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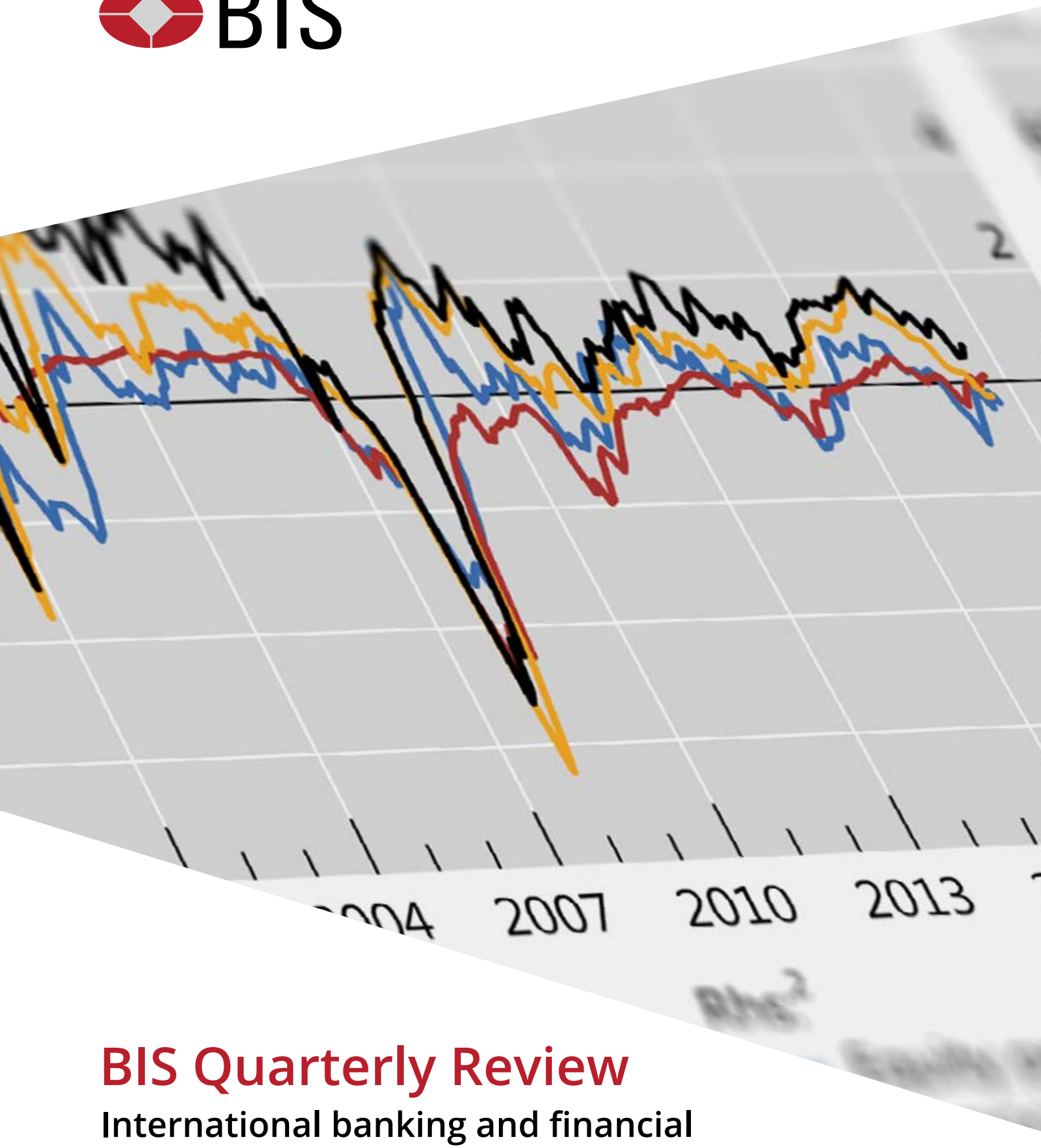

BIS Quarterly Review

International banking and financial market developments

September 2019

BIS Quarterly Review
Monetary and Economic Department

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Special features

Notations used in this Review

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

Differences in totals are due to rounding.
The term "country" as used in this publication also covers territorial entities that are not states as understood by international law and practice but for which data are separately and independently maintained.

Abbreviations

Currencies

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

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	Cabo Verde	IE	Ireland

Countries (cont)

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

Countries (cont)

TM	Turkmenistan	VC	St Vincent and the Grenadines
TO	Tonga	VE	Venezuela
TR	Turkey	VG	British Virgin Islands
TT	Trinidad and Tobago	VN	Vietnam
TW	Chinese Taipei	XM	euro area
UA	Ukraine	ZA	South Africa
US	United States	ZM	Zambia
UY	Uruguay	1C	International organisations
UZ	Uzbekistan	1Z	British West Indies

Markets swing on trade and monetary policy

Starting in May, prices of risky assets seesawed in response to unexpected turns in trade policy and adjustments to monetary policy.[1] The rally in equity and credit markets seen in early 2019 reversed course in May on the prospect of higher tariffs on US-China trade and US imports from Mexico. Facing weakening growth and subdued inflation, central banks in advanced economies (AEs) as well as emerging market economies (EMEs) eased policy to pre-empt a further deterioration.

The shift to a more stimulative monetary outlook reassured investors. In June, stocks surged and corporate bond spreads narrowed. In light of the broadly synchronous monetary easings, exchange rates for the US dollar against other AE currencies remained stable.

Trade tensions escalated again in August, which renewed downward pressure on equity and credit prices. The sell-off was accompanied by large outflows from EME funds. The renminbi dropped to multi-year lows against the US dollar, and its correlation with other EME currencies rose substantially, underscoring spillovers from China. Risky assets in AEs other than the United States were particularly sensitive to trade tensions, with equities losing more than the S&P 500. The macroeconomic backdrop remained especially vulnerable for export-oriented economies.

The confluence of trade tensions, deteriorating growth prospects and decisive monetary accommodation drove sovereign bond yields to new lows in August. The amount of fixed income securities with negative yields, mainly euro- and yen-denominated government bonds, reached record highs. Yield curves inverted in a number of countries. At times, markets interpreted this inversion as a signal of rising recession risk. However, other indicators painted a more mixed picture. As term premia fell to new troughs, equity prices stabilised. Financial conditions in most AEs remained fairly loose by historical standards.

[1] This overview focuses on developments between 1 May and 11 September 2019.

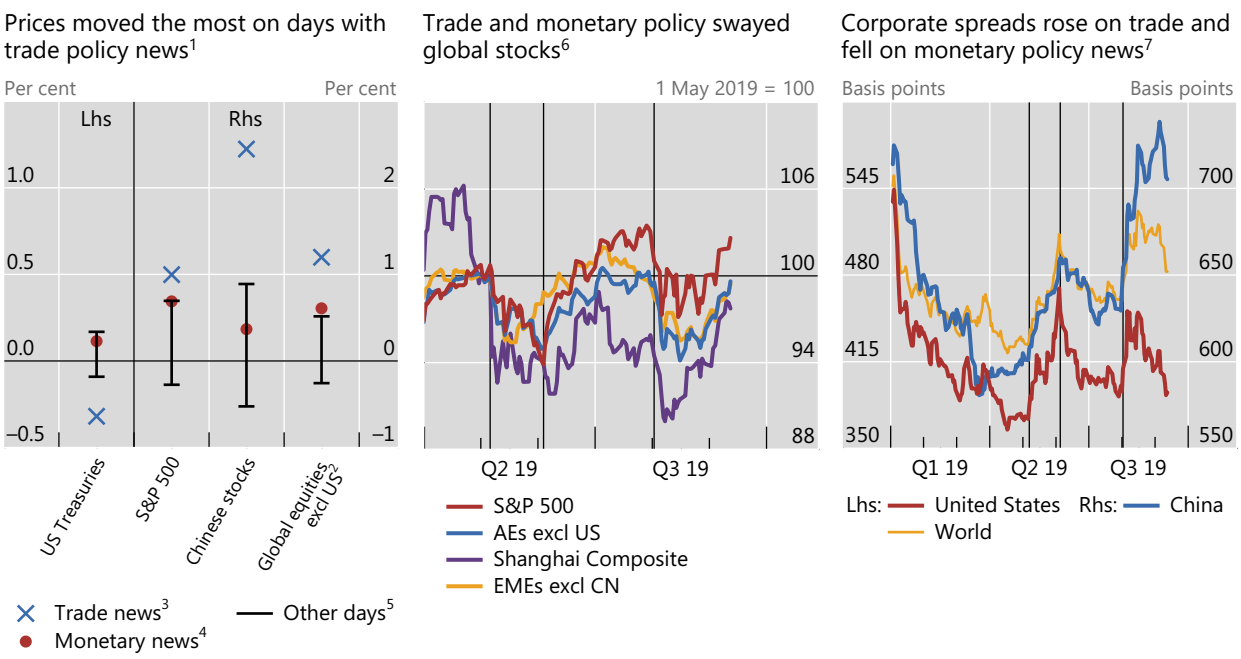
Trade and monetary policy drove markets in a weakening economy

Significant trade and monetary policy news drove the largest price movements during the period under review. When trade tensions eased, prices of US and Chinese equities posted outsize gains and US Treasury bond prices fell sharply. Similarly, risky asset prices rose when the Federal Reserve indicated a more accommodative stance than anticipated, although moves in those instances were not as pronounced (Graph 1, left-hand panel).

Starting in May, asset prices reflected increasing anxiety about trade. Global stock prices dropped 2% in early May after the United States announced higher tariffs on imports from China, and slid further in mid-May when China countered with its own tariffs. Equities sold off again in late May after the United States threatened to impose tariffs on imports from Mexico unless Mexico stemmed migration to the United States. These drops meant that global stocks closed the month down about 5% (Graph 1, centre panel).

Mirroring disquiet in equity markets, corporate bond spreads rose swiftly. The rise was particularly pronounced in the United States, with high-yield spreads up by

Trade and monetary policy were key drivers of asset prices — Graph 1



The vertical lines in the centre and right-hand panels indicate 6 May 2019 (first business day after US announces intention to raise tariffs on $200bn of Chinese imports), 4 June 2019 (Fed Chairman states that the Fed "will act as appropriate to sustain the expansion" in midst of trade uncertainty) and 1 August 2019 (US announces intention to impose new trade tariffs on $300bn of Chinese imports).

[1] Calculated daily changes for each variable over period 1 May–11 September 2019. US Treasuries = Vanguard intermediate-term Treasury ETF; S&P 500 = Vanguard S&P 500 ETF; Chinese stocks = iShares MSCI China ETF; global equities excl US = FTSE All-World ex US ETF. [2] The return has been corrected to account for the FX return. [3] Median calculated on days of trade events. Returns are multiplied by –1 when trade tensions escalated. [4] Median calculated on days of monetary policy events. Returns are multiplied by –1 when monetary policy news indicated a tighter stance than expected. [5] Interquartile range calculated on days with neither monetary policy nor trade events. [6] Based on GDP-weighted averages across countries. [7] For the United States, based on ICE BoAML indices; for China, based on JPMorgan Chase CEMBI HY index, stripped spread; for world, based on JPMorgan Chase global aggregate bond HY index denominated in US dollars; government spread.

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

about 100 basis points in May, exceeding the increase in global high-yield spreads. Nevertheless, spreads remained below the highs reached in late 2018 (Graph 1, right-hand panel).

In June, anxiety turned to reassurance on prospects of more accommodative monetary policy and an easing of trade tensions. On 4 June, the Fed indicated that it would act as appropriate to sustain the expansion in the face of economic challenges, including those originating from trade disputes. Later in June, the United States cancelled plans to impose tariffs on imports from Mexico, and the United States and China agreed to restart trade talks. These developments triggered a rapid rise in equity prices, with the S&P 500 reaching a new historical peak in late July, and corporate spreads declined (Graph 1, centre and right-hand panels).

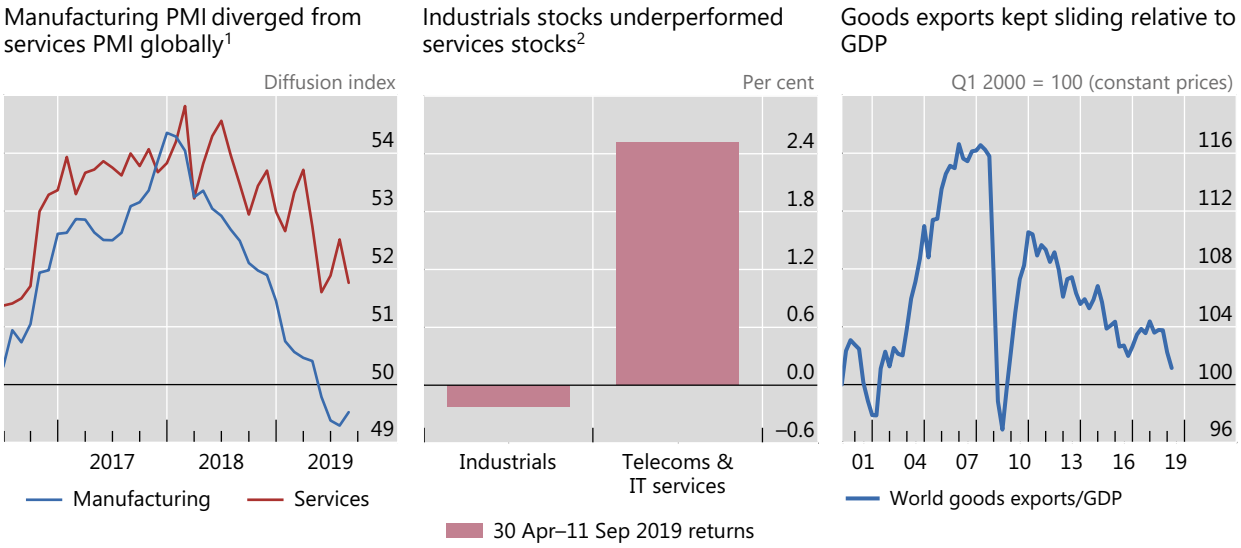
Anxiety returned in August on rekindled trade tensions. With new threats on 1 August of US tariffs on Chinese goods, equities dropped and corporate bond spreads widened across the board in a flight to safety (Graph 1, right-hand panel). Although the sell-off was over by mid-August, the prices of risky assets stayed volatile. The relative strength of the US economy helped US high-yield corporate spreads to recover more quickly in the second half of the month than spreads elsewhere.

Trade concerns eased again in early September, when China and the United States agreed to resume trade negotiations. This propelled equities higher and corporate spreads lower. By mid-September, US high-yield spreads were only slightly higher than in April, while their Chinese and global counterparts remained somewhat elevated. Chinese stocks rallied from mid-August, and by mid-September had recouped all of their post-June losses (Graph 1, centre panel).

Trade and monetary policy events unfolded in the context of a weakening global economy. Surveys of purchasing managers indicated a slowing of activity in the

Manufacturing weakness persisted globally

Graph 2



[1] A value of 50 indicates that the number of firms reporting improvement and deterioration is equal; a value above 50 indicates improvement (PMI = purchasing managers' index). [2] Based on daily returns of US dollar-denominated MSCI world industrials, communication services and information technology services indices.

Sources: IMF, *World Economic Outlook*; World Trade Organization; Datastream; IHS Markit; national data; BIS calculations.

services sector, although activity continued to expand faster than in manufacturing (Graph 2, left-hand panel; see also the special feature on purchasing managers' indices in this issue). The divergence between services and manufacturing was evident in equity returns, which were lower for industrial firms (centre panel). Furthermore, as a percentage of GDP, goods exports remained on the downward trend that had started soon after the Great Financial Crisis (GFC) of 2007–09 (right-hand panel).

In China, conjunctural indicators were generally weak, with GDP growing in the second quarter by 6.2%, the lowest rate since 1992. However, total social financing expanded at a faster pace than expected in August on the back of fiscal stimulus.

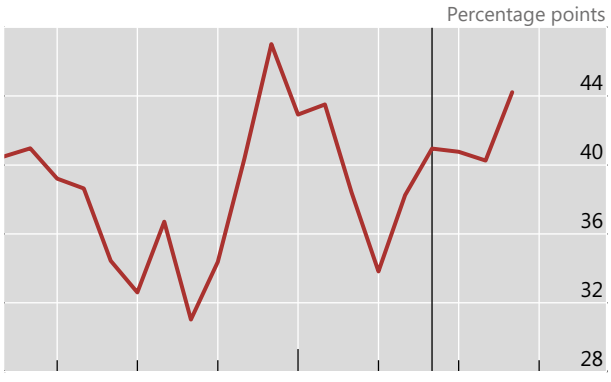
The US economy was not immune to trade tensions. Certain pockets showed signs of weakness, with slowing fixed investment growth and downward revisions to corporate profits forecasts. As a sign of how weaknesses in China could spill over to the United States, expected stock volatilities, calculated from option prices, were significantly higher for companies exposed to China than for the overall S&P 500 index. Indeed, in August this gap approached the heights reached in late 2018 (Graph 3, left-hand panel).

Despite the potential impact of trade tensions on the economic outlook, financial conditions were remarkably stable. In fact, in the United States they remained looser than during the late-2018 market turbulence and noticeably so relative to the long-term average. Financial conditions were also supportive in EMEs and in the euro area (Graph 3, right-hand panel).

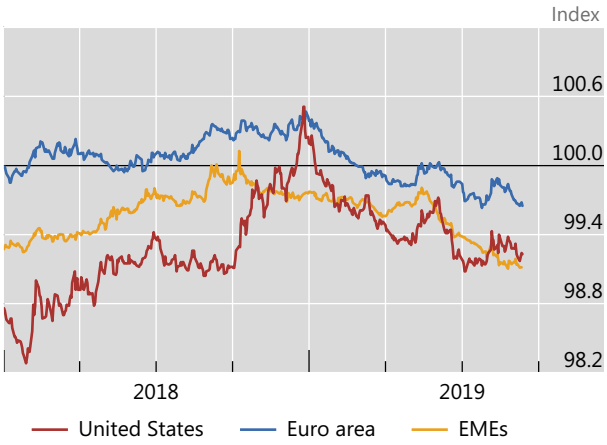
Despite benign financial conditions, US economy was vulnerable to trade conflict

Graph 3

Implied volatility rose in May for stocks exposed to China[1]



Financial conditions were supportive globally[2]



The vertical line in the left-hand panel indicates May 2019.

