

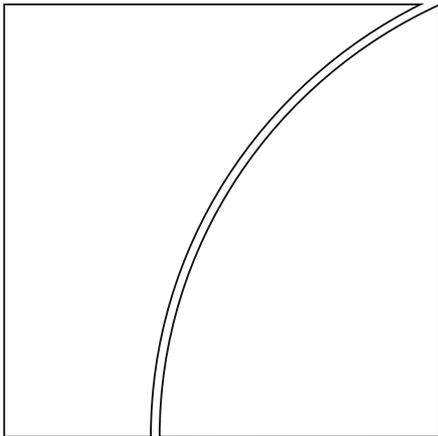


BANK FOR INTERNATIONAL SETTLEMENTS

BIS Quarterly Review

March 2019

International banking
and financial market
developments



BIS Quarterly Review
Monetary and Economic Department

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Notations used in this Review

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

Differences in totals are due to rounding.

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

Abbreviations

Currencies

ARS	Argentine peso	MAD	Moroccan dirham
AUD	Australian dollar	MXN	Mexican peso
BGN	Bulgarian lev	MYR	Malaysian ringgit
BHD	Bahraini dinar	NOK	Norwegian krone
BRL	Brazilian real	NZD	New Zealand dollar
CAD	Canadian dollar	OTH	all other currencies
CHF	Swiss franc	PEN	Peruvian sol
CLP	Chilean peso	PHP	Philippine peso
CNY (RMB)	Chinese yuan (renminbi)	PLN	Polish zloty
COP	Colombian peso	RON	Romanian leu
CZK	Czech koruna	RUB	Russian rouble
DKK	Danish krone	SAR	Saudi riyal
EUR	euro	SEK	Swedish krona
GBP	pound sterling	SGD	Singapore dollar
HKD	Hong Kong dollar	THB	Thai baht
HUF	Hungarian forint	TRY	Turkish lira
IDR	Indonesian rupiah	TWD	New Taiwan dollar
ILS	Israeli new shekel	USD	US dollar
INR	Indian rupee	VES	bolívar soberano
JPY	Japanese yen	ZAR	South African rand
KRW	Korean won		

Countries

AE	United Arab Emirates	CY	Cyprus
AF	Afghanistan	CZ	Czech Republic
AL	Albania	DE	Germany
AM	Armenia	DJ	Djibouti
AO	Angola	DK	Denmark
AR	Argentina	DM	Dominica
AT	Austria	DO	Dominican Republic
AU	Australia	DZ	Algeria
AZ	Azerbaijan	EA	euro area
BA	Bosnia and Herzegovina	EC	Ecuador
BD	Bangladesh	EE	Estonia
BE	Belgium	EG	Egypt
BF	Burkina Faso	ER	Eritrea
BG	Bulgaria	ES	Spain
BH	Bahrain	ET	Ethiopia
BI	Burundi	FI	Finland
BJ	Benin	FJ	Fiji
BM	Bermuda	FO	Faeroe Islands
BN	Brunei	FR	France
BO	Bolivia	GA	Gabon
BR	Brazil	GB	United Kingdom
BS	The Bahamas	GD	Grenada
BT	Bhutan	GE	Georgia
BY	Belarus	GH	Ghana
BZ	Belize	GN	Guinea
CA	Canada	GQ	Equatorial Guinea
CD	Democratic Republic of the Congo	GR	Greece
CF	Central African Republic	GT	Guatemala
CG	Republic of Congo	GW	Guinea-Bissau
CH	Switzerland	GY	Guyana
CI	Côte d'Ivoire	HN	Honduras
CL	Chile	HK	Hong Kong SAR
CM	Cameroon	HR	Croatia
CN	China	HT	Haiti
CO	Colombia	HU	Hungary
CR	Costa Rica	ID	Indonesia
CV	Cape Verde	IE	Ireland

Countries (cont)

IL	Israel	MW	Malawi
IN	India	MX	Mexico
IQ	Iraq	MY	Malaysia
IR	Iran	MZ	Mozambique
IS	Iceland	NG	Nigeria
IT	Italy	NL	Netherlands
JE	Jersey	NO	Norway
JM	Jamaica	NR	Nauru
JO	Jordan	NZ	New Zealand
JP	Japan	OM	Oman
KE	Kenya	PA	Panama
KG	Kyrgyz Republic	PE	Peru
KH	Cambodia	PG	Papua New Guinea
KR	Korea	PH	Philippines
KW	Kuwait	PK	Pakistan
KY	Cayman Islands	PL	Poland
KZ	Kazakhstan	PT	Portugal
LA	Laos	PY	Paraguay
LB	Lebanon	QA	Qatar
LC	St Lucia	RO	Romania
LK	Sri Lanka	RS	Serbia
LR	Liberia	RU	Russia
LS	Lesotho	RW	Rwanda
LT	Lithuania	SA	Saudi Arabia
LU	Luxembourg	SC	Seychelles
LV	Latvia	SD	Sudan
LY	Libya	SE	Sweden
MA	Morocco	SG	Singapore
MD	Moldova	SK	Slovakia
ME	Montenegro	SI	Slovenia
MK	Macedonia FYR	SR	Suriname
MM	Myanmar	SS	South Sudan
MN	Mongolia	ST	São Tomé and Príncipe
MO	Macao SAR	SV	El Salvador
MR	Mauritania	SZ	Eswatini
MT	Malta	TD	Chad
MU	Mauritius	TG	Togo
MV	Maldives	TH	Thailand

Countries (cont)

TJ	Tajikistan	UZ	Uzbekistan
TL	East Timor	VC	St Vincent and the Grenadines
TM	Turkmenistan	VE	Venezuela
TO	Tonga	VG	British Virgin Islands
TR	Turkey	VN	Vietnam
TT	Trinidad and Tobago	XM	euro area
TW	Chinese Taipei	ZA	South Africa
UA	Ukraine	ZM	Zambia
US	United States	AE	advanced economy
UY	Uruguay	EME	emerging market economy

Markets retreat and rebound

Shifting prospects for growth and monetary policy in major economies dominated market developments during the period under review.¹ In December, investors' concerns that monetary policy would remain on a firmer course, despite a softening global economy, drove risky asset prices sharply lower. Starting in January, an accommodative turn in policy and improved economic signals in the United States lifted those prices again.

As 2018 drew to a close, international markets were rattled by growth worries and a renewed focus on policy uncertainty, triggering a flight to safety. Equities fell and corporate spreads widened across the globe. Sovereign yields dropped and curves flattened slightly as term premia slid. Amid a generalised repricing, US assets were hit particularly hard. In contrast, emerging market economies (EMEs) were relatively stable even as China continued to slow. In a sign of tightening financing conditions, high-yield corporate bond funds experienced large outflows, and low-rated loan and bond issuance contracted.

Financial markets found firmer footing in January, after central banks reaffirmed that monetary policy stood ready to adjust in light of risks to the global economy. The Federal Reserve reiterated that interest rate and balance sheet decisions would be data-dependent, and kept policy rates on hold, citing concerns about the global economy and muted inflation expectations. The ECB underscored rising risks to growth in the euro area, and highlighted that it was ready to deploy all policy tools as necessary. The People's Bank of China injected significant liquidity into the banking system, and introduced new policy tools as part of a multi-pronged effort to stimulate the slowing economy and bolster bank lending.

Buoyed by policy moves and renewed optimism, global markets surged in January and February. Just as investors became reassured that US monetary policy would remain accommodative, more favourable than expected macroeconomic indicators in the United States helped fuel a rally for risky assets. Equities and corporate bonds retraced earlier losses, exhibiting relatively high correlation across countries in the process. Prices of oil and industrial metals recovered. In EMEs, an initial weakening of the dollar helped sustain inflows to fixed income and equity funds, and government bond yields dropped after holding steady at the end of the

¹ 5 December 2018 to 19 February 2019.

year. Later in the review period, these inflows continued, but at a slower pace as the dollar appreciated.

Developments in Europe at times diverged from the cautiously improving global mood. Sovereign vulnerabilities receded in Europe at first, but picked up later in the period under review. Amid persistent economic weakness, Italian government spreads fell through January before inching up again in February, while yields on German bunds kept sliding, hitting their lowest point in more than two years. Although the outcome of Brexit negotiations became increasingly unclear, sterling and UK sovereign yields did not see large price movements. UK stocks rose.

Phase 1: Markets fall as slowdown worries grow

Expectations of a further global economic slowdown, together with concerns that monetary policy would remain on a tightening course in advanced economies (AEs), led to market weakness and volatility early in the review period. A flight-to-safety phase set in.

Global equities declined sharply and AE sovereign yields fell. Cumulative losses for the S&P 500 peaked at more than 10% in December. Reversing the divergent trends that had characterised most of 2018,² US equities ceded more ground than other global stocks, while EMEs excluding China performed relatively well (Graph 1,

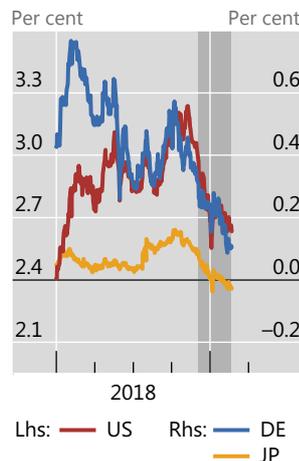
Markets were volatile as risks to the global economy rose

Graph 1

Stocks sold off in December before rebounding



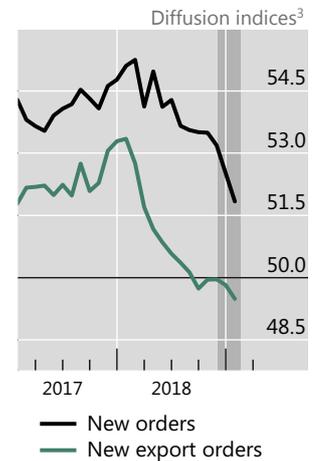
Long-term rates dropped sharply²



US and EMEs stood out amid the global weakness



Global exports on path to further contraction

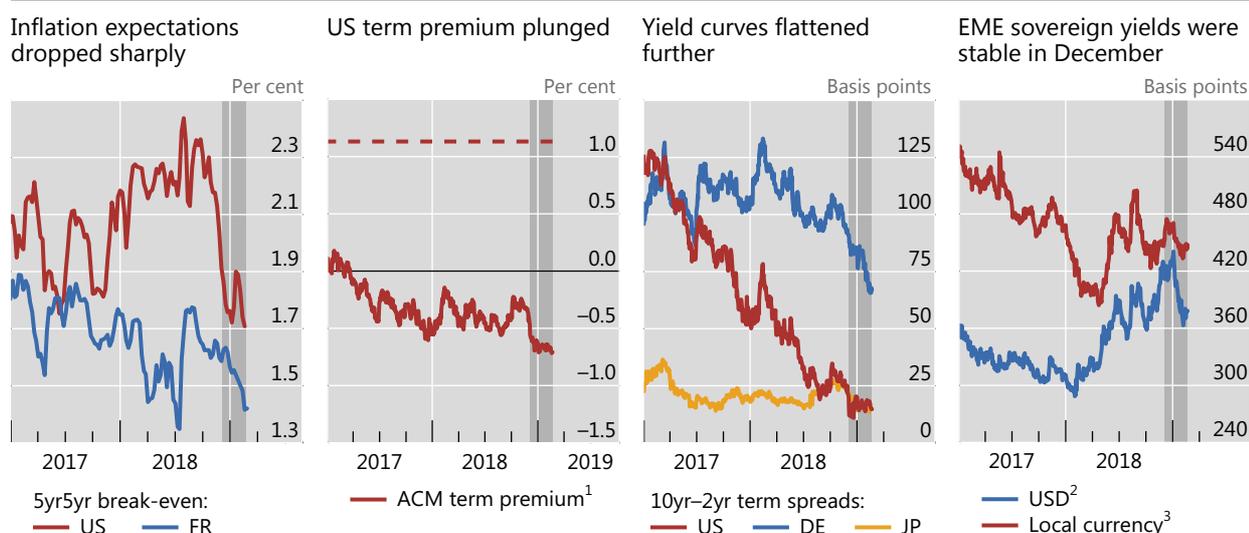


The shaded areas indicate the review period, 5 December 2018 to 19 February 2019.

¹ Simple average across country stock indices in local currency. ² Based on 10-year government bond yields. ³ A value of 50 indicates that the number of firms reporting business expansion and contraction is equal; a value above 50 indicates expansion of economic activity. ⁴ For EMEs, weighted average based on the GDP and PPP exchange rates of BR, IN, MX, RU and TR.

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

² See "Divergences widen in markets", *BIS Quarterly Review*, September 2018, pp 1–16.



The shaded areas indicate the review period, 5 December 2018 to 19 February 2019. The dashed line in the second panel indicates the simple average over the period 2010–14 (Federal Reserve balance sheet expansion).

¹ Based on 10-year government bond yields. ² JPMorgan EMBI Global (sovereign); stripped spread. ³ JPMorgan GBI index; spread over seven-year US Treasury securities.

Sources: T Adrian, R Crump and E Moench, "Pricing the term structure with linear regressions", *Journal of Financial Economics*, October 2013, pp 110–38; www.newyorkfed.org/research/data_indicators/term_premia.html; Bloomberg; JPMorgan Chase; national data; BIS calculations.

first panel). Long-term sovereign yields eased across the board, reflecting market views on increased risks to global growth and their implications for monetary policy. In Germany and Japan, yields reached the lowest 2018 levels in December. US yields dropped more than 20 basis points up to the end of the year (second panel), even as the foreign official sector's Treasury holdings continued to decline and net issuance remained brisk.

Growth kept steady in the United States, but stronger economic headwinds in Europe and China highlighted global downside risks. In December, purchasing managers' indices (PMIs) for the US manufacturing sector pointed to a continuing expansion. Market participants appeared to become increasingly concerned that, despite favourable domestic conditions, the US economy could eventually suffer from fragility elsewhere. Late-year readings of PMIs for the manufacturing sector signalled a contraction in China, and stalling activity in the euro area (Graph 1, third panel). Although new tariffs between China and the United States were put on hold until March 2019, persistent weakness in new export orders added to investors' worries (fourth panel).

With a more vulnerable outlook, market-based inflation expectations dropped, term premia compressed and sovereign yield curves flattened. Inflation expectations had increased steadily in the United States for most of 2018 but fell substantially between early December and year-end. Break-even inflation also retraced slightly in the euro area, continuing on a steady downward path (Graph 2, first panel). The US term premium decreased by about 40 basis points from late November to December, falling further into negative territory and closing 2018 at a level lower than at any time since 2016 (second panel). Sovereign yield curves were slightly flatter on net by year-end (third panel). In contrast to AEs, and reflecting broader resilience, sovereign yields in EMEs were largely stable (fourth panel).

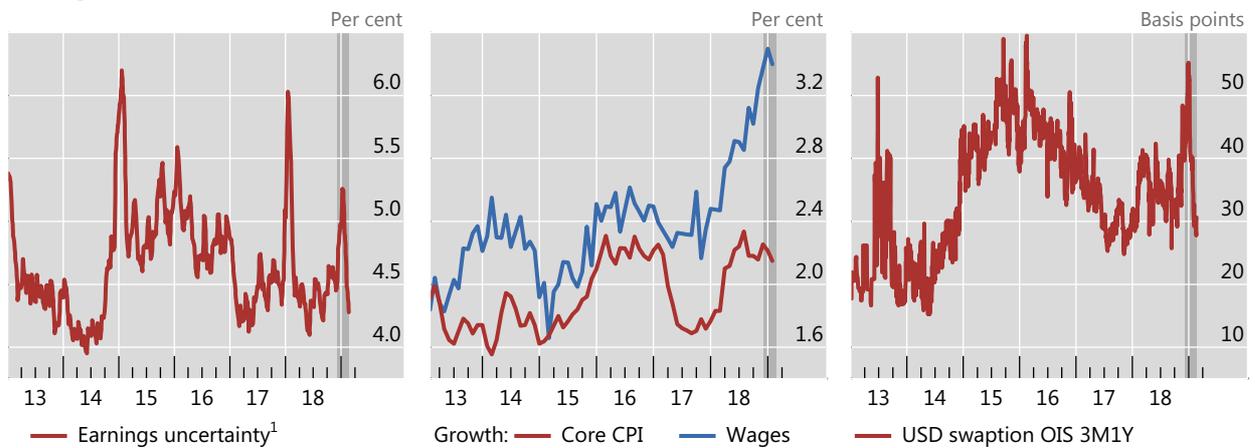
With uncertain earnings and labour market strengthening, US rate path was unclear

Graph 3

Investors were jittery about US earnings

Wage growth outstripped inflation

US rate path became uncertain



The shaded areas indicate the review period, 5 December 2018 to 19 February 2019.

¹ Five-day moving average of the standard deviation of earnings-per-share estimates divided by the average estimate for S&P 500 index.

Source: Federal Reserve Bank of St Louis, FRED; Bloomberg; Datastream; BIS calculations.

Conflicting economic signals increased uncertainty about the sustainability of corporate profits and the future path of monetary policy. The more vulnerable global economy and the relatively strong US dollar dimmed the outlook for US earnings growth, and earnings uncertainty rose quickly at the end of the year to levels reached just prior to the February 2018 market turbulence (Graph 3, left-hand panel). Despite

Corporate spreads rose sharply across the globe but reverted quickly

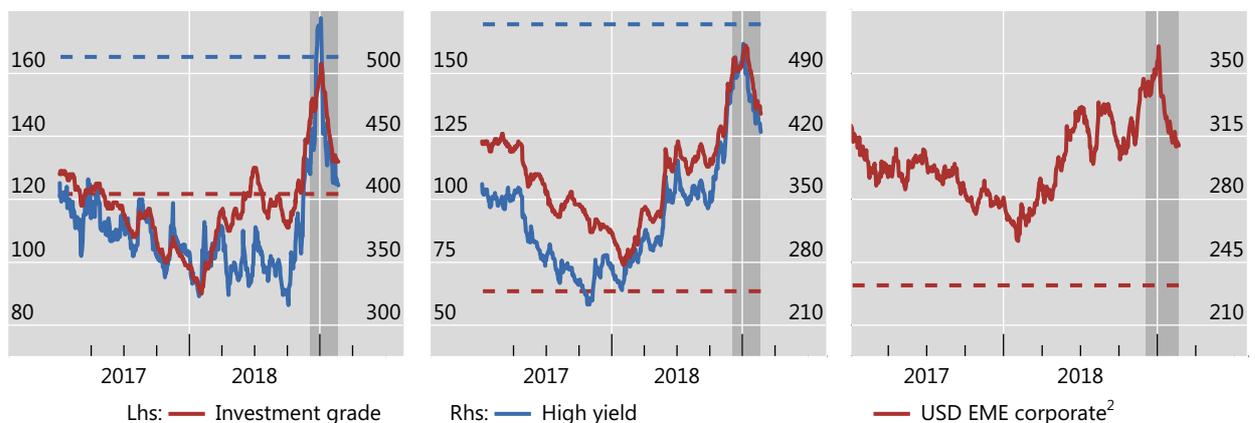
In basis points

Graph 4

Corporate spreads retraced earlier rise in US...¹

...and in Europe¹

EME corporates were no exception



The shaded areas indicate the review period, 5 December 2018 to 19 February 2019. The dashed lines indicate simple averages over the period 2002–06.

¹ Option-adjusted spread. ² JPMorgan CEMBI index; stripped spread.

Sources: Bloomberg; ICE BofAML indices; JPMorgan Chase; BIS calculations

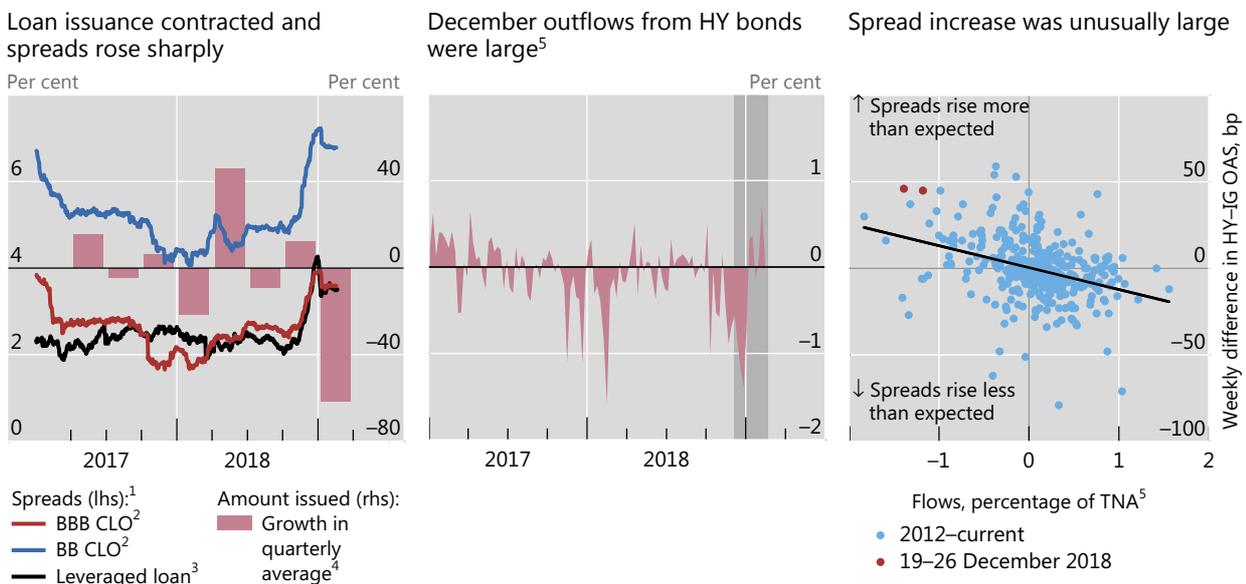
weak economic readings in the euro area and concerns of spillovers to the United States, wage growth was rapid and outstripped core inflation, indicating a possible pass-through of wage pressures to future headline inflation (centre panel). As a result, market measures of monetary policy uncertainty spiked late in December to levels similar to those during the “taper tantrum” episode in 2013 (right-hand panel).

Contributing to investors’ unease, monetary policy appeared set to continue on the preset tightening course in both the United States and the euro area. On 19 December, the Federal Reserve raised the policy rate and, while it expected a slower pace of rate increases in 2019, it also stated that balance sheet unwinding would proceed according to plan. In the euro area, the ECB’s asset purchase programme ended as scheduled.

Mounting worries about the growth outlook also jolted global corporate bond markets. As December got under way, corporate bond prices faced renewed pressure across the board. Credit spreads rose sharply in the United States. High-yield (HY) companies suffered most and saw their spreads briefly exceed the pre-crisis average. Investment grade (IG) spreads also rose, but not as much (Graph 4, left-hand panel). Moreover, corporate bond issuance contracted. In Europe and EMEs, spreads rose, albeit not as markedly as in the United States (centre and right-hand panels).

Stress in the markets for leveraged loans and collateralised loan obligations (CLOs) also pointed to tighter financial conditions for lower-rated companies. Issuance of leveraged loans dropped sharply in the United States, declining more than 50% in January (due to lags, January figures reflected the December slowdown). Spreads on leveraged loans and CLOs had been rising quickly since the beginning of the fourth quarter, and the run-up through December resulted in a doubling of the

Loan issuance nosedived as high-yield bonds faced large outflows in December Graph 5



The shaded area in the centre panel indicates the review period, 5 December 2018 to 19 February 2019.

¹ Spread to US 10-year Treasury. ² Yield of collateralised loan obligation tranches in the Palmer Square CLO Senior Index by rating. ³ US Leveraged Loan 100 Index, weighted average yield. ⁴ Quarterly average of monthly US leveraged loan total deal amounts reported by Bloomberg. For Q1 2019, January 2019 amount. Data accessed on 6 February 2019. ⁵ Weekly flows into funds that invest in North American and western European high-yield (HY) corporate bond funds, as a percentage of total net assets (TNA).

Sources: Bloomberg; EPFR; ICE BofAML indices; BIS calculations.

level prevailing in the past two years for leveraged loans. CLO spreads also rose rapidly in December (Graph 5, left-hand panel).

The spike in US corporate spreads largely reflected changing conditions in funding markets, but reduced year-end liquidity appeared to have played a role (Box A looks at late-December illiquidity). Spreads in the last two weeks of December proved especially sensitive to the large outflows from high-yield bond funds (Graph 5, centre panel) – more so than suggested by historical relationships. Indeed, the rise in spreads at the end of December 2018 was greater than when similarly large outflows occurred in the past (right-hand panel). This price reaction to outflows highlighted concerns about the robustness of liquidity in corporate bond markets at times of intense selling pressure (Box B discusses one possible source of outsize sales).

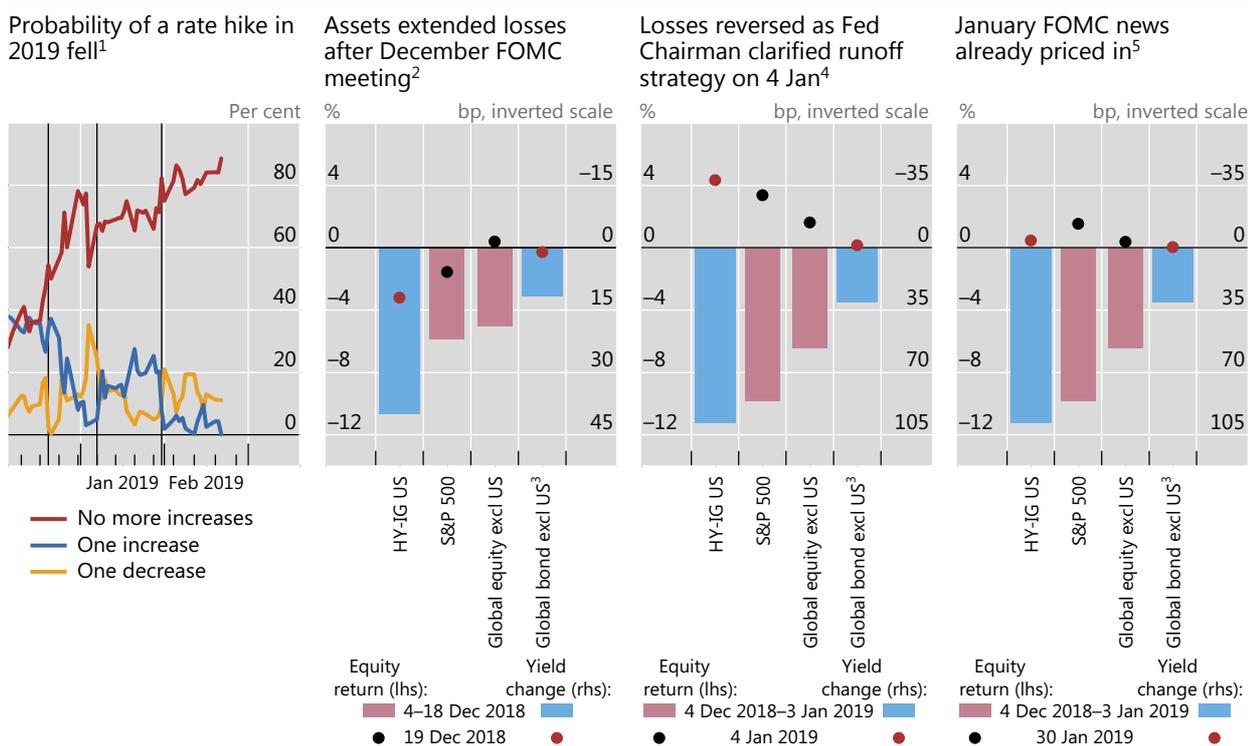
Phase 2: Sentiment picks up on more accommodative policy

As the global economic outlook remained unsettled, the course of monetary policy shifted in January. More accommodative signals by central banks in major economies set the tone for a market rally that started in January and reversed December losses. A phase of renewed optimism began.

The monetary policy outlook turned in January. On 4 January, the Federal Reserve Chairman underscored that both interest rate and balance sheet adjustments would be flexible to respond to incoming data. Eleven days later, the ECB President highlighted the increased downside risks to the economy and underscored that the full toolbox of monetary policy instruments remained available. On 23 January, the Bank of Japan revised its inflation forecast downwards and reaffirmed its commitment to purchase government bonds in order to keep the 10-year yield on target. During the press remarks following the Federal Open Market Committee (FOMC) meeting on 30 January, the Fed Chairman reiterated the main message of balance sheet flexibility that he had conveyed on 4 January.

Market participants responded to these monetary policy signals by resuming risk-on positions. A comparison of market developments on 19 December and 4 January illustrates the change in mood. On 19 December, investors had pulled back from risky positions in response to the FOMC policy statement. Even though the Federal Reserve had reduced the number of expected rate rises in 2019 from three to two, it had raised rates as anticipated and had indicated that balance sheet adjustments would stay on autopilot. On that day, even as investors started discounting the likelihood of a future rate increase, equities and corporate bonds added to earlier losses, especially in the United States (Graph 6, first and second panels). Later in December, investors attached a greater probability to a rate decrease than to an increase. Now, on 4 January, with the signal that balance sheet unwinding would be flexible if necessary, asset prices recouped some of their losses, with assets that had dropped more in December rallying to a larger extent (third panel).³ While the Federal Reserve articulated its balance sheet outlook in more detail on 30 January, the reaction to this FOMC meeting was more muted (fourth panel).

³ The Federal Reserve Chairman participated in a panel discussion between 10:15 and 12:15 Eastern Standard Time. At 08:30 EST, an unexpectedly positive Employment Situation report was released. Even excluding the first half-hour of trading, during which the positive macroeconomic news was reflected in prices, equities experienced a positive return.



¹ Federal funds future-implied odds of 25 basis point rate increase or decrease for 2019; December 2019 contract; over the review period (5 December 2018 to 19 February 2019). ² 19 December 2018. ³ Simple average of changes in HY-IG yield spreads for JPMorgan CEMBI indices and Europe Merrill Lynch indices. ⁴ Federal Reserve Chairman remarks that balance sheet unwinding would be flexible if necessary. ⁵ 30 January 2019.

Sources: Bloomberg; Datastream; ICE BofAML indices; JPMorgan Chase; BIS calculations.

Deteriorating financial conditions, and their potential impact on the real economy, contributed to the turn in monetary policy stance as reflected in remarks to the press following the two FOMC meetings. On 19 December, the Federal Reserve Chairman had highlighted that worsening financial conditions – reflecting broad developments in interest rates, corporate spreads, and currency and stock markets among others – had not fundamentally altered the outlook for the US economy.⁴ On 30 January, the Chairman underscored that the sustained worsening of financial conditions, together with rising spillover risk to the United States from more fragile global growth, was a factor in the decision to pause monetary tightening that was taken at the January FOMC meeting.⁵

As the monetary stance eased in AEs, Chinese authorities implemented a multi-pronged strategy to fend off a persistent slowdown. For much of 2018, weakness in Chinese asset prices and macroeconomic data had partly reflected efforts to

⁴ Transcript of Chairman Powell's press conference, 19 December 2018, pp 1 and 4, <https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20181219.pdf>.

⁵ Transcript of Chairman Powell's press conference, 30 January 2019, pp 11–12, <https://www.federalreserve.gov/mediacenter/files/FOMCpresconf20190130.pdf>.

Financial markets remain vulnerable to year-end stress

Sirio Aramonte and Egemen Eren

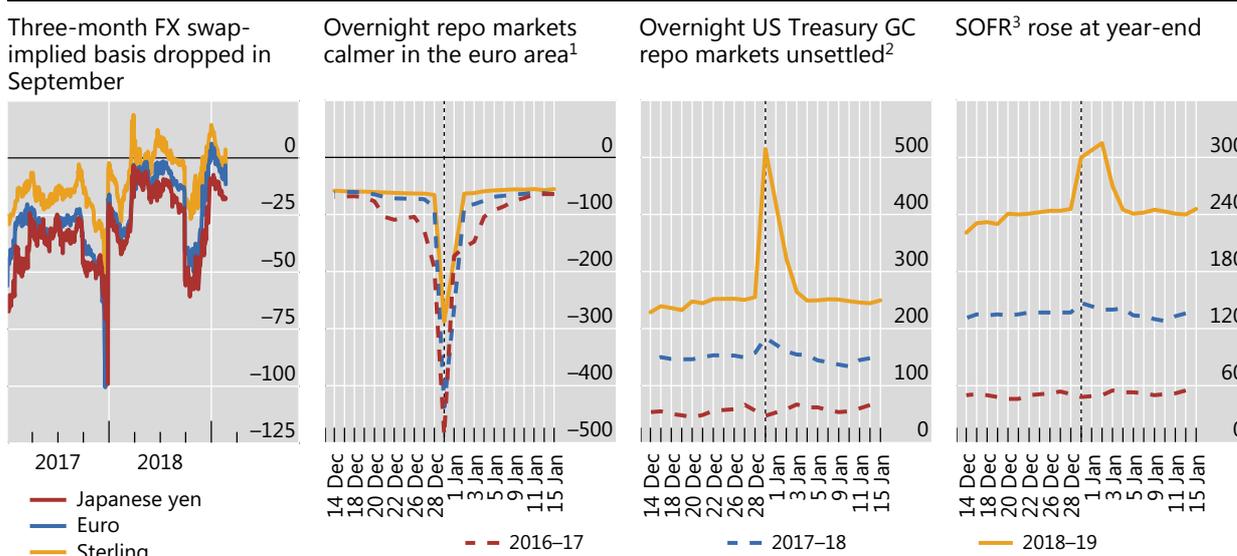
Sharp price movements are common at year-ends in many markets, reflecting the relatively low liquidity that results, in part, from infrequent point-in-time regulatory reporting. Events in late 2018 highlighted two developments. First, market participants and central banks made adjustments to cope with recurring price anomalies: the former front-loaded the adjustment; the latter sought to ease it. Second, year-end illiquidity makes funding and collateral markets vulnerable to unexpected events. The developments also illustrated the channels through which such price dislocations can propagate across financial markets.^①

FX swap markets were relatively steady in late December, although volatility had risen earlier in the year. In the past, these markets had seen sharp spikes in the cost of the US dollar against the euro and yen at year-end (Graph A, first panel). These occurred at different points over the past years, as traders manoeuvred to take positions ahead of crowded dates. This time, the three-month FX swap-implied basis dropped sharply at the end of September. This reflected a combination of investor demand from prefunding of US dollar positions and high price quotes by dealers in order to manage year-end inventory balances. Even though the drop was not as pronounced as in the past, the basis remained wider for longer, pointing to the less stark but longer-lasting effects of year-end pressures.^②

Year-end stress continued to cause price dislocations

In basis points

Graph A



¹ Overnight repo rate calculated using repos with German sovereign bonds as collateral, comprising 90% special and 10% general collateral trades. ² The graph shows the DTCC Treasury GCF repo weighted average rate. ³ Secured overnight financing rate.

Sources: Bloomberg; RepoFunds Rate, www.repofundsrate.com; BIS calculations.

European repo markets, too, were more resilient at the end of 2018 than in previous years. For example, repo rates for highly sought-after German collateral did not drop as much into negative territory as in prior episodes (Graph A, second panel). Anticipating year-end stress in markets, investors moved ahead to lock in funding and manage collateral. Moreover, broader and easier access to securities lending programmes by the ECB and national central banks no doubt helped mitigate year-end dislocations.

Despite front-loaded adjustments, financial markets remained vulnerable to the impact of unexpected events. Large-scale US Treasury issuance took place on the last day of December, a point in time when dealers are reluctant to expand their balance sheets due to regulatory reporting. As a result, the Treasury general collateral (GC) repo rate jumped by 260 basis points (Graph A, third panel).

Localised year-end stress can spill over to other markets if it affects rates used to calculate benchmarks. A case in point was the spike in the secured overnight financing rate, which is an alternative benchmark rate to LIBOR based partly on Treasury GC repo rates (Graph A, fourth panel).^③

① More generally, these developments reflect the fact that, post-crisis, financial institutions have recognised that the balance sheet has a price. This improvement in risk management has been hard-wired by regulation. See *BIS Annual Economic Report 2018, Chapter III*, for further discussion. ② See C Borio, R McCauley, P McGuire and V Sushko, “Covered interest parity lost: understanding the cross-currency basis”, *BIS Quarterly Review*, September 2016, pp 45–64, for further discussion of factors affecting the cross-currency basis. ③ See also A Schimpf and V Sushko, “Beyond LIBOR: a primer on the new benchmark rates”, *BIS Quarterly Review*, March 2019.

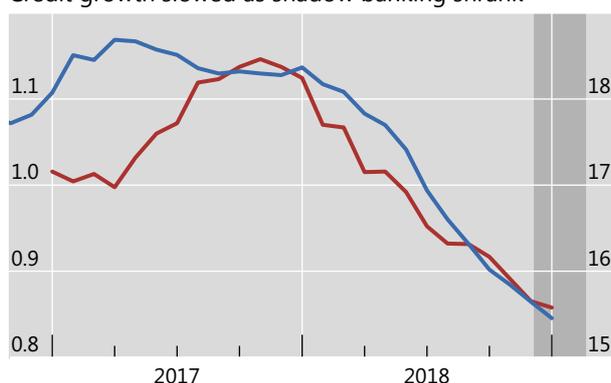
deleverage without compromising growth. Policymakers eased monetary and fiscal policy even as they sought to steer credit growth away from the shadow banking sector (Graph 7, left-hand panel). These efforts were reinforced in January. Monetary stimulus focused on banks, with the People’s Bank of China cutting reserve requirements, providing large amounts of liquidity through open market operations (right-hand panel) and launching a term lending facility aimed at bolstering credit to smaller firms. Regulators also approved the issuance of perpetual bonds by banks to shore up Tier 1 capital. These bonds can be swapped with central bank bills, which in turn can be used by holders as collateral to obtain financing. On the fiscal side, the stimulus was mainly routed through “local government special bonds” that funded infrastructure projects.

Chinese policy responded to slowdown

In per cent

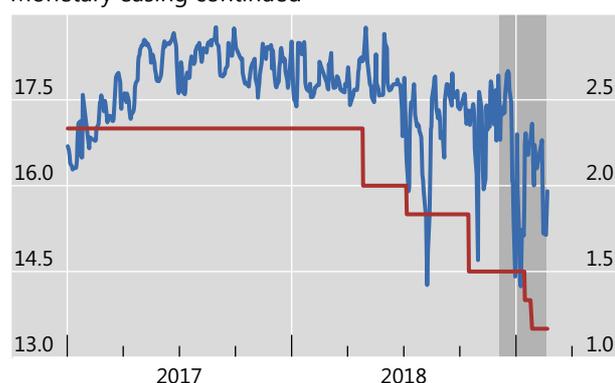
Graph 7

Credit growth slowed as shadow banking shrank



Credit: — Total (lhs)¹ — Non-bank share (rhs)

Monetary easing continued



Lhs: — Reserve requirement ratio — SHIBOR overnight²

The shaded areas indicate the review period, 5 December 2018 to 19 February 2019.

¹ Twelve-month moving average of the monthly growth rate. ² Shanghai interbank offered overnight rate.

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

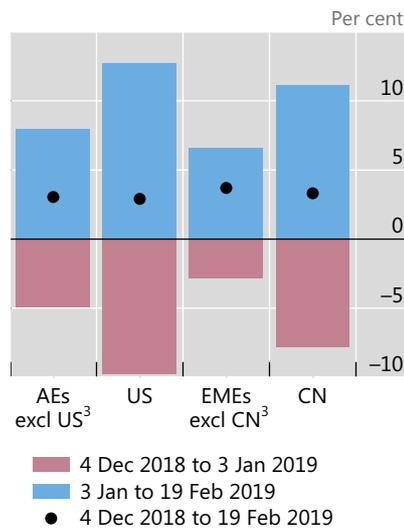
Renewed optimism in 2019 improved risk appetite for equities globally

Graph 8

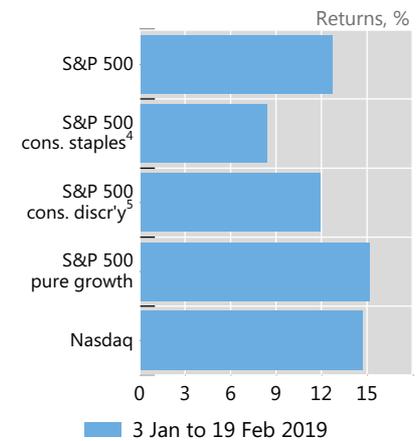
US economic surprises were positive¹



Stocks recouped losses globally²



Growth stocks performed best



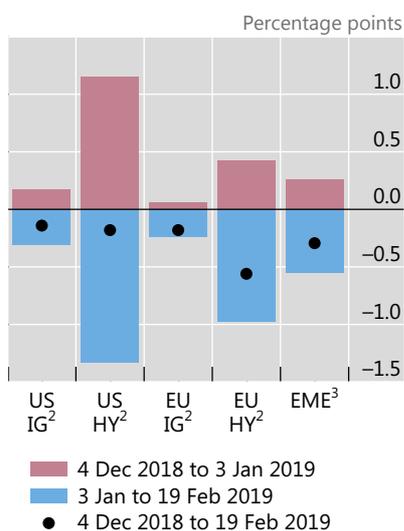
¹ Citi Economic Surprise Index; the shaded area indicates the review period (5 December 2018 to 19 February 2019). ² Returns are calculated on the closing price for the dates indicated in the legend. ³ Simple average across country stock indices in local currency. ⁴ Consumer staples. ⁵ Consumer discretionary.

Sources: Bloomberg; ICE BofAML indices; JPMorgan Chase; BIS calculations.

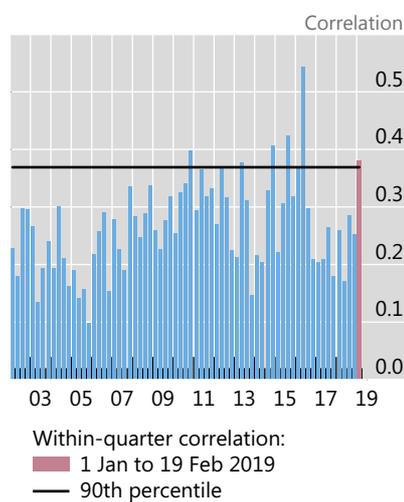
Corporate spreads compressed as sovereign yields slid

Graph 9

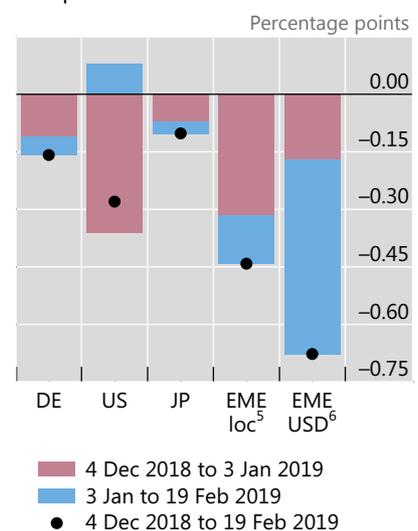
Corporate spreads reversed early increase¹



Stocks and corporate bonds co-moved across countries⁴



Sovereign yields dropped further, except in US¹



¹ Yield changes are calculated on the closing price for the dates indicated in the legend. ² Option-adjusted spread. ³ JPMorgan CEMBI index; stripped spread. ⁴ Average of within-quarter pairwise correlations (in absolute value) between S&P 500 index returns and (i) AE equity returns (average return of selected AE stock indices); (ii) EME equity returns (MSCI Emerging Markets stock index); (iii) changes in US corporate bond yields (average of US high-yield and investment grade corporate bond indices); (iv) changes in AE corporate bond yields (average of European high-yield and investment grade corporate bond indices); and (v) changes in EME corporate bond yields (average of CEMBI HY and CEMBI IG). ⁵ JPMorgan GBI index. ⁶ JPMorgan EMBI Global.

Sources: Bloomberg; Datastream; ICE BofAML indices; JPMorgan Chase; BIS calculations.

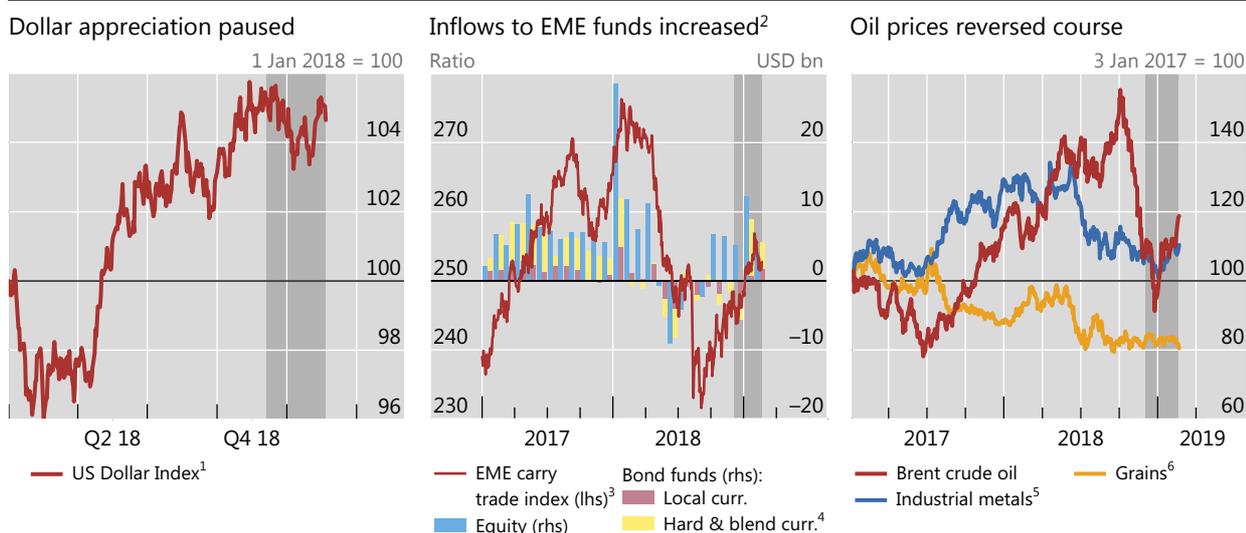
Increasingly accommodative global monetary policy and more positive than expected indicators in the United States led to renewed optimism in markets. In January, economic readings continued to weaken in Europe and remained broadly stable in EMEs, but were better than anticipated in the United States despite the prolonged government shutdown (Graph 8, left-hand panel). Stocks rallied worldwide and recouped the losses suffered in December, with growth-oriented equities performing especially well (Graph 8, centre and right-hand panels). Corporate spreads compressed globally, ending the review period lower on net (Graph 9, left-hand panel). As risky assets reacted to policy developments in unison, co-movement between US stocks and international securities – including equities and corporate bonds – jumped (Graph 9, centre panel).

Sovereign bond prices rose, except in the United States. As inflation expectations dropped, yields eased on net in Germany and Japan, but inched up in the United States (Graph 9, right-hand panel). In EMEs, sovereign yields declined, especially for US dollar-denominated bonds, which closed the review period with substantially lower yields.

EME assets experienced large inflows, and commodity prices climbed, as the US dollar weakened in early January (Graph 10, left-hand panel). With favourable interest rate differentials and comparatively low equity valuations in light of a correction earlier in 2018, EME bond and equity funds received sustained inflows. Bond funds gathered significant assets for the first time since the beginning of 2018 (centre panel). Growth-sensitive commodities, including oil and industrial metals, also rose. Oil prices in particular, which had dropped sharply in the last quarter of the year, reversed course (right-hand panel). Later in the review period, the US dollar appreciated, with some volatility. As a result, carry trades became less profitable, and inflows to EME assets slowed down.

As dollar slid in January, flows to EME assets rose and commodities climbed

Graph 10



The shaded areas indicate the review period, 5 December 2018 to 19 February 2019.

¹ The US Dollar Index (USDX) measures the value of the US dollar against major currencies. An increase corresponds to the appreciation of the US dollar. ² Monthly sums of weekly data up to 13 February 2019. ³ EM-8 carry trade index, which measures the cumulative total return of a buy and hold carry trade position that is long in eight EME currencies and fully funded with short positions in USD. ⁴ Blend currency funds invest in both local currency and hard currency bonds. ⁵ Bloomberg Industrial Metals Subindex. ⁶ Bloomberg Grains Subindex.

Sources: Bloomberg; EPFR; BIS calculations.

Investment mandates and fire sales: the case of mutual funds and BBB bonds

Sirio Aramonte and Egemen Eren

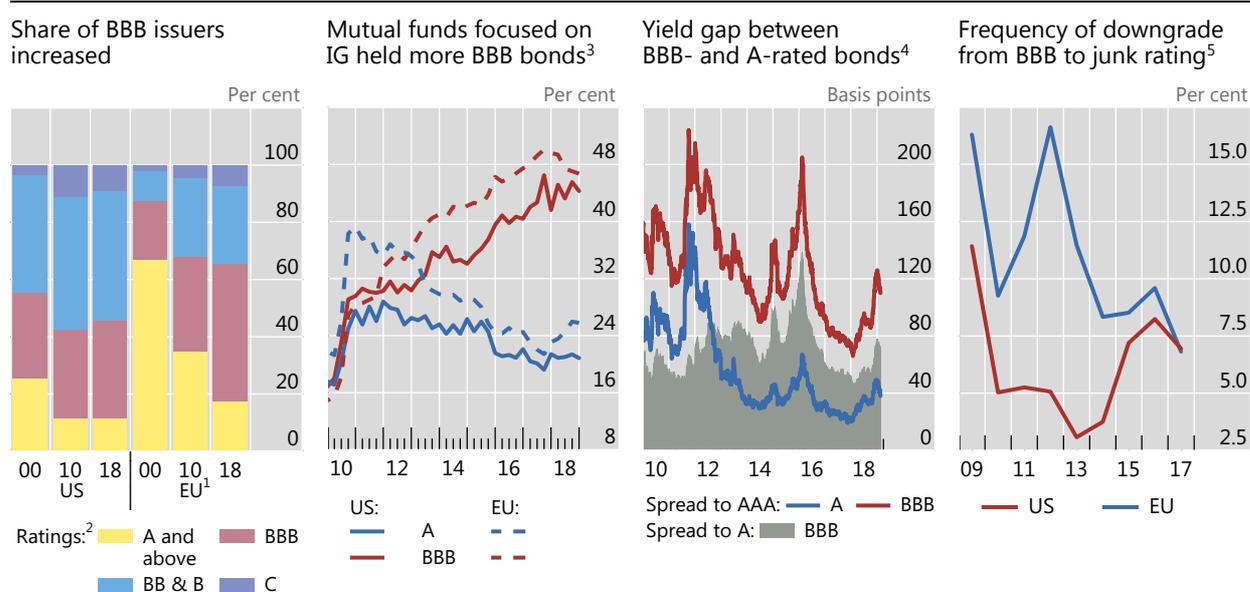
The share of corporate bond issuers with the lowest investment grade rating – BBB and equivalent – has risen in the United States and Europe since 2000 (Graph B, first panel). In the United States, the increase took place mainly prior to the Great Financial Crisis (GFC). In Europe, it continued after the GFC. As of 2018, the share of corporate bond issuers rated BBB stood at about one third in the United States and at nearly half in Europe.

Rating-based investment mandates require portfolio managers to hold assets above a minimum credit quality. Such mandates often apply to corporate bond mutual funds, and allow investors to easily choose the desired risk exposure, often focusing on the investment grade segment.

Since the GFC, investment grade corporate bond mutual funds have steadily increased the share of BBB bonds in their portfolios. In 2018, this share stood at about 45% in both the United States and Europe, up from roughly 20% in 2010 (Graph B, second panel). As interest rates remained unusually low post-GFC, portfolio managers were enticed by the significant yield offered by BBB-rated bonds, which was substantially higher than for better-rated bonds (third panel).

Mutual funds and the fire sale risk of BBB bonds

Graph B



¹ AT, BE, DE, DK, ES, EE, FI, FR, GR, IE, IT, LU, NL and PT. ² A = Aaa–A3; BBB = Baa1–Baa3; BB and B = Ba1–B3; C = Caa1–C. ³ IG indicates investment grade bonds. Average percentage of corporate bond mutual fund portfolios invested in bonds with the indicated rating. ⁴ Option-adjusted spreads. ⁵ Downgrade frequencies from BBB to junk or non-rated.

Sources: ICE BofAML indices; Lipper; Moody's Analytics CreditEdge; S&P Global; BIS calculations.

While attractive to investors that seek a targeted risk exposure, rating-based investment mandates can lead to fire sales. If, on the heels of economic weakness, enough issuers were abruptly downgraded from BBB to junk status, mutual funds and, more broadly, other market participants with investment grade mandates could be forced to offload large amounts of bonds quickly.

The odds of such fire sales depend on the likelihood that a sufficiently large number of companies are downgraded from BBB to junk status in short order. In 2009, when default rates reached record highs, the frequency of such downgrades was 11.4% in the United States and 16.3% in Europe (Graph B, fourth panel). By 2017, this frequency had fallen to around 7% in both regions. Under reasonable assumptions, a return to 2009 downgrade rates could force portfolio rebalancing in excess of daily turnover in corporate bond markets.^①

^① According to the Securities Industry and Financial Markets Association, about \$9,100 billion of US corporate bonds were outstanding as of Q3 2018, with a daily trading volume of about \$25 billion (0.27% turnover). With an 11.4% BBB-to-junk downgrade frequency, assuming 10% of the downgrades occurred around the same time and that one third of the bonds were offloaded quickly, about 0.38% of outstanding BBB bonds would be sold (compared with 0.27% daily turnover).

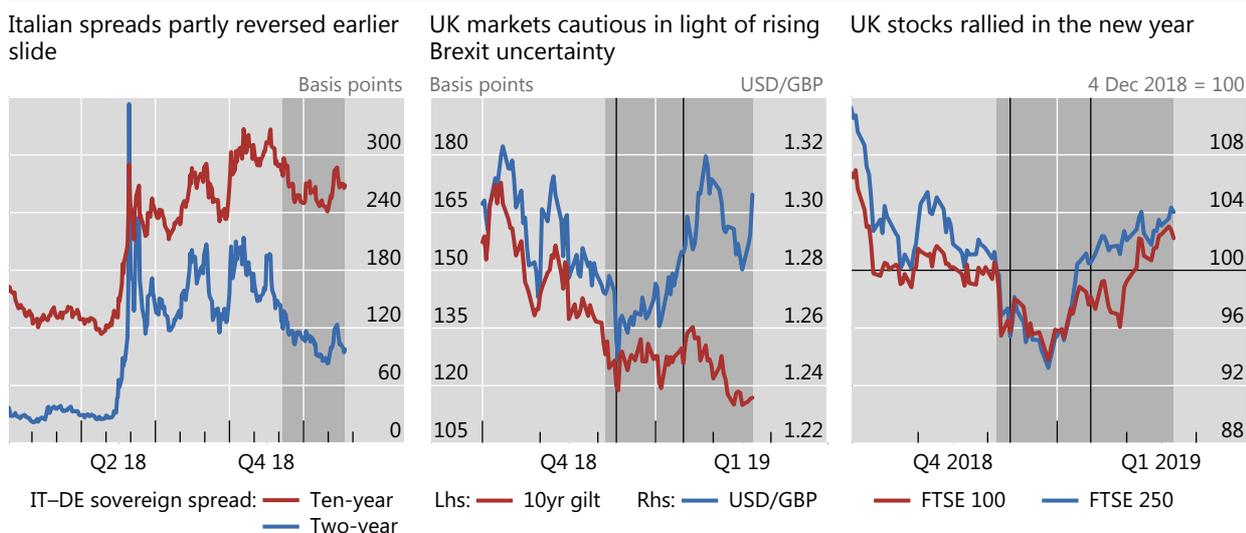
Sovereign risk steadies in euro area, Brexit uncertainty rises

Euro area markets witnessed an overall easing in sovereign risk indicators early in the review period. Spreads of Italian government bonds to German bunds continued to decline (Graph 11, left-hand panel). While still higher than in early 2018, Italian spreads were much lower than after the September release of the proposed government budget. Strong demand resulted in a series of significantly oversubscribed auctions for a number of countries, including Italy and Spain. In February, however, Italian spreads widened again when the European Commission slashed its 2019 GDP forecast for Italy.

Despite growing Brexit uncertainty and the reduction of growth forecasts by the Bank of England, UK assets performed well. There were only limited signs of flight to safety on 10 December, when a scheduled parliamentary vote on the draft EU-UK agreement was cancelled. Nor was there a sustained market reaction when the

Euro area sovereign risks eased overall as UK markets remained steady

Graph 11



The shaded areas indicate the review period, 5 December 2018 to 19 February 2019. The vertical lines in the centre and right-hand panels indicate 10 December 2018 (scheduled parliamentary vote on draft Brexit agreement cancelled) and 15 January 2019 (draft Brexit agreement rejected by parliament).

Sources: Bloomberg; BIS calculations.

agreement was rejected on 15 January. On both occasions, while sterling dropped against the dollar and 10-year gilt yields rose, the moves were not particularly pronounced and were quickly reversed (Graph 11, centre panel). UK stock indices followed their global counterparts and rallied in January and February, ending the review period with a positive return (right-hand panel).

Emerging markets' reliance on foreign bank credit¹

This article examines the importance of foreign banks in the provision of credit to emerging market borrowers. It documents this along two dimensions: the share of total credit provided and the concentration of claims from different foreign banking systems. The share of credit from foreign banks in total credit to emerging market economies has fallen since the Great Financial Crisis, but still stands at 15–20% on average, with the remainder provided by domestic banks or non-bank creditors. On the other hand, concentration in the market share of foreign creditor banking systems has risen. The official sector tends to be less reliant on foreign banks for credit, but more concentrated in its foreign banking system creditors than the private sector.

JEL classification: F34, G21.

Internationally active foreign banks are important providers of credit for borrowers in emerging market economies (EMEs). They straddle national borders with their operations and thus may provide a conduit for the transmission of financial conditions to (and from) EMEs (Cetorelli and Goldberg (2011, 2012), Ongena et al (2015), Schnabl (2012)). While foreign banks can provide needed credit to EME borrowers and help boost financial capacity, excessive reliance on them can make EMEs vulnerable to foreign developments, with negative events leading to a contraction in credit and positive events fuelling a domestic credit boom that could potentially result in financial stress as it turns to bust (Avdjiev, Binder and Sousa (2017), Borio et al (2011)).

This article examines the importance of foreign banks in EMEs, explores how the volume and landscape of foreign bank lending have changed over time, and highlights differences by type of claims and borrower sector. It introduces a new measure of foreign bank reliance which captures how much of an EME's total credit is obtained from foreign banks. The first section discusses and documents this measure. Foreign bank reliance has been declining since the Great Financial Crisis (GFC), in favour of credit from domestic banks and non-banks, but with significant differences across countries and sectors. The second section documents the recent evolution of concentration in market share among foreign creditor banking systems in lending to specific EMEs. Concentration is high, especially for local currency lending, and has been increasing since the crisis. The last section explores the correlation of foreign bank concentration with foreign bank reliance. On average, the

¹ The author thanks Stefan Avdjiev, Claudio Borio, Stijn Claessens, Benjamin Cohen, Robert McCauley, Patrick McGuire, Swapan-Kumar Pradhan, Hyun Song Shin and Philip Wooldridge for valuable comments. Deimante Kupciuniene provided excellent research assistance. The views expressed in this article are those of the author and not necessarily those of the BIS.

