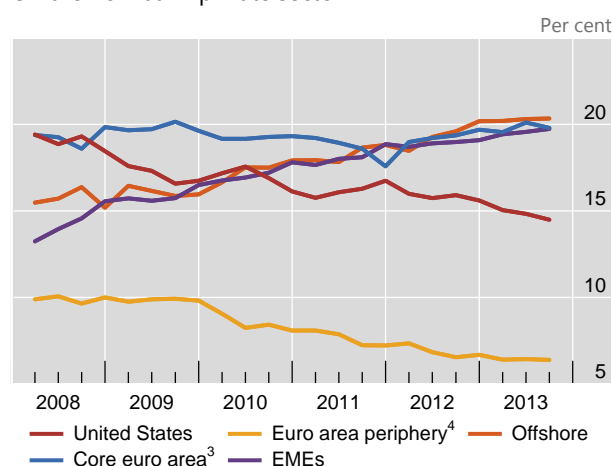
By residence and sector of immediate borrower

Graph 2

On the public sector



On the non-bank private sector



¹ As a percentage of BIS reporting banks' total international claims on the respective sectors. ² Cross-border claims in all currencies plus local claims in foreign currencies, excluding inter-office positions. ³ Austria, Belgium, Finland, France, Germany, Luxembourg and the Netherlands. ⁴ Greece, Ireland, Italy, Portugal and Spain.

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

³ International claims comprise cross-border claims in all currencies and local claims in foreign currencies, where local claims refer to credit extended by banks' affiliates located in the same country as the borrower.

International interbank activity in retreat

Pablo García-Luna and Adrian van Rixtel

The 2007–09 global financial crisis and the subsequent euro area financial strains have left a profound imprint on international *interbank* funding.^① According to the BIS locational banking statistics by residence, cross-border interbank lending (including inter-office positions) fell from \$22.7 trillion at end-March 2008 to \$17.0 trillion at end-September 2013. While this contraction affected most countries worldwide, it was largest for borrowers in Europe, especially the euro area. Claims of BIS reporting banks on banking offices in the euro area fell by a cumulative \$2.6 trillion (Graph A, left-hand panel), a reduction of 31%. Lending to banks in the United Kingdom dropped by \$1.7 trillion, or 35%. Claims on banks in the United States and Switzerland fell sharply as well, by \$415 billion (16%) and \$346 billion (42%), respectively. This box considers which factors were at work, with an emphasis on developments in the euro area.

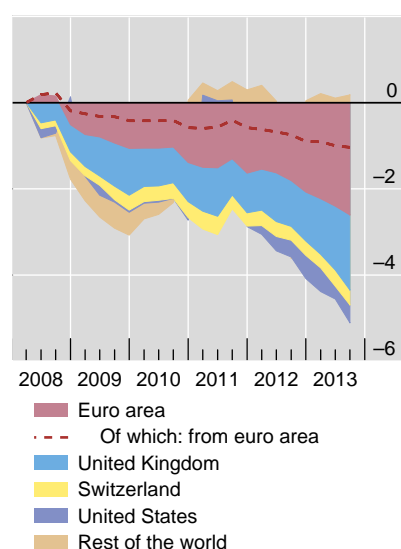
The BIS locational banking statistics by nationality show that banks headquartered in the euro area played a central role in the reduction in cross-border interbank lending, accounting for over two thirds of the total contraction (Graph A, centre panel). Swiss banks were responsible for most of the remainder. The large share of euro area and Swiss banks is partly related to the specific operation of their international interbank activities. These banks had traditionally routed a major part of their international operations through London.^② This practice was scaled down substantially during 2008–13. In fact, euro area and Swiss banks accounted almost entirely for the contraction in cross-border interbank activity registered by banks in the United Kingdom, reducing such activity by a cumulative \$1.1 trillion since end-March 2008 (Graph A, right-hand panel, shaded area). The decline in cross-border interbank operations from the United Kingdom was concentrated on the euro area, in terms of both lending and borrowing (Graph A, right-hand panel, blue and red lines).

Contraction in international interbank activity¹

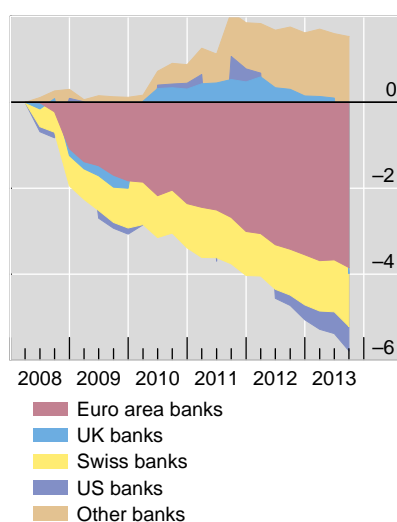
Cumulative change in cross-border interbank claims since end-March 2008, in trillions of US dollars²

Graph A

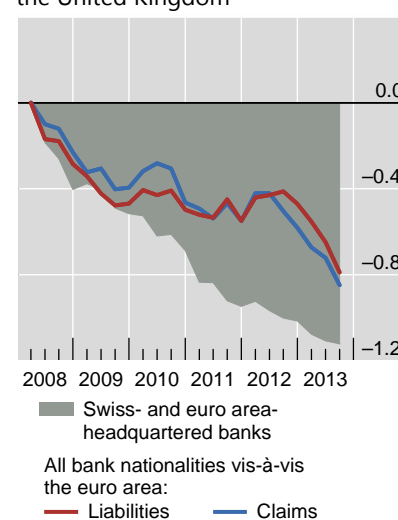
By debtor country



By lender nationality



Interbank activity of bank offices in the United Kingdom



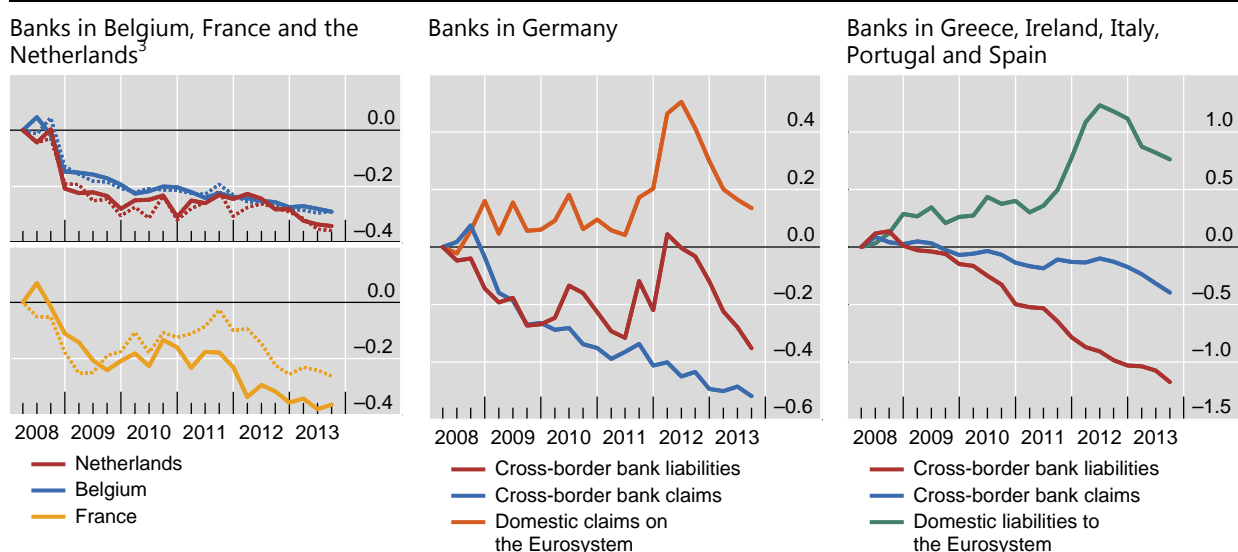
¹ Including banks' cross-border claims on their own offices abroad. ² Cumulative sum of quarterly break- and exchange rate-adjusted changes between end-March 2008 and end-September 2013. The absolute change in amounts outstanding over this period is less than the cumulative change because the absolute change is not adjusted for breaks in series or exchange rate movements.

Source: BIS locational banking statistics by residence and nationality.

Contraction in euro area international interbank markets¹

Cumulative change in cross-border interbank positions since end-March 2008, in trillions of US dollars²

Graph B



¹ Including banks' cross-border claims on their own offices abroad. ² Cumulative sum of quarterly break- and exchange rate-adjusted changes between end-March 2008 and end-September 2013. ³ The solid and dashed lines represent cross-border interbank liabilities and claims, respectively. For Belgium, loans and deposits only; for France and the Netherlands, all instruments.

Sources: IMF, *International Financial Statistics*; BIS locational banking statistics by residence.

The sharp decline in international interbank activity on the euro area showed different patterns across countries, which can be categorised in three groups according to the differences in the evolution of banks' cross-border lending and borrowing. A first group, comprising Belgium, France and the Netherlands, experienced a significant reduction in cross-border funding during 2008–13 that was mirrored by a similar contraction in their cross-border interbank lending, resulting in largely unchanged net funding positions (Graph B, left-hand panel). Cross-border interbank borrowing and lending by banks in France initially fell rapidly during the global financial crisis, but recovered from mid-2009 to mid-2011. The intensification of the euro area financial crisis from the summer of 2011 triggered another sharp retreat in these banks' international interbank activity.^③

The second group comprises banks in Germany, which were large net recipients of international interbank funding, especially during 2010–13. These banks saw both cross-border interbank lending and borrowing decline for most of 2008–09 (Graph B, centre panel), but not subsequently. With the first tremors of the euro area financial crisis hitting financial markets in the first half of 2010, cross-border interbank liabilities of banks in Germany increased, offsetting part of the cumulative decline of the previous two years (red line). At the same time, these banks continued to reduce their cross-border interbank lending (blue line). The worsening of the euro area financial crisis from June 2011 to June 2012 led to a further sharp increase in the interbank liabilities of banks in Germany. This expansion was mirrored in an increase of the deposits maintained by banks in Germany with the Eurosystem (orange line).

In contrast, banks in the euro area periphery (the third group) experienced a large fall in their cross-border interbank funding, while their interbank lending declined more modestly (Graph B, right-hand panel). Cross-border interbank borrowing by banks in Greece, Ireland, Italy, Portugal and Spain fell by a cumulative \$1.2 trillion during 2008–13 (red line). The resulting large international funding gap was covered by increased borrowing from the Eurosystem (green line). Hence, the Eurosystem replaced the international interbank market as a funding mechanism for these countries.

① See J Caruana and A van Rixtel, "International financial markets and bank funding in the euro area: dynamics and participants", originally published in *Economistas*, December 2012. ② See G von Peter, "International banking centres: a network perspective", *BIS Quarterly Review*, December 2007. ③ See A van Rixtel and G Gasperini, "Financial crises and bank funding: recent experience in the euro area", *BIS Working Papers*, no 406, March 2013.

The consolidated sectoral exposures of BIS reporting banks vis-à-vis specific countries have undergone sizeable changes in recent years, as regards both the public and non-bank private sectors. Between the first quarter of 2008 and the third quarter of 2013, the share of international claims on the public sector accounted for by entities in the euro area periphery more than halved, from 27% to 12% (Graph 2, left-hand panel). This was mirrored by strong increases in the relative weight of exposures to the US public sector⁴ and that of emerging market economies, to 20% and 17%, respectively. Relative exposures to the non-bank private sector shifted from the United States and the euro area periphery to offshore centres and emerging market economies (Graph 2, right-hand panel). On a consolidated basis, in the third quarter of 2013 the amount of international financing provided to non-bank private borrowers from the latter two regions was roughly equal to that granted to the euro area and United States combined.

Credit to emerging market economies

The BIS locational banking statistics show that reporting banks' cross-border claims on borrowers in emerging market economies expanded by \$60 billion (1.7%) in the third quarter of 2013. Cross-border credit to banks increased by \$33 billion (1.8%), while claims on non-banks rose by \$27 billion (1.7%). Increases were concentrated in a few, predominantly Asian, countries whereas declines were widespread (Graph 3). These developments coincided with a period of volatility in global financial markets, after announcements in May that the Federal Reserve envisaged phasing out large-scale asset purchases led to capital outflows from several emerging market economies.

Among those countries where cross-border claims expanded in the third quarter of 2013, the largest absolute increases were seen by China (\$62 billion or 8.5%), Chinese Taipei (\$15 billion or 15%), Malaysia (\$6 billion or 9.3%), and the United Arab Emirates (\$6 billion or 6.3%). The increase vis-à-vis Malaysia was the largest in two and a half years and was driven by lending to banks (\$5 billion or 11%).

The largest absolute declines in the third quarter were experienced by India (\$13 billion or 6.3%), Turkey (\$5 billion or 2.8%) and Brazil (\$3.4 billion or 1.1%). For Turkey, this was the first substantial drop in cross-border claims in about two years. Claims on Thailand fell by \$2 billion (2.8%), which marked a turnaround in the previous upward trend. Nevertheless, the decline was small compared with the \$13 billion cumulative increase in cross-border bank financing to the country in the first half of 2013.

In central and eastern Europe, cross-border claims again contracted (Graph 3, bottom left-hand panel). Increases in claims on Poland and the Czech Republic were more than offset by large declines vis-à-vis Hungary, Romania, Croatia and Latvia.

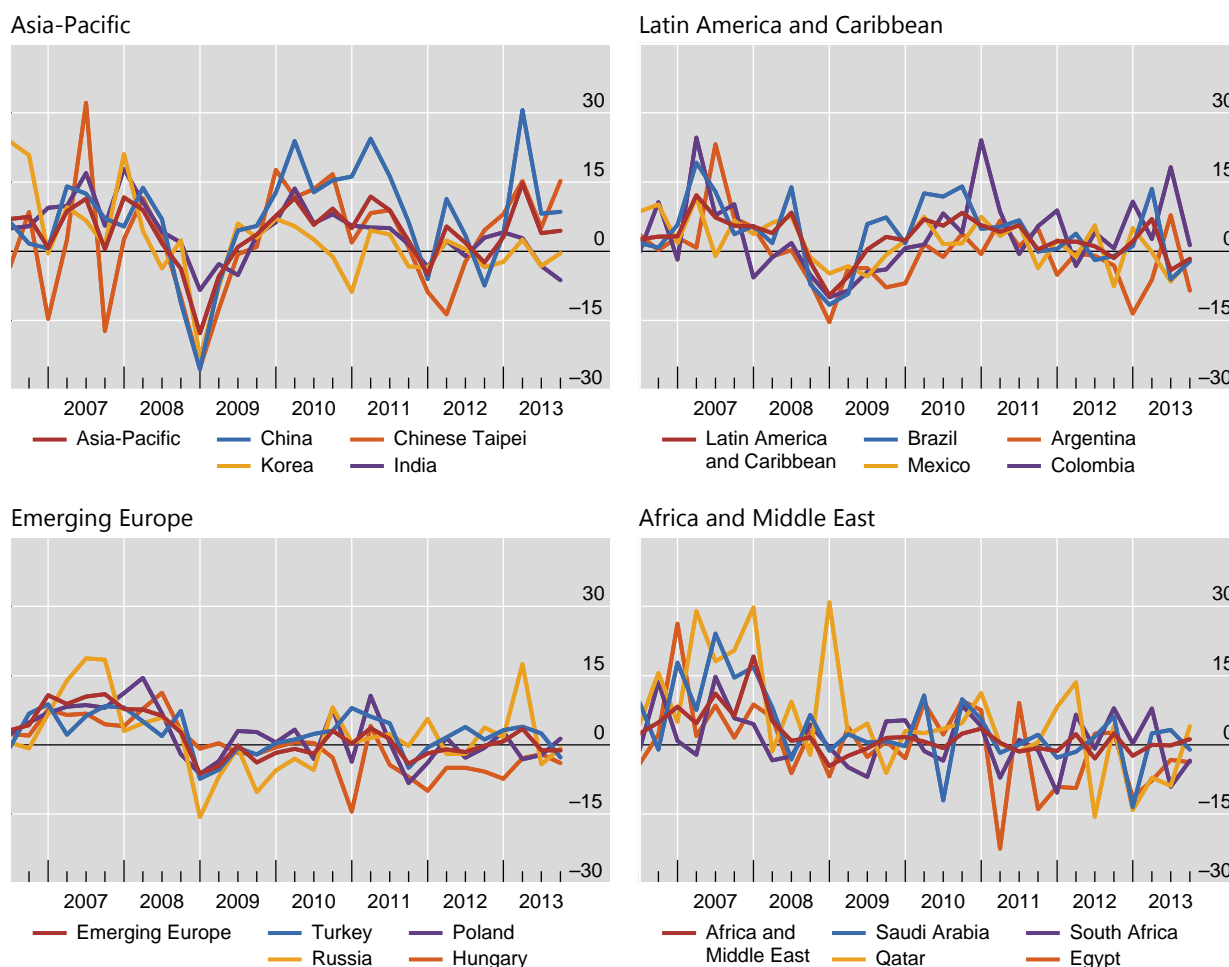
Turning to the nationality of creditor banks, US banks recorded the largest reductions in claims on emerging markets in the third quarter of 2013. European banks collectively maintained their lending to these countries. Smaller banking systems that have historically had a limited international presence continued to grant more credit. The share of foreign claims on emerging market borrowers accounted for by these smaller banking systems – specifically, all other BIS reporting

⁴ See R McCauley and P McGuire, "Non-US banks' claims on the Federal Reserve", this issue.

Growth of cross-border claims on residents of emerging markets, by region¹

In per cent

Graph 3



¹ Quarter-on-quarter changes in BIS reporting banks' cross-border claims (including inter-office claims) in all currencies.

Source: BIS locational banking statistics by residence.

banks except US, European and Japanese banks – rose from 12% at end-2012 to 13% at end-September 2013. Asian banks in particular continued to expand their international presence in the emerging Asia region.⁵

⁵ See also P McGuire and A van Rixtel, "Shifting credit patterns in emerging Asia", *BIS Quarterly Review*, December 2012.

Cross-border investments in global debt markets since the crisis

Branimir Gručić and Andreas Schrimpf

Global debt markets have grown to an estimated \$100 trillion (in amounts outstanding) in mid-2013 (Graph C, left-hand panel), up from \$70 trillion in mid-2007.¹ Growth has been uneven across the main market segments. Active issuance by governments and non-financial corporations has lifted the share of domestically issued bonds, whereas more restrained activity by financial institutions has held back international issuance (Graph C, left-hand panel).

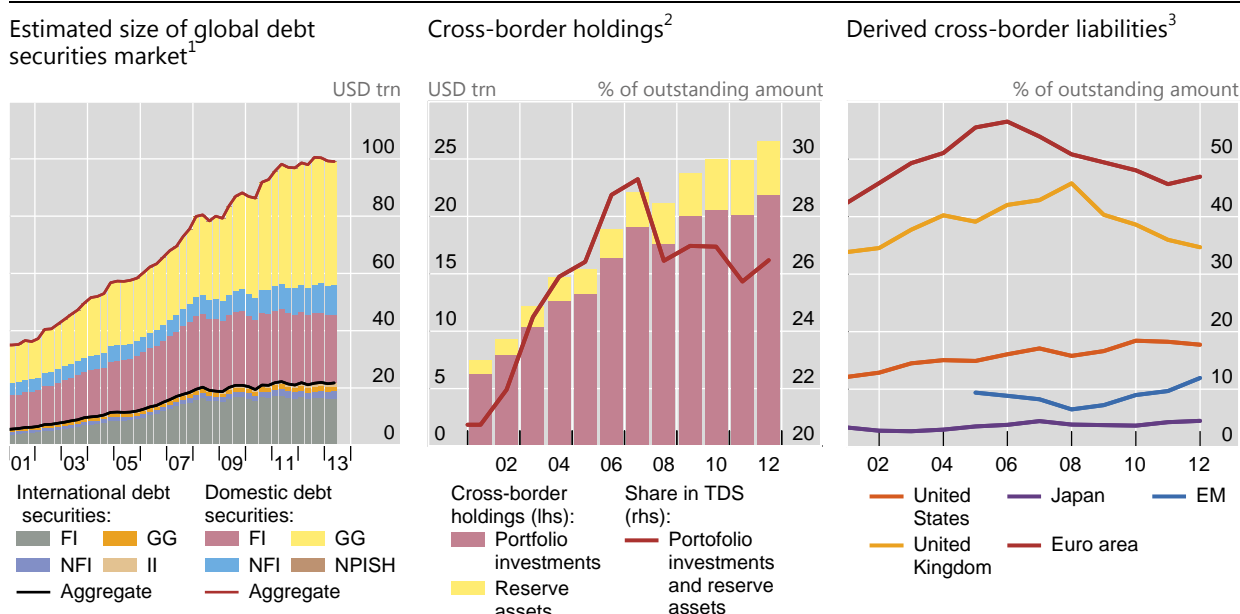
Not surprisingly, given the significant expansion in government spending in recent years, governments (including central, state and local governments) have been the largest debt issuers (Graph C, left-hand panel). They mostly issue debt in domestic markets, where amounts outstanding reached \$43 trillion in June 2013, about 80% higher than in mid-2007 (as indicated by the yellow area in Graph C, left-hand panel). Debt issuance by non-financial corporates has grown at a similar rate (albeit from a lower base). As with governments, non-financial corporations primarily issue domestically. As a result, amounts outstanding of non-financial corporate debt in domestic markets surpassed \$10 trillion in mid-2013 (blue area in Graph C, left-hand panel). The substitution of traditional bank loans with bond financing may have played a role, as did investors' appetite for assets offering a pickup to the ultra-low yields in major sovereign bond markets.

Financial sector deleveraging in the aftermath of the financial crisis has been a primary reason for the sluggish growth of international compared to domestic debt markets. Financials (mostly banks and non-bank financial

Global debt securities market

Outstanding amounts

Graph C



FI = financial corporations; GG = general government; II = international institutions; NFI = non-financial corporations; NPISH = non-profit institutions serving households; TDS = total debt securities; EM = emerging markets (Brazil, China, Korea, Mexico, Poland, Russia, South Africa and Turkey).

¹ Quarterly, by sector of issuer. The global size of the debt securities market was estimated by combining BIS securities statistics for countries in Table 18 (total debt securities) in the Statistical Annex: Detailed tables, countries in Table 16 (domestic debt securities) not providing TDS, and countries in Table 11 (international debt securities) not providing TDS. This approach made it possible to maximise the contribution of individual country aggregates from the various BIS securities statistics datasets to the global aggregate. ² Results of the IMF Coordinated Portfolio Investment Survey (CPIS). Cross-border holdings are investments by residents of one economy in securities issued by residents of another economy; these incorporate reserve assets and portfolio investments (as defined in *Balance of Payments Manual*, 6th edition). ³ CPIS liabilities derived from other countries' reported cross-border holdings.

Sources: IMF; Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; BIS.

corporations) have traditionally been the most significant issuers in international debt markets (grey area in Graph C, left-hand panel). That said, the amount of debt placed by financials in the international market has grown by merely 19% since mid-2007, and the outstanding amounts in domestic markets have even edged down by 5% since end-2007.

Who are the investors that have absorbed the vast amount of newly issued debt? Has the investor base been mostly domestic or have cross-border investments grown at a similar pace to global debt markets? To provide a perspective, we combine data from the BIS securities statistics with those of the IMF Coordinated Portfolio Investment Survey (CPIS).^② The results of the CPIS suggest that non-resident investors held around \$27 trillion of global debt securities, either as reserve assets or in the form of portfolio investments (Graph C, centre panel). Investments in debt securities by non-residents thus accounted for roughly one quarter of the stock of global debt securities, with domestic investors accounting for the remaining 75%.

The global financial crisis has left a dent in cross-border portfolio investments in global debt securities. The share of debt securities held by cross-border investors either as reserve assets or via portfolio investments (as a percentage of total global debt securities markets) fell from around 29% in early 2007 to 26% in late 2012. This reversed the trend in the pre-crisis period, when it had risen by 8 percentage points from 2001 to a peak in 2007. It suggests that the process of international financial integration may have gone partly into reverse since the onset of the crisis, which is consistent with other recent findings in the literature.^③ This could be temporary, though. The latest IMF-CPIS data indicate that cross-border investments in debt securities recovered slightly in the second half of 2012, the most recent period for which data are available.

The contraction in the share of cross-border holdings differed across countries and regions (Graph C, right-hand panel). Cross-border holdings of debt issued by euro area residents stood at 47% of total outstanding amounts in late 2012, 10 percentage points lower than at the peak in 2006. A similar trend can be observed for the United Kingdom. This suggests that the majority of new debt issued by euro area and UK residents has been absorbed by domestic investors. Newly issued US debt securities, by contrast, were increasingly held by cross-border investors (Graph C, right-hand panel). The same is true for debt securities issued by borrowers from emerging market economies. The share of emerging market debt securities held by cross-border investors picked up to 12% in 2012, roughly twice as high as in 2008.

① The global size of debt securities market is estimated based on three sets of BIS securities statistics: TDS (total debt securities), DDS (domestic debt securities) and IDS (international debt securities). The BIS classifies a debt security as international (IDS) if any one of the following characteristics is different from the country of residence of the issuer: country where the security is registered, law governing the issue, or market where the issue is listed. All other securities are classified as domestic (DDS). From a methodological point of view, the union of the two (IDS and DDS) makes up total debt securities (TDS). See B Gruić and P Wooldridge, “Enhancements to the BIS debt securities statistics”, *BIS Quarterly Review*, December 2012, pp 63–76. ② Data on cross-border investments in debt securities are sourced from the CPIS, which is conducted by the IMF as an annual voluntary portfolio investment data collection. The IMF data also incorporate information from the Securities Held as Foreign Exchange Reserves and Securities Held by International Organizations surveys (total \$4.8 trillion at end-2012.) For additional information about the CPIS, see <http://cpis.imf.org>. ③ See eg P Lane and G M Milesi-Ferretti, “International financial integration”, *IMF Staff Papers*, vol 50, for measures of international financial integration via international balance sheets (not just focusing on global debt securities as in this box). Recent evidence on the contraction of international balance sheets since the crisis is provided eg by G Ma and R N McCauley, “Global and euro imbalances: China and Germany”, *BIS Working Papers*, no 424.

Financial structure and growth¹

Up to a point, banks and markets both foster economic growth. Beyond that limit, expanded bank lending or market-based financing no longer adds to real growth. But when it comes to moderating business cycle fluctuations, banks and markets differ considerably in their effects. In normal downturns, healthy banks help to cushion the shock but, when recessions have coincided with financial crises, we find that the impact on GDP has been three times as severe for bank-oriented economies as it has for market-oriented ones.

JEL classification: G10, G21, O16, O40.

Banks and markets channel savings into investment in quite different ways. Banks perform intermediation mostly on their balance sheets. They take in savings typically as deposits and provide funding primarily in the form of loans, often through close relationships with borrowers. Markets, by contrast, keep savers and investors at arm's length, by serving as a forum where debt and equity securities are issued and traded. Banks can overcome problems arising from asymmetric information and contract enforcement using the knowledge they accumulate through relationships; markets do so by means of contract covenants and the courts.

All financial systems combine bank-based and market-based intermediation. But financial structure – the particular blend of the two intermediation channels – varies across countries. In this article, we discuss some of the determinants of financial structure, and how that structure might affect economic growth.

The latter question is much debated. Some studies find that *both* financial intermediaries and markets are important for economic growth (Boyd and Smith (1998), Levine and Zervos (1998)). Others conclude that financial structure per se does not matter: it is the overall provision of financial services (banks and financial markets taken together) that is important for growth (Demirgüç-Kunt and Levine (1996), Levine (2002)). Another possibility is that the relationship is more complex and that the answer varies depending on a country's level of economic and financial development (Demirgüç-Kunt et al (2011)).

¹ The authors would like to thank Claudio Borio, Stephen Cecchetti, Dietrich Domanski, Enisse Kharroubi and Christian Upper for useful comments and suggestions. Magdalena Erdem and Anamaria Illes provided excellent research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

We focus on three issues. The first relates to the relationship between a country's characteristics and its financial structure. We find that financial structure evolves alongside the changing profile of the economy. The second is the link between financial structure and economic growth. We find that banks and markets foster economic growth in a complementary way, but also that there comes a point of negative returns: beyond it, additional banking intermediation or larger markets go hand in hand with lower growth. The third issue relates to the role banks and markets play in moderating business cycle fluctuations. We find that the shock-absorbing function of bank-oriented systems is inhibited when the downturn coincides with a financial crisis.

The rest of the article consists of four sections. The first presents the facts and discusses the mix between bank- and market-based intermediation across a range of countries. The second explores the varying linkage between financial structure and economic growth. The third empirically tests the roles banks and markets play in moderating business cycle fluctuations. The concluding section summarises the main results.