[1] Average difference between option-implied volatilities for companies exposed to China and the S&P 500 implied volatility index VIX. [2] A value of 100 indicates country-specific long-term averages; each unit above (below) 100 denotes financial conditions that are one standard deviation tighter (looser) than the average. For the United States, average over 1 January 1990–current; for the euro area, average over 1 April 1999–current.

Sources: Bloomberg; BIS calculations.

Monetary easing gained momentum

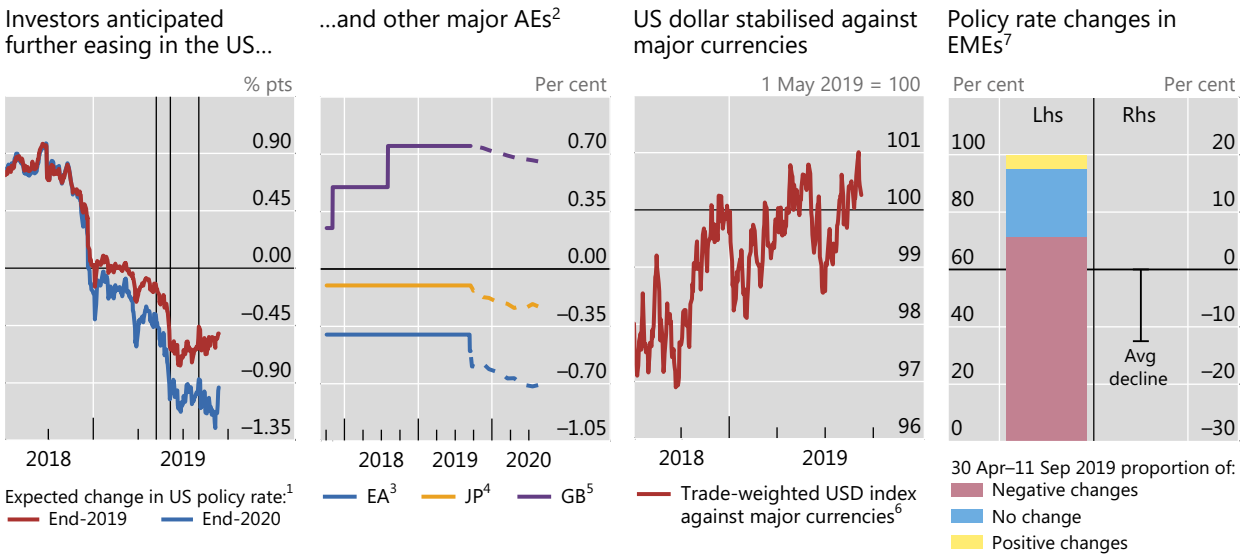
On the back of weakening economic activity, subdued inflation and volatile financial markets, monetary policy turned accommodative across the globe. The Federal Reserve cut its policy rate by 25 basis points in late July, and as of mid-September market participants expected further cuts of roughly 50 basis points by the end of 2019 and 90 basis points by the end of 2020 (Graph 4, first panel). On 12 September, the ECB cut the deposit rate by 10 basis points to –0.5% and restarted its asset purchase programme. Investors expected that policy rates would drop, by the end of 2020, by roughly another 20 basis points in the euro area and about 15 basis points in Japan (second panel).

The broad nature of monetary easing left the US dollar stable against most other AE currencies (Graph 4, third panel). An exception was sterling, where an increase in the prospect of the United Kingdom leaving the European Union without a withdrawal agreement led to a significant depreciation against the US dollar and the euro.

Central banks in many EMEs also eased their policy stance. Among others, Brazil, India, Korea and Mexico lowered their policy rate, with an average decline over the review period of more than 10% of the initial rate (Graph 4, fourth panel). China cut the reserve requirement ratio by 50 basis points for all financial institutions and by another 100 basis points for some smaller city commercial banks. In comparison, only about 25% of EMEs kept policy rates unchanged.

Monetary policy stance eased globally

Graph 4



The vertical lines in the left-hand panel indicate 6 May 2019 (first business day after US announces intention to raise tariffs on $200bn of Chinese imports), 4 June 2019 (Fed Chairman states that the Fed "will act as appropriate to sustain the expansion" in midst of trade uncertainty) and 1 August 2019 (US announces intention to impose new trade tariffs on $300bn of Chinese imports).

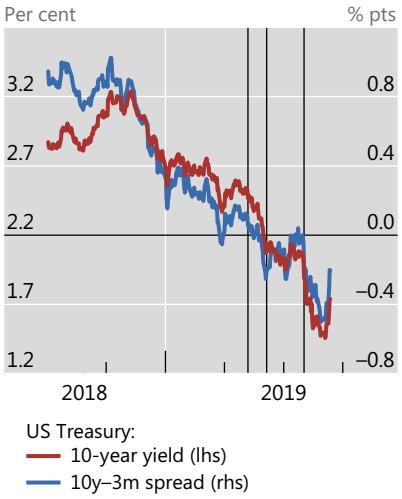
[1] Calculated as the difference between the simple average of December and January 30-day federal funds futures contracts and the effective federal funds rate. [2] The dashed lines indicate expected rates based on overnight index swap (OIS) forward rates; as of 13 September 2019. [3] Deposit facility rate. [4] Interest rate applied to policy rate balances in current accounts that financial institutions hold at the Bank of Japan. [5] Official bank rate. [6] Goods and services. [7] Brazil, Chile, China, Chinese Taipei, Colombia, the Czech Republic, Hong Kong SAR, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, the Philippines, Poland, Russia, Saudi Arabia, Singapore, South Africa and Thailand.

Sources: Federal Reserve Bank of St Louis, FRED; Bloomberg; Datastream; national data; BIS calculations.

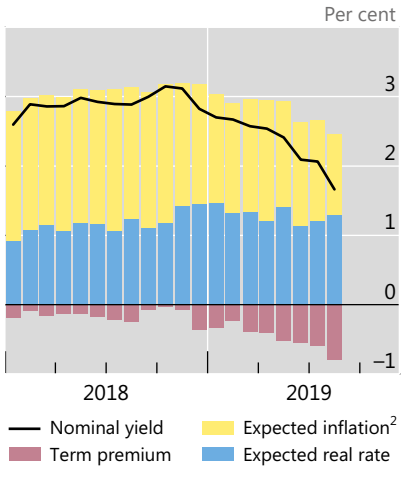
Long-term government bond yields declined across the board

Graph 5

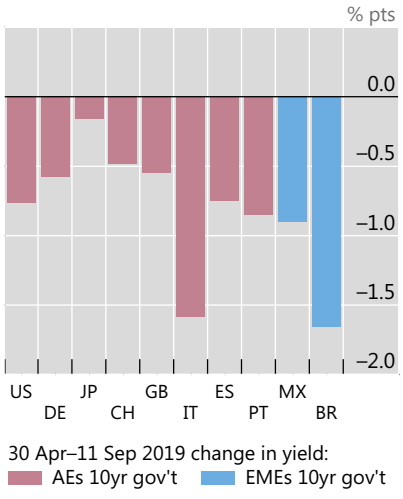
Ten-year Treasury yield slid and the term spread turned negative



Both expected inflation and the term premium contributed to the decline[1]



Long-term interest rates dropped globally[3]



The vertical lines in the left-hand panel indicate 6 May 2019 (first business day after US announces intention to raise tariffs on $200bn of Chinese imports), 4 June 2019 (Fed Chairman states that the Fed "will act as appropriate to sustain the expansion" in midst of trade uncertainty) and 1 August 2019 (US announces intention to impose new trade tariffs on $300bn of Chinese imports).

[1] The decomposition of the 10-year nominal yield according to an estimated joint macroeconomic and term structure model; see P Hördahl and O Tristani, "Inflation risk premia in the euro area and the United States", *International Journal of Central Banking*, September 2014. Yields are expressed in zero coupon terms. [2] Inflation for August 2019 has been proxied with the median forecast for the US year-on-year consumer price index. [3] Based on local currency securities.

Sources: Bloomberg; BIS; BIS calculations.

As the global easing gathered pace and trade tensions induced flight-to-safety flows, long-term yields fell across the board and in most AEs the yield curve inverted. The 10-year US Treasury yield dropped by about 80 basis points in the period under review (Graph 5, left-hand panel). The spread between 10-year and three-month Treasury yields dropped into negative territory in May and declined further as trade tensions escalated again in August before retracing part of its decline in early September. The expected real rate remained roughly unchanged, while expected inflation and, in particular, the term premium compressed noticeably (centre panel).

For Japan, 10-year yields declined about 10 basis points during the period under review and, for a number of other large AEs, yields fell by 50–100 basis points (Graph 5, right-hand panel). As a result, most AE sovereign yield curves were inverted, at least partially. Yields compressed in selected EMEs by somewhat larger amounts, although from higher levels. While US equity markets remained close to all-time highs, investor concerns mounted because yield curves typically invert ahead of recessions. As discussed in Box A, the inversion reflected an unusually compressed term premium, which complicates the evaluation of yield curve signals for future economic activity.

As interest rates declined, the amount of negative-yielding debt soared. While sovereign bond markets in the United States and the United Kingdom still offered positive yields, most tenors in Japan and the euro area dived into negative territory. In Switzerland, yields were below zero for maturities up to 30 years; and in Germany and the Netherlands, for up to 25 years. Even in countries with lingering growth and debt concerns, such as Italy, yield curves were negative at the shorter end (Graph 6,

Box A

Yield curve inversion and recession risk

Sirio Aramonte and Dora Xia

In mid-2019, long-term interest rates fell below short-term rates in a number of countries. In the United States, the spread between 10-year and three-month Treasury rates (henceforth, 10y–3m term spread) had already turned negative in late May and fell below –50 basis points in late August. In France, Germany and the United Kingdom, parts of the yield curve also inverted. While some market participants interpreted these developments as portending an imminent slowdown, exceptionally low term premia currently confound signals from the yield curve.

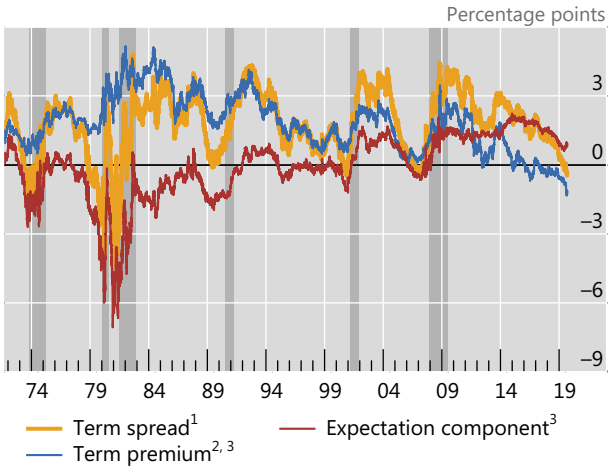
In the United States, an inverted Treasury yield curve has preceded all recessions since 1973. Each time the 10y–3m term spread turned negative during economic expansions, a recession ensued within the next two years (Graph A, left-hand panel).①

A commonly cited reason for the predictive power of the 10y–3m term spread is that, when investors forecast weaker economic activity, they also anticipate more stimulative monetary policy and, in turn, lower future short-term rates. If concerns are strong enough, expected rates can be sufficiently low to push current long-term rates below current short-term rates, resulting in an inverted yield curve.

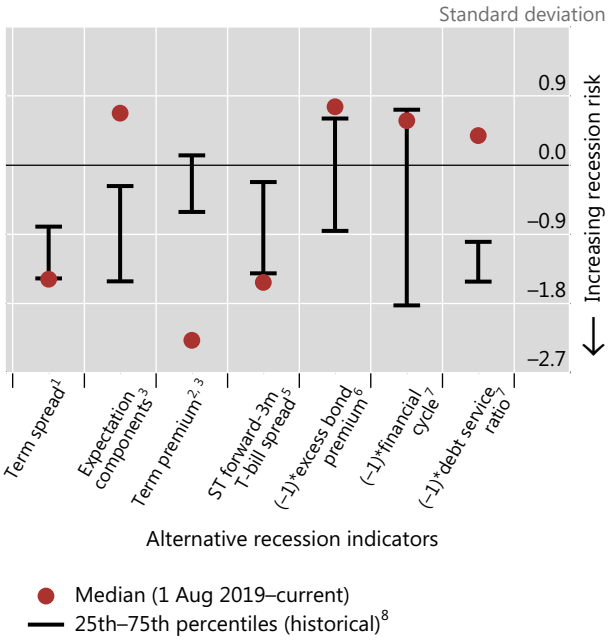
US yield curve inverted as term premium dropped to historical lows

Graph A

US term premium compressed further



A mixed assessment of recession risk[4]



The shaded areas in the left-hand panel correspond to recessions identified by the NBER since 1973: November 1973– March 1975, January–July 1980, July 1981–November 1982, July 1990–March 1991, March–November 2001 and December 2007–June 2009.

[1] Spread between 10-year and three-month Treasury rates. [2] Ten-year term premium. [3] Term premium and expectations component are based on data from Adrian et al (2013). [4] Each variable has been normalised over the whole sample. [5] ST forward: instantaneous forward rate 1.625 years ahead. [6] The dot represents the latest value, August 2019. [7] The dot represents the latest value, Q1 2019. [8] Corresponds to between one year and six months before each peak, as identified by the NBER; 1985–current for the financial cycle and debt service ratio, and 1973–current for others.

Sources: T Adrian, R Crump and E Moench, "Pricing the term structure with linear regressions", *Journal of Financial Economics*, October 2013, pp 110–38; G Favara, S Gilchrist, K Lewis, and E Zakrajšek, "Recession risk and the excess bond premium", *FEDS Notes*, 8 April 2016; S Gurkaynak, B Sack and J Wright, "The US Treasury yield curve: 1961 to the present", *Finance and Economics Discussion Series*, December 2006; Federal Reserve Bank of New York, www.newyorkfed.org/research/data_indicators/term_premia.html; Federal Reserve Bank of St Louis, FRED; NBER, http://www.nber.org/cycles.html; Bloomberg; Datastream; national data; BIS calculations.

However, in addition to expectations of future short-term rates, long-term rates also reflect term premia, which can thus influence the curve's dynamics. Term premia are extra returns demanded by investors to compensate for risks associated with long-term bonds. These returns can be affected by imbalances in the supply of and demand for particular maturities, in which case they have little information about future economic prospects as such.

In fact, the recent inversion of the US Treasury curve has coincided with exceptionally subdued term premia. Term premia in the US Treasury market have been declining since the Great Financial Crisis, likely because of demand pressure from price-inelastic buyers such as central banks, pension funds and life insurers (Graph A, left-hand panel).② Also, the current combination of a negative term premium and an easing monetary policy stance is unusual. During past episodes when the yield curve inverted, the monetary policy stance was tightening.

Considering such complications, it is useful to examine other indicators of recession risk. In addition to the 10y–3m term spread, the literature has identified several other measures that can signal an impending economic slowdown. For example, a low near-term forward spread, a stretched excess bond premium and elevated financial cycle measures can signal high downside risk.③ The right-hand panel of Graph A compares current readings for these variables with their historical distributions before past downturns (in some cases, the variables have been multiplied by –1 so that low values point to high recession risk).

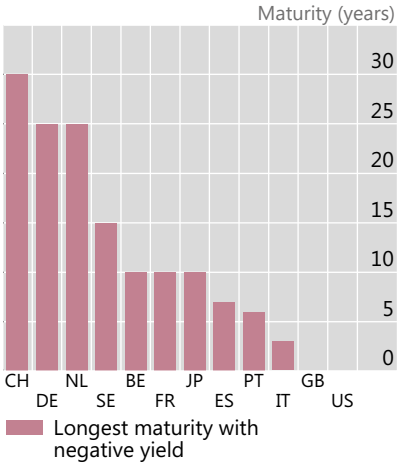
The indicators we consider provide a mixed assessment of imminent downside risks to the economy. While the term premium is clearly well below typical pre-recession levels, rate expectations are currently well above. The other indicators also do not yield a clear consensus on recession risk.

① A Estrella and F Mishkin, "Predicting US recessions: financial variables as leading indicators", *Review of Economics and Statistics*, vol 80, no 1, February 1998, pp 45–61, formally establish the relationship between the term spread and recession risk. ② See B Cohen, P Hördahl and D Xia, "Term premia: models and some stylised facts", *BIS Quarterly Review*, September 2018, pp 79–91. ③ See G Favara, S Gilchrist, K Lewis and E Zakrajšek, "Recession risk and the excess bond premium", *FEDS Notes*, 8 April 2016; E Engstrom and S Sharpe, "The near-term forward yield spread as a leading indicator: a less distorted mirror", *Finance and Economics Discussion Series*, 2018-055; and C Borio, M Drehmann and D Xia, "The financial cycle and recession risk", *BIS Quarterly Review*, December 2018, pp 59–71.