Key takeaways

- Emerging market borrowers' reliance on foreign bank credit has been decreasing since the Great Financial Crisis (GFC). The decline was driven by stagnation in foreign bank credit and expansion of credit from domestic banks and non-bank creditors.
- Emerging market borrowers obtain 15–20% of their credit from foreign banks on average, as of the second quarter of 2018, with a little over half of that in the form of local lending in local currency.
- Concentration amongst foreign creditor banking systems is high in emerging market economies. The share of foreign bank credit from a country's top three creditor banking systems has been increasing since the GFC and was over 75% as of Q2 2018.
- There are substantial differences across emerging market economies and sectors in terms of both foreign bank reliance and concentration of foreign creditor banking systems.

reliance on foreign banks moves opposite from the concentration among foreign creditor banking systems over time.

Reliance on foreign bank credit

Credit to non-financial borrowers in EMEs² has increased rapidly over the past decade from both bank and non-bank sources. Banks are the main source of credit to the private non-financial sector (77% of the total in the second quarter of 2018; Graph 1, left-hand panel). Credit from non-banks has been expanding, their claims growing at an average annual rate of 4.5% over the past decade.³ Credit from BIS reporting foreign banks⁴ rose in the lead-up to the GFC, but has increased little since.

Credit to EME governments, on the other hand, is largely provided by non-bank creditors (Graph 1, right-hand panel). Credit to governments is typically in the form of debt securities, which may influence the composition of creditors. Banks provide about one third of the credit, largely from domestic banks.

Foreign bank reliance (FBR) in EMEs has varied across countries, sectors and time. FBR denotes the fraction of total credit to non-financial borrowers in a country (or a sector within a country, such as non-financial corporations) that is accounted for by the consolidated claims of foreign banks (box).⁵ This measure also includes bond

² EMEs in this article are a subset of countries designated as EMEs in the BIS statistics, selected based on data availability in the total credit series and consolidated banking statistics: Argentina, Brazil, Chile, China, Colombia, Hungary, India, Indonesia, Israel, Malaysia, Mexico, Poland, Russia, South Africa, South Korea, Thailand and Turkey.

³ For these countries, credit in the form of international debt securities has grown at an average annual rate of 11% over the past decade. See also McCauley et al (2015) and Avdjiev, Gambacorta, Goldberg and Schiaffi (2017) for evidence and discussion on the growing importance of bonds for foreign currency credit to EMEs.

⁴ Foreign banks are those whose headquarters are located outside the counterparty's country of residence.

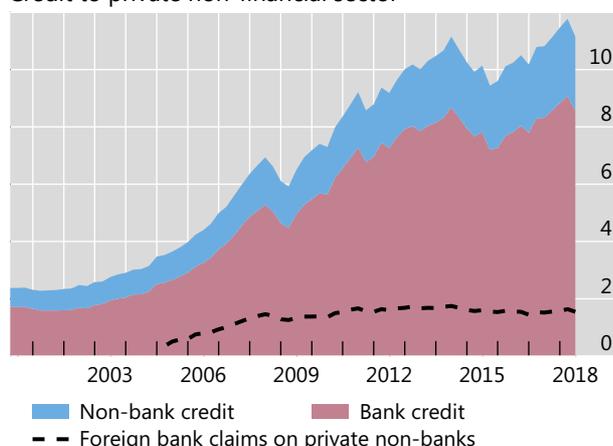
⁵ Foreign banks in this measure are only those with headquarters in BIS reporting countries. While this probably includes the bulk of foreign claims, some important lenders (eg China) are excluded.

Credit to EMEs has surged

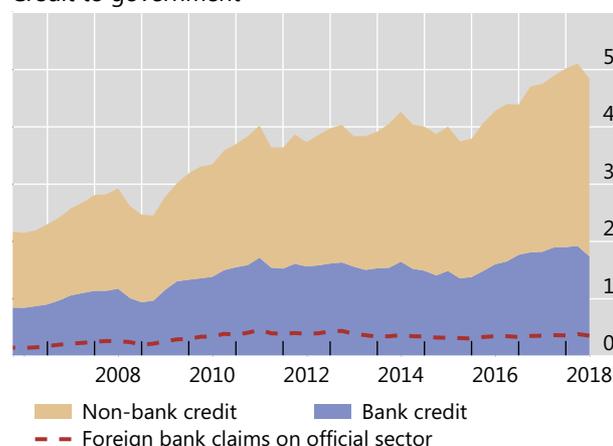
Total credit to EME non-financial borrowers (excluding China), in trillions of US dollars

Graph 1

Credit to private non-financial sector^{1, 2}



Credit to government^{2, 3}



¹ AR, BR, CL, CO, HU, ID, IL, IN, KR, MX, MY, PL, RU, TH, TR and ZA. Foreign bank claims (on an ultimate risk basis) are reported beginning in Q4 2004. ² Foreign banks are BIS reporting banks headquartered outside the country of residence of the counterparty. ³ AR, BR, IN, KR, RU, TH and TR. Sample limited to EMEs with data on credit to government from banks. Official sector includes government and central banks.

Sources: BIS consolidated banking statistics (ultimate risk basis); BIS statistics on total credit to the private non-financial and government sectors.

financing and borrowing from non-bank creditors, which has increased and become a substantial source of credit for many EMEs.

The foreign banks do not behave uniformly, with some operating more like domestic banks by setting up locally funded subsidiaries. Thus, a key distinction in the data is that between international claims (IC), ie cross-border claims and local claims in foreign currency, and local claims in local currency (LCLC). While the numerator of the FBR measure sums these two components, they often behave differently: LCLC are usually funded locally and so may be more insulated from foreign developments. Local lending and locally funded banks have been shown to be more stable in the face of external funding shocks (Avdjiev and Wooldridge (2018), Ehlers and McGuire (2017), McCauley et al (2017), Ongena et al (2015), Schnabl (2012)).

Reliance on foreign banks has decreased since the crisis

Across different measures, FBR increased leading up to the GFC, but has been steadily decreasing since (Graph 2, left-hand panel). On average, EME borrowers in the sample received over a quarter of their total credit from foreign banks prior to the GFC (including domestic bank borrowers). Most of that credit went directly to non-bank borrowers rather than indirectly via the local banking system.⁶ Within this category,

⁶ As the denominator is total credit to the non-financial sector, including all sectors in the numerator (ie including banks and non-bank financials) carries the implicit assumption that credit to the domestic financial sector is passed through to domestic non-financial borrowers. Thus, the three lines provide a range of possible FBR values. See the box for a discussion.

Measuring reliance on foreign bank credit

Foreign banks (ie those with headquarters outside the borrower's country of residence) have been prominent players in EMEs. Nevertheless, lack of comparable, complete data makes it difficult to measure how important a role they may play. This box discusses how the BIS banking and total credit data can be used to construct measures of foreign bank reliance, and what these measures capture.

Foreign bank participation rates

A first pass at a measure of foreign bank reliance, the foreign bank participation (FBP) rate, looks at the share of total credit from bank creditors provided by foreign banks (Ehlers and McGuire (2017), McGuire and Tarashev (2005)):

$$FBP = \frac{IC^{NB} + \alpha * LCLC}{XB^{NB} + DC}$$

XB^{NB} is cross-border bank credit to non-bank borrowers (from the BIS locational banking statistics). DC is domestic bank credit to non-bank borrowers (from the IMF *International Financial Statistics*).^① Thus, the denominator captures all credit provided by bank creditors, extended either locally or cross-border. The numerator is total foreign bank credit provided to non-banks in the economy (derived from the BIS consolidated banking statistics (CBS)), which comprises cross-border lending by foreign banks and local lending by the local affiliates of foreign banks. IC indicates international claims, which comprise cross-border credit and local credit extended in foreign currencies. $LCLC$ is local credit extended in the local currency. The IC data are broken down by borrowing sector, allowing one to focus on, for instance, the non-bank sector, but $LCLC$ does not include this sectoral counterparty breakdown in the time series. That breakdown is estimated by multiplying $LCLC$ by α , the share of credit to non-banks in IC (Ehlers and McGuire (2017)).

Foreign bank reliance

The FBP measure misses the important increase in bond financing and financing by non-bank creditors to emerging market borrowers in recent years (Aldasoro and Ehlers (2018), Avdjiev, Gambacorta, Goldberg and Schiaffi (2017)). Thus, a more comprehensive measure of credit in the denominator can more accurately capture the role of foreign banks in total credit provision. In 2013, the BIS began publishing series on total credit to the non-financial sector for individual countries (data extending to before 2013). These series capture credit extended in the form of currency and deposits, loans and debt securities from all lenders over a long time horizon (Dembiermont et al (2013), Dembiermont et al (2015)). These series allow us to estimate foreign bank reliance (FBR) as:

$$FBR^s = \frac{IC^s + \alpha^s * LCLC}{Total\ Credit^s}$$

The s superscript indicates the borrowing sector, as both the CBS and total credit data permit decompositions by the borrowing sector (eg private non-financial sector or official sector). To estimate the sector split of $LCLC$, the ultimate risk (UR) data from the CBS are used, which break down total claims ($IC + LCLC$) by the borrowing sector. This may provide a more accurate estimate than applying the shares from IC , especially if $LCLC$ is large relative to IC .^②

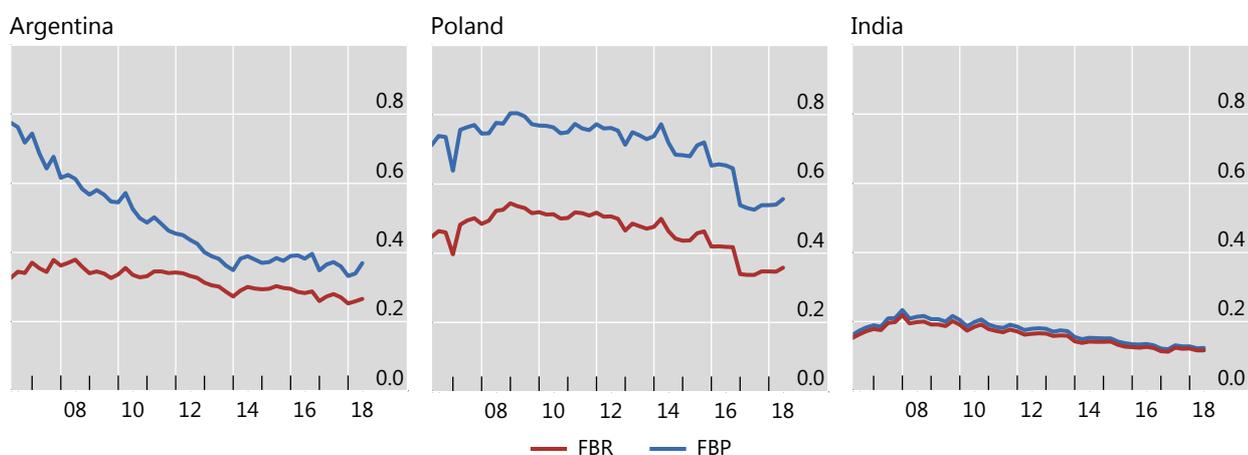
The inclusion of non-bank credit in the denominator makes a large difference for many EMEs (Graph A, left-hand and centre panels), but some still rely very little on bonds and other non-bank credit (Graph A, right-hand panel).

Role of the domestic financial sector

Foreign banks can provide credit *directly* to EME borrowers, either cross-border or via a local affiliate, or they can do so *indirectly* by lending to local banks or non-bank financials. Thus, examining credit from foreign banks directly to non-financial EME borrowers may underestimate the role of foreign banks in credit provision. However, including foreign bank claims on the domestic financial sector may also overstate the role of foreign banks if the financial sector in turn uses those funds to extend credit abroad. Alternative measures for the numerator shed light on the potential range of values for FBR : foreign bank claims on all sectors, foreign bank claims on the non-bank sector and foreign bank claims on the non-financial sector (Graph B). As it turns out, while including claims on banks in the numerator increases the FBR measure somewhat, non-bank financials do not contribute very much to the measure generally.

Impact of including non-bank credit in total credit

Foreign bank reliance (FBR) vs foreign bank participation (FBP) of the non-bank private sector (ratio)¹ Graph A



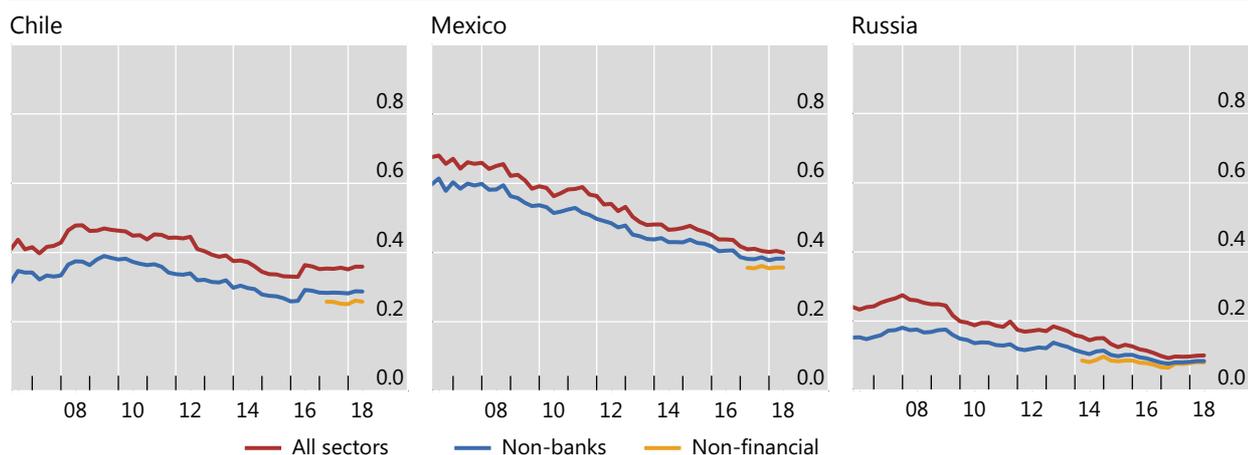
¹ FBR of the non-bank private sector is the estimated claims by BIS reporting foreign banks on private non-banks in the domestic economy, divided by total credit to the private non-financial sector. FBP of the non-bank private sector is the estimated claims by BIS reporting foreign banks on private non-banks in the domestic economy, divided by total bank credit to the private non-financial sector.

Sources: BIS consolidated banking statistics (immediate counterparty basis); BIS statistics on total credit to the private non-financial sector.

Besides the non-financial sector as a whole, it is useful to consider how reliant individual sectors of the economy (such as the private and official sectors) may be on foreign banks. Data to separate non-banks into financial and non-financial creditors are only available with recent enhancements to the BIS data. When disaggregating the borrower sector further, such as examining the private and official sectors, assumptions about the allocation of foreign bank credit lent indirectly through domestic banks become more tenuous. Thus, for those sectors it is safer to focus on a foreign bank reliance measure which is confined to direct credit provision.③

Foreign bank reliance measures for selected countries

FBR, by counterparty sector of foreign bank claims (ratio)¹ Graph B



¹ FBR is the estimated claims by BIS reporting foreign banks on the listed borrowing sector of the domestic economy, divided by total credit to the non-financial sector.

Sources: BIS consolidated banking statistics (immediate counterparty basis); BIS statistics on total credit to the private non-financial sector.

① DC corresponds to domestic claims or domestic credit to non-bank borrowers from monetary authorities and depository corporations (IMF *International Financial Statistics*). Some countries additionally provide domestic credit series including non-bank financial creditors. The DC series is no longer actively produced and maintained by the IMF across countries, and so cannot be used for recent data. For the construction of *FBR* in this box, total credit to the private non-financial sector from bank creditors is used, available from the BIS series on total credit. ② Using the previous method with *IC* on an immediate counterparty basis results in a very similar estimate. Using the total claims series from the ultimate risk data in the numerator also results in a similar series, but the immediate counterparty data are used in order to show the breakdown between *IC* and *LCLC*. The ultimate risk data are available from Q4 2004. ③ Given data constraints, the sector definitions do not always line up perfectly. Since the data enhancements for foreign bank claims on the private non-financial sector have not been available until recently, claims on the private non-bank sector are used in the numerator for time series plots of *FBR* for the private non-financial sector. For the official sector, foreign bank claims include claims on both the government and the central bank, whereas the total credit series captures credit to the government only. For EMEs, central bank liabilities are small, but this measure may not be appropriate for countries whose central banks have employed quantitative easing measures.

non-financial borrowers, for which data are only available at the end of the sample, record a slightly lower *FBR*.⁷

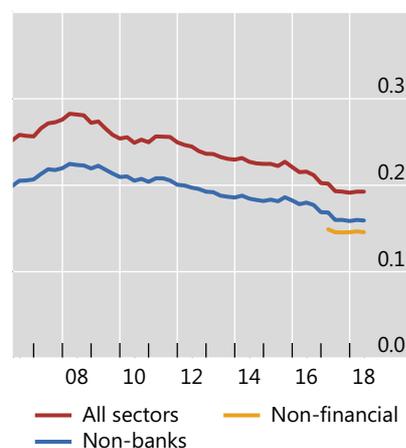
After the GFC, average reliance on foreign bank credit steadily decreased from 28% of the total in Q3 2008 to 19% by Q2 2018 (15% for direct credit to the non-financial sector). This reduction reflects a stagnation in credit from foreign banks as well as an increase in credit from both domestic banks and non-bank creditors (Graph 1).⁸ In general, both *IC* and *LCLC* reliance declined following the GFC, but *IC*

Reliance on foreign banks has fallen¹

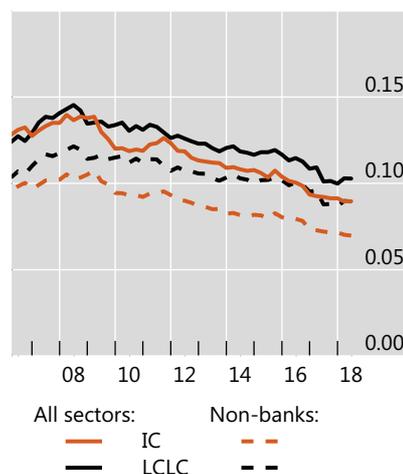
FBR measures (ratio)

Graph 2

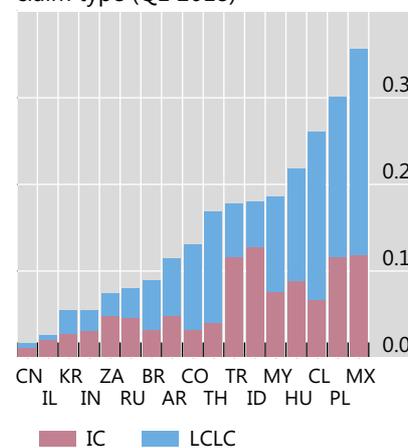
Average FBR



Average FBR by claim type²



FBR of non-financial borrowers, by claim type (Q1 2018)²



¹ FBR is the estimated claims by BIS reporting foreign banks on the listed borrowing sector of the domestic economy, divided by total credit to the non-financial sector. ² International claims (IC) consist of cross-border claims of foreign banks plus local claims extended in foreign currency. Local claims in local currency (LCLC) are claims made by foreign banks resident in the domestic economy to domestic borrowers in the domestic currency.

Sources: BIS consolidated banking statistics (immediate counterparty basis); BIS statistics on total credit to the private non-financial sector; author's calculations.

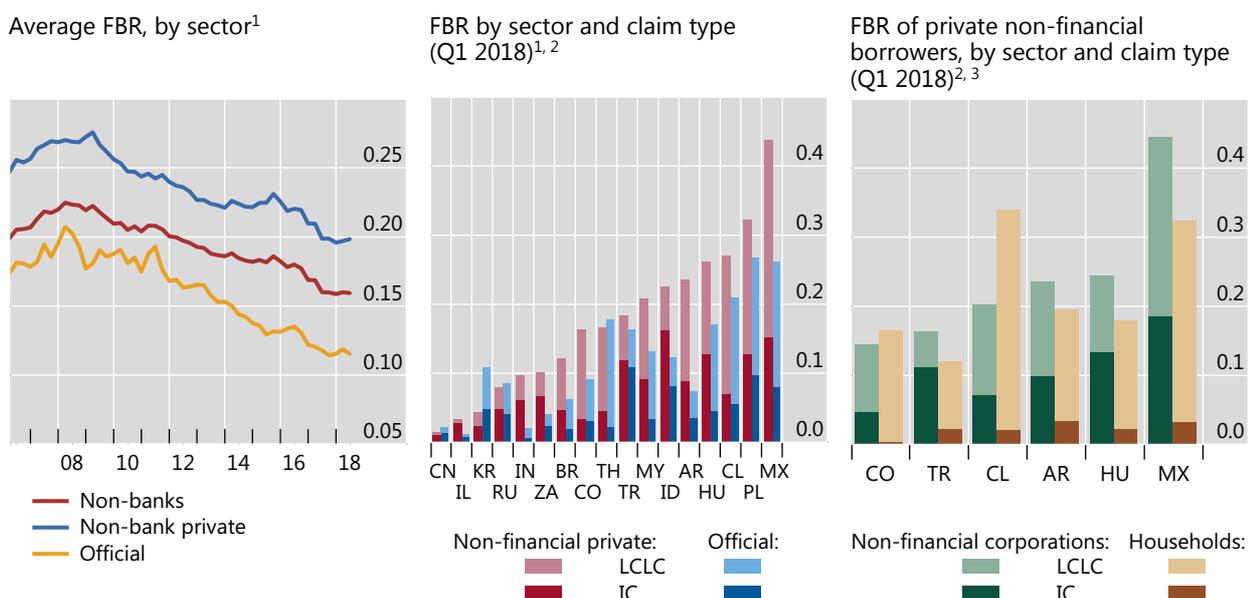
⁷ This indicates that the time series for non-bank borrowers may be informative about the time series for non-financial borrowers, which captures only direct credit provision from foreign banks.

⁸ FBR could be biased by the exclusion of foreign banks which do not report to the consolidated banking statistics, most notably Chinese banks (Cerutti et al (2018), Cerutti and Zhou (2018), Koch

Reliance on foreign banks is different for public and private borrowers

FBR measures (ratio)

Graph 3



¹ FBR of non-banks is the estimated claims by BIS reporting foreign banks on non-banks in the domestic economy, divided by total credit to the non-financial sector. FBR of the non-bank private sector is the estimated claims by BIS reporting foreign banks on private non-banks in the domestic economy, divided by total credit to the private non-financial sector. FBR of the official sector is the estimated claims by BIS reporting banks on the official sector of the domestic economy (government plus central banks) divided by total credit to the government. ² International claims (IC) consist of cross-border claims of foreign banks plus local claims extended in foreign currency. Local claims in local currency (LCLC) are claims made by foreign banks resident in the domestic economy to domestic borrowers in the domestic currency. ³ FBR of non-financial corporations is the estimated claims by BIS reporting foreign banks on non-financial corporations in the domestic economy, divided by total credit to non-financial corporations. FBR of households is the estimated claims by BIS reporting foreign banks on households in the domestic economy, divided by total credit to households.

Sources: BIS consolidated banking statistics (immediate counterparty basis); BIS statistics on total credit to the non-financial sector; author's calculations.

dropped by more, indicating a relative increase in local currency borrowing from foreign banks (Graph 2, centre panel).

The cross section shows substantial differences in FBR among EMEs (Graph 2, right-hand panel). Mexico (0.36), Poland (0.30) and Chile (0.26) have the highest, while Israel (0.03) and China (0.02) have the lowest. In most cases, countries with a higher FBR are host to foreign banks with large local operations (ie a large amount of LCLC). Indonesia (0.13) and Turkey (0.12) have the highest reliance in the form of IC.

Reliance on foreign banks remains higher for the private sector than the official sector

The decline in FBR following the GFC was common to both the official and private sectors (Graph 3, left-hand panel). The private sector is more reliant on foreign banks on average, with the share averaging around 0.2 in 2018 for private and 0.1 for official sector borrowers.

and Remolona (2018), McGuire and Van Rixtel (2012)). Including data of Chinese nationality banks from the locational banking statistics, covering Chinese banks located in China as well as in other BIS reporting countries, results in very similar FBR estimates.

There are significant differences in FBR for the two sectors in the cross section, even within the same country, both in terms of size and composition (Graph 3, centre panel). Mexico's private sector is the most reliant, receiving nearly 50% of its credit directly from foreign banks (including foreign banks operating locally), and China's is the least. Regarding the official sector, Poland's and Mexico's are the most reliant on foreign bank credit, while Israel's is the least. Within the private sector, households rely less on foreign banks than do non-financial corporations, and borrow overwhelmingly in the form of LCLC (Graph 3, right-hand panel).⁹ Firms in Mexico get nearly 20% of their credit in the form of IC, which comprises cross-border credit and local credit in foreign currency and thus may reflect a significant amount of foreign currency borrowing from banks.

While FBR captures the role that foreign banks play in providing credit, it does not capture the full range of ways in which a country's financial system may be exposed to developments in other jurisdictions. For example, credit from domestic banks may be funded with bonds and foreign currency liabilities, which may prove to be more volatile than funding with domestic deposits (McGuire and von Peter (2016)). On the other hand, the credit provided by foreign banks could be largely funded from domestic sources, as is the case in Mexico, making it less vulnerable to foreign developments despite the banks' foreign ownership.

Concentration among foreign bank lenders

Another aspect that may influence the vulnerability of EME credit to foreign developments is the exposure to individual national banking systems (eg French banks, Spanish banks). For instance, if an EME gets all of its foreign bank credit from banks headquartered in just one foreign country, developments in that country may have a significant effect on credit provision. As already noted, the distinction between IC and LCLC is crucial in understanding how these effects play out. To capture the concentration of credit from foreign banking systems, this section examines the share of total foreign bank claims from the top three national banking system creditors, noting the differences between concentration in IC and LCLC credit.¹⁰

Concentration has increased since the crisis

Concentration was declining leading up to the GFC, but has been increasing since (Graph 4, left-hand panel).¹¹ This rise was reflected in both the IC and LCLC credit from foreign banks (centre panel). IC tends to be much less concentrated in all countries, as banks from many jurisdictions lend cross-border (right-hand panel). In contrast, LCLC tends to be more concentrated on average. In general, concentration

⁹ The reporting of data breakdowns for non-financial corporations and households in the CBS does not start until the fourth quarter of 2013, and is not uniform across all CBS reporting countries. EMEs which have a major lender that does not report this more granular counterparty breakdown are dropped from the right-hand panel of Graph 3.

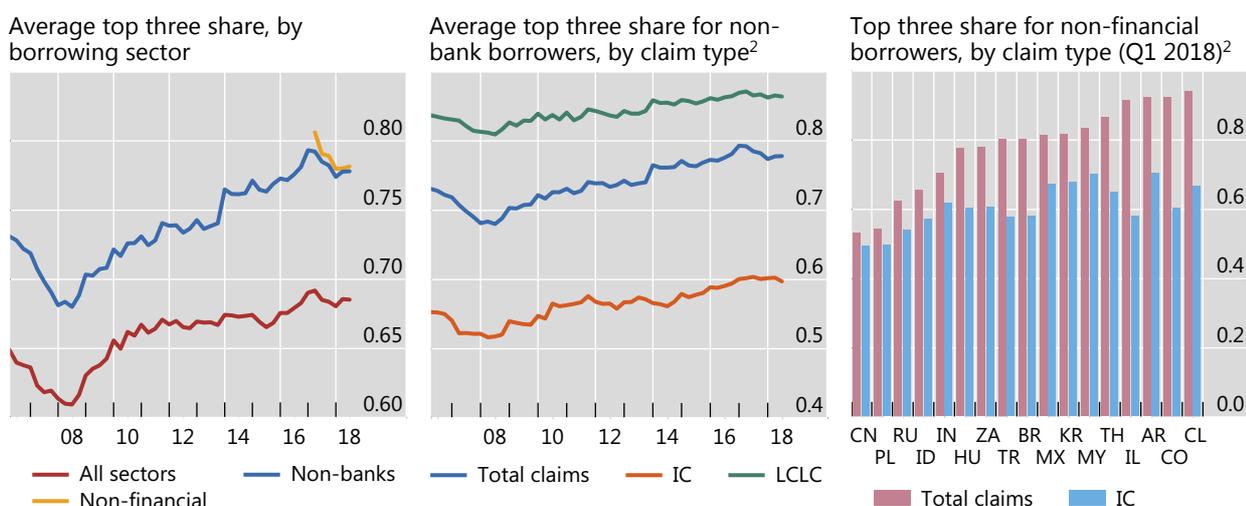
¹⁰ Alternative measures of concentration, such as a normalised Herfindahl index, reveal similar patterns.

¹¹ This indicates that the earlier findings of Ehlers and Wooldridge (2015) of increasing concentration among Asia-Pacific borrowers is a general trend among EMEs and has largely continued.

Concentration among foreign bank creditors has increased

Share of total foreign bank claims from the top three largest creditor banking systems for each EME¹

Graph 4



¹ Top three share is the foreign bank market share of the three largest creditor banking systems as a share of total consolidated claims of foreign banks for the listed borrowing sector (on an immediate counterparty basis). ² International claims (IC) consist of cross-border claims plus local claims extended in foreign currency. Local claims in local currency (LCLC) are claims made by foreign banks resident in the domestic economy to domestic borrowers in the domestic currency.

Sources: BIS consolidated banking statistics (immediate counterparty basis; author's calculations).

is high, with 70–80% of claims on the non-bank sector typically coming from the top three foreign banking systems.

Across EMEs, the share of foreign bank credit from the top creditor foreign banking system is quite high. The top ranked creditors provide 40% of total foreign bank credit for the sampled countries, while the second highest ranked creditors provide around 20% (Graph 5, left-hand panel). The top foreign creditor banking systems tend to have very large local currency claims, reflecting the presence of locally funded affiliates. Banking system creditors with lower rankings tend to have more IC claims.

Even though the foreign bank credit landscape tends to be quite concentrated, the importance of specific lending banking systems can vary over time. Following the GFC, several creditor banking systems, such as those of Belgium, Germany, the Netherlands and Switzerland, became comparatively less important (in terms of their claims volume) across EMEs (Graph 5, centre panel). This reflects in part the failure and restructuring of large internationally active banks in Belgium and the Netherlands, as well as a general deleveraging of the large European banking systems. Banks in Australia, Canada, Japan and Spain, among others, expanded post-crisis (McCauley et al (2017)).

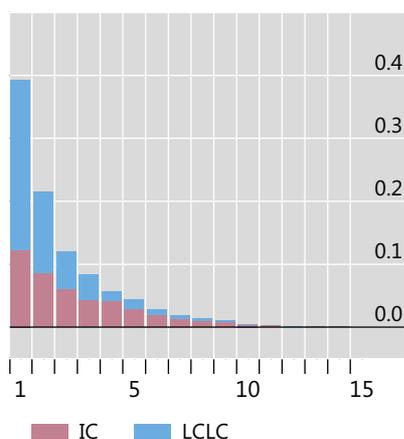
A small number of creditor banking systems tend to be the largest players across all EMEs. The United States and United Kingdom are among the three largest creditor banking systems in more of these EMEs than any other BIS reporting banking system,

Comparative importance of foreign bank creditors to non-banks in EMEs

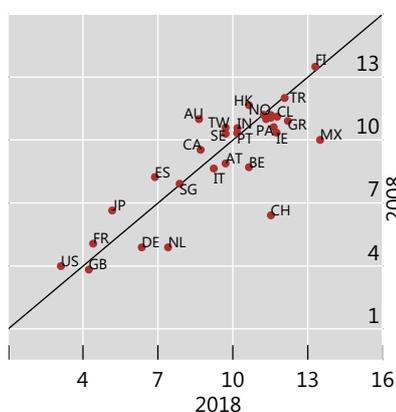
Ranking of creditors by volume of total claims on the non-bank sector

Graph 5

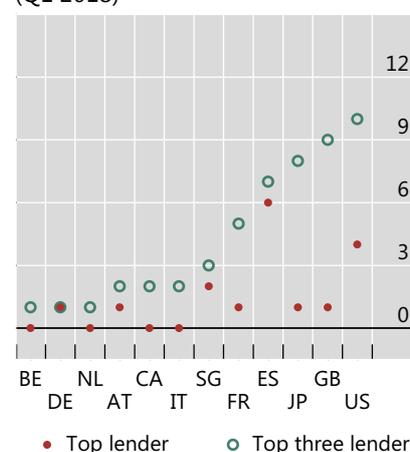
Aggregate claim share by ranking of creditor, by claim type (Q1 2018)^{1,2}



Average creditor banking system rankings, Q1 2008 versus Q1 2018³



Frequency of being an EME's top foreign creditor banking system (Q1 2018)⁴



¹ The height of each bar is the aggregate share of credit provided by the creditor banking system with the given ranking (along the horizontal axis) of market share among foreign banking system creditors in each country in the sample. For example, the third bar shows the aggregate credit from the third largest creditor banking system in each EME, divided by aggregate credit across EMEs. ² International claims (IC) consist of cross-border claims plus local claims extended in foreign currency. Local claims in local currency (LCLC) are claims made by foreign banks resident in the domestic economy to domestic borrowers in the domestic currency. ³ The average ranking of creditor banking systems across the EME sample, based on the share of foreign banking system creditors in lending to each EME. Ranking is based on total claims on the non-bank sector. Banking systems that do not lend to a country are given the same ranking (one below the smallest creditor). Countries above the 45 degree line rose in ranking from 2008 to 2018. ⁴ The red dot indicates the number of countries in sample for which the given banking system has the largest market share of foreign bank credit. The green circle indicates the number of countries in sample for which the given banking system has one of the three largest market shares of foreign bank credit.

Sources: BIS consolidated banking statistics (immediate counterparty basis); author's calculations.

followed by Japan, Spain and France. However, the Spanish banking system is most often the top lender in an EME (Graph 5, right-hand panel).¹²

Concentration rose for both the private and official sectors

Patterns of concentration among foreign bank lenders differ by borrowing sector. Credit to the official sector tends to be more concentrated than its private sector counterpart, but with heterogeneity across countries (Graph 6, left-hand panel). For example, credit to the South African official sector tends to be concentrated in just its top three creditor banking systems, while credit to the private sector in China is much more dispersed. Households are especially concentrated, with essentially 100% of their foreign bank borrowing from just three banking systems (centre panel). This fits with the previous facts: namely, that households tend to borrow from foreign banks mainly in local currency; and local currency operations are more concentrated (with relatively few foreign banking systems setting up local currency operations).

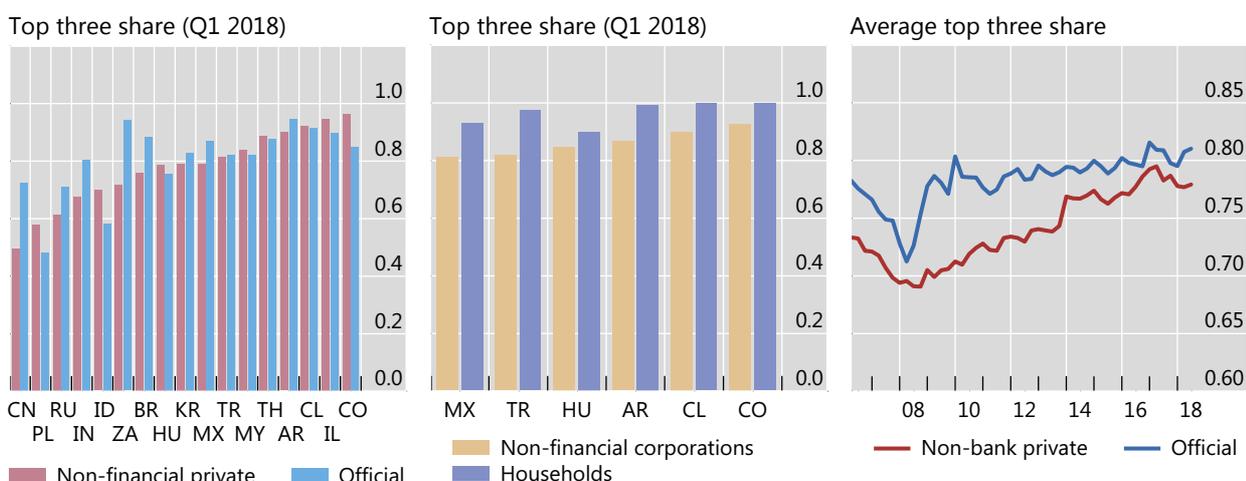
There has been some convergence in concentration in private sector and official sector borrowing over time. For both sectors, the low point of concentration across

¹² China does not report data to the CBS, but anecdotal evidence indicates that the Chinese banking system would be a highly ranked creditor for several EMEs. See Cerutti et al (2018) and Koch and Remolona (2018) for a discussion.

Concentration among foreign bank creditors by borrowing sector

Share of total foreign bank claims from the top three largest creditor banking systems for each EME¹

Graph 6



¹ Top three share is the foreign bank market share of the three largest creditor banking systems as a share of total consolidated claims of foreign banks for the listed borrowing sector (on an immediate counterparty basis).

Sources: BIS consolidated banking statistics (immediate counterparty basis); author's calculations.

creditor banking systems was at the onset of the GFC, since which concentration ratios in both private and official sector lending have steadily increased and drawn closer (Graph 6, right-hand panel).

Correlation between FBR and concentration

Having considered the reliance on foreign banks and the concentration among foreign lenders, this section examines these measures jointly to get a more complete picture of the activity of foreign banks in EMEs.

The cross section shows a mildly positive correlation between FBR and concentration (Graph 7, left-hand panel). For instance, a few countries, such as Mexico and Chile, exhibit both a relatively high reliance on foreign banks and a fairly high concentration across national creditor banking systems. Excluding Poland, which is a major exception to this pattern, the correlation is 0.31.

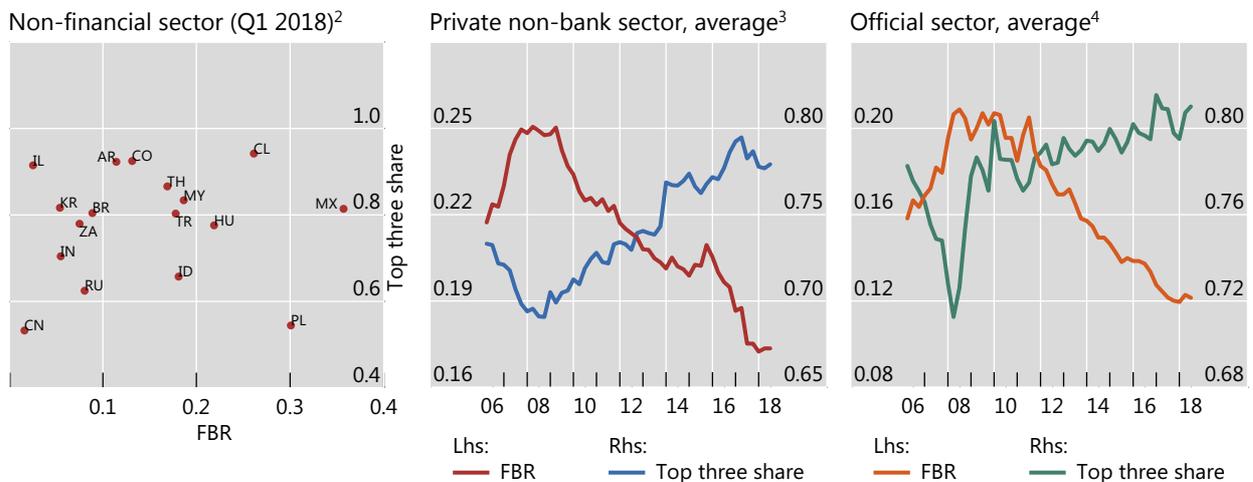
Over time, however, concentration and FBR tend to move in opposite directions (Graph 7, centre and right-hand panels). This is especially stark for the private non-bank sector (corr = -0.94). The negative correlation is striking, with reliance increasing and concentration decreasing leading up to the GFC, while following the GFC these trends reversed. Credit to the official sector shows the same negative correlation (-0.64).

This strong negative correlation in the time series reveals much about the landscape of credit provision by foreign banks in EMEs. Leading up to the GFC, banks from many foreign countries lent to EMEs, contributing to an increase in the FBR measure and a fall in concentration. After the crisis, domestic banks and non-bank creditors expanded into EME lending. Aggregate credit from foreign banks remained about the same, but the composition of lenders became more concentrated, as some creditors retreated from EME lending and others expanded.

Foreign bank reliance and concentration move opposite to each other

FBR and top three creditor foreign banking system share¹

Graph 7



¹ Top three share is the foreign bank market share of the three largest creditor banking systems as a share of total consolidated claims of foreign banks for the listed borrowing sector (on an immediate counterparty basis). ² FBR of the non-financial sector is the estimated claims by BIS reporting foreign banks on non-financial borrowers in the domestic economy, divided by total credit to the non-financial sector. ³ FBR of the non-bank private sector is the estimated claims by BIS reporting foreign banks on private non-banks in the domestic economy, divided by total credit to the private non-financial sector. ⁴ FBR of the official sector is the estimated claims by BIS reporting banks on the official sector of the domestic economy (government plus central banks) divided by total credit to the government.

Sources: BIS consolidated banking statistics (immediate counterparty basis); BIS total credit series; author's calculations.

Looking ahead, the diversity of funding sources may be important for EMEs to monitor. Diversifying funding sources can reduce the risk of sudden reversals of credit from foreign developments in a single creditor country. Moreover, the type of funding provided by creditors is important in determining the risk of credit reversals. Local funding has proven to be more stable through financial crises, while cross-border and foreign currency funding has been less so (Ehlers and McGuire (2017)). Bond credit and credit from non-banks are growing sources, but may bring new risks and financial stability concerns (Shin (2013)). Recent developments highlighted in this article have proven mixed in terms of funding diversity: LCLC lending plays an increasingly prominent role for foreign bank creditors to EMEs, but concentration across creditor banking systems has increased and credit from non-banks has risen.

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Beyond LIBOR: a primer on the new reference rates¹

The transition from a reference rate regime centred on interbank offered rates (IBORs) to one based on a new set of overnight risk-free rates (RFRs) is an important paradigm shift for markets. This special feature provides an overview of RFR benchmarks, and compares some of their key characteristics with those of existing benchmarks. While the new RFRs can serve as robust and credible overnight reference rates rooted in transactions in liquid markets, they do so at the expense of not capturing banks' marginal term funding costs. Hence, there is a possibility that, under the new normal, multiple rates may coexist, fulfilling different purposes and market needs.

JEL classification: D47, E43, G21, G23.

For decades, IBORs have been at the core of the financial system's plumbing, providing a reference for the pricing of a wide array of financial contracts. These include contracts for derivatives, loans and securities. As of mid-2018, about \$400 trillion worth of financial contracts referenced London interbank offered rates (LIBORs) in one of the major currencies.²

There is currently considerable momentum for transitioning away from LIBOR benchmarks.³ A major impetus for reform comes from the need to strengthen market integrity following cases of misconduct involving banks' LIBOR submissions. To protect them against manipulation, the new (or reformed) benchmark rates would ideally be grounded in actual transactions and liquid markets rather than be derived from a poll of selected banks. But the significant decline in activity in interbank deposit markets, together with structural changes in the money market landscape since the Great Financial Crisis (GFC), has complicated the search for alternatives. The reform process constitutes a major intervention for both industry and regulators, as it is akin to surgery on the pumping heart of the financial system.

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² Even though most of this amount refers to the notional value of derivatives, meaning that actual net exposures are considerably lower (eg Schrimpf (2015)), the sheer scale of funding and investment activity predicated on LIBOR cannot be understated.

³ Over the past 18 months, the reform process has accelerated following a speech by the CEO of the United Kingdom's Financial Conduct Authority, who raised serious concerns about LIBOR's sustainability and announced that, after 2021, the FCA will no longer "persuade or compel" banks to submit the rates required to calculate LIBOR (Bailey (2017)).

Key takeaways

- The new risk-free rates (RFRs) provide for robust and credible overnight reference rates, well suited for many purposes and market needs. In the future, cash and derivatives markets are expected to migrate to the RFRs as the main set of benchmarks. The transition will be most challenging for cash markets because of the bespoke nature of contracts and structurally tighter links to interbank offered rates.
- To manage asset-liability risk, financial intermediaries may continue to need a set of benchmarks that provide a close match to their marginal funding costs – a feature that RFRs or term rates linked to them are unlikely to deliver. This may call for RFRs to be complemented with some form of credit-sensitive benchmark, an approach already undertaken in some jurisdictions.
- It is possible that, ultimately, a number of different benchmark formats will coexist, fulfilling a variety of purposes and market needs. The jury is still out on whether any resulting market segmentation would lead to material inefficiencies or could even be optimal under the new normal.

In the major currency areas, authorities have already started publishing rates intended to eventually replace (or complement) the IBOR benchmarks. The initial focus has been on introducing credible, transaction-based overnight (O/N) RFRs anchored in sufficiently liquid money markets. Currently, cash and derivatives markets linked to the new RFRs are still in their infancy, but are gradually gaining in liquidity. In addition, a number of jurisdictions in which it was deemed feasible to reform IBOR-style benchmarks have opted for a two-benchmark approach complementing the new ones based on RFRs.

This special feature outlines some key aspects of the new reference rates. First, it sets out a framework and a taxonomy for the main characteristics of existing and new benchmark rates with the aim of highlighting the key trade-offs involved. Second, it reviews the state of financial markets linked to the new RFRs and what this means for the future of term benchmark rates (ie those longer than overnight). Third, it takes a closer look at the implications for banks' asset-liability management. It concludes by touching upon some broader issues surrounding the transition, such as legacy exposures linked to IBORs and cross-currency implications.

Desirable features of reference rates and main trade-offs

Devising a new reference rate is no easy task. This is because it may not be feasible to preserve all the desirable characteristics of IBORs while also ensuring that the new rates are grounded in actual transactions in liquid markets. Moreover, for the reform to succeed, a new reference rate must be broadly accepted by market participants that currently rely on IBORs.

The ideal

The ideal reference rate – one that could, like a Swiss army knife, serve every conceivable purpose – would have to:

- (i) provide a **robust and accurate representation of interest rates in core money markets** that is not susceptible to manipulation. Benchmarks derived from actual transactions in active and liquid markets, and subject

to best-practice governance and oversight, represent arguably the best candidates in terms of this criterion;

- (ii) offer a **reference rate for financial contracts** that extend beyond the money market. Such a reference rate should be usable for discounting and for pricing cash instruments and interest rate derivatives. For example, overnight index swap (OIS) contracts of different maturities should reference this rate without difficulty, providing an OIS curve for pricing contracts at longer tenors;⁴ and
- (iii) serve as a **benchmark for term lending and funding**. Given that financial intermediaries are both lenders and borrowers, they require a lending benchmark that behaves not too differently from the rates at which they raise funding. For instance, banks may fund a long-term fixed rate loan to a client by drawing on short-term (variable rate) funding instruments. To hedge the associated interest rate risk, a bank may enter into an interest rate swap as a fixed rate payer in return for receiving a stream of floating interest rate payments determined by a benchmark that reflects the bank's funding costs. If the two types of rate diverge, the bank runs a "basis risk" between its asset and liability exposures.⁵

In the past, market participants were guided in their choice of benchmarks more by funding cost considerations than the other considerations listed. For instance, in the late 1980s, market participants around the world shifted from using benchmarks based on US Treasury bill rates to those based on eurodollar rates (McCauley (2011)). The primary driver of this "benchmark tipping" was that, in seeking to manage asset-liability mismatches, banks found eurodollar rates a much closer approximation to their actual borrowing costs and lending rates than US T-bill rates (Box A).

The practical

Albeit imperfectly, LIBOR fulfils the second and third of the desirable reference rate features set out above, serving as both a viable reference rate and a term benchmark capturing fluctuations in banks' marginal funding costs. But it fails to meet the first criterion for four reasons.

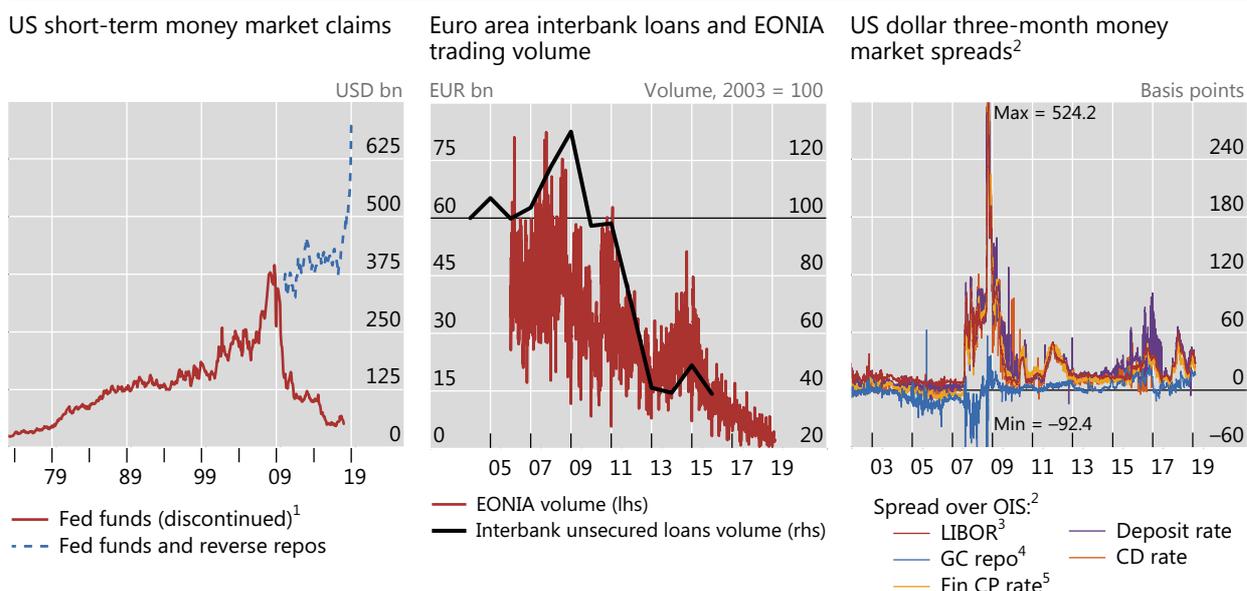
First, in what has turned out to be a design flaw, LIBOR was constructed from a survey of a small set of banks reporting non-binding quotes rather than actual transactions. This created ample scope for panel banks to manipulate LIBOR submissions (Gyntelberg and Wooldridge (2008), Vaughan and Finch (2017)).⁶

Second, sparse activity in interbank deposit markets stood, and still stands, in the way of a viable transaction-based benchmark based on interbank rates. Even before the GFC, very few actual transactions underpinned the submissions for the longer

⁴ An OIS is an interest rate swap in which daily payments of a reference O/N rate, such as the effective federal funds rate or the euro overnight index average, are exchanged for a fixed rate over the contract period. The OIS rate is the fixed leg of such a swap, and captures the expected path of the O/N rate over the contract term.

⁵ In general terms, basis risk can be defined as the risk that the value of a hedge (either a derivative or a contrary cash position) will not move in line with that of the underlying exposure.

⁶ LIBOR could be manipulated in two ways. First, some banks used their submissions to misrepresent their creditworthiness by understating their borrowing costs. Second, contributing trading desks colluded on their submissions in order to move LIBOR in a way that favoured their derivative positions (see also Abranetz-Metz et al (2012) and Duffie and Stein (2015)).



CD = certificate of deposit; CP = commercial paper; EONIA = euro overnight index average; GC repo = general collateral repo rate; OIS = overnight index swap.

¹ Discontinued as of 20 December 2017. ² Spread over three-month USD OIS rate. ³ Intercontinental Exchange (ICE) Benchmark Administration Limited began administering ICE LIBOR in February 2014. Previously, LIBOR was administered by the British Bankers' Association. ⁴ GC government repo rate. ⁵ Financial CP rate; index based on A1-rated financial CP rates.

Sources: ECB; Bloomberg; Datastream; authors' calculations.

LIBOR tenors. Since then, interbank trading has plummeted, especially in the unsecured segment (Graph 1, left-hand and centre panels). This was in no small measure driven by the abundant supply of reserve balances created as a result of central banks' unconventional policies (eg Bech and Monnet (2016)). Post-crisis, banks also repriced the risks associated with unsecured interbank lending, reflecting higher balance sheet costs due to tighter risk management and implementation of the new regulatory standards (BIS (2018)) (most notably through the liquidity standards).⁷ Interbank market activity is thus unlikely to recover much, even if central banks decide to reabsorb such excess liquidity (Kim et al (2018)).

Third, the increased dispersion of individual bank credit risk since 2007 has undermined the adequacy of benchmarks such as LIBOR that aim to capture common bank risk, even for users seeking a credit risk exposure (BIS (2013)). Moreover, money market pricing has become more sensitive to liquidity and credit risk, with banks

⁷ Banks have a strong incentive to deposit extra cash at central banks instead of lending to other banks, as holdings of reserves contribute to the minimum regulatory high-quality liquid asset (HQLA) requirement. By contrast, short-term unsecured wholesale bank funding is unattractive under the Liquidity Coverage Ratio (BCBS (2013)), being subject to greater rollover risk. Moreover, banks have lengthened their funding maturities, incentivised by the Net Stable Funding Ratio (BCBS (2014)).

LIBOR and “benchmark tipping”: then and now

This is not the first time a major shift towards a fundamentally different set of reference rates has taken place in the financial system. However, in contrast to earlier examples of “benchmark tipping”, the ongoing reform process is a public-private effort to shift away from unsecured interbank rates towards near risk-free benchmarks.^① This contrasts with the market-driven process from the late 1980s to the early 1990s of shifting away from risk-free reference rates based on US Treasury bill rates towards benchmarks that embed credit risk based on IBORs. Ironically, back then, market participants transitioned *away* from using risk-free benchmarks to the risky ones based on eurodollar rates. Banks seeking to manage asset-liability mismatches found the latter a much closer approximation to their actual borrowing costs and lending rates. Otherwise, hedging, say, a portfolio of privately issued securities with a short position in T-bill futures exposed dealers to so-called basis risk, as reflected in a widening TED spread.

LIBOR emerged in the late 1960s to support the burgeoning syndicated loan market. In 1986, the British Bankers’ Association (BBA) assumed control of the rate, taking responsibility for its publication until January 2014. The BBA collected interbank offered rate quotes from a panel of banks, reflecting the rates at which banks said they could borrow funds from other banks, just prior to 11:00 local time. The top and bottom four responses were discarded in computing LIBOR as an interquartile trimmed mean of the submissions. At one point, the BBA was computing LIBOR for 10 currencies. By October 2013, that number had dropped to five: the US dollar, euro, sterling, yen and Swiss franc. Some central banks have also relied on LIBOR for their operational policy targets (most notably the Swiss National Bank). Following the cases of LIBOR misconduct, in June 2012 the UK Treasury commissioned Martin Wheatley, then CEO-designate of the Financial Conduct Authority (FCA), to establish an independent review into the setting and usage of LIBOR. The findings, along with a plan for the reform of the benchmark, were published in September 2012 in the Wheatley Review. In April 2013, the FCA was given responsibility for regulating LIBOR, while a new private organisation, the Intercontinental Exchange (ICE) Benchmark Administration Limited (IBA), began to administer ICE LIBOR starting in February 2014, following a tender process.

A number of official bodies have steered the reform process since then. In February 2013, the G20 tasked the Financial Stability Board (FSB) with reviewing and reforming major reference rates. To take the work forward, the FSB commissioned an Official Sector Steering Group (OSSG) to monitor and oversee the efforts to implement the reforms. The FSB has convened a Market Participants Group (MPG) to represent private sector interests and address issues that may arise in the implementation and transition (FSB (2014a)). In July 2013, the International Organization of Securities Commissions (IOSCO) published an overarching framework for the principles underlying benchmarks for use in financial markets (IOSCO (2013)). This was followed by the July 2014 publication of FSB proposals on the implementation of the IOSCO principles by benchmark administrators as the starting point for robust reference rates (FSB (2014b)). The FSB continues to monitor and report on progress (eg FSB (2018)). Since then, various new committees and working groups comprising the official and private sectors have sought to establish viable alternative RFRs. Central banks have taken a lead role in the reforms, both as convenors of the committees or working groups tasked with identifying the new RFRs, and as benchmark administrators. This is largely because reference rates have the character of public goods. Further, the private sector faces coordination challenges while central banks have a long history of producing such measures due to their importance in policymaking (Dudley (2018)).

LIBOR has a host of cousins across currency areas and jurisdictions. As the dominant euro benchmark, EURIBOR was the second most widely used benchmark next to LIBOR. Other financial centres such as Hong Kong SAR, Mumbai, Singapore, Sydney, Tokyo and Toronto featured their own fixings in HIBOR, MIBOR, SIBOR, the bank bill swap rate (BBSW), TIBOR and CDOR, respectively. Overall, there were at least 13 similar poll- or quote-based IBOR-style benchmarks. Notably, several jurisdictions with their own IBORs have opted to reform and retain these rates, where reform was deemed feasible. In these cases, a credit-sensitive term benchmark will coexist with the local currency RFR.^② The reforms of credit-sensitive term benchmarks also aim to bring them into compliance with IOSCO principles by rooting them as far as possible in transactions or executable quotes, subjecting them to stricter oversight, and broadening the set of counterparties to include borrowing from non-banks.

^① McCauley (2001) referred to this process as “benchmark tipping”, defined as a strategic situation in which the benefits of a given benchmark choice to one player depend in a positive manner on a similar choice by other players. ^② Currency areas that have opted for such an approach include Australia, Canada and Japan, where reformed editions of the BSSW, CDOR and TIBOR will continue to exist. Meanwhile, attempts to reform EURIBOR are still in flux (EMMI (2019)).

reducing term lending to each other and increasingly turning to non-banks to source unsecured term funding. This has also exacerbated the dispersion among key money market rates (Duffie and Krishnamurthy (2016)) as well as the divergence between risk-free rates and credit/liquidity-sensitive benchmarks such as LIBOR (Graph 1, right-hand panel).

Fourth, due to regulatory and market efforts to reduce counterparty credit risk in interbank exposures, banks have also tilted their funding mix towards less risky sources of wholesale funding (in particular, repos). Derivatives market reforms (such as the mandatory shift to central clearing of standardised over-the-counter (OTC) derivatives, and a move towards more comprehensive collateralisation of OTC derivatives positions) have also increased the importance of funding with little or no credit risk. As a result, markets for swaps and other derivatives have already been transitioning away from LIBOR to OIS rates for discounting and valuation purposes for more than a decade. Against this background, the current reform effort can be seen as, in part, broadening the existing sweep to encompass cash markets and cementing the shift in a clear set of standards.

In light of these issues, reform efforts have focused on linking the new benchmarks with actual transactions in the most liquid segments of money markets. In practice, this has meant that the new reference rates incorporate some (or all) of the following attributes:

- (i) **shorter tenor**, essentially by moving to O/N markets, where volumes are larger than for longer-dated tenors such as three months;
- (ii) **moving beyond interbank markets** to add bank borrowing from a range of non-bank **wholesale** counterparties (cash pools/money market funds, other investment funds, insurance companies etc); and
- (iii) in some jurisdictions, drawing on **secured** rather than unsecured transactions. The secured transactions could also include banks' repurchase agreements (repos) with non-bank wholesale counterparties.

These changes bring the reformed benchmarks into line with the principles set out by IOSCO (2013) that have served as an important guide for the subsequent work of the FSB and market stakeholders (Box A). These stress that interest rate benchmarks should be anchored in active markets and derived from transactional data where possible, combined with best-practice governance arrangements for benchmark administrators.