Financial structure: cross-country differences and determinants

There is no direct measure of the intermediation services that banks and markets provide that allows straightforward comparisons across countries. As a result, empirical analysis of this topic relies on indicators that approximate different aspects of the two intermediation channels (Beck et al (2000), Levine (2004)). Even then, data availability and comparability over time and across countries are an issue. In this article, we rely on the World Bank's *Global Financial Development Database*.²

Graph 1 shows the financial structure of 41 countries over two periods: the 1990s and the 2000s. It plots the ratio of bank credit to the sum of bank credit plus total equity and bond market capitalisation as a proxy for the relative importance of banks and markets. The higher this ratio, the more a given financial system relies on banks and, consequently, the less it does on markets.

Two broad patterns stand out. First, financial structure differs considerably between countries. The relative importance of banking ranges from less than 20% in the United States to over 60% in Austria, Hungary and New Zealand. Second, financial structure is not static. Market-based intermediation has gained ground over the past two decades. To see this, note that roughly three quarters of the blue diamonds, which represent the ratio for the 1990s, lie above the bars, which represent the ratio for the 2000s. A closer look shows that the bulk of this shift reflects changes in emerging market economies.

Financial structure and country characteristics

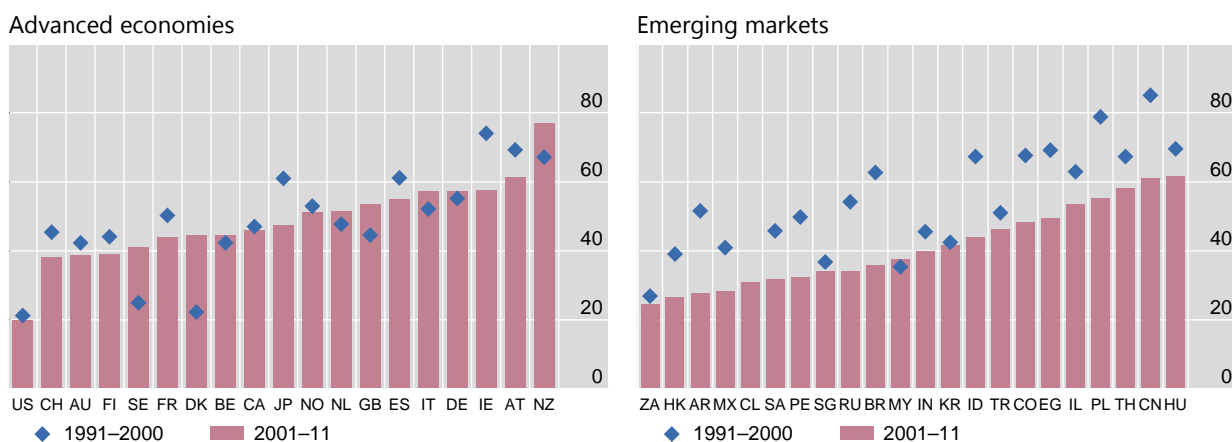
What drives cross-country variability in financial structure? What is the influence of real sector characteristics, such as the level of economic development or the sectoral composition of economic activity? And what is the role of institutional

² More information is available at <http://data.worldbank.org>.

Ratio of bank credit to total private sector funding

In per cent

Graph 1



AR = Argentina; AT = Austria; AU = Australia; BE = Belgium; BR = Brazil; CA = Canada; CH = Switzerland; CL = Chile; CN = China; CO = Colombia; DE = Germany; DK = Denmark; EG = Egypt; ES = Spain; FI = Finland; FR = France; GB = United Kingdom; HK = Hong Kong SAR; HU = Hungary; ID = Indonesia; IE = Ireland; IL = Israel; IN = India; IT = Italy; JP = Japan; KR = Korea; MX = Mexico; MY = Malaysia; NL = Netherlands; NO = Norway; NZ = New Zealand; PE = Peru; PL = Poland; RU = Russia; SA = Saudi Arabia; SE = Sweden; SG = Singapore; TH = Thailand; TR = Turkey; US = United States; ZA = South Africa.

The ratio of bank credit to the private sector is expressed as a percentage of the sum of bank credit plus bond and equity market capitalisation. A higher value of the indicator suggests a financial structure that is more bank-oriented. For four countries (Egypt, Israel, New Zealand and Saudi Arabia) data for outstanding bonds issued by the private sector are not available. However, the bond markets in these countries are modest in size and the ordering of the countries in the graphs does not change even in the light of proxies obtained from other sources. A blue diamond above (below) the bar indicates that a particular system became more (less) market-oriented during the 2000s than it was during the 1990s.

Sources: Beck et al (2000); World Bank, *Global Financial Development Database*; BIS; authors' calculations.

factors such as the legal framework? We discuss these issues by drawing on the literature and on cross-country sectoral information.

Generally, market-based financial intermediation tends to increase as per capita GDP rises.³ Several economic factors may explain this. One is that the financial literacy of households and firms improves with economic development, lifting demand for services linked to market-traded securities (Allen and Gale (2000), Boyd and Smith (1998)). For instance, insurance companies, pension funds and mutual funds account for a larger share of GDP in richer countries. Another factor may be that more highly developed countries have stronger institutions. In particular, market-based finance benefits from better enforcement of property rights through a stronger legal and judicial framework (see discussion below).

But differences in financial structure also reflect the sectoral composition of output. Some productive sectors are more likely to rely on bank loans as a source of external funds. By their nature, different lines of business are more suited to different types of intermediation. Sectors with tangible and transferable capital (such as agriculture), as well as those where output is easier to pledge as collateral (such as construction), are more amenable to bank debt finance. By contrast, sectors that rely heavily on human capital (eg professional services), or those where output is hard to collateralise, will tend to rely more on equity or bonds. Empirical analysis

³ See Levine and Zervos (1998) and Demirgüç-Kunt and Levine (2001).

based on a cross section of EU countries confirms this overall pattern (see box for details).

Firm size also has a bearing on the funding mix. Small firms typically depend on bank finance because of the fixed costs involved in tapping capital markets, not least those associated with the corresponding governance mechanisms. Graph 2 shows the negative correlation between bank dependence and firm size at the sectoral level. In particular, the graph plots on the horizontal axis an index of the economy's dependence on bank funding (the logarithm of bank loans over total firm liabilities) and on the vertical axis the average size of firms (measured by the logarithm of the total assets of the average firm in each sector). The downward slope means that sectors dominated by smaller firms are more bank-dependent.

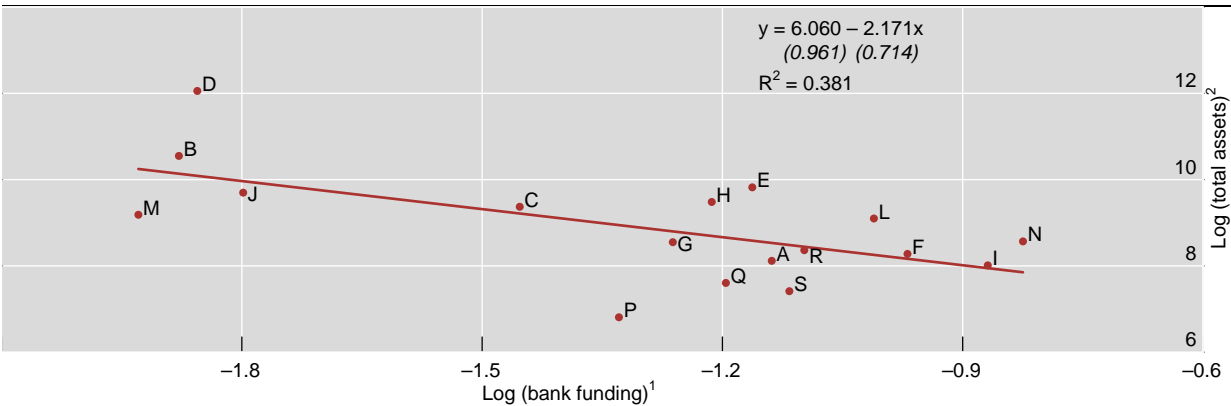
Turning to countries' institutional characteristics, as noted, financial contracts depend critically on the legal framework and the enforcement of contracts and property rights. Investors are more likely to part with their money if they feel sure of being able to claim it back.

Research on the interactions between law and finance has highlighted a number of regularities.⁴ First, legal frameworks originating in the common law tradition tend to offer higher protection to holders of equity and debt securities. Minority shareholders have more tools, such as the exercise of their voting rights, to protect their interests from actions by management or large shareholders.

For their part, creditors find it easier to avoid an automatic stay on assets and enjoy greater priority when their claims are secured and they face managements that have less freedom to seek court protection. As a result, common law systems foster the development of market-based finance, which depends on the efficiency of arm's length relationships between issuers of securities and investors. By contrast,

Bank funding dependence and average firm size for different sectors

Graph 2



A = agriculture, forestry and fishing; B = mining and quarrying; C = manufacturing; D = electricity, gas, steam and air-conditioning supply; E = water supply, sewerage, waste management and remediation activities; F = construction; G = wholesale and retail trade, and repair of motor vehicles and motorcycles; H = transporting and storage; I = accommodation and food service activities; J = information and communication; L = real estate activities; M = professional, scientific and technical activities; N = administrative and support service activities; P = education; Q = human health and social work activities; R = arts, entertainment and recreation; S = other service activities.

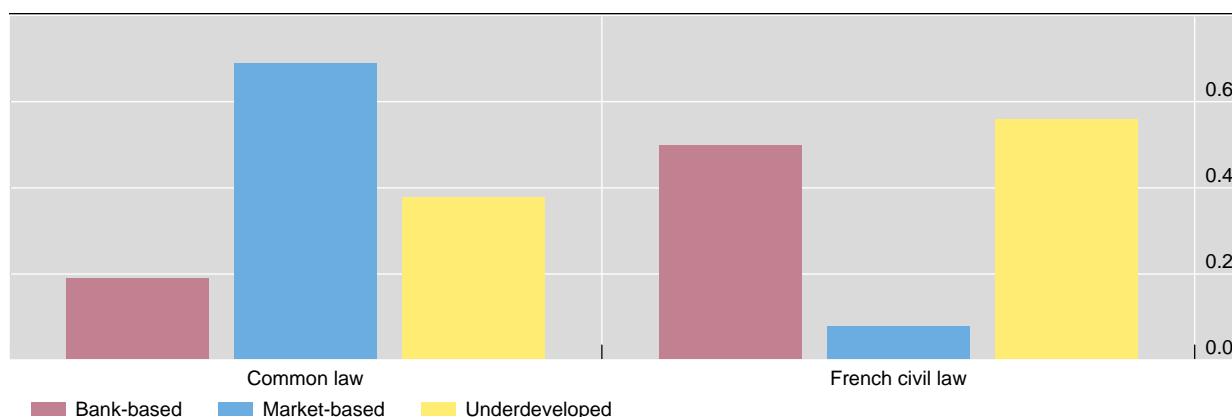
¹ The horizontal axis plots the average sectoral level of the logarithm of the bank funding ratio defined as bank loans over total liabilities (see box for further details). ² The vertical axis plots the average firm size in each sector (measured by the logarithm of total assets).

Sources: Bank of France, BACH (Bank for the Accounts of Companies Harmonised) database; authors' calculations.

⁴ See La Porta et al (1998), Giannetti (2003), Bancel and Mittoo (2004), De Jong et al (2008) and Fan et al (2010).

Determinants of financial structure: legal origin¹

Graph 3



¹ The figures are computed using the information in Table 3.13 in Demirgüç-Kunt and Levine (2001). The height of each bar represents the share of countries within each category (underdeveloped, bank-based and market-based financial system) that corresponds to countries with the specific legal origin. Financial structure in each country is classified as underdeveloped when it scores below the cross-country median in terms of both bank and market development indicators. Countries are classified as bank-based or market-based if they are, respectively, below or above the mean value of a financial market structure indicator. The latter is constructed as a simple average of three ratios: capitalisation/bank assets, trading/bank credit, and trading/overhead cost. Higher values of the financial market structure index mean a higher degree of stock market development relative to the development of the banking system. Countries are divided into three groups depending on the origins of their legal system: common law, French civil law and other civil law (not shown).

Source: Demirgüç-Kunt and Levine (2001).

banks, through their repeated interaction with clients and through their closer screening and monitoring of borrowers, can compensate for the more limited protection offered by French civil law frameworks. Legal systems in German and Scandinavian law tradition fall between common law and French civil law traditions in terms of the protection they offer to arm's length investors (La Porta et al (1998)).

Empirically, there is a strong association between the origin of a country's legal framework and the composition of its business financing. Firms in common law countries tend to rely more on traded equity and have a more diffuse shareholder base than firms in countries that follow the French civil law tradition (magenta and blue bars in Graph 3). In addition, there is a correlation between the origin of the legal system in the country and the financial system's overall degree of development. As shown by the yellow bars in Graph 3, common law countries tend to have more developed financial systems than countries with legal systems based on French civil law.

Banks, markets and economic growth

What is the relationship between financial structure and economic growth? The literature suggests that both bank- and market-based intermediation are positively linked with output growth. But Demirgüç-Kunt et al (2011) make the more nuanced observation that, as economies grow, economic output tends to become less sensitive to changes in bank development but more so to changes in financial market development. This suggests that the services provided by financial markets become comparatively more important as countries grow. In a similar vein, Cecchetti and Kharroubi (2012) examine how the size of the financial system affects

Is there a link between the sectoral composition of an economy and its financial structure?

This box investigates the link between an economy's financial structure (the relative importance of bank and market finance) and its sectoral composition. We construct an index of the importance of bank funding relative to other forms of financing (equity and bonds) using information from the BACH database on the funding of non-financial firms. This database covers 17 sectors in nine European countries. The index is defined as:

$$BF_{j,k} = \frac{\text{bank loans}}{\text{total liabilities}}$$

where $j=1, \dots, 17$ indicates the sector and $k=1, \dots, 9$ stands for the country. Both the numerator and denominator are averages over the period 2000–11, weighing yearly figures by sectoral gross value added. Unfortunately, it is not possible to disentangle control stakes from other equity financing raised on the market. As a result, the denominator includes total equity, together with bonds and bank loans, but excludes trade credit and provisions. Graph A shows the average bank funding ratio for three different groups of countries: (i) core euro area countries (BE, FR, GE, NL); (ii) peripheral euro area countries (IT, PT, SP); and (iii) eastern European countries (CZ, PL).

Regression analysis can help identify how far specific sectors tend to depend more on bank loans than others do. A simple model for the bank funding index is specified as:

$$BF_{j,k} = \alpha\theta_j + \beta\rho_k + \varepsilon_{j,k} \quad (1)$$

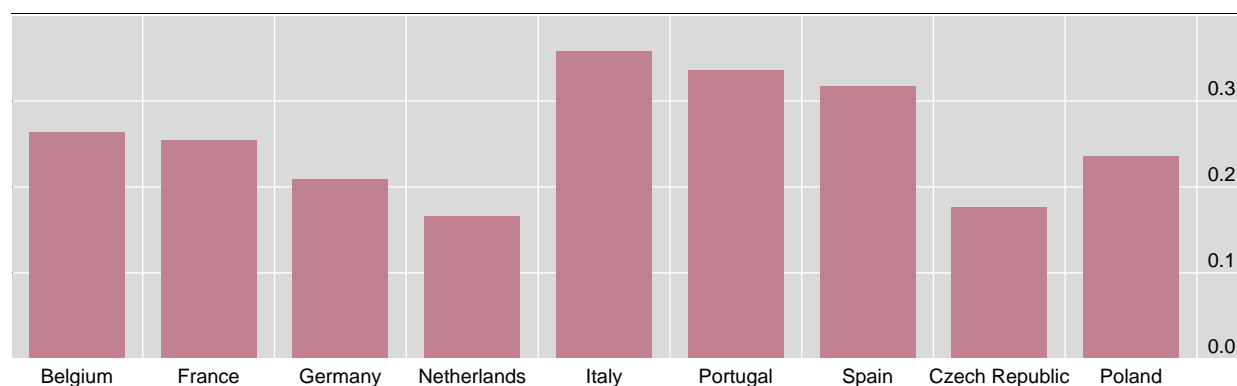
where j = sector, k = country, θ_j is a set of sectoral dummies (sector A = agriculture; forestry and fishing are excluded) and ρ_k is a set of country dummies (Poland is the omitted country).

Table A reports the regression results. The simple model explains more than half the overall sample variability in the bank funding index (R-squared of 55% shown in the last row of the table, column I). Moreover, sectoral dummies explain a larger share of overall variability (R-squared equal to 41%, column III) than the country dummies do (R-squared equal to 14%, column II). Finally, once differences in sectoral composition are taken into account, there are no significant differences in the results across groups of countries within the sample. Statistical tests reject the hypothesis that the coefficients are different for core and peripheral countries in Europe or across euro area countries (p-values greater than 5%). The coefficients on the sectoral dummies provide additional interesting results. Innovative sectors, such as "Professional, scientific and technical activities" (sector M) and "Information and communication" (sector J), rely less on bank funding, while sectors where firms are typically smaller, such as "Accommodation and food service activities" (sector I) and "Administrative and support service activities" (sector N), rely on it more.

Bank funding ratio¹

In per cent

Graph A



¹ Ratio between "amounts owed to credit institutions" and total liabilities; based on the items available in the balance sheets of BACH database. Weighted (by gross value added) average of sectorial bank funding.

Sources: Bank of France, BACH database; authors' calculations.

Reliance on bank funding: sectors vs countries

Table A

| Explanatory dummies ¹ | Dependent variable: bank funding index | | | | | |
|--|--|----------------|-------------|----------------|-------------|----------------|
| | (I) | | (II) | | (III) | |
| | Coefficient | Standard error | Coefficient | Standard error | Coefficient | Standard error |
| Mining and quarrying | −0.1676*** | (0.0515) | | | −0.1676*** | (0.0553) |
| Manufacturing | −0.0865* | (0.0454) | | | −0.0865 | (0.0529) |
| Electricity, gas, steam and air-conditioning supply | −0.1640*** | (0.0421) | | | −0.1640*** | (0.0514) |
| Water supply, sewerage, waste management and remediation activities | −0.0077 | (0.0635) | | | −0.0077 | (0.0718) |
| Construction | 0.0592 | (0.0504) | | | 0.0592 | (0.0650) |
| Wholesale and retail trade, and repair of motor vehicles and motorcycles | −0.0372 | (0.0498) | | | −0.0372 | (0.0575) |
| Transporting and storage | −0.0231 | (0.0566) | | | −0.0231 | (0.0679) |
| Accommodation and food service activities | 0.0991* | (0.0529) | | | 0.0991* | (0.0532) |
| Information and communication | −0.1548*** | (0.0508) | | | −0.1548*** | (0.0564) |
| Real estate activities | 0.0436 | (0.0714) | | | 0.0436 | (0.0769) |
| Professional, scientific and technical activities | −0.1669*** | (0.0453) | | | −0.1751*** | (0.0490) |
| Administrative and support service activities | 0.1180** | (0.0549) | | | 0.1180* | (0.0606) |
| Education | −0.0475 | (0.0477) | | | −0.0557 | (0.0603) |
| Human health and social work activities | −0.0096 | (0.0517) | | | −0.0178 | (0.0575) |
| Arts, entertainment and recreation | 0.0133 | (0.0486) | | | 0.0133 | (0.0560) |
| Other service activities | 0.0071 | (0.0442) | | | 0.0071 | (0.0556) |
| Germany | 0.0689* | (0.0358) | 0.0689 | (0.0488) | | |
| France | 0.0520* | (0.0280) | 0.0520 | (0.0402) | | |
| Belgium | 0.0596** | (0.0294) | 0.0596 | (0.0382) | | |
| Netherlands | 0.0255 | (0.0440) | 0.0255 | (0.0462) | | |
| Italy | 0.1208*** | (0.0323) | 0.1301*** | (0.0413) | | |
| Portugal | 0.1166*** | (0.0347) | 0.1166** | (0.0474) | | |
| Spain | 0.0957*** | (0.0258) | 0.0957*** | (0.0339) | | |
| Czech Republic | −0.0431 | (0.0355) | −0.0431 | (0.0437) | | |
| Constant | 0.2650*** | (0.0470) | 0.2340*** | (0.0274) | 0.3200*** | (0.0469) |
| Test 1: Are core euro area countries equal? ² | 0.8142 | | 0.8580 | | . | |
| Test 2: Are peripheral euro area countries equal? ² | 0.5621 | | 0.6253 | | . | |
| Test 3: Are all euro area countries equal? ² | 0.0621 | | 0.2555 | | . | |
| Test 4: Are eastern European countries equal? ² | 0.2269 | | 0.3252 | | . | |
| Observations | 150 | | 150 | | 150 | |
| R-squared | 0.5495 | | 0.1418 | | 0.4148 | |

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. ¹ Dummies for the agricultural sector and for Poland are not included. Core euro area countries are Belgium, France, Germany and the Netherlands. Peripheral euro area countries are Italy, Portugal and Spain. Eastern European countries are the Czech Republic and Poland. ² P-values reported.

Source: Authors' calculations.

productivity growth. They conclude that, at low levels, a larger financial system goes hand in hand with higher productivity growth. But there comes a point where larger financial activity is associated with lower growth. Law and Singh (2014) find a similar effect in the relationship between GDP growth and the size of the financial sector.

We revisit these issues using a panel of 41 advanced and emerging market economies during the period 1989–2011. We augment the statistical model of Beck and Levine (2004), which estimates the effect of stock market and banking sector development on economic growth, by allowing for this impact to change with the level of financial deepening.

Our benchmark statistical model follows Beck and Levine (2004, Table 4):

$$\Delta y_{i,t} = \alpha \Delta y_{i,t-1} + \delta B_{i,t} + \gamma M_{i,t} + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \quad (1)$$

where $\Delta y_{i,t}$ is real per capita GDP growth, $X_{i,t}$ represents a set of control variables i and t represents country and time period, respectively. The key variables are the two indicators of financial structure: $B_{i,t}$, defined as the logarithm of the ratio of bank credit to GDP; and $M_{i,t}$, which indicates the logarithm of the turnover ratio, ie the ratio of the value of total shares traded to average market capitalisation.⁵ The regression includes annual dummies to account for time-specific effects.⁶

The results reported in the first column of Table 1 show that only the development of the equity market has both a statistically significant and positive association with economic growth. In contrast to other findings in the literature, a higher ratio of bank credit to GDP does not go hand in hand with higher economic growth. This difference might reflect the fact that these findings are based on earlier data samples or on a somewhat different set of countries that includes a lower proportion of advanced economies.

We next modify the equation by allowing non-linear (quadratic) terms for both bank credit and the turnover ratio. In particular, we have:

$$\Delta y_{i,t} = \alpha \Delta y_{i,t-1} + \delta B_{i,t} + \gamma M_{i,t} + \delta^* B_{i,t}^2 + \gamma^* M_{i,t}^2 + \beta' X_{i,t} + \eta_i + \varepsilon_{i,t} \quad (2)$$

⁵ Using the stock market turnover ratio as a measure of financial market development has some advantages compared with alternatives such as the ratio of market capitalisation to GDP. The turnover ratio is not affected by asset price valuations, as both the numerator and the denominator refer to the market value of stocks (Beck and Levine (2004)), and it is common in the literature, facilitating the comparison of our results with those of other studies. However, the turnover ratio has some potential shortcomings. First, as an equity market indicator, it is distorted by the trading of foreign securities in the country and the trading of domestic securities abroad. And second, it does not reflect bond market development. To address these shortcomings, we conducted a robustness check using, as a measure of market development, the sum of stock and bond market capitalisation as a share of GDP. This measure is available for fewer countries (37 instead of 41) and years (mainly for the last decade), which reduces the number of observations from 812 to 656. The results are qualitatively very similar (available upon request).

⁶ As in Beck and Levine (2004), we used the dynamic Generalised Method of Moments (GMM) panel methodology to obtain consistent and unbiased estimates of the relationship between the financial structure and economic growth. The methodology reduces the endogeneity bias that may affect parameter estimates and accounts for unobservable factors affecting individual countries by relying on instrumental variables. Blundell and Bond (1998) argue that first differences of exogenous variables can be instrumented by themselves, while first differences of endogenous variables are instrumented by the lagged values of the variable in levels. The countries included in the regression are listed in Graph 1.

GDP growth and financial structure

Table 1

| Regressors | Beck and Levine (2004) | Non-linear model | Low-income countries | High-income countries | Test differences of effects between groups of countries H ₀ : (III)–(IV) ≠ 0 |
|---|---------------------------|------------------------|-------------------------|--------------------------|---|
| | (I) | (II) | (III) | (IV) | |
| Lagged dependent variable | 0.3726*** (0.0579) | 0.3402*** (0.0582) | 0.3194*** (0.0588) | 0.2691*** (0.0685) | 0.050 (0.090) |
| Logarithm of initial income per capita | –0.0114*** (0.0023) | –0.0117*** (0.0026) | –0.0173*** (0.0029) | –0.0107*** (0.0033) | –0.007 (0.004) |
| Bank credit | –0.0013 (0.0016) | 0.0331** (0.0162) | 0.0405** (0.0198) | 0.0012 (0.0014) | 0.039** (0.020) |
| Bank credit squared | | –0.0046** (0.0021) | –0.0061** (0.0029) | –0.0014 (0.0017) | –0.005 (0.003) |
| Turnover ratio | 0.0040*** (0.0014) | 0.0245** (0.0102) | 0.0242*** (0.0083) | 0.0173* (0.0093) | 0.007 (0.012) |
| Turnover ratio squared | | –0.0027** (0.0014) | –0.0026** (0.0011) | –0.0018 (0.0011) | –0.001 (0.002) |
| Average years of schooling (in logs) | 0.0231*** (0.0050) | 0.0248*** (0.0054) | 0.0386*** (0.0084) | –0.0015 (0.0100) | 0.040*** (0.013) |
| Government consumption (in logs) | –0.0067* (0.0036) | –0.0094* (0.0048) | –0.0040 (0.0054) | –0.0139*** (0.0036) | 0.010 (0.006) |
| Inflation rate ¹ | 0.0001 (0.0001) | –0.0000 (0.0001) | 0.0000 (0.0003) | –0.0146** (0.0068) | 0.015** (0.007) |
| Year dummies | yes | yes | yes | yes | |
| Observations | 812 | 812 | 415 | 397 | |
| Number of countries ² | 41 | 41 | 21 | 20 | |
| Serial correlation test ³ | 0.512 | 0.520 | 0.144 | 0.156 | |
| Hansen Test ⁴ | 0.253 | 0.229 | 0.232 | 0.018 | |

The dependent variable is the growth rate of real GDP per capita. The variable “bank credit” is given by the logarithm of the ratio between bank credit and GDP. The “turnover ratio” is given by the value of the total shares traded to average market capitalisation. Advanced (emerging) economies are those above (below) the median of the GDP per capita distribution. Robust standard errors in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% level in the first-stage regression, respectively.

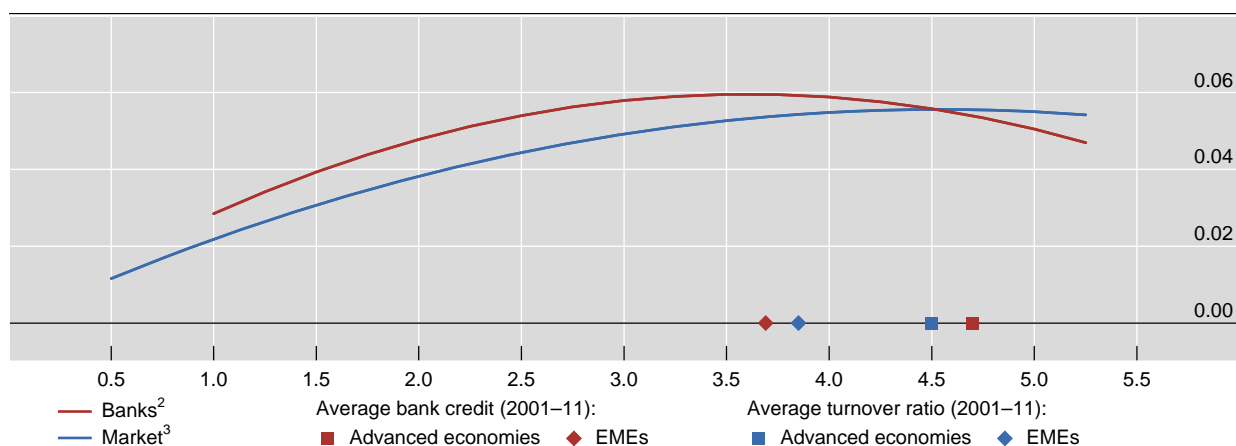
¹ In the regression, this variable is included as $\log(1+\text{variable})$. ² The list of countries is reported in Graph 1. ³ Reports p-values for the null hypothesis that the errors in the first-difference regression exhibit no second-order serial correlation. ⁴ Reports p-values for the null hypothesis that the instruments used are not correlated with the residuals.

Source: Authors’ calculations.