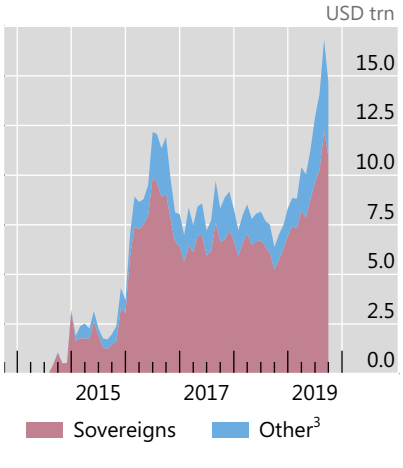
Negative-yielding debt soared

Graph 6

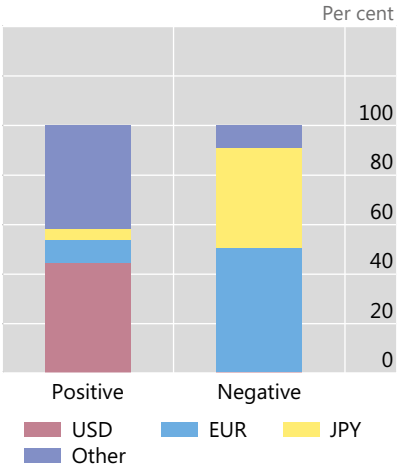
More sovereign yields became negative in more countries[1]



Amount of negative-yielding bonds kept rising[2]



Negative debt was mainly denominated in euros and yen[4]



[1] As of 11 September 2019. [2] Based on Bloomberg Barclays Global Aggregate Negative Yielding Debt indices; September 2019 corresponds to 11 September 2019. [3] Sum of government-related, corporates and securitised. [4] As of 11 September 2019; estimated on government and corporate securities tracked by Bloomberg.

Sources: Bloomberg; BIS calculations.

left-hand panel). Moreover, some corporate yields, and even some Danish mortgage lending rates, dipped below zero.

The pervasiveness and amount of negative-yielding debt this time around greatly exceeded that in 2016, when negative yields were mainly limited to sovereign bonds with shorter maturities. From almost nothing in 2014, the amount of bonds with negative yields rose to $12 trillion in 2016 and then slowly trended down. In 2019, it rose rapidly, reaching a new high of $17 trillion in late August (Graph 6, centre panel). In mid-September, about 50% of negative-yielding bonds were denominated in euros, 40% in yen and a negligible fraction in US dollars. In contrast, more than 40% of bonds with a positive yield were denominated in US dollars (right-hand panel).

Attracted by low interest rates, borrowers continued to tap debt markets, but at a slower pace. Corporate bond issuance in the United States remained relatively steady – in particular, of investment grade debt. The widening of spreads discouraged high-yield issuance. The issuance of leveraged loan and collateralised loan obligations (CLOs) slowed relative to the previous year. One reason is that, being floating rate, leveraged loans became less attractive in the face of a more accommodative monetary outlook. Nevertheless, questions persisted about the potential financial stability risks posed by CLOs, which shared some similarities with the collateralised debt obligations that were at the centre of the GFC (Box B).

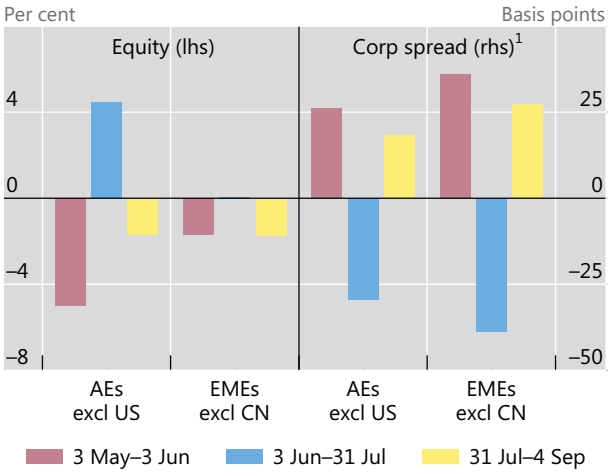
EMEs remained under pressure

Whereas for AE equities trade tensions had a larger impact in May than in August, EME equities were equally sensitive to trade news during the two sell-offs (Graph 7, left-hand panel). Corporate bond spreads behaved similarly in AEs and EMEs, widening in both May and August.

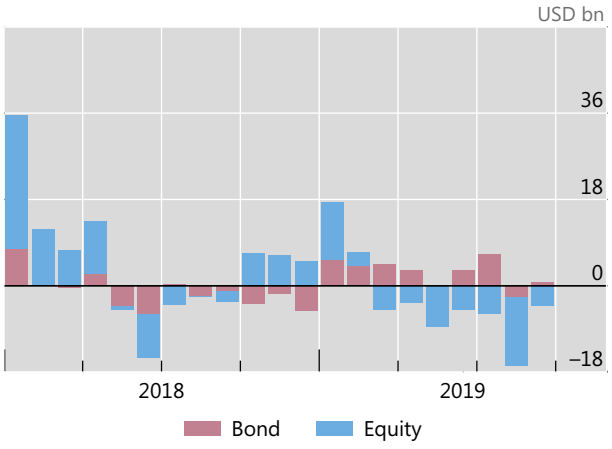
Consistent with the price dynamics of the underlying assets, outflows from EME funds gathered pace during the period under review. Equity funds had suffered sizeable and persistent outflows since the end of the first quarter, and investors

EME assets were under pressure — Graph 7

EME assets were especially vulnerable in August



Outflows from EME funds increased[2]

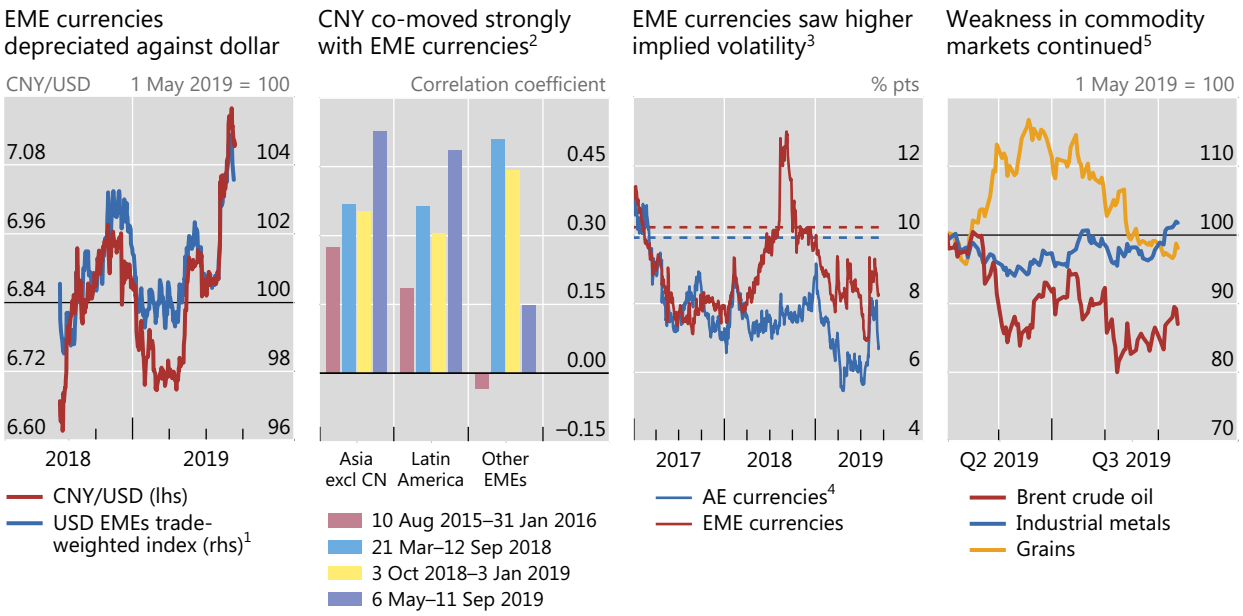


[1] GDP-weighted average of JPMorgan Chase global aggregate bond country indices denominated in US dollars; government spread. [2] Monthly sums of weekly data up to 11 September 2019.

Sources: Bloomberg; EPFR; JPMorgan Chase; BIS calculations.

Global developments affected EME currencies and commodities

Graph 8



The dashed lines in the third panel indicate 2000–current average.

[1] Goods and services. [2] Correlations between daily changes in local currency exchange rates and the renminbi against the US dollar over the stated periods; aggregates are based on medians across currencies in each region. [3] JPMorgan Chase implied volatility indices. [4] Based on JPMorgan Chase G7 currencies implied volatility index. [5] Bloomberg commodity indices.

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

withdrew assets more quickly in the third quarter (Graph 7, right-hand panel). Bond funds had seen volatile but still positive flows throughout 2019, but in August recorded small outflows. A turn in investor sentiment prompted correlated outflows in August, in conjunction with equity losses and corporate spread increases.

As sentiment towards EME assets soured, EME currencies depreciated sharply against the US dollar. The trade-weighted US dollar index was relatively stable between May and July, and then gained 4% against major EME currencies in August. The renminbi breached the symbolic threshold of 7 against the US dollar and dropped to its lowest level since the GFC (Graph 8, first panel). The renminbi was highly correlated with other Asian and Latin American currencies, more so than in previous episodes of stress (second panel). This highlighted the potential for contagion from slower growth in China and recurring bouts of trade tensions. Idiosyncratic developments worsened currency depreciation for some countries, in particular increased political uncertainty in Argentina.

On the back of hefty depreciation of EME currencies, implied volatility in foreign exchange markets rose, albeit to levels still below their long-term average (Graph 8, third panel). The implied volatilities of EME currencies had moved in virtual lockstep with those of AE currencies until early 2018, when trade tensions between China and the United States surfaced in full force. The gap between the implied volatility of AE and EME currencies narrowed in mid-2019 but remained fairly notable relative to 2017, before trade tensions took centre stage.

Against an unsettled outlook for economic growth and trade, prices for selected commodities slid. Oil prices declined through early August, despite simmering geopolitical risk linked to developments in Iran. Grain prices also fell during the period under review, while industrial metal prices were roughly stable (Graph 8, fourth panel).

Box B

Structured finance then and now: a comparison of CDOs and CLOs

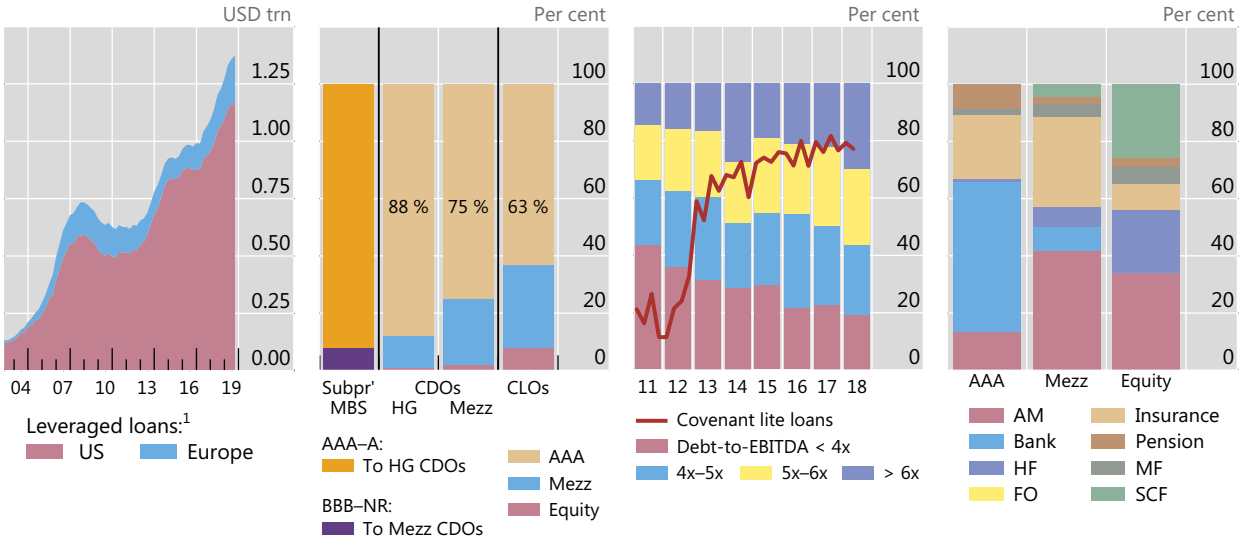
Sirio Aramonte and Fernando Avalos

Collateralised debt obligations (CDOs) that invested in subprime mortgage-backed securities (MBS) were at the centre of the Great Financial Crisis (GFC). The issuance of subprime CDOs ceased after the GFC, but other forms of securitisation have grown substantially – in particular, collateralised loan obligations (CLOs). CLOs invest mainly in leveraged loans, ie bank loans to firms that are highly indebted, have high debt service costs relative to earnings and are typically rated below investment grade. The leveraged loan market has surged in recent years to roughly $1.4 trillion outstanding, of which about $200 billion is denominated in euros and the rest in US dollars (Graph B, first panel). This rapid expansion has been accompanied by the securitisation of leveraged loans into CLOs. As of June 2019, over 50% of outstanding leveraged loans in US dollars and about 60% of those in euros had been securitised through CLOs.

The rapid growth of leveraged finance and CLOs has parallels with developments in the US subprime mortgage market and CDOs during the run-up to the GFC. We examine the CLO market in light of that earlier experience. There are significant differences between the CLO market today and the CDO market prior to the GFC: CLOs are less complex, avoiding the use of credit default swaps (CDS) and resecuritisations; they are little used as collateral in repo transactions; and they are less commonly funded by short-term borrowing than was the case for CDOs. In addition, there is better information about the direct exposures of banks. That said, there are also similarities between the CLO

CLOs improve on some CDO failings, but vulnerabilities remain

Graph B



AM = asset managers; EBITDA = earnings before interest, taxes, depreciation and amortisation; FO = family offices; HF = hedge funds; HG = high grade; MBS = mortgage-backed securities; Mezz = mezzanine; MF = mutual funds; NR = not rated; SCF = structured credit funds.

[1] For institutional leveraged loans, outstanding amounts are based on the S&P-LSTA leveraged loan index for the United States and the S&P European leveraged loan index for Europe (LSTA = Loan Syndications and Trading Association). From Q3 2018 onwards, outstanding amounts based on JPMorgan leveraged loans indices; data up to 11 September 2019. [2] Percentages indicate the fraction of the CLO capital structure with the indicated seniority. [3] Debt-to-EBITDA ratios are based on large institutional leveraged loan volumes. Covenant-lite ratio for US market deals. [4] The panel shows investors in CLOs issued in the Q4 2018, as provided by Citi Research. The shares refer to issuance and do not necessarily reflect the investor base of outstanding CLOs.

Sources: L Cordell, Y Huang and M Williams, "Collateral damage: sizing and assessing the subprime CDO crisis", Federal Reserve Bank of Philadelphia, *Working Papers*, no 11-30/R, May 2012; Citi Research; ICE BofAML indices; JPMorgan Chase; Lipper; Thomson Reuters Loan Pricing Corporation; BIS calculations.

market today and the CDO market then, including some that could give rise to financial distress. These include the deteriorating credit quality of CLOs' underlying assets; the opacity of indirect exposures; the high concentration of banks' direct holdings; and the uncertain resilience of senior tranches, which depend crucially on the correlation of losses among underlying loans. Table B contrasts the key features of the CDO and CLO markets, which are further elaborated below.

Complexity

CDOs and CLOs are asset-backed securities (ABS) that invest in pools of illiquid assets and convert them into marketable securities. They are structured in tranches, each with claims of different seniority over the cash flows from the underlying assets. The most junior or so-called equity tranche is often unrated and earns the highest yields, but is the first to absorb credit losses. The most senior tranche, which is often rated AAA, receives the lowest yields but is the last to absorb losses. In between are mezzanine tranches, usually rated from BB to AA, which start to absorb credit losses once the equity tranche is wiped out. The larger the share of junior tranches in the capital structure of the pool, the more protected the senior tranche (for a given level of portfolio credit risk).

CLOs are backed by simpler, more diversified pools of collateral than CDOs. CDOs issued in the run-up to the GFC consisted mainly of subprime MBS, and CDOs backed by other CDOs (so called CDO squared) were common. In 2006, almost 70% of the collateral of newly issued CDOs corresponded to subprime MBS, and a further 15% was backed by other CDOs. Furthermore, more than 40% of the collateral gathered by the CDOs issued that year was not cash MBS, but CDS written on such securities.① When conditions in the housing market turned, the complexity and opacity of CDOs amplified financial stress. In contrast, CLOs are much less complex. Their collateral is diversified across firms and sectors, and the known incidence of synthetic collateral or resecuritisations is minimal.

Default risk and loss correlation risk

Senior CLO tranches currently appear to benefit from larger loss-absorbing cushions than existed for CDOs. Equity and, in particular, mezzanine tranches make up larger shares of the capital structure of CLOs than they did for pre-crisis subprime CDOs (Graph B, second panel). However, the actual protection afforded to senior tranches depends crucially on their sensitivity to default risk and, importantly, loss correlation risk.

Default risk and losses-given-default depend on the quality of the underlying assets. For both CDOs and CLOs, strong investor demand led to a deterioration in underwriting standards. For example, US subprime mortgages without full documentation of borrowers' income increased from about 28% in 2001 to more than 50% in 2006. Likewise, leveraged loans without maintenance covenants increased from 20% in 2012 to 80% in 2018 (Graph B, third panel). In recent years, the share of low-rated (B–) leveraged loans in CLOs has nearly doubled to 18%, and the debt-to-earnings ratio of leveraged borrowers has risen steadily. Weak underwriting standards can reduce the likelihood of defaults in the short run but increase the potential credit losses when a default eventually occurs.

For CDOs, losses were exacerbated by the sensitivity of the structures to correlation risk. The underlying collateral was poorly diversified, disproportionally consisting of low-rated tranches of subprime MBS (BBB and lower). Such strong demand for low-rated MBS led to a growing reliance on synthetic exposures through CDS and resecuritisation through CDO-squared vehicles, as discussed above. As a result, a large share of CDO payoffs were driven by a relatively small outstanding supply of low-quality securities. When housing prices fell and defaults on subprime mortgages mounted, returns on CDO mezzanine and senior tranches proved to be more highly correlated with the losses on equity tranches than many investors had expected.

Uncertainty about loss correlations is less acute for CLOs, yet remains a risk. Given the relative simplicity of these vehicles and the long history of defaults on high-yield corporate debt, loss correlations for leveraged loans (and thus CLOs) can in principle be estimated with more confidence than for subprime mortgages. However, the unusually high share of deals with low investor protection could materially affect the timing and clustering of defaults, compromising the reliability of these estimations.