Trade-offs

From the above discussion, it is clear that any practical solution will almost inevitably entail trade-offs. A preference for O/N RFRs because of the liquidity and structural features in underlying markets has important implications for the type of term reference rate that will eventually form the backbone of the new regime. Such choices, in turn, will impact the economic characteristics of term benchmarks as well as their suitability for different uses. For example, OIS contracts of different tenors can be linked to the new O/N RFRs. The fixed rates in the OIS market yield a term structure based on risk-free rates, which, in turn, can be used as a reference curve in derivatives markets or for securities issued by governments or corporates. Yet LIBOR also incorporates a risk premium that borrower banks have to pay to compensate lenders

for the risks of supplying funds on unsecured terms beyond overnight.⁸ This risk premium comes on top of the expected average level of O/N rates embedded in an OIS rate. For hedging refinancing risks by banks for instance, term rates derived from O/N RFRs alone may thus not be sufficient.

Against this background, authorities in jurisdictions where it was deemed feasible to reform credit-sensitive term benchmarks similar to LIBOR have opted for a “two-benchmark” approach (as advocated by Duffie and Stein (2015)). This combines a benchmark based on O/N RFRs with another based on reformed term rates which embed a credit risk component, which would be more suitable for banks’ asset-liability management.

A taxonomy and properties of the new overnight RFRs

Authorities have taken steps to identify and construct alternative RFR benchmarks compliant with standards such as the IOSCO principles. Five of the largest currency areas have all moved to an O/N benchmark as the backbone of the new regime (Table 1). Graph 2 shows a classification of the old and new O/N reference rates based on key features, ie whether the rate (i) is transaction-based; (ii) is based on collateralised (secured) money market instruments; and (iii) reflects borrowing costs from wholesale non-bank counterparties. For ease of comparison, existing (or old) RFRs as well as O/N LIBOR are also shown.

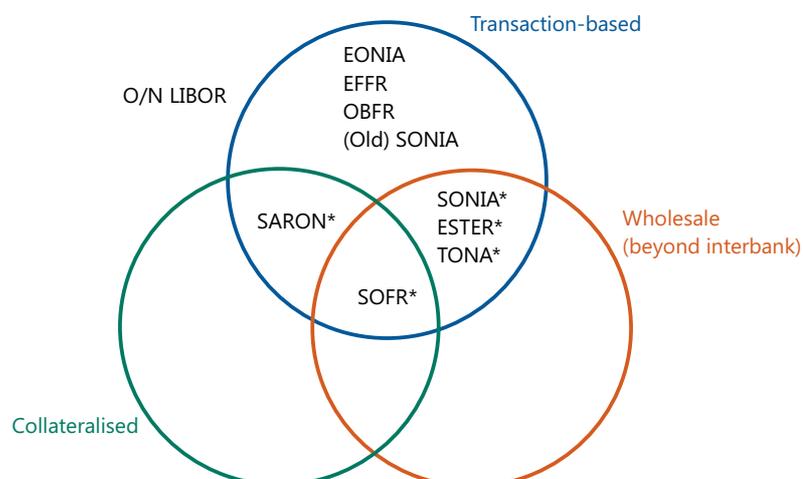
Overview of identified alternative RFRs in selected currency areas Table 1

	United States	United Kingdom	Euro area	Switzerland	Japan
Alternative rate	SOFR (secured overnight financing rate)	SONIA (sterling overnight index average)	ESTER (euro short-term rate)	SARON (Swiss average overnight rate)	TONA (Tokyo overnight average rate)
Administrator	Federal Reserve Bank of New York	Bank of England	ECB	SIX Swiss Exchange	Bank of Japan
Data source	Triparty repo, FICC GCF, FICC bilateral	Form SMMD (BoE data collection)	MMSR	CHF interbank repo	Money market brokers
Wholesale non-bank counterparties	Yes	Yes	Yes	No	Yes
Secured	Yes	No	No	Yes	No
Overnight rate	Yes	Yes	Yes	Yes	Yes
Available now?	Yes	Yes	Oct 2019	Yes	Yes

FICC = Fixed Income Clearing Corporation; GCF = general collateral financing; MMSR = money market statistical reporting; SMMD = sterling money market data collection reporting.

Sources: ECB; Bank of Japan; Bank of England; Federal Reserve Bank of New York; Financial Stability Board; Bank of America Merrill Lynch; International Swaps and Derivatives Association.

⁸ LIBOR incorporates both term liquidity and credit premia, although the relative contribution of the two can differ over time and by maturity (Michaud and Upper (2008), Gefang et al (2010)).



EFFR = effective federal funds rate; EONIA = euro overnight index average; ESTER = euro short-term rate; LIBOR = London interbank offered rate; OBFR = overnight bank funding rate; SARON = Swiss average overnight rate; SOFR = secured overnight financing rate; SONIA = sterling overnight index average; TONA = Tokyo overnight average rate.

* Indicates new (or reformed) transaction-based overnight risk-free rates.

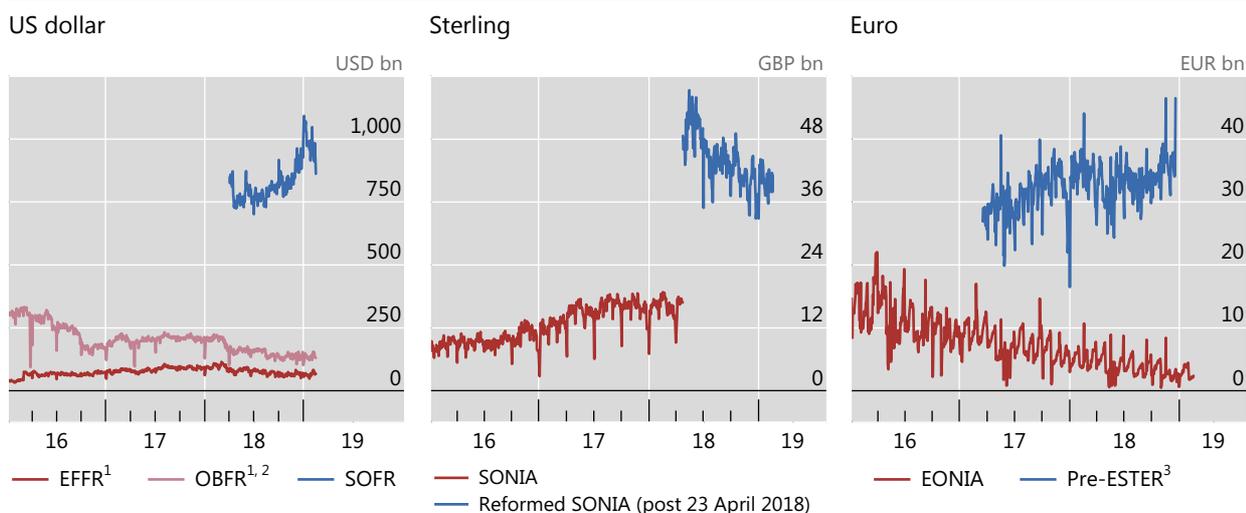
Source: Authors' elaboration.

A major feature for all currencies, with the exception of the Swiss franc, is that the range of eligible transactions is no longer limited to interbank, and includes interest rates paid by banks to non-bank lenders. The United States and Switzerland have further opted to base the secured overnight financing rate (SOFR) and Swiss average overnight rate (SARON) on secured (repo) transactions. Choices between unsecured and secured O/N RFRs have to a large extent been made on the basis of the liquidity and structural features of underlying money markets (FRBNY (2018)).⁹ One advantage of the United Kingdom's (unsecured) sterling overnight index average (SONIA) is that it has been in existence since 1997. The Bank of England took over the administration of SONIA in April 2016, while the publication of "reformed SONIA" began in April 2018 (Bank of England (2018b)).

Basic characteristics of overnight reference rates

The overnight RFRs are rooted in much deeper markets than their predecessors. Volumes underlying the new US SOFR benchmark dwarf those of the overnight bank funding rate (OBFR), an O/N rate covering the federal funds market and the (offshore)

⁹ In this regard, high trading volume appears to have been a necessary, but not sufficient, condition for authorities' choice of a particular market as a basis for the new RFRs. For instance, one reason for the decision by the Alternative Reference Rate Committee (ARRC) not to base the new RFR on the federal funds or eurodollar market is that O/N transactions in these markets have been dominated by arbitrage trades with little underlying economic rationale (FRBNY (2018)). In contrast, in the euro area it is the secured benchmark which would have been problematic, not least because of the high segmentation in repo markets due to differences in the credit quality of the sovereign bonds serving as collateral.



EFFR = effective federal funds rate; EONIA = euro overnight index average; ESTER = euro short-term rate; OBFR = overnight bank funding rate; SOFR = secured overnight financing rate; SONIA = sterling overnight index average.

¹ Up to 29 February 2016, brokered volumes. ² Based on eurodollar transactions in addition to fed funds. ³ Until ESTER becomes available in October 2019, the ECB is publishing figures referred to as pre-ESTER, which market participants can use to assess the suitability of the new rate.

Sources: Federal Reserve Bank of New York; Bloomberg.

eurodollar market (Graph 3, left-hand panel). The inclusion of non-bank counterparties has also significantly raised the volumes underlying the (reformed) SONIA and the predecessor to the definitive euro short-term rate (pre-ESTER) (Graph 3, centre and right-hand panels).¹⁰ For instance, in the case of SONIA, more than 70% of the underlying volume is made up of transactions with money market funds (MMFs) and other investment funds (Bank of England (2018a)), with funding from other banks and broker-dealers contributing less than 15%.

Movements in the new O/N RFRs track changes in key policy rates reasonably well. This can be said of SOFR (Graph 4, left-hand panel) as well as the reformed SONIA and pre-ESTER (Graph 4, centre and right-hand panels). Although the RFRs exhibit a spread to key policy rates (eg the rate of remuneration of reserve balances by banks), the stability of that spread suggests that monetary policy pass-through should generally be satisfactory, at least in normal times.¹¹

However, the inclusion of borrowing costs from non-banks in the calculation may have implications for how the new RFRs behave compared with key policy rates. Non-banks typically have no access to a central bank's deposit facilities. Due to segmentation, the new benchmarks are at times more likely to move outside the

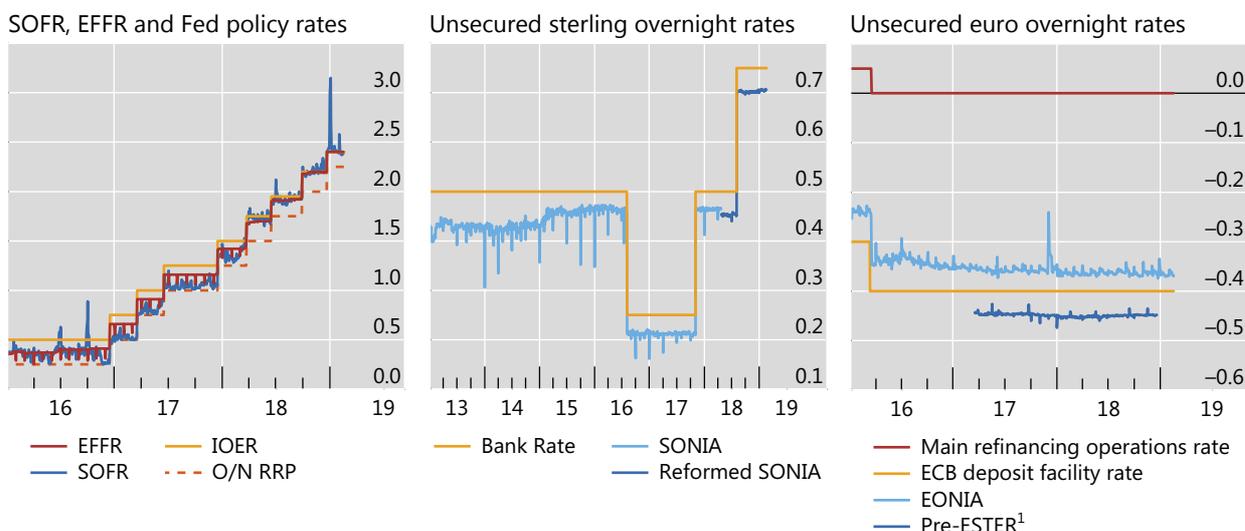
¹⁰ ESTER will be published by the ECB starting October 2019 (at the latest) and must replace EONIA in all new contracts starting 1 January 2020. In the meantime, the ECB has begun publication of "pre-ESTER" to facilitate a smooth transition to the new benchmark (ECB (2018)). On 25 February, EU policymakers agreed on an extension that allows EONIA and EURIBOR to be used by firms based in the bloc until the end of 2021.

¹¹ In a similar vein, Potter (2017) points out that the existence of wider post-GFC money market spreads arising from segmentation, and the fact that banks no longer treat their balance sheet as costless, have not materially impeded the Federal Reserve's ability to steer short-term interest rates under its current operating framework.

US dollar, sterling and euro overnight rates

In per cent

Graph 4



EFFR = effective federal funds rate; EONIA = euro overnight index average; ESTER = euro short-term rate; IOER = interest rate on excess reserves; O/N RRP = interest rate on the overnight reverse repo facility; SOFR = secured overnight financing rate; SONIA = sterling overnight index average.

¹ Until ESTER becomes available in October 2019, the ECB is publishing figures referred to as pre-ESTER, which market participants can use to assess the suitability of the new rate.

Sources: Federal Reserve Bank of New York; Bloomberg.

desired target ranges of central banks, or below the floor set by the deposit facility rate. In addition, differences in regulatory costs imply that the cost of bank borrowing from non-banks is somewhat lower than comparable interbank rates. That being the case, the reformed SONIA and pre-ESTER tend to fluctuate *below* the respective central bank deposit facility rates.

In turn, RFRs based on repo markets can also be expected to trade at different levels compared with unsecured O/N rates and, for some jurisdictions, to be more volatile. SOFR has increasingly tended to trade *above* the range set by the rate of remuneration on banks' excess reserves (interest rate on excess reserves, IOER) and the rate on the Federal Reserve's O/N reverse repo facility (RRP), which bounds the effective federal funds rate (EFFR). As it is rooted in repo markets, SOFR instead lies above the triparty general collateral (GC) and below The Depository Trust & Clearing Corporation's (DTCC's) GCF Treasury repo rate. Finally, SOFR also exhibits volatility due to conditions in collateral markets and dealer balance sheet management. A notable recent example is the December 2018 spike, which was due to a glut in Treasury markets interacting with banks' year-end window-dressing (Box B).

That said, the EFFR was also susceptible to such window-dressing behaviour, although it was affected differently from SOFR. The EFFR used to show a tendency to *drop* at month-ends because of balance sheet window-dressing by non-US banks facing month-end disclosure requirements. Still, downward spikes in the EFFR have never breached the floor set by the O/N RRP rate. Non-US banks have had a large presence in the fed funds and eurodollar markets because they could exploit

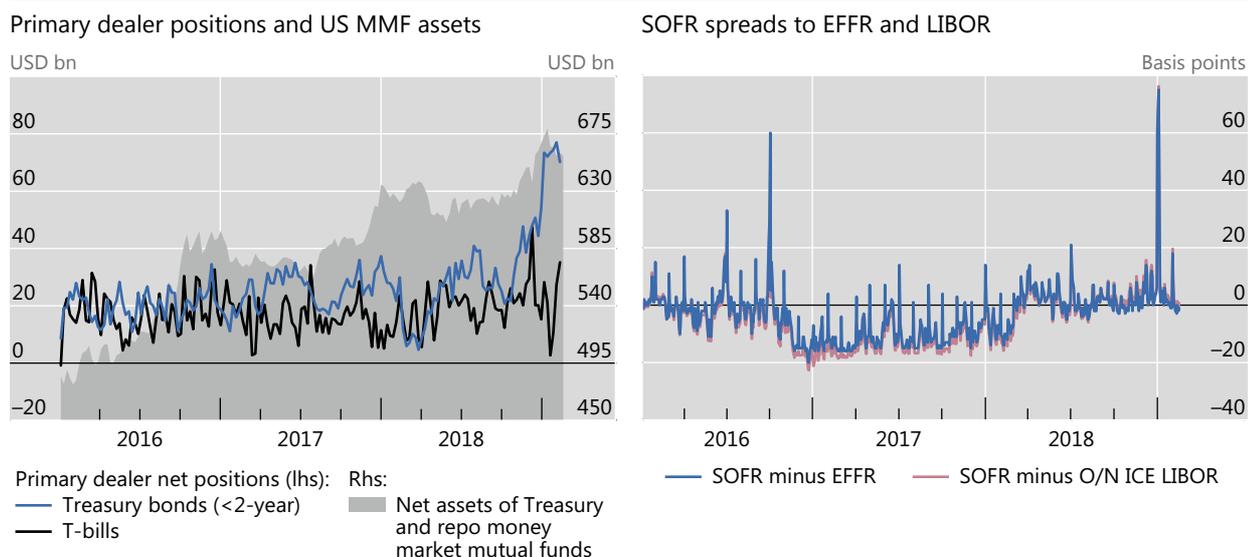
SOFR and supply and demand conditions in collateral markets

The secured overnight financing rate (SOFR) is based on secured overnight (O/N) transactions that reflect funding conditions in Treasury repo markets. To recall, a repo is a form of collateralised short-term loan, in which the cash borrower pledges a security as collateral while agreeing to repurchase it at a (typically) higher price at a future date. Historically, Treasury repos have served as an important source of funding for dealers in government securities, allowing them to raise cash in exchange for Treasuries pledged as collateral.

In normal times, repo rates tend to respond to the “cash” leg, ie the demand for, and supply of, funds against the collateral. However, this need not always be the case. For example, in flight-to-safety episodes when US Treasury collateral is in high demand, the collateral leg influences the cash leg, causing repo rates to fall. As a result, benchmarks based on repo rates, such as SOFR or the Swiss average overnight rate, will reflect the supply/demand conditions not only in funding markets, but also in markets for securities that serve as collateral. At times, this can cause the rates to diverge significantly and persistently from benchmarks based on unsecured rates. For example, SOFR was particularly compressed relative to the effective federal funds rate and O/N USD LIBOR from late 2016 to early 2018, in large part because of increased demand for Treasuries as balances shifted to government-only money market funds (MMFs) on the back of US MMF reform (Graph B).^① The spread then turned positive in Q1 2018 as the supply of Treasuries was boosted by higher securities issuance by the US government. The dynamics of SOFR spreads illustrate SOFR's sensitivity to supply/demand conditions in US Treasury markets.

Developments in US Treasury markets and SOFR spreads

Graph B



EFR = effective federal funds rate; LIBOR = London interbank offered rate; SOFR = secured overnight financing rate.

Sources: Federal Reserve Bank of New York; Bloomberg.

The pressure on the cash leg could also go in the opposite direction if there is a glut of collateral, rather than a scarcity. The spikes that SOFR exhibits around quarter-ends illustrate the point. These spikes reflect banks' balance sheet management around reporting dates for their exposures under the Basel III leverage ratio and surcharges for global systemically important banks.^② The spike at end-December 2018 is especially noteworthy (Graph B, right-hand panel). The magnitude was amplified because the US Treasury held additional auctions at year-end, a time when dealer balance sheets were particularly inelastic due to regulatory reporting, being already loaded with Treasury securities. Repo rates jumped as a result, reflecting the emergence of a premium for cash (discount for collateral) in secured funding markets, thus causing SOFR to jump.

^① See Chen et al (2017) for a detailed quantitative assessment. ^② See eg CGFS (2017).

arbitrage opportunities offered by the IOER.¹² The monthly periodicity in the EFFR disappeared around 2018 once the “IOER-fed funds arbitrage” became unprofitable.

Implications for monetary policy

At present, central banks have yet to decide and communicate what role, if any, the new benchmarks will eventually play for the conduct of monetary policy. An obvious issue is whether any shift in operational targets might be warranted (or will be necessary because of the discontinuation of existing benchmarks). Should central banks decide to target these rates explicitly, they would need to carefully evaluate the benefits and downsides of possible expansions to the set of counterparties in monetary operations (as well as remuneration policies).¹³

Implications for monetary transmission could also emerge, warranting further analysis. For benchmarks based on secured transactions, fluctuations in the new reference rate could be partly driven by the demand for and supply of safe assets available to the public, with central banks’ own outright asset purchases or sales likely to exert a non-negligible impact on that supply. Increasing usage of RFRs based on secured transactions could hence possibly alter the transmission of balance sheet policies to a broader set of interest rates and asset prices. It is conceivable that the transition to risk-free benchmarks could reinforce the broader transmission of policies. This effect, however, could also be mitigated (or even undone), as banks are likely to find other ways to pass changes in actual funding or hedging costs on to their customers.

Developing RFR-linked financial markets and term rates

The development of liquid financial markets linked to the new rates is crucial if the reforms are to succeed. In addition, term rates must eventually emerge if the new RFRs are to satisfy the second and third key features of an all-in-one benchmark – that is, to serve as an effective reference for financial contracts and discount curves, and to serve as a benchmark for lending/funding rates. While SONIA-linked OIS markets have already been in existence for a while, providing a term benchmark for sterling, OIS markets referencing the new RFRs would have to develop to replace the existing ones referencing traditional O/N rates such as EFFR or EONIA.

There is an inherent chicken-and-egg problem for underlying markets that have to develop from scratch. It is difficult for deep cash markets to emerge in the absence of liquid derivatives markets used to hedge the associated exposures, and vice versa. Users of derivatives markets have been accustomed to using term rates based on

¹² Unlike US banks, foreign banks could place borrowed funds (typically from government-sponsored enterprises such as the Federal Home Loan Banks) with the Fed to earn the IOER without being subject to the Federal Deposit Insurance Corporation’s charges for insured deposits, or the more stringent US leverage ratio regulations in the case of European and Asia-Pacific banks (McCauley and McGuire (2014), Keating and Macchiavelli (2018)).

¹³ In recent years, there has been a tendency for central banks to open up access to deposit facilities to critical financial market infrastructures such as central counterparties, mostly for financial stability reasons. In some cases, central banks have also allowed non-bank financial institutions such as money market funds to access reverse repo facilities in order to strengthen their control over key money market rates (most notably in the case of the United States). Traditionally, access to the central bank’s credit operations was granted only to banks.

compounded O/N rates, and therefore should find transitioning to the new O/N RFR based benchmarks less difficult. But participants in cash markets have been accustomed to using interest rates set for the entire term at the beginning of the period, finding the associated certainty useful for budgeting, cash flow and risk management purposes. That being the case, one open issue for cash markets is whether the transition to term rates derived from O/N RFRs is simply a question of “plumbing” or if it involves any notable economic trade-offs.

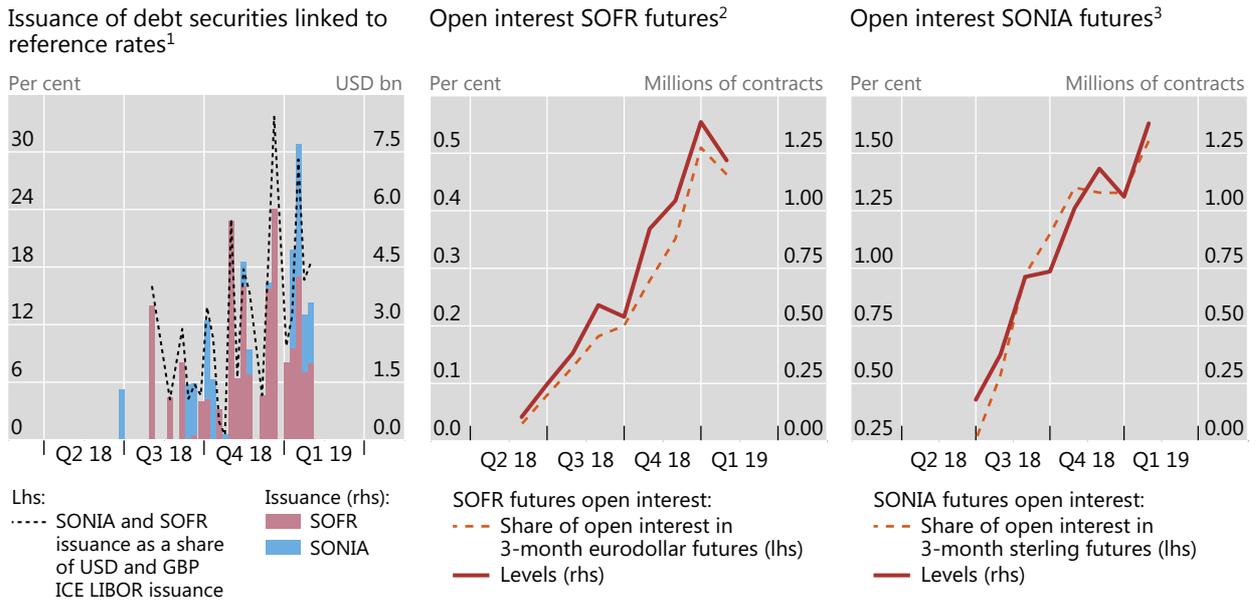
State of market development

The chicken-and-egg problem accentuates the need for the official sector to take on a coordinating role (Maechler and Moser (2018)). Indeed, it was sovereigns, supranationals and agencies (SSAs) that paved the way as the first issuers of RFR-linked floating rate notes (FRNs). Private financial issuers have now started to follow suit.¹⁴ Since mid-2018, the issuance of SOFR- and SONIA-linked securities has gradually picked up (Graph 5, left-hand panel). During a few weeks in late 2018, more than a third of the issued floaters referenced the new RFRs. That said, the volatility of the secured SOFR, especially around year-ends (see above and Box B), deterred some corporates from issuing SOFR-linked securities in early 2019, according to market sources. Market contacts further indicate that issuers of SOFR notes often immediately hedge their funding using LIBOR-SOFR basis swaps. This suggests that the development of the SOFR-linked cash market lags that of the SONIA-linked market for the time being.

With respect to derivatives, major futures exchanges (such as the Chicago Mercantile Exchange (CME) and Intercontinental Exchange (ICE)) have launched contracts linked to SOFR and SONIA since early 2018. Since then, open interest has increased notably (Graph 5, centre and right-hand panels). It is envisioned that liquid SOFR-linked OTC markets, such as OIS markets, will develop in due course. One market that is already well developed is the OTC market for SONIA swaps, where the amounts outstanding compare favourably with those of LIBOR-linked swaps. Arguably, this is due to the fact that the rate, in an older form, has existed since 1997. Overall, the transition of cash instruments to RFR benchmarks should lead to greater liquidity in OIS markets. These should see large trading volumes in response to monetary policy announcements, and also as a reflection of hedging activity related to the various forms of investment and funding that have migrated to new RFR benchmarks.

Despite this build-up of momentum, IBOR-linked business is still dominant in many market segments. Issuance of securities linked to LIBOR is still considerably greater than that linked to the new benchmarks. According to market sources, the transition in loan markets, a segment which is more difficult to monitor due to its opaqueness, has also yet to lift off. And open interest on SOFR and SONIA futures

¹⁴ Quasi-government and agency issuers were the first to open up the market (the European Investment Bank for SONIA and Fannie Mae for SOFR), thereby playing an important coordinating role. The Asian Development Bank and Export Development Canada also issued SONIA-linked debt securities in early 2019. Private issuers, including Barclays, Credit Suisse and MetLife, have also entered the SOFR-linked market. SOFR-linked notes have typically been in shorter maturities of three months to two years. The main US investors have been MMFs, which prefer to buy and hold shorter-term securities with daily floating rates. SONIA-linked notes have been issued with somewhat longer maturities, ranging from one to five years.



SOFR = secured overnight financing rate; SONIA = sterling overnight index average.

¹ Corporate and government issuance, weekly transactions. ² Monthly open interest; SOFR futures include one-month and three-month maturities. ³ Monthly open interest transactions; SONIA futures include the ICE one-month and three-month SONIA futures and the Curve Global three-month SONIA futures.

Sources: Bloomberg; authors' calculations.

currently stands at no more than 1% of that of their much more mature IBOR-linked counterparts.¹⁵

Towards term benchmark rates

A crucial, yet challenging, area of the reform process is the extension of the reference curve from O/N to term rates. In line with the desirable features of benchmarks outlined above, term benchmarks would ideally be grounded in transactions where market participants lock in their actual funding costs for a particular horizon. This would satisfy the third key feature of an all-in-one solution – namely, providing a benchmark for term funding and lending that is closely related to financial intermediaries' marginal funding cost.

Types of term benchmark rate

The economic properties of different types of term rate vary according to how they are constructed. It is helpful to distinguish along two dimensions. The first is whether or not the rate is known at the beginning of the period to which it applies, and whether it reflects expectations about the future or merely past realisations of O/N rates. The second is whether the term rate is based on the pricing of instruments used to raise term funding or on derivatives used to hedge fluctuations in O/N rates.

¹⁵ A similar observation can be made in the case of SARON in Switzerland.

Backward- vs forward-looking term rates

The simplest way to obtain a term rate is to construct it mechanically from past realisations of O/N rates. The leading examples are so-called backward-looking term rates based on a methodology known as “compounded in arrears”. To determine the interest payment obligation over a three-month horizon, the compounded O/N RFRs over the same three-month period would be used – a computation which is feasible only once the full realisation of O/N rates is known, ie *at the end of the period*.¹⁶ An advantage is that these term rates can be computed simply from O/N RFRs, even in the absence of underlying transactions in term instruments or in derivatives.¹⁷ By construction, backward-looking term rates do not reflect expectations about future interest rates and market conditions.

Backward-looking compounded rates have a number of use cases in cash and derivatives markets. For example, a three-month backward-looking average SOFR (Graph 6, left-hand panel) can be used as a reference rate by issuers of FRNs or for determining floating leg payments in the SOFR-linked OIS. A rate of this type is less prone to quarter- or year-end volatility due to its construction as a geometric average daily rate. The associated smoothness should render the rate attractive for market participants. But, by the same token, it also tends to lag the actual movements in the O/N rate. Especially when short rates exhibit a trend due to central bank easing or tightening, these backward-looking rates will be sluggish to respond to actual developments in O/N market interest rates. Similarly, thanks to its backward-looking construction, the SOFR-linked three-month compounded-in-arrears term rate, used in pricing SOFR futures, appears to have lagged the EFR-linked forward-looking OIS rate during a recent period of rising rates (Graph 6, right-hand panel).

Forward-looking term rates, by contrast, are known at the beginning of the period to which they apply and are not based on mechanical compounding of O/N rates. Because forward-looking rates are an outcome of a market-based price formation process, they embed market participants’ expectations about future interest rates and market conditions. For such rates, the interest obligation received/paid over, say, a three-month horizon is set at the beginning of the term over which the rate applies. Many market participants, especially in cash markets, value this certainty for budgeting, cash flow and risk management purposes. Moreover, the design of existing operational systems in cash markets relies on such rates.

Forward-looking term rates based on term funding instruments vs derivatives

One can further distinguish between forward-looking term rates based on the pricing of funding instruments and those based on derivatives pricing. Term rates based on funding instruments can capture fluctuations in intermediaries’ actual term funding costs, which can change over time due to credit and term liquidity premia. Examples are unsecured money market rates akin to three-month LIBOR as well as secured borrowing rates in term repo markets. Such term rates can also be constructed based

¹⁶ Participants in interest rate derivatives markets are accustomed to this type of rate. For example, floating rate payments at the maturity of an OIS contract are typically determined by compounding in arrears the O/N rates realised during the term of the swap.

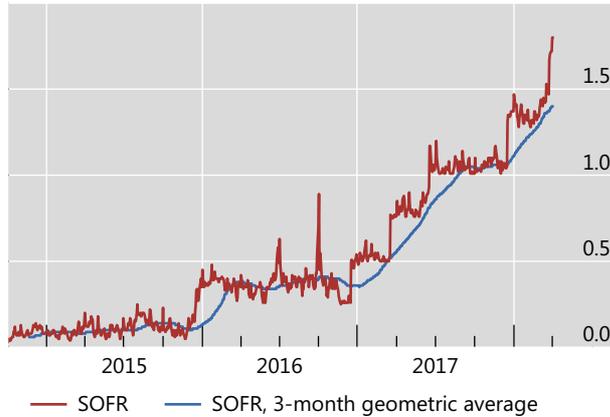
¹⁷ For instance, the US ARRC has published a timeline for a paced transition with the ultimate goal of creating a term RFR based on SOFR derivatives once liquidity has developed sufficiently. For the time being, backward-looking compounded term rates can be constructed based on O/N SOFR rates. Similar approaches have been considered in other currency areas (eg Switzerland).

Towards SOFR-based term rates

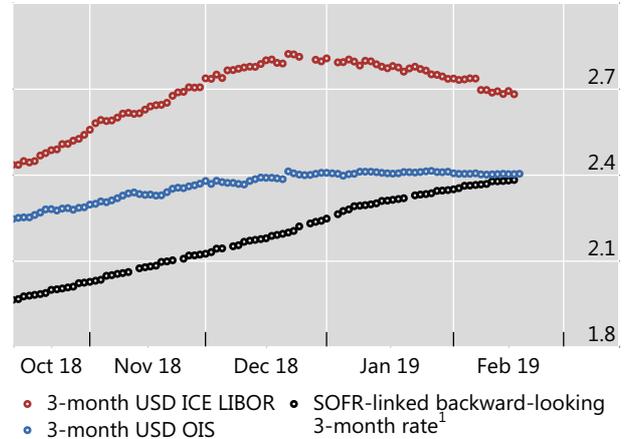
In per cent

Graph 6

SOFR vs backward-looking compounded average



SOFR-linked term rate vs LIBOR and OIS rates



LIBOR = London interbank offered rate; OIS = overnight index swap; SOFR = secured overnight financing rate.

¹ Term SOFR rate constructed by ICE Benchmark Administration (compounded in arrears); underlying data obtained from <https://www.theice.com/marketdata/reports/244>.

Sources: Federal Reserve Bank of New York; Chicago Mercantile Exchange; ICE Term RFR Portal.

on the pricing of funding vehicles which banks use to raise wholesale funding from non-banks such as MMFs. Prominent examples of such instruments are commercial paper and certificates of deposit. Such term rates, particularly when based on unsecured funding instruments, would reflect fluctuations in financial intermediaries' marginal term funding costs in their entirety.

By contrast, term rates based on derivatives reflect the market-implied expected path of future O/N rates over the term of the contract, but do not embed premia for term funding risk. An example of a derivatives-based term rate is the interest rate on the fixed leg of an OIS linked to the new O/N RFRs. That rate can be used once the corresponding derivatives markets in SOFR, ESTER, SARON etc have been developed. Another example would be a market-implied rate derived from futures prices linked to the new O/N RFRs. However, such derivatives are not term funding instruments, but are intended as instruments for hedging fluctuations in O/N rates. Term rates based on derivatives will therefore not capture fluctuations in intermediaries' term funding risk.

Hence, despite being forward-looking, term rates constructed from derivatives linked to the new RFRs will have structural features that are different from those of existing IBOR benchmarks. As discussed above, the derivatives-based SOFR-linked forward-looking term benchmark does not yet exist, as derivatives markets linked to SOFR are still in their infancy. But, even when liquidity in the SOFR-linked OIS market develops sufficiently to produce a market-based forward-looking term rate, the resulting curve will essentially be risk-free. Consequently, it will resemble the currently available (EFFR-linked) OIS rate more than it does LIBOR.

Implications for banks' asset-liability management

The new RFR-based benchmarks clearly fulfil the first two of the three desirable features of an all-in-one benchmark rate. Where they seem to fall short is the third key feature, ie serving as a benchmark for term funding and lending by financial intermediaries. Term rates derived from market prices for RFR-linked derivatives (eg OIS or futures) will readily yield a risk-free term structure that can be used for discounting purposes and fulfil various needs in the market. But banks will still lack a benchmark that adequately reflects their marginal funding costs as a substitute for LIBOR. This speaks to the limitations of using O/N rates, instead of those based on term transactions, to create term benchmarks.

As a consequence, banks' asset-liability management could become more challenging in the world of new benchmark rates. Specifically, banks could be exposed to basis risk in periods when their marginal funding costs diverge from interest rates earned on their assets benchmarked to the new RFRs, resulting in a margin squeeze. Consider, for instance, the case where a bank holds a large amount of RFR-linked floating rate loans (RFR plus x basis points) on the asset side of its balance sheet, while its marginal costs of refinancing may diverge if the funding mix includes a variety of secured and unsecured sources. The issue may be exacerbated due to banks' usual practice of funding illiquid assets (eg a loan with terms that are committed over a longer horizon) with instruments of shorter duration – in other words, if banks engage in maturity transformation. The costs at which banks can refinance will be subject to uncertainty as market-wide compensations for term funding risk (an amalgam of credit and term liquidity risk) evolve. If these risks cannot be adequately hedged, it is likely that they will be passed on to clients in one form or another.¹⁸

What is more, RFRs based on secured rates (ie repo rates) can actually move in the opposite direction to unsecured ones – a situation most likely to occur when markets are under stress. To illustrate this for O/N rates, we construct a backcasted SOFR to proxy for the rate's hypothetical behaviour during the GFC. We estimate the proxy by regressing SOFR published since 2014 on its close secured rate equivalent, ie the GCF Treasury repo rate. We then use the latter, along with the estimated regression coefficients, to generate backward-projected values for SOFR.¹⁹ The spread of the backcasted SOFR to O/N LIBOR widened significantly during the peak of the crisis (Graph 7, left-hand panel). The forces driving unsecured O/N rates (including credit risk) pulled these rates higher as the unsecured interbank markets froze. At the same time, the forces driving secured O/N rates were pulling them lower,

¹⁸ Banks are likely to differ in the extent to which they are exposed to such issues depending on their business model and where they are domiciled. For instance, the issue could be more pronounced for a global non-US bank with a large US dollar book, which needs to roll over its USD funding in offshore markets. A US bank with access to a large amount of insured retail deposits, by contrast, would be affected to a lesser extent.

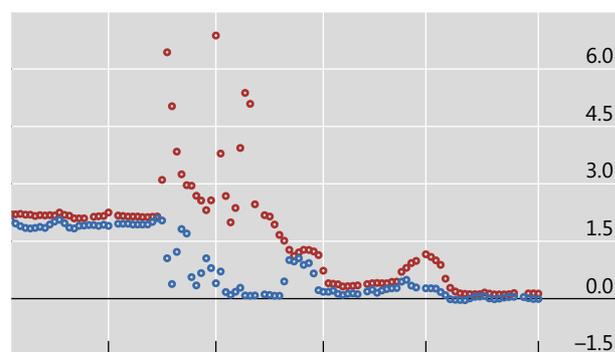
¹⁹ We use the GCF Treasury repo rate because it captures one of the three markets on which SOFR is based and because historical data are available going into the crisis period. The regression beta is 0.98 and the constant is -0.06 , both highly significant (p -value = 0.00), and R^2 is 0.990 (sample period: 22 August 2014 to 28 January 2019). For comparison, the analogous regression using the triparty GC repo rate yields a regression beta of 0.99 and a constant of 0.04 with an R^2 of 0.998. The sign of the constants is consistent with SOFR fluctuating below the GCF Treasury repo rate and above the triparty GC repo rate. The somewhat higher significance of the coefficient estimates in the triparty GC repo rate regression is also consistent with much higher transaction volume in this market compared with the GCF market. Another important market segment underlying SOFR is the bilateral repo market.

Illustration of basis risk due to rate divergence

In per cent

Graph 7

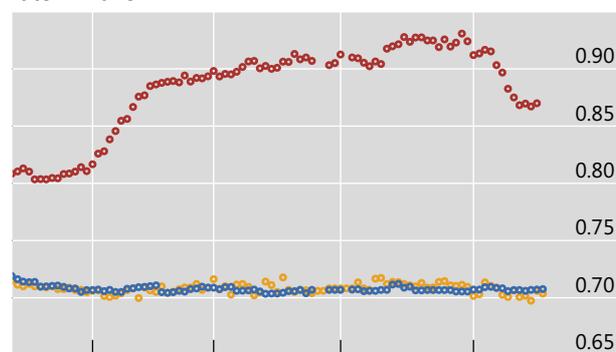
Overnight LIBOR vs backcasted SOFR in 2008



Aug 2008 Sep 2008 Oct 2008 Nov 2008 Dec 2008

• O/N USD BBA LIBOR • Backcasted SOFR¹

Three-month LIBOR and OIS rates vs SONIA-linked term rate in 2018



Nov 2018 Dec 2018 Jan 2019 Feb 2019

• 3-month GBP ICE LIBOR • 3-month GBP ICE Term RFR, forward-looking, futures derived²
• 3-month GBP ICE OIS

LIBOR = London interbank offered rate; OIS = overnight index swap; SOFR = secured overnight financing rate; SONIA = sterling overnight index average.

¹ Backcasted SOFR is based on a regression-based “proxy” based on one of the underlying SOFR components over the period 22 August 2014 to 28 January 2019. We use the GCF Treasury repo rate because it captures one of the three markets on which SOFR is based and because historical data are available going into the crisis period. Regression beta is 0.98 and the constant is -0.06 , both highly significant (p -value = 0.00), and R^2 is 0.99. ² ICE Benchmark Administration uses overnight SONIA rates, ICE one-month SONIA Index Futures settlement prices and a methodology for identifying expected rate change dates in order to imply projected SONIA rates over a one-, three- and six-month time period, which are then compounded over the relevant period to determine the applicable term SONIA rate (the GBP forward-looking ICE Term RFR) (ICE (2018b)); underlying data obtained from <https://www.theice.com/marketdata/reports/244>.

Sources: Federal Reserve Bank of New York; Chicago Mercantile Exchange; ICE Term RFR Portal; authors’ calculations.

owing to a collateral shortage and flight to safety. While such extreme situations do not happen frequently, if they do occur the repercussions can be significant for the financial system.

For longer tenors, term rates based on new RFRs are likely to deviate persistently from their LIBOR counterparts even in normal times. To illustrate this, consider the preliminary term rates based on futures linked to the reformed SONIA. In November 2018, three-month GBP LIBOR rose as funding costs for UK banks increased on the general tightening of financial conditions and the resurgence of Brexit-related concerns. Yet the SONIA futures-implied rates failed to reflect this change (Graph 7, right-hand panel). Instead, the “quasi” forward-looking term rates linked to SONIA appeared to closely track the virtually risk-free three-month OIS rates.²⁰

In search of credit-sensitive term benchmarks

While the sensitivity of banks’ profit margins to the spread between their actual funding costs and the risk-free rates may have declined, it has not disappeared. Granted, banks in aggregate may be less reliant on unsecured funding sources than

²⁰ We call them “quasi” forward-looking here because the ICE Benchmark Administration derives the associated (preliminary) three- and six-month term rates using only the ICE one-month SONIA index futures settlement prices. The reason is that liquidity is still lacking in longer tenors. Hence, even the so-called forward-looking rate shown incorporates a degree of compounding (ICE (2018b)).

they were pre-GFC, implying a generally lower level of basis risk in the financial system. Yet while the reliance on unsecured wholesale funding has lessened, it has not gone away (for example, see Box C for the amount of outstanding CP obligations). It has also shifted to non-bank wholesale (as opposed to interbank) funding sources. Such unsecured term funding obtained from wholesale non-bank lenders, eg money market funds, is an important marginal source of funding.

According to a 2017 survey conducted by a LIBOR panel bank, 80% of respondents indicated they would prefer LIBOR to remain in some form. Market sources also indicate that basis risk is a central consideration for dealers that currently trade SOFR futures. Such increased riskiness is likely to be passed on to borrowers, eg via higher loan rates, higher fees for services or reduced credit availability.

A “two-benchmark” approach

Given the importance of credit-sensitive term benchmarks, authorities have opted to complement the RFRs with reformed and improved local IBOR-type rates in jurisdictions where this was deemed feasible. In Japan, the reformed TIBOR will coexist with TONA; and in the euro area, there is an ongoing effort to reform EURIBOR to complement ESTER. In both cases, the reformed credit-sensitive term benchmarks are (or will be) computed using some form of hybrid methodology to address the scarcity of underlying term transactions, using techniques such as interpolation and expert judgment, and the inclusion of wholesale funding from non-bank counterparties (Bank of Japan (2016b), EMMI (2019)).

In some other jurisdictions, credit-sensitive term benchmarks were based on somewhat different instruments and may require less substantive reforms. In Australia, the reformed BBSW will be based primarily on transactions, supplemented with executable quotes when necessary, complementing the O/N benchmark based on the Reserve Bank of Australia’s cash rate (Alim and Connolly (2018)). In Canada, the liquidity underlying CDOR, which is based on the bankers’ acceptance market, has actually been on the rise (McRae and Auger (2018)), making its retention as a credit-sensitive term benchmark that much easier. Over time, additional market solutions may also emerge. Recent attempts by ICE to improve or replace LIBOR offer two such examples (Box C).

An obvious outcome of such uneven approaches to tackling credit-sensitive term benchmarks could be increased market segmentation and a wider variety of benchmarks coming into use across the financial system. Depending on their sophistication, some market players may be better able to adjust than others. On the one hand, this may reduce network efficiencies that come with an all-in-one solution. On the other hand, different benchmarks could emerge that are better fit for individual purposes than the “Swiss army knife approach” implicit in a single benchmark.

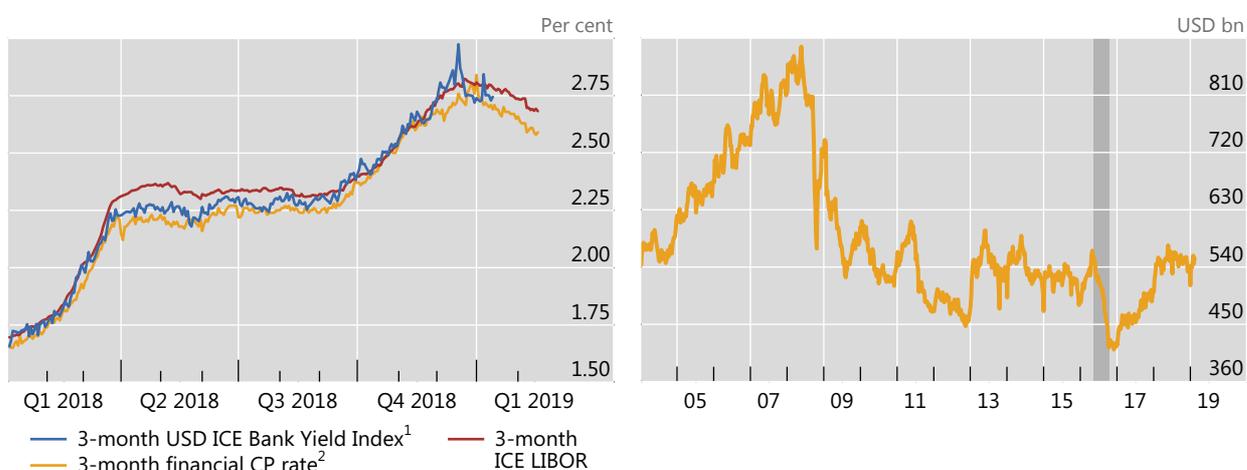
Private sector initiatives to create credit-sensitive term benchmarks

As part of its efforts to improve the LIBOR benchmark, and to bring it into line with IOSCO principles, the ICE Benchmark Administration (IBA) has set a list of objectives and introduced methodologies to produce a reformed LIBOR. In April 2018, the IBA announced that it intends to gradually shift the panel banks to the so-called waterfall methodology for computing LIBOR (ICE (2018a)). The key priorities are to: (i) base LIBOR on transactions to the greatest extent possible; (ii) expand the universe of eligible transactions to include wholesale funding from non-banks; and (iii) use techniques such as interpolation, plus expert judgment, to address gaps in eligible transactions. The IBA expects the transition to the new waterfall methodology to be completed by no later than the first quarter of 2019.

An alternative credit-sensitive term benchmark

Graph C

Three-month ICE BYI compared with US dollar LIBOR and US dollar financial CP outstanding³
CP rates



CP = commercial paper; LIBOR = London interbank offered rate.

¹ ICE Benchmark Administration has developed a preliminary methodology for a new interest rate index, designed to measure the yields at which investors are willing to invest US dollar funds in large, internationally active banks on a wholesale, unsecured basis over one-month, three-month and six-month periods (the USD ICE Bank Yield Index); see ICE (2019). ² Index based on A1-rated financial CP rates. ³ The shaded area indicates the adjustment phase to US money market fund reform (effective 14 October 2016).

Sources: Bloomberg; ICE Benchmark Administration.

In January 2019, the IBA announced that it was exploring yet another credit-sensitive term benchmark particularly suitable for cash markets. Called the US Dollar ICE Bank Yield Index (BYI) (Graph C, left-hand panel), it seeks to measure the interest rates at which investors are willing to invest in the unsecured debt obligations of a broad set of large internationally active banks for a specified forward-looking tenor (ICE (2019)). The index is underpinned entirely by transaction data representing short-term, unsecured bank funding vehicles. The set of lenders that fund these instruments is broad, and includes central banks, governments, non-bank financials, sovereign wealth funds and non-financial corporates in order to maximise volumes. The instruments include unsecured term deposits, commercial paper (CP) and certificates of deposit (CDs).

This indicates that unsecured term funding still plays a pivotal role in bank balance sheets. It is mostly wholesale non-bank financials such as money market funds that invest in these short-term funding vehicles. For example, while the CP liabilities of US banks have declined from their pre-crisis peak, the long-term average hovers around \$500 billion, which is comparable to the size of the market 15 years ago (Graph C, right-hand panel). More broadly, term deposits, CP and CDs still represent an important marginal source of term funding for banks.

Transition issues

Quite apart from the characteristics of the new RFR-based benchmarks, as discussed above, transition issues loom large. The most pressing one is perhaps the migration of legacy LIBOR-linked exposures to the new benchmarks should LIBOR publication cease after 2021. Trillions of dollars of legacy contracts will still be outstanding at that time. Given the material prospect of a possible LIBOR discontinuation, it is crucial from a financial stability perspective that credible fallback language be inserted into contracts.

In response, industry bodies, such as the International Swaps and Derivatives Association (ISDA) at the request of the FSB, have been consulting with stakeholders concerning fallback options. The main goal is to agree *ex ante* rather than *ex post* on the fallbacks should the benchmark cease to exist, ie before winners and losers are evident. For derivatives contracts, one feasible option could be shifting to a compounded RFR-linked backward-looking term rate plus a (constant) spread based on historical differences with LIBOR (ISDA (2018)).

The transition appears to be more challenging for cash instruments due to their more bespoke nature. Unlike with derivatives, there is no body that could help coordinate on an overarching industry-wide solution. According to some estimates, the amount of business loans, consumer loans, FRNs and securitised products referencing USD LIBOR with a maturity date after 2022 exceeds \$2 trillion (BlackRock (2018)). One can envision several different ways to address the transition. Floating rate cash instruments could be converted to fixed rate contracts. Alternatively, if contract terms have been amended accordingly, the floating rate might switch to an adjusted RFR-based term rate (similar to the solution for derivatives sketched out above). Some issuers may also recall LIBOR-linked debt instruments and replace them with those linked to the new benchmarks.

The transition will also raise important cross-currency issues. While these go beyond the scope of this article, they deserve an in-depth analysis in future work, not least because USD LIBOR has provided a unifying element to global funding markets. For example, Australian banks fund a large part of their home currency assets in US dollar markets. They can then hedge this funding using cross-currency basis swaps that reference USD LIBOR in one leg and the Australian dollar BBSW rate in the other. If US dollar benchmarks shift to quasi risk-free SOFR-linked rates, while the liquid benchmarks in other currency areas are based on unsecured transactions, new instruments may have to be developed to manage the ensuing basis risks.

In addition, interest rate benchmarks in a number of small open economies that lack deep money markets in their own currencies often rely on FX swap-implied benchmarks with USD LIBOR or EURIBOR as the input.²¹ Such local benchmarks are hence vulnerable to spillovers from the reform process in major currency areas, in turn posing potential market functioning risks.

²¹ One example where this has been the case is the Norwegian krone benchmark NIBOR (see Kloster and Syrstad (2019) for a discussion).

Conclusion

This special feature has mapped out the landscape of new RFR benchmarks, their basic characteristics compared with LIBOR, and the main trade-offs. A key conclusion is that a “Swiss army knife” solution for benchmark rates does not exist. That is, an all-purpose, all-in-one benchmark may be neither feasible nor desirable. The new RFRs provide for robust and credible overnight reference rates. In principle, they should also allow for the creation of term benchmarks beyond overnight tenors, which makes them well suited to many purposes and market needs (eg computation of interest obligations in cash instruments or discounting and valuation in derivatives markets). Where these indicators are less suitable, however, is in capturing fluctuations in the marginal funding costs of financial intermediaries. This, in turn, intensifies the challenge of hedging particular types of risk, especially asset-liability mismatches on banks’ balance sheets. It is hence possible either that reformed benchmarks suitable for such purposes will retain market share or that new market solutions will emerge.

As a consequence, the ultimate outcome of this transition may well feature the coexistence of multiple rates. These would have a variety of characteristics to fulfil differing purposes and market needs. The jury is still out on whether any resulting market segmentation would lead to material costs and inefficiencies, or whether this “new normal” might actually be optimal.

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Impact of financial regulations: insights from an online repository of studies¹

The BIS is launching a public, online and interactive repository of studies on the effects of financial regulations, called FRAME. The purpose of this repository is to keep track of, organise, standardise and disseminate the latest findings. FRAME currently covers 83 studies and 139 quantitative impact estimates from 15 countries or groups of countries, offering a new and comprehensive perspective on what the literature has been able to document to date, and where gaps exist. We observe a high degree of heterogeneity across impact estimates, notably in terms of the effects of capital regulation on loan growth: while on average the estimated effect is that more capital leads to more lending, there are large differences across studies. A meta-analysis shows that an important driver of these differences is whether the underlying study incorporates second-round effects.

JEL classification: E44, G21, G28.

Now that the main elements of the post-crisis banking regulations have been implemented (BIS (2018)), an evaluation of these regulations' impact comes within closer reach. And the G20 Leaders' request to the Financial Stability Board to evaluate the effects of financial reforms (FSB (2017)) has placed such analysis high on the international agenda. In recent years, the number of studies that assess regulatory impacts has grown, allowing judgments to be based on a larger sample of studies. The wide range of findings, however, calls for a systematic approach to understanding their drivers. The work presented here is an element of the response.

This special feature is structured as follows. First, we present the main features of a public repository of studies on the effects of bank regulations, called FRAME (Financial Regulation Assessment: Meta Exercise). This repository, maintained by the BIS, is not intended to be another literature stocktake, but to serve as a novel tool that tracks, organises, standardises and disseminates findings from many studies. It can be updated with new findings on a continuous basis, with the possibility for researchers to report their own studies online. Second, we present selected insights from FRAME on the effects of bank capital and liquidity, and relevant regulations – the area where most analysis has been conducted – on banks' funding costs, the pass-through of funding costs to lending rates, bank lending growth and the probability of a crisis. We show that there is a wide distribution of these estimated effects,

¹ The authors thank Claudio Borio, Ben Cohen, Tara Rice, Hyun Song Shin and Nikola Tarashev for helpful comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS.

Key takeaways

- **FRAME** is an online interactive repository of regulatory impact estimates. Its purpose is to keep track of, organise, standardise and disseminate the latest findings. The FRAME repository is also meant as a sharing platform, through which users can report their own studies.
- The repository is structured according to selected bank balance sheet measures and their effects on more than 10 variables. The ratios currently being considered relate to those Basel Committee on Banking Supervision (BCBS) capital and liquidity standards which are balance sheet-based. FRAME currently covers 83 studies and 139 quantitative impact estimates from 15 countries and regions. It classifies each of these along 18 dimensions, ranging from the specific countries analysed and the size of the banks studied, to the specific sample period.
- A comparison of the effects of the various regulatory ratios in normal and crisis times suggests that the Net Stable Funding Ratio has a much stronger countercyclical effect on bank lending than bank capital or liquidity.
- We document significant heterogeneity across quantitative impact estimates, notably regarding the effects of capital (regulation) on loan growth. On average, the effect is found to be positive, but there are large differences, in part due to whether the underlying study incorporates general – or only partial – equilibrium effects.

especially on bank lending. Third, we try to explain this heterogeneity using meta-analysis techniques. We document that one important driver of the heterogeneity is whether or not the analysis accounts for general equilibrium – that is, second-round – effects.

The FRAME repository in a nutshell

FRAME (<https://stats.bis.org/frame>) is an online repository of studies on the effects of financial regulations. It tracks, organises, standardises and disseminates the growing number of quantitative impact studies on the effects of financial regulations. It includes studies from academia, policy institutions and the private sector, covering the period 1991 to the present.

FRAME essentially spans and updates existing surveys (eg BCBS (2016, 2019), Dagher et al (2016)). One important novelty of FRAME is that it goes beyond collecting point estimates by adding relevant characteristics of the underlying studies. The repository is structured according to selected bank balance sheet ratios related to key regulatory standards and their effects on selected outcome variables. The regulatory ratios currently included relate to the Basel III capital and liquidity standards. As a convention, the repository refers to the outcome variables as “targets” (Graph 1 and box).

FRAME contains information for 12 different targets, ranging from banks’ cost of funding to overall GDP growth, and covers 83 studies and 139 quantitative impact estimates for 15 countries or groups of countries (Graph 2, left-hand panel). It is intended to be representative of the overall state of knowledge. About 60% of the estimates refer to analysis covering banks and other financial intermediaries in the United States, reflecting the greater weight in the academic literature of studies that use US data. The largest number of results are on the effects of bank capital and bank capital regulation on banks’ supply of loans, funding costs, lending rates and the probability of a crisis; and on the effect of liquidity ratios and liquidity standards on



Regulatory ratio:
 Long-term impact Transition
 Bank capital ratio

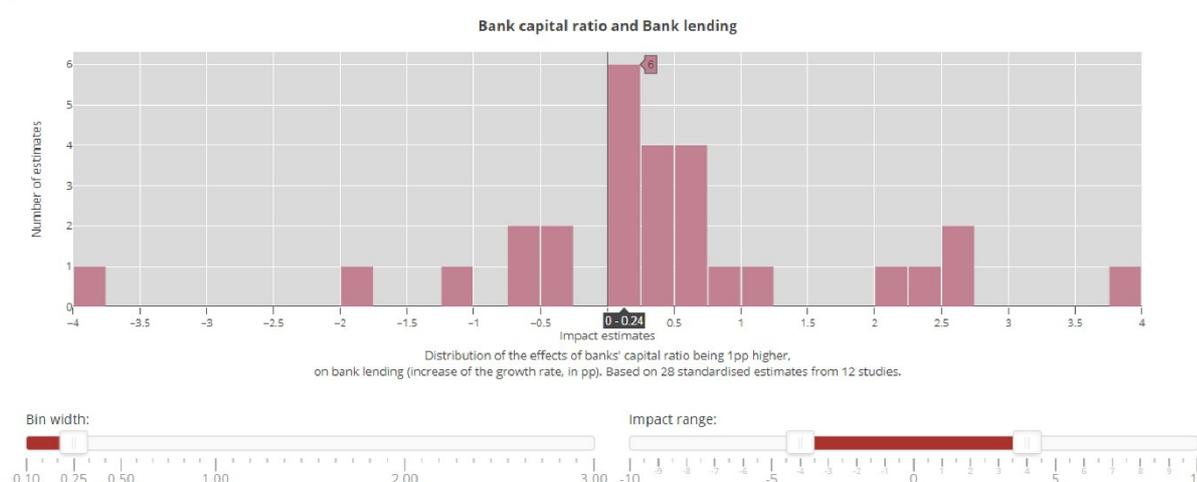
Target:
 Level Growth rate
 Bank lending

Breakdown options:
 No breakdown

Disclosure statement:
 Independent Commissioned

Freeze at QR March 2019 release:
 No Yes

[Reset](#)



Source: <https://stats.bis.org/frame>.