The results of the non-linear specification in the second column of Table 1 indicate that increases in both bank and market activity are associated with higher growth, but only up to a certain point. Both indicators are statistically significant, suggesting that banks and financial markets provide different services and are complementary. The limits of financial deepening on growth are more clearly depicted in Graph 4. The horizontal axis indicates both (the logarithm of) the credit/GDP and the turnover variable, while the vertical axis measures per capita GDP growth. Growth benefits from a higher ratio of bank credit to GDP until the logarithm of the ratio reaches 3.7, or a credit/GDP ratio of around 40%. The corresponding peak for the logarithm of turnover ratio is 4.5, equivalent to a ratio of around 95%.

Link between real GDP growth per capita and financial indicators¹

Graph 4



¹ The non-linear effect is calculated from the regression in column II of Table 1. The country sample contains the same list of advanced economies and emerging market economies (EMEs) reported in Graph 1. ² Bank credit is given by the logarithm of the ratio between bank credit and GDP. ³ The market indicator is given by the logarithm of the turnover ratio. The latter is calculated by dividing the value of the trades of shares on domestic exchanges by the total value of listed shares.

Source: Authors' calculations.

We also report on the horizontal axis the average values of the two ratios (bank credit and turnover) over the period 2001–11 for the advanced and emerging market economies in our data. Emerging market economies have, as a group, an average ratio of bank credit to GDP that is approximately equal to the value that corresponds to the peak of the relationship with growth (3.7), but an average turnover ratio (3.9) that is below the peak of the relationship of equity market deepening and growth. Taken at face value, these estimates suggest that in EMEs further market deepening would boost GDP growth while any gains from further development of the banking sector would be limited. Both indicators (at 4.7 and 4.5) are in the declining part of the respective curves in the case of advanced economies, suggesting that they have reached the point of negative returns to greater financial deepening.⁷

These results are in line with the findings of Rousseau and Wachtel (2008): the finance-growth relationship so firmly entrenched in the literature is less strong in more recent data. Using information for the period 1960–2004, they find that excessive financial deepening or rapid growth of credit may have led to both inflation and weaker banking systems, which in turn gave rise to growth-inhibiting financial crises.

The positive effect of financial deepening on growth is stronger for low-income than for high-income countries. The third and fourth columns of Table 1 split the sample on the basis of whether a country's per capita GDP is above or below the median for the sample. While the results for the lower-income countries are similar to those for the entire sample, only the coefficient on market turnover turns out to

⁷ The results are consistent with the general finding of Cecchetti and Kharroubi (2012). They also relate to the findings in Peia and Roszbach (2014), who study the cointegration and causality between finance and growth for 26 countries. In particular, they show that causality patterns depend on whether countries' financial development stems from the stock market or the banking sector. Their main result is that stock market development tends to cause growth, while a reverse or bidirectional causality is present between banking sector development and output growth.

be statistically significant for the group of richer countries, and even then its significance is weakened. Similarly, the tests for the statistical significance of the coefficients between the two country groups (last column) indicate that there is a significant difference in the two sets of estimated coefficients relating to the contribution of banks to growth.

These results confirm and corroborate the finding that banks provide intermediation services that differ from those provided by financial markets and which are particularly beneficial for countries at an earlier stage of development (Allen and Gale (2000), Demirgüç-Kunt et al (2011)). Banks are particularly useful to lower-income countries because they provide inexpensive risk management for standardised risks and can compensate for weaker institutions. As countries evolve and their financial needs become more elaborate, markets are better able to provide products tailored to specific users. Thus, as economies mature, increasing the demand for a broader set of risk management and capital-raising tools, they can benefit from a legal and regulatory environment that supports market-based activities.

Financial structure and output volatility

Banks and markets also behave differently when it comes to moderating business cycle fluctuations. In “normal” downturns, relationship banks, especially well capitalised ones, find it easier to keep lending than markets do (Bolton et al (2013)). Drawing on their long-term relationships with clients, banks are more inclined to offer credit during a downturn. By contrast, transaction lenders, who do not invest in information about the borrower, typically pull back during a recession.

However, a financial crisis can impair banks’ shock-absorbing capacity. When banks are under strain, they are less able to help their clients through difficult times. In addition, during a financial crisis, banks may put off necessary balance sheet restructuring (Caballero et al (2008)): instead, they may opt to roll over credit in an effort to postpone loss recognition (so-called zombie lending). This is something that capital market investors cannot afford to do. In a financial crisis, therefore, systems that are more market-oriented may speed up the necessary deleveraging, thereby paving the way for a sustainable recovery (Bech et al (2012)).

The differing responses of banks and markets can affect the severity of recessions. The average cost of recessions, in terms of forgone output, is similar between groups of countries with different financial systems (bank-oriented vs market-oriented). Table 2 shows average statistics for the output cost of recessions across different developed countries. The top two rows of column III show that about 4% of GDP is lost during a typical recession. Most of this loss is incurred during the period from the beginning of the recession to its trough (column IV). When comparing the top two rows of the table, note that there is no material difference between the average experience of countries with bank-oriented financial structures and that of more market-oriented countries.

When there is no financial crisis, economies with bank-based systems appear more resilient. This is highlighted in the middle two rows of Table 2, which suggest that bank-based systems registered virtually no GDP loss on average. By contrast, in these same episodes, countries with market-based systems experienced an average

Output cost of recessions and financial structure

Table 2

| | Financial structure ¹ | Number of observations | Total real GDP loss (d)+(r) | Real GDP loss during downturn (d) | Real GDP loss during recovery (r) | Primary fiscal balance to GDP |
|-----------------------|----------------------------------|------------------------|-----------------------------|-----------------------------------|-----------------------------------|-------------------------------|
| | (I) | (II) | (III) | (IV) | (V) | (VI) |
| All downturn episodes | Bank-based | 40 | 4.33 | 3.73 | 0.60 | -2.11 |
| | Market-based | 31 | 3.73 | 3.92 | -0.19 | -1.62 |
| no financial crisis | Bank-based | 26 | -0.09 ² | 1.70 | -1.79 | -1.62 |
| | Market-based | 16 | 3.24 | 3.60 | -0.36 | -2.02 |
| with financial crisis | Bank-based | 14 | 12.54 | 7.51 | 5.03 | -2.99 |
| | Market-based | 15 | 4.24 | 4.25 | -0.01 | -1.19 |

¹ The analysis is based on the database developed in Bech et al (2012), which selects a cross section of downturns and subsequent recoveries from a sample of 24 developed countries over the 1960–2013 period. Downturns are defined as periods of one or more consecutive years with negative real GDP growth. Similarly, the subsequent recovery is defined as the period from the trough to the year when real GDP recovers to its previous peak. For our exercise, 71 downturns are detected (29 associated with a financial crisis). A country's financial structure is considered as bank-based (market-based) if its bank assets to GDP ratio is above (below) median. The GDP loss is given by the cumulative sum of differences between the peak real GDP and the real GDP realised during the downturn (or recovery) phase. This can be graphically interpreted as an area that represents the relative GDP loss that the economy suffers during the downturn (and recovery) with respect to the pre-crisis GDP. ² As GDP growth during the recovery period could be large enough to exceed the pre-crisis peak within the same year, the real GDP loss during the recovery could be negative (a gain with respect to the pre-crisis peak).

Sources: Bech et al (2012); OECD, *Economic Outlook Database*; World Bank, *Global Financial Development Database*; national data; authors' calculations.

output loss of more than 3%. A simple explanation is that, when banks are not themselves under strain, they help their clients absorb economic shocks.

The opposite is true when recessions coincide with a financial crisis. In this case, countries that rely relatively more on bank financing tend to be more severely hit (bottom two rows of the table). In fact, recessions in countries with bank-oriented systems are three times as severe (12.5% of GDP) as in those with a market-oriented financial structure (4.2% of GDP). When the banking sector is itself handicapped by the effects of a crisis, recessions tend to be more severe and countries with bank-oriented systems suffer more than others.⁸

Conclusions

The results of this paper confirm the widely accepted view that both banks and markets are very important for economic growth. In line with Allen and Gale (2000) and Demirgüç-Kunt et al (2011), we also find that banks provide services which differ from those offered by financial markets and that such services prove to be particularly beneficial for less developed countries (as proxied by real income per capita). However, we also find that there is a point after which further growth in financial activity no longer contributes to growth but may even slow it down

⁸ Using a theoretical model where firms chose both the scale and composition of their borrowing, Crouzet (2014) finds that, over the business cycle, asymmetric shocks to banks' lending costs prompt substitution from bank loans to market debt, as in the United States during the 2007–09 recession. Additionally, these shocks have larger effects if the economy is initially more bank-dependent. For example, the recession they generate is 15–30% deeper in a version of the model calibrated to Europe than in one calibrated to the United States.

Finally, our evidence suggests that banks and markets differ considerably in their moderating effects on business cycle fluctuations. Banks are more likely to supply loans during a “normal” downturn, thus smoothing the impact of the recession. But their shock-absorbing capacity is impaired when the downturn is associated with a financial crisis. In this case, recessions in countries with bank-oriented systems are three times more severe than in those with a market-oriented financial structure.

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Forward guidance at the zero lower bound¹

Four major central banks have adopted new approaches to policy rate forward guidance with the aim of enhancing the effectiveness of monetary policy at the zero lower bound. In this special feature, we examine these approaches and assess their impact. So far, the forward guidance appears to have led to lower volatility of near-term expectations of the future path of policy rates, but the effects on the level of interest rate expectations and on the responsiveness of financial markets to news are less clear. At the same time, the forward guidance raises a number of significant challenges. How they are managed will ultimately determine the enduring value of this communication tool.

JEL classification: E52, E58.

Since 2008, forward guidance has become a key element of monetary policy. The Federal Reserve, the Bank of Japan, the ECB and the Bank of England have all provided forward guidance about future policy rates in various forms, some qualitative, others quantitative, and in some cases conditional on specific economic developments, including the behaviour of real variables such as the unemployment rate.

In this article, we first review key features of these recent forward guidance practices and the communication challenges involved. We then assess the empirical evidence on their impact. We investigate the extent to which forward guidance has affected the level and volatility of interest rate expectations and the sensitivity of markets to economic news. The article then discusses potential risks, specifically those to central banks' reputations and to financial stability.

We conclude that the recent increased reliance on forward guidance has been helpful in clarifying policy intentions in highly unusual economic circumstances. However, the mixed evidence concerning the effectiveness of these practices, and the challenges they raise, caution against drawing firm conclusions about their ultimate value.

¹ The views expressed in this article are those of the authors alone and do not necessarily reflect those of the BIS. We are grateful to Claudio Borio, Dietrich Domanski, Hans Genberg, Robert McCauley and Christian Upper for useful comments and to Bilyana Bogdanova and Michela Scatigna for excellent research assistance.

Objectives and recent approaches

Forward guidance is not new. Starting in the 1990s, central banks relied on qualitative descriptions of the main thrust of their interest rate policies to inform the public, which sometimes required deciphering “code words” in official policy statements. Since the late 1990s, a number of small inflation targeting economies have adopted quantitative forward guidance by regularly publishing their own quantitative forecast of the future path of policy interest rates.²

Forward guidance at the zero lower bound was first adopted by the Bank of Japan in the context of its zero interest rate policy in 1999. The Federal Reserve also adopted forward guidance on policy rates in 2003 when it stated that policy accommodation would be maintained for a considerable period. At that time, the policy rate was low but not at the zero lower bound. In the wake of the global financial crisis, the Federal Reserve, the Bank of England, the Bank of Japan and the ECB all adopted forward guidance on policy rates, albeit at different times and in different forms.³

Objectives and conditions for effectiveness

The objective of forward guidance at the zero lower bound has been to clarify the central banks’ intended policy rate path. This can provide additional stimulus at the zero lower bound when central banks communicate that policy rates will remain lower for longer than is priced into markets. Forward guidance can also reduce uncertainty, thereby lowering interest rate volatility and through this channel possibly also risk premia.⁴

The potential usefulness of forward guidance depends on it being (i) seen as a commitment; (ii) clearly communicated; and (iii) interpreted in the way intended by the central bank.

For forward guidance to be effective, it must be seen as a *credible commitment* of the central bank, ie the public must believe that the central bank will deliver on its guidance. Only then can the guidance have an impact on the public’s expectations of the future path of policy rates.

² The central banks routinely publishing interest rate projections include the Czech Republic, Iceland, Israel, New Zealand, Norway and Sweden. For an analysis of the performance of these quantitative forward guidance approaches, see Andersson and Hofmann (2010) and Kool and Thornton (2012).

³ In this special feature, we focus on policy rate forward guidance and leave issues of balance sheet forward guidance for future research.

⁴ Forward guidance therefore influences long-term interest rates mainly via the expected path of policy rates. Asset purchase announcements, in contrast, are widely seen as affecting mainly term premia in long-term interest rates via a portfolio rebalancing channel (Bernanke (2013b)). For instance, Banerjee et al (2012) and Cahill et al (2013) present evidence suggesting that the Bank of England’s and Federal Reserve’s asset purchases have mainly worked through a portfolio balance channel. A different strand of evidence has suggested that asset purchases mainly work through a signalling channel, shifting the expected path of future policy rates (see Bauer and Rudebusch (2012) and Woodford (2012)). This would imply that forward guidance could achieve the same effect as asset purchases, but without the large-scale accumulation of assets on the central bank’s balance sheet. That said, asset purchases could be a more effective signalling tool as the central bank could be regarded as “putting its money where its mouth is”. Addressing this question is, however, beyond the scope of this article.

Some academic observers, in particular Woodford (2012), have suggested that central banks should use forward guidance to commit to a very low policy rate beyond the point in time when economic developments would normally indicate a tighter policy. In principle, this strategy would yield greater monetary stimulus. However, this approach would require the central bank to pre-commit to a policy course that it would have an incentive to eventually renege on when conditions normalise (a “time inconsistent” policy).⁵ This highlights the trade-off that central bankers face when designing forward guidance aimed at stimulating the economy at the zero lower bound, ie the trade-off between the strength of the commitment and future policy flexibility. The stronger the perceived commitment is in the eyes of the public, the bigger the likely impact on financial market expectations and economic decisions, but the greater also the risk of a retrospectively undesirable tying of the central bank’s hands or of taking actions that are at odds with the original guidance.

Forward guidance effectiveness also requires that it is *clearly communicated* to the public. In principle, clarity can be enhanced by spelling out more explicitly the conditionality of the guidance, ie by explaining what the central bank aims to achieve and how it will respond to economic developments. However, if too complex, conditionality may end up confusing the public and leading to conflicting interpretations of policy intentions, with the risk of disruptive market reactions. Central banks then face the risk of getting involved in continuous discussions with the media and other observers about nuanced wording and technical details.

Even if forward guidance is quite explicit, it may not have the desired stimulative effects if it is not *interpreted* by the public in the intended way. In general, forward guidance conveys two types of information: the central bank’s assessment of the economic outlook and the degree of policy accommodation given the outlook.⁶ Communicating the intention to keep policy rates at the zero lower bound for longer in order to increase the degree of policy accommodation may be misinterpreted rather as signalling a more pessimistic economic outlook by the central bank. In this case, negative confidence effects would counteract the intended stimulus.

The common practice of monetary policy decision-making by monetary policy committees (MPCs) complicates forward guidance in a number of ways. Differences in viewpoints amongst committee members take on greater importance when a committee must endorse a trajectory for the future policy stance, making it more difficult for committee members to find common ground. This may lead to compromises that water down the clarity and credibility of guidance. In addition, committee cacophony in external communication can further undermine the clarity and credibility of forward

⁵ Woodford (2012) argues that overcoming the time-inconsistency issue requires “advance commitment to definite criteria for future policy decisions”. One approach mentioned is history-dependent targeting regimes, such as price level or nominal GDP targeting, in order to achieve a credible commitment to keep rates low for longer than under established inflation targeting regimes. See English et al (2013) for simulations of the potential size of the gains. See Bean (2013) for arguments against this time-inconsistency issue.

⁶ The former is sometimes referred to as Delphic forward guidance (the central bank acting as an oracle, like that of Delphi) and the latter as Odyssean forward guidance (the central bank providing information about the mast it ties itself to in order to withstand the call of the sirens, like Odysseus). This taxonomy was originally proposed by Campbell et al (2012).

guidance. And the public may question the credibility of an MPC's forward guidance far out into the future, owing to the inability of MPC members to pre-commit future ones.

Recent approaches at the major central banks

Three different broad forms of policy rate forward guidance can be distinguished: (i) qualitative, where the guidance does not provide detailed quantitative information about the path of the policy rate or the envisaged time frame (eg "the policy rate will be maintained for an extended period"); (ii) calendar-based, where the guidance applies to a clearly specified time horizon (eg "the policy rate will be kept at the current level for x years");⁷ and (iii) threshold-based, where the guidance is linked to specific quantitative economic thresholds (eg "the policy rate will not be raised at least until the unemployment rate has fallen below $y\%$ "). Various forward guidance approaches have been pursued over time by the Federal Reserve, the Bank of England, the Bank of Japan and the ECB since 2008; more detailed information is provided in Table A1 in the annex.⁸

The Federal Reserve adopted qualitative forward guidance on policy rates when it cut the federal funds rate to its effective lower bound in December 2008. Subsequently, in 2011, the Fed shifted to calendar-based guidance by communicating that economic conditions would warrant policy rates at their lower bound for at least two years. Since December 2012, the Federal Reserve has been pursuing threshold-based forward guidance, clarifying the key factors that would influence the timing of future changes in the policy stance. Specifically, the Fed stated its intention to maintain the federal funds rate at its prevailing level conditional on explicit quantitative thresholds for both the unemployment rate ($>6.5\%$) and inflation projections ($<2.5\%$) as well as on evidence of well anchored long-term inflation expectations.

The Bank of Japan implemented threshold-based forward guidance linked to the inflation rate in the context of its Comprehensive Monetary Easing (CME) programme in October 2010. It announced that the zero interest rate policy would remain in place until the Bank of Japan's price stability goal was achieved and conditional on the absence of significant risks, including the accumulation of financial imbalances. Under the Quantitative and Qualitative Easing (QQE) programme launched in April 2013, the Bank of Japan replaced the uncollateralised overnight rate with the monetary base as its operating target of money market operations. The stated goal of the programme is to achieve a 2% price stability target with a time horizon of two years through large-scale asset purchases and monetary base expansion. In other words, QQE included elements of both threshold- and calendar-based forward guidance but without explicit forward guidance on the policy rate. Nonetheless, one aim of the new programme is to shape the longer end of the yield curve via expectations of

⁷ Calendar-based guidance is also typically conditional on the economic outlook at the time of issuance. Such conditionality is intended to mitigate, on the one hand, the risk of excessively tying one's hands in case the outlook changes significantly and, on the other hand, the risk of the time inconsistency problem mentioned above.

⁸ For more detailed expositions of these central banks' approaches to forward guidance, see Bernanke (2013b) for the Federal Reserve, Dale and Talbot (2013) and Bank of England (2014) for the Bank of England, Cœuré (2013) for the ECB and Shirai (2013) for the Bank of Japan.

future rates and term premia, but now the communication focus is solely on quantitative targets for the central bank's balance sheet.⁹

The Bank of England and the ECB introduced new forward guidance policies in mid-2013. The Bank of England initially laid out its threshold-based forward guidance, linking the maintenance of prevailing low policy rate levels to a quantitative threshold for the unemployment rate ($>7\%$) with three so-called "knockout" criteria including a quantitative threshold for inflation projections 18–24 months ahead ($<2.5\%$) as well as anchored medium-term inflation expectations and the absence of financial instability risks. It noted that, with the recovery gaining traction at the time, there was a risk that financial markets might overreact to signs of recovery and excessively revise up their expectations of future policy rates. In February this year, against the backdrop of a much faster than expected fall in the unemployment rate, the Bank of England set out the factors that will guide its decisions about the path of policy rates when the unemployment threshold is reached, emphasising in particular the objective to further reduce economic slack.

The ECB adopted open-ended qualitative forward guidance on policy interest rates in July 2013, stating its intention to keep interest rates at prevailing or lower levels "for an extended period of time". This represented a break with the long-standing practice of not commenting on policy rates beyond the following policy meeting. Similar to the case of the United Kingdom, this decision was partly motivated at the time by a rise in the expected path of euro area policy rates that was seen to be inconsistent with the subdued outlook for inflation and broad-based economic weakness.

The different approaches taken by central banks and their changes over time reflect the evolution of the challenges, the public and academic debate, and lessons from experience at home and abroad. Against the backdrop of the discussion of forward guidance effectiveness in the preceding subsection, the different approaches a priori offer different pros and cons. Qualitative forward guidance, for instance, is a relatively vague form of forward guidance, but at the same time it minimises the risk of excessively tying one's hand and the complications of forging a consensus on the guidance in monetary policy committees.

Calendar-based forward guidance is more explicit than qualitative forward guidance, but could be seen as strongly tying the central bank's hand. At the same time, subsequent revisions to calendar-based forward guidance could be interpreted as indicating either a change in the outlook or a change in the degree of monetary accommodation deemed appropriate given the outlook. If the revision is misinterpreted as a change in the outlook, the guidance may prove to be counterproductive. In addition, early termination or extension of calendar-based forward guidance could be perceived as reflecting an inherently time-inconsistent policy, which could undermine the credibility of the approach.

Threshold-based forward guidance is less affected by time inconsistency since it spells out more clearly the conditionality, but at the risk of high complexity. Indeed, the shift to threshold-based forward guidance has generally been associated with an increased length of forward guidance statements. For

⁹ A key objective of the programme is to raise inflation expectations through a strong commitment to monetary easing until the price stability goal is achieved (Kuroda (2013)).

instance, in the case of the Federal Reserve, statements at the time of policy meetings increased from around 20 words under qualitative forward guidance to an average of about 100 words under the recent threshold-based forward guidance; the word count for the Bank of England's threshold-based forward guidance in August 2013 and February 2014 was roughly 200 words.

Empirical evidence

Forward guidance on policy rates can impact financial markets and the economy in three main ways.

First, to the extent that the guidance implies an easier future monetary policy stance than expected by market participants, it should affect the level of future expected short-term rates as well as long-term bond yields.

Second, to the extent that central banks provide greater clarity about the future path of policy interest rates, the volatility of market expectations of future policy rates should fall, possibly also compressing risk premia.

Third, to the extent that the conditional nature of forward guidance highlights specific indicators, the guidance should make markets more sensitive to data releases related to these indicators and less sensitive to other information.

What does the evidence tell us so far about forward guidance on policy rates?¹⁰

Lowering the path of expected future interest rates

Forward guidance on policy rates has had some impact on expectations of the future path of short-term rates and on long-term bond yields (Graph 1). The evidence from the reactions of three-month futures rates and 10-year benchmark bond yields to forward guidance announcements suggests, however, that the effects have varied across jurisdictions and over time.

For the United States, futures rates and long-term bond yields tended to decline on most announcement days (Graph 1, left-hand panel). The announcements associated with qualitative forward guidance saw the largest reactions, but on the days concerned these reactions also reflected announcements of actual policy rate cuts (December 2008) as well as asset purchases (both December 2008 and March 2009). The market reaction to calendar-based forward guidance shows a decline over time. For instance, the August 2011 announcement was associated with a drop in the two-year-ahead futures rate of more than 20 basis points, compared with a 5 basis point drop after the January and September 2012 statements.

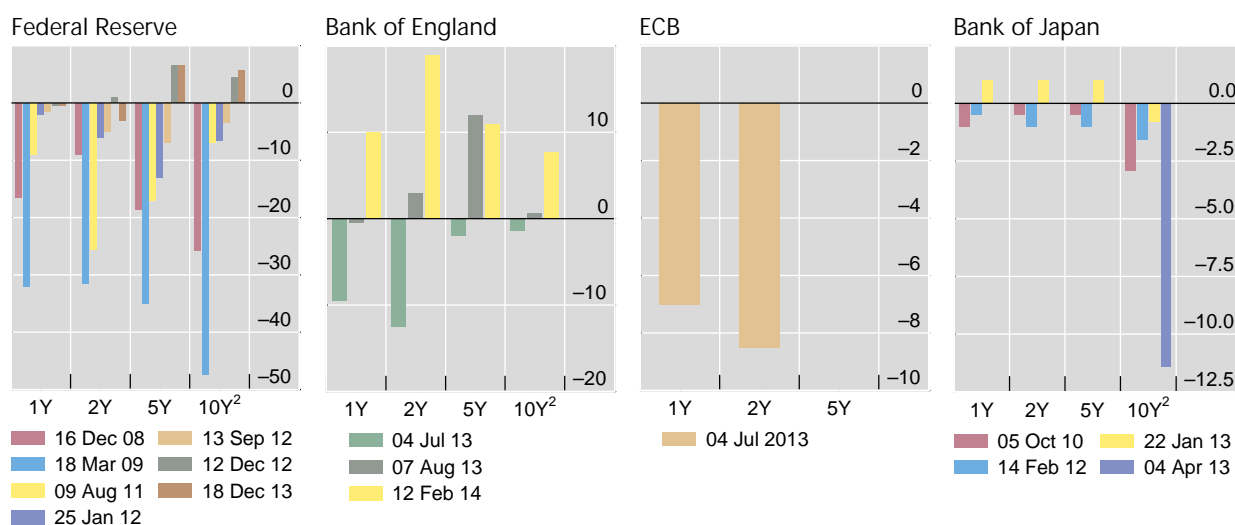
The threshold-based forward guidance of December 2012 and December 2013 had essentially no measurable impact on futures rates and long-term bond yields, but these effects are again contaminated by the effects of asset purchase

¹⁰ An overview of previous studies on the impact of forward guidance is provided in Bank of England (2013).

Announcement effects on three-month interbank rate futures and bond yields¹

One-day event window; in basis points

Graph 1



¹ Calculated as the end-of-day value on the announcement date minus the end-of-day value on the day before the announcement. For the Federal Reserve, futures on the three-month eurodollar rate; for the ECB, futures on the three-month Euribor; for the Bank of England, three-month sterling Libor futures; for the Bank of Japan, futures on the three-month euroyen. ² Nominal 10-year bond yield.

Sources: Bloomberg; authors' calculations.

announcements released at the same time. Specifically, the December 2013 guidance coincided with the announcement that the Federal Reserve would reduce the pace of its large-scale asset purchases. In that case, the absence of a significant market reaction in terms of futures and bond yields could be interpreted as a sign of the effectiveness of forward guidance, ie of its ability to offset the upward pressure on rates from the tapering announcement.

The impact of forward guidance on the expected path for future interest rates is also visible for the other major central banks (Graph 1). True, in the case of the Bank of England, futures rates did not drop following the formal introduction of forward guidance in August 2013. However, two-year futures rates did drop by more than 10 basis points in July 2013 when the MPC raised concerns about the appropriateness of market expectations for future policy rates. The ECB's forward guidance in July also had a negative impact on futures rates at the one- and two-year horizons (7 and 8 basis points, respectively).

For the Bank of Japan, the announcement effects on futures rates have generally been tiny, in part reflecting the entrenched expectation that the first policy rate increase lies way out in the future. That said, the 10-year bond yield registered a relatively sizeable decline, of more than 10 basis points, after the announcement of QQE in April 2013, while futures rates essentially remained unchanged. This suggests that the shift from policy rate forward guidance to balance sheet forward guidance mainly impacted term premia via the announced large-scale asset purchases.¹¹

¹¹ While the announcement effects have been accompanied by modest changes in the nominal yields, inflation expectations in Japan have increased significantly since the launch of the programme towards the Bank of Japan's 2% price stability target.

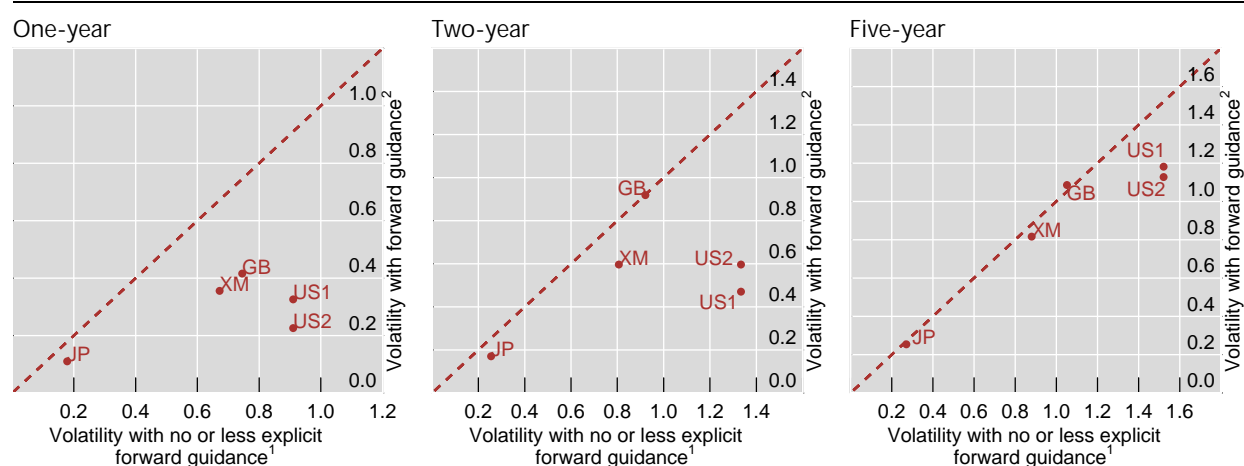
All these results suggest that in general there has been an immediate impact of policy rate forward guidance on the level of expected future interest rates, but it has varied over time with some indication of a diminishing effect. However, caution is called for when interpreting results from event studies of this type. In particular, they do not take into account prior market expectations or possible delayed reactions. For instance, the declining impact may reflect an improved ability of markets to anticipate the actions of the central bank over time. Moreover, they do not control for the influence of other relevant news; many forward guidance announcements have coincided with asset purchase announcements, making it harder to isolate their market impact. Also for these reasons, it is not possible to draw strong conclusions about the relative effectiveness of the different types of forward guidance from the announcement effect evidence alone.