Banks' exposure

When CDOs experienced losses, the eventual distress was worsened by opacity about banks' total exposures. Pre-crisis, banks retained mostly senior exposures, either directly or through structured investment vehicles (SIVs), off-balance sheet entities where banks collected exposure to CDOs and other securitised products. Sometimes, as investor

Key features of CDOs then and CLOs now

Table B

	CDOs in 2007	CLOs in 2018
Type of underlying asset	MBS, other CDOs and ABS (eg credit cards), CDS	Leveraged loans
Size of underlying market	USD 1.2–2.4 trillion (subprime MBS)	USD 1.4–2.0 trillion
CDOs/CLOs outstanding	USD 640 billion	USD 750 billion
Non-price terms (underwriting standards)	50% without full documentation	80% covenant lite
Complexity		
Resecuritisation[1]	14% of outstanding	Minimal
Synthetic securitisation[2]	40–50% of issuance	Minimal
Maturity transformation	Common as repo collateral; SIVs funded with asset-backed commercial paper	Minimal
Banks' exposures		
Direct	Unclear at the time	At least $250 billion
Indirect	Multifaceted (SIVs, prime brokerage)	Prime brokerage
Concentration	Unclear at the time	High in some jurisdictions
Type of tranche held	Mostly senior, some lower-rated	Mostly senior
Non-banks' exposure	Unclear at the time	About 20% of holders unknown

[1] Share of securitisation market represented by CDOs (CLOs) that invested in other CDOs (CLOs). [2] Through CDS or other derivatives.

Sources: Bank of England, *Financial Stability Report*, November 2018 and July 2019; US Congress Joint Economic Committee, *The subprime lending crisis*, October 2007; Basel Committee on Banking Supervision, *Credit risk transfer*, July 2008; L Cordell, Y Huang and M Williams, "Collateral damage: sizing and assessing the subprime CDO crisis", Federal Reserve Bank of Philadelphia, *Working Papers*, no 11-30/R, May 2012; G Gorton, "The subprime panic", *NBER Working Papers*, no 14398, October 2008; G Gorton and A Metrick, "Securitized banking and the run on repo", *Journal of Financial Economics*, vol 104, issue 3, 2012, pp 425–51; various reports on securitisation and leveraged loan markets by the Association of Financial Markets in Europe (AFME) and the US Securities Industry and Financial Markets Associations (SIFMA); Citi Research; authors' calculations.

demand for CDO mezzanine tranches swelled, banks ended up holding the senior tranches for which there was less demand. In other cases, banks became exposed to subprime BBB risk, as they "warehoused" the securities while the portfolio of MBS tranches was gathered by CDO managers. The SIVs, purportedly separate from their sponsoring banks, engaged in maturity transformation by funding themselves mainly in the short-term wholesale markets, making themselves susceptible to liquidity runs. Banks' indirect exposure through SIVs was underestimated by investors at the time, and banks' total exposure to CDOs before the GFC was hard to gauge accurately.

Currently, banks' exposure to CLOs is less opaque. Banks hold mostly AAA tranches (Graph B, fourth panel). These are recognised on their balance sheets and there is no indirect exposure through SIVs. That said, banks may have other indirect exposures (see below). Moreover, among banks the concentration of CLO holdings is high. US and Japanese banks are among the largest investors.② Relatively few institutions account for the majority of banks' holdings, and in some cases holdings are large relative to capital.

Spillover risks

Non-bank investors, such as hedge funds and insurance companies, are also major investors in CLOs, as they were in CDOs before the GFC. Ownership is more difficult to trace for non-bank investors than for banks. If non-bank investors were to experience losses on their CLO holdings, banks might be indirectly exposed. In particular, banks might be connected to those investors through legal and reputational ties, credit facilities or prime brokerage services. "Synthetic" prime brokerage, where hedge funds obtain leverage through derivatives with banks as counterparties, has grown rapidly in recent years.③ It also entails lower regulatory capital charges. Like banks' off-balance sheet exposure to CDOs, which was a source of instability in 2007, banks' prime brokerage exposure to CLO holders could result in larger losses than implied by direct exposures, creating heightened financial stress.

Additional spillovers could arise from disruptions in market liquidity. Since the GFC, assets managed by fixed income mutual funds, including bank loan funds, have increased substantially. Some investment funds offering daily redemption of shares hold a small share of their assets in CLOs. At times of market distress, investors may rush to redeem their shares, quickly depleting the liquidity buffers held by such funds. This rush could result in fire sales and large price volatility, imposing mark-to-market losses on other intermediaries. Price volatility could also disrupt short-term funding collateralised by CLOs, similarly to the "run on repo" in 2007. However, the use of CLOs as repo collateral appears minimal today, in contrast to the more widespread use of CDOs or MBS in the past.

① See L Cordell, Y Huang and M Williams, "Collateral damage: sizing and assessing the subprime CDO crisis", Federal Reserve Bank of Philadelphia, *Working Papers*, no 11-30/R, May 2012. CDOs sold CDS to investors in exchange for a payment replicating the return on the insured MBS. ② Fitch Ratings, "Leveraged loans & CLOs in financial institutions", August 2019. ③ Essentially, prime brokers swap with a hedge fund the return on some reference financial asset in exchange for a financing rate.

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Non-bank counterparties in international banking[1]

The BIS has expanded the details that it publishes about banks' balance sheet linkages with non-bank counterparties. These additional details show that banks have increasingly large positions vis-à-vis the non-bank financial sector. Their exposures to non-financial counterparties are highly concentrated, mainly in holdings of advanced economy government debt. At the same time, banks lend significant amounts to non-financial corporations located in financial centres. Banks' cross-border claims on households are relatively small, while their cross-border liabilities to this sector reflect non-resident nationals making deposits with banks in their home country.

JEL classification: C82, F30, G21, G23.

The 2007–09 financial crisis highlighted many gaps in the data covering banks' international assets and liabilities (CGFS (2012), FSB-IMF (2009)). One critical gap was a lack of information about the sector of banks' counterparties. In particular, information about the size and nature of banks' positions with non-bank financial institutions in specific countries was sorely needed, but mostly unavailable, during the crisis. A granular sectoral breakdown helps in tracking international financial integration and risk-sharing in international capital flows (Alfaro et al (2014), Avdjiev, Hardy, Kalemli-Özcan and Servén (2018)), and in monitoring financial stability vulnerabilities.

The BIS international banking statistics (IBS) have been enhanced to better capture banks' positions with particular counterparty sectors. Since the fourth quarter of 2013, banks have separately reported their positions with non-bank financial institutions. With this Quarterly Review, more detail is now published for their positons with non-financial counterparties (ie governments, non-financial corporations and households).

The IBS are collected on both a locational and a consolidated basis (see Box A for definitions of terms commonly used in the IBS). The two perspectives complement each other and, together with the new counterparty sector breakdowns, offer a more comprehensive view of banks' global balance sheet positions and linkages with non-bank counterparties. These new sectoral breakdowns enable analysis and monitoring previously impeded by lack of data (Cerutti et al (2014)).

[1] The authors thank Stefan Avdjiev, Claudio Borio, Stijn Claessens, Wenqian Huang, Maximilian Jager, Robert McCauley, Patrick McGuire, Benoît Mojon, Swapan-Kumar Pradhan, Hyun Song Shin and Philip Wooldridge for valuable comments. The views expressed in this article are those of the authors and not necessarily those of the BIS.

Key takeaways

- The BIS now publishes a more detailed breakdown of counterparty sectors in its international banking statistics.
- Banks' claims on and liabilities to non-bank financial institutions, especially those located in financial centres, have increased in recent years.
- Banks' cross-border liabilities to households largely reflect cross-border deposits by nationals living abroad.

The first section below is an overview of the sectoral breakdowns in the statistics and the coverage of the new data. Coverage of the breakdowns varies by data set, reporting banking system and counterparty country and sector. For example, virtually all reporting banks break out their positions with non-bank financial institutions. Thus, when aggregated across reporting banks, the sectoral coverage is excellent for nearly all counterparty countries and for the global total. By contrast, fewer reporting banking systems break out their positions with the non-financial subsectors, resulting in imperfect coverage of these sectors for some counterparty countries and for the global total.

The following sections review the data for each sector from a variety of angles to illustrate how the data can be used and to establish some stylised facts. We use the consolidated banking statistics (CBS) and locational banking statistics (LBS) in combination to analyse patterns from the perspective of both reporting banks and counterparty countries.

We show that banks' exposures to non-bank financial institutions (NBFIs) have trended upwards in recent years, particularly to those NBFIs located in a few key financial centres. At the same time, NBFIs have become important sources of cross-border funding for banks, particularly in international currencies.

The feature also shows that banks' balance sheet linkages to non-financial counterparties (ie non-financial firms, households and governments) are likewise concentrated in particular countries or regions. Banks' exposures to non-financial corporations (NFCs) and, even more so, governments are primarily to those in the large advanced countries. Their exposures to NFCs in offshore centres are also significant, reflecting, for example, credit to the financing arms of multinational corporations located there. Across all of the sectors and breakdowns, international banking is highly geographically concentrated.[2]

Finally, banks' positions with households are less international compared with other non-financial sectors. They tend to be locally booked (ie not cross-border), and are generally denominated in the local currency. While cross-border claims on households are relatively small, cross-border liabilities to this sector made up 14% of banks' cross-border liabilities to all non-bank counterparties at end-March 2019. Non-resident nationals making deposits in banks back home drive many of the patterns observed in the data.

[2] See Aldasoro and Ehlers (2019) and Hardy (2019) for further discussions of concentration in international banking.

Box A

Terms commonly used in the BIS international banking statistics

The glossary on the BIS website offers definitions of technical terms used in the locational banking statistics (LBS) and consolidated banking statistics (CBS). Selected terms are defined below.

Country – Territorial entity for which data are separately and independently maintained, including, but not limited to, national states as understood by international law and practice. A list of country abbreviations used in the graphs can be found on page iv in this issue.

Counterparty – Entity that takes the opposite side of a financial contract - for example, the borrower in a loan contract or the buyer in a sales transaction. The counterparty country is the country where the counterparty resides.

Reporting bank – Financial institution that participates in the compilation of the LBS or CBS.

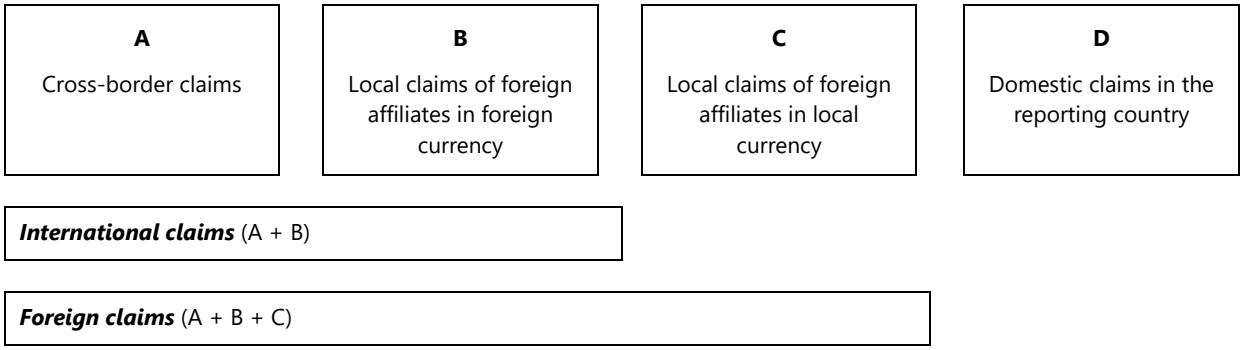
Immediate counterparty basis – Methodology whereby positions are allocated to the primary party to a contract. In the CBS, claims on an immediate counterparty basis are allocated to the country and sector of the entity to which the funds were lent.

Ultimate risk basis – Methodology whereby positions are allocated to a third party that has contracted to assume the debts or obligations of the primary party if that party fails to perform. In the CBS, claims on an ultimate risk basis are allocated to the country and sector of the entity that guarantees the claims (or, in the case of claims on branches, the country of the parent bank).

Claim – A financial asset that has a counterpart liability. In the CBS, claims exclude financial derivatives. The different types of claims in the banking statistics are summarised below.

> **Cross-border position** – Position on a non-resident - for example, claim on or liability to a counterparty located in a country other than the country where the banking office that books the position is located.
>
> **Local position** – Claim on or liability to a counterparty located in the same country as the banking office that books the position. Opposite of a cross-border position.
>
> **International claim** – Claim on a non-resident or denominated in a foreign currency. International claims comprise cross-border claims in any currency plus local claims of foreign affiliates denominated in non-local currencies.
>
> **Foreign claim** – Claim on residents of countries other than the country where the controlling parent is located, ie a claim of a domestic bank on non-residents of the reporting country. Foreign claims comprise local claims of the bank's offices abroad as well as cross-border claims of the bank's offices worldwide.
>
> **Domestic claim** – Claim of a domestic bank on residents of the bank's home country. Domestic claims comprise local claims of the bank's offices in the country as well as cross-border claims of the bank's offices abroad.

Types of claims in the LBS and CBS



Introducing a breakdown of non-bank counterparties

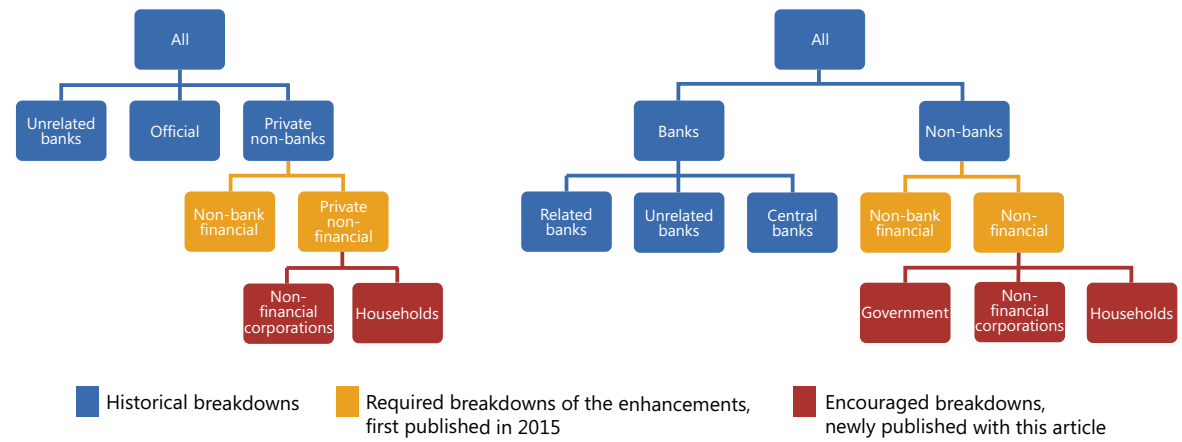
Historically, banks' positions in both the CBS and the LBS were split into bank and non-bank counterparties, but each data set offered unique details for particular sectors (Graph 1, blue boxes). The CBS, with their focus on country risk, provided more detail on banks' exposures to non-banks by separately reporting those to the official sector (government plus central bank) and those to the non-bank private sector. The LBS, with their focus on the evolution of the eurodollar market, put more emphasis on bank counterparties, and thus distinguished between central banks, unrelated banks and own offices.

This historical sectoral breakdown constrained the types of analysis that could be performed, and the 2007–09 financial crisis highlighted these gaps in the statistics. In 2012, the Committee on the Global Financial System (CGFS) endorsed enhancements to the BIS international banking statistics (CGFS (2012)), including greater detail on non-bank counterparties, especially a breakout of non-bank financial institutions and the non-financial sector (Graph 1, yellow boxes). The counterparty sector enhancements applied equally to the LBS and CBS, improving the consistency of sector details.[3]

Because of their size and importance, banks' positions with non-bank financial institutions – securities brokers, central counterparties, investment funds, hedge funds, special purpose vehicles and other non-bank financial entities – were given priority in the data collection over the other non-bank sector positions. The split of

Structure of sectoral breakdowns in the banking statistics[1]

Counterparties to banks' claims (LBS and CBS) and liabilities (LBS) Graph 1



[1] For each level, there is also an "unallocated" sector not depicted in the diagram. The household sector includes non-profit institutions serving households. [2] In the CBS, central banks are included in the official sector. The structure applies both to foreign claims on an ultimate risk basis and international claims on an immediate counterparty basis. [3] The structure applies to both banks' claims and liabilities.

Source: Authors' elaboration.

[3] The enhancements significantly expanded the amount of data reported by banks with international operations. Other enhancements to the LBS include expanded detail on counterparty country by bank nationality, currency composition and banks' domestic business.

Counterparty sector coverage in the banking statistics[1]

Share allocated by subsector, in per cent; at end-March 2019[2] Table 1

	Consolidated		Locational	
	Foreign claims (UR basis)	International claims (IC basis)	Cross-border claims	Cross-border liabilities[3]
Historical bank/non-bank sectors	99	100	98	87
Of which: required non-bank sectors	100	99	96	96
Of which: encouraged non-financial sectors	75	60	57	57

UR = ultimate risk; IC = immediate counterparty.

[1] Each line in the table corresponds to one colour in Graph 1. Note that reported coverage varies over time. [2] For example, 98% of total cross-border claims in the LBS can be allocated to either a bank or non-bank borrower; of the claims allocated to non-bank borrowers, 96% can be allocated to either non-bank financial or non-financial borrowers; of the claims allocated to non-financial borrowers, 57% can be allocated to either government, non-financial corporation or household borrowers. [3] The 13% of cross-border liabilities that cannot be allocated by any lender are largely debt securities, where banks are unsure who the holder of the security is.

Sources: BIS consolidated banking statistics (CBS); BIS locational banking statistics (LBS).

non-banks into non-bank financials and non-financials was first published in 2015. However, the separate reporting of positions with non-financial subsectors (corporations and households and, for the LBS, also government) was encouraged but not required (Graph 1, red boxes), and thus not all reporting countries provide this information. When working with these breakdowns, especially the encouraged breakdowns published for the first time with this feature, it is important to be mindful of the reporting coverage (Table 1).