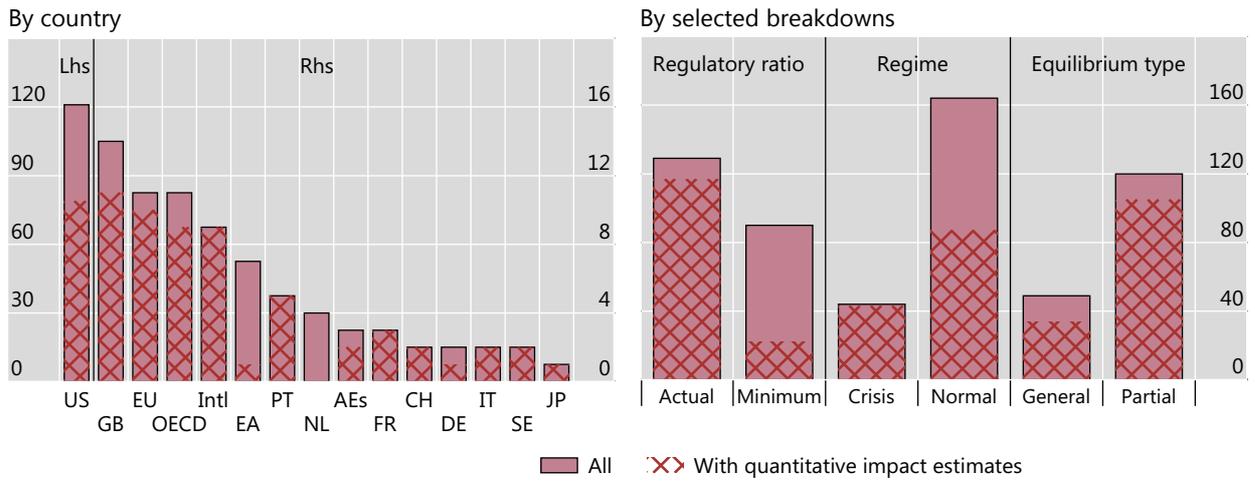
bank lending (Graph 3). To facilitate comparisons, estimates are all standardised. To allow for verification and full transparency, the repository contains the original estimates, and the methodologies applied to standardise them are described in detail.

FRAME will be updated with new estimates as analyses are completed. Indeed, the repository is meant as a sharing platform through which users can report their own findings.² To avoid potential selection bias, any study can be referenced in FRAME. The only prerequisite is, of course, that the study be public and accompanied with a disclosure statement as to whether it was sponsored (eg by the financial sector) or conducted independently (eg by academics). Users can filter studies based on this and other characteristics (see box). About half of the studies currently in FRAME were published in academic journals, and one fifth in journals uniformly rated as top ones. The quality of the estimates is expected to further improve over time, eg as researchers get access to more precise data and longer time series.

² Users are invited to self-report by filling in a reporting template, downloadable from the website. The data collected are shared upon request; please send requests to frame@bis.org.

Number of entries in FRAME

Graph 2



Source: <https://stats.bis.org/frame>.

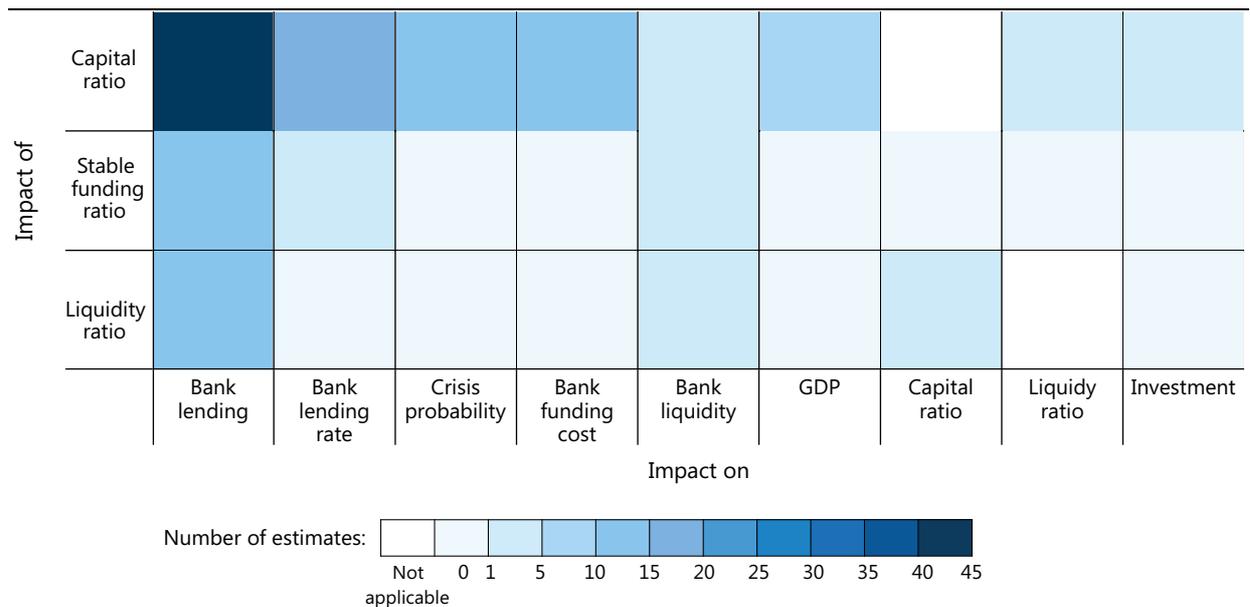
Interpreting the estimates

The estimates reported in FRAME must be interpreted with an eye towards the type of effect they are meant to capture. Two distinctions in particular matter.

One crucial distinction is whether the estimates refer to the effects of an increase (or decrease) in an *observed* regulatory ratio (eg the Basel III Common Equity Tier 1 (CET1) ratio) or the effects of a change in a *minimum* regulatory ratio (eg the Basel III

Number of estimates included in FRAME

Graph 3



Source: <https://stats.bis.org/frame>.

4.5% minimum CET1 ratio). This distinction is important, because changing a minimum regulatory ratio does not necessarily make banks change their actual regulatory ratio – ie their capital ratio measured according to the regulatory standards – to the same degree (or even at all). Vice versa, banks may change their actual regulatory ratios even when the regulatory minimum does not change. As the observed ratios can vary due to many factors, estimates based on them are noisier indicators of what regulatory changes may imply than estimates based on regulatory minima. Unfortunately, few studies exist on the latter.

The gap is very large. Mainly owing to the lack of hindsight and detailed supervisory data, only 15% of the estimates in FRAME (and more generally in the literature) capture the effects of higher minimum regulatory standards *stricto sensu* (Graph 2, right-hand panel).³ The remaining 85% are based on observed regulatory ratios, if not on proxies thereof. When the regulatory ratio is not observable (eg owing to banks not reporting it), studies typically use proxies, whose quality may vary, not least with the measure considered. Studies of Basel III's Liquidity Coverage Ratio (LCR) or Net Stable Funding Ratio (NSFR), for example, have so far been conducted using relatively coarse approximations, such as the ratio of liquid assets or deposits to total assets: banks have started to disclose their Basel III LCR or NSFR in their financial statements only recently. In contrast, studies of capital requirements can usually rely on a relatively long time series of individual banks' regulatory capital ratios, which banks have been forced to disclose.

The FRAME repository addresses this problem head-on. It gathers all types of estimates, but makes an explicit distinction between observed and minimum regulatory ratios, as well as – whenever applicable – between the various proxies used for the regulatory ratios themselves (see box).

Another important distinction is between *transition* and *permanent* effects, ie the impact during the transition towards a tighter standard versus the final effects of that standard.⁴ The transition effect is about the behaviour of banks (or the economy) as they adjust to a new regulation; it depends on how they adjust, and how fast.⁵ The permanent (long-term) effect, in contrast, is about how banks (or the economy) behave under the new regulation once they have fully transitioned to it, compared to how they would have behaved had the regulation not changed. The latter situation not being observable, estimations of the long-term impact most often rely on counterfactual analyses.⁶ With banks facing adjustment costs to raise their capital,

³ Those are relatively recent, and most often refer to those capital standards for which implementation is advanced enough to allow for analysis.

⁴ This latter effect is sometimes referred to as the "long-term economic impact" (BCBS (2010)). In the rest of this article, we use the term "long-term impact" to indicate the final effect of a regulation once banks have fully phased it in.

⁵ Following a tightening in capital standards, for example, a bank may retain earnings, raise new capital or shed risky assets ("deleverage"). The last option takes less time than the previous two, but is likely to have stronger overall economic effects (Gropp et al (2019), Macroeconomic Assessment Group (2010a,b).

⁶ There are several ways this can be done. In macroeconomic studies, the long-term impact of a policy change is typically associated with the lag structure of a dynamic model and calculated as the sum of lagged coefficients. This could also be used to measure the impact of regulatory changes, although few studies do so. More common are microeconomic studies, where the effect is often derived from the cross-sectional dimension of the data, eg by comparing, at a given point in time, the behaviour of banks that already comply with the new regulation with that of similar banks not subject to it or otherwise not having started their adjustment. Each approach has pros and cons. Cross-sectional comparisons could be misleading, as they rely on the assumption that the two groups

one can expect a regulatory tightening to have a larger impact during the transition than once banks have fully adjusted. In the case of capital regulation, estimates in FRAME include both those referring to the transitional effects of banks increasing their capital ratio by 1 percentage point and the effects of the capital ratio being 1 percentage point higher over the long term, whatever the transition dynamics.

FRAME users can also break down the distributions of impact estimates along 16 other dimensions.

For example, a user can ask whether the estimates hold for crisis or normal times (Graph 2, right-hand panel). About 30% of the estimates in FRAME approximate the benefits if banks enter a crisis with more capital, more liquid assets or more stable funding; the other 70% study such effects in normal times.

Another example is the breakdown between partial and general equilibrium effects (Graph 2, right-hand panel). By affecting many banks simultaneously, a change in the regulatory standards is likely to impact overall quantities (eg lending volume) and prices (eg deposit rate, return on equity, asset prices). These effects can have further repercussions that reinforce, dampen or reverse the initial – first-round – effects of the regulatory change. For example, higher capital requirements may make lending more costly and less easily available – which in turn may lower asset prices (eg house prices), making collateral less valuable and inducing even less lending. About 30% of the estimates in FRAME capture such indirect – yet potentially relevant – effects.

Further breakdowns include classifications by country, type of regulatory ratio (eg risk-weighted or not), methodology, whether the study has been peer-reviewed and other aspects (see box).

Selected insights from FRAME

FRAME can be used to spotlight what the literature has, and has not, been able to document to date. Looking across the included studies, there is no indication that raising bank liquidity or stable funding ratios reduces bank lending (Graph 4, left-hand panel, red and yellow bars). Recent studies also find that if a bank has a higher capital ratio this tends to be accompanied by a higher liquidity ratio (beige bar). To the extent that holding more liquid assets is associated with more prudent behaviour, this finding is in line with the notion that banks tend to take less risk when they have more “skin in the game”. Studies also confirm that the effects during the transition to tighter regulation may be different from the impact once banks have reached the new standard. For example, a 1 percentage point higher capital ratio is found to have a positive effect on loan growth in the long term, but a negative effect during the

of banks are similar otherwise. At the same time, compared with macroeconomic approaches they can better identify the effects of (changes in) banks’ balance sheet conditions on loan supply. They can control for credit demand, for example through firm-time fixed effects. Another approach is using model simulations, which try to address selection, endogeneity and other issues, though these are very sensitive to the modelling assumptions. With its transparency, FRAME allows users to break down the estimates based on the specific approach used and assess robustness to the methodology.

The FRAME repository: options and lexicon

FRAME enables users to plot the distributions of the estimated effects of a given regulation on a number of variables. This box briefly presents the main options available and terms used (Graph A).

FRAME repository: main options¹

Graph A

1 Regulatory ratio: Long-term impact Transition 2
Bank capital ratio

3 Target: Level Growth rate 4
Bank lending

5 Breakdown options:
No breakdown

6 Disclosure statement: Independent Commissioned

Freeze at QR March 2019 release:
 No Yes

Reset

¹ The numbers shown in the screenshot correspond to those in the text in the box.

Source: <https://stats.bis.org/frame>.

1. Regulatory ratio: refers to the bank's balance sheet ratio subject to the regulation (eg capital ratio, LCR, NSFR). While ideally the estimates are based on the changes in the minimum regulatory requirements and individual banks' exposure to those changes, there are, in practice, too few regulatory changes and too little detailed supervisory information to allow for a precise analysis. In FRAME, 85% of the estimates are currently based on changes in the observed ratios, rather than on changes in the minimum regulatory requirement. This proportion is expected to diminish as supervisory data and longer time series become available.

2. Transition and long-term impact: refer to the cost/gain of the transition towards a tighter standard and the final effects of a higher minimum regulatory ratio. The impact estimates are standardised, to capture the transitory effect of banks increasing their regulatory ratio by 1 percentage point, or the long-term effects of the regulatory ratio being 1 percentage point higher. In microeconomic studies, transitory effects are often derived by exploiting the time series dimension of the data (eg by comparing the situation of a given bank at two points in time), whereas the long-term impact is often derived from the cross-sectional dimension of the data (eg by comparing the situations of two or more otherwise similar banks at a given point in time).^① Long-term impacts may also be derived from simulating estimated or calibrated macro models.

3. Target: the variable on which the regulation has the impact. Importantly, this term does not refer to any objective of the regulation considered.

4. Level and growth rate: whether the target is a level or a growth rate, ie whether estimates capture the effects on the growth rate of economic aggregates (eg bank lending, investment, GDP) or their level, with the effects accordingly reported as a percentage point variation in growth rate, or as a percentage variation of the level.

5. Breakdown options: the multiple splits of the estimates in FRAME. These include:

- **Actual or minimum regulatory ratio:** whether the estimated effect is that of a change in the observed ratio, or of a change in the minimum regulatory ratio, with the latter typically derived either from calibrated or estimated macro models, or from micro data on individual banks' exposure to the change in regulation (eg Pillar 2 information, Basel III liquidity ratios).
- **Regulatory ratio – detail:** definition of the regulatory ratio, or proxy for it, used in the study.
- **Regime:** whether the estimated effect holds in crisis or normal times.
- **Equilibrium type:** whether the estimated effect accounts for general equilibrium (second-round) effects. In most cases, microempirical studies are classified as "partial equilibrium". Macroempirical studies and estimates from general equilibrium macro models are classified as "general equilibrium".
- **Peer review:** whether the study has been peer-reviewed, ie published in an academic journal.
- **Mean of the regulatory ratio:** refers to the mean of the regulatory ratio over the sample used for the estimation, allowing one to assess how the marginal effect of a change of a regulatory standard varies with its tightness.
- **Statistical significance:** whether the estimate is statistically significant at the 5% threshold.^②

Methodology: the methodology used in the study, eg estimation, macro model, theory.

6. Disclosure statement: whether the authors of the study had relevant or material financial interests that relate to their analysis (eg research sponsored or commissioned by lobbying groups).

① State-of-the-art microempirical studies identify the long-term impact of regulation using difference-in-difference estimates. Those typically compare the behaviour (eg lending) of two groups of banks with varied exposure to the regulation (eg different regulatory ratios), before and after a given event (eg a crisis). One prerequisite, though, is that the two groups have the same behaviour before the event, ie are comparable in terms of whether, and how far, they had started a transition towards the new requirements. Note that this terminology varies from that used in macroempirical studies, in which the transition and long-term impacts are typically related to the lag structure of the econometric model (the long-term impact being calculated, for example, as the sum of lagged coefficients). ② The precise standard errors of the estimates, as reported in the studies, are available on request (email frame@bis.org).

transition (compare the red bars in the left- and right-hand panels of Graph 4).⁷ Some of these findings should be treated as preliminary, however, since there have not always been enough studies to draw robust conclusions.

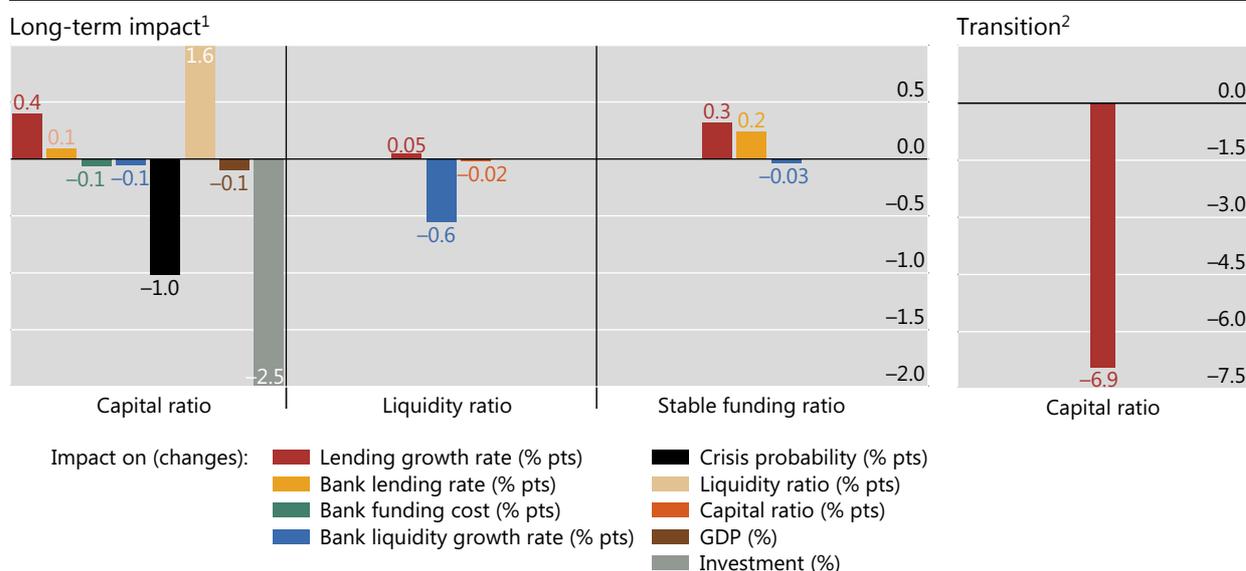
Despite recent progress, the literature remains largely focused on the long-term impact of capital regulation on banks' lending activities. As an illustration, we present three insights.

First, higher bank capital raises the overall funding cost – debt plus equity – only marginally. A 1 percentage point higher bank capital ratio is associated with a less than 20 basis point higher average cost of funding (weighted average cost of capital (WACC)), which takes account of an imputed equity funding cost (Graph 5, left-hand

Effects of banking regulations: a bird's eye view of the literature

Average impact estimate

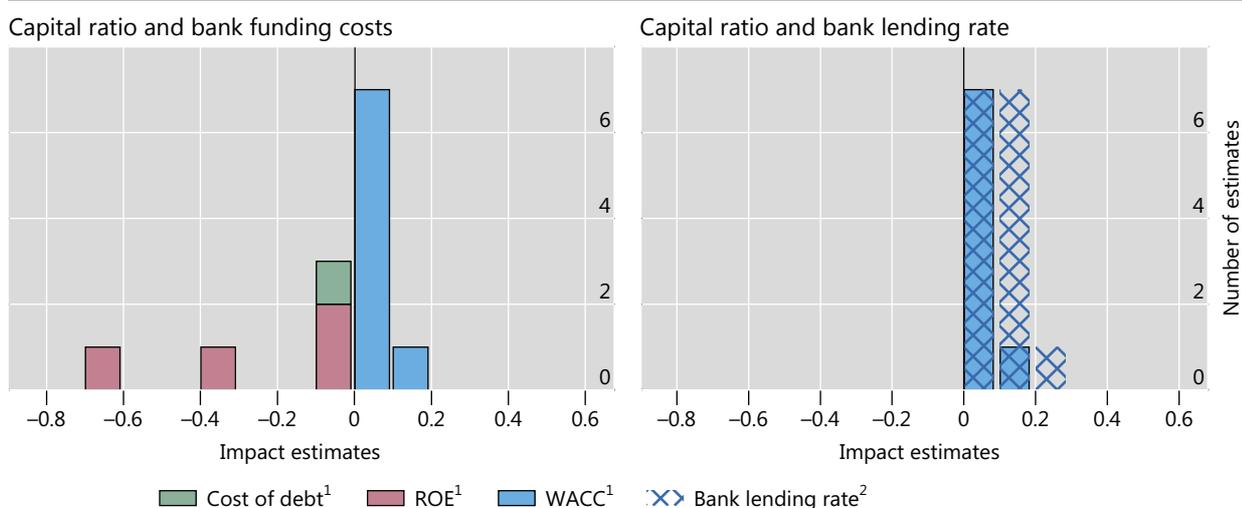
Graph 4



¹ Effect of capital, liquidity or stable funding ratio being 1 percentage point higher. ² Effect of a 1 percentage point increase in the capital ratio.

Sources: <https://stats.bis.org/frame>; authors' calculations.

⁷ As noted earlier, the transition effect probably depends on the way (and speed) banks adjust to the regulation.



¹ Distribution of the effects of banks' capital ratio being 1 percentage point higher on banks' deposit rate (change, in percentage points). Based on 13 standardised estimates from eight studies. ² Distribution of the effects of banks' capital ratio being 1 percentage point higher on banks' lending rate (change, in percentage points). Based on 15 standardised estimates from 11 studies.

Source: <https://stats.bis.org/frame>.

panel, blue bars).⁸ Tighter capital regulation may raise the weight of equity funding in the WACC. But this is almost offset by the lower unit cost of both debt (green bars) and equity funding (red bars). This result should be set against the benchmark in the Modigliani-Miller theorem, which holds that, under ideal conditions, changes in a firm's WACC should not be affected at all by its mix of debt and equity funding.⁹ The fact that the WACC increases, but only marginally, suggests that the logic underlying the Modigliani-Miller theorem applies to the impact of changes in bank capital, but does not operate to the full extent.

A second insight, provided by a number of papers, is that banks with a higher capital ratio charge a higher loan rate (Graph 5, criss-crossed area). Surprisingly, the loan rate is much higher than what a one-to-one pass-through from the WACC would generate (blue bars). This finding points to a potential inconsistency between the two strands of the literature, which deserves more careful scrutiny.¹⁰ A key piece of the puzzle is the impact of higher capital on the cost of non-equity financing, which ought to be unambiguously negative.

A third insight relates to the effects of banking regulation on bank lending growth. One objective (among others) of the post-crisis regulatory reforms was to foster banking system resilience in times of stress (BCBS (2011)), while preventing

⁸ Investors' required returns on equity are not directly observable and have to be imputed from an equity asset pricing model. The standard capital asset pricing model (CAPM) predicts that a bank's expected return on equity is proportional to its estimated equity beta, obtained by regressing the bank's excess returns on the excess value-weighted market returns (see eg Baker and Wurgler (2015)). Bogdanova et al (2018) provide an application.

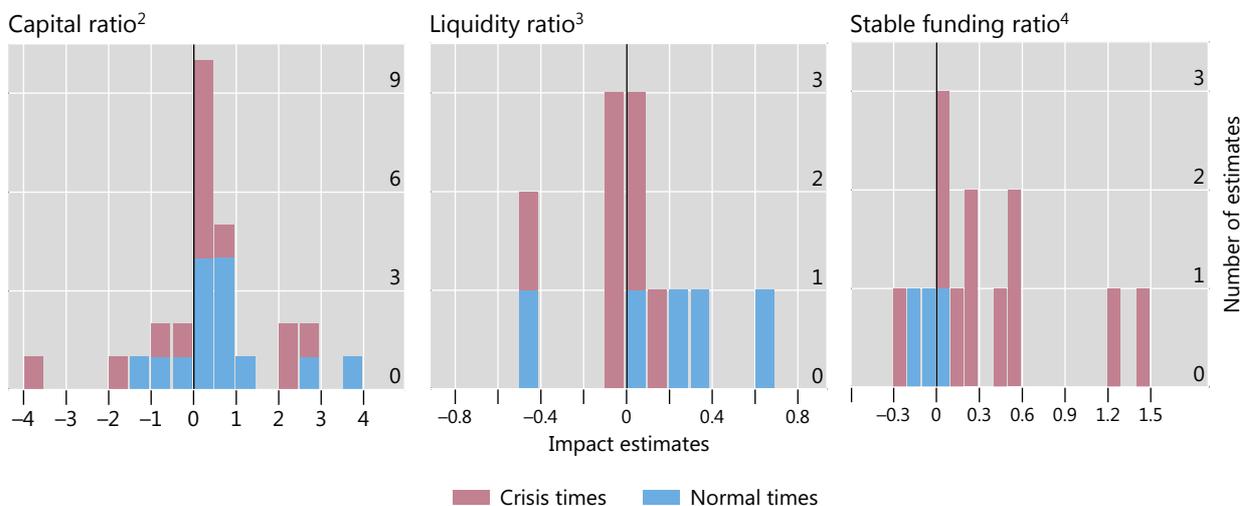
⁹ Modigliani and Miller (1958).

¹⁰ One possible explanation could be that the two strands of the literature have been using different methodologies, with some addressing endogeneity issues better than others. Another explanation is that banks' internal markets do not operate as basic models suggest, creating segmentation, with capital adequacy requirements binding more in lending than in other business segments.

Effects of bank capital, liquidity and stable funding on bank lending¹

By regime

Graph 6



¹ Distribution of the effects of banks' regulatory ratio being 1 percentage point higher on bank lending (increase in the growth rate, in percentage points). ² Based on 28 standardised estimates from 12 studies. ³ Based on 12 standardised estimates from six studies. ⁴ Based on 14 standardised estimates from seven studies.

Source: <https://stats.bis.org/frame>.

future crises by deterring *excessive* credit growth – a strong predictor of banking crises (eg Aldasoro et al (2018)). Accordingly, following regulatory tightening, one would expect banks to be less inclined to boost lending in good times or to cut lending in bad times. To see if banking regulations indeed have this potential to smooth the credit cycle, we report in Graph 6 the effects of higher capital, liquidity and stable (ie core) funding ratios on lending growth, comparing crisis (red bars) and normal (blue bars) times. Only the stable funding ratio (right-hand panel) seems to have a clearly countercyclical impact: banks with more stable funding lend relatively more than other banks during crisis times, ie they are more resilient. They also do not increase loan growth as much in normal times. In contrast, the capital and liquidity ratios appear to have much weaker countercyclical effects.

Heterogeneity of estimates

What explains the heterogeneity of estimates? To understand better why some estimates vary so widely, we use meta-analysis techniques, which are particularly well suited when studies are not directly comparable but evaluate the same – or closely related – questions.¹¹

¹¹ We assess whether the differences observed across studies reflect “genuine” heterogeneity (eg due to the true impact of regulation varying across countries, periods, methodologies) or “random” heterogeneity (eg due to the studies using different samples of observations for the same country, period, methodology, etc). The meta-analysis allows us to decompose the variance of the estimates into those two sources of heterogeneity. The key statistic is the I^2 , which is the percentage of the variance of the estimates that is attributable to genuine between-study heterogeneity as opposed to sampling variance. As a rule of thumb, heterogeneity is considered high when $I^2 > 75\%$ (Harbord and

Impact of banking regulations: mean and dispersion across estimates

Table 1

Impact of:	Capital ratio			Liquidity ratio	Stable funding ratio
Impact on:	Loan growth	Lending rate	Crisis/default probability	Loan growth	
Average effect (in % pts) ¹	0.41***	0.04***	-1.07***	0.07	0.15***
I ² (in %) ²	94.86	79.7	0.00	99.68	99.76
Number of observations	28	20	16	12	14

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

¹ Weighted average of estimates across studies. ² Percentage of the residual variation that is attributable to between-study heterogeneity. As a rule of thumb, heterogeneity is considered high when I² > 75 (Harbord and Higgins (2008)).

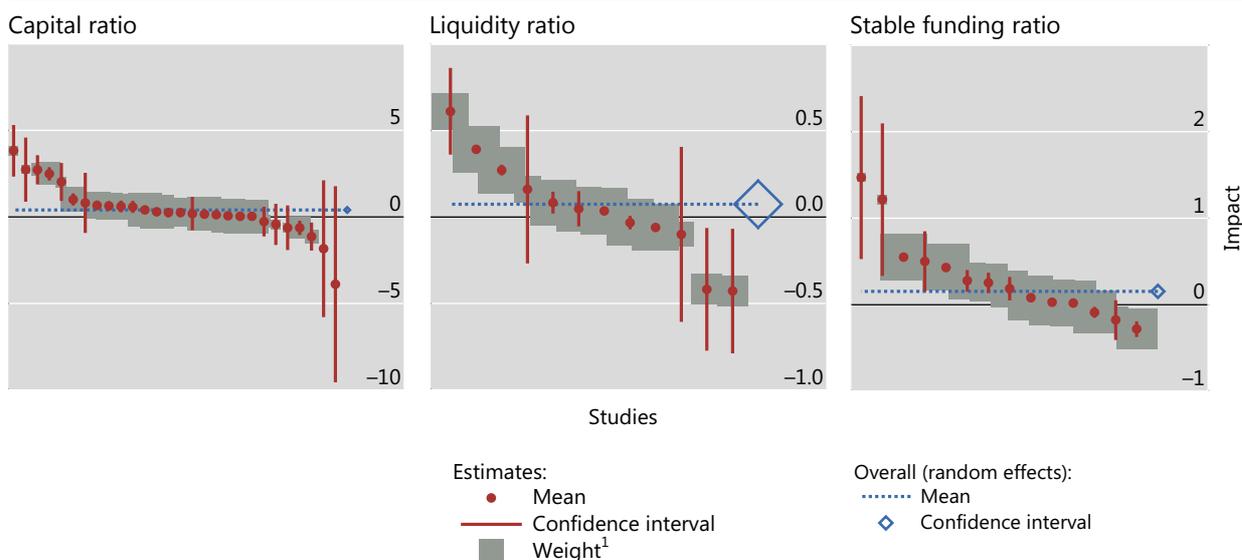
Sources: <https://stats.bis.org/frame>; authors' calculations.

Averages can mask a fair amount of heterogeneity. On average, banks with a 1 percentage point higher capital ratio (eg 13% versus 12%) have a 0.41 percentage point higher growth rate of loans, while a 1 percentage point increase in a bank's stable funding ratio increases loan growth by 0.15 percentage points (Table 1). But these estimates vary widely across studies (Graph 7). For the effect of bank capitalisation on loan growth, estimates range from -3.89 percentage points to 3.82 percentage points (left-hand panel, red dots). This range is large by the usual statistical standards (the I² statistic is above 75%; see footnote 11), highlighting the lack of consensus in the literature. In the case of the impact of bank liquidity on loan growth, the studies do not even agree as to the sign of the average effect, which is not statistically significant. However, the literature does agree that a higher bank capital ratio reduces the probability of a crisis. On average, a 1 percentage point higher ratio is associated with a 1 percentage point lower crisis probability, with a very low dispersion in the estimates.¹²

We next use meta-regressions to test whether specific characteristics of the studies can explain the observed heterogeneity. Given the limited number of observations, we have to restrict our analysis to the effects of bank capital on loan growth, and consider only four potential factors: whether the capital ratio is risk-weighted or not; whether the analysis underlying the estimate controls for loan

Higgins (2008)). For a more detailed explanation of meta-analysis techniques applied to economics, see Gambacorta and Murcia (2017).

¹² This result, which to a large extent is based on studies using a similar approach (BCBS (2010)), has recently been subject to debate. New findings by Jordà et al (2017) have shifted attention from the crisis prevention effects of capital to the cost containment benefits. Using more detailed bank balance sheet and crisis historical data, they conclude that bank capital "...has no value as a crisis predictor but does reduce crisis costs". But as there are still very few studies on the effect of regulation on the cost of crises (eg in terms of GDP loss; see Graph 3), this result has yet to be confirmed. FRAME does not cover the literature on the cost of crises per se (see eg Romer and Romer (2017) and Cerra and Saxena (2017)).



¹ For each point estimate, the size of the grey square is proportional to the weight that the estimate contributes to the meta-analysis. This weight is given by the inverse of the estimate’s standard error, as reported in the underlying study, plus the estimated between-study variance.

Sources: <https://stats.bis.org/frame>; authors’ calculations.

demand;¹³ whether the analysis accounts for general equilibrium feedback effects;¹⁴ and whether the impact is estimated during a crisis.

The results are shown in Table 2. The “baseline” meta-regression (column 1) yields the average estimate, absent using any control for these four characteristics. By construction, it is the same as the average estimate reported in Table 1 (0.41 percentage points).

The comparison suggests that general equilibrium considerations are an important driver of heterogeneity. While partial equilibrium analyses find a statistically significant and positive average impact of a 1 percentage point higher capital ratio on loan growth (0.29 percentage points), the impact is estimated to be 2.13 percentage points stronger when macroeconomic feedback (second-round) effects are taken into consideration (Table 2, column 4).¹⁵ Controlling for those

¹³ One state-of-the-art methodology (Khwaja and Mian (2008)) uses bank-firm loan data (typically from credit registries) and firm fixed effects in the regression to control for loan demand. Under the assumption that firms spread their demand equally across their respective banks, such fixed effects capture variations in loan demand from each firm towards each of its banks. Controlling for those, the effect of regulation or balance sheet ratios on banks’ loan supply can then be identified by comparing the lending behaviour of the banks most affected by the regulation with lending by other banks. Accordingly, to account for the quality of estimates, we distinguish between studies using firm fixed effects (ie those that control for loan demand effects) and those that do not.

¹⁴ Those are typically estimates derived from macroeconomic analyses.

¹⁵ In a meta-regression, each observation is weighted by the inverse of the sum of its variance (here the standard error of the estimate) and the between-study variance (so-called “residual heterogeneity”). Graph 6 (left-hand panel) shows that there are negative point estimates. But because those negative estimates are not precise (their confidence interval extends over zero values; see Graph 7, left-hand panel), they are not given large weights in the meta-regression. This explains why the average partial equilibrium effect is positive and statistically significant in the regression (Table 2, column 4, coefficient 0.29), in spite of some point estimates being negative.

Effects of bank capital on loan growth: general equilibrium feedback effects matter

Table 2

Variable	Model				
	Baseline	Risk weights	Firm fixed effects	Partial vs general equilibrium	Crisis
Risk-weighted capital ratio ¹		-0.48 (0.31)			
Firm fixed effects ²			-0.67 (1.21)		
General equilibrium ³				2.13*** (0.48)	
Crisis times ⁴					-0.14 (0.27)
Constant	0.41*** (0.14)	0.76*** (0.27)	0.42*** (0.15)	0.29** (0.10)	0.46** (0.19)
I ² (in %) ⁵	94.86	94.94	95.04	93.00	91.57
Number of observations	28	28	28	28	28

Standard errors in parentheses. ***/**/* indicates statistical significance at the 1/5/10% level.

Results based on meta-regressions of the growth rate of bank loans. The coefficients are weighted by the inverse of the estimate's standard error, as reported in the underlying study, plus the estimated between-study variance.

¹ Dummy equal to 1 if the regulatory ratio considered in the study is risk-weighted. ² Dummy equal to 1 if the analysis controls for loan demand through firm-time or industry-time fixed effects. ³ Dummy equal to 1 if the estimate incorporates general equilibrium effects. ⁴ Dummy equal to 1 if the sample underlying the analysis corresponds to crisis times. ⁵ Percentage of the residual variation that is attributable to between-study heterogeneity. As a rule of thumb, heterogeneity is considered high when $I^2 > 75$ (Harbord and Higgins (2008)).

Sources: <https://stats.bis.org/frame>; authors' calculations.

effects reduces the residual heterogeneity across the studies by 1.86 percentage points (compare the I^2 statistic in columns 1 and 4). And, while the reduction in heterogeneity is small, it is statistically significant.

None of the other potential drivers seems nearly as relevant. For example, the risk-weighted capital ratio is found to have only a 0.48 percentage point lower impact on loan growth than the leverage ratio (Table 2, column 2), and this difference is not statistically significant. The average estimated impact is also essentially the same, whether or not the study controls for loan demand (column 3) or crisis times (column 5).

Conclusion

FRAME is an online interactive repository of regulatory impact estimates. Its purpose is to track, organise, standardise and disseminate the latest studies on the impact of financial regulation on banks, the financial system and the macroeconomy. Its broad content offers a new and comprehensive perspective on what researchers have been able to document to date, and where gaps exist.

Comparing, inter alia, the effects of regulatory ratios in normal and crisis times, we find that the stable funding ratio has a much stronger countercyclical effect on bank lending than bank capital or liquidity ratios. But the number of studies remains

relatively small. We will have much more to learn about these effects as the regulatory reforms are implemented and more analysis is done.

We document significant heterogeneity across quantitative impact estimates, notably regarding the effect of capital regulation on loan growth. The average estimated effect is positive, but varies widely across studies. Studies that incorporate second-round (general equilibrium) effects, in particular, find a much more positive impact than those that do not. The difference is statistically significant and economically sizeable. This suggests that it is very important to account for the macroeconomic impact and other indirect effects of capital regulation.

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Following the imprint of the ECB's asset purchase programme on global bond and deposit flows¹

We trace the imprint of the ECB's expanded asset purchase programme (APP) on international bond portfolios and euro-denominated deposits. Our analysis suggests that non-bank financial institutions (NBFIs) located outside the euro area sold large volumes of euro area government bonds and kept a substantial fraction of the proceeds as euro-denominated deposits, primarily in UK-resident banks. Since the APP's modalities did not allow the NBFIs to engage directly with the Eurosystem, their deposits left an international trail of euro-denominated claims. Our findings highlight the role of the United Kingdom as a gateway to the euro area financial system for investors outside the euro area.

JEL classification: E50, E52, F30, F40.

Since its launch 20 years ago, the euro has consolidated its role as a major currency in the international financial system, second only to the US dollar (Chinn and Frankel (2008), ECB (2018)). Monetary policy actions undertaken by the ECB can thus have consequences beyond the immediate borders of its currency area.

In this special feature, we attempt to piece together evidence from multiple international data sets to trace the imprints left by the ECB's expanded asset purchase programme (APP) on the international financial system. Concretely, we document notable shifts in euro-denominated bonds and deposits between the euro area and the rest of the world during the period associated with the ECB's APP. Our findings shed light on the channels through which the APP interacted with the global financial system.

A distinctive feature of the ECB's APP was that investors outside the euro area were very active sellers of euro area government bonds to the ECB (Adalid and Palligkinis (2016), ECB (2016, 2017), Koijen et al (2017), Cœuré (2018)). They accounted for roughly 50% of all APP bond sales. The asset purchase programmes conducted by other major central banks elicited much less involvement on the part

¹ The authors would like to thank Claudio Borio, Stijn Claessens, Benjamin Cohen, Ingo Fender, Branimir Gruić, Robert McCauley, Benoît Mojon and Gillian Phelan for helpful comments; Zuzana Filková and Deimantė Kupčiūnienė for excellent research assistance; Conor Parle and Swapan-Kumar Pradhan for excellent data assistance; and Mario Barrantes for excellent assistance with graph design. Mary Everett developed parts of this work while visiting the Bank for International Settlements under the Central Bank Research Fellowship Programme. The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank for International Settlements, the Central Bank of Ireland or the European System of Central Banks.

Key takeaways

- Non-bank financial institutions (NBFIs) located outside the euro area were active as sellers of euro area bonds during the ECB's expanded asset purchase programme (APP).
- Our analysis suggests that non-euro area NBFIs retained a substantial fraction of their bond sale proceeds as euro-denominated deposits in banks outside the euro area.
- Banks located in the United Kingdom and their euro area affiliates were the main facilitators of the APP bond sales by non-euro area investors.

of non-resident investors (Carpenter et al (2015), Joyce et al (2017), Hogen and Saito (2014)).

The evidence suggests that the non-euro area APP sellers of euro area bonds retained a large fraction of their bond sale proceeds as euro-denominated deposits, rather than immediately repatriating the proceeds or reinvesting them in other bonds. UK-based investors, for instance, appear to have retained roughly a fifth of the bond sale proceeds as euro-denominated deposits.

Our analysis also highlights the key role of the United Kingdom as the main gateway to the euro area banking system for non-euro area investors during the ECB's APP. Non-bank financial institutions (NBFIs) located in the United Kingdom were both the largest non-resident sellers of euro area bonds during the APP period and the largest contributors to the concurrent increase in euro-dominated deposits outside the euro area.² Furthermore, the majority of those deposits were with banks in the United Kingdom, which, together with their euro area affiliates, appear to have been the main facilitators of the APP bond sales by non-euro area investors, and the conduits to the Eurosystem.

The remainder of the article is organised as follows. In the following section, we provide a stylised overview of the APP's imprint on the global financial system. We then present a "before and after" picture of the impact of the asset purchase programme, beginning with the key non-euro area bondholders on the eve of the ECB's expanded APP. Next, we track the evolution of non-euro area investors' portfolio allocations during the ECB's APP period. We go on to link these non-resident portfolio choices to the dynamics of international euro-denominated deposits, making use of the enhanced BIS locational banking statistics (LBS). We conclude by highlighting the policy relevance of our insights and posing questions for further research.

Some simple balance sheet arithmetic

We start with the following stylised example of how the ECB's APP purchases can impact on the balance sheets of the key protagonists involved in the APP (Graph 1).

² NBFIs include non-bank entities engaged in the provision of financial services and in activities auxiliary to financial intermediation such as fund management. Examples of the entities included in this category are insurance companies, pension funds, money market funds and other financial corporations (eg investment funds, financial auxiliaries, and securities and derivatives dealers). For more details, see IMF (2009) and BIS (2013).

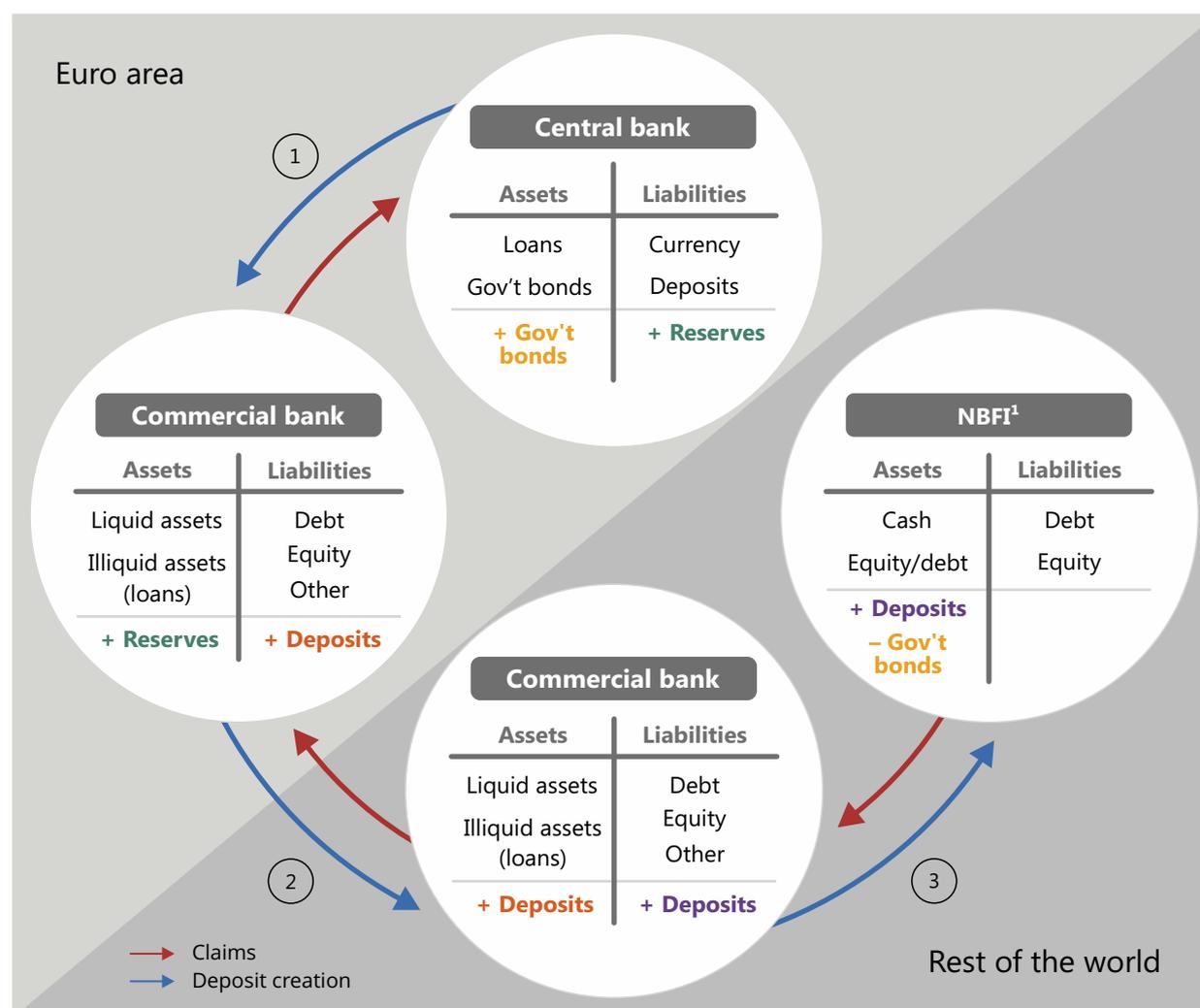
As a large share of euro area government securities were owned by non-euro area investors prior to the start of the APP, we consider a case in which the holder of an APP-eligible security is an NBFI located outside the euro area – for example, in the United Kingdom.

Suppose that, following the launch of the asset purchase programme, the UK investor opts to sell its holdings of euro area government securities. Since, due to the technical modalities of the APP, the NBFI cannot engage directly with the Eurosystem, it has to accept the Eurosystem bid through a bank (which is assumed to be in the United Kingdom for this example). The Eurosystem credits the bank's affiliate in the euro area with the sale proceeds in the form of central bank reserves (Graph 1, arrow 1). The affiliate in the euro area credits the bank in the United Kingdom with a within-banking group claim (arrow 2). In turn, the bank in the United Kingdom credits the selling NBFI with a euro-denominated deposit (arrow 3).

Impact of the ECB's APP purchases on balance sheets

A stylised example

Graph 1



¹ Non-bank financial institution.

Source: Authors' elaboration.

Following the sale of its government securities, the non-euro area NBFIs in the above example will have several options for the proceeds. First, it can opt to rebalance its portfolio towards higher-yielding euro-denominated assets (for example, non-APP-eligible euro-denominated public sector bonds or corporate bonds). Second, the NBFIs can swap the euros into, say, US dollars and invest in US dollar bonds on a hedged basis. In this case, the far leg of the swap will leave a forward sale of dollars against euros. Third, the NBFIs can close its euro position in order to invest in assets denominated in a different currency (eg the US dollar). Fourth, the NBFIs could keep the euro-denominated deposits.

The closest substitutes to the NBFIs' previous position would be the first two options. According to standard portfolio choice models, the first option would be seen as the most likely outcome. If so, the impact will be consistent with the portfolio rebalancing channel of unconventional monetary policy (Dunne et al (2015), Carpenter et al (2015), Joyce et al (2017)). The portfolio rebalancing channel is frequently considered to be the most effective channel through which central bank asset purchases impact the real economy (Joyce et al (2012)). Greater demand for higher-risk assets, whether of longer duration or with more credit risk, increases their prices and lowers their yields. Higher asset prices increase the wealth of investors, which should boost their spending. Falling bond yields also reduce the borrowing costs for other bond issuers (eg non-financial corporates). This could spur investment, and thereby improve the overall prospects for economic growth.

Nevertheless, as we find in the next section, a substantial fraction of the APP-generated deposits of non-euro area investors may have been "sticky" in a certain sense. That is, we find that NBFIs located in the United Kingdom and in other countries outside the euro area that sold euro area securities during the APP period increased their holdings of euro-denominated deposits in banks located in the United Kingdom. This suggests that a substantial portion of the APP bond sale proceeds was retained in that form.³

Major non-resident bondholders prior to the APP

On the eve of the ECB's expansion of the APP to include public sector securities, the euro area government bond market was characterised by significant, although not overwhelming, regional bias. As of end-2014, the majority of investors in euro area government securities unsurprisingly resided in the euro area (Graph 2, left-hand panel, blue bars).⁴ Financial institutions – namely banks, asset managers, insurance companies and pension funds – were the primary holders of euro area government securities. Nevertheless, non-euro area investors still held almost a third of outstanding euro area government securities (left-hand panel, red bar).

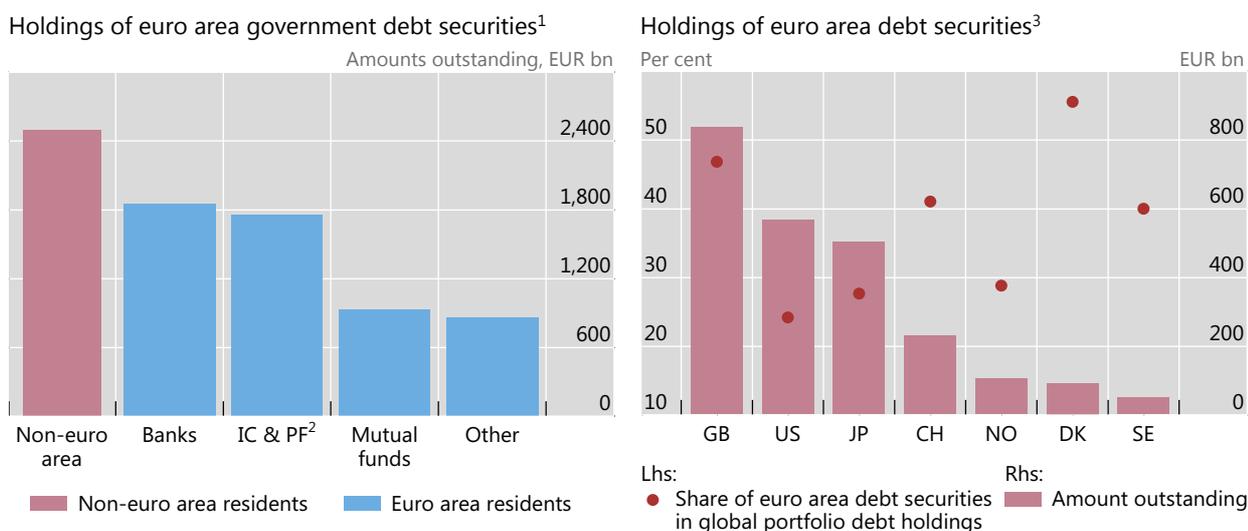
³ It bears emphasis that the available data do not allow us to examine whether *individual* bond sellers increased their deposits, but reveal only that the largest increases in euro deposits outside the euro area came from the sector-country pairs (eg NBFIs in the United Kingdom) that sold the largest volumes of euro area bonds during the APP period. This pattern is consistent with the seller retaining the deposit, and for concreteness we will phrase the finding this way, but strictly speaking the data only provide evidence of sectoral stickiness.

⁴ When the available data allow us to do so, we focus on euro area *government* securities since they represent the overwhelming majority of the ECB's APP purchases.

Holders of euro area bonds, end-2014

By sector and residence of holder

Graph 2



¹ Excluding holdings of the Eurosystem. ² IC = insurance companies; PF = pension funds. ³ Securities denominated in all currencies and issued by all sectors.

Sources: ECB, euro area balance of payments statistics; ECB, euro area sector accounts; IMF, CPIS; authors' calculations.

The IMF's Coordinated Portfolio Investment Survey (CPIS) sheds light on the distribution of non-euro area investors' holdings of euro area debt securities.⁵ These data suggest that investors from only a few countries accounted for most of the euro area bonds held outside the euro area on the eve of the ECB's expanded APP (Graph 2, right-hand panel, red bars). Investors from only seven countries – Denmark, Japan, Norway, Sweden, Switzerland, the United Kingdom and the United States – accounted for close to 90% (or €2.4 trillion) of all non-euro area investors' holdings. Investors based (but not necessarily headquartered) in the United Kingdom alone held close to a third of those securities.⁶

These holdings represented a significant proportion of the international portfolios of investors located in countries near the euro area (Graph 2, right-hand panel, red dots). This pattern is consistent with a gravity model of international diversification (Portes and Rey (2005), Lane and Milesi-Ferretti (2008)). The portfolio shares of euro area securities were highest for Denmark (56%) and the United Kingdom (47%). Switzerland (41%) and Sweden (40%) were not far behind. The respective shares for investors in Norway (29%), Japan (28%) and the United States (24%) were also considerable.

NBFIs owned the majority of the non-resident holdings of euro area bonds. NBFIs resident in the United Kingdom alone held €560 billion worth of euro area bonds on the eve of the ECB's APP, accounting for two thirds of the euro area bond

⁵ The CPIS covers bilateral country holdings of debt securities. Since not all countries report detailed bilateral sectoral breakdowns, we examine bilateral holdings of debt securities issued by all sectors for the cases where more detailed sectoral breakdowns are not available.

⁶ The CPIS data set is compiled on a residence basis, ie it reports the asset holdings of a creditor based on its geographical residence rather than the location of its ultimate owner.

holdings of all UK residents and over a fifth of the euro area bond holdings of all investors outside the euro area.

The large share of euro area bonds held by investors based in the United Kingdom underlines its role as a gateway to the euro area financial system for non-euro area investors. To a large degree, it reflects the United Kingdom's role in hosting an international financial centre (Lane and Milesi-Ferretti (2018)).⁷ Importantly, UK-resident NBFIs include the investment management subsidiaries of financial firms headquartered in other countries.

Tracking cross-border bond flows during the ECB's APP

In the first quarter of 2015, the ECB significantly expanded the scale of its APP by starting to acquire euro area government bonds and public sector bodies' bonds under the Public Sector Purchase Programme (PSPP).⁸ The intensity of the targeted pace of APP purchases fluctuated considerably – from a high of €80 billion a month between April 2016 and March 2017 to a low of €15 billion a month between October and December 2018. At the cessation of net purchases at end-December 2018, Eurosystem holdings of debt securities under the APP had reached €2.6 trillion, with holdings of public sector securities at €2.1 trillion, or 82% of the total.⁹ In this section, we examine the dynamics of non-euro area investors' holdings of euro area debt securities during the APP.

Non-euro area investors sold large amounts of euro area government bonds into the Eurosystem bid. In fact, these investors accounted for approximately half of net sales during this period (ECB (2017)). This represented a sharp reversal of the trend from the pre-APP period, when non-euro area investors were net purchasers.

Investors located in the United Kingdom were the most active sellers located outside the euro area (Graph 3, left-hand panel, red bars).¹⁰ Their portfolio holdings of euro area debt contracted by more than 50% between end-2014 and end-2017.¹¹ The share of the euro area in the global debt portfolio of UK-based investors fell from 47% at end-2014 to 33% at end-2017 (left-hand panel, blue bars). Over the same time period, the positions of investors in Denmark, Sweden and Switzerland

⁷ Unfortunately, the existing data do not allow us to attribute the UK-resident NBFIs' holdings to their ultimate beneficial owners.

⁸ In March 2016, the APP was enhanced through the inclusion of euro-denominated debt securities issued by non-bank corporations resident in the euro area. Known as the Corporate Sector Purchase Programme, it commenced in June 2016 and as of end-December 2018 it accounted for just under 7% of the APP's total asset holdings.

⁹ In December 2018, the ECB's Governing Council announced that the principal payments from maturing securities would be reinvested for an extended period of time, past the horizon of interest rate increases. See Hartmann and Smets (2018) for a detailed discussion of the evolution of ECB non-standard monetary policy measures.

¹⁰ As mentioned above, we examine bilateral holdings of debt securities issued by all sectors, since more detailed sectoral breakdowns are not available for most countries. Nevertheless, data from the ECB balance of payments statistics reveal that almost the entire contraction in the portfolio debt liabilities of euro area residents vis-à-vis the rest of the world between end-2014 and end-2017 can be attributed to debt securities issued by the government sector.

¹¹ We stop our empirical investigation at end-2017, due to the fact that this is the date of the latest available data points from the CPIS series we examine.

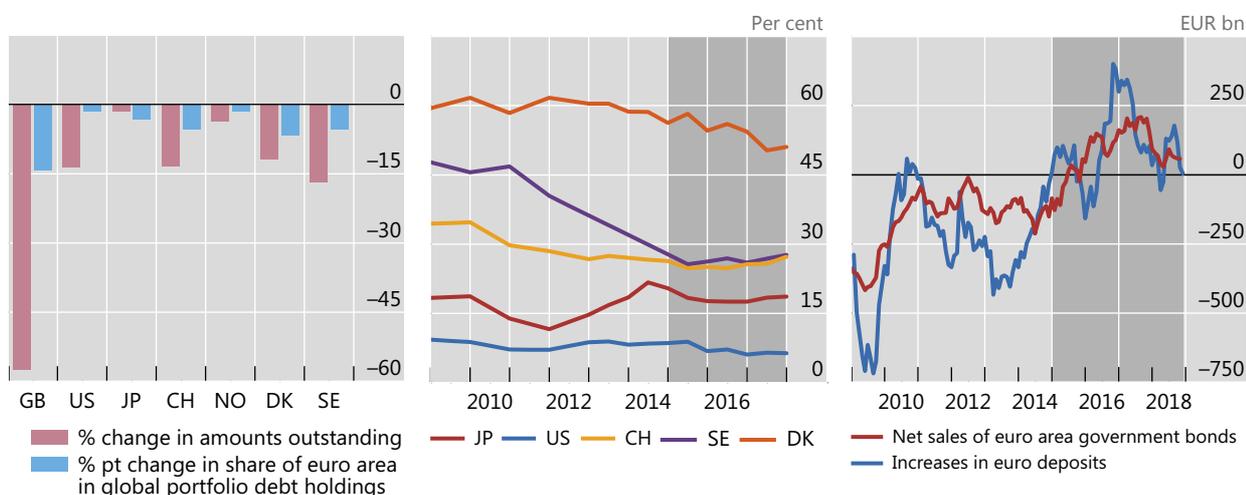
Non-euro area investors' holdings of euro area bonds, euro-denominated bonds and euro-denominated deposits

Graph 3

Euro area bond holdings, changes between 2014 and 2017, by residence of bond holder¹

Share of euro-denominated debt securities in international portfolio debt holdings^{2,3}

Net sales of euro area bonds and increases in euro-denominated deposits, annual flows^{2,4}



¹ Euro area government bond holdings for the countries that report a borrowing sector breakdown (US); euro area total (all sectors) bond holdings for the countries that do not report a borrowing sector breakdown (CH, DK, GB, JP, NO and SE). ² The shaded area refers to the period of the ECB's expanded asset purchase programme. ³ The currency breakdowns for the portfolio debt holdings of NO and UK residents are not available. Missing observations have been filled using linear interpolation. ⁴ Net sales of euro area bonds by investors located outside the euro area. Increases in euro-denominated deposits by non-euro area residents in banks located in the euro area. Positive figures indicate net sales (red line) or net increases in deposits (blue line).