Reducing the volatility of expected future rates

Graph 2 presents evidence that policy rate forward guidance at the zero lower bound has reduced the volatility of expected interest rates at short horizons, but less so at longer horizons. The graph plots 10-day realised futures volatilities during periods of forward guidance (vertical axis) against those in periods without forward guidance (horizontal axis).¹² For the United States, the scatter plot distinguishes between the period of calendar-based (US1) and threshold-based (US2) forward guidance.

Realised volatilities at the zero lower bound

Graph 2



Average 10-day realised volatilities on three-month interbank rate futures. Observations below the 45-degree line indicate a reduction in volatility during the forward guidance period.

¹ For the ECB, Bank of England and Bank of Japan, volatility at the zero lower bound before forward guidance was given. In particular, periods were specified as follows: ECB = 08 May 2009–3 Jul 2013; BoE = 06 Mar 2009–3 Jul 2013; BoJ = 22 Dec 2008–4 Oct 2010. For the Federal Reserve, volatility during times of qualitative forward guidance (16 Dec 2008–08 Aug 2011). ² Periods with forward guidance were specified as follows: US1 = 9 Aug 2011–11 Dec 2012 (calendar-based); US2 = 12 Dec 2012–current (threshold-based); GB = 7 Aug 2013–current; XM = 4 Jul 2013–current; JP = 5 Oct 2010–3 Apr 2013.

Sources: Bloomberg; BIS calculations.

¹² Note that, for the Federal Reserve, the reference period is that of qualitative forward guidance because this type of guidance was adopted as the policy rate was cut to the zero lower bound.

The clustering of the points below the 45-degree line indicates that the interest rate volatility in the forward guidance period tends to be lower than in the non-forward guidance period. This pattern is evident in the case of the one-year horizon. Not surprisingly, the volatility relationship between forward guidance and non-forward guidance periods appears weaker at longer horizons. At the two- and five-year horizons, the clustering of the dots is much closer to the 45-degree line. This presumably reflects market views that the policy rate forward guidance from the respective central banks is a commitment of limited duration and fades with the horizon.

Changing sensitivity to economic news

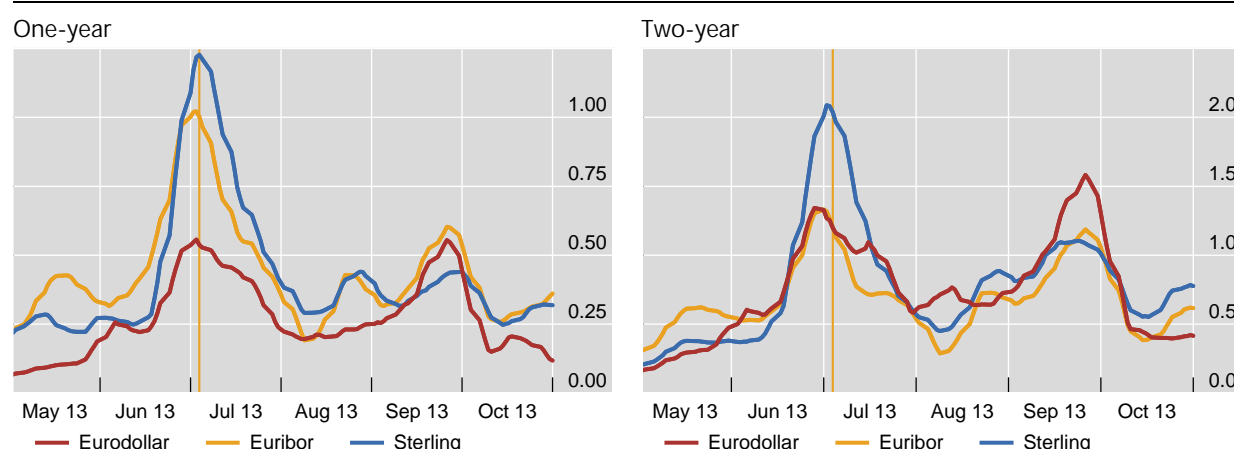
Policy rate forward guidance appears to have influenced the sensitivity of financial variables to economic news. Some studies have documented a reduction in the sensitivity of interest rate futures to news at the zero lower bound for short policy horizons under calendar-based forward guidance (Swanson and Williams (2013)).

Additional evidence comes from the Bank of England's and the ECB's forward guidance experience in mid-2013. Graph 3, which shows the volatility of three-month futures rates at the one- and two-year horizon between May and October 2013, supports the view that the guidance helped to insulate their respective economies from the news about Federal Reserve tapering. The first spike in US interest rate volatility occurred in mid-year and was associated with prospects of early Federal Reserve tapering of large-scale asset purchases. The graph documents the outsize volatility reaction at the time for the euro area and the United Kingdom. By contrast, in late summer, the second spike in US rate volatility had a more muted impact on Europe, for both the one- and two-year horizons, after the ECB and the Bank of England had adopted forward guidance.

Volatilities on three-month interbank rate futures contracts in 2013¹

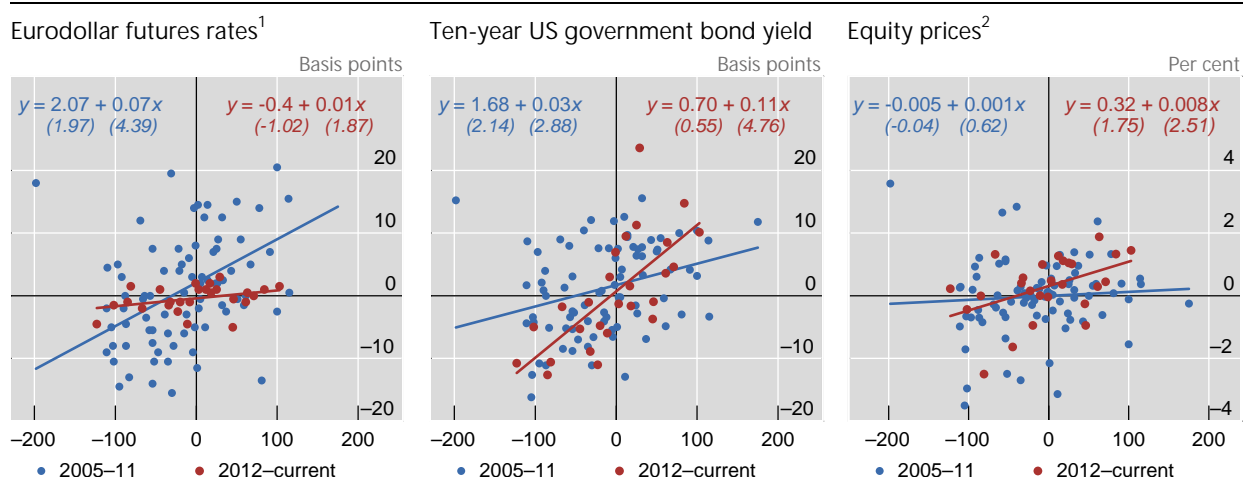
In per cent

Graph 3



¹ Ten-day standard deviation of daily price changes; centred 10-day moving averages. The vertical line indicates 4 July 2013, when the ECB provided qualitative forward guidance and the Bank of England commented on the market-expected path of policy rates.

Sources: Bloomberg; BIS calculations.



The x-axis shows the surprise in the change in non-farm payrolls, calculated as the difference between the actual value and the survey value, in thousands. The y-axis shows the one-day change, calculated as the end-of-day value at the release date minus the end-of-day value on the previous day. The t-statistic is shown in brackets.

¹ Eurodollar futures contract expiring in one year. ² S&P 500.

Sources: Bloomberg; BIS calculations.

In addition, there is evidence, at least for the United States, that financial markets responded to news about threshold variables differently in the forward guidance period. In the case of the Federal Reserve, Graph 4 (left-hand panel) shows that one-year futures rates became less sensitive to news about non-farm payroll employment surprises (the twist of the blue line to the red line). This is consistent with the interpretation that the surprises had little information content about whether the unemployment rate threshold would be breached within a year. This relationship, however, is likely to change as the unemployment rate approaches the threshold and a near-term policy shift is likely. In particular, interest rate futures are likely to become more sensitive to labour market developments as the threshold is approached.

On the other hand, Graph 4 (centre and right-hand panels) illustrates the increased sensitivity of the 10-year bond yield and equity prices to non-farm payroll surprises since 2012 (slope of the red line relative to the slope of the blue line (representing the relationship from 2005 to 2011)). One interpretation is that big positive surprises reflected a stronger recovery and hence brought forward the expected time at which the unemployment threshold would be breached and policy rate lift-off would ensue.

Challenges ahead

Policy rate forward guidance raises a number of challenges. These include in particular the risks to central banks' reputations and to financial stability.

Central bank reputation

Forward guidance exposes central banks to various reputation risks. If the public fails to fully understand the conditionality of the guidance and the uncertainty surrounding it, the reputation and credibility of the central bank may be at risk if the guidance is revised frequently and substantially. This is particularly relevant in the case of calendar-based forward guidance, in which deviations in the preannounced timetable may be perceived as renegeing on a commitment even if conditions change unexpectedly.

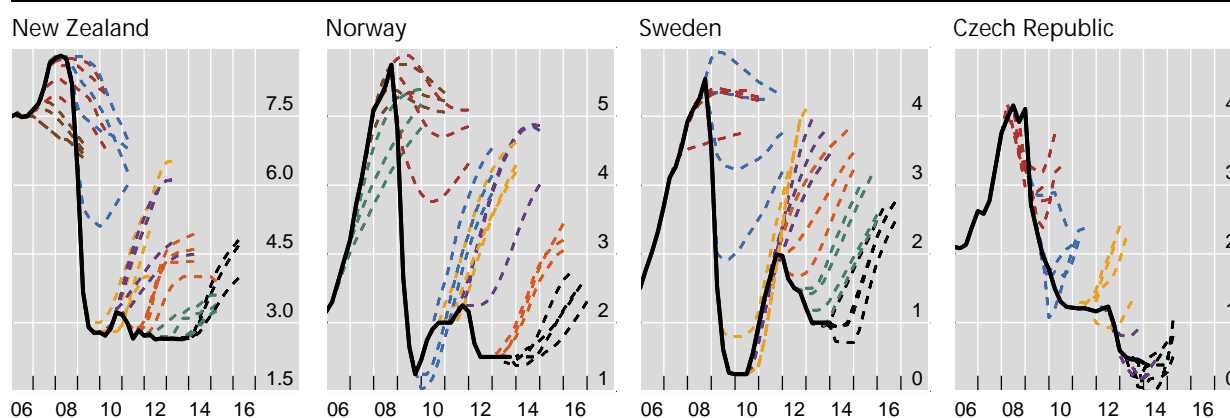
And while state-contingent forward guidance helps to address the risk of an appearance of renegeing, it raises others. For example, the announcement of unemployment-based thresholds could be seen as signalling a fundamental shift in monetary strategies and goals. And, as history has shown, the perception that central banks have elevated the role of real variables in monetary policy frameworks can adversely affect a central bank's credibility for price stability. A widespread perception of this could also create policy uncertainty about what central banks are truly aiming at, which would be counterproductive in the current post-crisis environment. Further, central banks may ex post be seen as having seriously misjudged the outlook, especially if such misjudgments are not widely shared with other forecasters.

That being said, it is important not to underestimate the public's ability to understand the conditionality of policy rate forward guidance. For example, the publication of projections for policy rate paths seems not to have had any major effect on central banks' reputation or credibility in New Zealand, Norway, Sweden and the Czech Republic, even though actual interest rates often differed considerably from projections (Graph 5).¹³ The deviations have been quite sizeable at times. One possible explanation for the seemingly limited impact of these deviations on credibility is that the central banks have been seen as behaving consistently with their policy objectives given what was known about the economic and financial environment at the time decisions were made.

Policy rate projections by central banks

In per cent

Graph 5



For New Zealand, 90-day interest rate; for Norway, sight deposit rate; for Sweden, repo rate; for the Czech Republic, three-month Pribor.

Source: Central bank monetary policy reports.

¹³ Reputational success is assessed by the anchoring of inflation expectations.

Another explanation is that these central banks have not been operating at the zero lower bound for policy rates, which is a more complicated environment where the commitment dimension of forward guidance takes on greater prominence; at the zero lower bound, the constraint on the policy rate reduces the signalling value of policy rate changes and naturally leads to greater weight on the choice of words to describe the policy stance.

Financial stability risks

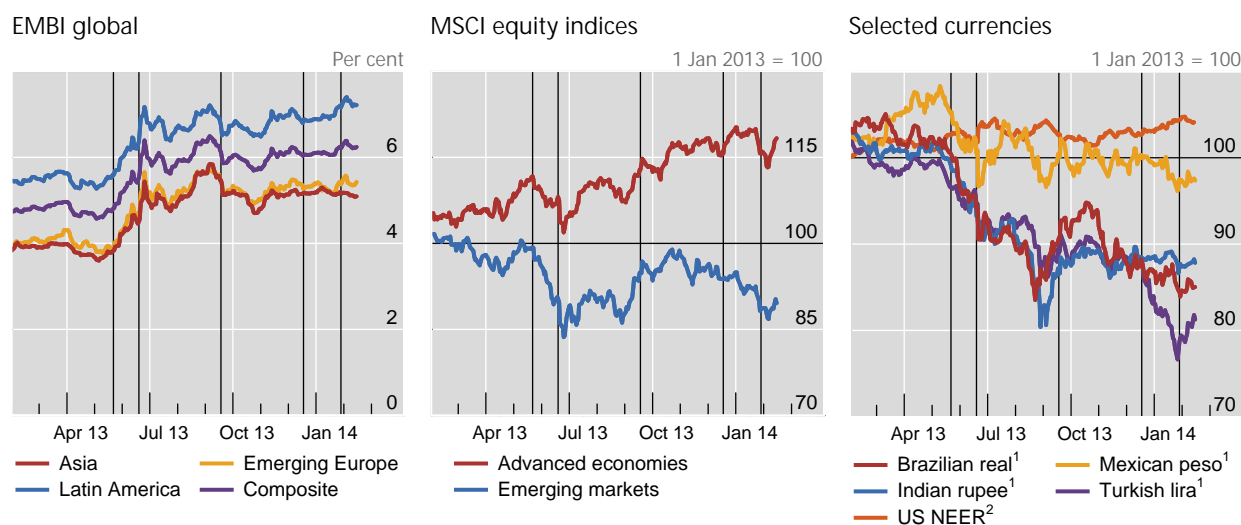
Forward guidance can give rise to financial stability risks in two ways. First, if financial markets become narrowly focused on certain aspects of a central bank's forward guidance, a broader interpretation or recalibration of the guidance could lead to disruptive market reactions. The global financial market developments last May and June in response to the Federal Reserve's tapering communication highlight such a risk. In that episode, financial markets fundamentally reassessed the path of future interest rates in the United States, and a global bond market sell-off ensued, along with a break in equity markets and a sharp depreciation of some emerging market exchange rates (Graph 6).¹⁴

Second, and perhaps more importantly, forward guidance can indirectly create financial stability risks if monetary policy becomes increasingly concerned about adverse financial market reactions (also referred to as the risk of financial dominance). At the current juncture, this could translate into an undue delay in the speed of monetary policy normalisation and raise the risk of an unhealthy accumulation of financial imbalances.¹⁵ Moreover, the mere perception of this possibility, over time, could encourage excessive risk-taking and thereby foster a build-up of financial vulnerabilities.

In the end, the reputational and financial stability risks associated with forward guidance have to be weighed against the risks associated with less forward-looking information. The cost-benefit calculus will depend on the particular situation in each economy and is likely to change over time.

¹⁴ These global market dynamics were driven in part by an unwinding of risky, leveraged trade positions which were predicated on policy interest rates remaining very low for a long time. See Bernanke (2013a) for an assessment of the financial market developments in the aftermath of the June tapering announcement. State-contingent forward guidance may be especially vulnerable here because of the lack of appropriate hedging instruments, ie the lack of state-contingent financial assets tailored to the conditions included in the guidance (Tucker (2013)). In this environment, financial investors by and large have to translate state-contingent forward guidance into trading strategies using time-contingent financial assets. This raises the likelihood of disruptive volatility whenever evolving conditions revise the expected timetable for actions, eg when financial market participants fundamentally rethink the likely lift-off and pace of a policy rate normalisation. This financial market risk could call into question the overall value of the more information-intensive forward guidance practices when markets lack appropriate hedging instruments.

¹⁵ Caruana (2013) addresses the risk to financial stability from undue delay in policy rate normalisation. See Hannoun (2012) for a description of the risk of financial dominance.



The vertical lines indicate the Fed Chairman's testimony on 22 May 2013 and the FOMC's policy communication on 19 June 2013, 18 September 2013, 18 December 2013 and 29 January 2014.

¹ Against the US dollar. ² Nominal effective exchange rate.

Sources: Bloomberg; Datastream.

Concluding remarks

The empirical evidence on the effectiveness of policy rate forward guidance at the zero lower bound presented in this article provides some support for the view that it has helped to shape market expectations. We find that recent forward guidance by four major central banks has so far reduced the volatility of near-term expectations about the future path of policy interest rates, suggesting that near-term policy intentions have been clarified. Beyond the impact on near-term policy rate volatility, the evidence is more mixed. In particular, the impact of the new forward guidance practices on expected interest rates has varied across episodes and economies and has not been very systematic in one direction or another. This has made it difficult to draw firm conclusions about their effectiveness in reliably providing further stimulus.

How long the new forward guidance practices will remain in place in the post-exit period is an open question, especially when it comes to the more explicit, state-contingent measures. One view is that greater central bank transparency has been a natural continuation of an earlier trend and that recent efforts represent an acceleration in its pace. An alternative view is that the recent forward guidance measures represent an unconventional monetary policy tool to be used in times of stress but not under normal conditions. Which view ultimately prevails will depend on how well recent forward guidance measures work in navigating the final stages of the recovery from the crisis and ultimately in the normalisation of prolonged monetary accommodation.

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Forward guidance on policy rates by major central banks since 2008

Table A.1

Federal Reserve*Open-ended (Dec 2008–Jul 2011)*

- 16 Dec 2008 [...] the Committee anticipates that weak economic conditions are likely to warrant exceptionally low levels of the federal funds rate for some time.
- 18 Mar 2009 The Committee will maintain the target range for the federal funds rate at 0 to 1/4 percent and anticipates that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period.

Calendar-based (Aug 2011–Nov 2012)

- 9 Aug 2011 The Committee currently anticipates that economic conditions – including low rates of resource utilization and a subdued outlook for inflation over the medium run – are likely to warrant exceptionally low levels for the federal funds rate at least through mid-2013.
- 25 Jan 2012 [...] the Committee [...] currently anticipates that economic conditions – including low rates of resource utilization and a subdued outlook for inflation over the medium run – are likely to warrant exceptionally low levels for the federal funds rate at least through late 2014.
- 13 Sep 2012 [...] the Committee [...] currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015.

Threshold-based (Dec 2012 – present)

- 12 Dec 2012 [...] the Committee decided to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that this exceptionally low range for the federal funds rate will be appropriate at least as long as the unemployment rate remains above 6.5 percent, inflation between one and two years ahead is projected to be no more than a half percentage point above the Committee's 2 percent longer-run goal, and longer-term inflation expectations continue to be well anchored. The Committee views these thresholds as consistent with its earlier date-based guidance. In determining how long to maintain a highly accommodative stance of monetary policy, the Committee will also consider other information, including additional measures of labor market conditions, indicators of inflation pressures and inflation expectations, and readings on financial developments. When the Committee decides to begin to remove policy accommodation, it will take a balanced approach consistent with its longer-run goals of maximum employment and inflation of 2 percent.
- 18 Dec 2013 The Committee now anticipates, based on its assessment of these factors, that it likely will be appropriate to maintain the current target range for the federal funds rate well past the time that the unemployment rate declines below 6-1/2 percent, especially if projected inflation continues to run below the Committee's 2 percent longer-run goal. When the Committee decides to begin to remove policy accommodation, it will take a balanced approach consistent with its longer-run goals of maximum employment and inflation of 2 percent.

Bank of Japan*Threshold-based (Comprehensive monetary easing (CME), Oct 2010–Mar 2013)*

- 5 Oct 2010 The Bank will maintain the virtually zero interest rate policy until it judges, based on the “understanding of medium- to long-term price stability”, that price stability is in sight, on condition that no problem will be identified in examining risk factors, including the accumulation of financial imbalances.
- 14 Feb 2012 For the time being, the Bank will pursue the powerful easing by conducting its virtually zero interest rate policy and by implementing the Asset Purchase Program, with the aim of achieving the goal of 1 percent in terms of the year-on-year rate of increase in the CPI. The Bank will continue pursuing the powerful easing until it judges that the 1 percent goal is in sight on the condition that the Bank does not identify any significant risk, including the accumulation of financial imbalances, from the viewpoint of ensuring sustainable economic growth.
- 22 Jan 2013 The Bank will pursue aggressive monetary easing, aiming to achieve the 2 percent target, through a virtually zero interest rate policy and purchases of financial assets, as long as the Bank judges it appropriate to continue with each policy measure respectively.

European Central Bank

Open-ended (July 2013 – present)

4 Jul 2013 The Governing Council expects the key ECB interest rates to remain at present or lower levels for an extended period of time.

Bank of England

Threshold-based (August 2013 – present)

7 Aug 2013 [...] the MPC intends not to raise Bank Rate from its current level of 0.5% at least until the Labour Force Survey headline measure of the unemployment rate has fallen to a threshold of 7%, subject to the conditions below. The MPC stands ready to undertake further asset purchases while the unemployment rate remains above 7% if it judges that additional monetary stimulus is warranted. But until the unemployment threshold is reached, and subject to the conditions below, the MPC intends not to reduce the stock of asset purchases financed by the issuance of central bank reserves and, consistent with that, intends to reinvest the cash flows associated with all maturing gilts held in the Asset Purchase Facility.

The guidance linking Bank Rate and asset sales to the unemployment threshold would cease to hold if any of the following three 'knockouts' were breached:

- in the MPC's view, it is more likely than not, that CPI inflation 18 to 24 months ahead will be 0.5 percentage points or more above the 2% target;
- medium-term inflation expectations no longer remain sufficiently well anchored;
- the Financial Policy Committee (FPC) judges that the stance of monetary policy poses a significant threat to financial stability that cannot be contained by the substantial range of mitigating policy actions available to the FPC, the Financial Conduct Authority and the Prudential Regulation Authority in a way consistent with their objectives.

12 Feb 2014 The MPC sets policy to achieve the 2% inflation target, and, subject to that, to support the Government's economic policies, including those for growth and employment.

- Despite the sharp fall in unemployment, there remains scope to absorb spare capacity further before raising Bank Rate.
 - When Bank Rate does begin to rise, the appropriate path so as to eliminate slack over the next two to three years and keep inflation close to the target is expected to be gradual.
 - The actual path of Bank Rate over the next few years will, however, depend on economic developments.
 - Even when the economy has returned to normal levels of capacity and inflation is close to the target, the appropriate level of Bank Rate is likely to be materially below the 5% level set on average by the Committee prior to the financial crisis.
 - The MPC intends to maintain the stock of purchased assets at least until the first rise in Bank Rate.
 - Monetary policy may have a role to play in mitigating risks to financial stability, but only as a last line of defence if those risks cannot be contained by the substantial range of policy actions available to the Financial Policy Committee and other regulatory authorities.
-

The credit-to-GDP gap and countercyclical capital buffers: questions and answers¹

Basel III uses the gap between the credit-to-GDP ratio and its long-term trend as a guide for setting countercyclical capital buffers. Criticism of this choice centres on three areas: (i) the suitability of the guide given the objective of the buffer; (ii) the early warning indicator properties of the guide for banking crises (especially for emerging market economies); and (iii) practical measurement problems. While many criticisms have merit, some misinterpret the objective of the instrument and the role of the indicator. Historically, for a large cross section of countries and crisis episodes, the credit-to-GDP gap is a robust single indicator for the build-up of financial vulnerabilities. As such, its role is to inform, rather than dictate, supervisors' judgmental decisions regarding the appropriate level of the countercyclical buffer.

JEL classification: E44, E51, E61, G01, G21.

Basel III introduced a countercyclical capital buffer (CCB) aimed at strengthening banks' defences against the build-up of systemic vulnerabilities. The framework assigns the credit-to-GDP gap a prominent role as a guide for policymakers. The guide is intended to help frame the analysis of whether to activate or increase the required buffer and the communication of the related decisions. But the link between the credit-to-GDP gap and the capital buffer is not mechanical. Instead the framework allows for policymakers' judgment on how buffers are built up and released. Judgment, however, should complement quantitative analysis, which may also use indicators other than the credit-to-GDP gap, in managing the instrument. The framework envisages that authorities would refer to the common reference guide in communicating decisions (BCBS (2010)).

The credit-to-GDP gap ("credit gap") is defined as the difference between the credit-to-GDP ratio and its long-term trend. Borio and Lowe (2002, 2004) first documented its property as a very useful early warning indicator (EWI) for banking crises. Their finding has been subsequently confirmed for a broad array of countries and a long time span that includes the most recent crisis.²

¹ We thank Claudio Borio, Juan Carlos Crisanto, Dietrich Domanski, Tamara Gomes and Christian Upper for very helpful comments, as well as Angelika Donaubaue and Michela Scatigna for excellent research assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

² See eg Borio and Drehmann (2009), FitchRatings (2010), Behn et al (2013) and Drehmann and Juselius (2014).

The credit-to-GDP gap has received attention from academics and practitioners. Some have confirmed its usefulness as an indicator of financial vulnerabilities, but others have been more critical about its properties. The criticisms of the credit-to-GDP gap follow three main lines: (i) the credit gap is not a good guide for setting the buffer because it can lead to decisions that conflict with the CCB's objective; (ii) the credit gap is not the best EWI for banking crises, especially in the case of emerging market economies; and (iii) the credit gap has measurement problems.

The purpose of this article is to review these criticisms in the context of the role of the indicator within the CCB framework. In what follows, we address each area of criticism in a separate section. We argue that many criticisms, while factually accurate, misinterpret the role of the credit gap as a common reference guide for CCB decisions. We also review and extend the evidence on the reliability of the credit gap as an EWI for banking crises, which is essential for an instrument aimed at protecting banks from the build-up of aggregate vulnerabilities. We also discuss some of the practical measurement problems that arise in the calculation of the credit gap.

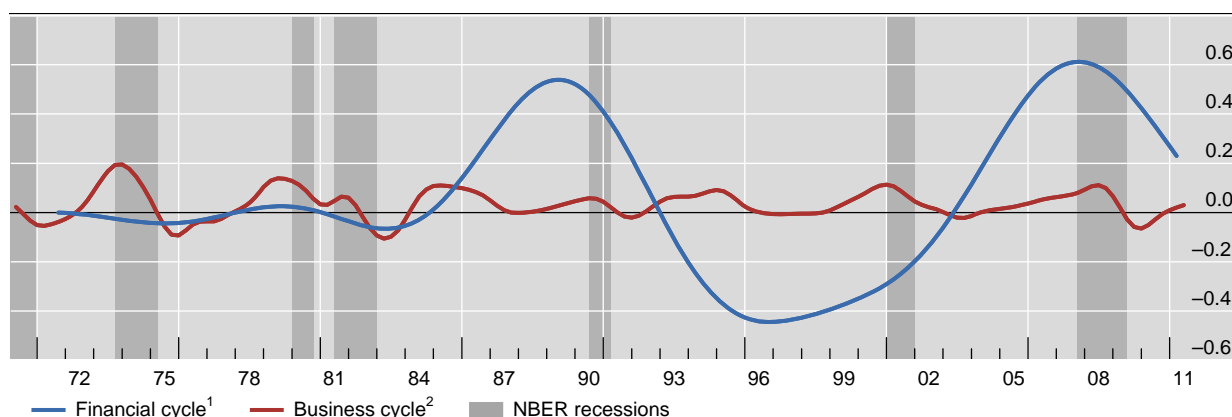
The credit-to-GDP gap and the objective of the CCB

Taking a broad perspective, some critics argue that the credit-to-GDP gap is unsuited as guide for the CCB because it does not conform to the buffer's objective. In particular, they suggest that the guide might trigger procyclical changes in the buffer, that is, lead to increases in bank capital during periods of recession and declines in periods of economic expansion. A related, but more conceptual, critique is that the credit gap does not correspond to an equilibrium notion of credit in the economy.