Both the LBS and the CBS can be analysed either from the perspective of reporting banks or from the perspective of counterparty countries. For example, from the perspective of reporting banks, we can show that 34% of US banks' consolidated claims (CBS) are on NBFIs. Aggregating across all reporting banks' claims on an individual counterparty country shows the latter perspective, and reveals, for example, that 77% of banks' consolidated claims (CBS) on borrowers in the Cayman Islands are on NBFIs.

Annex Tables 1 and 2 help to give a sense of the data coverage and the size of the new sector breakouts. They take the perspective of counterparty countries, and show the complete sectoral composition of all reporting banks' foreign claims (CBS; Annex Table 1) and their cross-border claims (LBS; Annex Table 2) on individual counterparty countries. Column 1 lists banks' combined total claims on the country, and the remaining columns show the share of these claims on each sector, including claims that are unallocated by sector. For most counterparty countries, banks' claims on non-banks are almost completely allocated to either the non-bank financial or the non-financial sectors (in both the CBS and the LBS). But the share of banks' claims allocated to the non-financial *subsectors* varies considerably by counterparty country. For some countries, eg Italy and the Czech Republic, coverage is excellent, in the sense that a relatively small share of the total claims on the non-financial sector (column 6 in Annex Table 1, column 5 in Annex Table 2) is left unallocated to a specific subsector (column 9 in both tables). For others, eg Malaysia and Indonesia, coverage is relatively poor.

As noted above, the LBS and CBS historically emphasised different sectors. Using these data sets *in combination* yields a more complete sectoral breakdown for several counterparty countries than either data set provides in isolation. For example, as

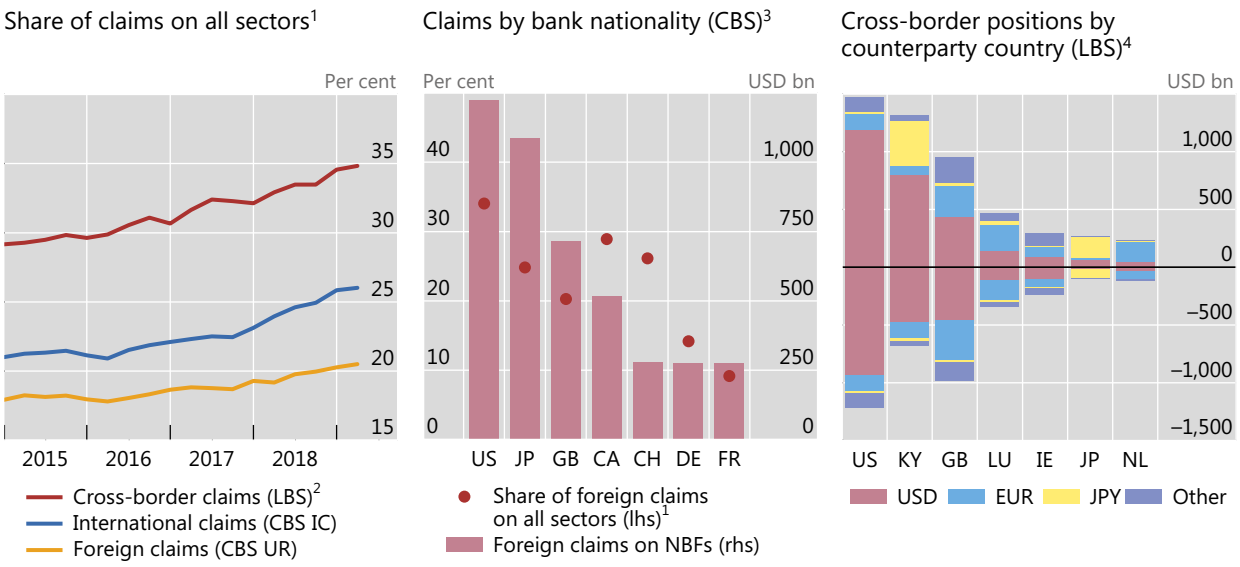
shown in Box B, the CBS, which have near complete coverage of the official sector, can be used to allocate a portion of the unallocated cross-border claims in the LBS. This exercise provides a more representative sectoral breakdown for the global total and shows that, for some countries, the reported LBS data alone do not provide accurate sectoral shares. In what follows, we make use of the data as reported in the CBS and LBS in order to take advantage of the unique dimensionality each data set has to offer (eg instrument and currency breakdowns in the LBS). But we highlight those areas where coverage is poor and caution is thus warranted.

Non-bank financial institutions

Banks' claims on and liabilities to non-bank financial institutions (NBFIs) have been growing in recent years. On a locational basis, banks' cross-border claims on NBFIs increased from 30% of their total claims at end-March 2016 to 35% at end-March 2019 (Graph 2, left-hand panel), or from $4.8 trillion to $6.6 trillion. On a consolidated basis, the share of their foreign claims on NBFIs rose from 18% to 20% during the same period.

On a consolidated basis, just four banking systems – those headquartered in the United States, Japan, the United Kingdom and Canada – accounted for the bulk (70%) of all banks' total foreign claims on NBFIs at end-March 2019 (Graph 2, centre panel).

Banks' positions with non-bank financial institutions — Graph 2



IC = immediate counterparty basis; UR = ultimate risk basis.

[1] Shares are calculated as the ratio of claims on the non-bank financial institutions sector to claims on all counterparty sectors. Fixed sample of banks reporting positions vis-à-vis the non-bank financial institutions sector at end-2014. [2] Denominator excludes claims on related banks. [3] Consolidated claims on an ultimate risk basis. At end-March 2019. [4] Cross-border claims and liabilities are shown as positive and negative amounts, respectively. At end-March 2019.

Sources: BIS consolidated banking statistics (CBS); BIS locational banking statistics (LBS); authors' calculations.

Box B

Expanding coverage of non-financial sectors in the locational banking statistics

In the LBS, a significant share (43%) of banks' cross-border claims on the non-financial sector cannot be broken down by subsector. This is because not all reporting banks provide the complete sector split. Reporting countries that do not provide this split host the main creditor banks for some individual counterparty countries. Thus, for these counterparty countries the sector shares derived by aggregating across all creditor banks are incomplete (Annex Table 2). Combining the CBS and the LBS can improve the sectoral breakdown for cross-border claims on some of these countries and indicate whether the sectoral composition in the reported data is representative of total cross-border claims on the country. However, this expanded sector decomposition is limited to total cross-border claims as the CBS do not include breakdowns by currency or instrument, and have limited data on bank liabilities.

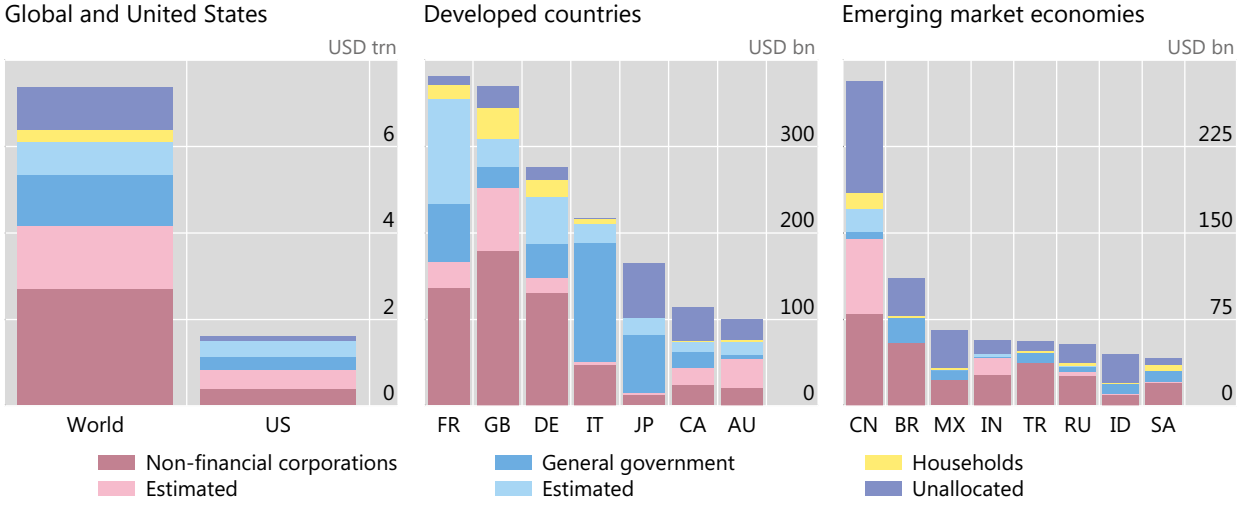
The CBS break down international claims on non-banks into those on the official sector and those on the private non-financial sector. The LBS indicate that cross-border claims on central banks and households are relatively small. Thus the breakdown in the CBS corresponds mostly to claims on governments and on NFCs, respectively. Using non-public LBS data by nationality, it is possible to isolate consolidated cross-border claims booked by banks' home offices and compare them with the corresponding LBS amounts. When the two measures are sufficiently close, the CBS (non-bank subsector) shares can be applied to the corresponding LBS amounts.

Even when the match between CBS and LBS is not perfect, international claims are often overwhelmingly with only one non-financial subsector. In such cases, unallocated cross-border claims can be assigned to that sector. For example, the CBS data show small or no amounts of international claims on the official sector for many counterparty countries. As a result, the unallocated claims on those countries can be attributed to NFCs. These countries are either large offshore centres (eg Bermuda, the Cayman Islands) or developing economies (eg Bahrain, Ethiopia).

Applying the method above, the share of global cross-border claims with a non-financial subsector breakdown increases from 57% to 87%. This includes large expansions in coverage for positions with both NFCs and governments (Graph B, left-hand panel). The increase is mainly due to enhanced sectoral breakdowns of banks' positions vis-à-vis developed countries such as the United States, France and the United Kingdom (centre panel). Coverage for major emerging market economies also improves, but remains incomplete for several countries, including China, Brazil and Russia (right-hand panel).

Expanded data coverage of non-financial sectors in the LBS

Cross-border claims on selected counterparty countries — Graph B



Estimates based on the consolidated statistics on an immediate counterparty basis using the reported sector breakdown by bank nationality and counterparty country.

Sources: BIS locational banking statistics (LBS); authors' calculations.

This exercise shows that it would not be accurate to apply the shares from the reported data in the LBS to the unallocated portions to obtain the full sectoral breakdown. For instance, the estimates using the above methodology have a substantially higher government share for some countries (eg France, 50% instead of 30%), but lower shares for others (eg Canada, 39% instead of 42%). Although this exercise was done with non-public data, a rough approximation of the unallocated sector split can be obtained using publicly available data on the international claims on the official sector and the private non-financial sector (CBS) and applying the shares to the unallocated cross-border claims (LBS) for each reporting country.

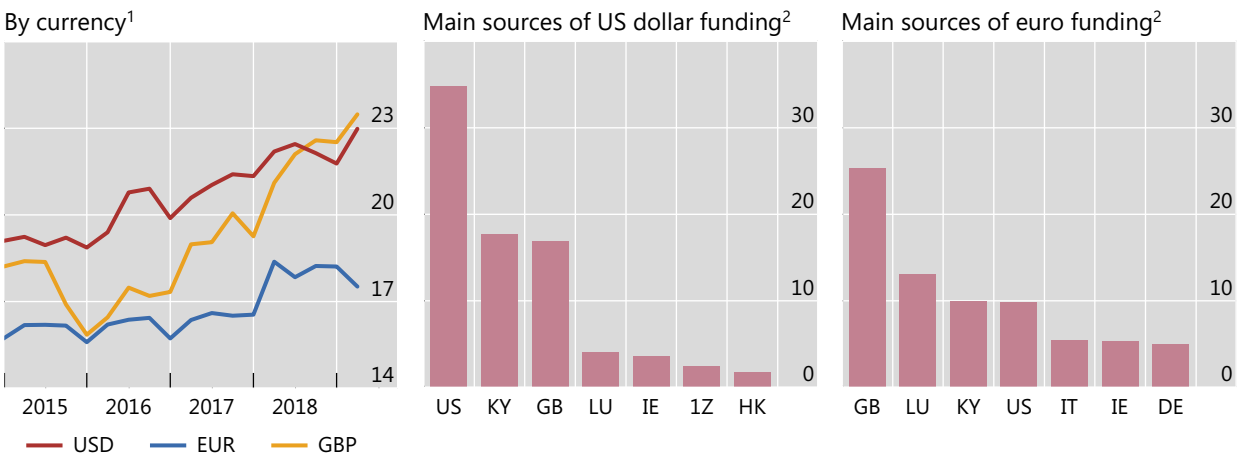
And for each of these banking systems, claims on NBFIs were a significant share (over 20%) of their total foreign claims on all sectors. For US banks, the largest creditors to this sector, a full third of their foreign claims were on NBFIs, while 25% of Japanese banks' and 20% of UK banks' claims were.

NBFI counterparties tend to be concentrated in just a few countries. From the LBS, the top seven countries accounted for 75% of reporting banks' combined cross-border claims and liabilities to NBFIs (Graph 2, right-hand panel; see also Annex Table 2). Positions vis-à-vis NBFIs in the US, the Cayman Islands and the UK were primarily denominated in US dollars, while those with NBFIs in Luxembourg and the Netherlands were mainly denominated in euros. Claims denominated in yen were a significant component of claims on Japan and the Cayman Islands.[4]

Banks have been increasingly turning to NBFIs for funding in international currencies (LBS; Graph 3, left-hand panel). The share of their cross-border US dollar, euro and sterling liabilities to NBFIs has increased over the past four years. Banks'

Importance of non-bank financial institutions in banks' cross-border funding

Cross-border liabilities to non-bank financial institutions, in per cent — Graph 3



[1] For each currency, share of cross-border liabilities to non-bank financial institutions denominated in a currency in total cross-border liabilities denominated in the same currency. Fixed sample of banks reporting positions vis-à-vis the non-bank financial institutions sector at end-2014. [2] Share of all reporting banks' combined US dollar (centre panel) and euro (right-hand panel) liabilities to non-bank financial institutions in the country listed on the x-axis in their total liabilities in the respective currency to non-bank financial institutions in all countries. At end-March2019.

Sources: BIS locational banking statistics (LBS); authors' calculations.

[4] The LBS track banks' on-balance sheet positions in particular currencies. Off-balance sheet positions in particular currencies, eg FX swaps and forwards, are not captured and thus the reporting amounts may understate bank's claims and liabilities in individual currencies (Borio et al (2017)).

dollar liabilities to NBFIs were heavily concentrated in those located in three countries – the US, the Cayman Islands and the UK – which accounted for close to 70% of their total dollar liabilities to all NBFIs at end-March 2019 (centre panel).[5] While banks' euro liabilities to NBFIs were less concentrated (right-hand panel), those located in four countries (the UK, Luxembourg, Italy and the US) accounted for roughly 60%. Thus, banks' funding in major international currencies could be significantly affected by the behaviour of NBFIs in just a few key locations.

Non-financial sectors

Data that shed light on international banks' claims on and liabilities to non-financial counterparties are essential for analysing the impact of international finance on the real economy.[6] Banks are the primary providers of funds to the non-financial sector and their cross-border credit can be fickle (Ehlers and McGuire (2017)), amplifying domestic credit booms and exacerbating busts (Borio et al (2011)). The new non-financial subsectoral breakdowns can illuminate banks' exposures to these sectors as well as the direct cross-border credit they provide.

Banks' most significant non-financial counterparties are non-financial corporations (NFCs) and governments. They accounted for roughly 40% each of banks' foreign claims (CBS) on the non-financial sector at end-March 2019 (Graph 4, left-hand panel).[7] By counterparty country, claims were largest on these subsectors in the large advanced economies, eg the United States (72%), Germany (76%) and Japan (97%) (centre panel).[8]

Banks' exposures to the household sector typically capture mortgage lending, which usually is done locally. In the CBS, 21% of banks' foreign claims were on households at end-March 2019, while only 8% of their international claims were. This indicates that the bulk of banks' lending to foreign households is in the form of local currency claims extended by the banks' foreign affiliates in the respective country. Data from the LBS confirm this, as claims on households represent a small share of cross-border claims on the non-financial sector, but a large share of local claims (Graph 4, right-hand panel).

Households are also an important funding source for banks. They are net creditors to banks in terms of both local and cross-border positions. However, less attention has been paid to households' cross-border deposits with banks. Cross-border deposits in our statistics are largely explained by non-resident nationals

[5] See Aldasoro and Ehlers (2018) for a discussion on US dollar liability sources for non-US banks.