Sources: ECB, euro area balance of payments statistics; ECB, money, credit and banking statistics; IMF, CPIS.

also fell considerably.¹² Holdings of investors in Japan fell somewhat less in percentage point terms, but from a much larger initial stock. The upward slope to the euro area yield curve and the flattening of the US yield curve made hedged Japanese investment in euro area government bonds relatively attractive, even with low yields.

Among individual sectors, NBFIs sold the most euro area bonds during the period of the ECB's APP. Our estimates suggest that NBFIs resident in the United Kingdom cut their holdings of euro area debt securities by approximately €300 billion between end-2014 and end-2017. NBFIs resident in Denmark and Sweden also reduced their holdings of euro area bonds considerably.

In contrast to the share of bonds issued by euro area residents, the share of euro-denominated bonds remained relatively stable for most major investor countries outside the euro area during the APP period (Graph 3, centre panel). This finding suggests that those investors purchased euro-denominated bonds issued by non-euro area residents. This is in line with the surge in euro-denominated ("reverse yankee") bond issuance by US (and other non-euro area) corporates that occurred during the APP period (Borio et al (2016)).¹³

¹² The reported changes in stocks from the CPIS data may have been affected by valuation effects.

¹³ For a detailed analysis of the determinants of the currency composition of international bonds portfolios, see Maggiori et al (2018).

Tracing cross-border euro deposits during the ECB's APP

The net sales of euro area securities by non-euro area investors during the APP have gone hand in hand with a significant rise in non-euro area-sourced euro-denominated deposits in euro area-resident banks (Graph 3, right-hand panel). The simultaneous increase in the two series is not coincidental. It most likely has two drivers. First, as illustrated in Graph 1, the modalities of the APP necessitated that sales by non-euro area investors be settled through banks in the euro area (via central bank reserves). This generated new cross-border positions between banks located outside the euro area and their affiliates inside the euro area. Second, non-euro area NBFIs considerably increased their euro deposits during the APP period, suggesting that they are likely to have retained a non-negligible fraction of their bond sale proceeds in the form of euro-denominated deposits.

In this section, we combine the enhanced BIS LBS with the IMF CPIS data set to link the evolution of cross-border bond flows with the international flows of euro-denominated deposits.¹⁴ In the process, we identify the residence and the sector of the most important participants and quantify their respective contributions.

The investors that were the most active sellers of euro area bonds during the period of the ECB's APP were from sectors and countries that were also the main drivers of the concurrent sizeable increases in euro-denominated deposits in banks outside the euro area (Graph 4).¹⁵ Most notably, NBFIs located in the United Kingdom reported a large contraction in their holdings of euro area bonds (Graph 4, red bars) and a sizeable increase in their euro-denominated deposits (blue bars). The respective bond and deposit holdings of NBFIs in several other countries exhibited a broadly similar pattern, although the amounts involved were much smaller.¹⁶

The increase in euro-denominated deposits outside the euro area between end-2014 and end-2017 was substantial (Graph 5, left-hand panel). At approximately €190 billion, it amounted to almost 20% of the total volume of APP public sector securities sold by non-euro area investors. NBFIs accounted for the majority of the expansion in euro-denominated deposits. Most of those were placed in UK-resident banks.¹⁷

The substantial increase in the euro-denominated deposit liabilities of banks located outside the euro area was closely matched by a simultaneous, similarly sized expansion in their euro-denominated claims on related offices in the euro area (Graph 5, centre panel). The latter series grew by €236 billion between the start of 2015 and the end of 2017. The majority of the surge took place between Q2 2016 and Q1 2017, which was the period when the pace of purchases (€80 billion per month) was at its highest.

¹⁴ See Avdjiev et al (2015) for a detailed description of the enhanced LBS.

¹⁵ The category "Deposits" in the BIS LBS also includes repurchase agreements (repos).

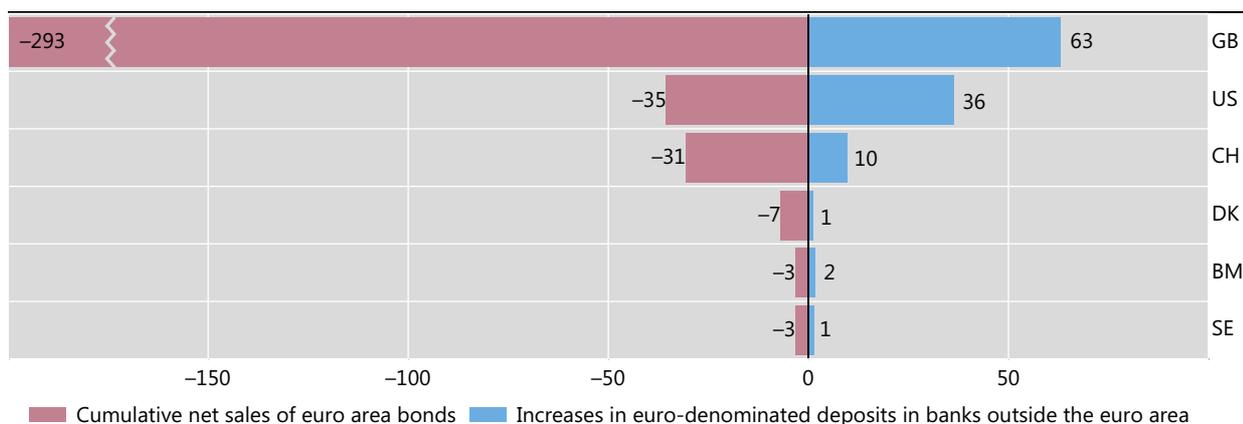
¹⁶ As noted above, the CPIS data allow us to track only the country of residence of the seller, thus ignoring the country of the ultimate investor. Hence, given the United Kingdom's role as an international financial centre, the CPIS numbers are likely to overstate the volumes of euro area bonds sold by UK-owned investors and understate the respective volumes for investors headquartered in other economies.

¹⁷ We end our empirical analysis based on the enhanced BIS LBS at end-2017 in order to match the last data point currently available in the CPIS data set.

Net sales of euro area bonds¹ and increases in euro-denominated deposits²

By residence of bond holder and depositor, in billions of euros, Q1 2015 to Q4 2017

Graph 4



The numbers in the graph are for bondholders and depositors from the non-bank financial institution (NBFI) sector, with the following exceptions: for Switzerland, bondholders (all sectors) and depositors (non-banks); for the United States, bondholders (NBFI subsector: "other"). For the exact sectoral definitions, see IMF (2017) and BIS (2013).

¹ Bonds (in all currencies) issued by borrowers (from all sectors) resident in the euro area. Negative figures indicate net sales. See online data files for treatment of missing/confidential bilateral observations. ² Changes in exchange rate- and break-adjusted stocks.

Sources: IMF, CPIS; BIS locational banking statistics; authors' calculations.

Banks located in the United Kingdom were the main drivers of the expansion in euro-denominated deposits between affiliated offices of the same banking organisation during the APP period (Graph 5, centre panel, red area). Roughly three quarters (or €176 billion) of the overall expansion was reported by banks located in the United Kingdom. This total also reflects the role played by banking groups headquartered outside the United Kingdom, underscoring the role of London as a global banking centre (McCauley et al (2017)). Within-group deposits from all other non-euro area jurisdictions followed a similar pattern (centre panel, blue area), but rose by a smaller amount (€60 billion). The latter comparison highlights the important role of the United Kingdom as a financial gateway to the euro area.

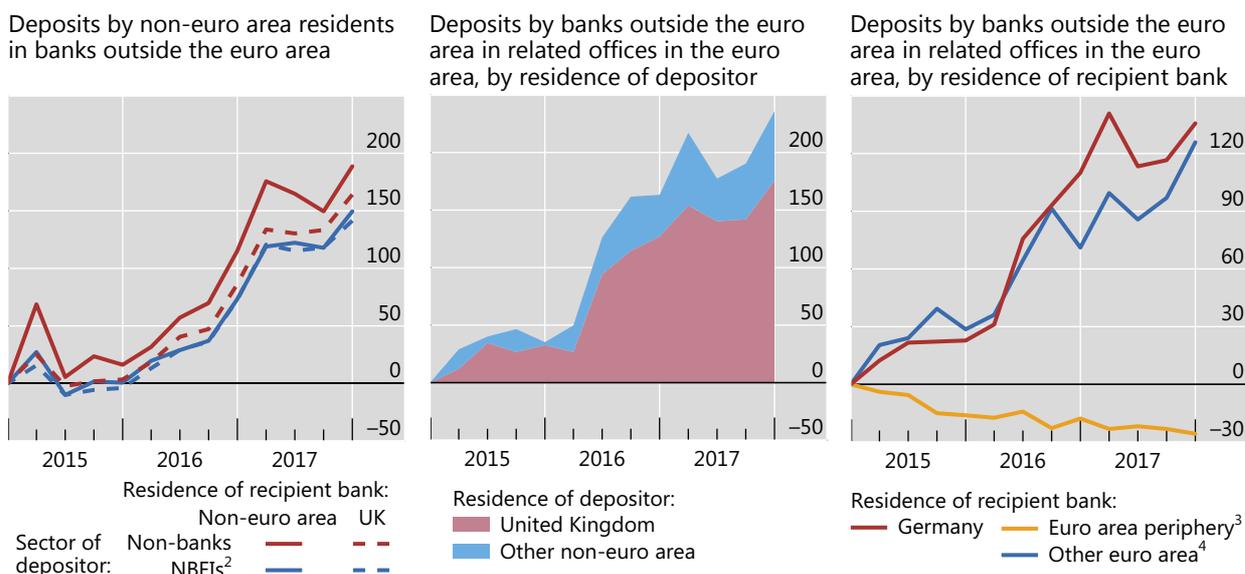
The main recipients of the APP-induced increase in euro-denominated deposits from outside the euro area were banks located in the traditional financial gateways inside the euro area. Banks in Germany alone received €136 billion of additional deposits from their related offices outside the euro area (Graph 5, right-hand panel). The corresponding increase for banks in other (non-periphery) euro area countries was €126 billion. By contrast, deposits into related offices in the euro area periphery countries (Cyprus, Greece, Ireland, Italy, Portugal and Spain) contracted by €26 billion.¹⁸

¹⁸ The combination of the fact that banks outside the euro area primarily selected their affiliates in core euro area countries to facilitate the APP sales and the fact that banks in the euro area tend to hold reserves at their respective national central banks contributed significantly to the widening of TARGET2 balances during the implementation of the APP; see Auer and Bogdanova (2017), ECB (2016) and Eisenschmidt et al (2017). The dynamics of this latest episode differed sharply from those of the earlier episode of widening TARGET2 balances, as described by Cecchetti et al (2012).

Euro-denominated deposits

Normalised outstanding stocks (end-2014 = 0),¹ in billions of euros

Graph 5



¹ Exchange rate- and break-adjusted stocks. ² Non-bank financial institutions. ³ Cyprus, Greece, Italy, Ireland, Portugal and Spain. ⁴ Austria, Belgium, Estonia, Finland, France, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Slovakia and Slovenia.

Source: BIS locational banking statistics.

Lessons learned and questions for further research

In this special feature, we have combined information from multiple sources in an attempt to trace the imprint left by the ECB's APP on international bond portfolios and euro-denominated deposits.

We find that NBFIs located in the United Kingdom and in other countries outside the euro area sold large volumes of euro area bonds during the ECB's APP. Given that the NBFIs could not engage directly with the Eurosystem due to the technical framework of the operations, the "sticky" portion of their APP proceeds left a trail in the global financial system in the form of a chain of euro-denominated deposits. The substantial rise in the NBFIs' euro-denominated deposits in banks outside the euro area was mirrored by contemporaneous expansions in those banks' deposits in their euro area affiliates as well as by corresponding increases in those affiliates' reserves at the Eurosystem. We argue that, taken together, the above pieces of empirical evidence suggest that non-euro area NBFIs kept a substantial fraction of their APP bond sale proceeds as euro-denominated deposits at banks outside the euro area.

Our study highlights the key role of the United Kingdom as a gateway to the euro area financial system for investors outside the euro area. During the APP period, NBFIs located in the United Kingdom were the most active non-resident sellers of euro area bonds and the main drivers of the increase in euro-denominated deposits. Moreover, banks in the United Kingdom acted as the main facilitators of the APP bond sales by non-euro area investors.

Our findings highlight possible channels through which unconventional monetary policy can have significant cross-border effects. In a complementary study

using micro data (Avdjiev et al (2019)), controlling for global factors and bank-specific characteristics, we provide additional empirical support for the effects of the ECB's APP on non-euro area-sourced deposits with euro area banks. Avdjiev et al (2019) also document how banks in the euro area that received the funds not only increased their excess reserves with the Eurosystem but also expanded their lending to borrowers outside the euro area. Continued monitoring of these cross-border positions and transactions would allow a better assessment of the possible economic impact of the completion of net asset purchases by the Eurosystem as of December 2018.

Our exploration of the international dimension of the ECB's APP also raises questions for further research on unconventional monetary policy measures. Understanding the mechanisms of unconventional monetary policy may provide insights as to how investors will react to its unwinding. Is it likely that, in contrast to more standard forms of stimulus, there will be asymmetry between the effects of the implementation and the unwinding of unconventional monetary policy? And, does the behaviour of global investors depend on the degree of divergence among the monetary policy stances of central banks in charge of major reserve currencies?

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The zero lower bound, forward guidance and how markets respond to news¹

Short-term market interest rates seem to have been less responsive to economic news in the post-crisis period. We evaluate two potential reasons: forward guidance and the constraint on monetary policy imposed by the zero lower bound (ZLB). We quantify how the ZLB has dampened market reactions to news in the United States, using estimates of the probability of hitting the ZLB derived from overnight index swap rates. For short maturities, variations in the ZLB's probability are sufficient to account for the fall in the sensitivity of market interest rates while the ZLB was binding. However, since it was precisely at the ZLB that forward guidance was most actively used, its role cannot be ruled out. But even after the policy rate rose, significantly reducing the ZLB's probability, the market's response to news continued to be more muted for shorter-maturity bonds and some risky assets. This suggests that other mechanisms also played a part, including forward guidance about gradual policy rate normalisation.

JEL classification: E52, E58.

Many central banks have used forward guidance in recent years to influence interest rate expectations, particularly when rates are at the effective or zero lower bound (ZLB) or close to it. Forward guidance is also seen as a useful tool for promoting a smooth adjustment when central banks are seeking to return policy rates to normal levels. Beyond clarifying the central bank's policy reaction function, forward guidance might cause market interest rates to be less sensitive to economic news if market participants take it as a firm commitment to follow a certain policy path.² But if rates are already at or close to zero, measuring this effect is a challenge: market interest rates could be less responsive to news simply because monetary policy is constrained by the ZLB (Swanson and Williams (2014a)).

In this special feature, we contribute to this debate in two ways. First, we show that short-term market interest rates have indeed become less sensitive to economic news since the Great Financial Crisis (GFC) in the euro area, the United Kingdom and the United States. We then quantify how the ZLB has affected market reactions to economic news in the United States, using estimated probabilities of hitting the ZLB

¹ We would like to thank Claudio Borio, Stijn Claessens, Benjamin Cohen, Ingo Fender, Gabriele Galati, Benoît Mojon, Hyun Song Shin and Christian Upper for useful comments and discussions. We would also like to thank Burcu Erik for excellent research assistance. The views expressed in this article are those of the authors and do not necessarily reflect those of the BIS.

² It is difficult to determine whether this reduced sensitivity is desirable from the policymaker's perspective, which ultimately depends on the underlying objective of forward guidance. We do not attempt any normative analysis in this article.

Key takeaways

- Both forward guidance and a binding zero lower bound (ZLB) can influence how markets incorporate economic news into asset prices.
- While the ZLB was binding, variations in the probability of hitting the ZLB can account for the decline in the sensitivity to news of short-maturity interest rates. The role of forward guidance in this period remains difficult to assess.
- After policy normalisation started in the United States, significantly reducing the ZLB's probability, the response to news of short-maturity yields and some risky asset prices remained attenuated, suggesting that forward guidance had some effect during this phase.

derived from overnight index swap rates. We find that, for short maturities, a 10 percentage point increase in the ZLB probability is associated with a reduction of around 10% in the responsiveness of market interest rates to economic news. Constructing a counterfactual where the effect of the ZLB is absent, we estimate that the responses of market interest rates to economic news at horizons two and four quarters ahead would mostly not have been significantly below their pre-crisis averages. While suggestive, this finding does not definitely rule out that forward guidance played a role, as it could still be correlated with the ZLB probability or even influence it.

Second, we focus on the latest policy tightening phase in the United States, which has involved forward guidance about gradual policy rate normalisation. Here, we find that forward guidance has affected the market's sensitivity to news of short-maturity US government bonds as well as of some risky assets. In particular, the reactions of bond yields to economic news during this period have been attenuated at shorter maturities (up to three years), but not at longer ones, as compared with the pre-crisis period. This raises two possibilities. Either forward guidance about gradual normalisation has had a larger impact than its ZLB-period counterpart, or the effect of forward guidance during the ZLB period was in fact material. To the extent that the 10-year interest rate has a prominent role in price discovery, our results suggest that forward guidance has not affected price discovery by market participants since the GFC.

The rest of the article is structured as follows. In the first section, we discuss forward guidance as a monetary policy tool at the ZLB and during policy normalisation. In the second, we quantify the effects of the ZLB on market reactions to economic news. In the third, we focus on the period after policy normalisation started, and investigate how forward guidance about gradual policy normalisation may have affected market reactions to economic news.

Forward guidance, the ZLB and financial conditions

Forward guidance and quantitative easing (large-scale asset purchases) are the two main unconventional monetary policy tools used to provide further monetary accommodation at the ZLB (Woodford (2012)). During the GFC, these tools were used together, and may have worked in complementary ways. For example, quantitative easing can convey information about the future path of the policy interest rate (the "signalling channel" of Bauer and Rudebusch (2014)), reinforcing the effect of forward

guidance. Coenen et al (2017) find that the credibility of forward guidance is strengthened if the central bank has also embarked on an asset purchase programme.³

Forward guidance can take different forms. It can be open-ended – for example, a central bank might announce that “Interest rates are expected to remain low for an extended period”. It can entail more concrete conditionality in terms of timing (date-dependent), eg “Interest rates are expected to remain at present levels at least through the summer of next year”; or in terms of economic developments (state-dependent), eg “Current policy is anticipated to be appropriate at least as long as the unemployment rate remains above 6.5%”. Forward guidance can be quantitative or qualitative, depending on whether it provides specific figures or not.

Whatever its form, forward guidance can influence public perceptions about the monetary policy reaction function and policy commitment, and thereby influence market prices and economic outcomes. The guidance could be more or less specific, but any perception that policymakers might renege on a prior commitment could undermine credibility. This is why flexibility, and hence conditionality, is an important part of any forward guidance. An unconditional commitment can tie a central bank’s hands too tightly. If economic conditions warrant a deviation by the central bank from the stated path, the resulting damage to the central bank’s credibility could hurt its effectiveness over the long term.

All forms of forward guidance thus face a trade-off between the strength of the statement and flexibility. Unequivocal statements, by specifying more restrictive conditionality (for example, a clear date or threshold when the policy rate will be changed), signal a stronger and clearer policy intention. Thus, date-dependent forward guidance is arguably more constraining than the state-dependent variety, especially if the latter has many qualifications attached.⁴ State-dependent guidance offers more flexibility to respond to changing economic conditions, but may have a weaker impact on expectations, especially if the criteria for policy moves are viewed as subjective or qualitative.

A key advantage of more restrictive conditionality is that it gives the central bank more influence over market prices. In some cases, a central bank may want markets to be less sensitive to economic developments – for example, during a period of heightened downside risks. During an easing phase, this can help a central bank maintain and strengthen the degree of policy accommodation. And in the early stages of normalisation, a more restrictive approach can help pin down market expectations, making for a more gradual adjustment in financial conditions. In this sense, some effect of forward guidance on market reactions to news may be intentional.

At the same time, restrictive conditionality could engender market complacency. Market participants may place too much confidence in previous guidance even as circumstances change, and take on greater risk based on the wrong assumptions. For central banks, this can make it harder to deviate from what they have previously

³ See Borio and Zabai (2018) for a review of existing evidence on various unconventional policy measures introduced post-GFC; and Moessler et al (2017) for a review of the theory and practice of forward guidance.

⁴ The Federal Open Market Committee (FOMC) has changed the nature of its forward guidance over time and as conditions have evolved. It deployed open-ended forward guidance starting in December 2008, subsequently shifting to date-dependent guidance and then to state-dependent forward guidance. Since December 2015, the FOMC has provided guidance that policy rate normalisation will be gradual.

announced for fear of creating market turbulence and damaging credibility. And the more central banks “whisper”, the more market participants may lean in to hear and react to even small shifts in nuance. When a change in the policy stance becomes inevitable, the market adjustment will then be all the more violent.^{5, 6}

These considerations suggest that one way of assessing market perceptions of the central bank’s commitment to its forward guidance is to look at market reactions to economic news (Moessner and Nelson (2008)). The stronger the perceived intention to adhere to a certain policy rate trajectory (more restrictive conditionality), the more muted the response of market prices to news.

Research findings on the relationship between forward guidance and market sensitivity to news have been mixed. There is some evidence that the pre-crisis forward guidance from the Federal Open Market Committee (FOMC) from late 2003 to end-2005 did not dampen market interest rate reactions to news (Moessner and Nelson (2008)). Bongard et al (2016) provide evidence that markets interpreted as conditional in nature the Fed’s forward guidance about policy rates and FOMC members’ Summary of Economic Projections (SEP) forecasts of the policy rate during the ZLB phase (from 2012 to 2015). There is also evidence from the cases of New Zealand and Sweden that market participants assign a degree of conditionality to their central banks’ forward guidance (Moessner and Nelson (2008), Detmers and Nautz (2012), Moessner et al (2016)).

Yet other studies, including those based on post-crisis experience, have tended to find that forward guidance has helped reduce market reactions to economic news. For the United States, Feroli et al (2016) find that date-dependent forward guidance has dampened the reaction of market interest rates to economic news. Coenen et al (2017) find different effects based on the nature of the guidance and the time horizon: long-horizon date-dependent forward guidance almost completely inhibited the market’s responsiveness to macroeconomic news; state-dependent forward guidance lowered it, but did not fully eliminate it; open-ended forward guidance had no effect on the responsiveness to news; and short-horizon time-dependent forward guidance in fact raised sensitivity to news.⁷

The findings of reduced sensitivity to news post-crisis could reflect expectations of unchanged policy due to a binding ZLB. The ZLB could subdue market reactions to news even without any perception of policy commitment (Williams (2016), Swanson and Williams (2014a,b)).⁸ Since the policy rate cannot fall below the ZLB, news that would ordinarily induce the central bank to ease could not be reflected in interest rates over relatively short maturities. And the further away the central bank is from tightening, the more muted the response would be along the curve. Thus, if markets are indeed generally less sensitive to economic news at the ZLB (or the effective lower

⁵ See Stein (2014) and Shin (2017).

⁶ Any discrepancy between central bank guidance and market expectations may simply be a reflection of market participants doing their own price discovery (eg on balance having a different macroeconomic outlook from the central bank’s). At the same time, a very prolonged and persistent gap may test the central bank’s credibility.

⁷ They consider periods when the policy rate was at or below 1% in Canada, the Czech Republic, Germany, Italy, Japan, Norway, Sweden, the United Kingdom and the United States.

⁸ Central banks can resort to unconventional monetary policy tools at the ZLB, eg quantitative easing, which may also affect the reaction of yields to news. This could explain evidence that longer-term market rates continue to respond to macroeconomic news at the ZLB even when short-term rates do not (Swanson and Williams (2014a)).

bound), this could make it more difficult to identify any distinct effects from forward guidance.⁹ In addition, forward guidance may be correlated with, or affect, the ZLB probability, further complicating the identification of any distinct effect of forward guidance.

Quantifying the effects of the ZLB on market reactions

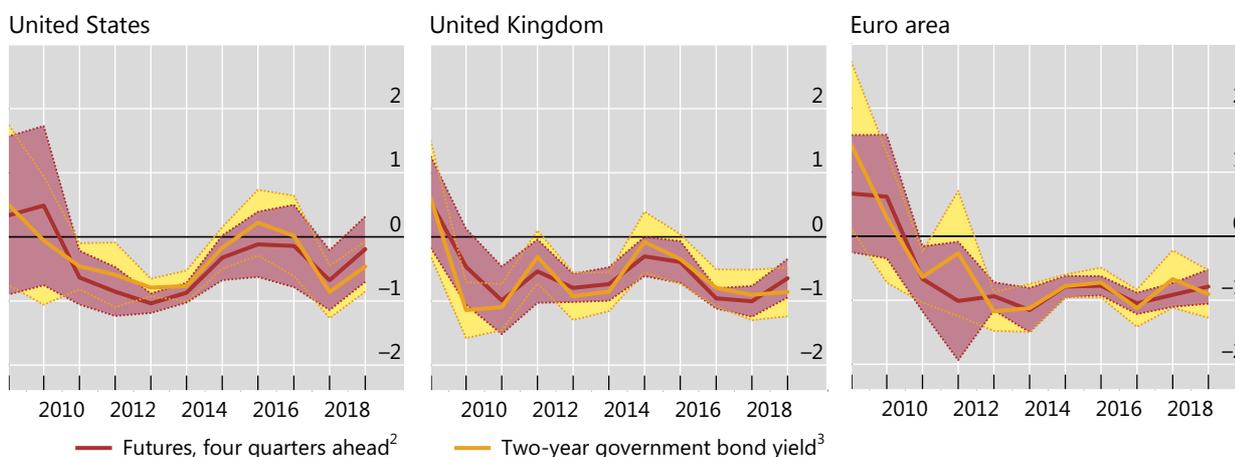
To understand the effects of the ZLB on market reactions to news, we directly estimate them. Our procedure, detailed in the box below, extends the analysis of Swanson and Williams (2014a), who compare market reactions during the ZLB era and previous periods. Specifically, we derive a measure of the market-implied probability of being at the ZLB based on the overnight index swap (OIS) market, and examine whether variations in this probability help explain changes in market reactions to economic news in the post-GFC period. The decision tree-based calculation of the ZLB probability, detailed in the box and its footnote 3, avoids several problems associated with parametric density estimation.

Our empirical model produces estimates for changes in market reactions to news, relative to the pre-GFC period (June 1998–December 2007), which provides the baseline for “normal” market reactions. These changes (the coefficients g_i in equation

Market reactions to economic news¹

Changes compared with pre-GFC reference period

Graph 1



The shaded areas indicate 95% confidence intervals.

¹ Changes compared with reference period June 1998–December 2007, estimated according to box equation (1). A vertical axis value of -0.1 (corresponding to the coefficient g_i in box equation (1)) implies a reduction in market reactions to economic news of 10% compared with the pre-GFC reference period. ² For the United States, eurodollar; for the United Kingdom, short sterling; for the euro area, Euribor. ³ For the euro area, German government bond yield.

Sources: Bloomberg; authors' calculations.

⁹ Swanson and Williams (2014a) document empirical findings consistent with these predictions. They also show analytically that the ZLB would weaken market interest rate reactions more at the short end of the curve, where the effect of a binding ZLB is stronger.

Estimating the impact of ZLB and forward guidance on market reactions to news

Quantifying the effect of the ZLB probability

The empirical procedure consists in a two-stage regression. In the first stage, we estimate the sensitivity of money market futures rates and government bond yields to economic news in each of the post-GFC years relative to the average sensitivity during the pre-GFC reference period of June 1998 to December 2007. Following Moessner and Nelson (2008), we estimate:

$$y_t^n - y_{t-1}^n = c + \sum_{i=1}^{11} (c_i dum_{2007+i}(t)) + \sum_{j=1}^M (b_j surprise_j(t)) + \left[\sum_{i=1}^{11} (g_i dum_{2007+i}(t)) \sum_{j=1}^M (b_j surprise_j(t)) \right] + \varepsilon_t \quad (1)$$

over a daily sample from 1 June 1998 to 17 December 2018, using non-linear least squares. Here, $y_t^n - y_{t-1}^n$ are daily changes in the market interest rate (we use two sets of interest rates: money market futures n quarters ahead, and government bond yields of a maturity of n years). $dum_{2007+i}(t)$ are yearly dummy variables, which are equal to one for every day in year $2007 + i$, and zero otherwise, for $i = 1, 2, \dots, 11$. The dummies thus cover the period when the ZLB was binding as well as thereafter. $surprise_j(t)$ is the actual data release of macroeconomic variable j minus its median survey expectation from Bloomberg, normalised by the standard deviation of the difference over the sample period.^① It is zero when t is not a data release date.

Under specification (1), b_j can be interpreted as the pre-GFC average market sensitivity to surprises in macroeconomic variable j , while $(1 + g_i)b_j$ is the sensitivity to the same variable in year $2007 + i$. For example, a coefficient $g_i = -0.1$ implies a reduction of 10% in market reactions to economic news in year $2007 + i$, as compared with the pre-GFC reference period.^② Estimates for g_i are shown in Graph 1, which shows the extent of the decline in market reactions to news in the pre-GFC period.

In the second stage, we quantify how the variations in g_i across years i can be explained by the evolution of the ZLB probability. We thus regress g_i on $prob_{ZLB1,i}$, where the latter is the probability of the US OIS rate being below 50 bp around nine months ahead, averaged over year $2007 + i$,

$$g_i = \alpha + \beta_i prob_{ZLB1,i} + \varepsilon_i \quad (2)$$

For robustness, we also consider an alternative measure, $prob_{ZLB2,i}$, the probability of the US OIS rate being below 25 bp around nine months ahead.

OIS-implied probabilities are obtained via rate decision tree calculations from Bloomberg based on OIS forward rates. At the end of each month, we aggregate the OIS-implied probabilities for the various rate levels below 50 bp (as well as 25 bp) at the FOMC meeting date around nine months ahead.^③ The nine-month horizon is the longest one available from Bloomberg data, and allows us to gauge the extent to which the ZLB is binding, even in the earlier phase of the crisis.

Table 1 shows the estimates for α and β_i in specification (2), which quantify the impact of the ZLB probability on market reactions to news. Graph 2 shows the result from a counterfactual exercise where the ZLB effect is turned off.

Market reactions to news in the post-liftoff period

In the second empirical exercise, we zoom in on the normalisation period following liftoff from the ZLB where the policy rate is no longer constrained by the ZLB, at least in the very short run. Any reduction in the sensitivity of market interest rates to news is thus far less likely to be due to the ZLB effect. One caveat is that the probability of the

ZLB binding again in future may still affect some segments of the market. As a robustness check, we also directly control for the previously used ZLB probability, which leads to results for the post-liftoff period that are very similar to the baseline specification below.

We again evaluate market reactions relative to the pre-GFC benchmark period. To make this comparison, we introduce a dummy to control for the intervening period of the binding ZLB, in addition to a dummy for the post-liftoff normalisation period. We consider US Treasury yields across the yield curve with maturities of one to 10 years, and estimate the following specification:

$$y_t^n - y_{t-1}^n = c + c_{>2015} dum_{>2015}(t) + c_{ZLB} dum_{ZLB}(t) + \sum_{j=1}^M (b_j surprise_j(t)) \\ + (g_{>2015} dum_{>2015}(t) + g_{ZLB} dum_{ZLB}(t)) \sum_{j=1}^M (b_j surprise_j(t)) + \varepsilon_t \quad (3)$$

for a sample period of 1 June 1998 to 17 December 2018, using non-linear least squares. Here, $y_t^n - y_{t-1}^n$ are daily changes in US Treasury yields of a maturity of n years, $dum_{>2015}(t)$ equals 1 during the recent US tightening episode from 16 December 2015 following liftoff from the ZLB, and $dum_{ZLB}(t)$ equals 1 during the binding ZLB period of 16 December 2008 to 15 December 2015, and zero otherwise. $surprise_j(t)$ are normalised economic surprises in 10 US macroeconomic variables, as above.

Estimates for g_{ZLB} and $g_{>2015}$ are plotted in Graph 3, which compares market reactions to news during the binding ZLB period and during the latest policy normalisation period with those during the pre-GFC reference period. A coefficient $g_{>2015}$ of -0.1 implies a reduction in market reactions to economic news of 10% in the recent US tightening episode, as compared with the pre-GFC reference period. Similarly, a coefficient g_{ZLB} of -0.1 implies a reduction of 10% in market reactions to economic news in the ZLB period, as compared with the pre-GFC reference period.

① The number of macroeconomic variables M is 10 for the United States (US non-farm payrolls, the ISM manufacturing index, the unemployment rate, retail sales, industrial production, housing starts, CPI inflation, hourly earnings, the trade balance and the advance GDP estimate). For the United Kingdom, we expand the set to include surprises in 10 additional UK macroeconomic variables (UK RPIX inflation, average earnings, the unemployment rate, retail sales, industrial production, producer price inflation, GDP, current account balance, trade balance and public sector borrowing requirement); and for the euro area, we use an additional four (euro area CPI inflation, the euro area unemployment rate, the Ifo German business climate index and German CPI inflation). ② Swanson and Williams (2014a) find that the sensitivity of US Treasury yields to positive and negative economic news fell by about the same amount at the ZLB. Intuitively, when the equilibrium interest rate is far below zero, short-term yields do not respond to small positive or negative shocks. Moreover, the response of longer-term yields is also symmetrical, partly since expected future short-term rates respond symmetrically to positive and negative shocks in periods when the ZLB is not binding. ③ Calculations involve an interpolation of the OIS curve, which is then used to extract forward rates between any adjacent FOMC decision dates. These forward rates are used to infer the implied probability distribution of the OIS rate at each decision meeting, based on a binomial tree structure, as follows. For each meeting, two possible outcomes are assumed. For the nearest meeting, the first forward rate is bracketed by the two possible rate levels, whose probability-weighted average is equated to the forward rate. For the next meeting, four possible rates are considered and so on. For further details, see the Bloomberg Function XLTP XOIP. These ZLB probability estimates are available only from May 2002. Between May 2002 and end-2007, they were below 0.05 and 0.005 for $prob_{ZLB1,i}$ and $prob_{ZLB2,i}$ respectively.

(1) in the box) are shown in Graph 1 for the United States, the United Kingdom and the euro area, where a value of -0.1 implies a reduction of 10% in market reactions to news, as compared with the average during the pre-GFC reference period.

Interestingly, market reactions to macroeconomic news in both the United Kingdom and the euro area had already decreased significantly by 2012, when the ZLB was binding in those economies. Since forward guidance in these two economies

Effect of ZLB probabilities on market reactions to news

Dependent variable: changes in reactions to economic news compared with pre-GFC reference period for n -quarters-ahead eurodollar futures¹

Table 1

	n -quarters-ahead					
	2	2	4	4	8	8
Constant	0.125	-0.035	-0.016	-0.012	0.175	0.276
$prob_{ZLB1}^2$	-1.116**		-0.695*		-0.185	
$prob_{ZLB2}^3$		-1.310***		-1.023***		-0.585

*/**/** indicates statistical significance at the 10/5/1% level. White heteroscedasticity-consistent standard errors.

¹ Changes compared with reference period June 1998–December 2007; annual estimate according to equation (1). ² Probability of US OIS rates below 50 bp around nine months ahead; annual average of end-month data. ³ Probability of OIS rates below 25 bp around nine months ahead; annual average of end-month data.

Sources: Bloomberg; authors' calculations.

was introduced only later, in 2013, the result suggests that other factors – such as the ZLB itself – may have been at work in subduing the market's sensitivity to news.¹⁰

The estimated impact of ZLB probabilities in the United States on the market's reaction to news is significant (Table 1). For short horizons (two and four quarters ahead), a 10 percentage point increase in the ZLB probability nine months ahead is associated with a reduction of 7–13% in the responsiveness of market interest rates to economic news. For a longer horizon (eight quarters ahead), the ZLB probability has no significant effect.

We construct a counterfactual news sensitivity measure for US interest rates using these estimates (Graph 2). In the absence of the ZLB effect, the response of short-dated interest rates to economic news would have been very similar to the pre-GFC historical average. Indeed, when one takes account of estimation uncertainty, the difference between the post- and pre-GFC sensitivity to news is largely statistically insignificant.

While these results, taken at face value, point to the ZLB's importance in explaining the reduced market reaction to news, they do not conclusively rule out that forward guidance played a role. To begin with, the use of forward guidance is likely to be correlated with the ZLB probability, as it was precisely when conventional policy was constrained by the ZLB that such guidance was used. Moreover, forward guidance about the need for an extended accommodation could endogenously increase the ZLB probability. These positive interactions complicate the identification problem; and indeed, the empirical analysis here is not designed to disentangle the ZLB and forward guidance effects. Thus, the finding is only suggestive. However, the recent normalisation period provides an opportunity to gauge the impact of forward guidance that has been largely free from the ZLB influence. The next section turns to this assessment.

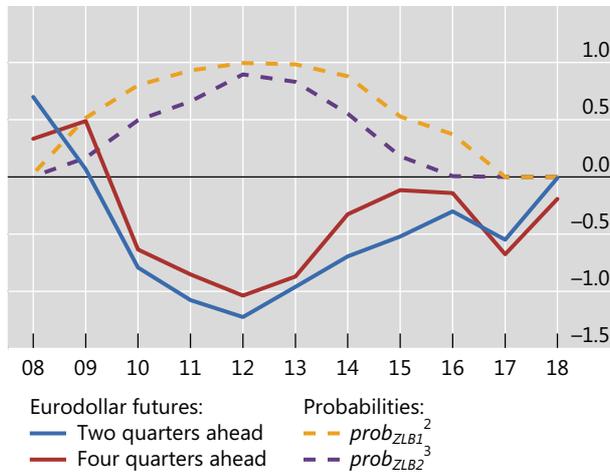
¹⁰ Williams (2016) makes a similar observation.

Market reactions to economic news and ZLB probabilities in the United States

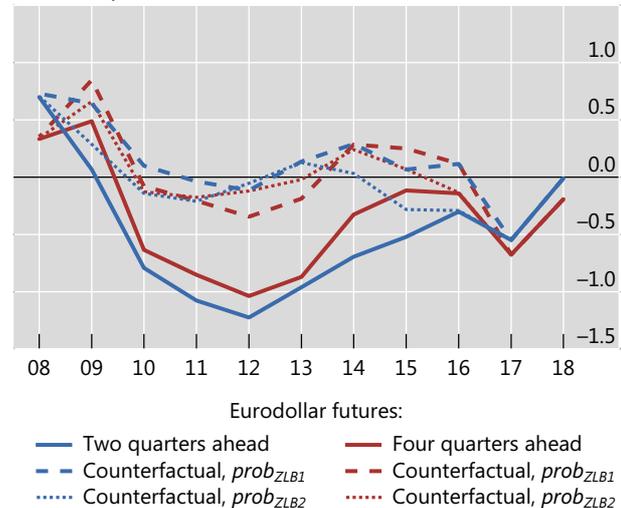
Changes in market reactions compared with pre-GFC reference period¹

Graph 2

Market reactions to news and ZLB probabilities



Market reactions to news and counterfactual assuming zero ZLB probabilities⁴



¹ Reactions to economic news refer to changes compared with reference period June 1998–December 2007, estimated according to box equation (1). A coefficient of -0.1 implies a reduction in market reactions to economic news of 10% compared with the reference period. ZLB probabilities refer to probabilities of OIS rates below 25 bp or 50 bp around nine months ahead. ² Probabilities of OIS rates below 50 bp around nine months ahead. ³ Probabilities of OIS rates below 25 bp around nine months ahead. ⁴ Counterfactuals (shown by dashed and dotted lines) are constructed by setting ZLB probabilities to zero in the two-stage regressions (box equations (1) and (2)).

Sources: Bloomberg; authors' calculations.

Effects of forward guidance during policy normalisation

The recent phase of policy normalisation in the United States, which started in December 2015, was accompanied by forward guidance emphasising the gradual nature of policy adjustments. This was intended to foster a smooth tightening in financial conditions. We now investigate whether market interest rate reactions to economic news were weaker during this episode. The reference period for comparison is, as before, the pre-crisis period, although for this analysis the reference period extends to December 2008 in order to draw a sharper contrast between the time when the ZLB was binding and when it was not. In this exercise, any dampening effect from the ZLB is largely absent, given that the policy rate had already started to rise above zero.¹¹

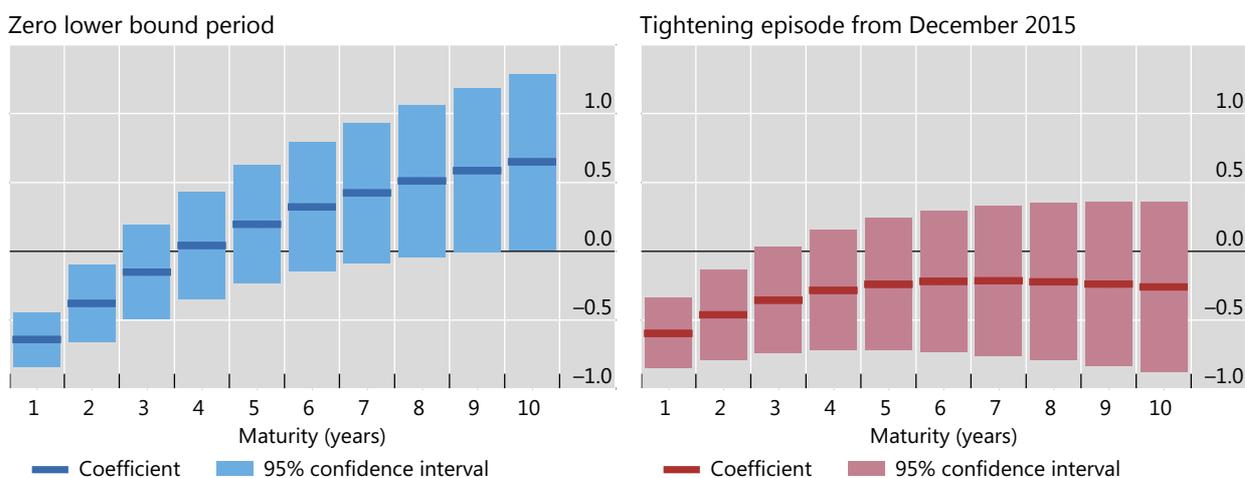
We find that forward guidance about policy normalisation has significantly dampened the sensitivity to economic news of short-maturity US government bonds. This is shown in Graph 3, which plots changes in market reactions to news during the ZLB period and the normalisation episode, relative to the pre-crisis average reaction. As before, -0.1 implies a 10% weakening in market sensitivity to news compared with the reference period. During the ZLB period, the reactions of US Treasury yields to economic news were significantly reduced at shorter maturities, but not at longer

¹¹ The findings remain largely the same if one controls for the ZLB probability nine months ahead, as in the previous section (the probability, albeit small, was still positive early in the normalisation episode; see Graph 2, left-hand panel).

Reactions of US Treasury yields to macroeconomic news

Changes in market reactions compared with the pre-crisis reference period¹

Graph 3



¹ A coefficient of -0.1 implies a reduction of 10% in market reactions to economic news, as compared with the pre-crisis reference period of 1 June 1998–15 December 2008 (this choice of reference period, slightly different from the previous one, draws a sharper contrast between the period when the ZLB was binding and when it was not). Tightening episode: from 16 December 2015; zero lower bound period: 16 December 2008–15 December 2015. Estimated according to box equation (3).

Sources: Bloomberg; authors' calculations.

maturities (left-hand panel), consistent with the previous results. After the Fed started to raise policy rates, US government bond yields at longer maturities reacted to economic news no differently than they did during the reference period, but sensitivity is dampened for Treasuries with maturities of one to two years (right-hand panel).¹² To the extent that the 10-year interest rate has a prominent role in price discovery, our results suggest that forward guidance has not affected price discovery by market participants after the GFC.

However, some risk spreads have become less sensitive to news since December 2015. Applying the same methodology to a variety of risk measures, credit spreads and equity indices, we find evidence of a reduction in the sensitivity of some US and euro area risk measures to economic news in the recent US tightening episode (Table 2). This might reflect a broad increase in risk-taking. At the same time, the evidence does not yet give a definite answer as to which risk spectrum is likely to be more affected. More research is still needed to ascertain how forward guidance affects different classes of financial market risk.

¹² Further analysis shows that the term premium component of long-term yields (with maturities of two years or higher), the part that reflects the risk appetite of investors, has not become less sensitive to news since the liftoff from the ZLB. The term premia are calculated based on Adrian et al (2013). The results are available from the authors on request.

Reactions of equity prices and risk measures to macroeconomic news

Changes relative to those during the pre-crisis reference period¹

Table 2

	Dow Jones	S&P 500	VIX ²	MOVE ³	US HY ⁴	US IG ⁴	US Aaa ⁵	US Baa ⁵	US ERP ⁶	EA HY ⁴	EA IG ⁴	DE ERP ⁶
<i>g</i> _{>2015}	2.20	16.52	-3.16*	-0.97**	0.25	-0.85***	-0.43	-0.64***	-0.24	-0.96***	-0.78**	-0.01
<i>g</i> _{ZLB}	6.10	42.69	1.28	1.76	0.21	-0.92***	-0.91***	-0.79***	1.02*	-0.54***	-0.29	1.43

*/**/*** indicates statistical significance at the 10/5/1% level. Newey-West adjusted standard errors.

¹ Tightening episode: from 16 December 2015; zero lower bound period: 16 December 2008–15 December 2015; pre-crisis reference period: 1 June 1998–15 December 2008. Regression of daily changes in equities (in %) and in risk measures (in bp) on surprises in 10 US macroeconomic variables; on the surprises interacted with the dummy variables; on dummy variables; and on a constant. For the euro area, surprises in additional four euro area macroeconomic variables are included. Estimated according to box equation (3). Coefficients on surprises in macroeconomic surprises, on dummy variables and on constant not shown. ² Chicago Board Options Exchange S&P 500 implied volatility index. ³ Merrill Lynch Option Volatility Estimate. ⁴ ICE BofAML option-adjusted spreads for investment grade (IG) and high-yield (HY) corporate bonds. ⁵ Moody's seasoned Aaa/Baa corporate bond yield relative to yield on 10-year Treasury constant maturity. ⁶ Equity risk premium = [100 * (1 / price/earnings ratio of equities)] – 10-year bond yields.

Sources: Bloomberg; Datastream; ICE BofAML indices; authors' calculations.

Conclusion

We find that the ZLB helped dampen the response of short-term market interest rates to news after the GFC. These results support the conclusions of Swanson and Williams (2014a) and Williams (2016). For short maturities, a 10 percentage point increase in the ZLB probability was associated with a reduction of around 10% in the responsiveness of market interest rates to economic news. When we construct a counterfactual that corrects for the effect of the ZLB, we find that, in the absence of this effect, market reactions to economic news at horizons of two and four quarters ahead would mostly not have been significantly below their pre-crisis average.

Studying the recent episode of US policy normalisation allows us to isolate the effect of forward guidance on these market reactions, since the effect of the ZLB is largely absent. We find that bond yield reactions to news have been weakened at shorter maturities of up to three years, but not at longer maturities. It thus appears that forward guidance has affected market reactions to news in the US government bond market at short maturities during the recent tightening episode, but not at longer maturities. To the extent that the 10-year interest rate has a prominent role in price discovery, our results suggest that forward guidance has not affected price discovery by market participants since the GFC.

Taken at face value, these findings seem to suggest that the effect of forward guidance on market reactions to news has become more discernible in the recent normalisation period. One possible explanation is that forward guidance about gradual policy normalisation may have been associated with a stronger perception of policy commitment, given that central banks may use such guidance to prevent yields from overshooting. Alternatively, the ZLB and forward guidance effects may both have dampened the market's sensitivity to news during the ZLB period. Disentangling these effects is a challenge, especially since the two may be correlated and forward guidance may affect the ZLB probability. Nevertheless, this would be a fruitful topic for future research.

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Annexes

BIS Statistics: Charts

The statistics published by the BIS are a unique source of information about the structure of and activity in the global financial system. BIS statistics are presented in graphical form in this annex and in tabular form in the *BIS Statistical Bulletin*, which is published concurrently with the *BIS Quarterly Review*. For introductions to the BIS statistics and a glossary of terms used in this annex, see the *BIS Statistical Bulletin*.

The data shown in the charts in this annex can be downloaded from the *BIS Quarterly Review* page on the BIS website (www.bis.org/publ/quarterly.htm). Data may have been revised or updated subsequent to the publication of this annex. For the latest data and to download additional data, see the statistics pages on the BIS website (www.bis.org/statistics/index.htm). A release calendar provides advance notice of publication dates (www.bis.org/statistics/relcal.htm).

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A Locational banking statistics

Cross-border claims, by sector, currency and instrument

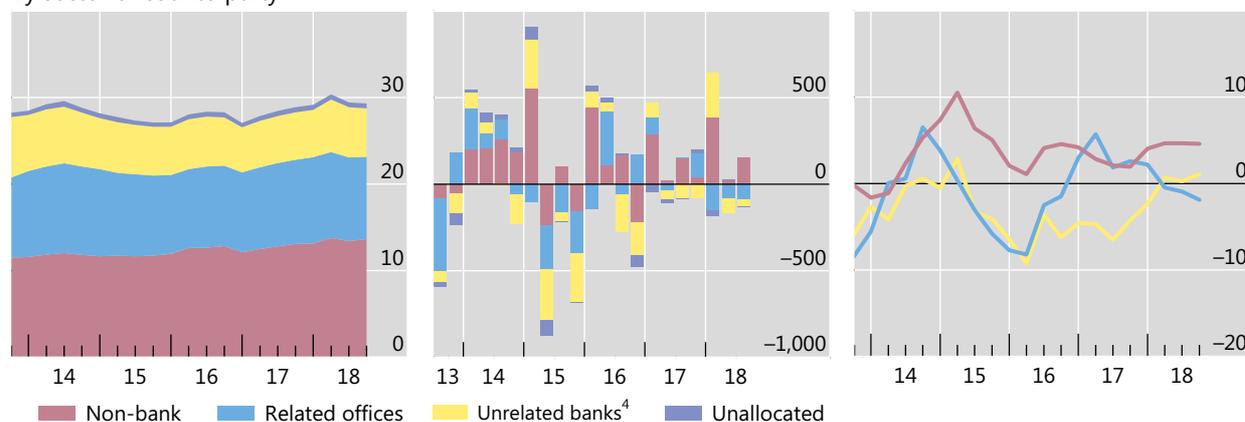
Graph A.1

Amounts outstanding, in USD trn¹

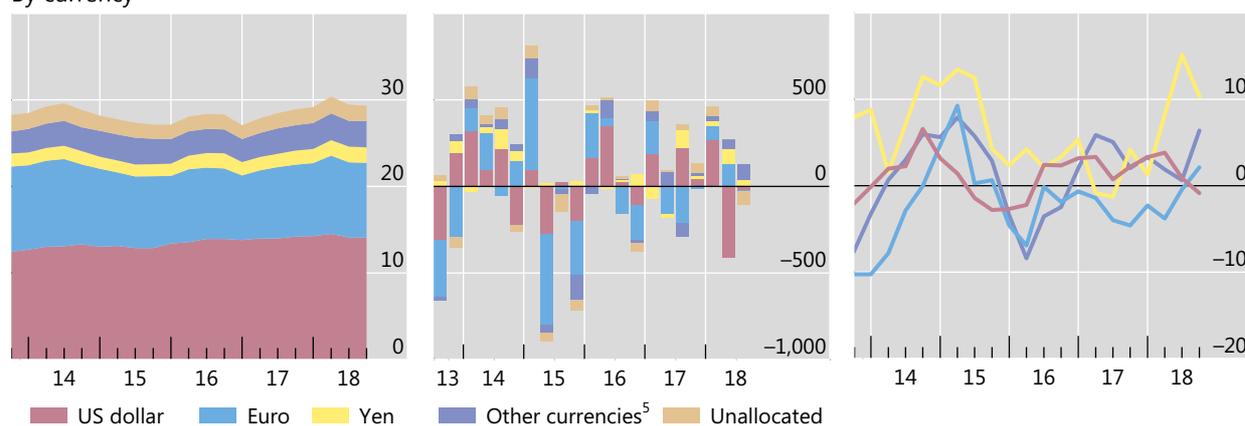
Adjusted changes, in USD bn²

Annual change, in per cent³

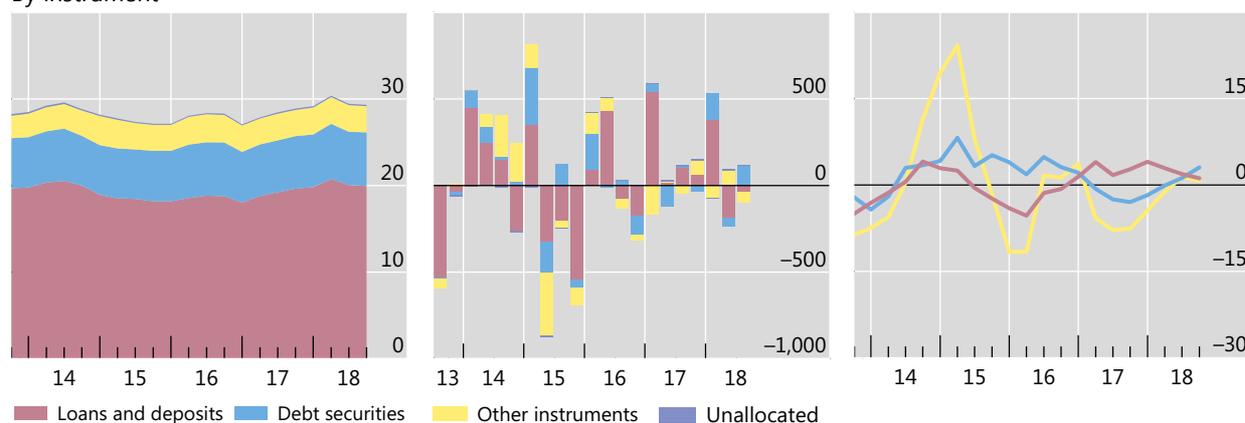
By sector of counterparty



By currency



By instrument



Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly changes in amounts outstanding, adjusted for the impact of exchange rate movements between quarter-ends and methodological breaks in the data. ³ Geometric mean of quarterly percentage adjusted changes. ⁴ Includes central banks and banks unallocated by subsector between intragroup and unrelated banks. ⁵ Other reported currencies, calculated as all currencies minus US dollar, euro, yen and unallocated currencies. The currency is known but reporting is incomplete.

Source: BIS locational banking statistics.

Cross-border claims, by borrowing region

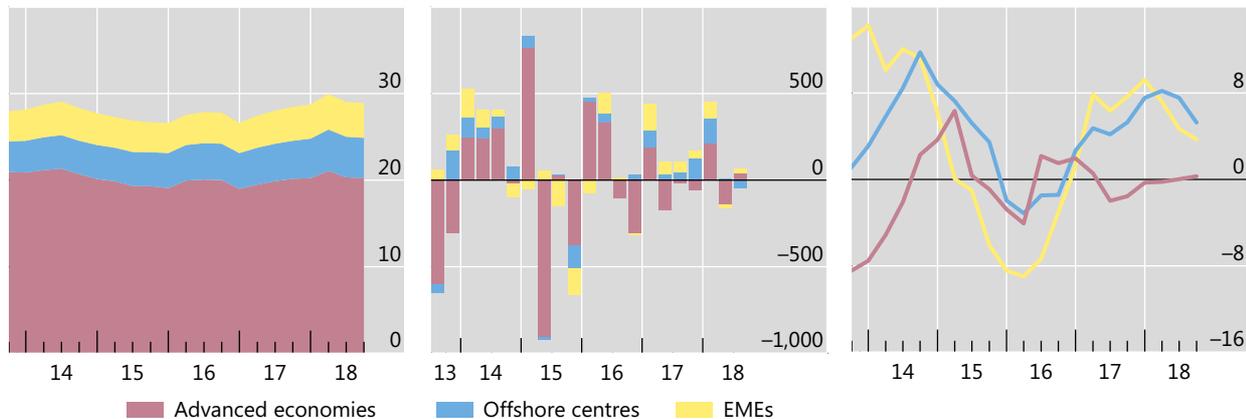
Graph A.2

Amounts outstanding, in USD trn¹

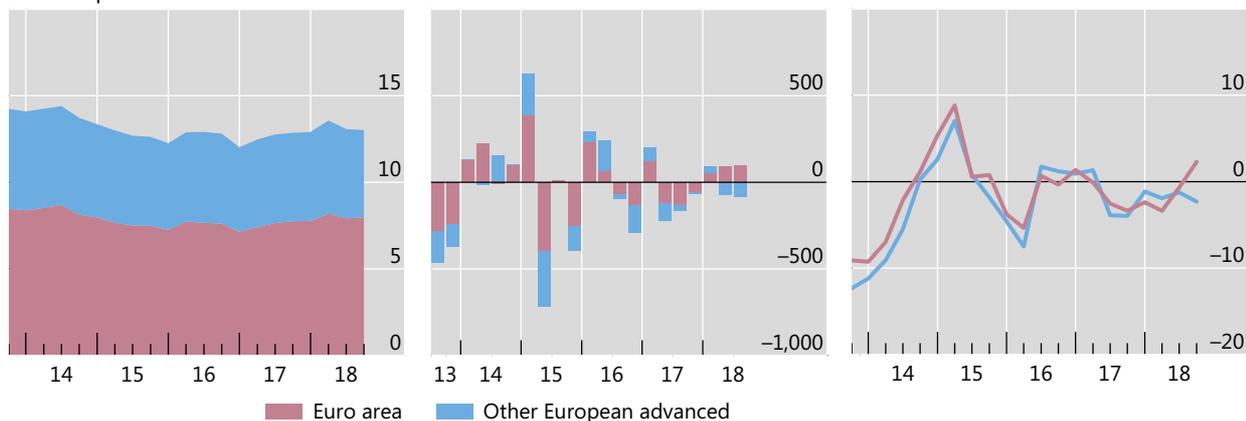
Adjusted changes, in USD bn²

Annual change, in per cent³

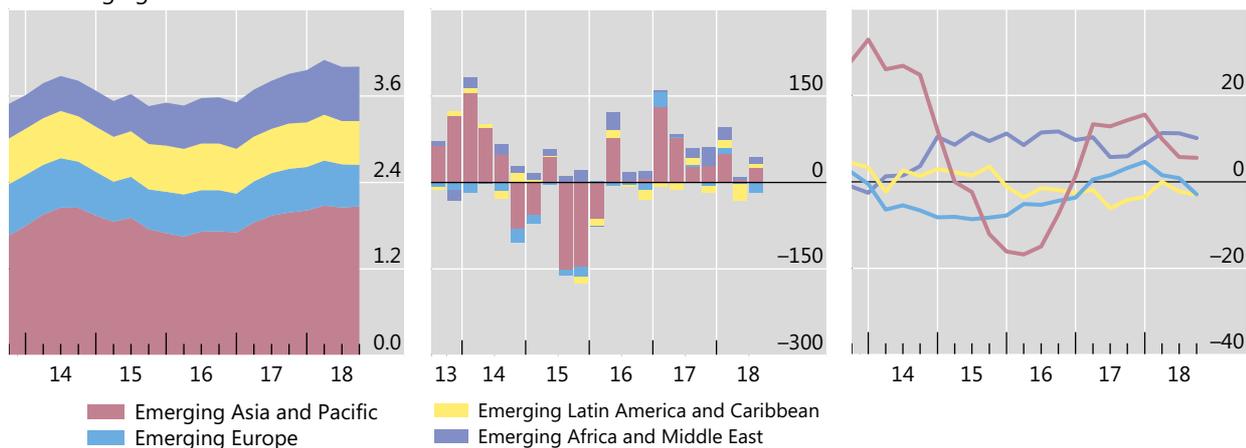
On all countries



On Europe



On emerging market economies



Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly changes in amounts outstanding, adjusted for the impact of exchange rate movements between quarter-ends and methodological breaks in the data. ³ Geometric mean of quarterly percentage adjusted changes.