The main objective of the CCB is to protect banks from the effects of the financial cycle (BCBS (2010, page 1)). The idea is to boost capital in periods when aggregate vulnerabilities are building up. Buffers accumulated in good times can then be released (ie used up) in bad times, helping to absorb losses.

Importantly, the relevant cycle for the instrument is not the business cycle but the "financial cycle" – the boom and bust cycles that characterise the financial system. Aikman et al (2010), Claessens et al (2011) and Drehmann et al (2012) document that financial variables (in particular, credit and property prices) have pronounced and largely coincident cycles. These financial cycles have greater amplitude and duration than the fluctuations in economic activity, known as the business cycle. Graph 1 (taken from Drehmann et al (2012)) illustrates this for the United States. More often than not, financial cycle peaks are punctuated by banking crises. The CCB aims to help banks survive such episodes. However, the CCB is not a tool intended to actively manage the cycle. The Basel Committee notes the instrument's "potential moderating effect on the build-up phase of the credit cycle" but characterises this as no more than "a positive side benefit" (BCBS (2010, page 1)).

Repullo and Saurina (2011) argue that the credit gap is not the right anchor for the buffer because it moves countercyclically with GDP growth. Their argument places the business cycle centre stage and suggests that a CCB driven by the credit gap would exacerbate rather than smooth fluctuations in GDP. There are both statistical and economic counterarguments against this criticism.



¹ The line traces the financial cycle measured as the average of the medium-term cycle in the component series using frequency-based filters. ² The line traces the GDP cycle identified by the traditional shorter-term frequency filter used to measure the business cycle.

Source: Drehmann et al (2012).

From a statistical point of view, the criticism regarding the correlation between the credit gap and real GDP growth is only partly correct. This correlation is indeed negative across a panel of 53 countries over the period 1980–2013 but small in size (Table 1, first column).³ Closer examination of the data reveals that the negative sign is driven primarily by periods when the information from the indicator is of no consequence for the capital buffer. These are either periods during which the credit gap was low and the capital buffer would not have been activated, or periods following crises when the buffer would have been released. Excluding these periods renders the correlation either positive or statistically indistinguishable from zero (Table 1, second and third columns).

More importantly, the starting point of the criticism is incorrect. The value of a guide for the CCB must be assessed against the buffer's economic objectives, which is not to manage the business cycle, but to defend banks against the financial cycle.

To be sure, the lack of coincidence between financial and business cycles does raise challenges. There have been periods when the credit gap would have suggested increasing capital buffers in the midst of a recession. And a decision to increase the countercyclical buffer in such times, even if justified on prudential grounds, may meet with stiff political resistance. But, even in these circumstances, it is unclear how strong the real impact on GDP would be: the empirical literature fails to provide evidence of a strong link between higher bank capital requirements and lower growth. Recent studies put the median estimates for the impact of a 1 percentage point increase in capital requirements on GDP in the range of 0.1 to 0.2 percentage points, while the long-term impact of better capitalised banks on economic output is estimated to be positive (BCBS (2010)).⁴

Edge and Meisenzahl (2011) as well as Buncic and Melecky (2013) point out that the credit-to-GDP gap is not necessarily an equilibrium notion of credit for the economy. These authors agree with the idea that the CCB should protect banks

³ See the next section for a more detailed description of the data used in this article.

⁴ For a recent overview, see CGFS (2012).

Correlations between real GDP growth and the credit-to-GDP gap¹

Table 1

| | All periods | Periods when gaps indicate positive buffers ² | Non-crisis periods when gaps indicate positive buffers ^{2,3} |
|----------------|-------------|--|---|
| France | −0.24*** | −0.38*** | −0.01 |
| Germany | −0.24*** | 0.65*** | 0.65*** |
| Italy | −0.09 | −0.36*** | −0.14 |
| Japan | 0.54*** | 0.59 | 0.55*** |
| Spain | 0.14 | 0.11 | 0.29* |
| United Kingdom | 0.07 | 0.13 | 0.44*** |
| United States | −0.02 | −0.23** | −0.07 |
| All countries | −0.08*** | −0.06*** | 0.02 |

***/**/* indicates statistical significance at the 1/5/10% level.

¹ Correlations between real GDP growth and countercyclical capital buffer levels reveal a similar picture, albeit with even lower negative correlations, where present. ² Only periods when the credit-to-GDP gap is above 2 percentage points are considered, as this is the critical threshold suggested by BCBS (2010) when countercyclical capital buffers should start to become positive. ³ The quarter in which financial crises are recorded and the following two years are defined as crisis periods and are hence excluded.

Sources: National data; authors' calculations.

from the consequences of financial booms, but they express doubt that the credit gap can correctly identify periods of "excessive" credit growth.

This is a valid point in the sense that no formal model underpins the choice of this indicator, but it does not imply that the measure entirely lacks theoretical foundations or that it is not fit for purpose. Conceptually, the credit gap encapsulates the build-up of financial vulnerabilities in line with the ideas of Kindleberger (2000) and Minsky (1982) about the mechanisms that lead to crises. Empirically, it is consistent with a growing literature documenting that unusually strong credit growth tends to precede crises (Schularick and Taylor (2012), Gourinchas and Obstfeld (2012)). Furthermore, given that the function of the credit gap is not to set a target for aggregate credit but to guide the build-up of bank capital ahead of problems, it should be judged solely on its indicator properties for incipient banking stress. We discuss those in the next section.

Is the credit-to-GDP gap the best EWI for banking crises?

Many authors have proposed indicators other than the credit gap as anchors for the CCB (eg Barrell et al (2010), Shin (2013), Behn et al (2013)). They argue that their preferred alternative to the credit-to-GDP gap works better as an EWI for banking crises. In this section, we review the evidence in favour of the credit-to-GDP gap.

Predicting banking crises is an exercise in compromise. The ideal indicator would signal all impending crises and never crises that fail to materialise. All known EWIs fall short of this ideal, and hence they must be evaluated on the basis of how they trade off the rate of missed crises against the rate of false positives (ie the percentage of signals they emit for crises that do not happen). This evaluation depends on policymakers' preferences concerning these two types of error.

Good EWIs must fulfil a number of additional requirements that go beyond statistical accuracy. Drehmann and Juselius (2014) propose three such requirements

in the context of macroprudential policymaking. The first is *timing*: EWIs must provide signals early enough for policy measures to take effect. For instance, the Basel III guidance states that “the indicator should breach the minimum [critical threshold] at least 2–3 years prior to a crisis” (BCBS (2010, page 16)). The second requirement is *stability*: the indicator should not flip-flop between signalling a crisis and being “off”. EWIs that issue stable signals reduce uncertainty regarding trends and allow for more decisive policy actions. The final requirement is *interpretability*. Forecasts and signals that policymakers find hard to understand and interpret are likely to be ignored (eg Önkai et al (2002), Lawrence et al (2006)). This puts a premium on simplicity and ease of communication, making *single* indicators with robust performance particularly appealing.

The credit gap fares well against these criteria. As we discuss below, it is the EWI of banking crises, having the best overall statistical performance among *single* indicators across a large panel of countries over the past several decades. It also satisfies the three policy requirements listed above, and its calculation requires data (credit and GDP) which are generally available in most jurisdictions. These characteristics are essential considering that the BCBS guidance underpins a globally harmonised framework.

We use a panel of 26 countries over the period 1980–2012 to compare the performance of six indicators: the credit-to-GDP gap, credit growth, GDP growth, residential property price growth, the debt service ratio (DSR) and the non-core liability ratio.⁵ The DSR is defined as the proportion of interest and amortisation payments to income and was first suggested in this context by Drehmann and Juselius (2012). The non-core liability ratio was proposed by Hahm et al (2012) and captures the reliance of a banking system on wholesale and cross-border funding.⁶

We follow Drehmann and Juselius (2014) in evaluating the forecast performance of EWIs using the area under the curve (AUC): a statistical methodology that captures the trade-off between true positives and false positives for the full range of policymakers’ preferences (see box for a description). A completely uninformative indicator has an AUC of 0.5: it is no better than tossing a coin. The greater the difference of the AUC from 0.5, the better the forecast performance of the indicator. For indicators whose value increases ahead of crises, the perfect AUC score would be equal to 1. For indicators that decline ahead of crises, the perfect AUC score would be zero. Importantly for the problem at hand, the AUC is robust to a technical issue that complicates regression-based assessments. Variables that satisfy the stability requirement, which is desirable from a policy perspective, are bound to be very persistent (ie move very smoothly over time). This persistence complicates the statistical evaluation of their forecasting power on the basis of standard regression models, such as those used by Barrell et al (2010).⁷

⁵ Using somewhat different techniques, Drehmann et al (2011) found that indicators of banking sector performance (eg aggregate non-performing loans) and market-based indicators (eg credit spreads) perform poorly. Drehmann and Juselius (2014) also consider real equity price growth and gaps of property and equity prices that are not shown here for the sake of brevity.

⁶ In line with the findings of Hahm et al (2012), the non-core liability ratio is empirically measured by cross-border liabilities plus M3 minus M2 (proxy for non-core liabilities) divided by M2 (proxy for core liabilities).

⁷ Park and Phillips (2000) offer a discussion of how series persistence can lead to misleading inference in binary choice models.

Evaluating EWIs with the AUC

The AUC (the area under the receiver operating characteristics curve, or ROC curve) is a statistical tool used in assessing the performance of signals that forecast binary events (ie events that either occur or do not). The term ROC reflects the origins of the tool in the analysis of radar signals during World War II, although it has a long tradition in other sciences (eg Swets and Picket (1982)). Its applications to economics are more recent (eg Cohen et al (2009), Berge and Jorda (2011), Jorda et al (2011)). The AUC summarises the trade-off between correct and false signals for all different operator (policymaker) preferences, as explained below.

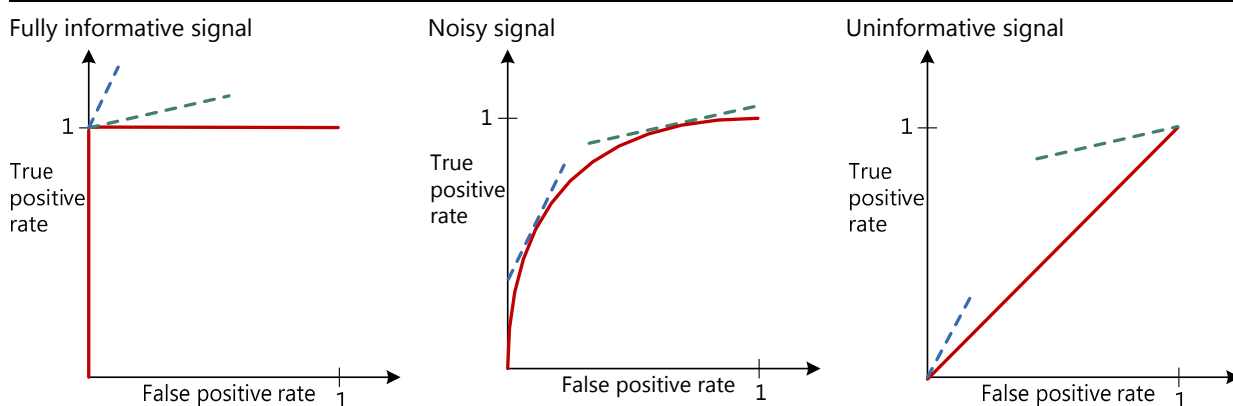
Selecting an indicator involves making a choice on the trade-off it offers between the rate of correct event predictions and the rate of false calls. There are four possible value combinations of a binary signal (which can be "on" or "off") and subsequent event realisations ("occurrence" or "non-occurrence"). The perfect indicator signals "on" ahead and only ahead of all occurrences, while the signal from an uninformative indicator has an equal probability of being right or wrong. Signals from continuous variables (such as those considered in this article) must be calibrated. This means that the operator will define a threshold and consider as a signal a value of the indicator variable that exceeds this threshold. Varying the threshold varies the relationship between true positives (signal "on" and "event occurs") and false positives (signal "on" and "non-occurrence"). If it is set at a very high value, the indicator will miss many events but it will also make very few false positive signals. A very low threshold value will generate many signals, capturing more events but also making many more false calls.^①

The ROC curve for an indicator captures the relationship between the rate of true positives (as a share of all occurrences) and the rate of false positives (as a share of all non-occurrences) for different values of the threshold. The red lines in the graph below illustrate the ROC curve for three different indicators. The left-hand panel corresponds to the perfect indicator. Since the indicator is able to perfectly signal occurrences, decreasing the threshold value from the maximum implies that more and more events are predicted without any false calls being made (vertical segment). When the threshold is set so as to capture all occurrences, lowering it further will not increase the rate of correct predictions, which is already at 1, but will add to the rate of false calls (horizontal segment). The right-hand panel shows the other extreme: the completely uninformative indicator. Lowering the threshold in this case changes the true positive and false positive rates, but always by the same amount. The trade-off is thus depicted by the 45° line. The more interesting cases are between the extremes (centre panel): as calibration moves away from the origin of the graph (by lowering the threshold from its maximum value), it initially improves the true positive rate at a low cost in terms of increases in the false positive rate. The cost of improving the true positive rate, however, increases (the ROC curve flattens) as the threshold is progressively lowered.

The operator (the policymaker) is not indifferent about this trade-off and assigns a positive weight to the success rate (correct predictions of occurrences) and a negative weight to the rate of false positives. These preferences are shown as straight lines. The steeper (blue dotted) line corresponds to an operator who dislikes false

Signal quality and policymakers' preferences

Graph A



The red line denotes the ROC curve. The dotted lines denote preferences of a policymaker who weights the expected costs and expected benefits of macroprudential interventions linearly. The blue (green) line indicates high (low) costs relative to benefits.

Source: Based on Drehmann and Juselius (2014).

positives relatively more than another operator who is more interested in not missing an occurrence (green dotted line). Each operator tries to achieve the highest extension of the slope that represents their preferences. For the two extreme cases, the choice is trivial. In the case of the fully informative indicator, all operators will select the calibration that offers perfect accuracy. In the case of the uninformative indicator, the two operators will position themselves at opposite ends: one at the point of zero false positives and zero success rate (the origin), and the other at the point where all occurrences are captured but also the false positive rate is 100%. In realistic situations of informative but noisy indicators, each operator will select a different calibration as seen by the points of tangency in the centre panel. For each operator, the distance between the red line at the point of tangency and the 45° line represents the gain they obtain given their preferences and the options offered by the specific indicator.

The AUC is calculated as the area under the entire ROC curve. Intuitively, it captures the average gain over the uninformed case across all possible preferences of the operator (ie for all possible combinations of weights assigned to the two types of error). As such, it provides a summary measure of the signalling quality over the full range of possible preferences and calibrations (Elliott and Lieli (2013)). This is particularly appealing given the difficulties of offering precise quantification of the costs and benefits of macroprudential policymaking (CGFS (2012)). The uninformative indicator has an AUC equal to 0.5 (area under the 45° line), while that for the fully informative indicator is equal to 1. The intermediate cases have values in between. For indicators that decline ahead of events, the AUC takes values between 0.5 (uninformative) and zero (fully informative).

① This assumes that the indicator increases ahead of an event. If the opposite is true, then a signal is “on” when the variable is below the threshold and the explanation is reversed.

Graph 2 shows the AUC metric for the six EWIs over forecast horizons that range from 20 quarters to one quarter prior to a banking crisis. A solid blue line indicates that the specific variable for the given horizon is statistically different from an uninformative indicator, while a dashed blue line indicates that a variable is statistically indistinguishable from an uninformative indicator. We use circles and diamonds to indicate the ranking of performance among the six indicators for a given forecast horizon. For each horizon, the best-performing indicator (ie the one with the highest AUC) is denoted by a red diamond. A blue diamond denotes that the specific variable is not statistically different from the best-performing indicator. A blue circle shows that the signal is stable in the sense that it does not reverse direction within the forecast horizon until the crisis.

The clear message from Graph 2 is that, among those considered, the credit-to-GDP gap is statistically the best single EWI for forecast horizons between five and two years. At shorter horizons, the best single indicator is the DSR. The other indicators have an inferior performance to these two and often fail to satisfy the stability property.

The credit-to-GDP gap as a mechanical anchor for the CCB

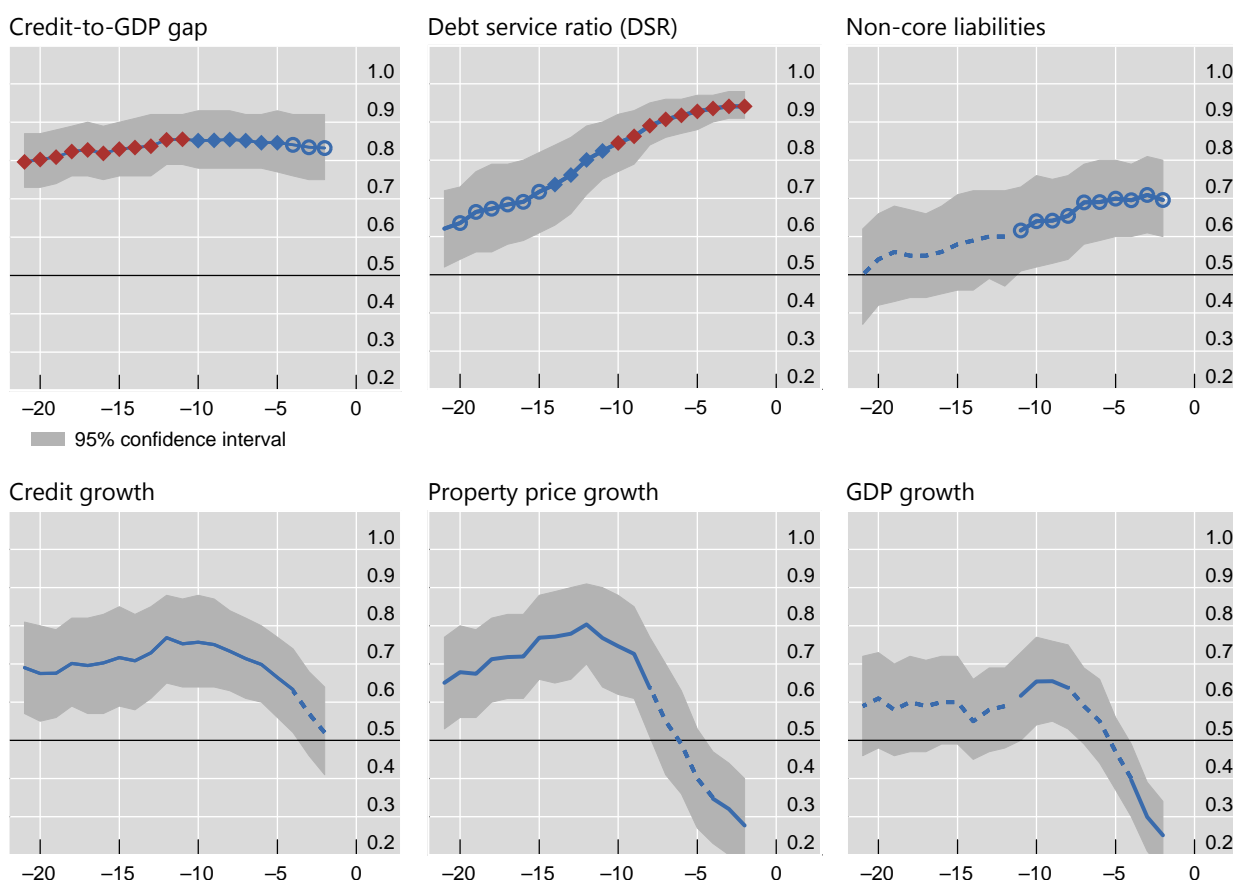
Given its overall robust performance, should the CCB be anchored mechanically on the credit-to-GDP gap? The answer is no, for a number of reasons. For one, since no indicator is infallible, policymaking requires judgment. For another, combinations of indicators perform better than single ones. And, as many observers have pointed out, what works best for the entire panel might work for most countries and periods but not necessarily for all individual situations.

As with other countercyclical policies, including monetary policy, decisions incorporate a substantial element of judgment. A rules-based, mechanical approach has attractions, especially when it comes to dealing with political economy problems, but it also has pitfalls, because all indicators and models are subject to error and the future is, by definition, unknown. The uncertainties in the context of

The signalling quality of different EWIs

AUCs for different forecast horizons

Graph 2



The horizontal axis denotes the forecast horizons in quarters before crises. The vertical axis denotes the AUC. The horizontal line at 0.5 highlights the value of an uninformative indicator. A solid blue line indicates that the specific variable for the given horizon is statistically different from an uninformative indicator, while a dashed blue line indicates the opposite. A hollow blue circle shows that the signal is stable in the sense that it does not reverse direction within the forecast horizon until the crisis. A red diamond highlights that the specific variable is statistically the best indicator for this particular horizon. Other indicators that are not statistically different from the best-performing indicator are marked by solid blue diamonds.

Source: Drehmann and Juselius (2014).

CCB decisions are no different. The role of the credit gap in the CCB framework is not that of a rigid benchmark, but that of a guide: an easy-to-calculate indicator that can facilitate the communication between the policymaker, the banks and the public. It should work as a yardstick to anchor judgment and explain the rationale for decisions. It is not meant to be the one-size-fits-all benchmark for CCB application, but a source of discipline in the application of judgment by national authorities.

Combinations of indicators could also act as benchmarks. Indeed, research points to composite indicators that statistically outperform the credit-to-GDP gap. For instance, Borio and Lowe (2002) as well as Behn et al (2013) found that combinations of the credit gap and a similarly calculated asset price gap produce a more precise signal, while Drehmann and Juselius (2014) found complementary information content in the debt service ratio. Yet problems with universal data availability for such indicators and additional framework complexity argued in favour of adopting a simpler, single indicator as guide for the CCB.

A number of jurisdictions that have implemented the framework have made the case for using indicators that better capture the specific circumstances of their financial system. For instance, the Bank of England (2014) has introduced a framework that is based on 18 core indicators, including the credit gap. Similarly, the Swiss National Bank (2013), the Central Bank of Norway (2013) and the Reserve Bank of India (2013) have explained that they monitor a small number of indicators in addition to the credit gap in evaluating aggregate vulnerabilities and making decisions regarding the CCB.⁸ As in the Bank of England's approach, these additional indicators relate primarily to conditions in the residential and commercial property markets and sometimes include bank liabilities.

Others have argued that the credit gap is not appropriate in a particular country at a given point in time (eg Reserve Bank of South Africa (2011), Wolken (2013)). The latter type of argument must be carefully backed by analysis, as there is a temptation to generalise from episodes when the gap gave wrong signals. This in and of itself does not invalidate the early warning properties of the credit gap, as these can be assessed only in a larger sample. And its superior cross-country performance sets a high bar for such arguments, suggesting that they would be the exception rather than the rule. The background analysis must also tackle the challenge of a small sample: statistical assessments for single countries are difficult given the low number of crises (generally two or fewer).

Noise in the signal produced by the credit gap in specific circumstances may occur in periods when the ratio increases because of a collapse in the denominator (GDP) rather than a surge in the numerator (credit). This tends to occur in the early stages of a recession. As discussed above, the mechanical use of the indicator could produce unintended effects in these situations, but this risk is low given the room for discretion provided by the framework and the fact that the CCB would not be active in most of those situations. Nevertheless, Kauko (2012) suggests using a five-year moving average instead of current GDP levels in the denominator of the ratio as a way of minimising the problem of sudden falls in GDP. This approach could reduce the number of wrong signals in recessions, but results in a credit gap with a somewhat lower AUC compared with those using actual GDP. So, reducing the rate of false positives when a fall in GDP is the driver of the increase comes at the cost of lower overall predictive ability.⁹

Ironically, the adoption of the credit gap as an anchor for policy decisions may eventually weaken its signalling properties without invalidating its function as a guide. Goodhart (1975) postulated that a variable used to guide policy may lose its information content precisely because it is embedded in the policy framework. In an ideal world where signals are accurate and policy responses perfectly gauged, the building of capital buffers would protect banks against the build-up of vulnerabilities but may also defuse the underlying risks, and thus weaken the statistical link between the credit gap and crises. But this should be seen as a sign of success and not negate the usefulness of the indicator for policy, or be interpreted as a reason to abandon the CCB altogether.¹⁰

⁸ All three institutions use these indicators expressed in "gap" form, that is, in terms of the difference between their current value and their respective long-term trend.

⁹ We have performed analysis that demonstrates this for our panel of countries. The results are available upon request.

¹⁰ See Drehmann et al (2011).

Is the credit-to-GDP gap a good early warning indicator for emerging market economies?

A number of commentators question the usefulness of the credit-to-GDP gap as a guide in the case of emerging market and transition economies (eg Geršl and Seidler (2012)). They point out that the evidence provided by BCBS (2010) and previous research (eg Drehmann et al (2011)) is based on samples comprising largely advanced economies. Sceptics also argue that emerging market economies (EMEs) are more likely to be undergoing a period of financial deepening which renders the specification of the trend for the calculation of the credit gap problematic (eg World Bank (2010)). We deal with these issues in turn.

We present evidence that the performance of the credit gap as an EWI carries over to a sample of EMEs, albeit this performance is not as good as it is for the sample that includes advanced economies. To this end, we constructed an enlarged panel of 53 countries with data starting at the earliest in 1980. In doing so, we had to overcome two issues.

The first relates to data availability, a common challenge in implementing the CCB in EMEs. For many EMEs, credit statistics are either not available for longer time spans (we need at least 20 years of data in order to properly assess the forecasting ability of the credit gap), or they are plagued by structural breaks. As we show in the next section, these breaks can affect very strongly the credit gap calculation. For 32 countries, we use total credit to the private non-financial sector from the BIS database.¹¹ For another 21 countries, we use bank credit to the private non-financial sector from the IMF's *International Financial Statistics*, requiring that data are available quarterly (as this suggests a minimum of data quality) and for at least three years prior to a crisis.

The second issue has to do with the classification of economies as advanced or emerging markets. For robustness, we split the sample in two different ways. The first simply classifies countries into emerging market and advanced economies. The second is based on the level of the credit-to-GDP ratio: we classify countries with a ratio below the (arbitrary) threshold of 100% as EMEs.¹² Both classifications have their shortcomings, but the thrust of the results is not sensitive to the choice.¹³

¹¹ Basel III suggests the use of data on total credit, capturing not only bank credit but all sources of credit, including bonds and cross-border finance, to the private non-financial sector. Drehmann (2013) shows that the credit gaps based on total credit outperform the credit gaps based on bank credit as early warning indicators for banking crises. Total credit series are available at www.bis.org/statistics/credtopriv.htm.

¹² If the credit-to-GDP ratio breaches 100% in the run-up to a crisis, this episode is considered to be part of the low credit-to-GDP sample.

¹³ EME = emerging market economy. Adv = advanced economy. <100 = credit-to-GDP ratio below 100%. If given, the date indicates the quarter when the ratio breached 100%. Algeria (EME, <100), Australia (Adv, <100 1986q2), Austria (Adv, <100 1990q2), Belgium (Adv, <100 1990q3), Brazil (EME, <100), Bulgaria (EME, <100), Canada (Adv, <100 1980q1), Chile (EME, <100), China (EME, <100 1998q2), Colombia (EME, <100), Croatia (EME, <100), the Czech Republic (EME, <100), Denmark (Adv, <100 1980q1), Estonia (EME, <100 2009q2), Finland (Adv, <100 1985q4), France (Adv, <100 1990q2), Germany (Adv, <100 1981q1), Greece (Adv, <100 2007q2), Hong Kong SAR (EME, <100 1988q4), Hungary (EME, <100 2005q4), Iceland (Adv, <100 2002q1), India (EME, <100), Indonesia (EME, <100 1998q1), Ireland (Adv, <100 1993q1), Israel (Adv, <100), Italy (Adv, <100 2005q3), Japan (Adv, <100 1980q1), Korea (EME, <100 1984q4), Latvia (EME, <100), Lithuania (EME, <100), Malaysia (EME, <100 1990q4), Mexico (EME, <100), the Netherlands (Adv, <100 1980q3), New Zealand (Adv, <100 1997q4), Norway (Adv, <100 1980q1), Peru (EME, <100), the Philippines (EME, <100), Poland

The left-hand panel of Graph 3 shows the performance of the credit-to-GDP gap as an early warning indicator for the two groups of countries. It plots the AUC for the indicator estimated for different country samples and different forecasting horizons.

The credit gap performs well for EMEs, albeit not as well as it does for the group of advanced economies. Regardless of the classification approach for EMEs (purple and yellow lines), the AUC remains above the 0.5 threshold, although it is below the level that corresponds to the sample of advanced economies (blue line). In fact, for forecasting horizons greater than three years, the AUC is marginally better than the uninformative benchmark value of 0.5. This deterioration in performance is very likely driven by the small number of crises in the EME samples (no more than 10 episodes in either classification).