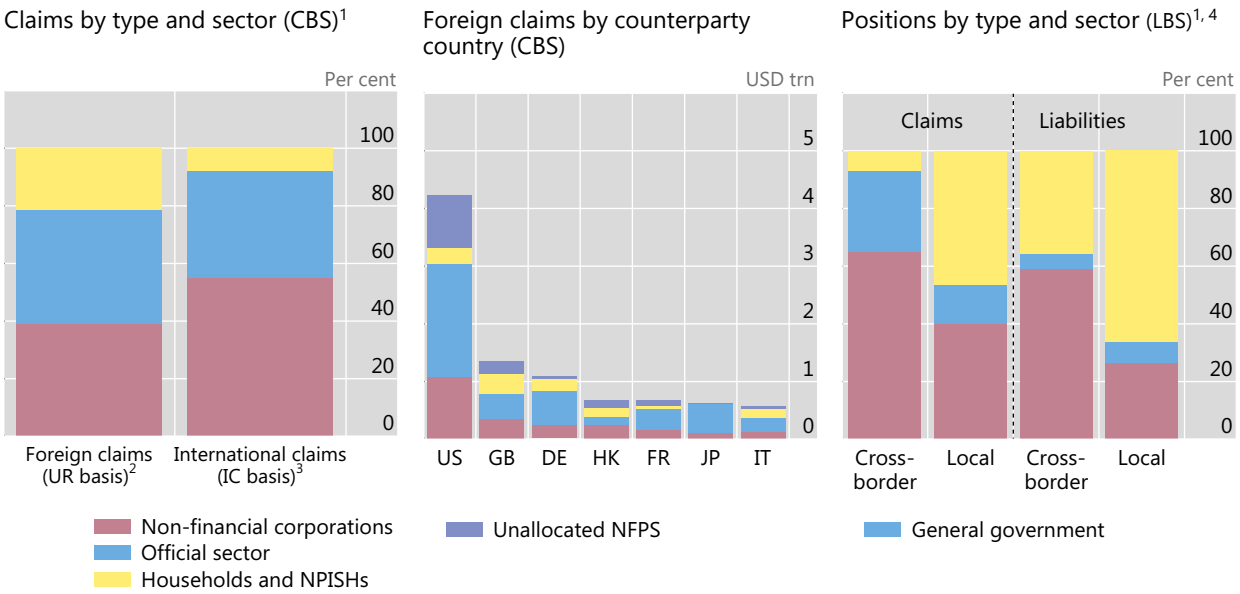
[6] The non-financial subsectoral breakdowns – into non-financial corporations, households and (in the case of the LBS) government – are an encouraged rather than a required reporting item. As a result, the aggregate coverage for these subsectors from the perspective of a specific counterparty country is not as complete as for higher-level sectoral breakdowns (eg non-bank financial institutions; Table 1 and Annex Tables 1 and 2). US, Japanese, Chinese and Hong Kong SAR banks are among the most important foreign creditors to the non-financial sector. However, as of September 2019, these jurisdictions do not report the non-financial subsectors (in the CBS or the LBS). See the CBS and LBS for tables that show which sectoral breakdowns are reported by which countries.

[7] For banks that report the breakdown of the private non-financial subsectors in the CBS. For the full sample, the share of the official sector in total non-financial exposures remains at 40%.

[8] All of the unallocated in Graph 4 is either households or non-financial corporations, as the official sector is well reported in the CBS.

Non-financial counterparties in international banking

Sectoral composition, at end-March 2019 Graph 4



[1] Shares are calculated as the ratio of positions on individual non-financial sector counterparties to positions on the non-financial sector as a whole. [2] For banks with parents in the 20 reporting countries that collect consolidated positions on non-financial corporations and households including non-profit institutions serving households (NPISHs) on an ultimate risk (UR) basis. [3] For banks with parents in the 22 consolidated reporting countries that collect positions on non-financial corporations and households including NPISHs on an immediate counterparty (IC) basis. [4] For banks in the 30 LBS reporting countries that collect positions on non-financial corporations, general government and households including NPISHs.

Sources: BIS consolidated banking statistics (CBS); BIS locational banking statistics (LBS); authors' calculations.

making deposits with banks back home (Box C). Our statistics can thus be combined with other data to help better distinguish cross-border household assets that reflect remittances and cross-border employment from those related to tax evasion (Alstadsæter et al (2018), Zucman (2013)). The new subsectoral breakdowns thus provide fresh insights into financial inclusion and development and the role of banks in households' cross-border financial activities.

Non-financial corporations

As with other aspects of the international banking statistics, claims on NFCs are highly concentrated. Among the consolidated banking systems that report this breakdown, French banks had the largest credit exposure to NFCs at end-March 2019 (in the CBS; Graph 5, left-hand panel), with the top three banking systems accounting for 44% of total claims on the sector. The importance of NFC exposures varies by banking system: 31% of Italian banks' foreign claims and 29% of French banks' foreign claims were on NFCs, but only 19% of US banks' foreign claims were.

Box C

Households' cross-border deposits

During the last few years, households' cross-border assets have received increased attention. Most of the research and discussion has revolved around the hidden wealth in offshore financial centres (Alstadsæter et al (2018), Zucman (2013)). The newly available data on cross-border bank positions vis-à-vis households in the locational banking statistics (LBS) offer additional insight into the nature of households' cross-border deposits. They can be combined with immigration statistics to help identify cross-border deposits linked to non-resident nationals making deposits with banks back home.

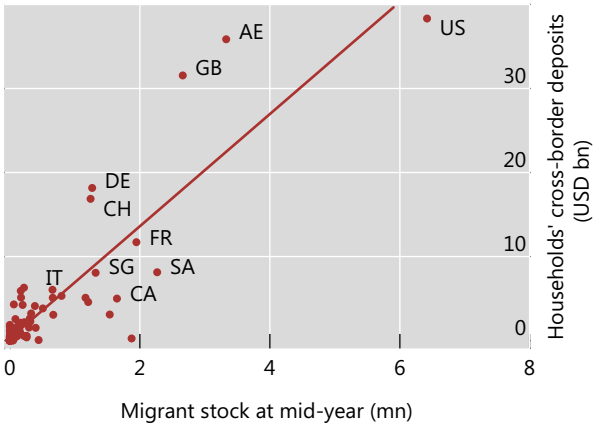
Households (including non-profit institutions serving households) have a limited presence in banks' international operations. At end-March 2019, they accounted for only 4% of BIS reporting banks' cross-border claims on non-banks and 14% of banks' cross-border liabilities to non-banks.① Banks in Switzerland are an exception: foreign households accounted for 20% of their cross-border claims on non-banks and 51% of their cross-border liabilities to non-banks. Banks in Switzerland were the largest recipients of cross-border household deposits ($227 billion as of end-March 2019), accounting for 30% of the reported total (LBS).

A significant share of households' cross-border deposits are placed in banks located in emerging market economies (EMEs), largely denominated in the domestic currency of the respective EME. Foreign households also have deposits in countries with relatively high tax rates (eg Austria, Denmark, France, Sweden). With the newly available statistics (including unpublished bilateral data), we examine how the location of non-resident nationals can explain the geographical distribution of households' cross-border deposits with banks.

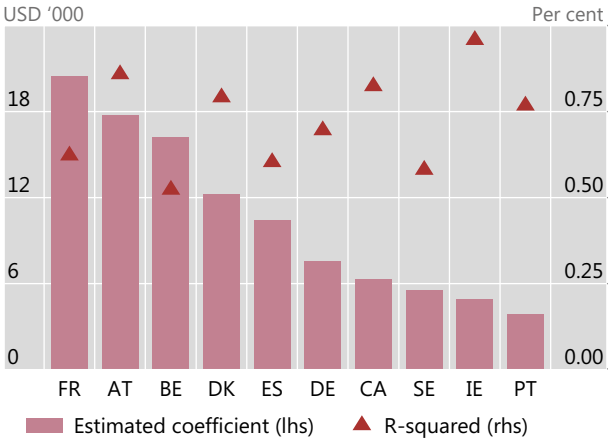
Deposits from households are strongly correlated with migrant numbers (Graph C, left-hand panel). For each bank location, we estimate the relationship between the number of non-resident nationals in a given destination country and the corresponding stock of cross-border household deposits from that country (right-hand panel). Results show that, for most countries, immigration patterns can explain the geographical distribution of cross-border deposits from households. The estimated coefficients are highly significant, and can be interpreted as the amount of deposits per non-resident national living abroad deposited with banks back home. Estimates range from around $4,000 for Portuguese nationals living abroad to around $20,000 for non-resident French nationals.

Role of immigration patterns in households' deposits with foreign banks — Graph C

Bank deposits and nationals living abroad, by destination country[1]



Estimated bank deposits per non-resident national, selected countries[2]



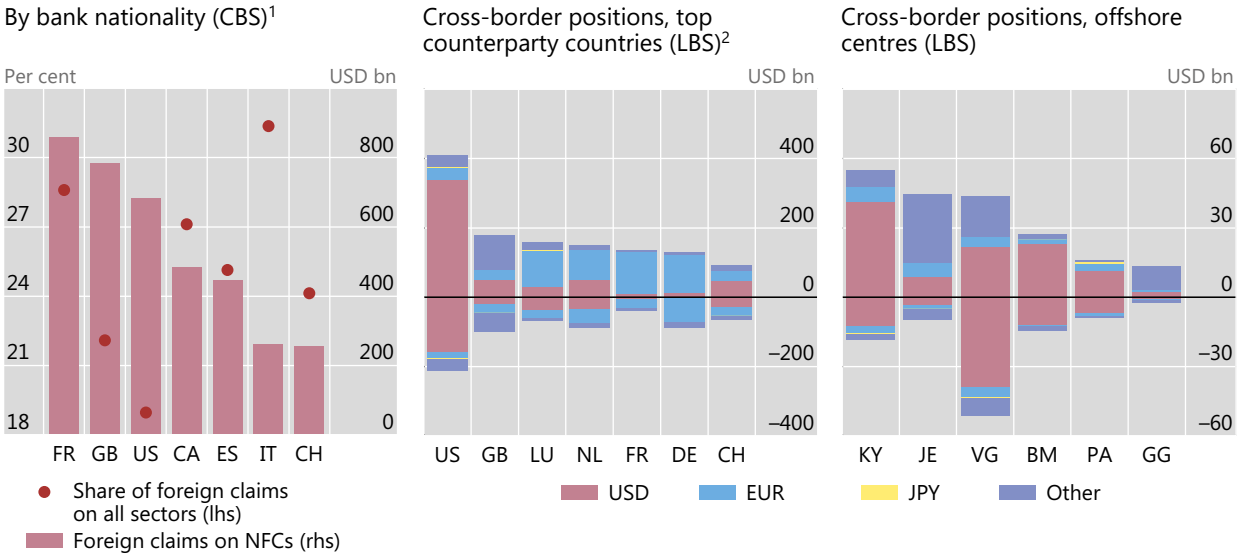
[1] Aggregate bank deposits in selected reporting countries at end-2017. Banks located in Austria, Belgium, Bermuda, Canada, Denmark, France, Germany, India, Ireland, Italy, Korea, Malaysia, Norway, Portugal, South Africa, Spain and Sweden. Total migrant stock at mid-2017 by origin and by major area, region, country or area of destination. [2] For banks in each reporting country, we estimate the regression explaining foreign household deposits by country of origin using the corresponding number of non-resident nationals living in each of those countries.

Sources: UN Population Division; BIS locational banking statistics (LBS).

① Figure computed for the sample of 31 countries that report the encouraged non-financial sector breakdowns for banks' domestic positions in the LBS.

Banks' positions vis-à-vis non-financial corporations (NFCs)

At end-March 2019 Graph 5



[1] Consolidated foreign claims on NFCs on an ultimate risk basis. Shares are calculated as the ratio of foreign claims on NFCs to total foreign claims. [2] Aggregate positions for banks located in the 30 reporting countries that collect positions on NFCs in the LBS vis-à-vis the indicated counterparty country.

Sources: BIS consolidated banking statistics (CBS, ultimate risk basis); BIS locational banking statistics (LBS); authors' calculations.

Banks' cross-border claims (LBS) on NFCs were primarily on those located in advanced economies (Graph 5, centre panel). The bulk of banks' US dollar claims and liabilities were on non-financial firms in the US. Their euro positions, on the other hand, were mainly on those in Luxembourg, the Netherlands, France and Germany.[9]

Offshore financial centres are known to host banks and non-bank financial entities; however, banks' cross-border positions with NFCs in those locations are also large (LBS; Graph 5, right-hand panel). This reflects the fact that NFCs' financial activities can span national borders; indeed, corporates regularly set up entities in these centres for the purpose of raising funds (Avdjiev et al (2016) and Avdjiev, Everett, Lane and Shin (2018)). For instance, banks' claims on NFCs in the Cayman Islands were larger than on those in Italy, an advanced economy where data coverage is good. Claims on NFCs in the Cayman Islands are probably substantially larger, as 85% of end-March 2019 claims on non-financial borrowers there are unallocated by subsector, and borrowing by households and government is likely to be small. Banks also had large claims on NFCs in Jersey and the British Virgin Islands.[10] These data complement statistics that show an increase in foreign direct investment positions with financial centres, which capture when NFCs in offshore centres transfer the capital raised there to related affiliates elsewhere (Lane and Milesi-Ferretti (2017)).

[9] This represents the geographical distribution of cross-border lending to NFCs only by the banks that report this breakdown. Actual claims on non-financial firms in these countries may be higher. See Annex Table 2 for coverage details by counterparty country.

[10] Claims on NFCs in the Marshall Islands and Guernsey were also unusually large given the economic size of the jurisdictions.

Government

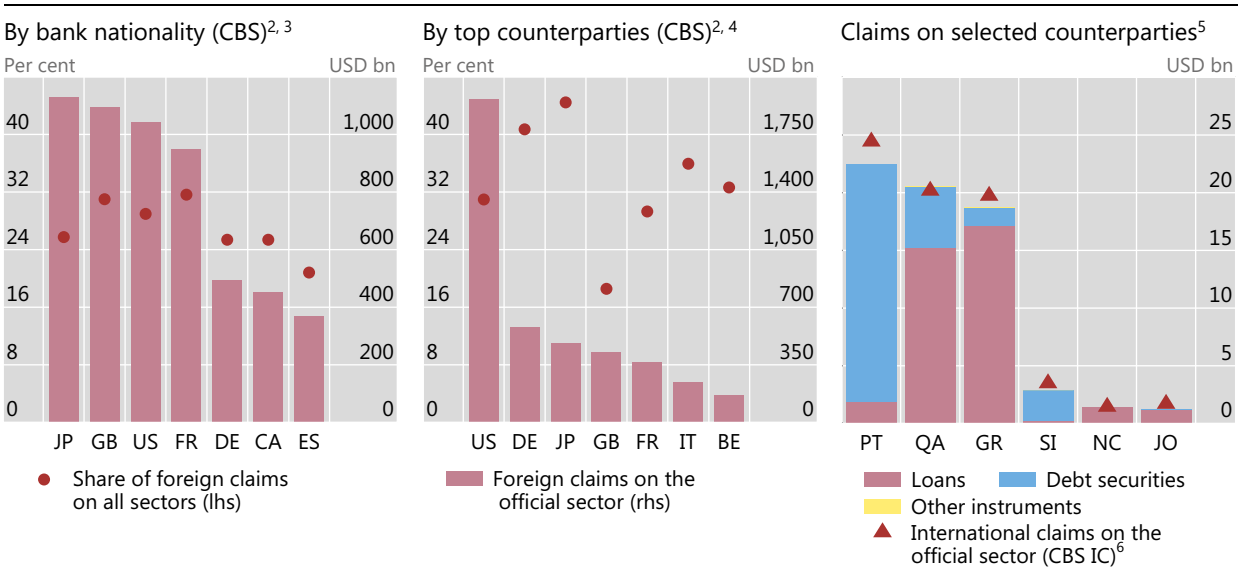
Government debt is a central element of banks' balance sheets. At end-March 2019, 26% of banks' consolidated foreign claims (CBS) were on official counterparties (including the central bank).[11] Japanese, UK, US and French banks reported the largest exposures to the official sector (Graph 6, left-hand panel). For those bank nationalities, the share of the official sector in total credit exposure ranged from a quarter to a third.

The largest counterparty countries for claims on the official sector tend to be advanced economies. Governments in these countries supply large amounts of debt, and some central banks have implemented quantitative easing programmes, which have boosted banks' holdings of reserves at central banks (Graph 6, centre panel; see also McCauley and McGuire (2014)).[12] Claims on the official sector are almost entirely denominated in the issuing country's currency. For example, the largest claims on the official sector are on the United States, all in US dollars. The official sector constitutes 30–40% of all consolidated claims on the US, Germany and Japan (see Annex Table 1 for others).

While the CBS provide no details on the instrument or currency composition of international claims on the official sector, the new government breakdown in the LBS

Bank claims on the official sector[1]

At end-March 2019 — Graph 6



[1] The official sector comprises the general government and the central bank. [2] Consolidated foreign claims on an ultimate risk basis on the official sector. [3] The dots show the share of foreign claims on the official sector in total claims on all sectors from the indicated bank nationality. [4] The dots show the share of foreign claims on the official sector in total claims on all sectors vis-à-vis the indicated counterparty country. [5] Aggregate cross-border claims of banks located in the 30 reporting countries that collect positions on general government in the locational banking statistics. [6] International claims on an immediate counterparty (IC) basis.

Sources: BIS consolidated banking statistics (CBS); BIS locational banking statistics (LBS); authors' calculations.

[11] Claims on the official sector include government securities used as collateral in repurchase agreements.

[12] Mostly by local affiliates in local currency. Cross-border claims on central banks tend to be small.

makes it possible to infer these splits when cross-border claims (LBS) match well with international claims (CBS) (Graph 6, right-hand panel).[13] Most claims on government were in the form of debt securities (79% of all cross-border claims for which there is a breakout of claims on government at end-March 2019 (LBS)).[14] For example, in the case of Portugal and Slovenia, debt securities made up nearly all of the cross-border bank claims on the government. However, loans represented a large share of cross-border claims on some countries (Qatar, Greece, New Caledonia and Jordan). For these countries, claims from banks may follow different dynamics than for countries where all the claims are in the form of securities.

Conclusion

The newly released data on counterparty sectors in the BIS international banking statistics provide a novel and interesting perspective on international banking and the balance sheet exposures and linkages banks have with non-bank counterparties.

Non-bank financial institutions (NBFIs) are increasingly integrated into the funding and lending patterns of international banks. Banks source more and more of their funding in international currencies from NBFIs. This sector is also a growing counterparty for bank lending. Banks' positions with NBFIs are concentrated in few countries, particularly financial centres.

Banks have substantial credit exposure to foreign governments and non-financial corporations, particularly those located in advanced economies. Offshore financial centres also play an important role for non-financial corporations. Exposures to households are concentrated in local positions in local currencies. Households' cross-border deposits can be important, however, and are determined in part by non-resident nationals placing deposits with banks in their home country. Claims and liabilities are highly geographically concentrated in international banking, including for individual subsectors of the counterparties and further breakdowns.

These data will be broadly useful to researchers and policymakers to better understand and address questions relating to international finance and financial stability.

[13] The counterparty countries shown in this panel all have more than 85% of claims on the non-financial sector allocated by subsector, so the magnitudes shown are representative of cross-border claims by banks.