Source: BIS locational banking statistics.

Cross-border claims, by borrowing country

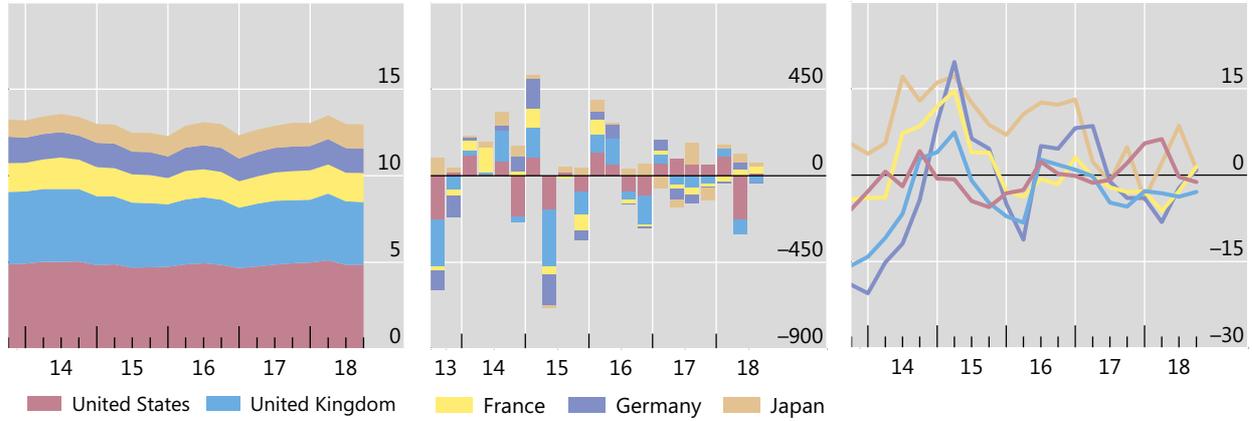
Graph A.3

Amounts outstanding, in USD trn¹

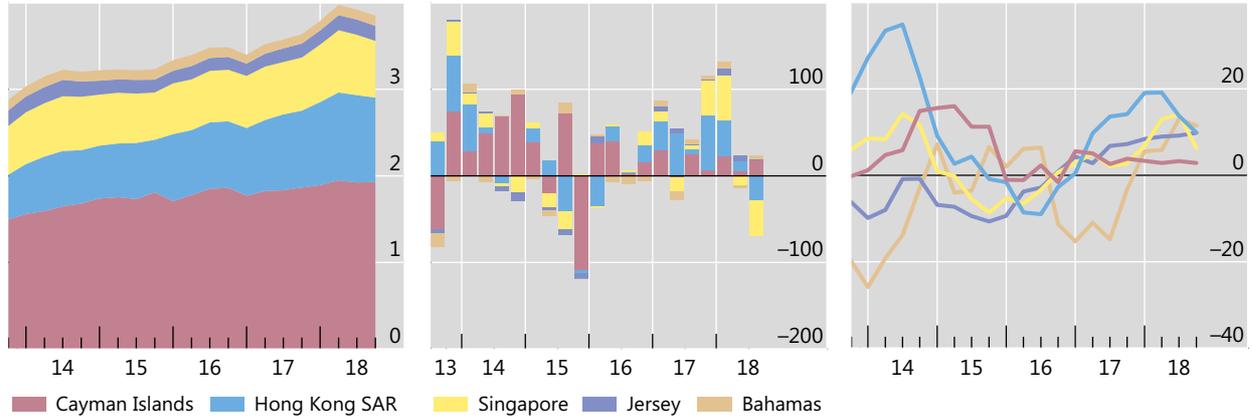
Adjusted changes, in USD bn²

Annual change, in per cent³

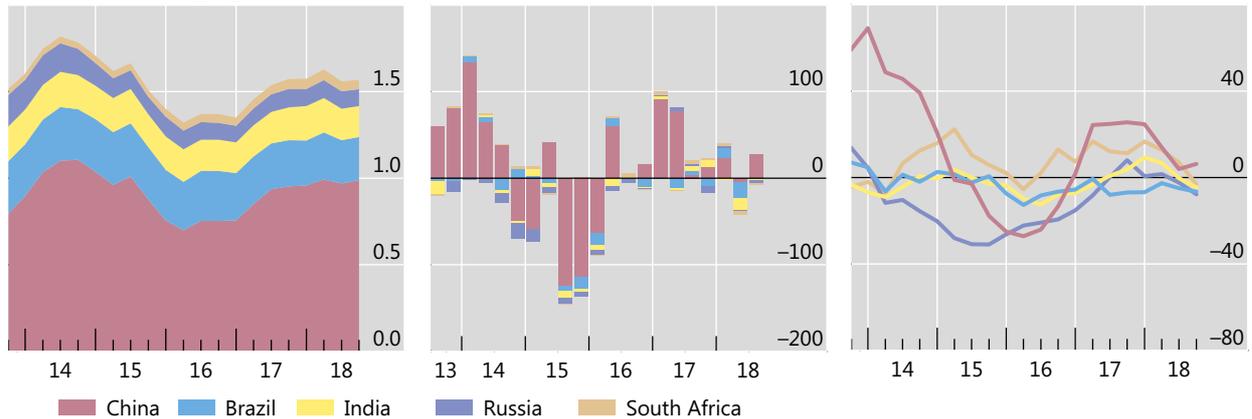
On selected advanced economies



On selected offshore centres



On selected emerging market economies

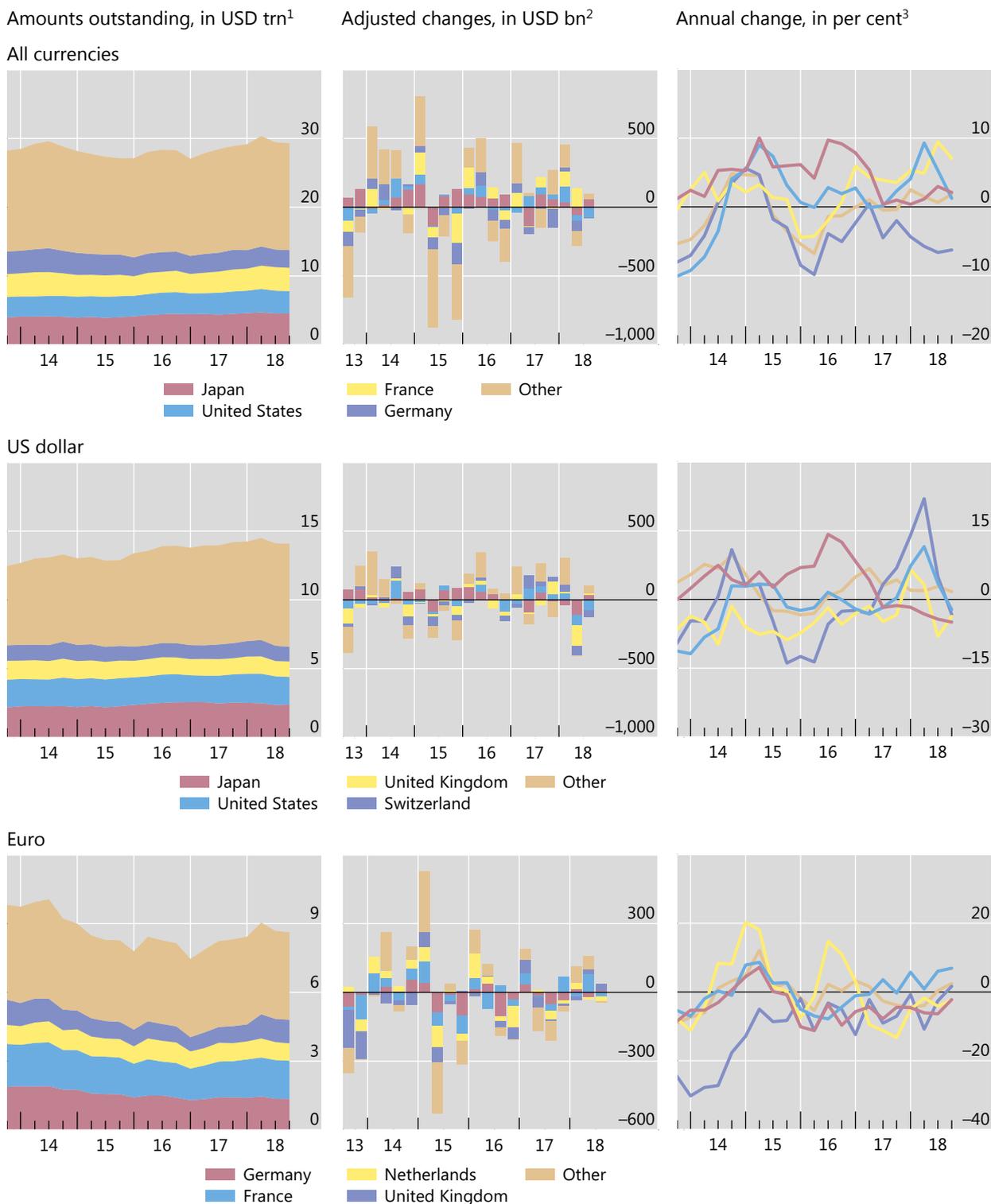


Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly changes in amounts outstanding, adjusted for the impact of exchange rate movements between quarter-ends and methodological breaks in the data. ³ Geometric mean of quarterly percentage adjusted changes.

Source: BIS locational banking statistics.

Cross-border claims, by nationality of reporting bank and currency of denomination Graph A.4



Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly changes in amounts outstanding, adjusted for the impact of exchange rate movements between quarter-ends and methodological breaks in the data. ³ Geometric mean of quarterly percentage adjusted changes.

Source: BIS locational banking statistics.

Cross-border liabilities of reporting banks

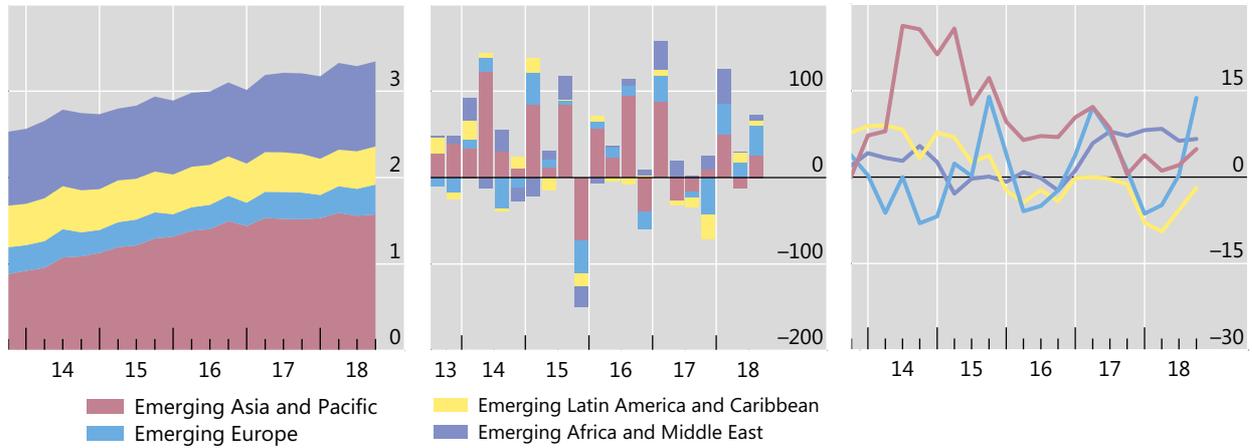
Graph A.5

Amounts outstanding, in USD trn¹

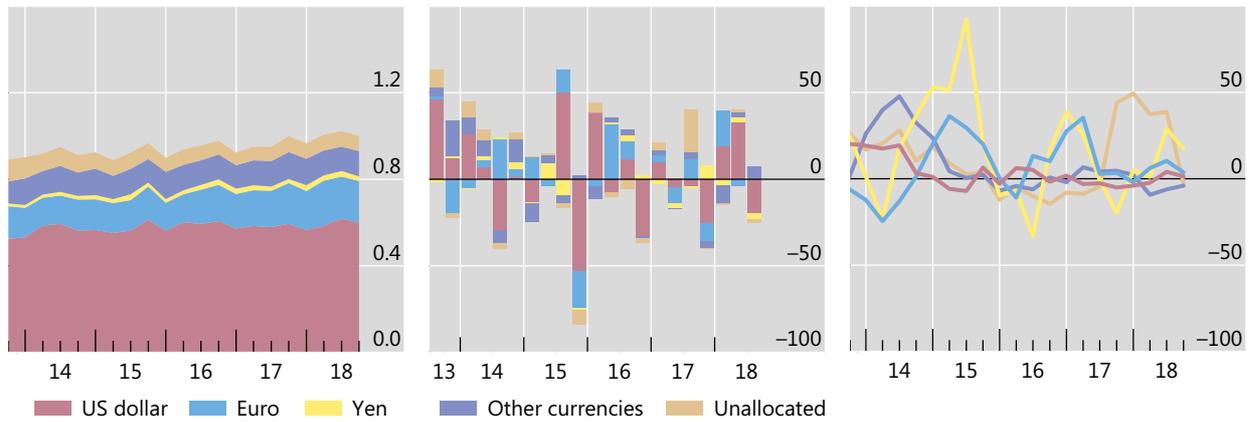
Adjusted changes, in USD bn²

Annual change, in per cent³

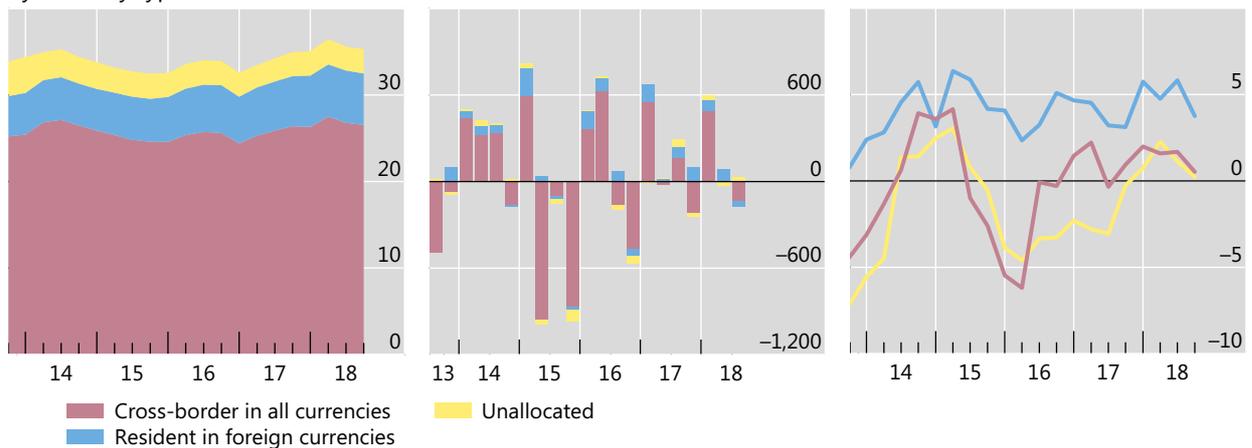
To emerging market economies



To central banks



By currency type and location



Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly changes in amounts outstanding, adjusted for the impact of exchange rate movements between quarter-ends and methodological breaks in the data. ³ Geometric mean of quarterly percentage adjusted changes.

Source: BIS locational banking statistics.

B Consolidated banking statistics

Consolidated claims of reporting banks on advanced economies

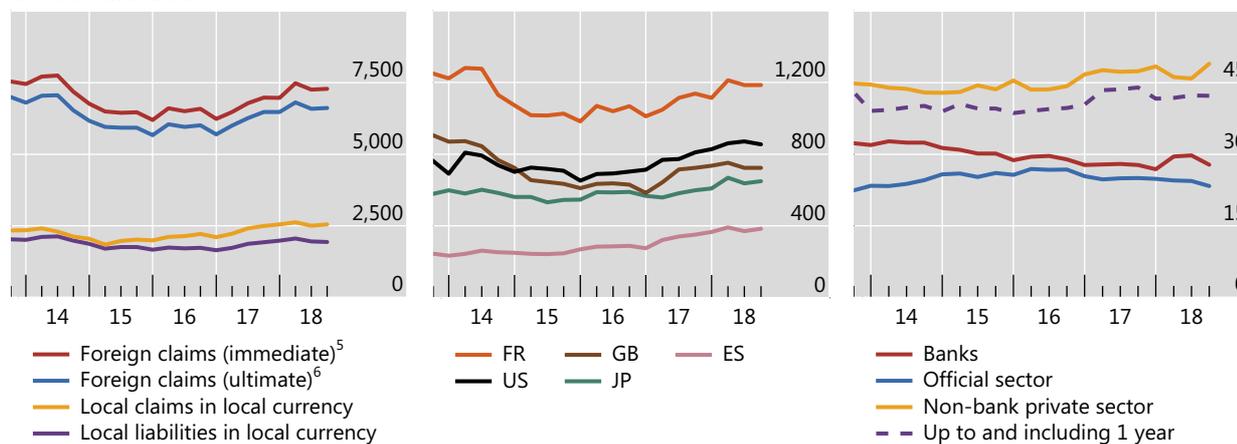
Graph B.1

Foreign claims and local positions, in USD bn^{1,2}

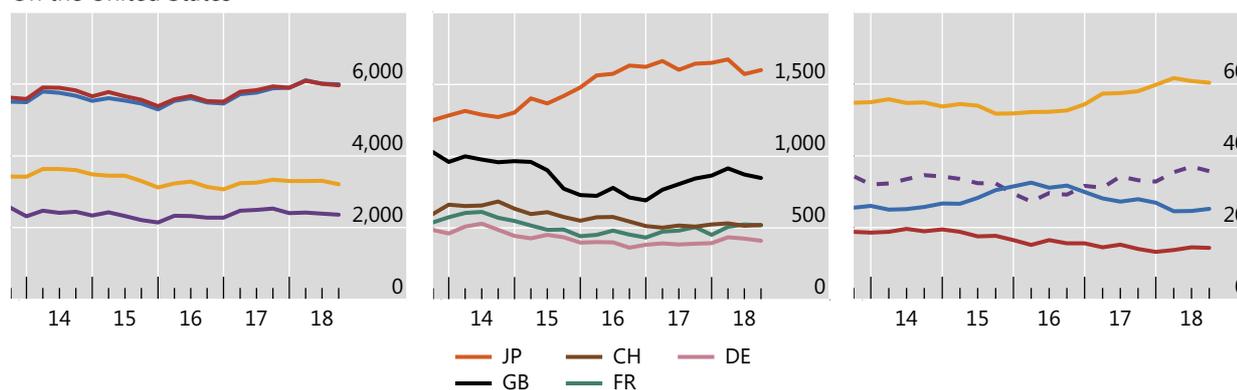
Foreign claims of selected creditors, in USD bn^{1,3}

International claims, by sector and maturity, in per cent⁴

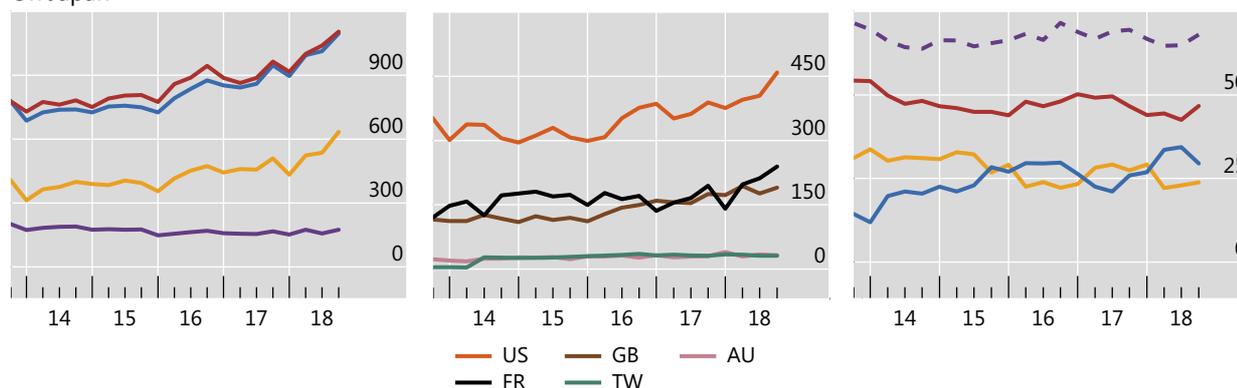
On the euro area



On the United States



On Japan



Further information on the BIS consolidated banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ Amounts outstanding at quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Excludes domestic claims, ie claims on residents of a bank's home country. ³ Foreign claims on an ultimate risk basis, by nationality of reporting bank. The banking systems shown are not necessarily the largest foreign bank creditors on each reference date. ⁴ As a percentage of international claims outstanding. ⁵ On an immediate counterparty basis. Includes the unconsolidated claims of banks headquartered outside but located inside CBS-reporting countries. ⁶ On an ultimate risk basis.

Source: BIS consolidated banking statistics (CBS).

Consolidated claims of reporting banks on emerging market economies

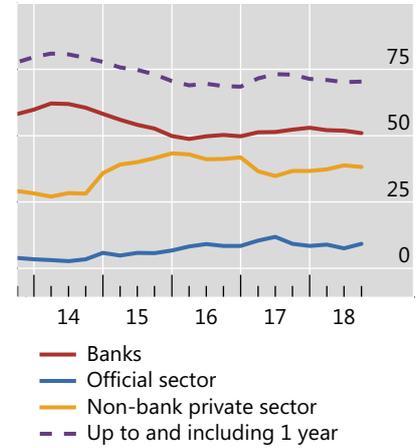
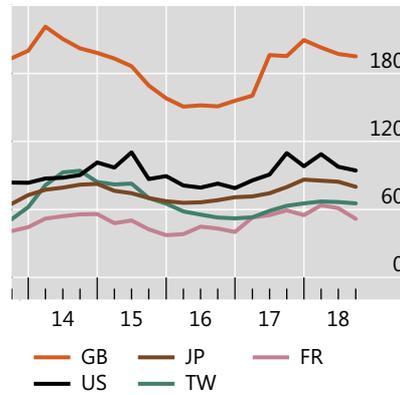
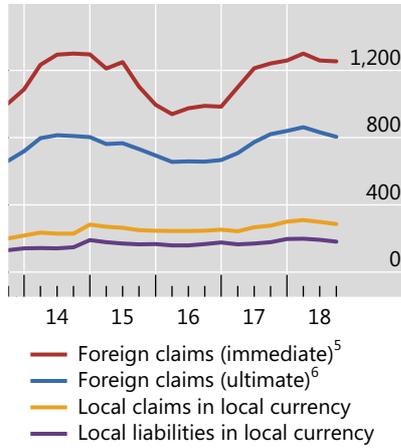
Graph B.2

Foreign claims and local positions, in USD bn^{1,2}

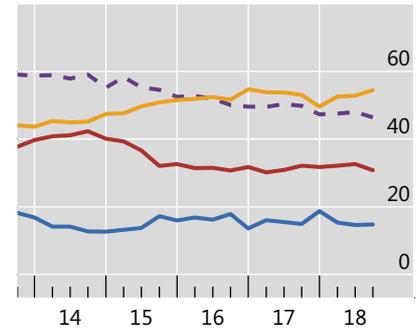
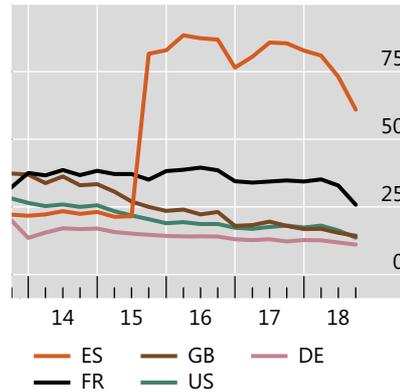
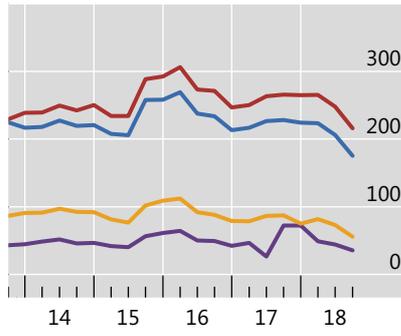
Foreign claims of selected creditors, in USD bn^{1,3}

International claims, by sector and maturity, in per cent⁴

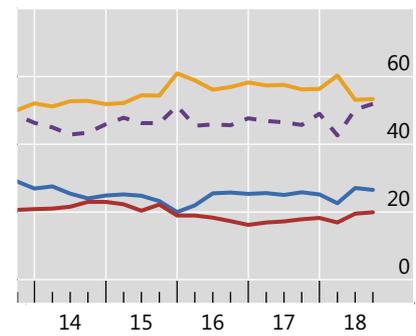
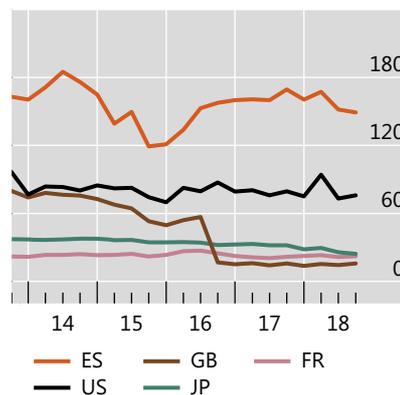
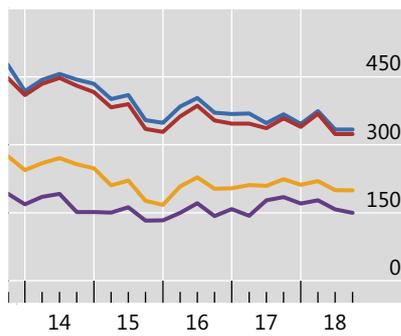
On China



On Turkey



On Brazil



Further information on the BIS consolidated banking statistics is available at www.bis.org/statistics/bankstats.htm.

¹ Amounts outstanding at quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Excludes domestic claims, ie claims on residents of a bank's home country. ³ Foreign claims on an ultimate risk basis, by nationality of reporting bank. The banking systems shown are not necessarily the largest foreign bank creditors on each reference date. ⁴ As a percentage of international claims. ⁵ On an immediate counterparty basis. Includes the unconsolidated claims of banks headquartered outside but located inside CBS-reporting countries. ⁶ On an ultimate risk basis.

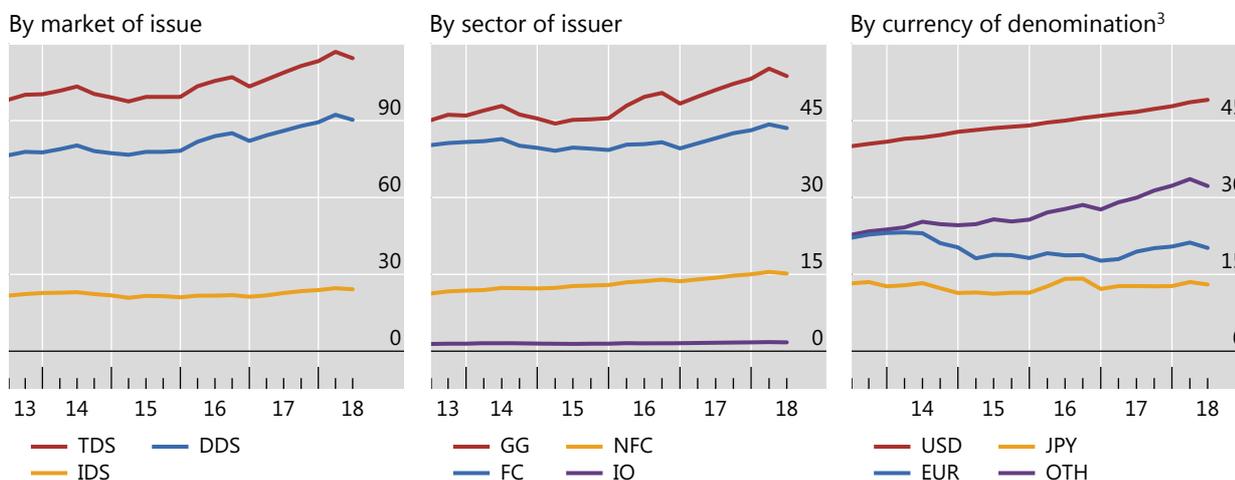
Source: BIS consolidated banking statistics (CBS).

C Debt securities statistics

Global debt securities markets¹

Amounts outstanding, in trillions of US dollars²

Graph C.1



DDS = domestic debt securities; IDS = international debt securities; TDS = total debt securities.

FC = financial corporations; GG = general government; HH = households and non-profit institutions serving households; IO = international organisations; NFC = non-financial corporations.

Further information on the BIS debt securities statistics is available at www.bis.org/statistics/secstats.htm.

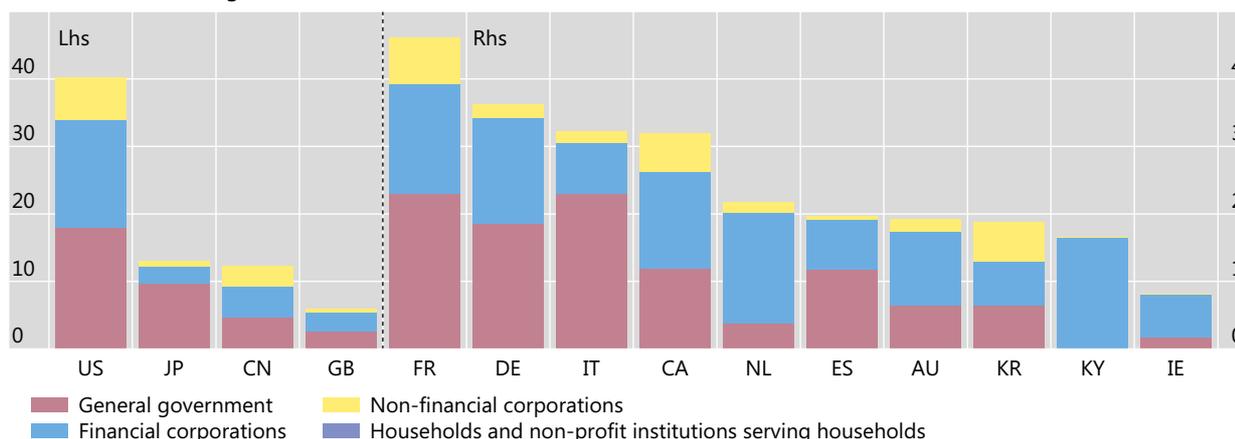
¹ Sample of countries varies across breakdowns shown. For countries that do not report TDS, data are estimated by the BIS as DDS plus IDS. For countries that do not report either TDS or DDS, data are estimated by the BIS as IDS. ² At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ³ Where a currency breakdown is not available, DDS are assumed to be denominated in the local currency.

Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; national data; BIS debt securities statistics; BIS calculations.

Total debt securities, by residence and sector of issuer¹

Amounts outstanding for the latest available data, in trillions of US dollars²

Graph C.2



Further information on the BIS debt securities statistics is available at www.bis.org/statistics/secstats.htm.

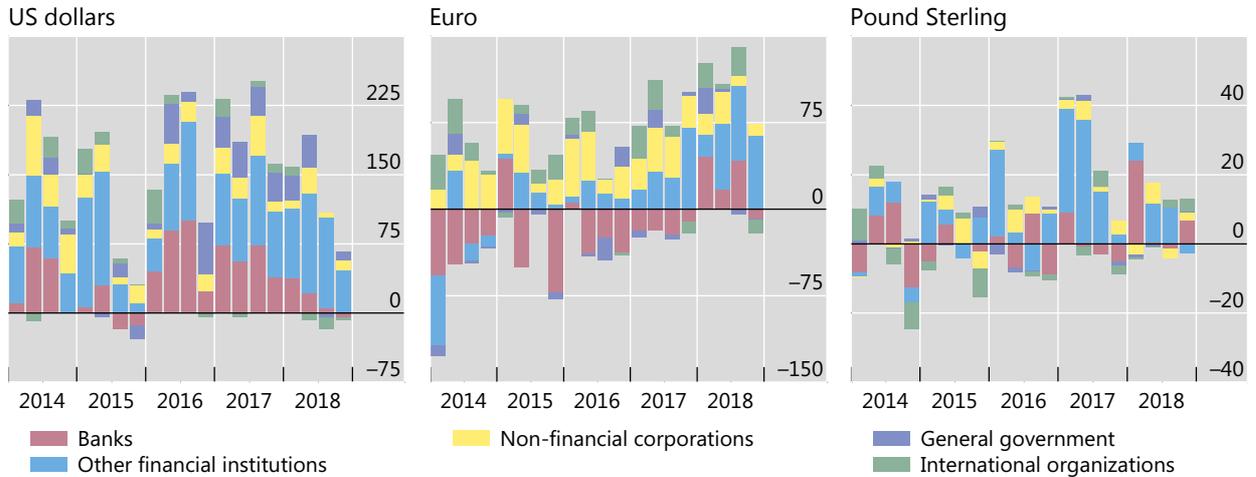
¹ For countries that do not report TDS, data are estimated by the BIS as DDS plus IDS. ² Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Sources: National data; BIS debt securities statistics.

Net issuance of international debt securities

By issuer sector and currency of denomination, in billions of US dollars

Graph C.3



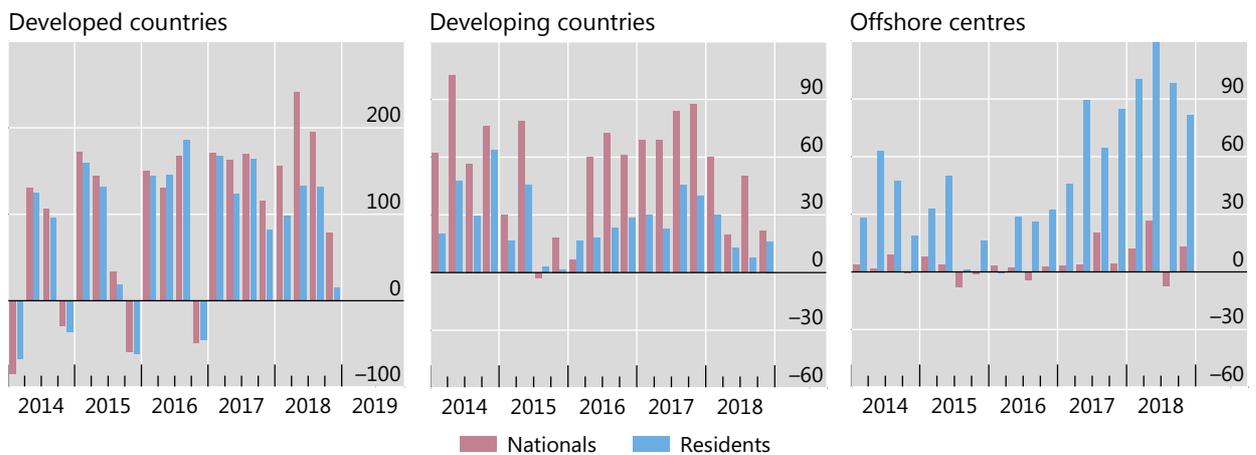
Further information is available at www.bis.org/statistics/secstats.htm.

Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; BIS debt securities statistics.

International debt securities issued by financial and non-financial corporations¹

Net issuance by region, in billions of US dollars²

Graph C.4



Further information is available at www.bis.org/statistics/secstats.htm.

¹ Excluding general government. ² For a list of countries in each region, see Table C1 (<http://stats.bis.org/statx/srs/table/c1>).

Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; BIS debt securities statistics.

D Derivatives statistics

Exchange-traded derivatives

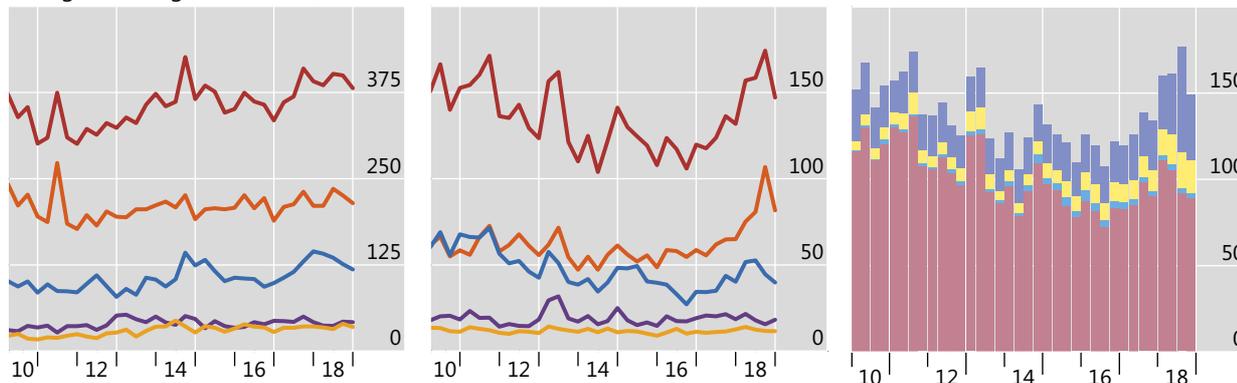
Graph D.1

Open interest, by currency¹

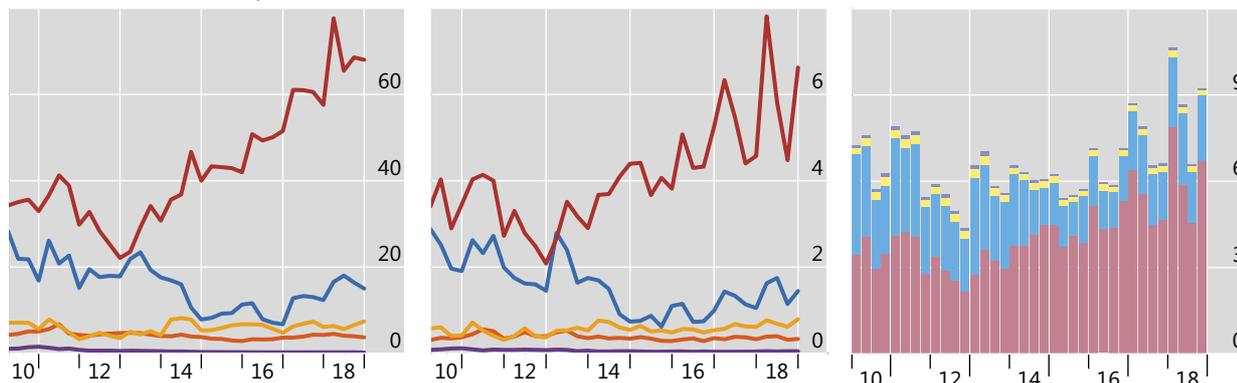
Daily average turnover, by currency²

Daily average turnover, by location of exchange²

Foreign exchange derivatives, USD bn³



Interest rate derivatives, USD trn³



— US dollar — Pound sterling — Other
— Euro — Yen

— North America — Asia and Pacific
— Europe — Other markets

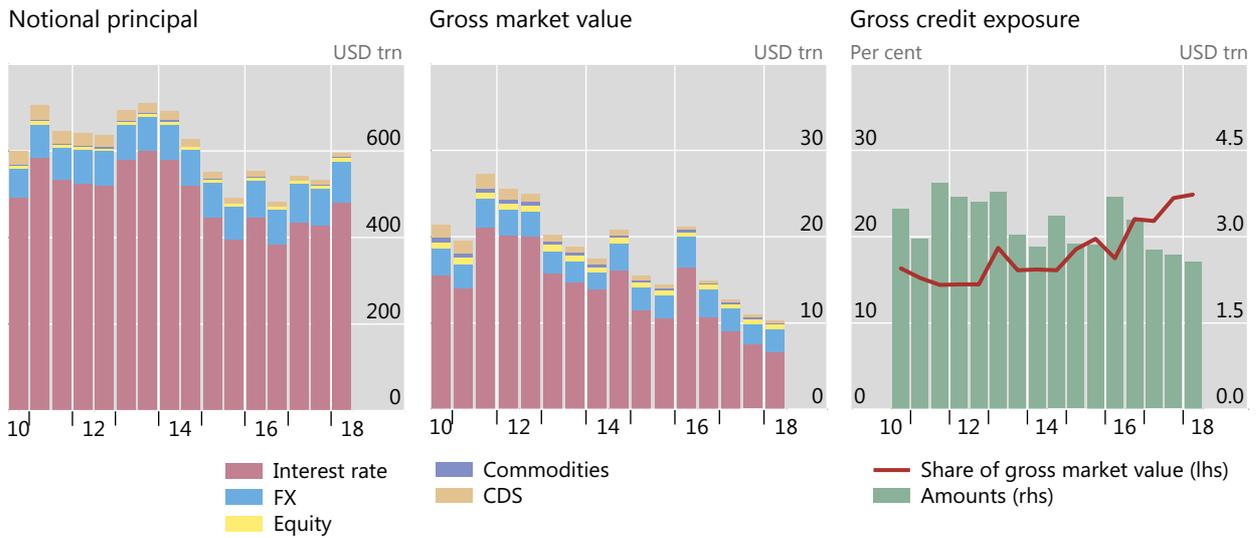
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/extderiv.htm.

¹ At quarter-end. Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date. ² Quarterly averages of daily turnover. ³ Futures and options.

Sources: Euromoney TRADEDATA; Futures Industry Association; The Options Clearing Corporation; BIS derivatives statistics.

Global OTC derivatives markets¹

Graph D.2



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

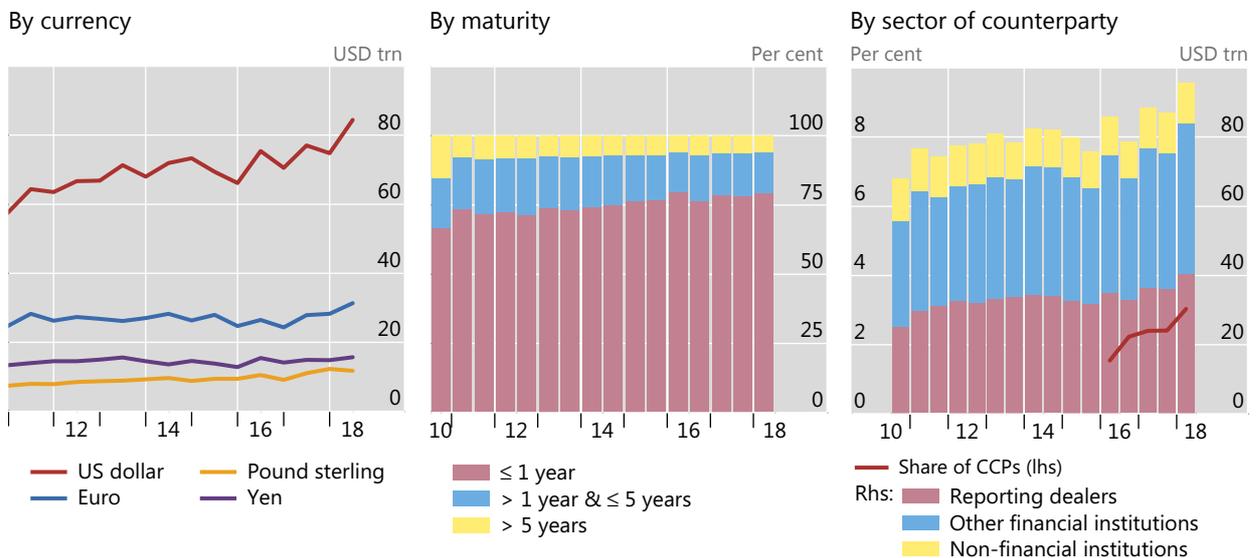
¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

OTC foreign exchange derivatives

Notional principal¹

Graph D.3



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

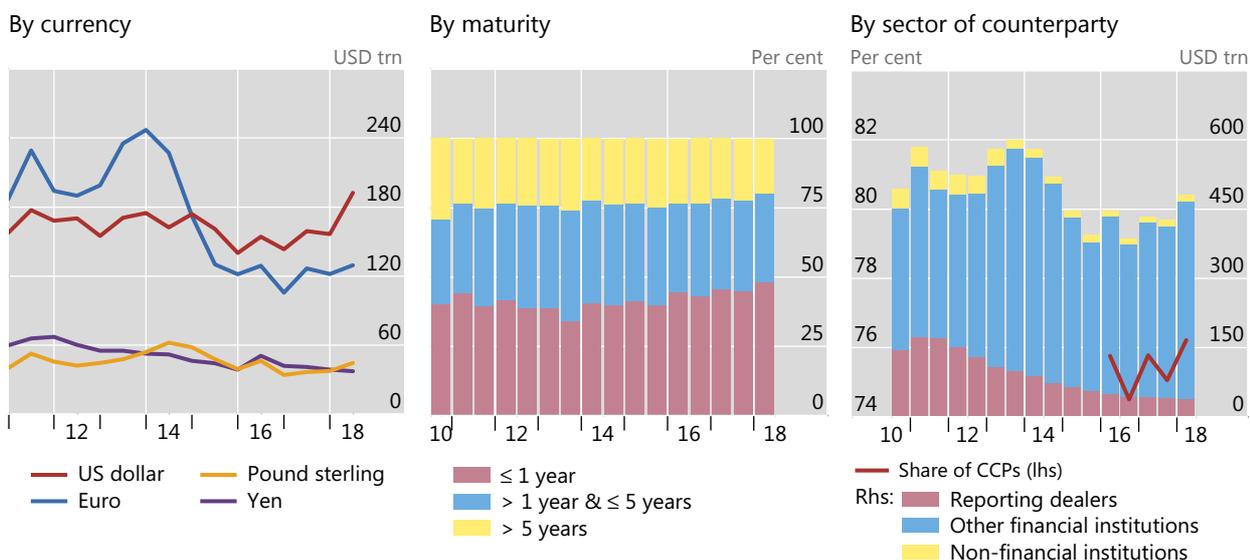
¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

OTC interest rate derivatives

Notional principal¹

Graph D.4



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

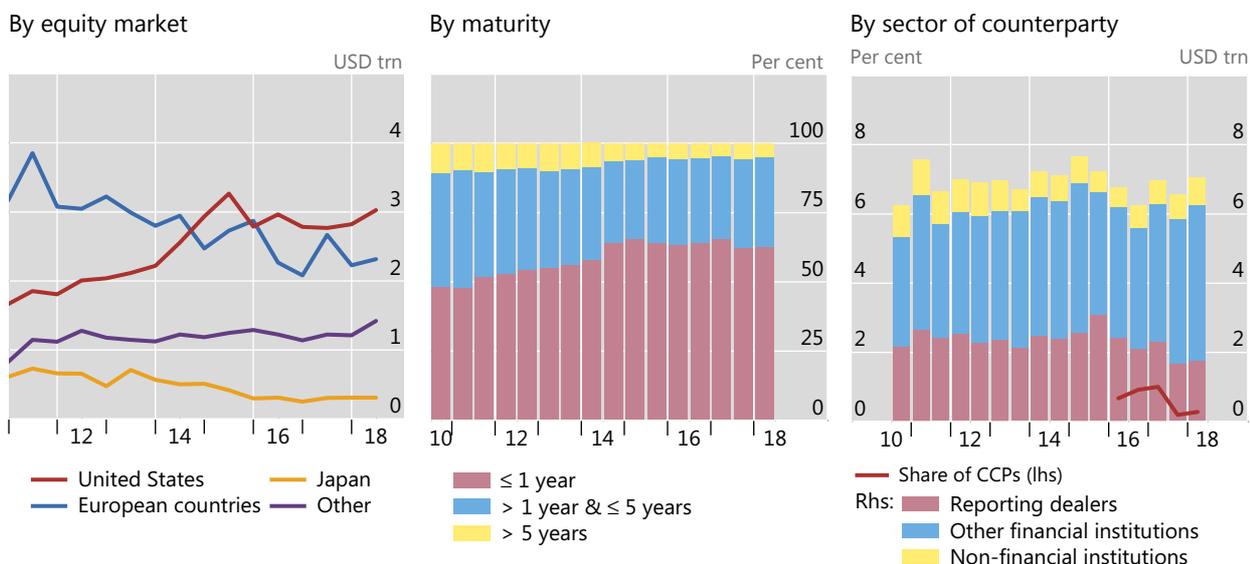
¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

OTC equity-linked derivatives

Notional principal¹

Graph D.5



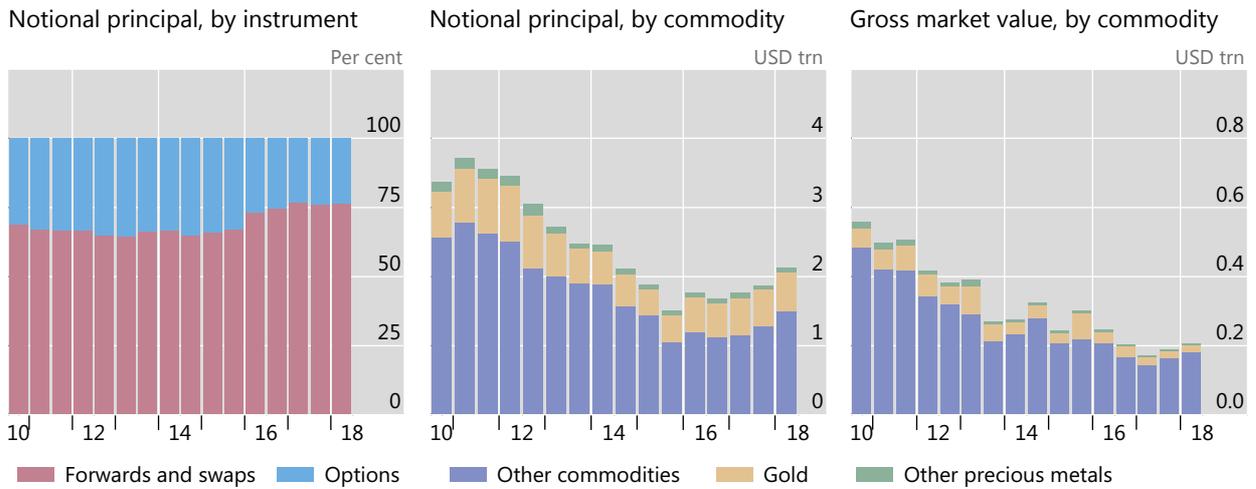
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

OTC commodity derivatives¹

Graph D.6



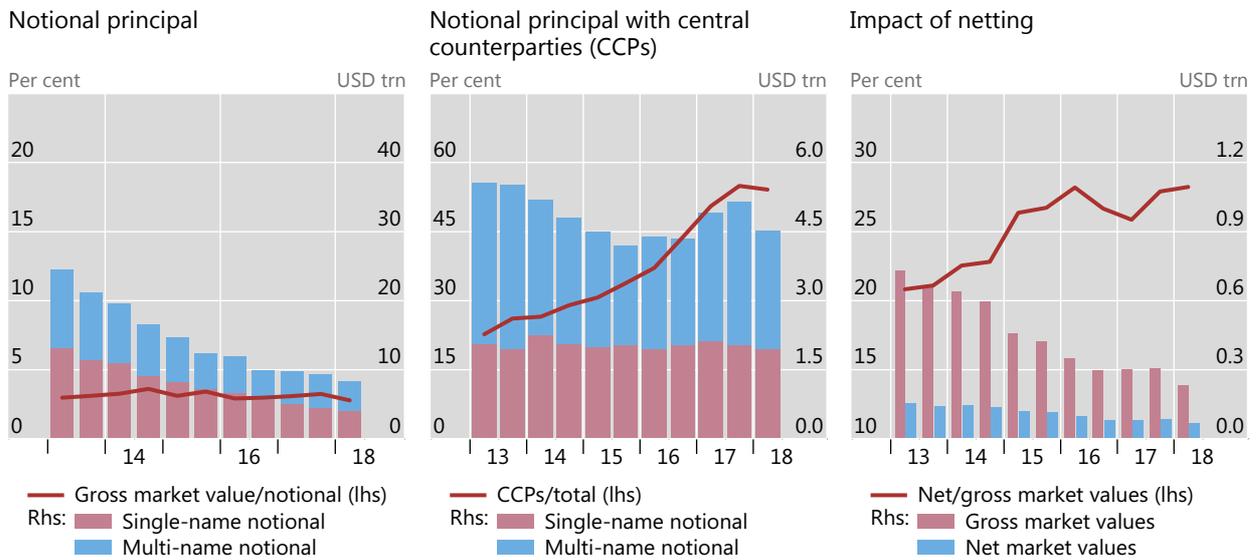
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

Credit default swaps¹

Graph D.7



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

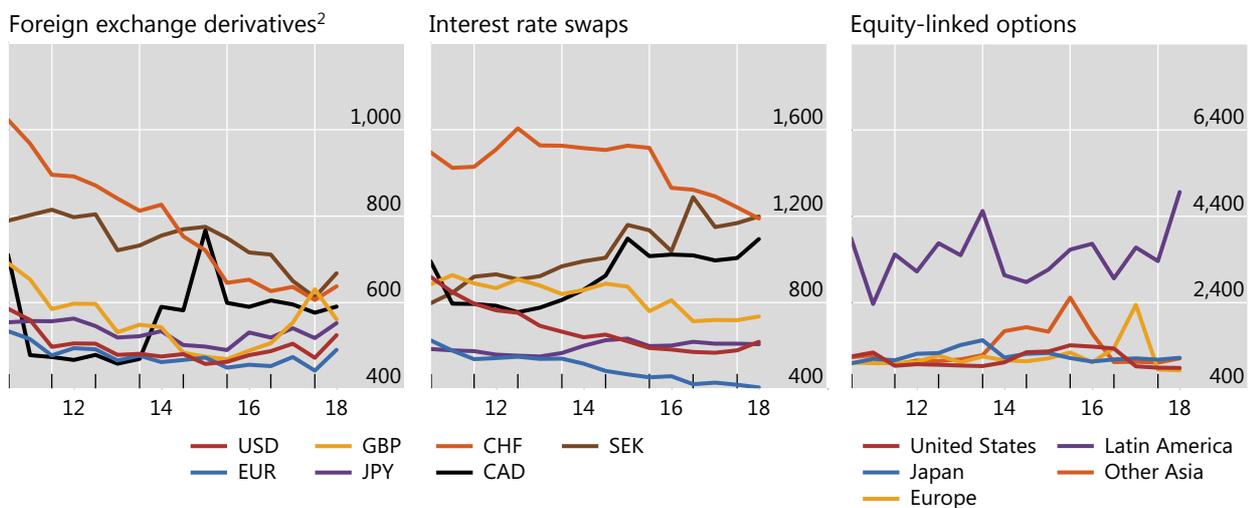
¹ At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

Concentration in global OTC derivatives markets

Herfindahl index¹

Graph D.8



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm.

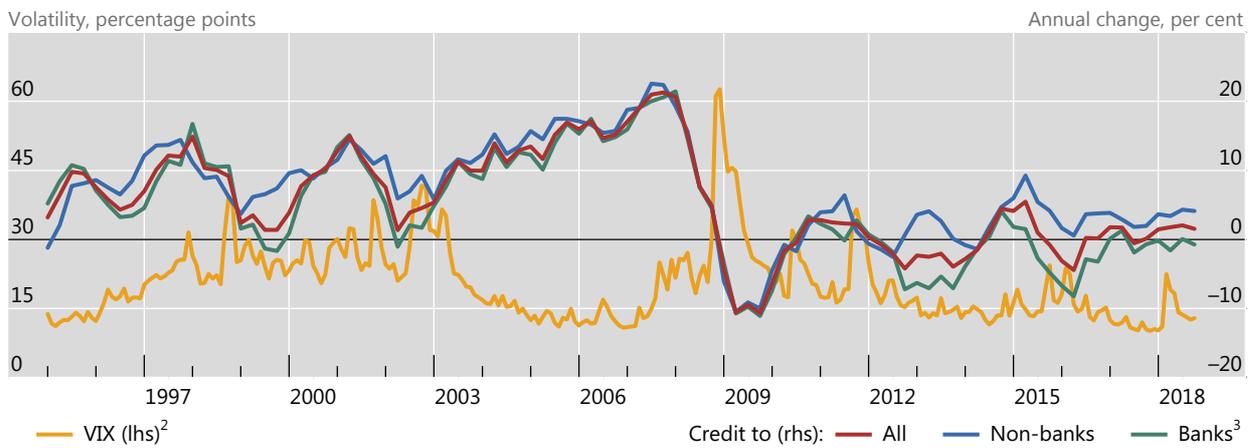
¹ The index ranges from 0 to 10,000, where a lower number indicates that there are many dealers with similar market shares (as measured by notional principal) and a higher number indicates that the market is dominated by a few reporting dealers. ² Foreign exchange forwards, foreign exchange swaps and currency swaps.

Source: BIS derivatives statistics.

E Global liquidity indicators

Growth of international bank credit¹

Graph E.1



Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

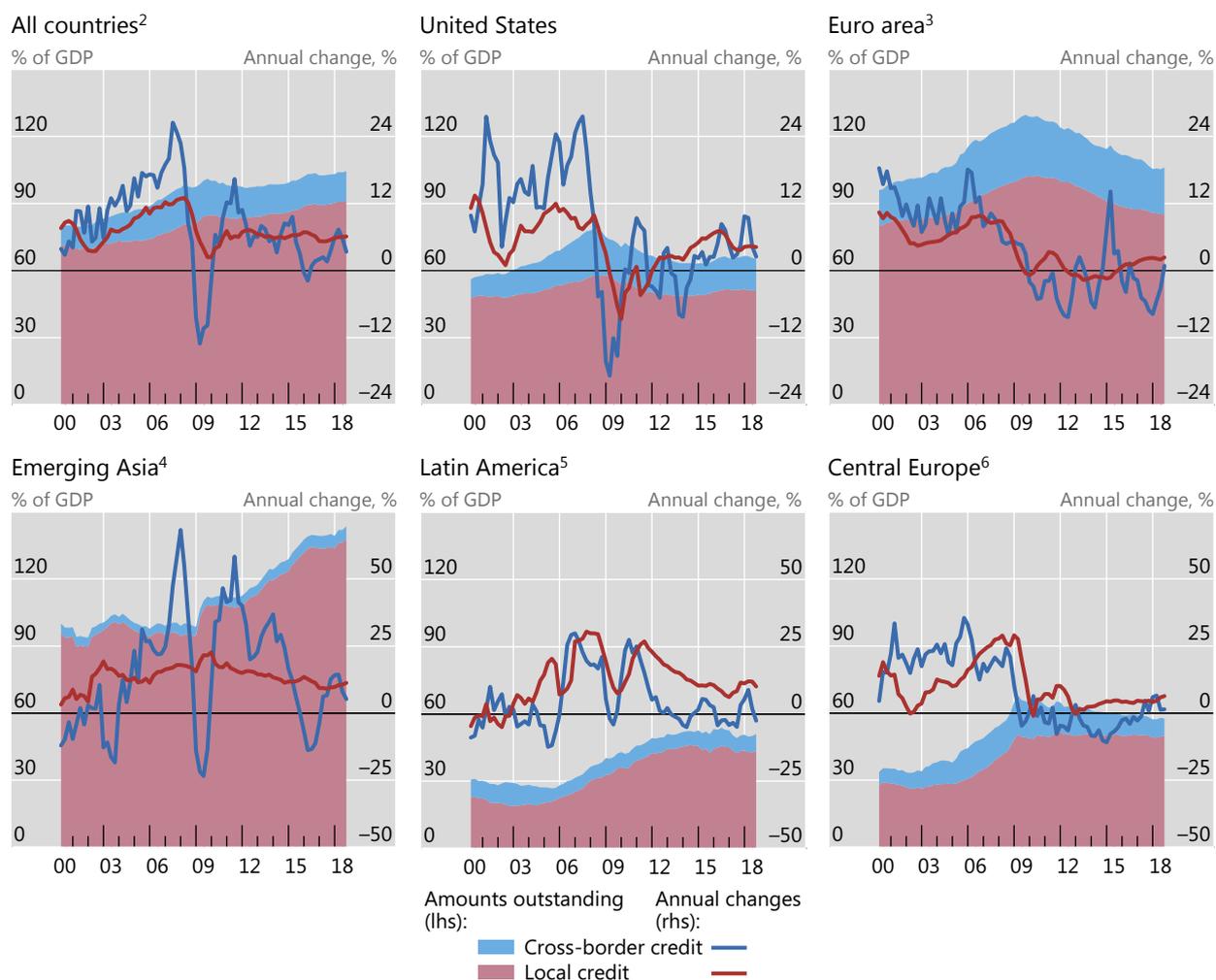
¹ LBS-reporting banks' cross-border claims plus local claims in foreign currencies. ² Chicago Board Options Exchange S&P 500 implied volatility index; standard deviation, in percentage points per annum. ³ Including intragroup transactions.