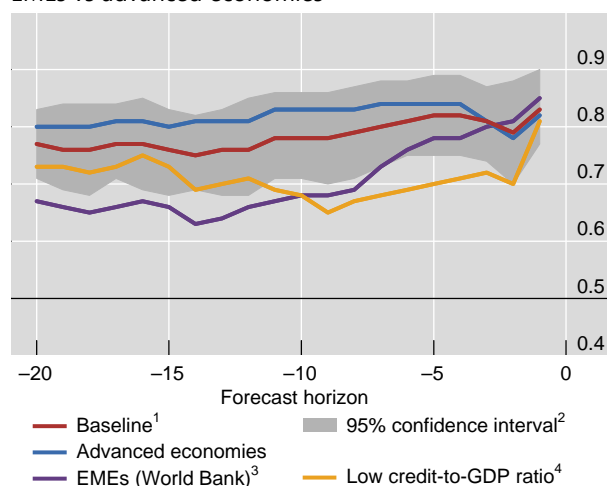
Another criticism of the credit gap with respect to its applicability for EMEs is that it may hinder beneficial financial deepening. As pointed out in World Bank (2010) or Reserve Bank of India (2013), economies that go through the process of financial development can experience prolonged periods of credit growth. To the extent that credit growth exceeds past norms, it could trigger increases in the CCB that could be a drag on further deepening and slow the process of catching up with financially more advanced economies.

The forecast performance of the credit-to-GDP gap

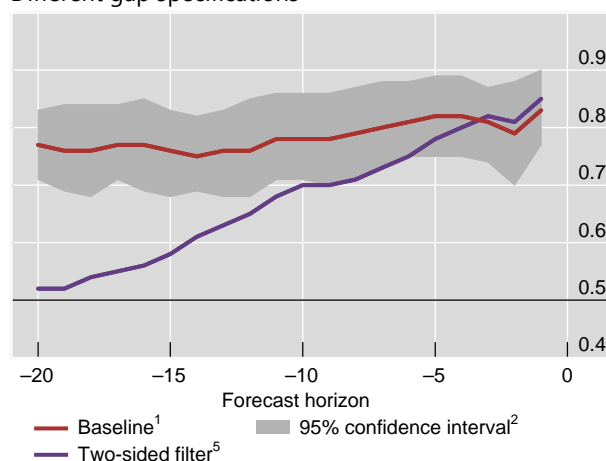
AUCs for different forecast horizons

Graph 3

EMEs vs advanced economies



Different gap specifications



The horizontal axis denotes the forecast horizons in quarters before crises. The vertical axis denotes the AUC. The horizontal line at 0.5 highlights the value of an uninformative indicator.

¹ As baseline, credit-to-GDP gaps are calculated by the standard methodology and the full sample of all countries is used. ² 95% confidence interval for the AUC using the baseline model. ³ EMEs according to World Bank classification. ⁴ Countries with a credit-to-GDP ratio below 100%. ⁵ The credit-to-GDP gap is derived by using the standard two-sided Hodrick-Prescott filter with the smoothing parameter lambda of 400000.

Source: Authors' calculations.

(EME, <100), Portugal (Adv, <100 1980q1), Romania (EME, <100), Russia (EME, <100), Saudi Arabia (EME, <100), Singapore (EME, <100 1985q4), South Africa (EME, <100), Spain (Adv, <100 1981q3), Sweden (Adv, <100 1980q1), Switzerland (Adv, <100 1985q2), Thailand (EME, <100 1991q1), Turkey (EME, <100), the United Arab Emirates (EME, <100), the United Kingdom (Adv, <100 1987q3), the United States (Adv, <100 1982q3) and Venezuela (EME, <100).

This issue relates to the calculation of the long-run trend. If financial deepening occurs at a steady pace, a gradual and persistent growth of credit will be embedded in the trend of the credit-to-GDP ratio and will not affect the gap. By contrast, rapid expansions of credit are likely to be flagged by the credit-to-GDP gap as periods of financial vulnerabilities. The flip side of this is that a protracted credit boom will weaken the credit gap's signalling ability, an aspect that concerns also advanced economies (Wolken (2013)). A prolonged but large steady increase in the credit-to-GDP ratio will eventually lead to a lower credit gap without necessarily implying that financial stability risks have receded. For example, the credit gap in the Netherlands signalled vulnerabilities from 1998 to 2004, but a systemic banking crisis emerged only in 2008 (admittedly also due to cross-border factors).

These problems highlight the risk from a mechanical use of the credit gap. Policymakers have to assess whether in these situations credit levels are sustainable or whether they are a source of aggregate vulnerability. In practice, and in line with the Basel III proposal, this can only be done by looking at a range of different indicators rather than relying on any mechanical rule.

Measurement problems and the credit-to-GDP gap

Several authors have argued that the performance of the credit-to-GDP gap can be severely hampered by measurement problems. The majority of these problems relate to the calculation of the long-term trend of the ratio. We will tackle them first, before briefly commenting on measurement noise from statistical revisions relating to the ratio itself.

Basel III specifies that the long-term trend of the credit-to-GDP ratio should be calculated using the time series filter suggested by Hodrick and Prescott (1981) (HP filter) with a suitably large smoothing parameter. Critics have pointed to two potential measurement problems in this calculation. The first problem is linked to the stability of the filter's outcome as new data points become available. The second problem arises because structural breaks in the underlying series can have an important effect on the calculation of the trend. We discuss these aspects below.

Following the original work by Borio and Lowe (2002), the long-term trend of the credit-to-GDP ratio is calculated by means of a one-sided (ie backward-looking) HP filter. The filter is run recursively for each period, and the ex post evaluation of performance of the credit gap is based on this recursive calculation. Thus, a trend calculated for, say, end-1988 only takes account of information up to 1988 even if this calculation is done in 2008 when more observations have become available. As specified in Basel III, the filter uses a much larger smoothing parameter than the one employed in the business cycle literature involving quarterly data.¹⁴ This choice can be motivated by the observation that credit cycles are on average about four times longer than standard business cycles and crises tend to occur once every 20–25 years.¹⁵ It turns out that this specific choice of the smoothing parameter also

¹⁴ Hodrick and Prescott (1981) set λ equal to 1600. Ravn and Uhlig (2002) show that, for series of other frequencies (daily, annual etc), it is optimal to set λ equal to 1600 multiplied by the fourth power of the observation frequency ratio. Borio and Lowe (2002) suggest that, for the credit-to-GDP gap, λ be set equal to 400000.

¹⁵ See BCBS (2010).

delivers the credit-to-GDP gap with the best forecasting performance (Drehmann et al (2011)).

The HP filter suffers from a well-known end point problem.¹⁶ This means that the estimated trend at the end point (the most recent observation) can change considerably as future data points become available. Since Basel III prescribes that the trend be calculated recursively, policy decisions are always based on a trend that consists only of end points. Edge and Meisenzahl (2011) argue that the backward revision of the trend (and, by consequence, also the deviation of the ratio from the trend) renders the credit gap unreliable as a guide for the CCB.

Drehmann et al (2011) and van Norden (2011) note that the end point problem does not invalidate the signalling ability of the credit-to-GDP gap. From a practical perspective, it would be impossible for the policymaker to apply a two-sided filter since the future is not observable. But even if policymakers did somehow know the future values of the credit-to-GDP ratio and calculated credit gaps based on this knowledge, the resulting indicator would not outperform the gap calculated with the backward-looking HP filter except for exceedingly short forecast horizons of less than four quarters (purple line in Graph 3, right-hand panel). For policy-relevant horizons, the gap based on the one-sided filter (red line) performs much better than the gap calculated with the two-sided filter. Nevertheless, Gerdrup et al (2013) suggest an alternative approach to the problem of trend stability. At each end point, they extend the sample by five years with forecasts of the credit-to-GDP ratio and calculate a two-sided filter for this augmented series. They find that the resulting credit gap has good forecasting performance for Norway. By contrast, Farrell (2013) finds that this approach worsens the credit gap's performance, especially during pronounced credit booms.

A similar problem arises at the beginning of the time series used to compute the credit gap. Geršl and Seidler (2012) point out that the trend calculation can depend significantly on the starting point of the data. This is particularly important for short data series, which is the case in several EME countries. To assess the severity of this problem more formally, we use an estimated time series model to generate 100 artificial series of credit-to-GDP ratios, each 400 quarters long.¹⁷ For each of these hypothetical series, we computed two series for the credit-to-GDP gap: one starting from the beginning of the simulated data, and another starting 20 quarters later. We then compare the two gap series for the 380 observations over which the two overlap. In line with this approach, we also estimate a second series of gaps for our actual data, starting 20 quarters after the first observation of the credit-to-GDP ratio in each country.

Graph 4 shows that the starting point for estimating the trend can have major implications for the measurement of the gap. While the median difference between the two gaps across the 100 hypothetical series is less than half a percentage point after 40 quarters, the 25th and 75th percentiles of the distribution of simulated differences show gaps of up to 4 percentage points at the same horizon (left-hand panel). The problem is less severe when we use actual data from our panel (centre panel), although even in this case it can take 20 years for measurement differences to fully disappear.

¹⁶ See eg Orphanides and van Norden (2002).

¹⁷ The model postulates that the credit-to-GDP ratio follows an AR(2) process with positive drift. Its coefficients and error variance are estimated using a random-effects regression for our panel of countries.

But in practice, the impact of this mismeasurement is not as great as the above figures suggest. For one, the forecast performance of the two differently derived gaps in the actual data is the same (Graph 4, right-hand panel). Furthermore, even if there are differences in the gaps, the differences in the resulting CCB levels are small. If one were to apply the Basel III rule mechanically, the CCB is set to zero for values of the credit gap below 2 percentage points and capped at 2.5% for values of the gap above 10. Given this transformation, the difference in the CCB levels driven by the start point problem is 0 in most cases after 10 years. Even at extreme ends of the distribution, the difference is smaller than 1 percentage point.

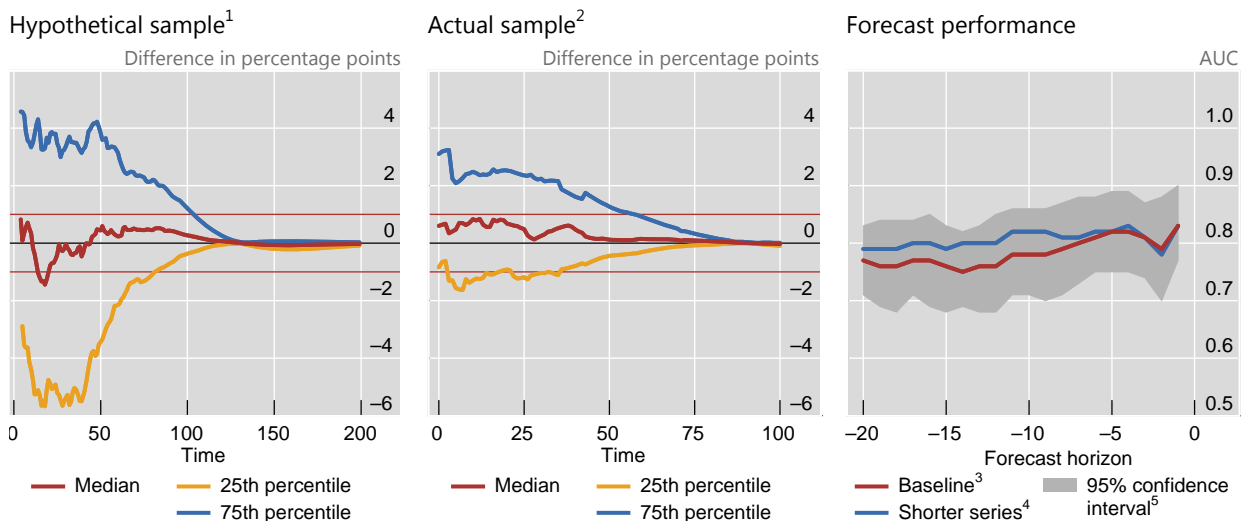
Overall, these results validate the practical rule of thumb that suggests using the credit gap only when at least 10 years of data for the credit-to-GDP ratio are already available. This was originally suggested by Borio and Lowe (2002) and adopted in BCBS (2010).

In particular situations, caution is warranted nonetheless. Closer examination of the simulated data shows that large differences between the gaps calculated on shorter and longer samples tend to arise in situations where the shorter sample starts near the peak or the trough of the financial cycle. In these instances, the trend stays too high or too low for a long period. This was the case for transition economies during the 1990s. In these contexts, policymakers may consider dropping some initial data points. As more data become available, the problem becomes less important for policymaking, although it remains an issue for the ex post assessment of the performance of the credit gap.

Structural breaks in the credit-to-GDP series present similar challenges to the start point problem discussed above (FitchRatings (2010), World Bank (2010)). Graph 5 (left-hand panel) illustrates the effect of such a statistical break assuming

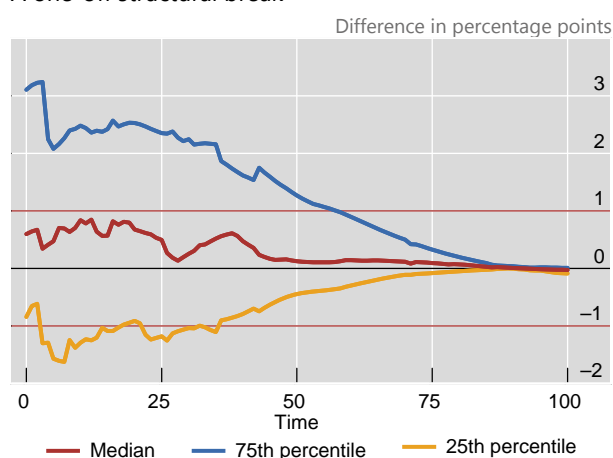
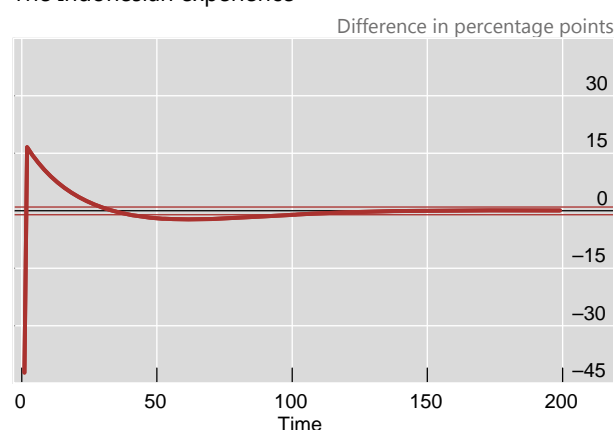
The start point problem

Graph 4



¹ Distribution of the difference between credit-to-GDP gaps when measurement starts at the beginning of the 100 hypothetical series or 20 quarters afterwards. 1 in the time line corresponds to the first time the shorter series are available. The red horizontal lines indicate ± 1 percentage point. ² Distribution of the difference between credit-to-GDP gaps when measurement starts at the beginning of the actual data or 20 quarters afterwards. Dates in the actual time series are normalised so that 1 in the time line corresponds to the first time the shorter series are available. The red horizontal lines indicate ± 1 percentage point. ³ As baseline, credit-to-GDP gaps are calculated by applying the standard methodology and the full sample of all countries is used. ⁴ The first five years of available credit-to-GDP ratios are not used to determine the trend, which is calculated in the standard fashion. ⁵ Of the AUC for the baseline model.

Source: Authors' calculations.

A one-off structural break¹The Indonesian experience²

¹ Effect of a 10 percentage point structural break in the credit-to-GDP ratio on the measurement of the credit-to-GDP gap. ² Effect of a change in the credit-to-GDP ratio in line with Indonesia's experience during the Asian financial crisis on the measurement of the credit-to-GDP gap.

Source: Authors' calculations.

that the credit-to-GDP ratio jumps by 10 percentage points. The Japanese total credit series registered a break of similar magnitude in 1998 due to a change in the way the series was compiled. The simulation shows that it takes more than 20 years for such an effect of this magnitude to fully disappear, underscoring the importance of properly adjusting the underlying series for breaks prior to use as a guide for policy.¹⁸

Economic factors can also create jumps in the credit-to-GDP series similar to statistical revisions. For example, during the Asian crisis, in Indonesia a combination of foreign currency loans, rapid devaluation and large-scale defaults led to a 50 percentage point jump in the credit-to-GDP ratio followed by a 6 percentage point drop. A simulation of this very dramatic swing (Graph 5, right-hand panel) suggests that such events can impact the measurement of the credit-to-GDP gap for around 10 years. Their influence on the signalling function of the credit gap must be understood prior to the series being used in the context of the CCB.

Lastly, another measurement issue is linked to routine statistical revisions in the underlying data. This is a problem with economic variables that policymakers often have to grapple with. In the case of the credit gap, the main concern is that it can impair its signalling performance. Edge and Meisenzahl (2011) carefully evaluate the impact of revisions to the credit-to-GDP gap in the United States and find that they have an impact on gap estimates. However, they also find that this impact is contained and much smaller than variations in the trend estimate due to the end point problem, discussed above. Gerdrup et al (2013) and Farrell (2013) argue along the same lines for Norwegian and South African data, respectively.

¹⁸ The new BIS total and bank credit series are available as raw and break-adjusted series.

Conclusion

We have reviewed the main practical and conceptual criticisms of the credit-to-GDP gap as a guide to setting countercyclical capital buffers under Basel III.

From a practical perspective, there are relevant measurement issues with the credit gap, which critics have pointed out. In particular, the length of the underlying series for the credit-to-GDP ratio and thus the starting point for calculating the trend matter. Structural breaks in the credit-to-GDP ratio can also have long-lasting effects. Our simulations indicate that it is important to properly adjust the data for structural breaks. In addition, a valid rule of thumb suggests using the credit gap only for credit-to-GDP series with at least 10 years of available data.

We argue that the conceptual criticism that the credit gap is not aligned with the buffer's objective misinterprets this objective and, by extension, the envisaged role of the guide. The CCB framework provides supervisors with an instrument to increase capital in order to protect banks from the bust phase of the financial cycle. It is not an instrument to manage the cycle, even if it may potentially have a smoothing impact. From this viewpoint, its usefulness must be judged exclusively on whether it provides policymakers with reliable signals about when to raise the buffer. Reviewing the evidence, we show that the credit-to-GDP gap is on average (across many countries and several decades) the best *single* indicator in this context, including for emerging market economies. This does not mean that there are no composite indicators that may perform better, or single indicators that may provide clearer signals either in the context of individual countries or at particular points in time. But it does mean that even in those cases the credit gap is a very useful common reference point and helps frame the discussion.

This is a central feature of a CCB framework which combines rules and discretion. There are no foolproof models that can deliver an effective rule-based countercyclical instrument. Policymakers are expected to use judgment as well as quantitative analysis within the parameters of the framework. But they are also expected to communicate the rationale of their decisions clearly. The credit gap can be instrumental in this process.

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Non-deliverable forwards: 2013 and beyond¹

Non-deliverable forwards (NDFs) allow investors and borrowers to take positions in currencies that are subject to official controls. Turnover in NDFs has risen in recent years as non-residents use them to hedge increasing investment in local currency bonds. Pricing in deliverable forward and NDF markets is segmented, with NDFs leading in times of strain. Experience shows that NDF markets tend to fade away gradually after liberalisation. But, looking ahead, market centralisation might reduce the costs of maintaining them. In a unique development, offshore deliverable renminbi forwards are gaining on the established NDF.

JEL classification: F31, G15, G18.

Non-deliverable forwards (NDFs) are contracts for the difference between an exchange rate agreed months before and the actual spot rate at maturity. The spot rate at maturity is taken as the officially announced domestic rate or a market-determined rate. The contract is settled with a single US dollar payment. Thus NDFs yield payoffs related to a currency's performance without providing and requiring funding in the underlying currencies as do deliverable forwards.

NDFs trade principally outside the borders of the currency's home jurisdiction ("offshore"). This enables investors to circumvent restrictions on trading in the home market ("onshore") and limits on delivery of the home currency offshore. Market participants include direct and portfolio investors wishing to hedge currency risk and speculators (Ma et al (2004)). Banks and firms with onshore and offshore operations arbitrage, and thereby reduce, differences in forward rates. In recent years the growing importance of non-resident investors in local currency bond markets has increased the salience of NDF markets, particularly in times of strain.

This special feature provides answers to three questions. First, how big was the NDF market in 2013, and what can be said about its growth? Second, how does pricing of NDFs differ from that of onshore deliverable forwards, and where are prices discovered, especially in stressed markets? And third, how might NDFs evolve?

In 2013, the BIS Triennial Central Bank Survey showed that NDFs constitute only a fifth of the global foreign exchange market in outright forwards and a tiny fraction

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of overall foreign exchange trading. For the separately identified NDFs, however, dollar NDFs represent three quarters of all dollar forwards in the six currencies detailed by the survey. Data from the Bank of England on London trading, from the Depository Trust & Clearing Corporation (DTCC) and from an electronic broker show that the market for NDFs grew rapidly from April 2008 to April 2013, but its development since April 2013 is less clear.

By analysing the relationship between the prices of NDFs and deliverable forwards, the feature finds that the segmentation between deliverable forwards and NDFs is evident in deviations from the law of one price. The NDF market tends to lead the domestic market, especially in stressed periods.

Looking forward, we chart two paths for the evolution of NDFs. With capital account opening, offshore and onshore markets can merge. But this seems to take time. There is also a different path, taken by the Korean won. Its deliverable and non-deliverable markets persist in parallel even as arbitrage joins them and markets deepen. The Chinese renminbi's recent internationalisation follows neither path and the offshore deliverable renminbi is outcompeting the NDF.

How big is the NDF market and how fast is it growing?

The latest Triennial Survey reported \$127 billion in daily NDF turnover (Table 1). This represented 19% of all forward trading globally and 2.4% of all currency turnover. Almost two thirds took place in six currencies against the dollar, for which the survey obtained detail. Like forward markets and emerging market currencies in general, a very high share of NDF trading (94%) takes place against the dollar.

Data published by the London Foreign Exchange Joint Standing Committee show that London accounts for 36% of NDF trading.² Asian centres are especially important

Global and London NDF turnover

Daily turnover in millions of US dollars, April 2013

Table 1

| | USD | | | | | | | | EUR | JPY | Other | Total |
|---------------------------|--------------|--------------|--------------|--------------|--------------|------------|---------------|---------------|--------------|------------|------------------------|---------------|
| | BRL | CNY | INR | KRW | RUB | TWD | Other | Total | | | | |
| Global | | | | | | | | | | | | |
| Net-net ¹ | 15,894 | 17,083 | 17,204 | 19,565 | 4,118 | 8,856 | 36,790 | 119,510 | 1,642 | 973 | 4,438 | 126,563 |
| Net-gross ² | 19,928 | 23,696 | 22,678 | 29,086 | 4,975 | 12,131 | 45,309 | 157,803 | 1,916 | 1,156 | 5,478 | 166,353 |
| London² | 12,315 | 5,970 | 10,471 | 8,735 | 4,225 | ... | 16,530 | 58,246 | 1,260 | ... | 5083 | 60,019 |
| <i>Memo:</i> | | | | | | | | | | | | |
| <i>Oct 2013</i> | <i>8,141</i> | <i>4,453</i> | <i>6,014</i> | <i>6,807</i> | <i>2,291</i> | <i>...</i> | <i>13,794</i> | <i>41,500</i> | <i>1,044</i> | <i>...</i> | <i>414³</i> | <i>42,959</i> |

BRL = Brazilian real; CNY = Chinese renminbi; EUR = euro; INR = Indian rupee; JPY = Japanese yen; KRW = Korean won; RUB = Russian rouble; TWD = New Taiwan dollar; USD = US dollar.

¹ Adjusted for local and cross-border inter-dealer double-counting. ² Adjusted for local inter-dealer double-counting. ³ Includes sterling.

Sources: Bank of England; Triennial Central Bank Survey; authors' calculations.

² Note, however, that the Triennial Survey allocates trading by the location of the sales desk, while the London survey does so by the location of the trading desk. Because two big banks have moved their sales desks out of London but still trade there, the London share on the sales desk basis is only about a third of net-net turnover.

for NDFs in the renminbi (Ehlers and Packer (2013)) and, to a lesser extent, the Korean won.

The relationship between location and deliverability

Onshore trading is concentrated in deliverable forwards and offshore trading is specialised in NDFs. As shown in the top section of Table 2, NDF trading represents 72% of all forward trading in the featured currency pairs, and offshore trading 87%. Based on these observations, one would expect 62% of forward trading to occur in NDFs offshore ($72\% \times 87\% = 62\%$). In fact, the percentage is even higher, 68%. Correspondingly, there is more onshore deliverable trading than one would expect. Indeed, the chi-squared test strongly rejects the independence of trading and deliverability, confirming the concentration of deliverable forwards onshore and NDFs offshore.

The remaining sections of Table 2 make clear that the strength of the relationship varies across the six currency pairs (though it is highly statistically significant in all cases). Segmentation is strongest in the Indian rupee, followed by the renminbi,³ the Brazilian real, the Korean won, the New Taiwan dollar and finally the Russian rouble.

The strength of this relationship testifies to the robustness of the controls separating the onshore and offshore markets. In India, the sense that NDF activity

Trade location and deliverability of forwards

Daily turnover in millions of US dollars, April 2013

Table 2

| Six currencies | DFs | NDFs | Total | Memo % | DFs | NDFs | Total |
|-----------------------|------------|-------------|--------------|--------------------------|------------|-------------|--------------|
| Onshore | 10,138 | 4,550 | 14,688 | <i>Onshore</i> | 8.9% | 4.0% | 12.8% |
| Offshore | 21,543 | 78,170 | 99,713 | <i>Offshore</i> | 18.8% | 68.3% | 87.2% |
| Total | 31,680 | 82,720 | 114,401 | Total | 27.7% | 72.3% | 100.0% |
| Brazilian real | DFs | NDFs | Total | Chinese renminbi | DFs | NDFs | Total |
| Onshore | 2,709 | 559 | 3,268 | Onshore | 2,441 | – | 2,441 |
| Offshore | 6,908 | 15,335 | 22,243 | Offshore | 7,102 | 17,083 | 24,185 |
| Total | 9,617 | 15,894 | 25,511 | Total | 9,543 | 17,083 | 26,626 |
| Indian rupee | DFs | NDFs | Total | Korean won | DFs | NDFs | Total |
| Onshore | 3,140 | – | 3,140 | Onshore | 1,118 | 3,538 | 4,656 |
| Offshore | 1,879 | 17,204 | 19,083 | Offshore | 1,410 | 16,027 | 17,437 |
| Total | 5,019 | 17,204 | 22,223 | Total | 2,528 | 19,565 | 22,094 |
| Russian rouble | DFs | NDFs | Total | New Taiwan dollar | DFs | NDFs | Total |
| Onshore | 512 | 231 | 743 | Onshore | 218 | 222 | 440 |
| Offshore | 3,187 | 3,887 | 7,074 | Offshore | 1,057 | 8,634 | 9,691 |
| Total | 3,699 | 4,118 | 7,817 | Total | 1,274 | 8,856 | 10,130 |

DFs = deliverable forwards; NDFs = non-deliverable forwards. Data are reported on a net-net basis, ie adjusted for local and cross-border inter-dealer double-counting. Chi-squared statistics strongly reject the null hypothesis of no relationship between location and deliverability: 14,375 for all six currencies; 3,260 for BRL; 4,811 for CNY; 12,534 for INR; 920 for KRW; 154 for RUB; 572 for TWD. The critical value for $p = .0005$ is 12, so all are highly statistically significant.

Sources: Triennial Central Bank Survey; authors' calculations

³ See Ma and McCauley (2013) for a multidimensional comparison of China and India.

strongly affected the domestic market in August 2013 has led to discussion of how to bring NDF trading into the domestic market (see below). From 2010, the relationship for the renminbi weakened when an offshore deliverable forward market started trading in parallel with the onshore deliverable forward and offshore NDF markets (McCauley (2011, Graph 1)). In Korea and Chinese Taipei, some domestic financial firms are allowed to trade NDFs (Tsuyuguchi and Wooldridge 2008), Annex A). The rouble foreign exchange market was liberalised in mid-2006.

Growth of the NDF market

NDF turnover grew rapidly in the five years up to April 2013, in line with emerging market turnover in general (Rime and Schrimpf (2013)). Following Bech and Sobrun (2013), we examine partial data since April 2013, which raise the question of how much the growth through April reflected a search for yield.

London surveys show that the NDF market grew faster than the forward market or the foreign exchange market as a whole from April 2008 to April 2013 (Table 3). During those five years, NDF turnover doubled its share to 2.4% of overall turnover and 23% of forwards. Looking further back, there is no doubt that NDF trading has grown: the turnover in Asian NDFs in Table 1 is at least 10 times estimates of their turnover from the early 2000s (Ma et al (2004), Kim and Song (2010)).

Since April 2013, NDF trading has been affected by investors' and borrowers' hedging in anticipation of a reduction in global monetary easing. Over the last several years, investors poured large sums into emerging market local currency bonds, and in some markets increased their holdings to substantial shares of outstanding bonds. For their part, many emerging market firms that had used their unprecedented access to the global dollar (and euro) bond market to fund domestic assets also had exposures to hedge.