[14] This figure will probably rise with better reporting vis-à-vis large advanced countries like the US and France, whose government debt is almost entirely in the form of debt securities (Box B).

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Annex: Claims by counterparty country and sector

Foreign claims on an ultimate risk basis by counterparty country and sector

Selected countries, share of counterparty sector as a percentage of foreign claims on all sectors – consolidated banking statistics; at end-March 2019 Table A1

	Total (USD bn)	By sector of counterparty (per cent)									
		Banks	Official sector	Non-bank private sector (NBPS)							Unallo-cated sector
				Total	Non-bank financial	Non-financial private sector (NFPS)				Unallo-cated NBPS	
						Total	Non-financial corporate	House-holds	Unallocated NFPS		
All countries	27,034	14	26	59	19	40	19	11	10	0	1
Developed countries	18,743	15	28	56	19	38	18	10	9	0	1
Euro area	6,547	17	30	52	15	37	19	13	6	0	1
France	1,245	31	29	38	14	24	14	3	8	0	1
Germany	1,431	15	41	44	8	36	18	15	3	0	1
Italy	685	10	36	52	5	47	19	23	5	0	2
Spain	409	17	38	43	6	37	18	12	7	0	2
Japan	1,089	25	44	30	17	13	11	1	1	0	1
United Kingdom	2,317	20	19	60	20	40	15	16	10	0	1
United States	6,346	7	31	61	26	36	17	4	14	0	1
Developing Asia	2,265	23	21	55	8	47	21	7	20	0	1
China	802	36	15	49	8	40	21	4	15	0	0
Chinese Taipei	206	15	30	55	9	46	17	10	19	0	0
India	284	21	21	57	10	47	28	5	14	0	1
Indonesia	142	11	27	61	7	54	18	3	34	0	1
Korea	322	17	31	53	11	42	16	13	12	0	0
Malaysia	164	16	21	63	6	57	12	10	35	0	0
Developing Europe	1,048	6	33	55	3	52	28	21	4	0	5
Czech Republic	256	3	49	39	2	38	19	17	1	0	8
Hungary	60	6	38	48	4	44	30	12	2	0	8
Poland	255	3	30	61	3	57	23	28	7	0	6
Romania	76	1	33	59	2	56	28	28	0	0	7
Russia	104	11	18	68	4	64	42	14	8	0	3
Turkey	167	19	20	61	5	56	37	15	3	0	0
Developing Latin America	1,079	11	28	60	5	56	31	22	3	0	0
Argentina	42	4	46	50	2	48	33	13	1	0	0
Brazil	364	16	34	50	5	46	28	14	3	0	0
Chile	130	12	9	79	5	74	33	37	4	0	0
Mexico	364	7	29	64	5	59	33	23	3	0	0
Peru	61	9	24	67	1	65	41	23	2	0	1
Offshore centres	3,026	5	10	84	42	42	19	8	15	0	0
Cayman Islands	1,319	1	0	98	77	21	6	0	15	0	0
Hong Kong SAR	824	6	19	75	10	65	29	19	16	0	0
Singapore	459	12	31	56	9	47	24	11	12	0	1

Source: BIS consolidated banking statistics (CBS).

Cross-border claims by counterparty country and sector

Selected countries, share of counterparty sector as a percentage of total cross-border claims on all sectors – locational banking statistics; at end-March 2019 Table A2

	Total (USD bn)	By sector of counterparty (per cent)									
		Banks	Non-banks								Unallocated by sector
			Total	Non-bank financial	Non-financial sector (NFS)					Unallocated non-banks	
					Total	Non-financial corporate	Government	Households	Unallocated NFS		
All countries	30,473	50	48	22	24	9	4	1	11	2	2
Developed countries	21,000	54	44	21	23	9	5	1	9	1	2
Euro area	8,248	55	44	18	25	12	6	1	6	1	1
France	1,878	71	28	7	20	7	4	1	8	0	1
Germany	1,406	71	26	7	20	9	3	1	6	0	2
Italy	749	47	52	22	29	6	18	1	4	0	2
Spain	435	48	52	6	45	20	18	1	6	1	1
Japan	1,390	67	32	19	12	1	5	0	6	0	1
United Kingdom	3,785	59	36	25	10	5	1	1	3	1	5
United States	5,085	38	61	29	32	8	6	0	17	0	1
Developing Asia	2,081	55	43	5	31	10	1	1	19	7	2
China	966	61	37	5	29	8	1	1	19	4	1
Chinese Taipei	151	73	26	8	16	4	0	0	12	2	1
India	191	41	52	5	30	14	1	0	15	17	7
Indonesia	125	34	61	3	36	8	7	1	21	22	6
Korea	210	70	26	8	17	4	1	0	11	1	5
Malaysia	82	60	36	3	24	3	0	2	19	10	4
Developing Europe	546	50	49	6	38	21	8	2	8	5	1
Czech Republic	86	79	21	2	19	12	6	1	0	0	0
Hungary	30	61	39	5	34	21	6	1	6	1	0
Poland	86	46	51	9	42	21	17	1	4	0	3
Romania	22	42	57	20	37	21	12	2	1	0	1
Russia	93	37	63	4	58	28	4	3	22	1	0
Turkey	166	44	55	7	34	23	5	1	5	14	0
Developing Latin America	631	37	61	13	45	18	7	1	19	3	2
Argentina	25	19	80	14	63	24	11	2	26	3	1
Brazil	266	48	51	8	42	21	8	0	12	1	1
Chile	53	51	45	9	35	18	2	1	14	1	4
Mexico	127	19	78	24	52	18	6	2	26	2	4
Peru	35	36	63	5	55	17	2	2	33	3	1
Offshore centres	4,935	40	60	35	22	7	0	1	14	3	0
Cayman Islands	2,168	21	79	61	17	3	0	0	14	1	0
Hong Kong SAR	954	60	39	12	22	6	0	1	14	6	1
Singapore	680	81	19	6	13	6	1	1	5	0	0

Source: BIS locational banking statistics (LBS).

Derivatives trading in OTC markets soars

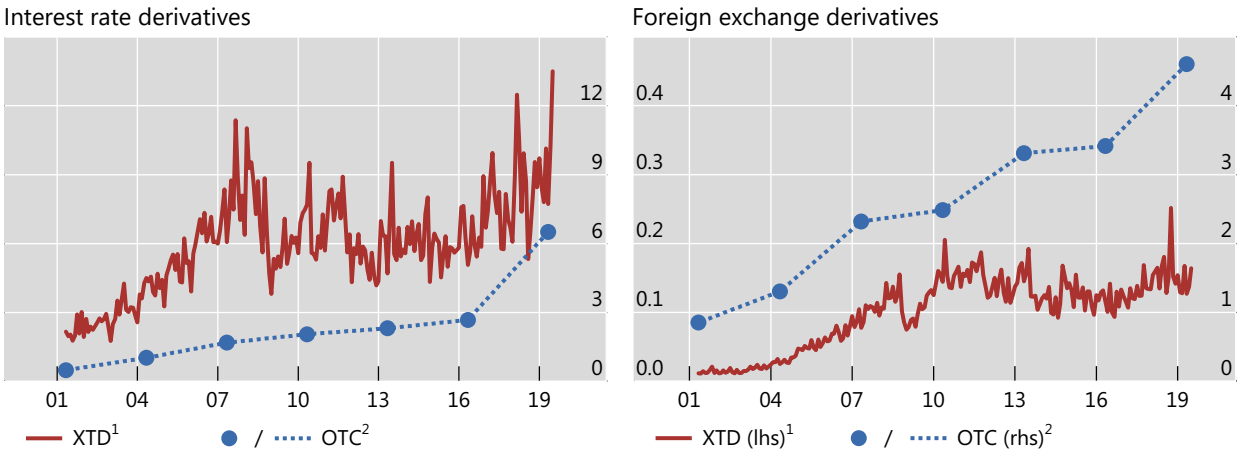
Philip Wooldridge and Dora Xia

Derivatives trading in over-the-counter (OTC) markets rose even more rapidly than that on exchanges, according to the latest BIS Central Bank Triennial Survey of Foreign Exchange and Over-the-counter Derivatives Markets. The daily average turnover of interest rate and FX derivatives on markets worldwide – on exchanges and OTC – rose from $11.3 trillion in April 2016 to $18.9 trillion in April 2019. OTC trading outpaced exchange trading, continuing the trend that started around 2010 and resulting in exchanges' share falling to a historical low of 41%.

The Triennial Survey is the most comprehensive source of information on the size and structure of OTC markets.① Close to 1,300 financial institutions located in 53 countries participated in the latest Survey, which was conducted in April 2019. When the results are combined with the BIS statistics on exchange-traded derivatives, they provide a global (albeit infrequent) snapshot of activity in interest rate and FX derivatives markets.

OTC trading of interest rate and FX derivatives outpaced exchange trading

Daily average turnover, in trillions of US dollars — Graph A1



XTD = exchange-traded derivatives; OTC = over-the-counter derivatives.

[1] Turnover on exchanges worldwide, at monthly frequency. [2] Turnover in April, adjusted for local and cross-border inter-dealer double-counting. The dashed line shows a linear interpolation of data between Triennial Surveys.

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

The turnover of interest rate derivatives increased markedly between April 2016 and April 2019, especially in OTC markets, where trading more than doubled from $2.7 trillion per day to $6.5 trillion (Graph A1, left-hand panel). More comprehensive reporting contributed to the increase, yet even after adjusting for this, OTC trading was still up twofold.② On exchanges, trading rose by about 50% over this period from $5.1 trillion per day to $7.7 trillion. Consequently, the proportion of interest rate derivatives traded on exchanges fell from 65% in April 2016 to 54% in April 2019. As recently as 2010, this proportion had been close to 80%.

A key driver of the rapid growth in interest rate derivatives trading was changing expectations about the path of monetary policy. In the mid-2010s, a sustained period of low and stable policy rates in advanced economies had reduced hedging and positioning. US dollar activity – which accounts for the majority of trading – started to pick up in late 2016, when the US Federal Reserve embarked on a series of rate hikes, and in 2019 dollar turnover surpassed its previous highs, in the context of renewed monetary stimulus. The turnover of interest rate contracts denominated in euros, yen and other major currencies also increased substantially between 2016 and 2019.

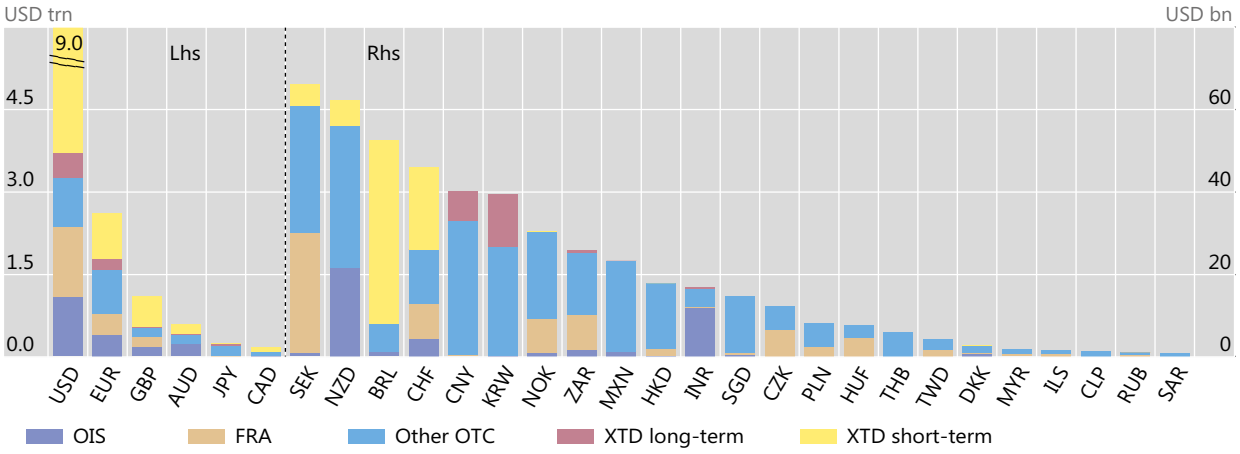
Derivatives referencing short-term interest rates are increasingly traded OTC, though the bulk of activity in such instruments is still on exchanges, in particular for US dollar-denominated contracts. A shift in OTC trading towards short-term instruments would tend to boost turnover because such contracts need to be replaced more often. A maturity breakdown of interest rate derivatives is not collected in the Triennial Survey; nevertheless, it can be

approximated from the instrument breakdown because the maturity of overnight index swaps (OIS) – which were collected for the first time in the 2019 Survey – and forward rate agreements (FRAs) is typically less than one year. The instrument breakdown suggests that in April 2019 OTC trading of derivatives on short-term interest rates probably surpassed that on long-term rates. While the share of FRAs in OTC trading has shown no trend since 2010, fluctuating around 30%, the share of OIS appears to have increased, rising above 30% in April 2019 (Graph A2).

OTC trading benefited from innovations that made OTC instruments more attractive. Historically, exchanges had the advantage of centralised trading and, through their use of central counterparties, simpler counterparty risk management. The Great Financial Crisis led to initiatives to strengthen the resilience of OTC markets, such as central clearing, trade compression and swap execution facilities.③ In effect, these initiatives reformed OTC markets so that they more closely resembled exchanges.

Turnover of interest rate derivatives, by currency and instrument

Daily average turnover in April 2019 — Graph A2



OIS = overnight index swaps; FRA = forward rate agreements; other OTC = options and other interest rate swaps; XTD long-term = exchange-traded derivatives on long-term interest rates; XTD short-term = exchange-traded derivatives on short-term interest rates.

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

In emerging market economies (EMEs) too, the turnover of interest rate derivatives increased significantly, driven by OTC trading. For all EME currencies combined, turnover rose from $182 billion in April 2016 to $280 billion in April 2019. Whereas the turnover of listed derivatives increased by around 10%, that of OTC instruments increased by almost 75%. The most actively traded contracts were denominated in the Brazilian real ($52 billion), Chinese renminbi ($40 billion) and Korean won ($40 billion) (Graph A2). Activity denominated in EME currencies is more concentrated in a few instruments than that of major currencies. Interest rate swaps (including OIS) accounted for the largest share: over 60% of trading in most EME currencies compared with 21% for the US dollar and 35% for the euro. This is partly because there are very few actively traded futures contracts denominated in EME currencies. The real, renminbi and won are the only EME currencies where a significant share of interest rate derivatives are traded on exchanges.

The OTC trading of FX derivatives also rose substantially, according to the latest Triennial Survey. In OTC markets, the daily average turnover of FX derivatives increased from $3.4 trillion to $4.6 trillion between April 2016 and April 2019. By contrast, on exchanges it remained a mere $0.1 trillion (Graph A1, right-hand panel). In only two currencies did exchanges account for a substantial share of FX derivatives activity: the Brazilian real and Indian rupee, where exchanges accounted for 36% and 13% of turnover in April 2019, respectively. OTC markets dominate owing in large part to FX swaps, which accounted for close to 70% of FX derivatives trading. FX swaps are popular as funding instruments because they are collateralised and do not change FX exposures. Furthermore, OTC deals better serve customised demands, such as trading currency pairs not involving the US dollar. Whereas the US dollar was on one side of 99% of trades on exchanges in April 2019, its share in OTC markets was much lower at 90%.

① For more about the Triennial Survey, see www.bis.org/publ/rpfx19.htm. The December 2019 *BIS Quarterly Review* will include several articles that analyse the results of the 2019 survey. ② BIS, "Triennial Central Bank Survey: OTC interest rate derivatives turnover in April 2019", statistical release, September 2019. ③ See T Ehlers and E Eren, "The changing shape of interest rate derivatives markets", *BIS Quarterly Review*, December 2016, pp 53–65; and L Kreicher, R McCauley and P Wooldridge, "The bond benchmark continues to tip to swaps", *BIS Quarterly Review*, March 2017, pp 69–79.

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Playing it safe: global systemically important banks after the crisis[1]

Post-crisis reforms aim to mitigate the systemic risks that arise from global systemically important banks (G-SIBs). Based on our estimates of G-SIBs' probability of distress, we find that their resilience has improved in recent years on the back of higher capital ratios. Furthermore, by benchmarking G-SIBs' balance sheet adjustments against those of other major banks, we show that these adjustments accord with the incentives set by the post-crisis regulatory framework. This suggests that the systemic importance of G-SIBs has declined in recent years.

JEL classification: G21, G28, C25.

During the Great Financial Crisis (GFC), the distress of large, complex and interconnected financial institutions undermined financial stability. Post-crisis financial reforms aim to reduce the systemic risk of these global systemically important banks (G-SIBs). They seek to increase the banks' resilience or, in other words, make them less likely to fail. And, they encourage these banks to reduce their systemic importance or, roughly speaking, soften the impact on the financial system if they were to face distress. Two key elements of these reforms – henceforth jointly referred to as the "G-SIB framework" – are the assessment methodology to identify G-SIBs and the capital surcharges imposed on these banks.

This special feature assesses whether G-SIBs' resilience and systemic importance have evolved in line with regulatory objectives since the GFC. We start by reviewing trends in resilience. Specifically, we estimate G-SIBs' probability of distress (PD) based on bank-specific and macroeconomic risk factors. Our estimates point to a decline in G-SIBs' PDs on the back of higher capital ratios and reduced funding risk after the GFC. Weak profitability, however, has hindered further improvements in recent years.

While the G-SIB framework has helped raise banks' capital ratios, it may also have reduced their PDs by encouraging changes in their funding mix. To test this, we exploit national differences in the framework's implementation. We find that the wholesale funding ratio of US G-SIBs has fallen further than that of EU G-SIBs. This

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Key takeaways

- The risk posed by global systemically important banks (G-SIBs) has declined in line with the incentives set by the post-crisis regulatory framework.
- Higher capital ratios and a shift towards more stable sources of funding have strengthened G-SIBs' resilience.
- G-SIBs' systemic importance has fallen in recent years relative to that of other banks.

is consistent with the US regulation which, unlike the EU's, incorporates this ratio in the calculation of capital surcharges.