Sources: Bloomberg; BIS locational banking statistics.

Global bank credit to the private non-financial sector, by residence of borrower

Banks' cross-border credit plus local credit in all currencies¹

Graph E.2



¹ Cross-border claims of LBS reporting banks to the non-bank sector plus local claims of all banks to the private non-financial sector. Weighted averages of the economies listed, based on four-quarter moving sums of GDP. ² Australia, Canada, Denmark, Japan, New Zealand, Norway, Russia, Saudi Arabia, South Africa, Sweden, Switzerland, Turkey and the United Kingdom, plus the countries in the other panels. ³ Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal and Spain. ⁴ China, Hong Kong SAR, India, Indonesia, Korea, Malaysia, Singapore and Thailand. ⁵ Argentina, Brazil, Chile and Mexico. ⁶ The Czech Republic, Hungary and Poland.

Sources: BIS credit to the non-financial sector; BIS locational banking statistics; BIS calculations.

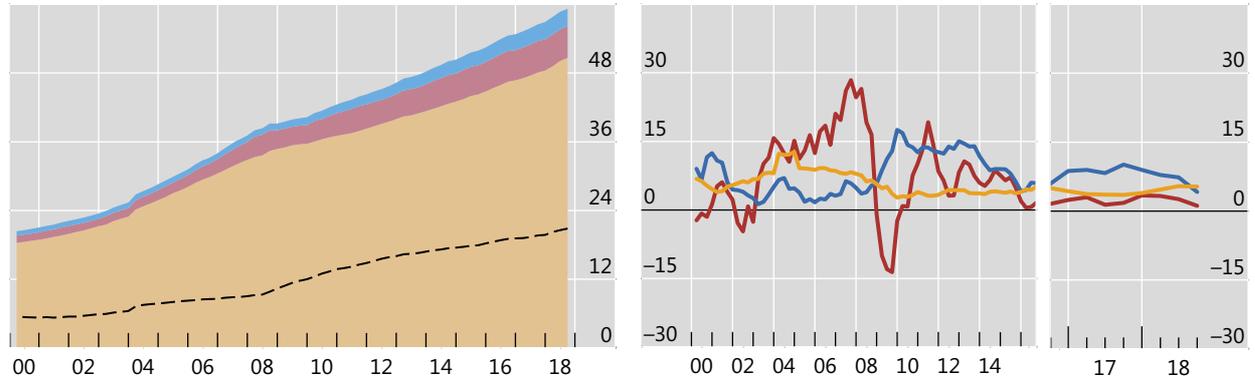
Global credit to the non-financial sector, by currency

Graph E.3

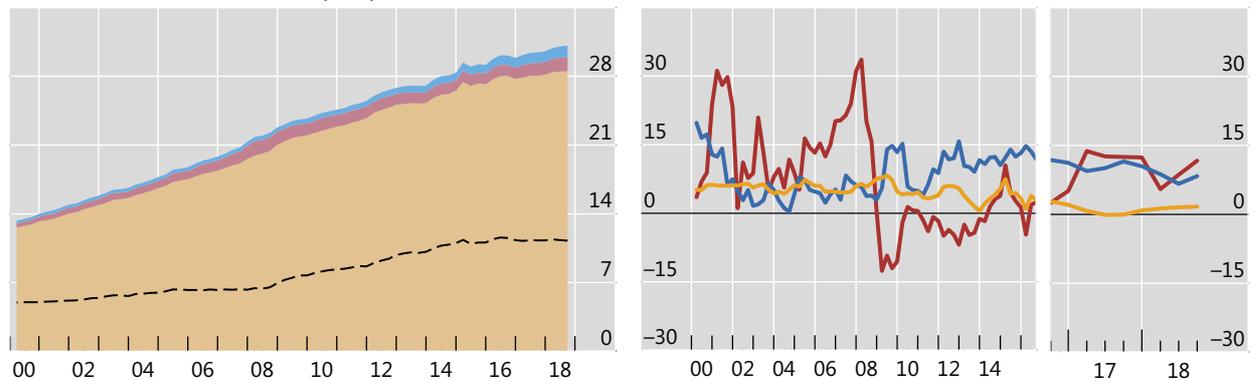
Amounts outstanding, in trillions of currency units¹

Annual change, in per cent²

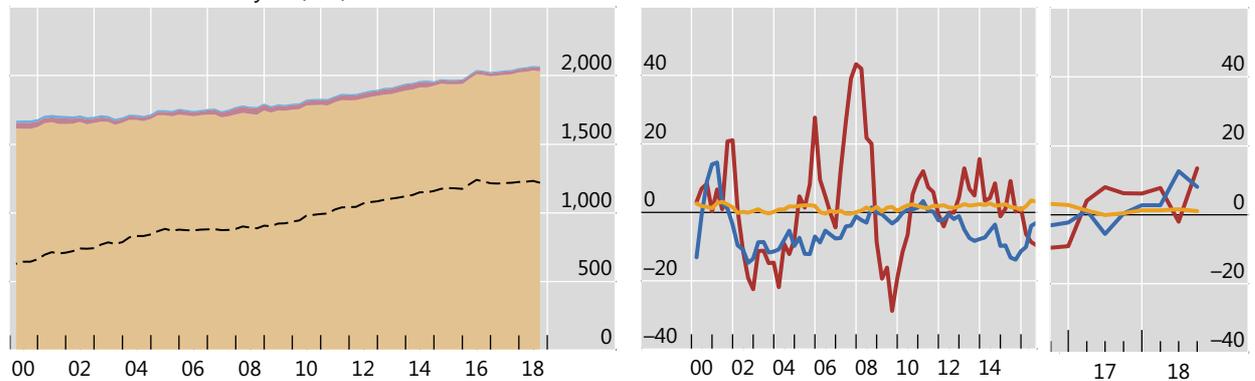
Credit denominated in US dollars (USD)



Credit denominated in euros (EUR)



Credit denominated in yen (JPY)



Credit to residents³
 Credit to non-residents:

 Of which:

 Credit to government

 Loans⁵

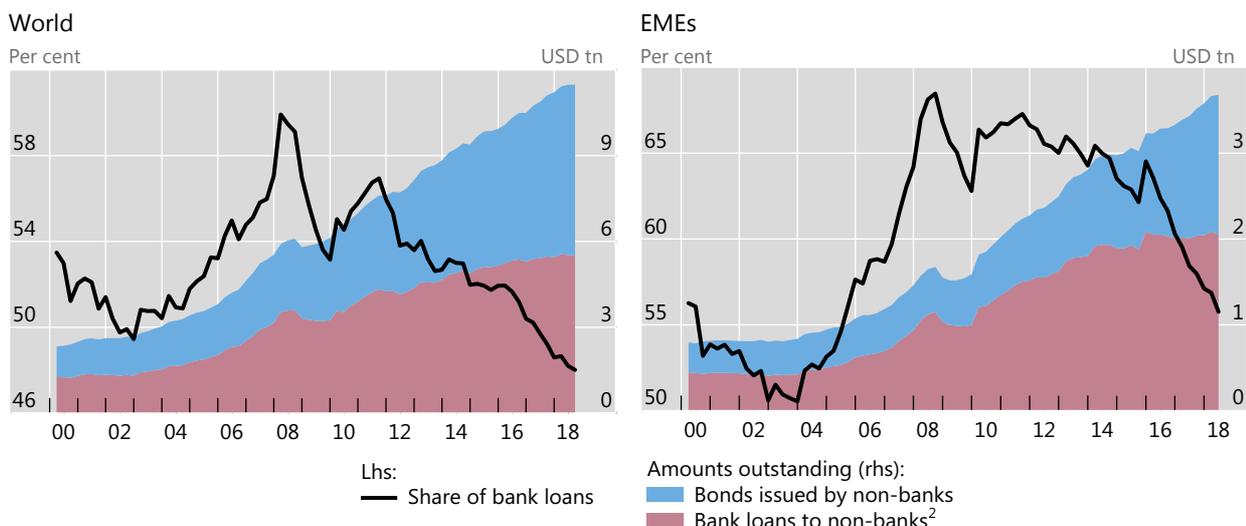
Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

¹ Amounts outstanding at quarter-end. ² Based on quarterly break- and exchange rate-adjusted changes. ³ Credit to non-financial borrowers residing in the United States/euro area/Japan. National financial accounts are adjusted using BIS banking and securities statistics to exclude credit denominated in non-local currencies. ⁴ Excluding debt securities issued by special purpose vehicles and other financial entities controlled by non-financial parents. EUR-denominated debt securities exclude those issued by institutions of the European Union. ⁵ Loans by LBS-reporting banks to non-bank borrowers, including non-bank financial entities, comprise cross-border plus local loans.

Sources: Datastream; Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

US dollar-denominated credit to non-banks outside the United States¹

Graph E.4



Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

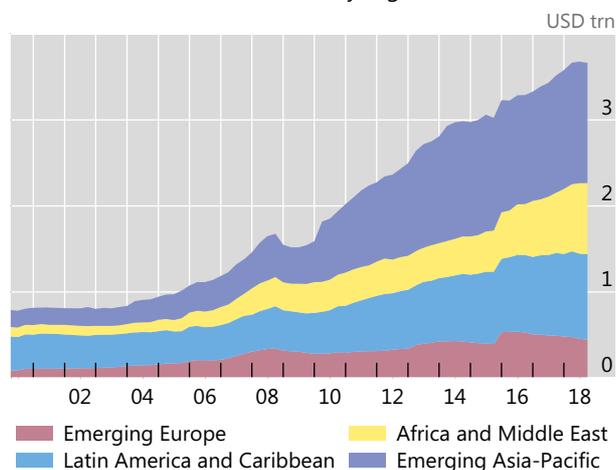
¹ Non-banks comprise non-bank financial entities, non-financial corporations, governments, households and international organisations. ² Loans by LBS-reporting banks to non-bank borrowers, including non-bank financial entities, comprise cross-border plus local loans.

Sources: Datastream; Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

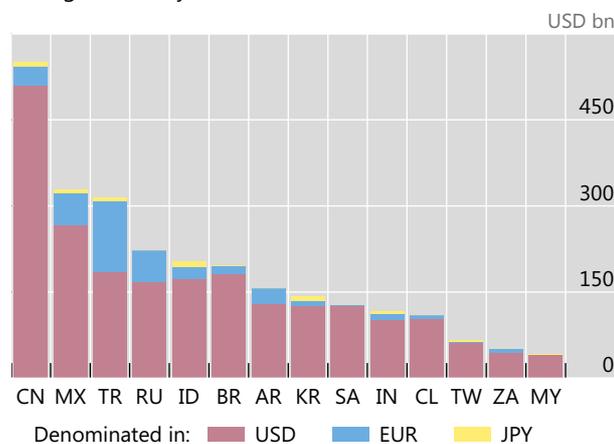
Foreign currency credit to non-banks in EMEs

Graph E.5

US dollar-denominated credit by region



Foreign currency credit to selected EMEs¹



Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

¹ Amounts outstanding for the latest available data.

Sources: Datastream; Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

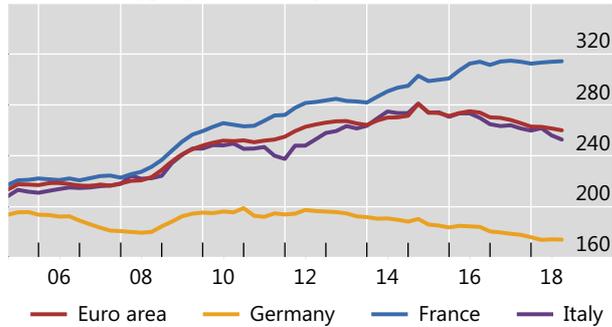
F Statistics on total credit to the non-financial sector

Total credit to the non-financial sector (core debt)

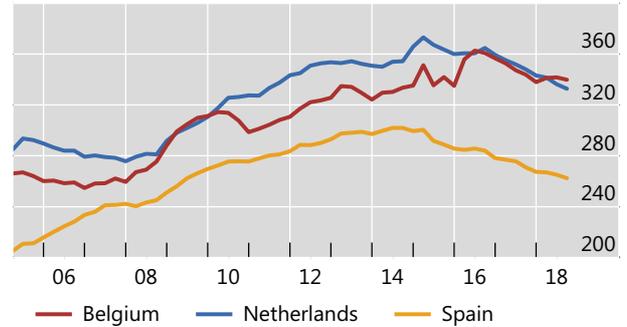
As a percentage of GDP

Graph F.1

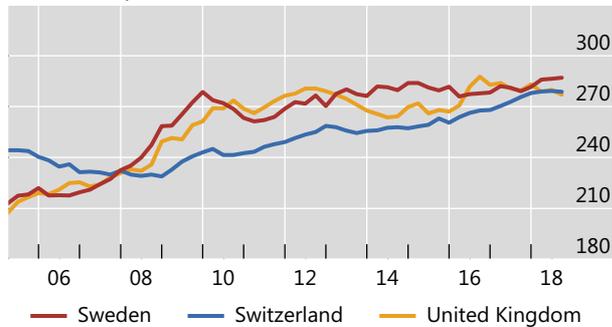
Euro area: aggregate and major countries



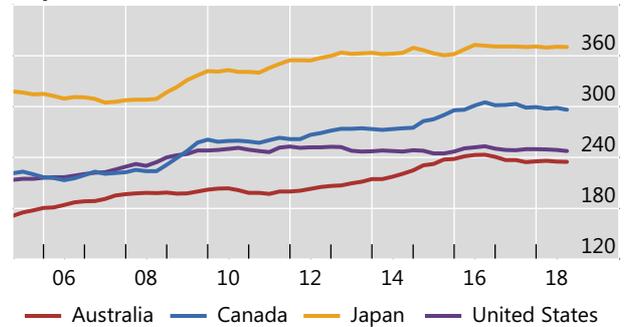
Euro area: other countries



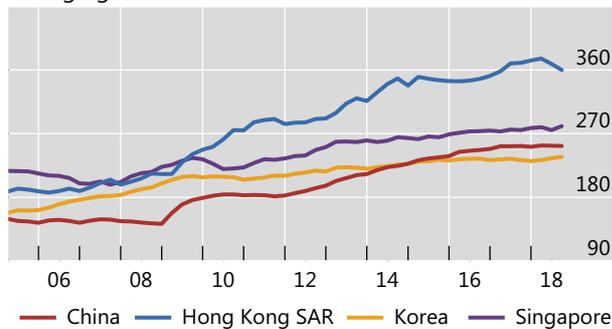
Other European countries



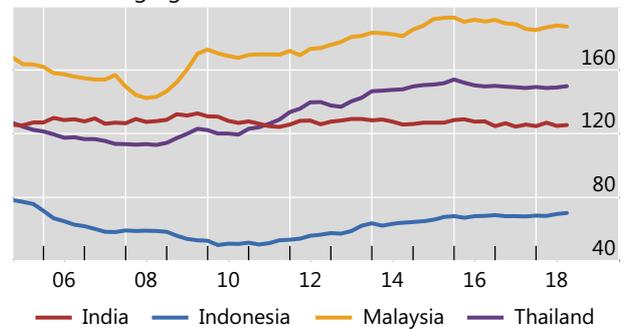
Major advanced economies



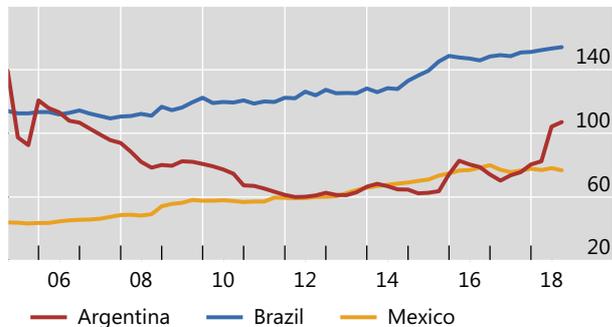
Emerging Asia



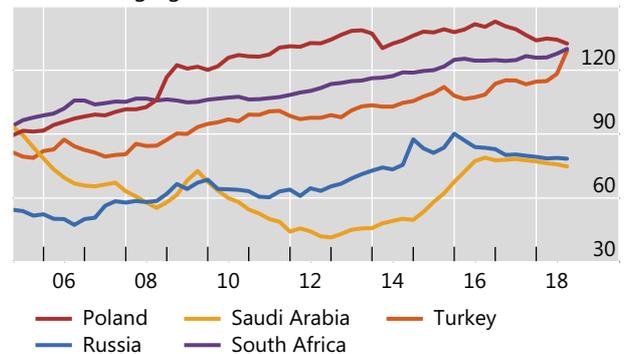
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

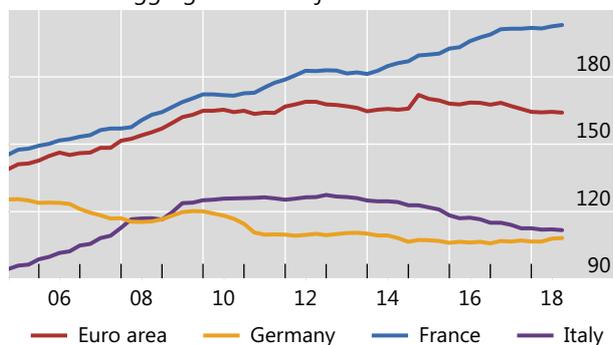
Source: BIS total credit statistics.

Total credit to the private non-financial sector (core debt)

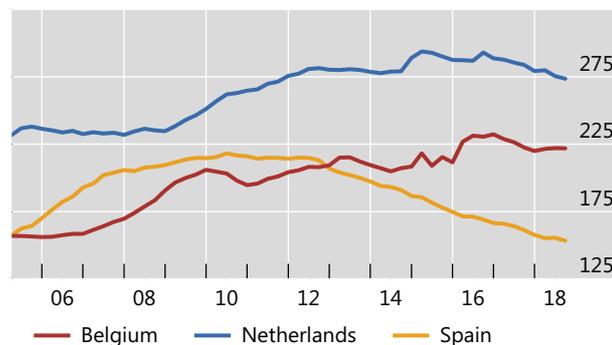
As a percentage of GDP

Graph F.2

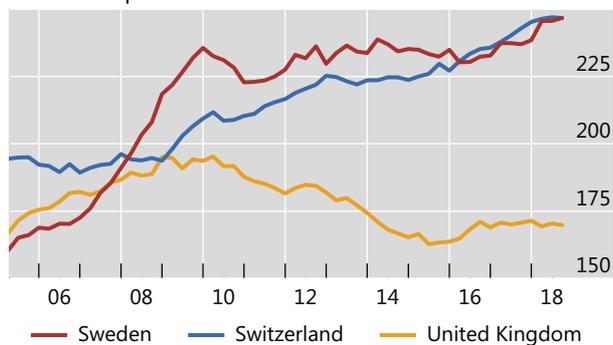
Euro area: aggregate and major countries



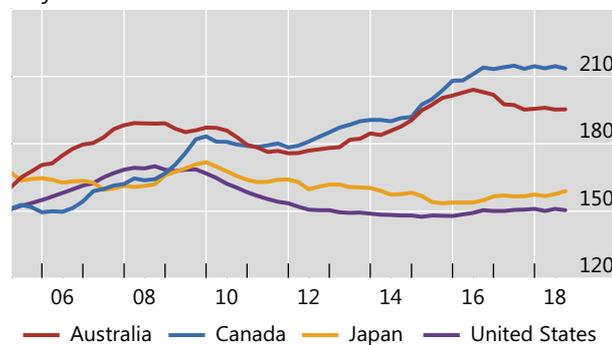
Euro area: other countries



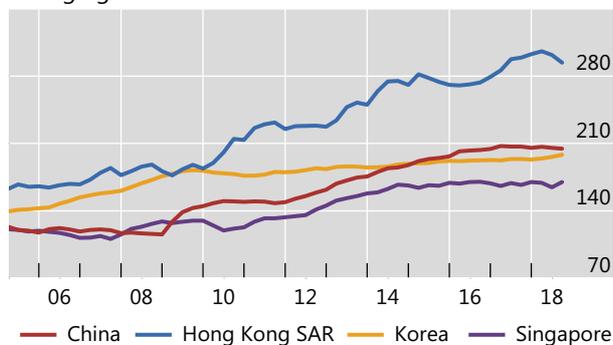
Other European countries



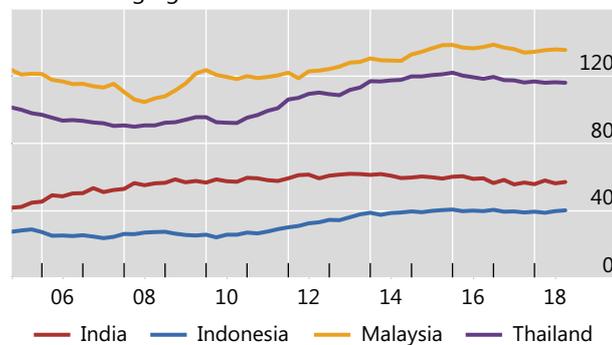
Major advanced economies



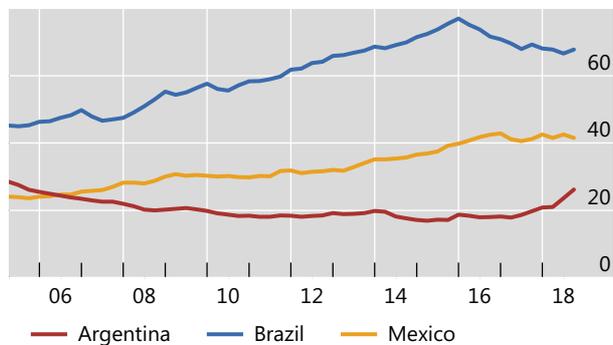
Emerging Asia



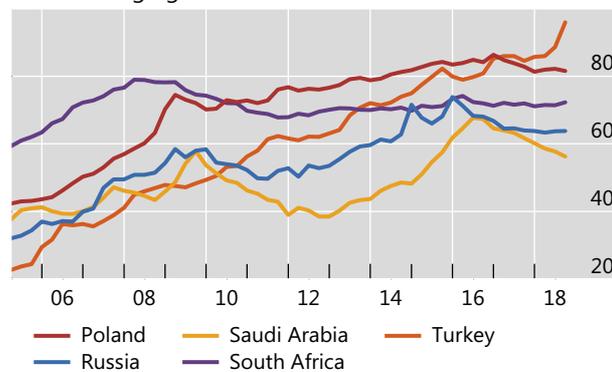
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

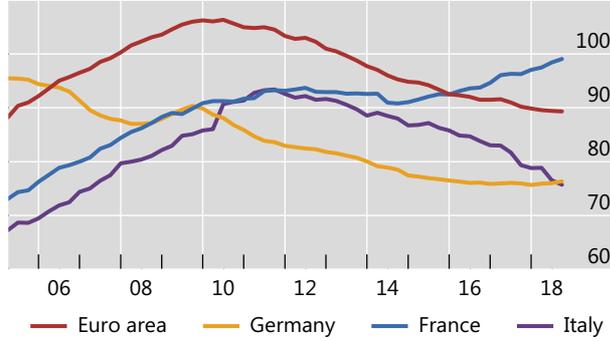
Source: BIS total credit statistics.

Bank credit to the private non-financial sector (core debt)

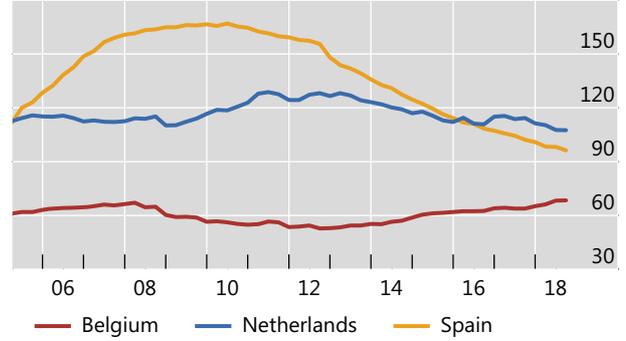
As a percentage of GDP

Graph F.3

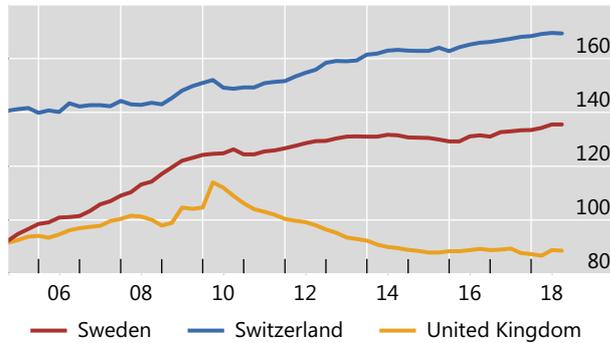
Euro area: aggregate and major countries



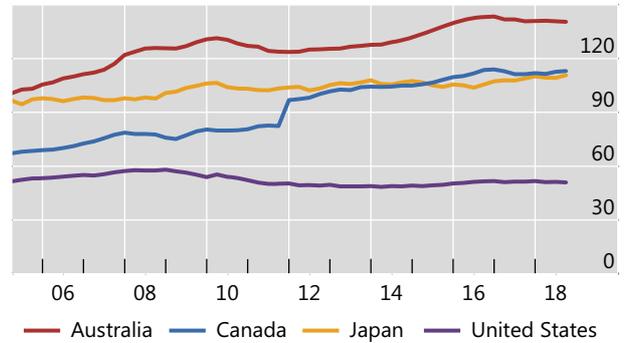
Euro area: other countries



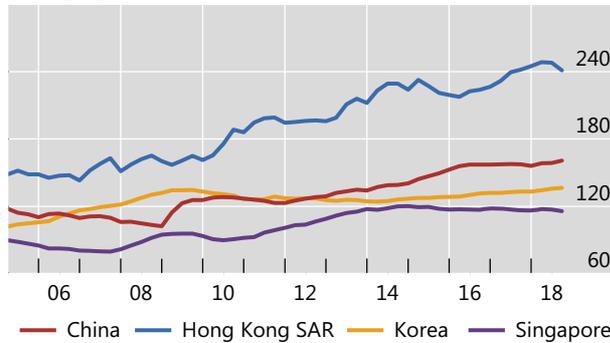
Other European countries



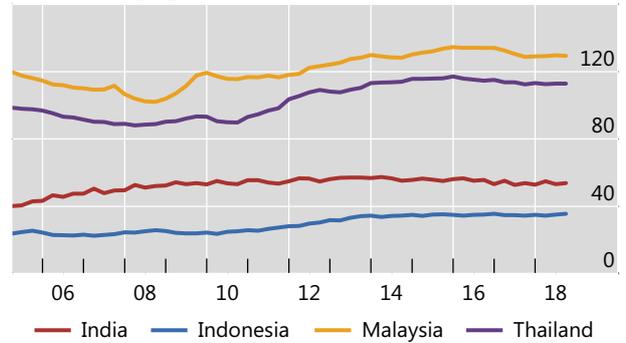
Major advanced economies



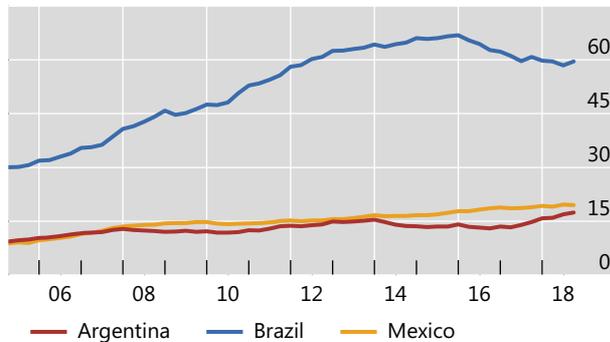
Emerging Asia



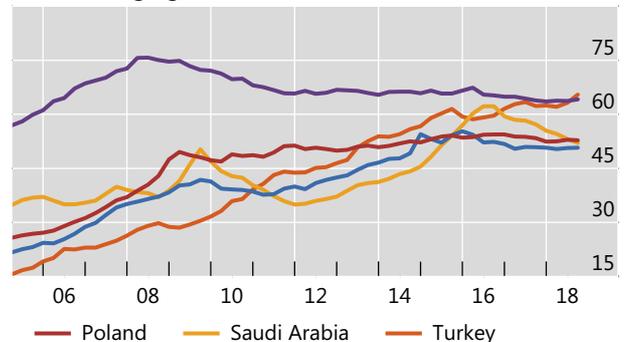
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

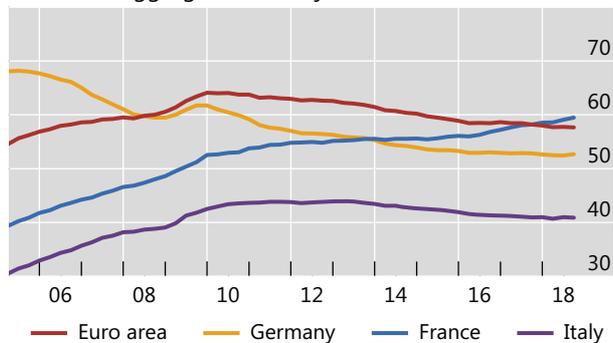
Source: BIS total credit statistics.

Total credit to households (core debt)

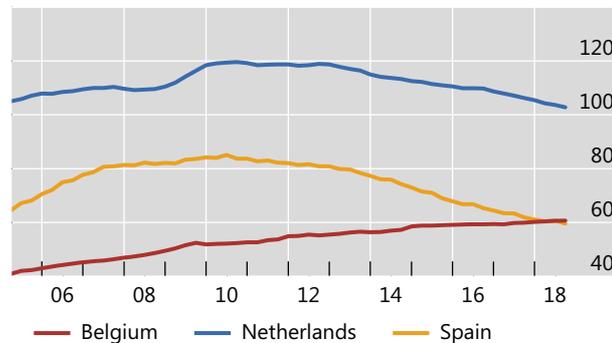
As a percentage of GDP

Graph F.4

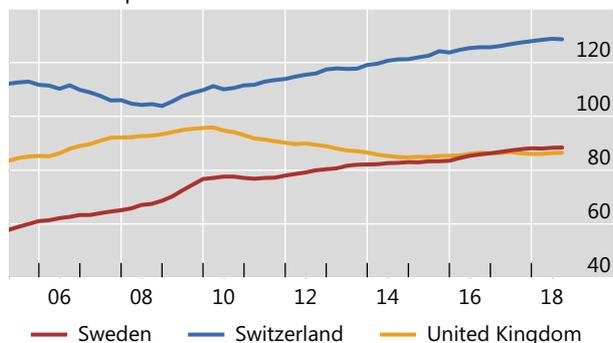
Euro area: aggregate and major countries



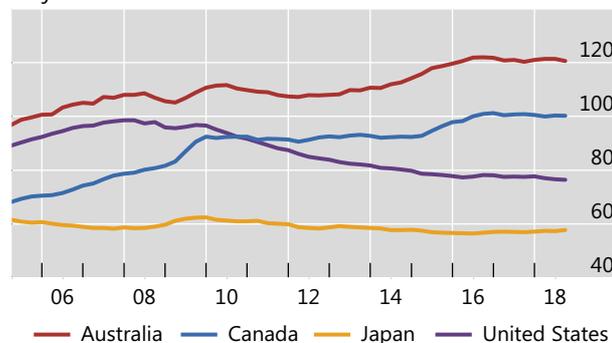
Euro area: other countries



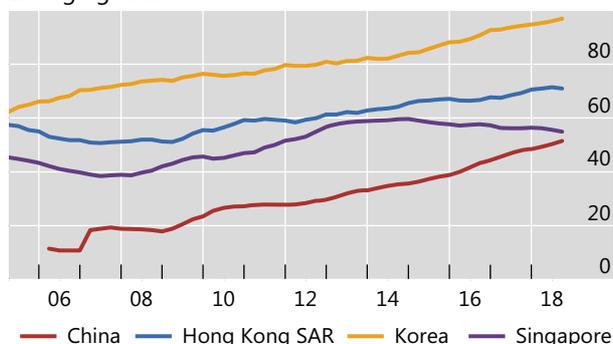
Other European countries



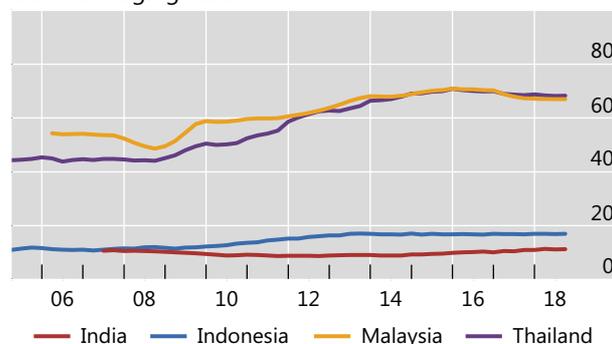
Major advanced economies



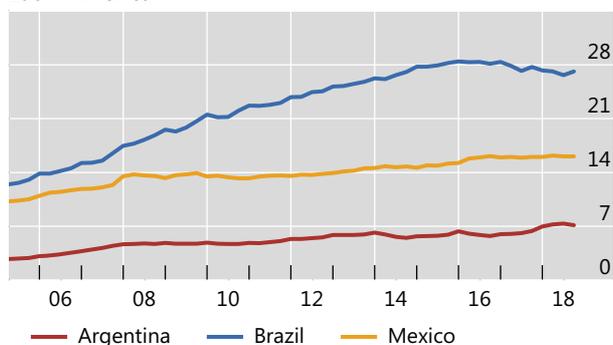
Emerging Asia



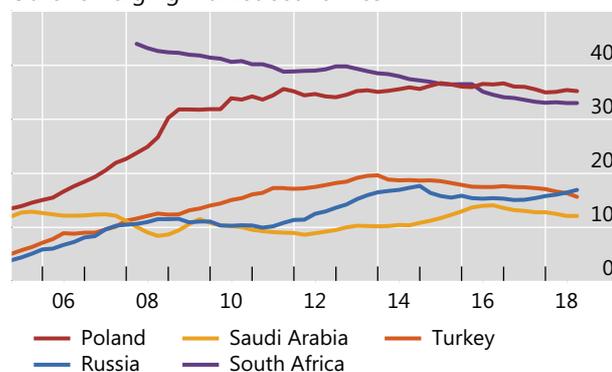
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

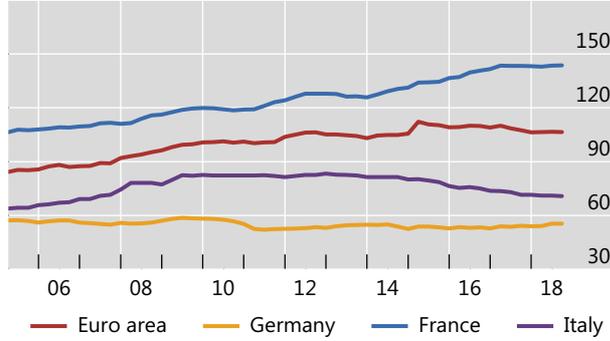
Source: BIS total credit statistics.

Total credit to non-financial corporations (core debt)

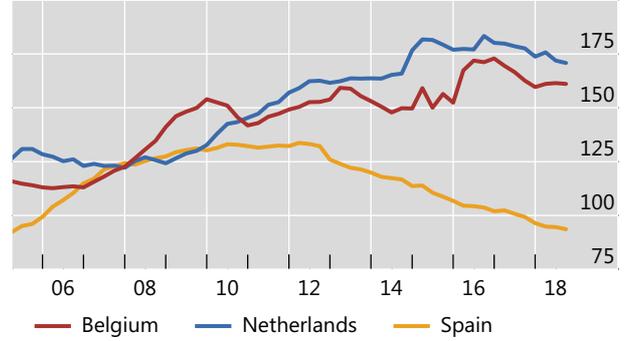
As a percentage of GDP

Graph F.5

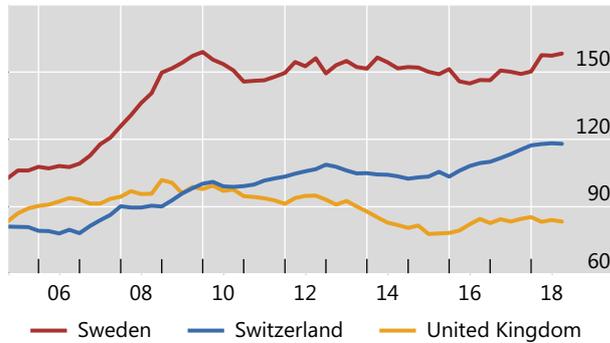
Euro area: aggregate and major countries



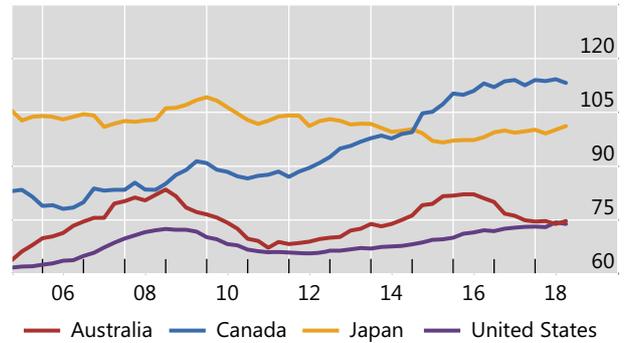
Euro area: other countries



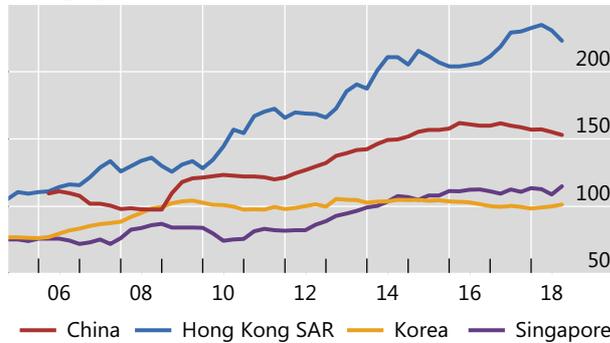
Other European countries



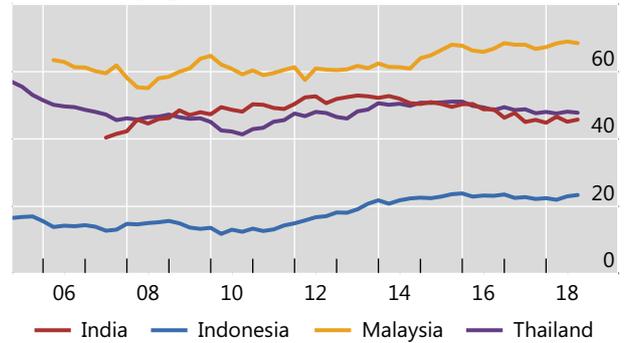
Major advanced economies



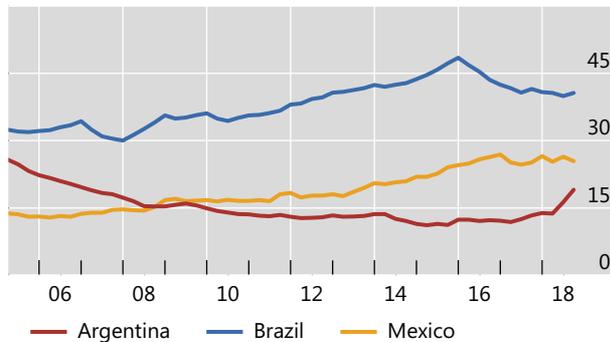
Emerging Asia



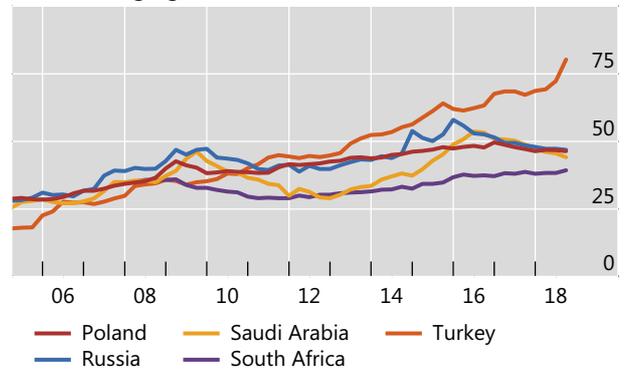
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

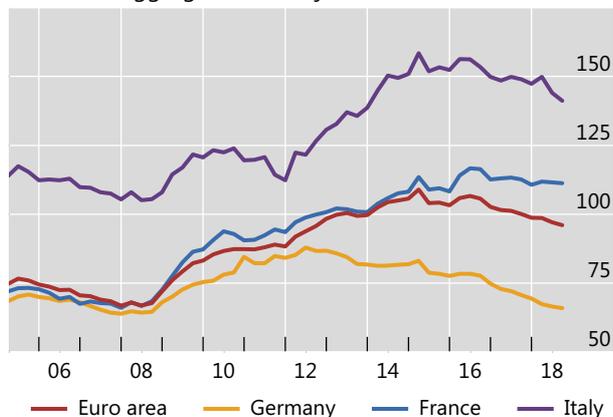
Source: BIS total credit statistics.

Total credit to the government sector at market value (core debt)¹

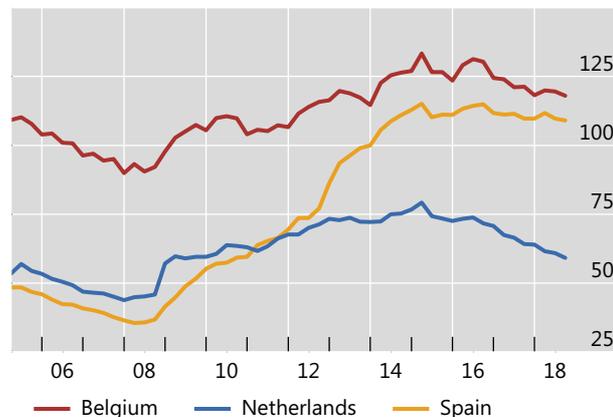
As a percentage of GDP

Graph F.6

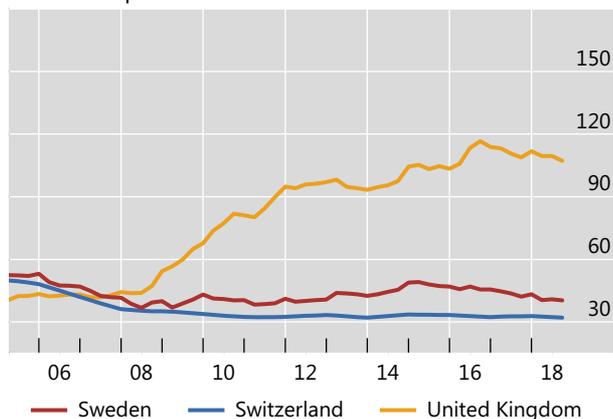
Euro area: aggregate and major countries



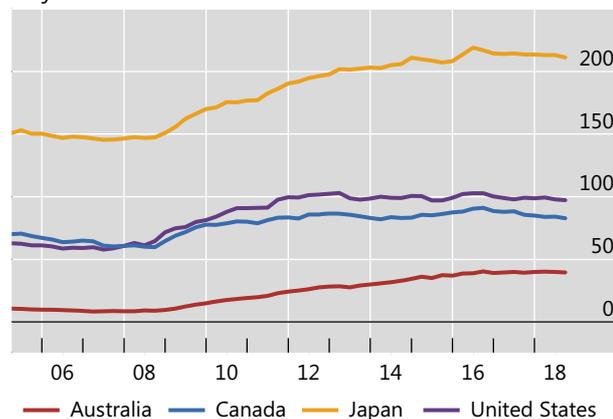
Euro area: other countries



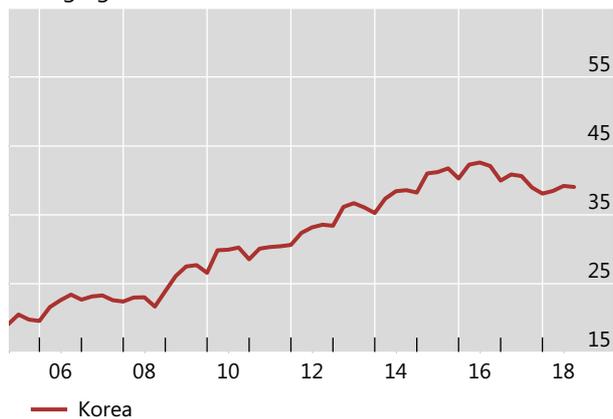
Other European countries



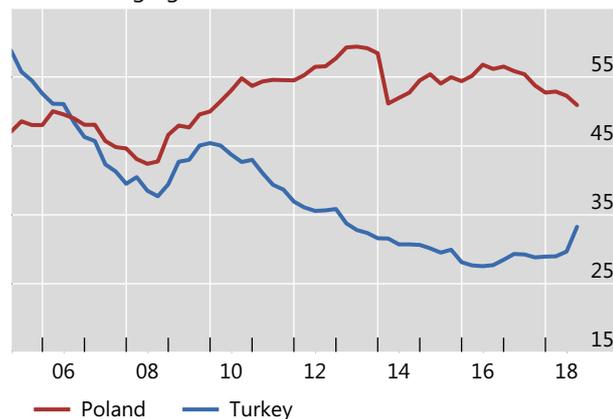
Major advanced economies



Emerging Asia



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

¹ Consolidated data for the general government sector.

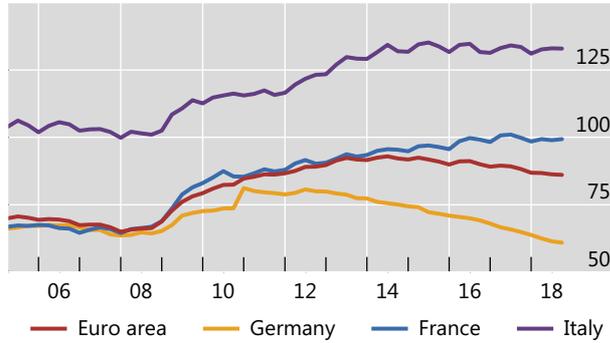
Source: BIS total credit statistics.

Total credit to the government sector at nominal value (core debt)¹

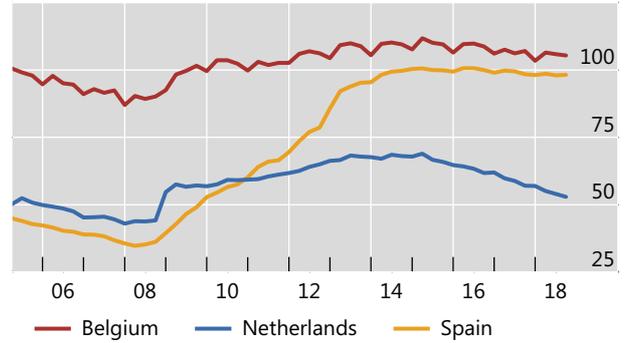
As a percentage of GDP

Graph F.7

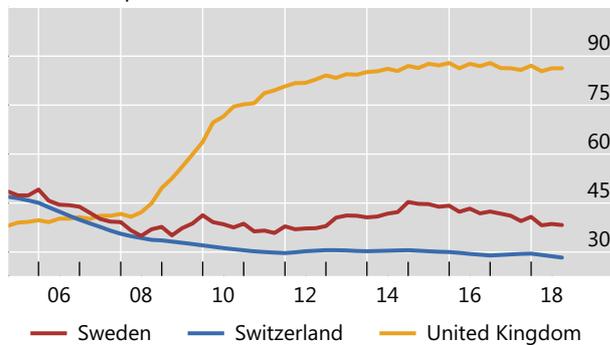
Euro area: aggregate and major countries



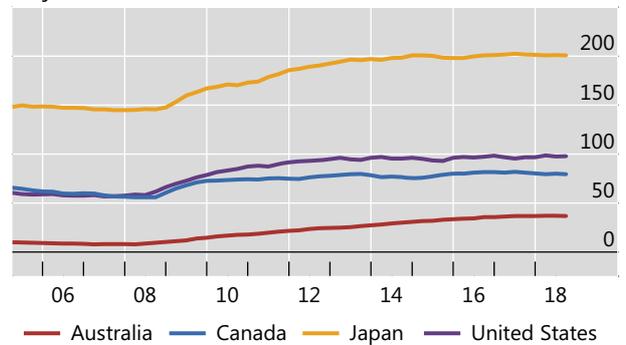
Euro area: other countries



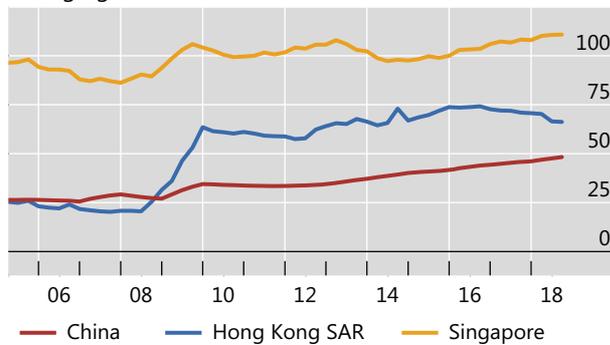
Other European countries



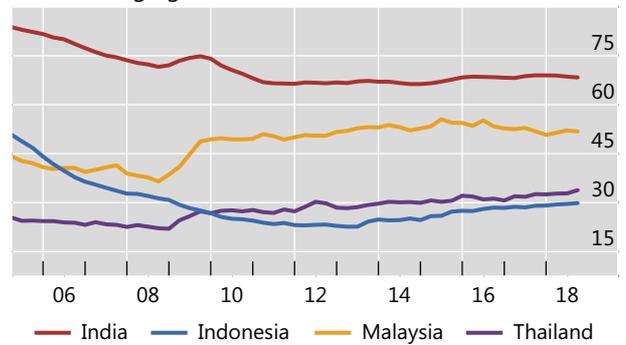
Major advanced economies



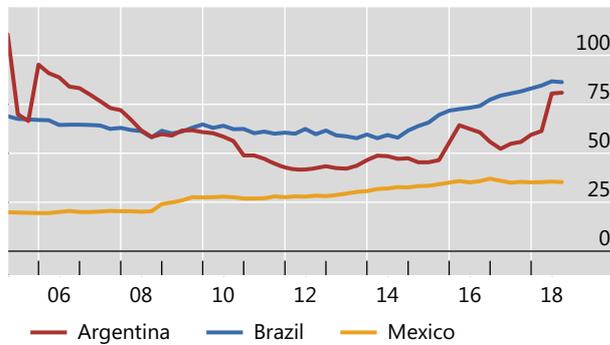
Emerging Asia



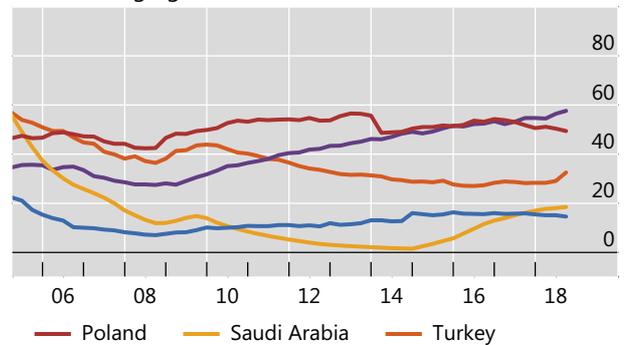
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

¹ Consolidated data for the general government sector; central government for Argentina, Indonesia, Malaysia, Mexico, Saudi Arabia and Thailand.

Source: BIS total credit statistics.

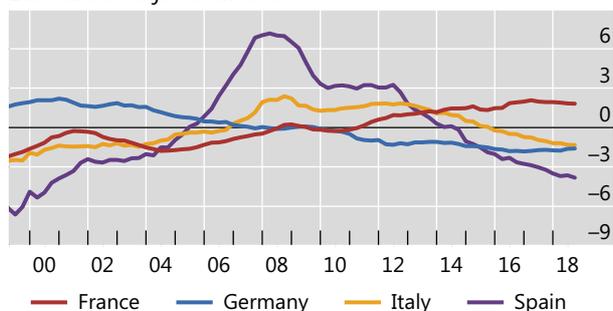
G Debt service ratios for the private non-financial sector

Debt service ratios of the private non-financial sector

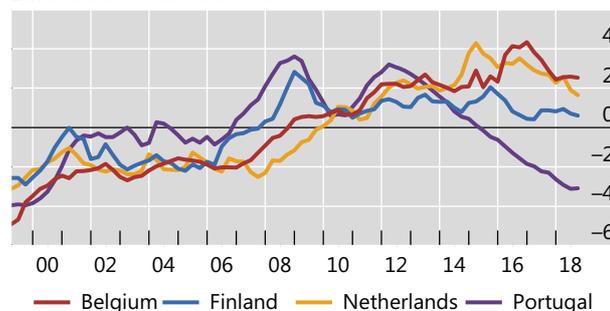
Deviation from country-specific mean, in percentage points¹

Graph G.1

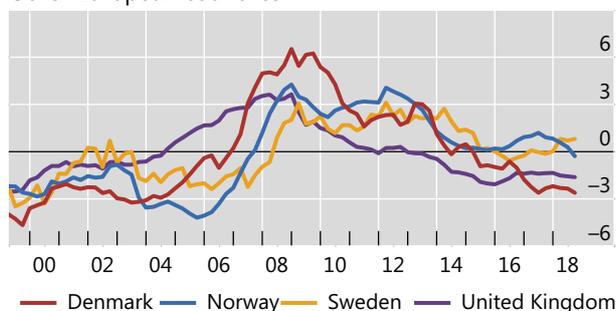
Euro area: major countries



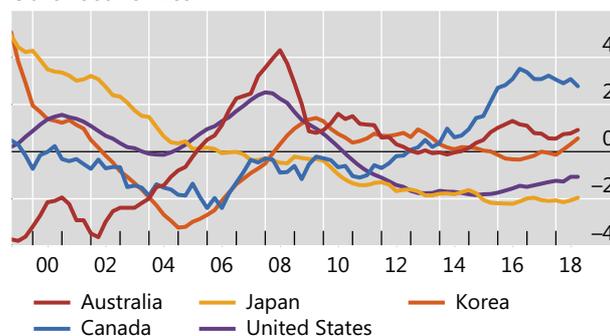
Euro area: other countries



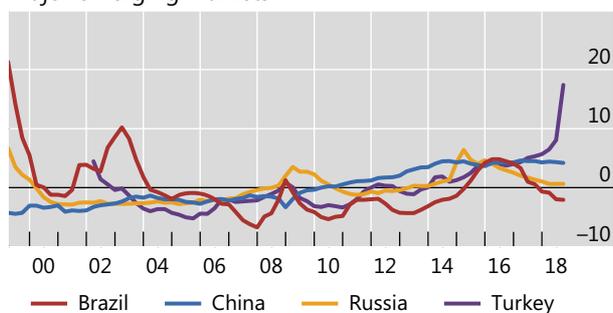
Other European countries



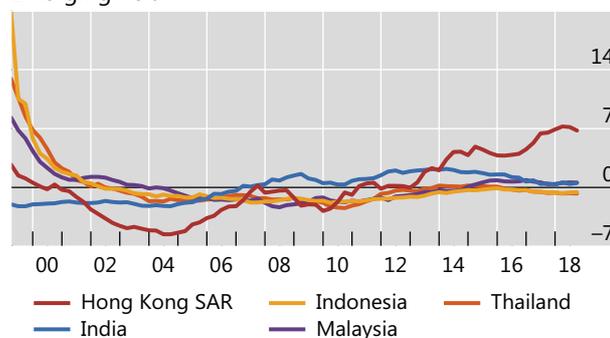
Other economies



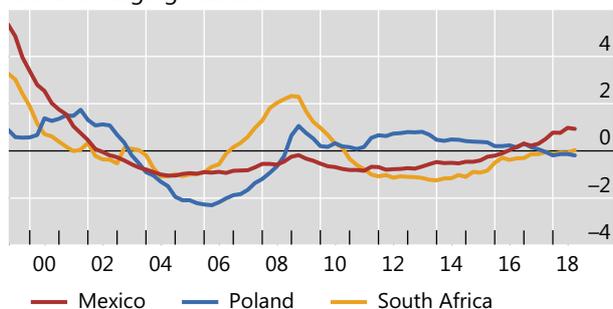
Major emerging markets²



Emerging Asia²



Other emerging markets²



Further information on the BIS debt service ratio statistics is available at www.bis.org/statistics/dsr.htm.

¹ Country-specific means are based on all available data from 1999 onwards. ² Countries which are using alternative measures of income and interest rates. Further information is available under "Methodology and data for DSR calculation" at www.bis.org/statistics/dsr.htm.

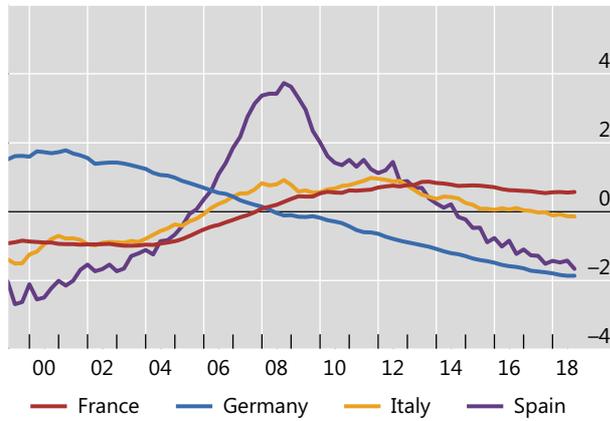
Source: BIS debt service ratios statistics.