NDF trading in London¹

Average daily volume, in billions of US dollars

Table 3

| | NDFs | All forwards ² | NDFs as % of all forwards | All FX | NDFs as % of all FX | <i>Memo: Tokyo NDF³</i> |
|----------|------|---------------------------|------------------------------|--------|------------------------|--|
| Apr 2008 | 23 | 200 | 11.5 | 1,832 | 1.3 | 2.4 |
| Oct 2008 | 19 | 230 | 8.3 | 1,699 | 1.1 | ... |
| Apr 2009 | 16 | 162 | 9.9 | 1,356 | 1.2 | 0.3 |
| Oct 2009 | 26 | 191 | 13.6 | 1,522 | 1.7 | ... |
| Apr 2010 | 25 | 186 | 13.4 | 1,687 | 1.5 | 0.3 |
| Oct 2010 | 37 | 188 | 19.7 | 1,787 | 2.1 | ... |
| Apr 2011 | 42 | 192 | 21.9 | 2,042 | 2.1 | 1.6 |
| Oct 2011 | 37 | 192 | 19.3 | 2,038 | 1.8 | ... |
| Apr 2012 | 36 | 192 | 18.8 | 2,014 | 1.8 | 1.4 |
| Oct 2012 | 45 | 211 | 21.3 | 2,017 | 2.2 | 1.9 |
| Apr 2013 | 60 | 265 | 22.6 | 2,547 | 2.4 | 2.4 |
| Oct 2013 | 43 | 205 | 21.0 | 2,234 | 1.9 | 1.9 |

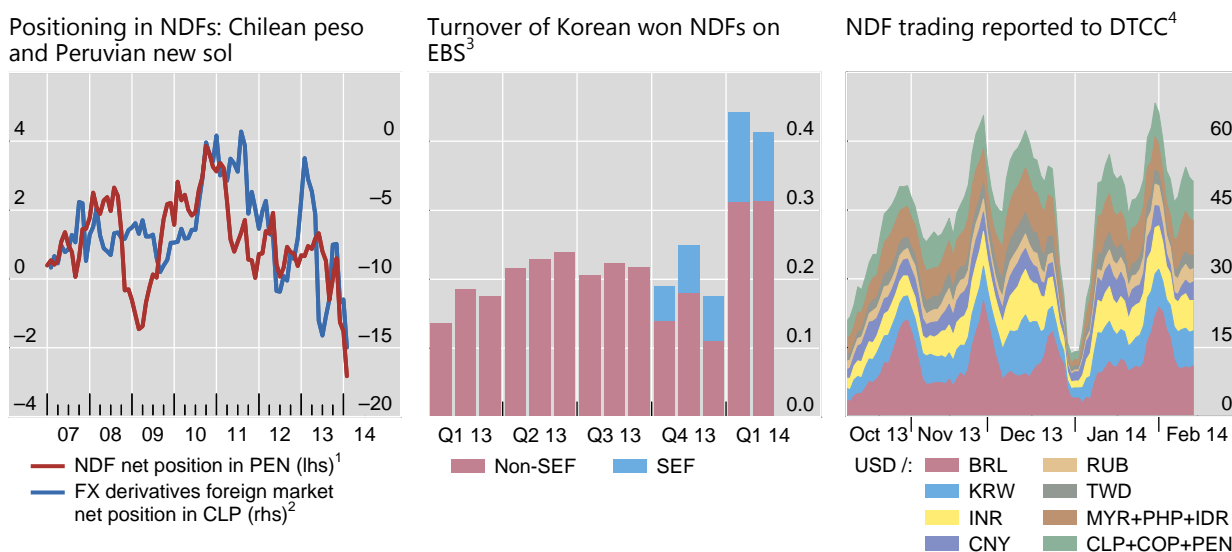
¹ Adjusted for local and cross-border inter-dealer double-counting. ² Non-deliverable forwards and outright forwards. ³ Transactions in Asian and other emerging market currencies.

Sources: London Foreign Exchange Joint Standing Committee; Tokyo Foreign Exchange Market Committee.

Positioning and activity in selected NDF markets

In billions of US dollars

Graph 1



BRL = Brazilian real; CLP = Chilean peso; CNY = Chinese renminbi; COP = Colombian peso; IDR = Indonesian rupiah; INR = Indian rupee; KRW = Korean won; MYR = Malaysian ringgit; PEN = Peruvian new sol; PHP = Philippine peso; RUB = Russian rouble; TWD = New Taiwan dollar; USD = US dollar; SEF = swap execution facility.

¹ Of counterparties of commercial banks in Peru. ² Of the Chilean formal exchange market; includes some deliverable forwards. ³ One-month USD/KRW NDFs, average daily volume; data through 24 February 2014. ⁴ Total notional amounts by currency, five-day moving average. From Clarus Financial Technology, based on DTCC data.

Sources: Central Bank of Chile; Central Reserve Bank of Peru; Clarus Financial Technology; EBS.

Surprisingly, when seemingly impending “tapering” by the US Federal Reserve led investors to reduce their exposures to emerging market bonds, some markets experienced little net selling. Instead, investors sold local currencies in well-functioning forward currency markets, including NDFs. These served as what Chang (2013) called the “main adjustment valve”, allowing investors to hedge the currency risk in their bond holdings.⁴

For instance, in the smaller markets of Chile and Peru,⁵ where the central bank measures not just turnover but also net positions, the data show a sharp turnaround in positioning in May–June 2013. The left-hand panel of Graph 1 shows stocks of long positions in the Chilean peso and Peruvian new sol. The larger stock of positions in Chile declined by \$9 billion between end-April and end-June 2013. The smaller position in Peru declined by \$2 billion between end-May and end-August. NDFs were used to reduce net exposures, while the Peruvian data show a decline in turnover consistent with the London data for October 2013 discussed below.

Regulatory changes promising high-frequency and granular reporting of trades also buffeted the NDF market in the latter half of 2013. Global efforts to shift derivatives markets to more transparent trading venues and to centralise clearing

⁴ Chang (2013, pp 14–15) shows that rising bond yields tracked falling currencies, allowing the liquid foreign exchange market to proxy hedge rates as well. See also the results of Eichengreen and Gupta (2013), who find that larger, more liquid markets felt more pressure during the tapering episode.

⁵ Which together reported trades of about \$6 billion per day to the DTCC in January 2014.

include not just swaps but also NDFs. In mid-2013, the US Commodity Futures Trading Commission (CFTC) required that NDF trading involving a US resident be reported to the DTCC starting in October 2013 and that NDFs traded on multilateral platforms be transacted on an authorised swap execution facility. Market participants expect the CFTC to mandate centralised clearing of NDFs in 2014, and pending European legislation to do so in 2015. Meanwhile, post-trade transparency and regulation of multilateral trading venues were implemented for US residents in October 2013.

The London data indicate a sharp contraction (28%) in NDF turnover in October 2013 (Tables 1 and 3). The dollar/yen spot apart, this contraction was larger than that for the foreign exchange market in general, and only part of the contraction can be ascribed to the depreciation of the emerging market currencies.

However, daily DTCC data show higher turnover since October 2013. Trades reported to the DTCC have reached \$40–60 billion a day (Graph 1, right-hand panel). This is equivalent to a third to a half of the global volume in April 2013. Data on one-month Korean won NDFs traded on the electronic broker EBS also show strong turnover in January 2014 (Graph 1, centre panel).

All in all, despite the huge amounts of data now available, it is difficult to reach a firm conclusion on the trend of NDF turnover since the Triennial Survey. Some of the growth to April 2013 may have reflected the cyclical search for yield.

How do deliverable forward and NDF pricing differ?

Effective capital controls can drive a wedge between on- and offshore exchange rates, especially at times of market strain. In this section, after documenting the deviations, we test which market, onshore or offshore, provides leading prices. Then we examine how the two markets respond differently to global factors.

Forward rate differentials

Differences between deliverable forward and NDF rates reflect the effectiveness of capital controls. On the whole, deviations are largest for the renminbi and the Indian rupee, as well as the Indonesian rupiah and Philippine peso (Table 4). The liberalised Russian rouble serves as a benchmark, with much narrower differentials.

The pricing differentials tend to widen sharply in stressed market conditions (Table 4). The 2008–09 global financial crisis witnessed a spike in pricing deviations across the board. Market strain also occurred in May–August 2013 during the sell-off in emerging market currencies, bonds and equities. Yet, with the exception of Indonesia, nothing happened like the fracturing of the markets observed during the global crisis. This suggests that the NDF market still functioned reasonably as the main adjustment valve for asset managers holding long positions in local bonds and firms with unhedged dollar bonds outstanding.

Interpreting lead-lag relationships

If the deliverable and non-deliverable forward markets are segmented, which market moves first and subsequently influences the pricing of the other? One way

Onshore less offshore foreign exchange forward premia¹

Average of absolute value as a percentage of spot price, for three-month contracts

Table 4

| | Full sample | Non-crisis | Global financial crisis | Taper fears (May–Aug 2013) |
|-----|-------------|------------|-------------------------|----------------------------|
| CNY | 0.43 | 0.41 | 0.59 | 0.48 |
| INR | 0.44 | 0.35 | 1.17 | 0.57 |
| IDR | 0.82 | 0.56 | 2.37 | 2.53 |
| KRW | 0.30 | 0.23 | 0.90 | 0.25 |
| MYR | 0.29 | 0.26 | 0.51 | 0.26 |
| PHP | 0.44 | 0.31 | 1.62 | 0.24 |
| TWD | 0.39 | 0.38 | 0.59 | 0.10 |
| BRL | 0.22 | 0.18 | 0.60 | 0.17 |
| RUB | 0.08 | 0.08 | 0.08 | 0.10 |

BRL = Brazilian real; CNY = Chinese renminbi; IDR = Indonesian rupiah; INR = Indian rupee; KRW = Korean won; MYR = Malaysian ringgit; PHP = Philippine peso; RUB = Russian rouble; TWD = New Taiwan dollar.

¹ Daily data for the forward premium gap are calculated as the difference between onshore forward and offshore NDF rates as a percentage of the spot price. Full sample = January 2005–December 2013; global financial crisis = September 2008–July 2009; non-crisis = rest of sample period.

Sources: Bloomberg; CEIC; authors' calculations.

of approaching this question is to measure which market leads the other in the sense of today's rate in one market providing a useful clue to tomorrow's rate in the other. Previous studies of the won, Indian rupee and Indonesian rupiah tend to show that there is two-way influence between deliverable forwards and NDFs in normal times, but that the NDF market drives the domestic market during more volatile periods (Misra and Behera (2006), Kim and Song (2010), Behera (2011), Cadarajat and Lubis (2012) and Goyal et al (2013)).⁶

We broadly confirm this finding. We analyse the direction of influence for nine currencies in 2005–13 as well as separately for the 2008–09 crisis and May–August 2013. Granger causality tests point to two-way causation for most currencies for the full sample (Table 5). The exception is the Malaysian ringgit, where the NDF influences the deliverable forward market. There is no case where the deliverable rate leads the NDF.

Analysis of the two subsample periods shows that the NDF's influence seems to increase during market stress. During the global financial crisis, the NDF tended to lead the onshore market. A rise in the influence of the NDF was even more noticeable in May–August 2013 (eight out of nine cases). In India, the impression that the offshore NDF drove the domestic market in summer 2013 has reportedly prompted consideration of opening up the domestic market to foreign investors (Sikarwar (2013)).

However, not too much should be read into this finding, no matter how sophisticated the econometrics. One often ignored subtlety is that the price change in the NDF market is measured at the close in London or New York, whereas the domestic forward is measured at the close in the domestic market, generally in a

⁶ Such results are robust to use of different econometric methodologies, including Granger causality tests, autoregressive models with time-varying volatility and co-integration analysis.

Granger causality test for three-month deliverable forwards and NDFs

Table 5

| | | CNY | IDR | INR | KRW | MYR | PHP | TWD | BRL | RUB | |
|-------------------------|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Full sample | DF | ↔ | ↔ | ↔ | ↔ | ← | ↔ | ↔ | ↔ | ↔ | NDF |
| Non-crisis | | ↔ | ↔ | ↔ | ← | ← | ↔ | ↔ | ↔ | ↔ | |
| Global financial crisis | | ← | ↔ | × | ← | ← | ← | ← | × | ← | |
| Taper fears | | ← | ← | ← | ← | ← | ← | × | ← | ← | |

BRL = Brazilian real; CNY = Chinese renminbi; IDR = Indonesian rupiah; INR = Indian rupee; KRW = Korean won; MYR = Malaysian ringgit; PHP = Philippine peso; RUB = Russian rouble; TWD = New Taiwan dollar.

Full sample = January 2005–December 2013; global financial crisis = September 2008–July 2009; taper fears = May–August 2013; non-crisis = rest of sample period. The lag selection is based on the Schwarz information criterion. ↔ indicates two-way causality between DF and NDF rates; ← indicates the NDF causes the DF; × indicates no relationship.

Sources: Bloomberg, authors' estimations.

different time zone. For Asian currencies, the London or New York close reflects news from Europe and the US morning that arrives after the domestic market has closed. Thus, it is not surprising that the NDF market moves the domestic forward market on the following day, especially when financial markets are more volatile. The Granger causality test for the Brazilian real is much more revealing given more proximate time zones.

All that said, how NDF trading in the home currency affects pricing in the domestic market is still of interest to market participants and central bankers. For Asian markets, the influence of NDF market action must be understood as reflecting news flows after the Asian market close as well as a more global set of market participants.

The response of deliverable forward and NDF rates to global factors

A different exercise is to ask how global factors affect pricing in the two markets. Consistent with the discussion above, we use observations on global factors that match the observations on domestic forwards. Thus we use Tokyo closing rates for the major currencies to analyse East Asian domestic forward rates, London rates for the rupee and the rouble, and New York closing rates for the real.

Table 6 shows that both deliverable forwards and NDFs generally respond to global factors. Following Cairns et al (2007), we supplement the (Haldane and Hall / Frankel and Wei) regression of a given currency on the major currencies with an indicator of global risk – the VIX. That is, we regress both the deliverable forward and NDF of a given currency on percentage changes in the euro/dollar forward rate, the yen/dollar rate and the VIX. If the forward rate is affected by global risk conditions, a rise in the VIX would lead to a depreciation, ie an increase in the forward rate defined as above. Note that we lag the VIX for the Asian currencies, using the previous day's New York close.

The estimation results suggest that, by and large, domestic markets, not just NDFs, incorporate global factors. In particular, contemporaneously measured major exchange rates figure similarly in both deliverable forwards and NDFs. The only cases where global factors seem to figure much more in the NDF rate are the renminbi, Indian rupee and Indonesian rupiah.

How do NDF markets evolve?

Two different paths for the evolution of NDF markets can be distinguished. First, if non-residents are allowed to buy and sell forwards domestically – in effect, to lend and to borrow domestic currency – such liberalisation makes an NDF market unnecessary. But the NDF market does not necessarily go away immediately. Second, if restrictions remain, the NDF persists. However, markets can still develop based on the NDF.

One example of the first path is the Australian dollar. Debelle et al (2006) tell the surprising story of the slow passing of the Australian dollar NDF. Deliverable forwards opened up in 1983, but the NDF continued to trade, lingering until 1987.

The NDF share of trading in the rouble has declined even more gradually. The Russian authorities made the rouble fully convertible in mid-2006 amid current account surpluses, large foreign exchange reserves and ambitions for its international use. Since then, the London data show that NDFs fell from 75–80% of

Elasticity of three-month forward rates to major currencies and the VIX

Table 6

| Deliverable | BRL | CNY | IDR | INR | KRW | MYR | PHP | RUB | TWD |
|----------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
| €/ \$ | 0.522** (15.196) | 0.038** (8.917) | 0.183** (8.567) | 0.052** (2.752) | 0.403** (15.692) | 0.250** (20.305) | 0.173** (12.745) | 0.644** (34.456) | 0.145** (16.912) |
| ¥/ \$ | -0.162** (-5.019) | 0.010* (2.397) | -0.059** (-2.852) | 0.005 (0.294) | -0.229** (-9.149) | -0.054** (-4.474) | -0.068** (-5.125) | -0.148** (-8.611) | 0.005 (0.640) |
| VIX | 0.047** (14.733) | 0.000 (0.423) | 0.015** (7.971) | 0.012** (7.270) | 0.021** (8.844) | 0.012** (10.760) | 0.011** (9.095) | 0.008** (5.040) | 0.007** (8.889) |
| Observations | 2,088 | 1,974 | 2,107 | 1,927 | 2,014 | 1,876 | 2,183 | 2,049 | 2,033 |
| R ² | 0.263 | 0.048 | 0.073 | 0.037 | 0.177 | 0.246 | 0.121 | 0.379 | 0.169 |
| NDF | | | | | | | | | |
| € | 0.513** (15.067) | 0.077** (13.616) | 0.422** (13.575) | 0.367** (17.893) | 0.488** (18.186) | 0.274** (19.916) | 0.209** (11.932) | 0.556** (28.212) | 0.172** (13.190) |
| ¥ | -0.196** (-6.149) | -0.017** (-3.141) | -0.267** (-9.161) | -0.124** (-6.458) | -0.213** (-8.456) | -0.065** (-5.029) | -0.077** (-4.665) | -0.109** (-5.903) | -0.035** (-2.864) |
| VIX | 0.049** (15.460) | 0.002** (3.017) | 0.013** (4.628) | 0.018** (9.732) | 0.021** (8.625) | 0.013** (9.996) | 0.011** (6.520) | 0.010** (5.252) | 0.003* (2.347) |
| Observations | 2,061 | 2,183 | 2,181 | 2,159 | 2,181 | 2,140 | 2,183 | 2,156 | 2,161 |
| R ² | 0.278 | 0.105 | 0.143 | 0.232 | 0.232 | 0.259 | 0.119 | 0.329 | 0.096 |

BRL = Brazilian real; CNY = Chinese renminbi; IDR = Indonesian rupiah; INR = Indian rupee; KRW = Korean won; MYR = Malaysian ringgit; PHP = Philippine peso; RUB = Russian rouble; TWD = New Taiwan dollar.

Table reports estimates of $\Delta \log(DF \text{ or } NDF)/\$t = \alpha + \beta_1 \Delta \log \text{€}/\$t + \beta_2 \Delta \log \text{¥}/\$t + \beta_3 \Delta \text{VIX} + \varepsilon_t$. For deliverable forwards, data for the major currencies and the lag structure vary to match timing of the domestic market. For CNY, IDR, KRW, MYR, PHP and TWD, changes in Tokyo close prices for the euro and yen and changes in the VIX from the New York close lagged one day are used; for INR, changes in London open prices for the euro and yen and changes in the VIX lagged one day; for RUB, changes in London close prices for the euro and yen and changes in the VIX lagged one day; for BRL, contemporaneous changes of the euro, yen and VIX from the New York close. For NDF regressions, contemporaneous changes in all variables from the New York close are used. * represents significance at the 5% level; ** represents significance at the 1% level.

Source: Authors' estimates.

forwards in 2008 to about half in April 2013 (Graph 2).⁷ Especially given the bounce of the NDF share back to more than 60% in October 2013, the rouble NDF could linger for 10 years after its liberalisation in 2006.

On the other path, the Korean authorities have shown caution in removing restrictions, and the won NDF continues to trade – and in fact remains the most traded NDF. Still, its markets have developed quite a bit. Korean banks' ability to arbitrage the onshore forward and NDF markets has tended to keep the gap between them narrow. And non-deliverable currency options, interest rate swaps and cross-currency swaps trade actively. As noted, there is substantial turnover of won NDFs on EBS. Key to the market development is an acceptable and representative mechanism for determining the market average spot rate for the NDF to settle on.⁸

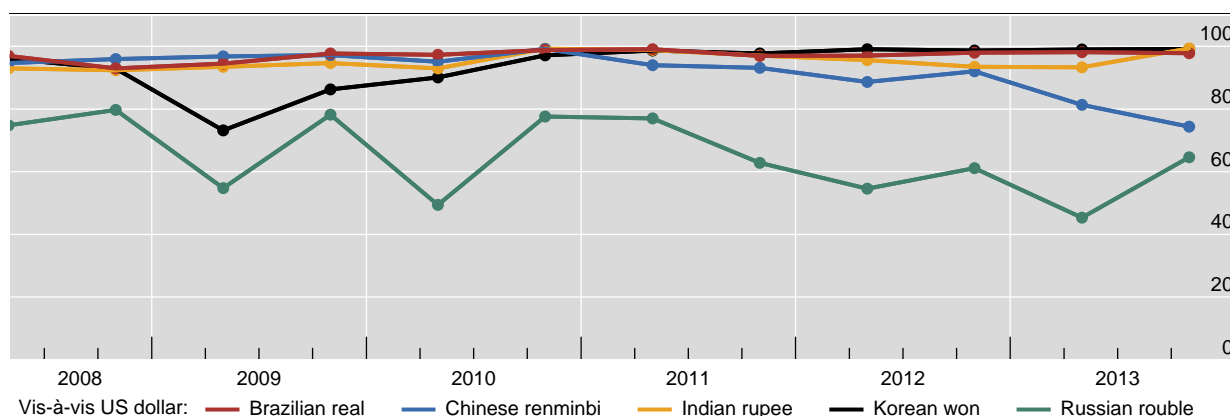
The costs to Korea of maintaining won NDFs may decline with the changing market structure. The continuing existence of the NDF market alongside deliverable forwards no doubt exacts a cost in terms of lower liquidity from the division of the forward markets. However, it is possible that the change in the NDF market to more transparent trading and centralised clearing will make NDF markets deeper and more liquid. If so, the won's path may prove to be conducive to more market development than seen to date.

The renminbi, with its idiosyncratic internationalisation, is not travelling either path. Certainly, the Chinese authorities have not allowed unrestricted non-resident access to the onshore forward market. Instead, they have permitted, within still effective (although leaky) capital controls, a pool of renminbi to collect offshore that can be freely traded and delivered offshore (Shu et al (2013)). A three-way split of

NDFs as a share of forward turnover in five currencies

In per cent

Graph 2



Source: London Foreign Exchange Joint Standing Committee.

⁷ Similar to the unique features of the Australian dollar NDF (domestic trading and AUD settlement), special factors may limit the applicability of the rouble's lessons. Foreign investors suffered defaults in 1998 on rouble forwards with domestic banks contracted to hedge their holdings of Russian government securities. HSBC (2013, p 121) notes, "A large portion of [forward market] liquidity is still offshore due to credit constrain[t]s among local banks."

⁸ An acceptable measure of the spot rate of the rupiah for NDFs, by contrast, has proven elusive, with the Association of Banks in Singapore opting for one based on the NDF itself in August 2013. Illiquidity associated with this problem was said in interviews to lie behind some of the observations above regarding the rupiah.

the renminbi forward market has resulted, with an onshore market (dating to 2006), an offshore NDF market (dating back to the 1990s) and an offshore deliverable, or CNH, market (since 2010).

As is evident from Table 2, the offshore deliverable forward is challenging the offshore NDF market: between April 2010 and April 2013, CNH forwards rose from zero to \$7 billion per day, while NDFs probably rose by less, to \$17 billion per day. Since April 2013, the CNH may have closed in further on the NDF market. Graph 2 shows that the London share of renminbi NDFs in all renminbi forwards dropped between April and October 2013 from 80% to 75%, as CNH trading spread from Hong Kong SAR to Singapore and London.⁹ It is remarkable how similar the NDF shares of rouble and renminbi trading in London are, given the differences in Russian and Chinese capital account policies.

CNH forwards have several advantages in competing with NDFs. First, some investors, including official investors, have mandates that do not permit NDFs but do permit CNH. Second, the Triennial Survey shows \$17 billion in renminbi options, including those written offshore on the CNH, and these generate activity in deliverable forwards. Implied volatility in the CNH tends to be very low, and market participants report a reach for yield among investors who bet on the stability of the renminbi/dollar rate. The liquidity thereby generated in the CNH market, however cyclical, has attracted asset managers, including some hedge funds, to switch from NDFs.

In addition, the limited loosening of the exchange rate system in Shanghai has also increased the so-called basis risk of using the NDF market, which seems to be another factor encouraging corporate hedgers to shift from NDFs to CNH (Minikin and Lau (2013)). NDFs settle by reference to the official central parity rate against the US dollar (the “fixing rate”) set every day at 9.30 am in the Shanghai, China Foreign Exchange Trade System. However, actual trading occurs within $\pm 1\%$ bands around this fixing rate, which were widened from $\pm 0.5\%$ in April 2012. Many market participants anticipate another widening of the band.

As Graph 3 shows, the widening of the band and the tendency for actual trading to occur near its edges make for substantial basis risk. When the NDF settles at the fixing rate, this can be 1 percentage point higher or lower than the rate at which the renminbi can actually be sold onshore. From the standpoint of a firm trying to fix the dollar value of profits to be remitted from China, a 1% gap between the NDF and the actual rate of exchange can produce unwanted volatility. Since the band’s widening, the CNH has averaged an absolute difference from the Shanghai close of just 0.1%, much narrower than the 0.7% absolute gap between the Shanghai fixing and close. The CNH is becoming more attractive to those seeking to hedge because it tracks the onshore rate better than the NDF.

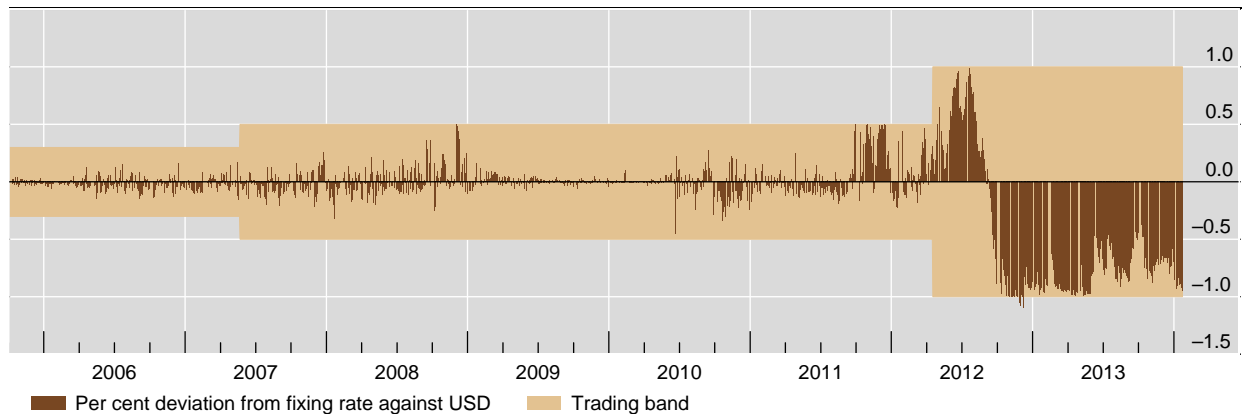
As things stand, NDFs are evolving along distinct paths. While the rouble deliverable forward is slowly displacing the NDF, the Korean won NDF continues to dominate trading and may gain liquidity from ongoing market centralisation. At the

⁹ Interviews with market participants in Hong Kong in late 2013 suggested that they perceived that the CNH had already eclipsed the NDF market in April. In the Triennial Survey, renminbi NDFs represented 71% of offshore forwards. Summing CNH forwards, CNH spot and renminbi NDFs, on the grounds that any one of them transforms currency exposure, NDFs were still 45% of such offshore trading. London data for October 2013 show that this share fell by 10 percentage points over the previous six months.

Chinese renminbi closing and trading band¹

In per cent

Graph 3



¹ The trading band was widened from +/- 0.3% to +/- 0.5% on 21 May 2007, and then to +/- 1% on 16 April 2012.

Source: Bloomberg.

same time, the renminbi offshore deliverable forward is closing in on the NDF, notwithstanding capital controls.

Conclusions

The NDF market will continue to grow faster than the foreign exchange market as long as authorities try to insulate their domestic financial systems from global market developments, albeit at the cost of lower liquidity. The insulation, however, can seem pretty thin at times. When NDFs serve as a main adjustment valve for non-resident investors in local assets and local firms with dollar debt, they can lead domestic markets.

Looking forward, as suggested by the current experience of the rouble and the previous experience of the Australian dollar, NDFs are likely to disappear only gradually even after non-residents are allowed full access to domestic forward markets. At the same time, continuing restrictions do not preclude considerable market development, as seen with the Korean won. NDF markets may become more transparent and liquid as trading moves to authorised multilateral trading and centralised clearing in accord with the current wave of regulatory reforms. The fast-developing offshore deliverable market in the renminbi is challenging the incumbent NDF as a better hedging tool.

If foreign investors use NDFs to hedge exposures in local assets in times of stress, sales of these assets in the balance of payment statistics capture their behaviour only very partially. Analysts need not only to follow the money, ie measure capital flows, but also to follow the risk, and newly available data on NDFs can help (Caruana (2013)).