Debt service ratios of households

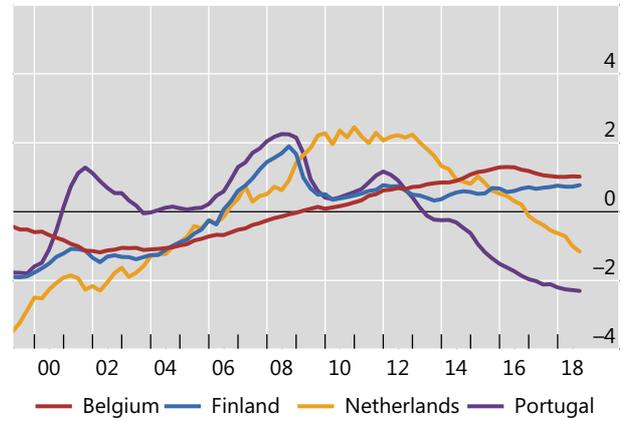
Deviation from country-specific mean, in percentage points¹

Graph G.2

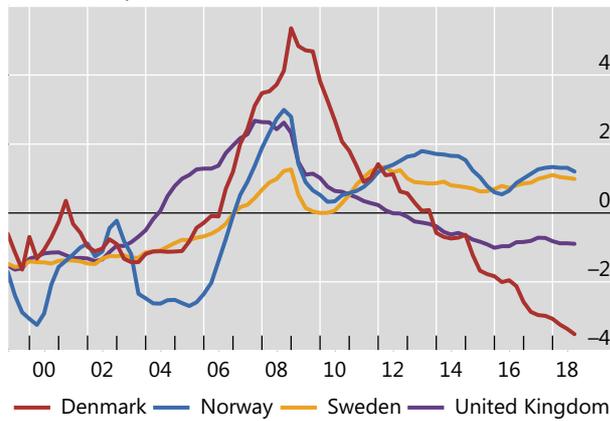
Euro area: major countries



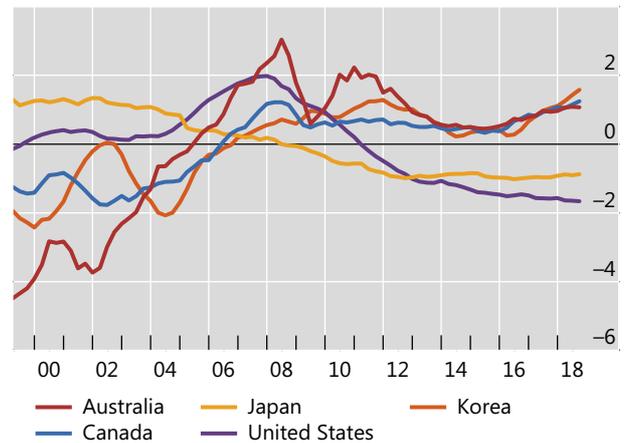
Euro area: other countries



Other European countries



Other economies



Further information on the BIS debt service ratio statistics is available at www.bis.org/statistics/dsr.htm.

¹ Country-specific means are based on all available data from 1999 onwards.

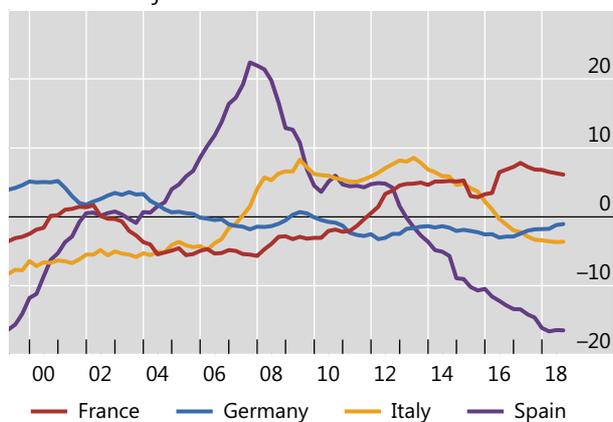
Source: BIS debt service ratios statistics.

Debt service ratios of non-financial corporations

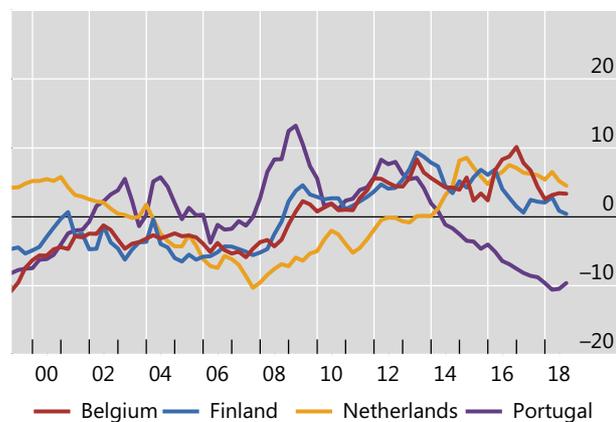
Deviation from country-specific mean, in percentage points¹

Graph G.3

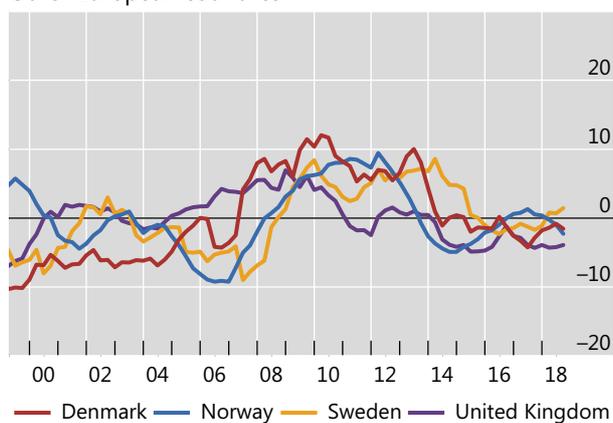
Euro area: major countries



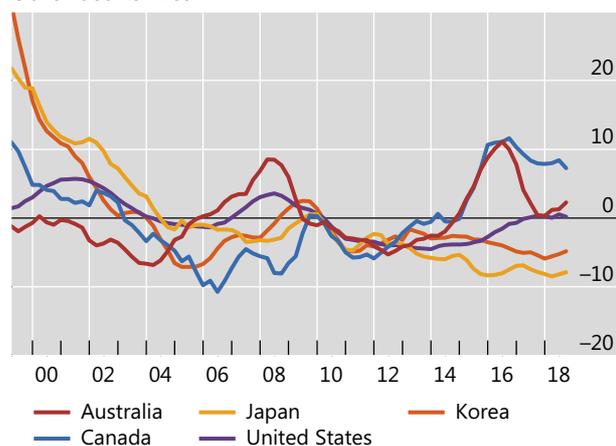
Euro area: other countries



Other European countries



Other economies



Further information on the BIS debt service ratio statistics is available at www.bis.org/statistics/dsr.htm.

¹ Country-specific means are based on all available data from 1999 onwards.

Source: BIS debt service ratios statistics.

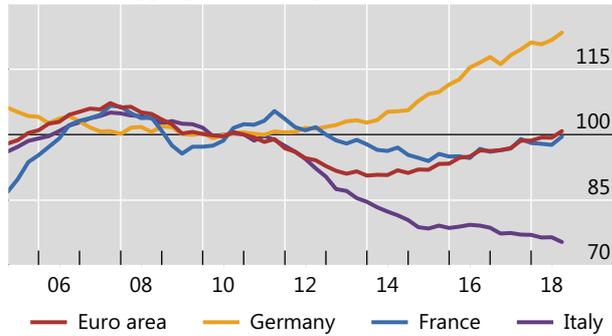
H Property price statistics

Real residential property prices

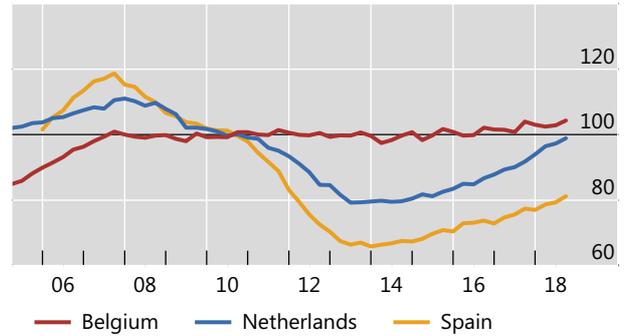
CPI-deflated, 2010 = 100

Graph H.1

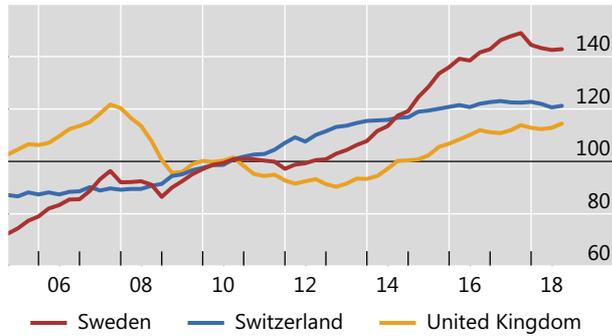
Euro area: aggregate and major countries



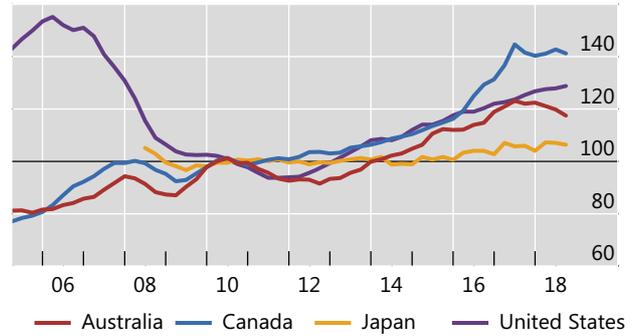
Euro area: other countries



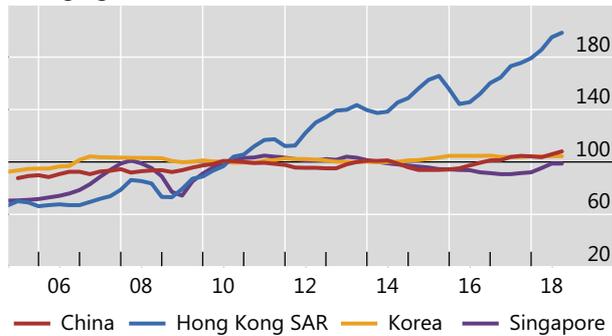
Other European countries



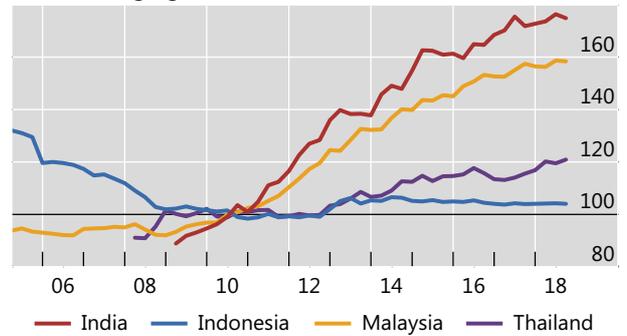
Major advanced economies



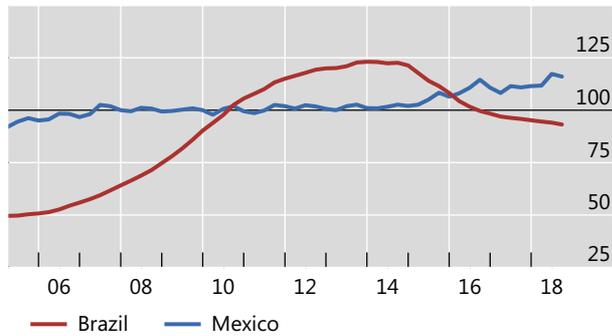
Emerging Asia



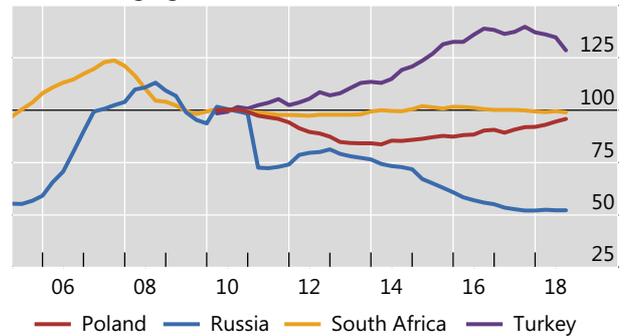
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS property price statistics is available at www.bis.org/statistics/pp.htm.

Source: BIS property prices statistics.

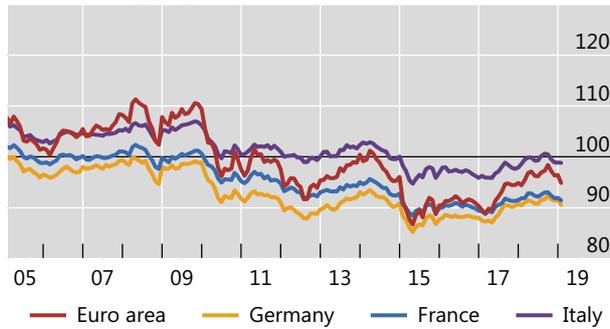
I Effective and US dollar exchange rate statistics

Real effective exchange rates

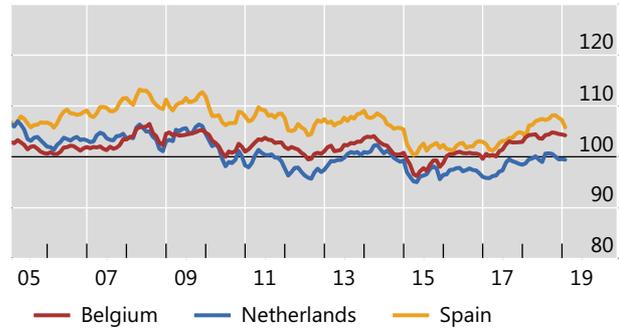
CPI-based, 1995–2005 = 100¹

Graph I.1

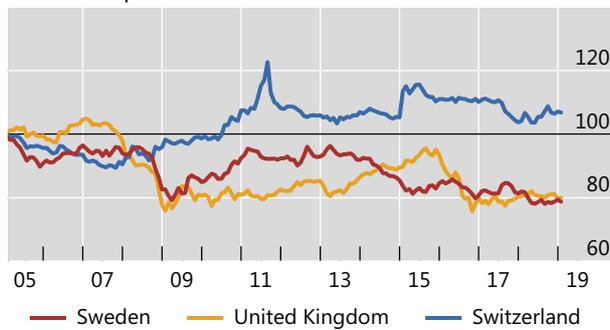
Euro area: aggregate and major countries



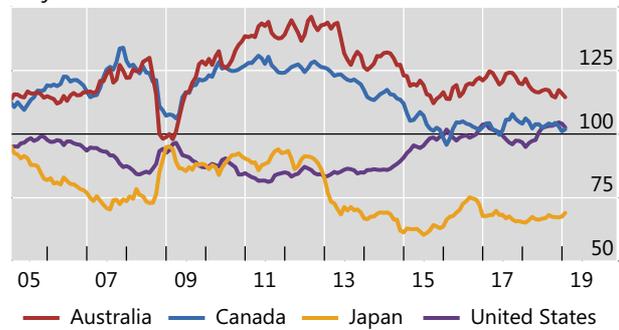
Euro area: other countries



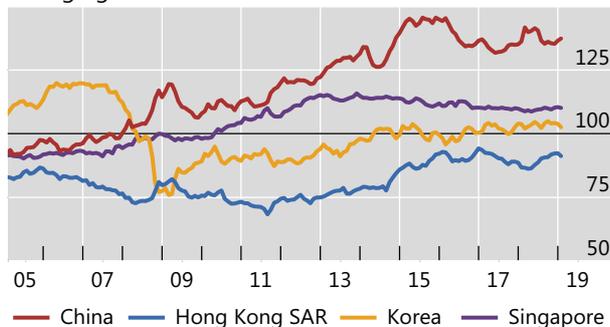
Other European countries



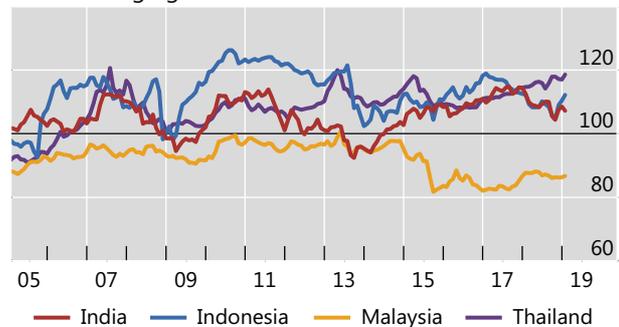
Major advanced economies



Emerging Asia



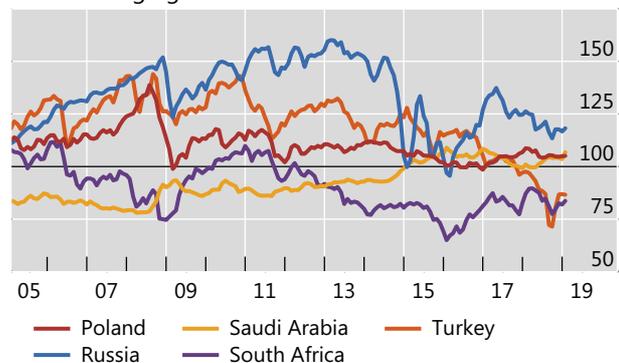
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS effective exchange rate statistics is available at www.bis.org/statistics/eer.htm.

¹ An increase indicates a real-term appreciation of the local currency against a broad basket of currencies.

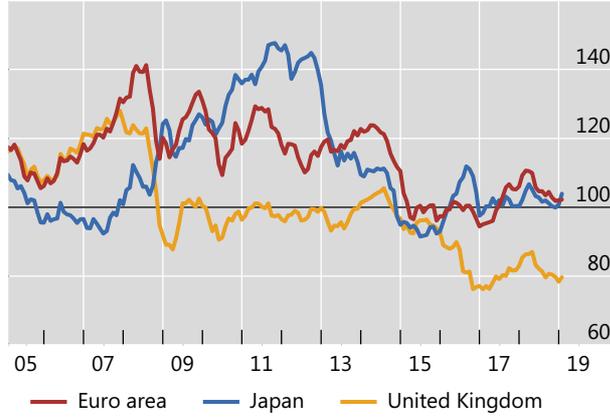
Source: BIS effective exchange rates statistics.

US dollar exchange rates

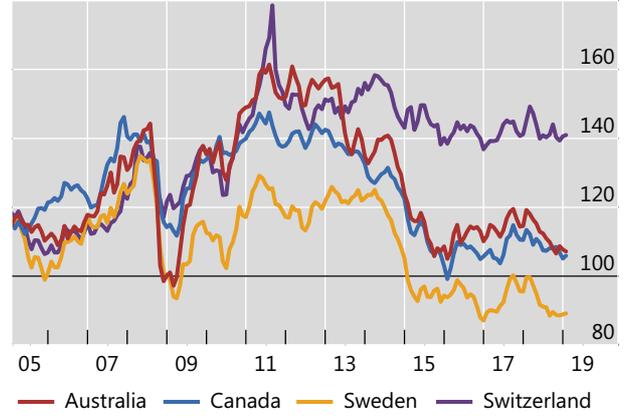
Indices, 1995–2005 = 100¹

Graph I.2

Major advanced economies



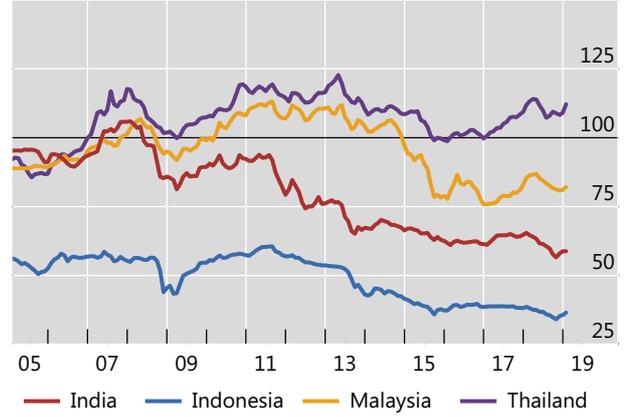
Other advanced economies



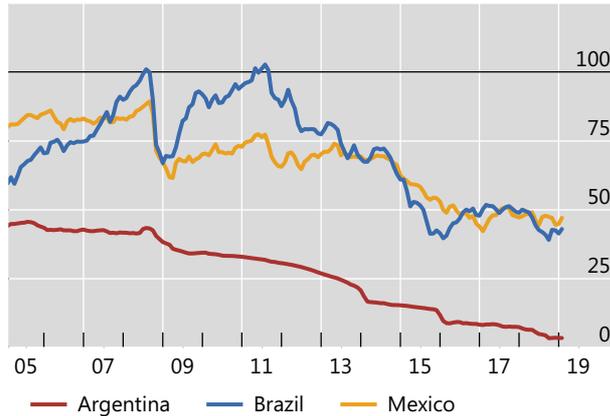
Emerging Asia



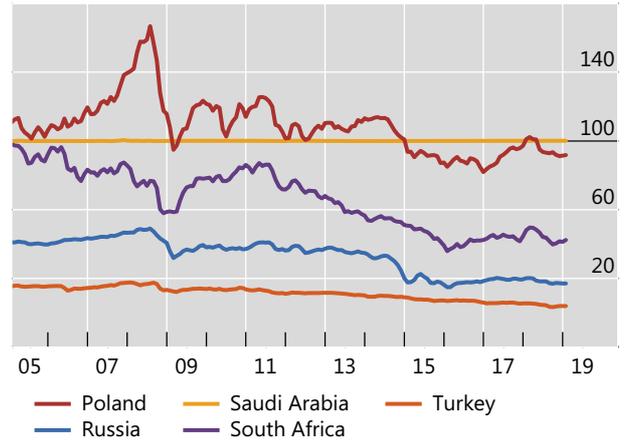
Other emerging Asia



Latin America



Other emerging market economies



Further information on the exchange rate statistics is available at www.bis.org/statistics/xrusd.htm.

¹ An increase indicates an appreciation of the local currency against the US dollar.

Source: BIS US dollar exchange rates statistics.

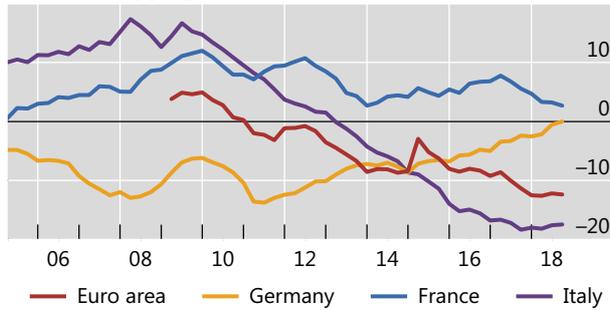
J Credit-to-GDP gaps

Credit-to-GDP gaps

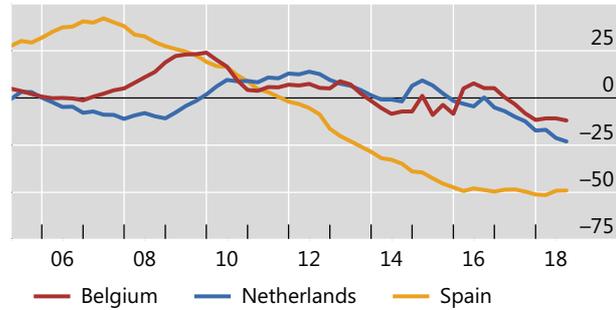
In percentage points of GDP

Graph J.1

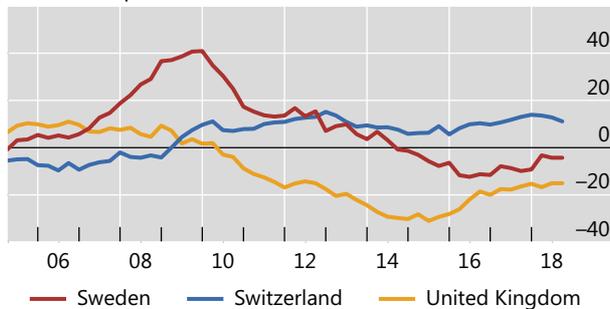
Euro area: aggregate and major countries



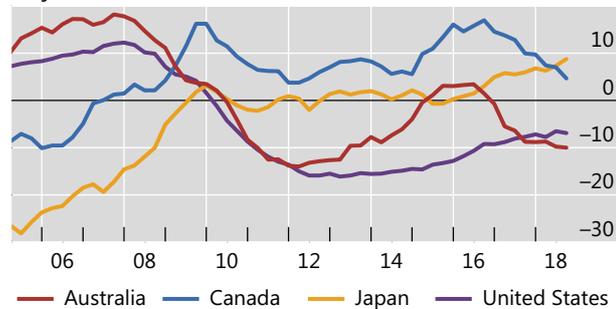
Euro area: other countries



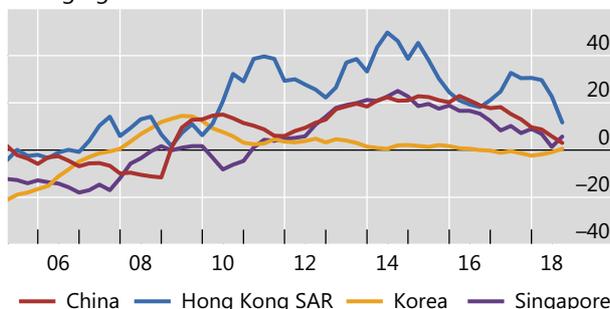
Other European countries



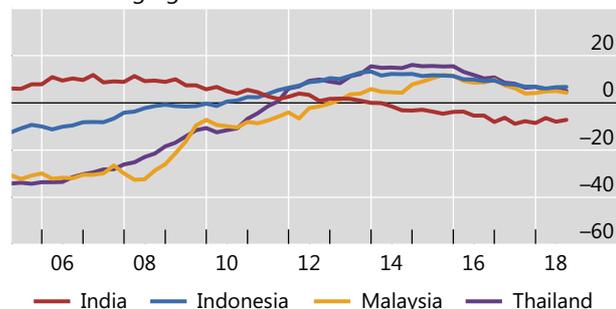
Major advanced economies



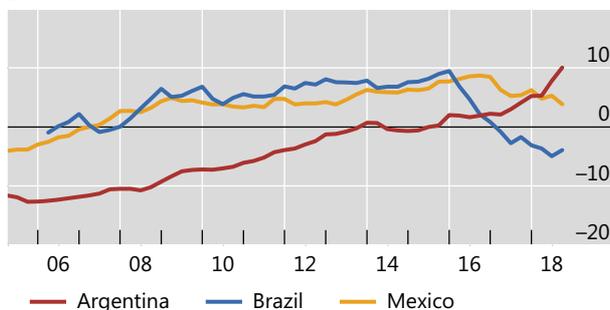
Emerging Asia



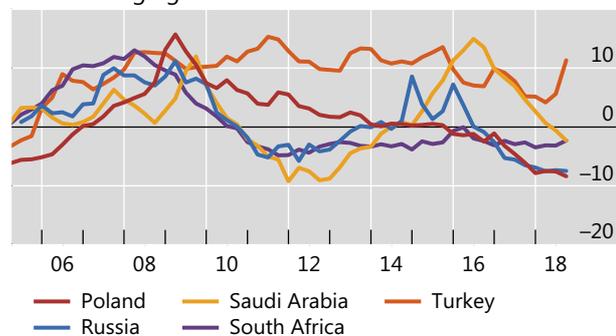
Other emerging Asia



Latin America



Other emerging market economies



¹ Estimates based on series on total credit to the private non-financial sector. The credit-to-GDP gap is defined as the difference between the credit-to-GDP ratio and its long-term trend; the long-term trend is calculated using a one-sided Hodrick-Prescott filter with a smoothing parameter of 400,000. Further information on the BIS credit-to-GDP gaps is available at www.bis.org/statistics/c_gaps.htm.

Source: BIS credit-to-GDP gaps statistics.

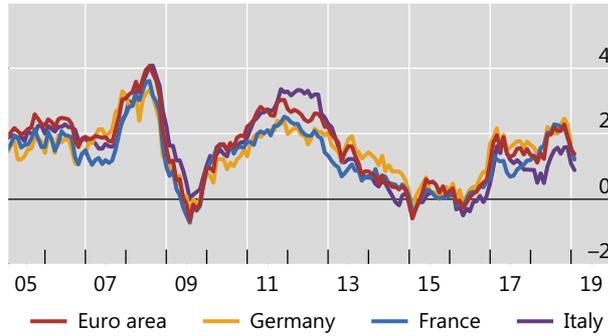
K Consumer prices

Consumer prices

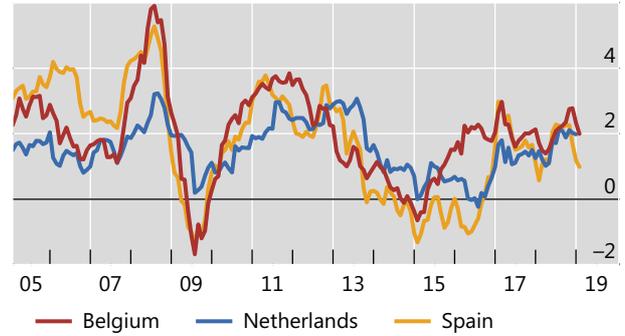
Year-on-year percentage changes

Graph K.1

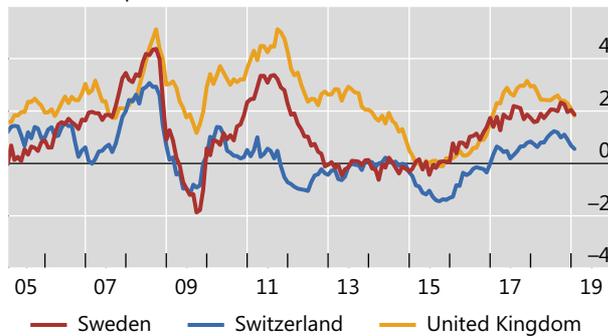
Euro area: aggregate and major countries



Euro area: other countries



Other European countries



Major advanced economies



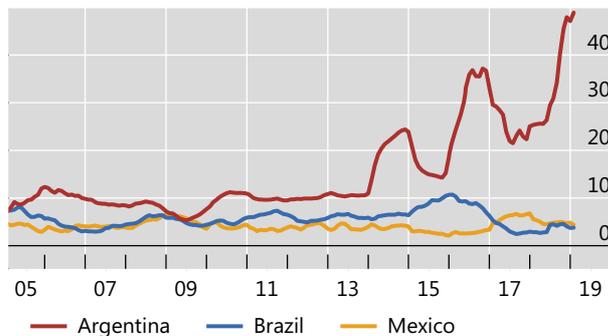
Emerging Asia



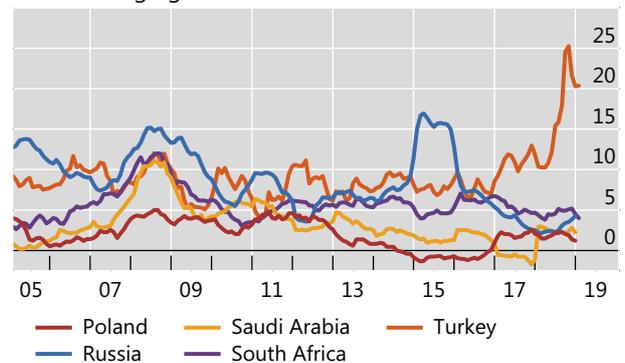
Other emerging Asia



Latin America



Other emerging market economies



Further information on the BIS consumer prices is available at www.bis.org/statistics/cp.htm.

Source: BIS consumer price statistics.

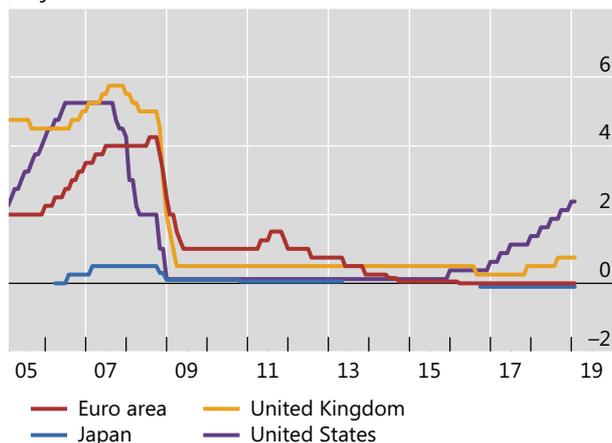
L Central bank policy rates

Central bank policy or representative rates

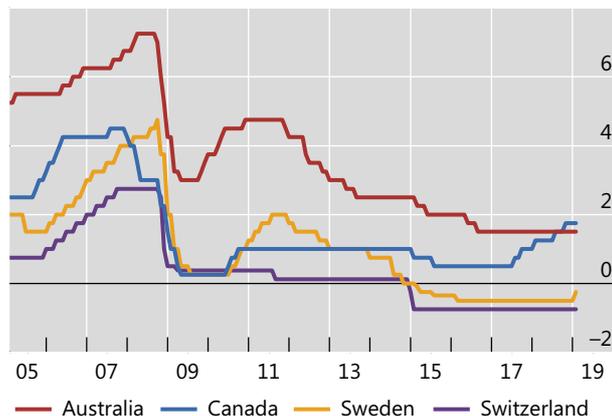
Month-end; in per cent

Graph L.1

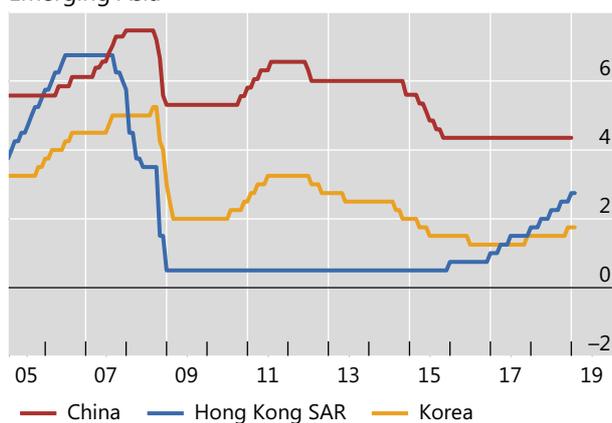
Major advanced economies



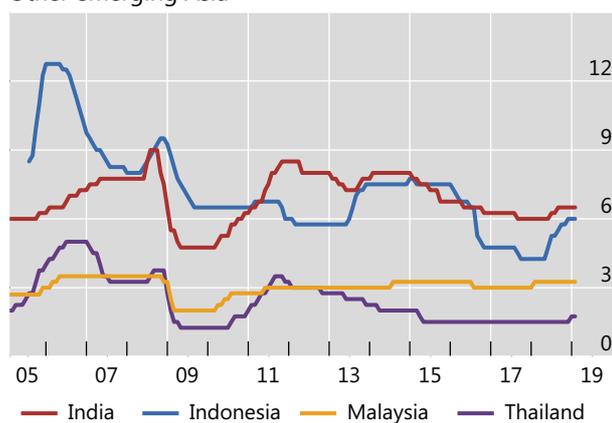
Other advanced economies



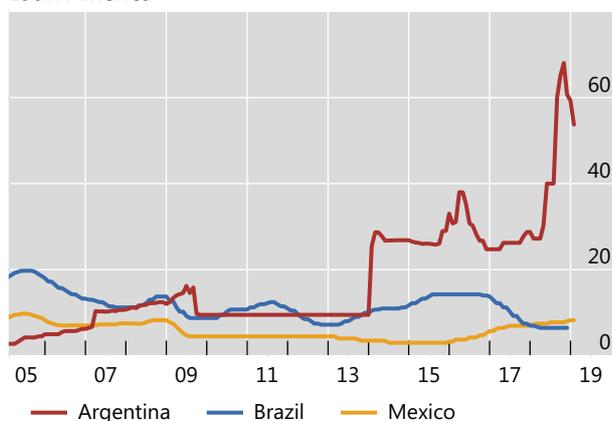
Emerging Asia



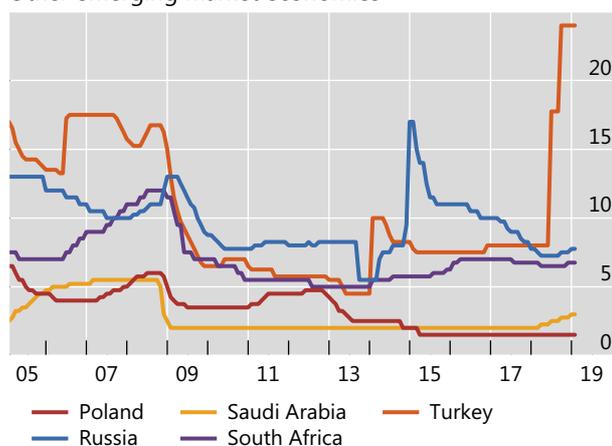
Other emerging Asia



Latin America



Other emerging market economies



Further information on the policy rates is available at www.bis.org/statistics/cbpol.htm.

Source: BIS policy rates statistics.

Special features in the BIS Quarterly Review

December 2018	<u>The growing footprint of EME banks in the international banking system</u>	Eugenio Cerutti, Catherine Koch & Swapan-Kumar Pradhan
December 2018	<u>The 2008 crisis: transpacific or transatlantic?</u>	Robert N McCauley
December 2018	<u>The financial cycle and recession risk</u>	Claudio Borio, Mathias Drehmann & Dora Xia
December 2018	<u>Clearing risks in OTC derivatives markets: the CCP-bank nexus</u>	Umar Faruqui, Wenqian Huang & Előd Takáts
September 2018	<u>Fintech credit markets around the world: size, drivers and policy issues</u>	Stijn Claessens, Jon Frost, Grant Turner & Feng Zhu
September 2018	<u>Regulating cryptocurrencies: assessing market reactions</u>	Raphael Auer & Stijn Claessens
September 2018	<u>The rise of zombie firms: causes and consequences</u>	Ryan Banerjee & Boris Hofmann
September 2018	<u>Term premia: models and some stylised facts</u>	Benjamin H Cohen, Peter Hördahl & Dora Xia
March 2018	<u>Early warning indicators of banking crises: expanding the family</u>	Iñaki Aldasoro, Claudio Borio & Mathias Drehmann
March 2018	<u>Tracking the international footprints of global firms</u>	Stefan Avdjiev, Mary Everett, Philip R Lane & Hyun Song Shin
March 2018	<u>Payments are a-changin' but cash still rules</u>	Morten Bech, Umar Faruqui, Frederik Ougaard & Cristina Picillo
March 2018	<u>The ABCs of bank PBRs: What drives bank price-to-book ratios?</u>	Bilyana Bogdanova, Ingo Fender & Előd Takáts
March 2018	<u>Mortgages, developers and property prices</u>	Michael Chui, Anamaria Illes & Christian Uppe
March 2018	<u>The implications of passive investing for securities markets</u>	Vladyslav Sushko & Grant Turner

Recent BIS publications¹

BIS Papers

Proceeding with caution - a survey on central bank digital currency

BIS Papers No 101, January 2019

The hypothetical benefits and risks of central bank digital currencies are being widely discussed. This BIS paper adds to these discussions by taking stock of how progress and plans in this area are developing, based on a global survey of central banks. Responses show that central banks are proceeding with caution and most are only at a conceptual stage with their work. However, a handful have moved to considering practical issues and a couple of central banks with idiosyncratic circumstances might issue a digital currency in the short or medium term

Globalisation and deglobalisation

BIS Papers No 100, December 2018

Globalisation has had a profound effect on economic outcomes, especially in emerging market economies (EMEs). In particular, it is widely acknowledged to have been a major driver of the strong income growth and reduction in poverty witnessed in EMEs in the past few decades. Despite these benefits, there has recently been a backlash against globalisation and growing support for inward looking policies in many parts of the world. Against this backdrop, this volume takes stock of the EME experience with two facets of globalisation-trade and migration. It summarises different country experiences with regard to the aggregate as well as distributional consequences. In doing so, it highlights several examples and avenues for policy action to continue to harness the benefits of globalisation while limiting the costs.

BIS Working Papers

Macroprudential policy with capital buffers

Josef Schroth

February 2019, No 771

This paper studies optimal bank capital requirements in a model of endogenous bank funding conditions. I find that requirements should be higher during good times such that a macroprudential "buffer" is provided. However, whether banks can use buffers to maintain lending during a financial crisis depends on the capital requirement during the subsequent recovery. The reason is that a high requirement during the recovery lowers bank shareholder value during the crisis and thus creates funding-market pressure to use buffers for deleveraging rather than for maintaining lending. Therefore, buffers are useful if banks are not required to rebuild them quickly.

¹ Requests for publications should be addressed to Bank for International Settlements, Press & Communications, Centralbahnplatz 2, CH-4002 Basel. These publications are also available on the BIS website (<http://www.bis.org/>).

The expansionary lower bound: contractionary monetary easing and the trilemma

Paolo Cavallino and Damiano Sandri

February 2019, No 770

We provide a theory of the limits to monetary policy independence in open economies arising from the interaction between capital flows and domestic collateral constraints. The key feature is the existence of an "Expansionary Lower Bound" (ELB), defined as an interest rate threshold below which monetary easing becomes contractionary. The ELB can be positive, thus binding before the ZLB. Furthermore, the ELB is affected by global monetary and financial conditions, leading to novel international spillovers and crucial departures from Mundell's trilemma. We present two models in which the ELB may arise due to either carry-trade capital flows or currency mismatches.

Safe assets: made, not just born

Robert N McCauley

February 2019, No 769

Official reserve managers have a big stake in the debate over safe assets: their portfolios just about define such assets. This paper conveys the message that reserve managers need not worry about a shortage of safe assets. The debate turns first on whether demand for dollar safe assets will grow as rapidly as emerging market economies (EMEs). Second, it turns on whether the supply of dollar safe assets only grows with US fiscal deficits. Neither holds. On the demand side, EMEs' growth does not require ever higher dollar reserves. Indeed, the global economy may have reached "peak reserves" in 2014. On the supply side, law and policy extend state backing to various IOUs, thereby creating safe assets. US government support for the housing agencies Fannie Mae and Freddie Mac has made their debt into safe assets, albeit with wobbles. Federal Reserve liquidity, Federal Deposit Insurance Corporation insurance, and, in extremis as in 2008, Treasury equity also work to make US bank deposits safe. Elsewhere, government support of banks allows those from well rated countries to compete with US banks in issuing safe dollar deposits. Moreover, supranational organisations, non-US sovereigns and their agencies all compete with the US Treasury in issuing safe dollar bonds. In allocating their dollar foreign exchange reserves, central banks make room for such competitors. In particular, they hold more than a third of such reserves in instruments other than US Treasury securities.

Over-the-counter market liquidity and securities lending

Nathan Foley-Fisher, Stefan Gissler and Stéphane Verani

February 2019, No 768

This paper studies how over-the-counter market liquidity is affected by securities lending. We combine micro-data on corporate bond market trades with securities lending transactions and individual corporate bond holdings by U.S. insurance companies. Applying a difference-in-differences empirical strategy, we show that the shutdown of AIG's securities lending program in 2008 caused a statistically and economically significant reduction in the market liquidity of corporate bonds predominantly held by AIG. We also show that an important mechanism behind the decrease in corporate bond liquidity was a shift towards relatively small trades among a greater number of dealers in the interdealer market.

Central counterparty capitalization and misaligned incentives

Wenqian Huang

February 2019, No 767

Financial stability depends on the effective regulation of central counterparties (CCPs), which must take account of the incentives that drive CCP behavior. This paper studies the incentives of a for-profit CCP with limited liability. It faces a trade-off between fee income and counterparty credit risk. A better-capitalized CCP sets a higher collateral requirement to reduce potential default losses, even though it forgoes fee income by deterring potential traders. I show empirically that a 1% increase in CCP capital is associated with a 0.6% increase in required collateral. Limited liability, however, creates a wedge between its capital and collateral policy and the socially optimal solution to this trade-off. The optimal capital requirements should account for clearing fees.

Risk endogeneity at the lender/investor-of-last-resort

Diego Caballero, André Lucas, Bernd Schwaab and Xin Zhang

January 2019, No 766

We address to what extent a central bank can de-risk its balance sheet by unconventional monetary policy operations. To that end, we propose a novel risk measurement framework to empirically study the time variation in central bank portfolio credit risks associated with such operations. The framework accommodates a large number of bank and sovereign counterparties, joint tail dependence, skewness, and time-varying dependence parameters. In an application to selected items from the consolidated Eurosystem's weekly balance sheet between 2009 and 2015, we find that unconventional monetary policy operations generated beneficial risk spillovers across monetary policy operations, causing overall risk to be non-linear in exposures. Some policy operations reduced rather than increased overall risk.

Beyond the doomsday economics of "proof-of-work" in cryptocurrencies

Raphael Auer

January 2019, No 765

This paper discusses the economics of how Bitcoin achieves data immutability, and thus payment finality, via costly computations, ie "proof-of-work". Further, it explores what the future might hold for cryptocurrencies modelled on this type of consensus algorithm. The conclusions are, first, that Bitcoin counterfeiting via "double-spending" attacks is inherently profitable, making payment finality based on proof-of-work extremely expensive. Second, the transaction market cannot generate an adequate level of "mining" income via fees as users free-ride on the fees of other transactions in a block and in the subsequent blockchain. Instead, newly minted bitcoins, known as block rewards, have made up the bulk of mining income to date. Looking ahead, these two limitations imply that liquidity is set to fall dramatically as these block rewards are phased out. Simple calculations suggest that once block rewards are zero, it could take months before a Bitcoin payment is final, unless new technologies are deployed to speed up payment finality. Second-layer solutions such as the Lightning Network might help, but the only fundamental remedy would be to depart from proof-of-work, which would probably require some form of social coordination or institutionalisation.

Global Banking, Financial Spillovers, and Macroprudential Policy Coordination

Pierre-Richard Agénor and Luiz Awazu Pereira da Silva

January 2019, No 764

The gains from international macroprudential policy coordination are studied in a two-region, core-periphery macroeconomic model with imperfect financial integration and cross-border banking. Financial frictions occur at two levels: between firms and banks in each region, and between periphery banks and a global bank in the core region. Macroprudential regulation takes the form of a countercyclical tax on bank loans to domestic capital goods producers, which responds to real credit growth and is subject to a cost in terms of welfare. Numerical experiments, based on a parameterized version of the model, show that the welfare gains from macroprudential policy coordination are positive, albeit not large, for the world economy. In addition, these gains tend to increase with the degree of international financial integration. However, depending on the origin of financial shocks, they can also be highly asymmetric across regions.

On money, debt, trust and central banking

Claudio Borio

January 2019, No 763

This essay examines in detail the properties of a well functioning monetary system - defined as money plus the mechanisms to execute payments - in both the short and long run, drawing on both theory and the lessons from history. It stresses the importance of trust and of the institutions needed to secure it. Ensuring price and financial stability is critical to nurturing and maintaining that trust. In the process, the essay addresses several related questions, such as the relationship between money and debt, the viability of cryptocurrencies as money, money neutrality, and the nexus between monetary and financial stability. While the present monetary system, with central banks and a prudential apparatus at its core, can and must be improved, it still provides the best basis to build on.

A key currency view of global imbalances

Robert N McCauley and Hiro Ito

December 2018, No 762

This working paper contributes to a growing body of work that breaks free of the "triple coincidence" often assumed in international finance. A currency's domain does not coincide with the borders of the jurisdiction that issues it. Instead, key currencies enjoy global use. A key currency perspective can change how global imbalances look to economists, policymakers and market participants.

Non-monetary news in central bank communication

Anna Cieslak and Andreas Schrimpf

December 2018, No 761

We quantify the importance of non-monetary news in central bank communication. Using evidence from four major central banks and a comprehensive classification of events, we decompose news conveyed by central banks into news about monetary policy, economic growth, and separately, shocks to risk premia. Our approach exploits high-frequency comovement of stocks and interest rates combined with monotonicity restrictions across the yield curve. We find significant differences in news composition depending on the communication channel used by central banks. Non-monetary news prevails in about 40% of policy decision announcements by the Fed and the ECB, and this fraction is even higher for communications that provide context to policy decisions such as press conferences. We show that non-monetary news accounts for a significant part of financial markets' reaction during the financial crisis and in the early recovery, while monetary shocks gain importance since 2013.

Gross capital flows by banks, corporates and sovereigns

Stefan Avdjiev, Bryan Hardy, Sebnem Kalemli-Ozcan and Luis Servén

December 2018, No 760

We construct a new data set of quarterly international capital flows by sector, with an emphasis on debt flows. Using our new data set, we establish four facts. First, the co-movement of capital inflows and outflows is driven by inflows and outflows vis-à-vis the domestic banking sector. Second, the procyclicality of capital inflows is driven by banks and corporates, whereas sovereigns' external liabilities move acyclically in advanced and countercyclically in emerging countries. Third, the procyclicality of capital outflows is driven by advanced countries' banks and emerging countries' sovereigns (reserves). Fourth, capital inflows and outflows decline for banks and corporates when global risk aversion (VIX) increases, whereas sovereign flows show no response. These facts are inconsistent with a large class of theoretical models.

Basel Committee on Banking Supervision

An examination of initial experience with the global systemically important bank framework

February 2019

This paper presents a first analysis of the experience to date with the global systemically important bank (G-SIB) framework, the methodology for assessing the systemic importance of G-SIBs. Several issues are examined. First, we investigate whether G-SIBs and non-G-SIBs have behaved differently since the implementation of the G-SIB framework and if observed differences in behaviour are in accordance with the framework's aims. Next, we ask whether there are regional differences in the behaviour of G-SIBs and non-G-SIBs.

Minimum capital requirements for market risk

January 2019

The Minimum capital requirements for market risk replaces an earlier version of the standard as published in January 2016.

The standard has been revised to address issues that the Basel Committee identified in the course of monitoring the implementation and impact of the framework. This final standard

incorporates changes that were proposed in a March 2018 consultative document and has been informed by a quantitative impact based on data as of end-December 2017.

As in the January 2016 framework, the core features of the standard include:

- a clearly defined boundary between the trading book and the banking book;
- an internal models approach that relies upon the use of expected shortfall models and sets out separate capital requirements for risk factors that are deemed non-modellable; and
- a standardised approach that is risk-sensitive and is designed and calibrated to serve as a credible fallback to the internal models approach.

Revisions to the January 2016 framework include the following key changes:

- a simplified standardised approach for use by banks that have small or non-complex trading portfolios;
- clarifications on the scope of exposures that are subject to market risk capital requirements;
- refined standardised approach treatments of foreign exchange risk and index instruments;
- revised standardised approach risk weights applicable to general interest rate risk, foreign exchange and certain exposures subject to credit spread risk;
- revisions to the assessment process to determine whether a bank's internal risk management models appropriately reflect the risks of individual trading desks; and
- revisions to the requirements for identification of risk factors that are eligible for internal modelling.

This revised standard comes into effect on 1 January 2022.

Revisions to leverage ratio disclosure requirements **December 2018**

The Basel III leverage ratio standard comprises a 3% minimum level that banks must meet at all times, a buffer for global systemically-important banks and a set of public disclosure requirements. For the purpose of disclosure requirements, banks must report the leverage ratio on a quarter-end basis or, subject to approval by national supervisors, report a measure based on averaging (eg using an average of exposure amounts based on daily or month-end values).

Heightened volatility in various segments of money and derivatives markets around key reference dates (eg quarter-end) has alerted the Basel Committee to potential regulatory arbitrage by banks. A particular concern is "window-dressing", in the form of temporary reductions of transaction volumes in key financial markets around reference dates resulting in the reporting and public disclosure of elevated leverage ratios. In this regard, the Committee published a newsletter in October 2018 in which it indicated that window-dressing by banks is unacceptable, as it undermines the intended policy objectives of the leverage ratio requirement and risks disrupting the operations of financial markets.

Pillar 3 disclosure requirements - updated framework **December 2018**

Pillar 3 of the Basel framework seeks to promote market discipline through regulatory disclosure requirements. The revised Pillar 3 framework reflects the Committee's December 2017 Basel III post-crisis regulatory reforms and pertains to the following areas:

- credit risk, operational risk, the leverage ratio and credit valuation adjustment (CVA) risk;
- risk-weighted assets (RWAs) as calculated by the bank's internal models and according to the standardised approaches; and
- an overview of risk management, RWAs and key prudential metrics.

Cyber-resilience: range of practices

December 2018

The Basel Committee on Banking Supervision today published the report. It identifies, describes and compares the range of observed bank, regulatory and supervisory cyber-resilience practices across jurisdictions.

Based on analysis of authorities' responses to previous international surveys and on exchanges between international experts, the report gains insight into the effective practices and expectations in place. It also benefited from industry participants' input.

Committee on the Global Financial System

Establishing viable capital markets

January 2019, No 62

The Capital markets provide an important channel of financing for the real economy, they help allocate risk, and they support economic growth and financial stability. Moreover, capital markets have played an important part in financing the recovery from the Great Financial Crisis (GFC), a reminder of their "spare tyre" role in the financial system. This report examines recent trends in capital market development and identifies the factors that foster the development of robust capital markets.

The report finds that large differences persist in the size of capital markets across advanced and emerging economies. Emerging-economy markets have been catching up with their more advanced peers, but the gap has not yet been closed.

The analysis highlights the importance of macroeconomic stability, market autonomy, strong legal frameworks and effective regulatory regimes in supporting market development. Better disclosure standards, investor diversity, internationalisation, and deep hedging and funding markets, as well as efficient and robust market infrastructures, also play a key role.

The report's recommendations across six broad areas outline practical ways to support the development of robust and efficient markets.

Committee on Payments and Market Infrastructure

Implementation monitoring of PFMI: Assessment report for Switzerland

January 2019 No 183

The Committee on Payments and Market Infrastructures (CPMI) and the International Organization of Securities Commissions (IOSCO) closely monitors the implementation of the Principles for financial market infrastructures (PFMI). This report presents the conclusions drawn by the CPMI and IOSCO from a Level 2 assessment of whether, and to what degree, the legal, regulatory and oversight frameworks for financial market infrastructures (FMIs) in Switzerland, including rules and regulations, any relevant policy statements, or other forms of implementation, are complete and consistent with the Principles.

The assessment found that - as of 30 June 2017 - Switzerland has generally implemented the PFMI. For PSs, CSDs/SSSs and CCPs, the Principles have been implemented in a complete and consistent or broadly consistent manner with the exception of Principle 7 on liquidity risk management and Principle 22 on communication procedures and standards, as well as Principle 19 (as applicable for PSs) on tiered participation arrangements. For TRs, a number of gaps were identified with varying severity. Principles 1, 3, 15, 17, 20, 22 and 24 on legal basis, the framework for the comprehensive management of risks, general business risk, operational risk, FMI links, communication procedures and standards, and disclosure of market data, respectively, have not been fully implemented.

Market Committee

Monitoring of fast-paced electronic markets

September 2018 No 10

The Foreign exchange and other fast-paced electronic markets (FPMs) have undergone a wide range of structural changes in recent years. Trading in FPMs has become increasingly electronic and automated, significantly changing the market ecosystem. Against this background, the report explores aspects of structural change with immediate relevance for central banks' market monitoring approaches.

The three key structural changes include greater speed and fragmentation of trading activity; greater concentration of liquidity provision among the largest banks and the new set of non-bank intermediaries; and the rise in volume and commoditisation of large quantities of high-frequency data on the back of greater electrification.

At the same time, the market-monitoring capacities of market participants in both the public and private sector have been transformed. Central banks have striven to adapt their near-time and medium-term monitoring approaches to these changes. Monitoring needs naturally vary according to central bank mandates and how far markets have been electrified. Central banks' monitoring requirements will also naturally differ from those of the private sector.

Speeches

Distributed ledger technology and large value payments: a global game approach

Lecture by Mr Hyun Song Shin, Economic Adviser and Head of Research of the BIS, • University of Cambridge, 22 January 2019.

Payment systems built around distributed ledger technology (DLT) operate by maintaining identical copies of the history of payments among the participant nodes in the payment system. Cryptocurrencies are perhaps the best-known example of the application of DLT, but the applicability of the technology is much broader. Payment systems based on DLT are compatible with oversight by the central bank, and several central banks have conducted successful trials of interbank payments. In these trials, payment system participants transfer digital tokens that are redeemable at the central bank and use DLT to transfer them to other system participants. Decentralised consensus is achieved through agreement of a supermajority of the participants (typically 75-80%) who collectively validate payments.

Nevertheless, the technology by itself does not overcome the credit needs of the payment system to maintain settlement liquidity. In conventional real-time gross settlement (RTGS) payment systems, the value of daily payments can be over 100 times the deposit balance maintained by the system participant at the central bank. As such, incoming payments are recycled into outgoing payments, and credit provided by the central bank supplements private credit from outside the payment system for the smooth functioning of the system as a whole.

We examine the liquidity properties of decentralised payment systems in an economic model of payments, in which the cost of credit to finance payments enters explicitly.

Claudio Borio interview with Capital

Original quotes from interview with Mr Claudio Borio, Head of the Monetary and Economic Department of the BIS, with Capital, conducted by Mr Lukas Zdrzalek and published on 24 January 2019.

BIS Quarterly Review, December 2018 - media briefing

Remarks by Claudio Borio and Hyun Song Shin.

Shelter from the storm

Remarks by Mr Agustín Carstens, General Manager of the BIS, at a seminar at the European Stability Mechanism, Luxembourg, 7 December 2018.

Getting one's house in order, building a resilient and flexible economy, and reducing vulnerabilities - all these things are of first-order importance. But it would be naive to believe that we can avoid all future crises. And when they do occur, having a shelter from the storm is very important. This speech reviews the achievements and unintended consequences of the policy response to the Global Financial Crisis and the subsequent European debt crisis. It then sketches the challenges authorities might face in the years to come and discusses what can be done to safeguard economic and financial stability.

Big tech in finance and new challenges for public policy

Keynote address by Mr Agustín Carstens, General Manager of the BIS, at the FT Banking Summit, London, 4 December 2018.

Large technology companies with established user networks ("big tech") are challenging traditional finance. Having started with payments, in some markets such companies have been expanding into the provision of credit, insurance and even wealth management. They have been doing so either directly or in cooperation with incumbent financial institutions. This raises a host of questions around competition, financial inclusion, data protection and financial stability. Will this growth lead to a more diverse financial system or to new forms of concentration? Is the expansion of big tech driven by efficiency gains, or by arbitrage of the current regulatory system? And how should public policy adapt to these developments in order to protect client data and help sustain strong and balanced growth?

Financial instability: can Big Data help connect the dots?

Remarks by Mr Luiz Awazu Pereira da Silva, Deputy General Manager of the BIS, and Goetz von Peter, Principal Economist at the BIS, based on a speech delivered at the Ninth European Central Bank Statistics Conference on "20 years of ESCB statistics: what's next?", Frankfurt am Main, 11 July 2018.

The Great Financial Crisis fuelled a broad-based expansion of financial statistics. A second, much larger wave of data hits the shores as central banks and the financial sector embrace Big Data. Collecting more data or dots is necessary, but connecting the dots is the critical step for understanding the implications for financial stability. It is the lens that matters: it takes purposeful analysis to turn data into useful information. Financial markets are flush with data, yet the bigger picture can slip out of sight. This is where policymakers and market participants fall short time and again: in run-ups to previous crises, simple aggregates would signal problems yet warnings went unheeded. The onset of a crisis then sharpens the focus on critical data for the management and resolution of the crisis. Later, when the financial cycle turns again, innovation and changing structure make financial risks harder to locate using the existing data.