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Non-US banks' claims on the Federal Reserve¹

Non-US banks' affiliates in the United States took on about half of the claims on the Federal Reserve that it created to pay for its large-scale bond purchases. They did so largely through uninsured branches unaffected by a new Federal Deposit Insurance Corporation charge on wholesale funding payable by US-chartered banks. These branches funded the reserves by drawing from their affiliates abroad. Thus, counterintuitively, large-scale bond buying by the Fed drew dollar funding into the United States from the eurodollar market. On a consolidated basis, non-US banks raised dollars by swapping other currencies and increasing dollar liabilities, even as they increased dollar claims outside the United States. In sum, seemingly small national regulatory differences led international banks to make big adjustments in their balance sheets. Looking forward, a large shift of the Fed's liabilities from banks' reserves to reverse repos with non-banks could again induce changes in the global dollar flow of funds.

JEL classification: E43, E52, E65, G01, G15, G21, G28.

Up to December 2013, the Federal Reserve created \$2.2 trillion in bank reserves to fund \$4 trillion of US Treasury and mortgage bonds.² With short-term interest rates near zero, these asset purchases aim to provide additional monetary ease through lower bond yields. From this monetary policy perspective, it does not really matter which banks hold the Fed's liabilities.

Yet from a regulatory perspective it does matter. Non-US banks' branches hold a disproportionate share of those reserves as a result of seemingly small regulatory differences. These have induced massive changes in internationally active banks' balance sheets. This is a point of more than historical interest in a world in which jurisdictions can choose to calibrate regulations differently.

This short feature shows how non-US banks' branches and agencies in the United States drew on dollar funding from the rest of the world to take up almost \$1 trillion of reserves at the Fed. Perhaps counterintuitively, the Fed's large-scale bond buying led to a massive inflow of bank funding from the eurodollar market. We follow the money to show how the dollar balance sheets of these banks' offices outside the United States came up with the dollars. The still experimental Fed operations to raise funds directly from non-banks could, if ramped up, again induce large changes in the global dollar flow of funds.

¹ The authors would like to thank Claudio Borio, Dietrich Domanski, Lawrence Kreicher and Christian Upper for comments and Angelika Donaubaue for assistance. The views expressed are those of the authors and do not necessarily reflect those of the BIS.

² Reserves at the Federal Reserve reached \$2.6 trillion by 19 February 2014.

Non-US banks' uptake of reserves at the Fed

Non-US banks operate in the United States in the legal forms of subsidiaries and branches. One key difference for the distribution of claims on the Fed is that non-US banks' branches and agencies in the United States operate without FDIC (deposit) insurance.³ This did not make much of a competitive difference before the crisis of 2007–9, when payments to the FDIC were effectively zero for most US-chartered banks. The Dodd-Frank legislation set a goal of a larger FDIC fund, requiring all insured banks to contribute, and as of April 2011 widened the assessment base from an insured bank's deposits to its total assets less equity, thereby imposing a charge on short-term wholesale funding. As of then, uninsured branches of non-US banks found themselves at a competitive advantage in raising wholesale funding.⁴

In the aftermath of the global financial crisis, some observers argued for a G20 levy on short-term wholesale bank funding on the grounds that it contributed to systemic instability (Shin (2010)). Proponents feared that, if such a levy were not implemented in a coordinated fashion, regulatory arbitrage would shift assets to those banks not paying the levy. The wider FDIC assessment, though not necessarily motivated for systemic reasons, has had results that support such concerns.

The wider FDIC charge added 2.5 to 45 basis points to the costs of large and complex US chartered banks' short-term wholesale funding. The calculation is complex and its result by bank is not disclosed, but the rate for the largest US bank was said to be 8 basis points (Kreicher et al (2013, page 4)). Short-term wholesale funding includes borrowing from other banks, short-term repos, or funding from affiliates outside the United States. With wholesale rates of 10 basis points or less, the new FDIC charge made bidding for such funds and parking them at the Fed at 25 basis points unattractive for many US-chartered banks but not to the US branches of foreign banks, which pay no FDIC fee.

In the event, the Fed's large-scale bond purchases combined with the FDIC charge had the unintended effect of leaving non-US banks' branches and agencies in the United States holding a disproportionate share of excess reserves at the Fed.⁵ When the Fed buys bonds, it credits a bank with reserves. The receiving bank may pay them out, *but some bank in the United States must ultimately hold them*.⁶ In December 2013, foreign bank branches held \$0.958 trillion of the \$2.249 trillion in reserves at the Fed, or 43% of the total. This share was clearly out of line with their 13% of banking assets in the United States.⁷

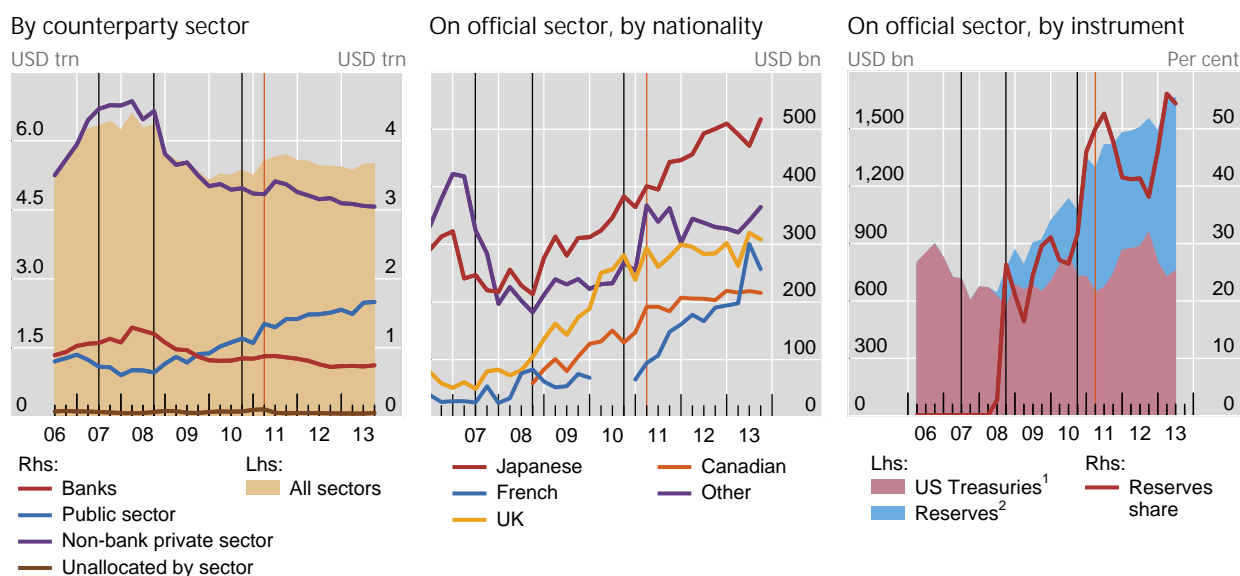
³ Except for those few grandfathered under the Federal Deposit Insurance Corporation Improvement Act of 1991.

⁴ Note that deposit insurance only extends to the first \$250,000 of a large deposit, so that insured banks do not gain much from insurance when competing for large deposits.

⁵ Kreicher et al (2013) note that non-US bank branches in the United States took less than a third of the rise in claims on the Fed during the first round of bond buying between September 2008 and March 2010 but two thirds in the second round of bond buying between September 2010 and mid-2012 that included the new FDIC levy on wholesale funding. For an analysis of the distribution of Fed reserves across US-chartered banks, see Ennis and Wolman (2012).

⁶ Some non-banks (eg Fannie Mae) can hold unremunerated claims on the Fed, but these are small.

⁷ Banks headquartered outside the United States had subsidiaries in the United States with assets about half those of the branches and agencies of foreign banks, and their claims on the Fed pushed the overall share of non-US banks' holdings of reserves above 50% in the second quarter of 2013. This fell back to 45% in the third quarter.



The vertical lines indicate the start of the financial crisis (end-Q2 2007), the collapse of Lehman Brothers (end-Q3 2008), the announcement of the change to the FDIC assessment base (end-Q3 2010) and the implementation of the change (1 April 2011).

¹ Estimated holdings of US Treasury securities. Difference between claims on the US official sector in the consolidated (ultimate risk basis) statistics and holdings of reserves at the Federal Reserve. May include government agency paper. ² Reserves held at the Federal Reserve by the US branches and agencies of non-US BIS reporting banks.

Sources: Federal Financial Institutions Examination Council, *Call Reports*; BIS consolidated banking statistics (ultimate risk basis).

Widening our perspective from the US branch to the *consolidated* balance sheet of non-US banks, the claims on the Fed drove up their claims on the official sector in the United States. This has tended to offset the post-crisis decline in claims on the US private sector (Graph 1, left-hand panel). Consolidated claims on the non-bank private sector in the United States, including private-label mortgage-backed securities, have declined by about \$1.5 trillion since the peak in 2008. Since 2010, an increase in claims on the US official sector has more than offset this decline. Canadian, French, Japanese and UK banks have been especially prominent (Graph 1, centre panel).

Are these non-US banks loading up on Treasury securities? Not much. To illustrate this, Graph 1 combines two data sources: “call reports”, which show the claims of non-US banks’ US offices on the Federal Reserve, and the BIS consolidated banking statistics (on an ultimate risk basis), which show their worldwide consolidated claims on the US official sector. Note that, in the BIS data, claims on the official sector include both claims on the public sector (ie general government) and claims on the Federal Reserve. Since the global financial crisis, foreign banks have more than doubled their exposure to the US official sector to \$1.75 trillion. However, most of this increase reflects overnight claims on the Fed rather than greater holdings of US Treasuries and other bonds (Graph 1, right-hand panel).

Non-US banks' funding of reserves at the Fed

Like US commercial banks in general, non-US banks’ branches and agencies in the United States have generally not been selling Treasury and agency bonds to the Fed

on a net basis. They thus had to fund their increased holdings of claims on the Fed by other means.

Non-US banks' branches in the United States swap assets

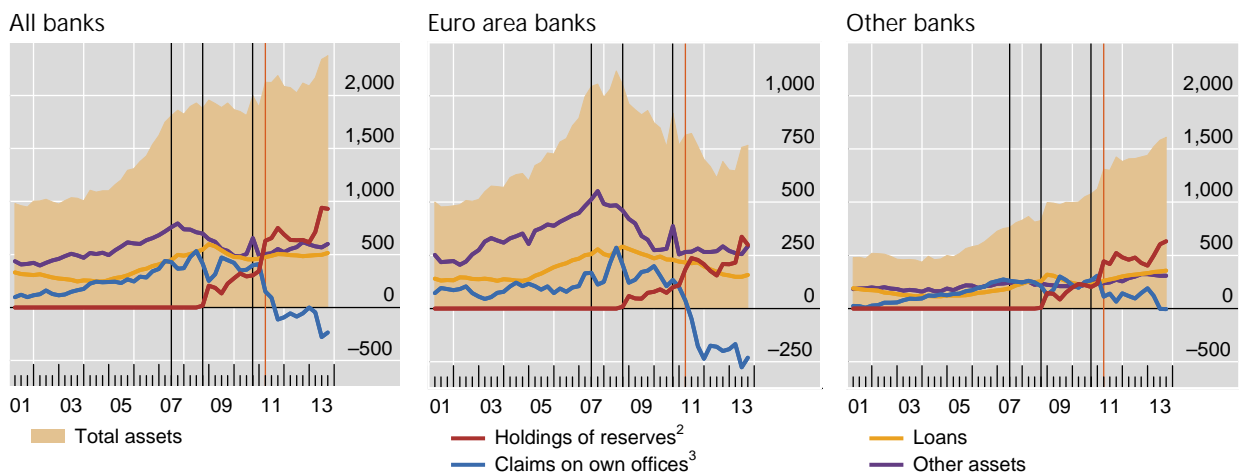
Non-US banks' branches in the United States made room for the claims on the Fed without reducing loans or other assets in aggregate (Graph 2, left-hand panel). Instead, they recalled advances to their affiliates outside the United States (blue line). Even the branches of euro area banks, which shed more than 25% of their assets between 2008 and 2012, built up reserves at the Fed despite the severe funding difficulties they faced in 2011 and 2012 (Graph 2, centre panel).⁸ The US branches of banks from the rest of the world raised both their US assets and their holdings of excess reserves (Graph 2, right-hand panel).

Prior to the crisis, the US branches of non-US banks operating without FDIC insurance had built up net claims on their own offices outside the United States in excess of \$400 billion (Graph 3, left-hand panel). In effect, on top of their intermediation between US lenders and borrowers, these branches borrowed from US money market mutual funds (MMMFs) and others to fund the dollar balance sheets of their parent banks outside the United States (Baba et al (2009)). Following the FDIC regulatory change, they went from being net lenders, to the tune of \$400 billion, to net borrowers, by \$200 billion by 2013. Counter to the popular metaphor that the Fed's bond buying represented an injection of liquidity that could flow *out of the United States*, non-US banks' branches brought dollar funds *into the United States*.

Uninsured branches and agencies of non-US banks in the United States¹

In billions of US dollars

Graph 2



The vertical lines indicate the start of the financial crisis (end-Q2 2007), the collapse of Lehman Brothers (end-Q3 2008), the announcement of the change to the FDIC assessment base (end-Q3 2010) and the implementation of the change (1 April 2011)

¹ Balance sheets of non-US banks' uninsured branches and agencies in the United States aggregated by bank nationality. ² Balances due from Federal Reserve Banks. ³ Sum of net due from (assets side) and net due to (liabilities side) related depository institutions.

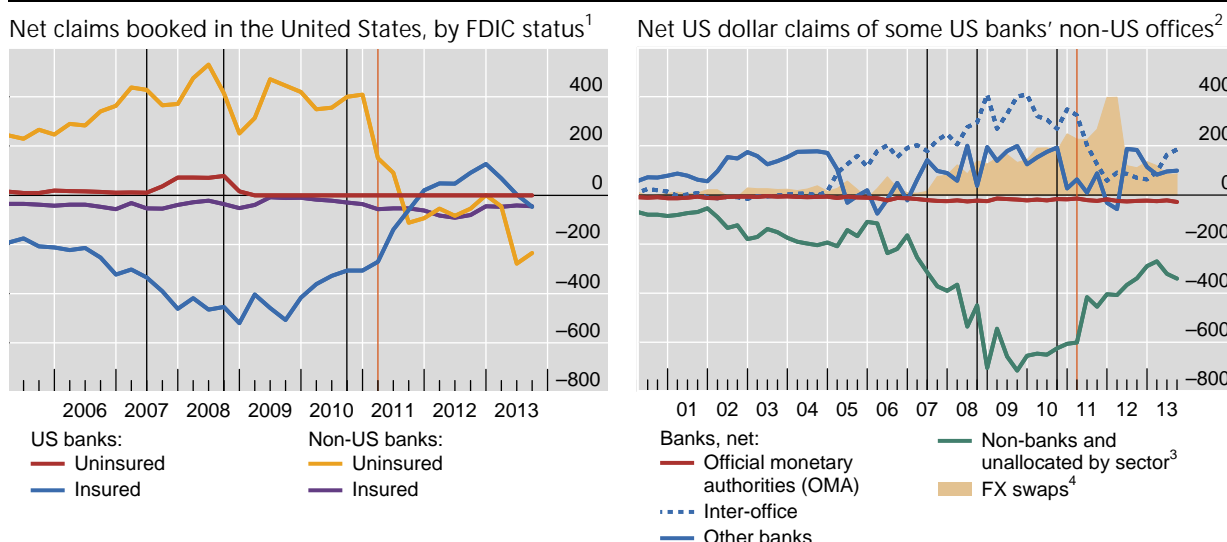
Source: Federal Financial Institutions Examination Council, *Call Reports*.

⁸ While some euro area banks may have sought at times to reassure wholesale lenders by pointing to their holdings at the Fed, the overall funding squeeze on them arguably limited their increase of holdings at the Fed. See Correa et al (2012).

Inter-office positions inside and outside the United States

In billions of US dollars

Graph 3



The vertical lines indicate the start of the financial crisis (end-Q2 2007), the collapse of Lehman Brothers (end-Q3 2008), the announcement of the change to the FDIC assessment base (end-Q3 2010) and the implementation of the change (1 April 2011).

¹ Net inter-office positions as captured in the FFIEC Call Reports data. ² Includes positions booked by US banks' offices located in The Bahamas, Bermuda, the Cayman Islands, Curaçao, the Netherlands Antilles, Panama and the United Kingdom. Net positions are assets minus liabilities. ³ Net positions on non-banks and vis-à-vis counterparties that are unallocated by counterparty sector. ⁴ Implied cross-currency funding that equates gross US dollar assets and liabilities booked in the selected offices. Negative value indicates net borrowing of US dollars via FX swaps.

Sources: Federal Financial Institutions Examination Council, *Call Reports*; BIS consolidated statistics (immediate borrower basis); BIS locational statistics by nationality; authors' calculations.

Constrained by the FDIC charge on wholesale funding, US banks moved in an opposite direction: they repaid advances from their foreign offices that now attracted the FDIC charge. Data from the Caribbean banking centres and London show how the US banks managed this. For years, US banks had booked deposits by US firms and funds in their Caribbean and London branches, and had then brought back the funds as wholesale (eurodollar) funding.⁹ Once such round-tripped funds attracted the same FDIC assessment as domestic deposits, there remained no reason to book the liabilities offshore. In Graph 3 (right-hand panel), both the net liability to non-banks, including large deposits from the US firms and funds (green line), and the net claim on own offices (dashed blue line) contracted sharply in 2011 and thereafter. De facto domestic deposits that US banks had routed through Caribbean and London branches became de jure domestic deposits.

Thus, US-chartered banks could easily repay advances from their foreign branches by rebooking deposits.¹⁰ This still leaves the question of how non-US-

⁹ While it is not possible to simultaneously identify the nationality and location of the bank together with the location of the counterparty, the BIS locational banking statistics by residency – which do not include a breakdown by bank nationality, but do include information on the location of the counterparty – suggest that the bulk of the liabilities to non-banks booked by banks located in the Caribbean were vis-à-vis counterparties in the United States.

¹⁰ The rebooking of these deposits from offshore branches onshore helped to boost the deposits of particularly the largest US banks (Kreicher et al (2013, Graph 5, right-hand side)) as well as US M2 (Anderson and Duca (2014, page 22)).

chartered banks funded their massive flow in the opposite direction (Graph 3, left-hand panel, yellow line). From the standpoint of the US branch, claims on foreign affiliates became reserves at the Fed – a substitution of one asset for another. But from the consolidated non-US bank's standpoint, it had to come up with over \$400 billion in dollar funding in a matter of months.

Where did the consolidated non-US banks get the dollars?

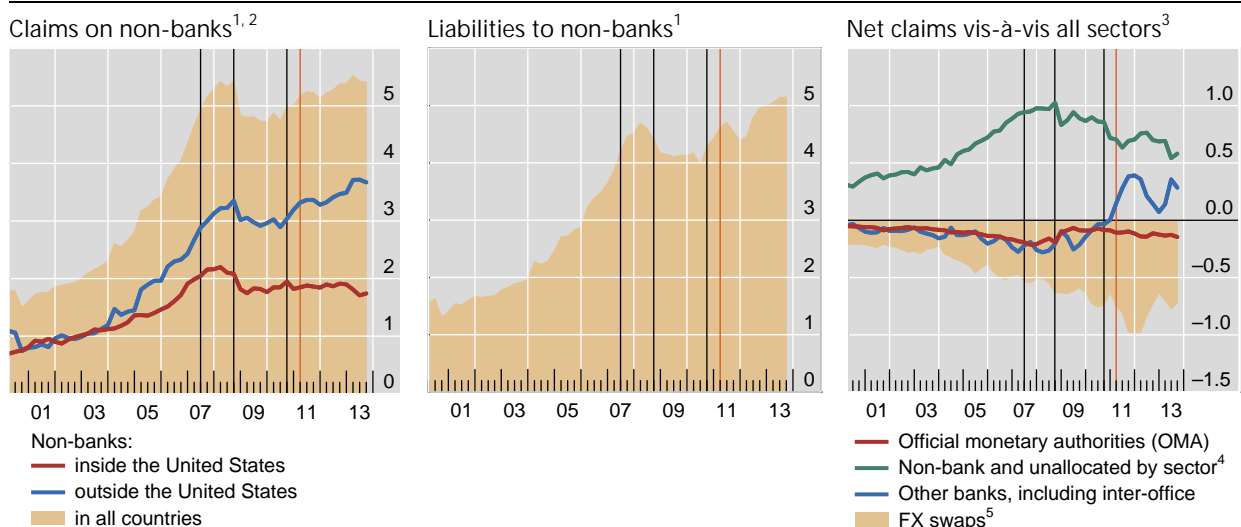
How did the consolidated non-US banks raise the dollars outside the United States? They did not raise them by cutting dollar loans to borrowers there.¹¹ More broadly, notwithstanding the deleveraging of European banks, non-US banks increased their overall dollar claims (securities as well as loans) on non-banks outside the United States into the \$3–4 trillion range (Graph 4, left-hand panel, blue line). In other words, there was no compression in non-US banks' dollar credit outside the United States that would have freed up funds to repay dollars to their US branches.

Instead, non-US banks seem to have raised the dollars through a combination of increased deposits and increased swapping of other currencies. Their dollar

US dollar positions of non-US banks' offices outside the United States

In trillions of US dollars

Graph 4



The vertical lines indicate the start of the financial crisis (end-Q2 2007), the collapse of Lehman Brothers (end-Q3 2008), the announcement of the change to the FDIC assessment base (end-Q3 2010) and the implementation of the change (1 April 2011).

¹ The shaded area is US dollar-denominated positions booked by non-US banks' offices outside the United States (BIS locational banking statistics by nationality). For liabilities, excludes positions booked by offices in Germany. ² The red line is non-US banks' consolidated international claims on the United States from the BIS consolidated banking statistics. The blue line is the difference between the shaded area and the red line, and implicitly assumes that (a) non-US banks' cross-border claims on the United States are denominated in US dollars, and (b) locally booked non-US dollar claims on residents of the United States, included in international claims, are negligible. ³ Net positions are assets minus liabilities. Positions booked by Canadian, French, German, Japanese and UK banks' offices located in Canada, the euro area (excluding Germany), Japan, the United Kingdom and in offshore centres. ⁴ Positions vis-à-vis non-banks and counterparties that are unallocated by sector. ⁵ Implied cross-currency funding that equates gross US dollar assets and liabilities booked in the selected offices. Negative value indicates net borrowing of US dollars via FX swaps.

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

¹¹ See BIS (2013, Graph I.3). See Martin et al (2011) for the argument that holding reserves at the Fed potentially competes with loans.

liabilities grew (Graph 4, centre panel), but not sufficiently to support their offshore dollar asset growth even as they repaid and advanced dollars to their US branches.¹²

Since banks tend to fully hedge any currency mismatch between their assets and liabilities, we infer that the consolidated non-US banks obtained the remaining dollars through foreign exchange swaps. When we look at Canadian, French, German, Japanese and UK banks' US dollar positions booked at selected offices outside the United States, their net claims on non-banks fell from a peak of roughly \$1 trillion to about half that in September 2013 (Graph 4, right-hand panel, green line). But this smaller sum still needed to be funded. Similarly, interbank and inter-office sources of funds (blue line) became a use of funds in 2011 as dollars were shipped back to US branches. With net claims on non-banks, other banks and own offices well in excess of the modest funding from official depositors (red line), we infer that non-US banks relied on foreign exchange swaps, as depicted by the shaded area.¹³ Apparently, euro, yen and sterling funding was heavily swapped for dollars in 2011, only to recede as dollar liabilities continued to increase.

Looking forward: Fed operational changes

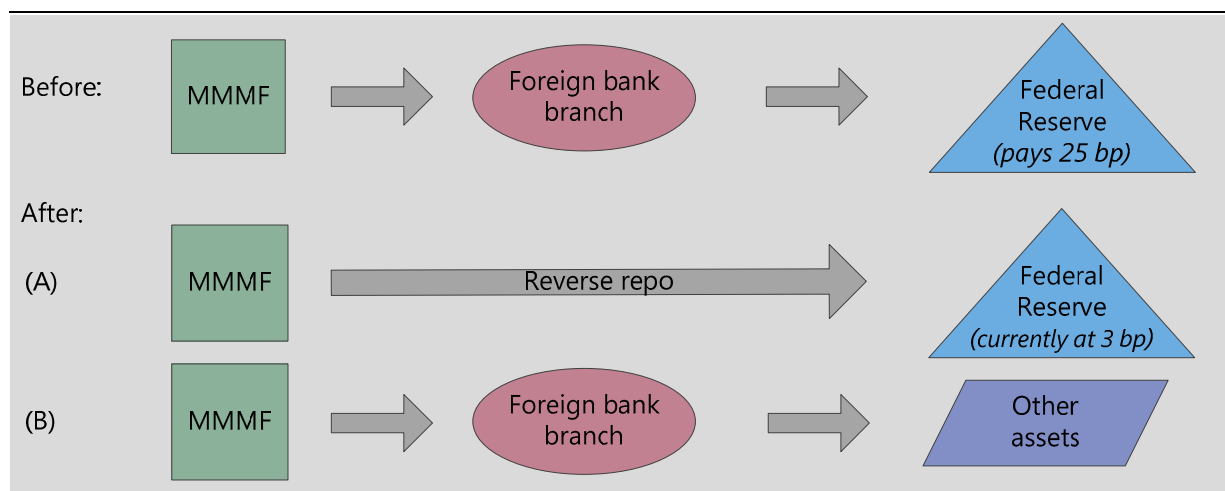
The Federal Reserve is experimenting with a new operational tool – the reverse repo – that could substantially reduce banks' \$2.5 trillion (and rising) claims on the Fed, even as the Fed continues to hold its bond portfolio. In a reverse repo, the Fed borrows overnight from a cash-rich counterparty like a money market mutual fund against the security of a bond from the Fed's portfolio, which reached \$4.1 trillion on 19 February 2014.

From an aggregate perspective, these operations would necessarily drain banks' holdings of balances at the Fed, in particular those in addition to those needed to meet reserve requirements ("excess reserves"). For some banks, especially US branches of non-US banks, it would reduce any profit to be made by taking in wholesale funds at 10 basis points (or less) and holding reserves at the Fed at 25 basis points. In effect, the new operations disintermediate the banks that have done this low-risk trade (Graph 5).

This possibility was demonstrated by operations over the turn of the year. On the last day of 2013, 102 eligible counterparties lent the Fed \$198 billion at a rate of 3 basis points. According to Crane Data, MMMFs accounted for \$139 billion, or 70% of this amount. Lower-risk Treasury and government MMMFs allocated 7% of their assets to the Fed repos, while the higher-risk "prime" funds (ie those invested in corporate and especially bank securities) allocated 5%. Grossman et al (2014) report that the 10 largest prime MMMFs invested 3.7% of their assets in the Fed repos at the end of 2013 while their allocation to European banks' debt fell by a matching 3.8% in December. This experience is consistent with a shift from the first row in

¹² This amounts to assuming that banks fully hedge the currency mismatch of their assets and liabilities. Note that much of the shift in the blue line in Graph 4 (right-hand panel) is the result of changes in inter-office positions. However, several reporting jurisdictions do not provide a clean break between inter-office positions and positions vis-à-vis other banks, and thus they have been combined into a single line in Graph 4.

¹³ See McGuire and von Peter (2009) for discussion of European banks' US dollar funding positions.



Graph 5 (before) to the middle row, in which the MMMF places funds directly with the Fed (after).¹⁴

Going forward, however, only lower-risk MMMFs can devote much of their portfolio to repos with the Fed. That is, Treasury and government MMMFs might devote much of their portfolios to very safe, overnight placements with the Fed. But prime MMMFs' mandates require them to seek higher returns by taking on yield curve and especially credit risk. Hence, for prime funds the last row of Graph 5 is more likely: the MMMF continues to fund the foreign bank branch which in turn finds another dollar asset if the Fed drains away the excess reserves.

Under the scenario in the last row, heavy Fed reliance on reverse repo operations to drain reserves would leave non-US banks with their funding from MMMFs but would take away their claims on the Fed. Should a reflow of dollar funds out of the United States by non-US banks be expected: the asset substitution in reverse? How might the funds be deployed? Just as the uptake of claims on the Fed by branches of banks headquartered outside the United States led to large changes in the global dollar flow of funds, so too could the Fed's draining of its excess reserves.

Conclusions

We have shown how seemingly small differences in regulation across banks from different jurisdictions can trigger huge and rapid adjustments in bank behaviour and balance sheets. In the process, we have underscored the importance of distinguishing a branch-specific (residence-based) behaviour from the behaviour of the consolidated entity. And finally, when – through some combination of repos with non-banks and reduction of its bond portfolio – the Fed extinguishes a large stock of bank claims on itself, the resulting flows of funds bear watching.

¹⁴ To be sure, there was an element of window-dressing at the turn of the year, with banks restricting their wholesale funding at year-end and driving MMMFs to the Fed facility, which option kept repo and other short-term rates from turning negative. As of 19 February, the Fed reverse repo stood at just \$83 billion.

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