Turning to the framework's second objective, we show that G-SIBs' systemic importance, as captured by the G-SIB assessment methodology, has on average been declining since it was put in place. This decline reflects a downward trend in regulatory indicators for bank size, interconnectedness and complexity.

When G-SIBs' post-crisis balance sheet adjustments are benchmarked against those of non-G-SIBs, several other trends emerge that are consistent with the incentives generated by the framework. For one, while G-SIBs have been expanding more slowly than non-G-SIBs since the GFC, the difference has widened after the introduction of the G-SIB framework. Relative to their peers, G-SIBs have also cut back on their securities holdings and reduced their reliance on interbank deposits after the regulatory change. Lending has evolved similarly for G-SIBs and other banks.

In the following section, we present the G-SIB framework, ie the assessment methodology and its approach to strengthening G-SIB resilience. We then estimate the PDs of major banks to analyse structural trends and drivers of bank resilience. Next, we look at changes in banks' systemic importance through the lens of the G-SIB framework. To tease out the role of the G-SIB assessment and capital surcharges in driving these changes, we contrast G-SIBs' post-crisis adjustments with those of non-G-SIBs. The final section concludes.

G-SIB assessment methodology and capital surcharges

First published by the Basel Committee on Banking Supervision (BCBS) in 2011, the G-SIB framework is designed to reduce G-SIBs' probability of failure (BCBS (2018)). To that end, it sets out a methodology to identify G-SIBs, and defines capital surcharges that increase in step with a bank's approximated systemic importance. While this feature focuses on the impact of the framework, the new regulatory landscape for G-SIBs also provides for more intensive supervision as well as more effective resolution regimes (FSB (2013)).

The assessment methodology seeks to measure banks' *relative* systemic importance. The measurement is based on indicators of bank size, interconnectedness, the substitutability of their services, cross-border lending and funding, and the complexity of their portfolios. Each indicator is normalised by dividing the bank's indicator value by the sum of the indicator values across the largest global banks, the so-called assessment sample. A bank's systemic importance proxy – its G-SIB score – is equal to the weighted average of its

G-SIB capital surcharges Table 1

Bucket	Capital surcharge[1] (% of CET1/RWA)	Number of banks in 2018
5	3.5	0
4	2.5	1
3	2.0	3
2	1.5	8
1	1.0	17

[1] As of 2022, G-SIBs will also be subject to a leverage ratio buffer requirement equivalent to half of their CET1/RWA capital surcharge.

Source: FSB (2018).

normalised indicators. Banks above a score cutoff are designated as G-SIBs.[2] G-SIB assessment results are published annually. In the most recent result, 29 banks were designated as G-SIBs. The assessment sample currently comprises 76 banks, with a total size of more than €73 trillion at end-2017.[3]

The G-SIB framework seeks to enhance bank resilience by imposing varying capital surcharges. The surcharge (or the higher loss absorbency requirement) is expressed as a ratio of Common Equity Tier 1 capital to risk-weighted assets (CET1 ratio). It currently varies between 1 and 3.5%, depending on the G-SIB score. Banks with a higher G-SIB score are allocated to a higher "bucket" and face a higher capital surcharge (Table 1). Conceptually, this is designed to reduce each G-SIB's potential impact of failure on the financial system to that posed by the non-G-SIB with the highest score (BCBS (2011), Passmore and von Hafften (2019)). In turn, since capital is costly, the surcharges encourage G-SIBs to reduce their systemic importance.

Bank resilience: trends and drivers

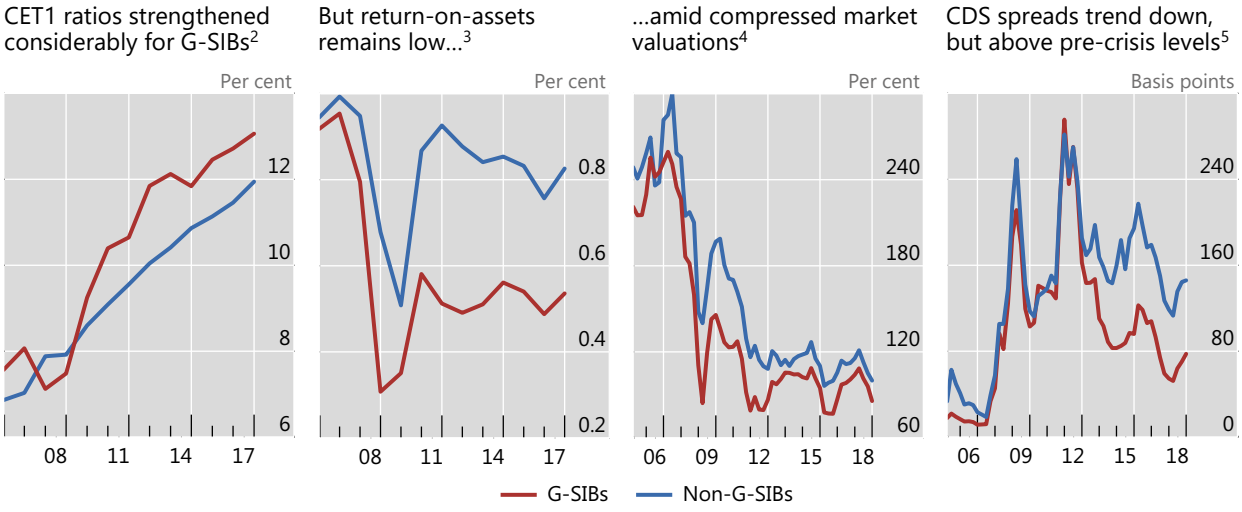
Assessing how banks' resilience has evolved in recent years must take account of some opposing forces. On the one hand, the capital ratios of both G-SIBs and non-G-SIBs have trended up (Graph 1, first panel), suggesting a substantial improvement in resilience. On the other hand, profitability has yet to recover for many G-SIBs (Graph 1, second panel), which weighs on their ability to strengthen or even maintain capital buffers in the medium term. Indeed, equity investors seem to be sceptical about the odds of such a recovery in the near future, as reflected in the low market valuations of many banks (Graph 1, third panel; BIS (2019)).

[2] Scope is allowed in the framework for supervisors to override G-SIB designations using their supervisory judgment (BCBS (2018)).

[3] Size is measured in terms of the banks' leverage ratio exposure measure, which comprises on-balance sheet exposures (such as loans), derivative exposures, exposures from securities financing transactions and off-balance sheet items (eg standby letters of credit).

Opposing forces are driving G-SIB resilience[1]

Graph 1



[1] *G-SIB*s are the 33 banks that have been designated as such at least once between 2012 and 2017. *Non-G-SIB*s are the remaining banks from the assessment sample. Using the actual list of G-SIBs in each year does not alter the qualitative findings. [2] Annual average Common Equity Tier 1 to risk-weighted assets. [3] Annual average return on average assets. [4] Quarterly average price-to-book ratios. [5] Quarterly average five-year on-the-run credit default swap (CDS) spreads.

Sources: BCBS; FSB; Datastream; IHS Markit; SNL; authors' calculations.

Relying only on market-based measures to gauge bank resilience falls short of providing a comprehensive assessment. For instance, credit default swap (CDS) spreads have generally trended down in recent years, while remaining above their pre-crisis levels (Graph 1, fourth panel). But market-based measures can give ambiguous signals regarding resilience for the following reasons. For one, these measures tend to be prone to swings in investor risk appetite, with limited ability to predict future distress (Borio and Drehmann (2009)). CDS spreads, for instance, reached long-term lows in the run-up to the GFC – clearly a misleading benchmark. Second, post-crisis regulation may have shifted the relationship between some of these measures and bank resilience. Regulatory reforms to improve the resolvability of major banks have, for example, helped to weaken market expectations for public sector support, thus redistributing risks to bank creditors.[4] This would widen CDS spreads, even in the absence of any change in bank resilience.

To apply a more structured approach to assessing bank resilience, we estimate banks' PD based on a parsimonious logit model. The model combines market indicators of distress, bank risk factors and indicators of macroeconomic conditions.

We define bank distress as a 50% decline in the stock price or a rating downgrade to non-investment grade within the next year.[5] This choice is motivated by the observation that market prices are good coincident indicators of distress,

[4] In line with this interpretation, credit rating agencies have lowered their estimates of the likelihood of sovereign support for many banks in recent years. Furthermore, contract terms for CDS have been adjusted post-crisis to cover losses from government intervention and bail-in events (Neuberg et al (2016)).

[5] Based on this definition, about 2.5% of the bank-quarter observations indicate distress, three fifths of which occurred during the GFC. While failures and resolutions would provide a more severe measure of distress, such events are too rare in the case of large banks to support a meaningful PD model.

Bank risk factors and macro factors help assess bank distress[1]

Dependent variable: indicator of future bank distress

Table 2

	(1)	(2)	Baseline
CET1 ratio	–0.27***	–0.26***	–0.21***
Deposit-to-liability ratio		–0.03***	–0.02**
Cash-to-asset ratio		–0.03*	–0.08***
Cost-to-income ratio		0.02**	0.03***
Non-performing loan (NPL) ratio		0.06**	0.08***
Credit-to-GDP gap			0.03*
Debt service ratio gap			0.41***
Number of observations	9,581	7,010	5,718
Pseudo R-squared	0.04	0.08	0.14
Area under ROC[2]	0.68	0.73	0.79

*/**/*** indicates statistical significance at the 10/5/1% level. Standard errors are clustered at the bank level.

[1] PDs are estimated based on a logit model: $PD_{ijt} = F(\tau + \beta_t X_{ijt})$, where F is the logit transformation, and X are the predictors. Distress is defined as a 50% decline in the stock price or a rating downgrade to non-investment grade within the next year. A bank's observations are dropped from the sample for eight quarters following a distress event. Estimates are based on an unbalanced sample of 500 banks using quarterly data from 2005–18. Raw coefficients are reported, which do not indicate the marginal impact on the PDs of a change in a predictor. [2] Area under receiver operating characteristic (ROC). A higher value indicates better ability of the model-based PD estimates to identify distressed banks.

Sources: Fitch Solutions; IHS Markit; SNL; authors' calculations.

despite typically having limited longer-term predictive power. For bank risk factors, we include measures of bank capitalisation, asset quality, efficiency and liquidity (as listed in Table 2). As macro predictors, we consider the credit-to-GDP gap and the debt service ratio gap as early warning indicators of overheating in credit markets (Aldasoro et al (2018)). Our analysis covers an (unbalanced) sample of around 500 large banks globally using quarterly data from 2005 to 2018. Table 2 presents estimates of the baseline model (third column), which we select based on comparing alternative specifications in terms of their goodness of fit and predictive ability.[6] While we use this model for the estimates that follow, they are robust to alternative specifications, as well as to changing the definition of distress or the forecasting horizon.[7]

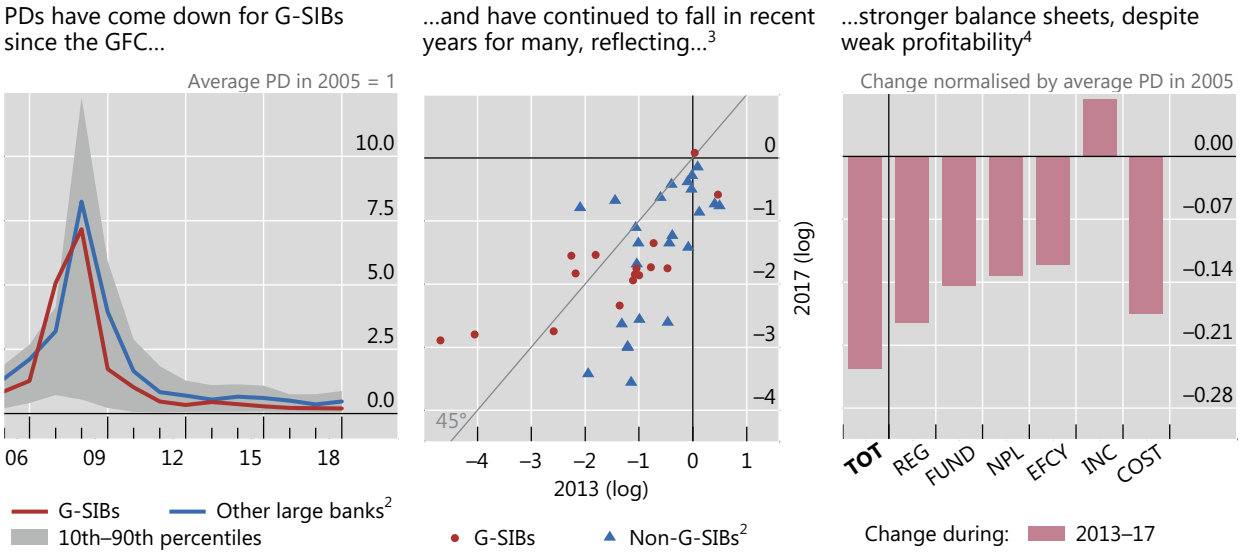
A model-based approach to measuring resilience has several advantages. For one, the model combines various determinants of bank resilience, which helps assess the joint effect of these determinants. This is especially useful when potential drivers of resilience, as in our case, point in opposite directions. In addition, the regression estimates allow us to tease out the relative contribution of specific drivers of PDs. For instance, the model provides an estimate of the decline in PDs due to an increase in capital ratios, controlling for changes in, say, profitability. In turn, this helps identify the direct effect of regulatory reforms on resilience.

[6] The area under ROC of the baseline model, for instance, equals 79%. The classification accuracy – that is, the rate at which the model predicts the correct outcome – is 71%. These goodness-of-fit statistics are in line with comparable models in the literature (eg Betz et al (2014)).

[7] Alternative definitions of distress include a decline in stock prices by at least 40% over the next four quarters or a decline of 30% within the next quarter. These alternative definitions help ensure that the model is robust, in particular, to noise in stock prices.

G-SIBs' resilience improves post-crisis[1]

Graph 2



[1] PDs are normalised by the average PD of banks in the estimation sample in 2005; the average is weighted by banks' assets. [2] "Other large banks" (non-G-SIBs) indicates banks in the estimation (assessment) sample that are not G-SIBs. [3] PDs are not available for all banks in the G-SIB assessment sample due to missing data on the predictors. [4] TOT depicts the change in weighted average PD of G-SIBs between 2013 and 2017. We select these years for consistency with the analysis of G-SIB scores in the next section. G-SIB scores are currently available for the 2013–17 period. Bars to the right of TOT indicate the change in the average PD of G-SIBs due to a change in a given set of predictors while keeping all other predictors at their 2013 values. REG = CET1 ratio; FUND = cash/assets and deposit/liability ratios; NPL = non-performing loan ratio; EFCY = cost-to-income ratio; INC = income varies but cost fixed at its baseline value in the cost-to-income ratio; COST = cost varies but income fixed at its baseline value in the cost-to-income ratio. The sum of REG, FUND, NPL and EFCY does not necessarily equal TOT because of non-linearity in how the PDs are computed.

Sources: BCBS; FSB; CreditEdge; IHS Markit; SNL; authors' calculations.

Our PD estimates point to an improvement in G-SIBs' resilience over time and relative to that of other banks. G-SIBs' estimated PDs have, on average, declined significantly relative to the aftermath of the GFC and also relative to their pre-crisis levels. And, they have continued to decline in recent years (Graph 2, left-hand and centre panels). Furthermore, while PDs have come down for both G-SIBs and non-G-SIBs, estimated PDs are lower for G-SIBs, consistent with the framework's aim of bolstering the resilience of systemically important banks.

By decomposing the contribution of bank-level predictors to the decline in G-SIBs' PD estimates, we reveal the opposing forces at work (Graph 2, right-hand panel). PDs have declined on average because of improvements in G-SIBs' capital buffers and the reduced risks of funding disruptions since the GFC, a trend that has continued in recent years. At the same time, cost-to-income ratios have declined only modestly, with lower revenues offsetting the effect of cost savings.

Our results indicate that increased capital ratios have been a key factor in improving resilience. However, the framework could impact PDs through other channels as well, such as through its effect on the funding mix. In particular, differences in the implementation of the G-SIB framework in the United States and the European Union tally with observed changes in banks' reliance on wholesale funding (see box), a key source of funding risk and driver of PDs during the GFC (Passmore and von Hafften (2019)).

Exploiting transatlantic differences to tease out the role of the G-SIB framework

Confounding factors complicate the task of identifying the drivers of G-SIBs' post-crisis adjustments. These factors include concurrent regulatory reforms, macroeconomic policies, and structural changes in financial markets. One way to overcome this obstacle is to ask whether the effects of the G-SIB framework varied according to differences in the way it was implemented in different jurisdictions. We make use of the fact that the European Union's implementation is based on the BCBS assessment methodology, whereas the United States uses two distinct methods to calculate capital surcharges (BCBS (2014, 2016)). The first one is identical to the BCBS methodology, while the second, among other differences, takes into account G-SIBs' reliance on short-term wholesale funding. US banks are subject to the higher of the two surcharges, which has been the second one to date. As such, we conjecture that US G-SIBs have had stronger incentives than their EU peers to reduce their reliance on wholesale funding.

To test our hypothesis, we set up a regression that identifies trends within US G-SIBs relative to (i) their pre-2012 trends; (ii) EU G-SIBs; and (iii) US and EU non-G-SIBs. We restrict the sample to only the US and EU banks from the assessment sample (34 in total). These large internationally active banks are subject to similar regulatory requirements, suggesting that the non-G-SIBs in the sample represent a suitable control group in order to identify the effect of differences in the G-SIB assessment methodologies across the Atlantic.

The results in Table A support our hypothesis. US G-SIBs reduced their short-term wholesale funding after 2012 by roughly 7 percentage points more than the EU G-SIBs did (first row, column (1)). This result is robust to excluding G-SIBs designated after 2012 ("switching banks", column (2)), using quarterly instead of annual data for the assessment sample (column (3)) or using an expanded sample of banks (column (4)).

Wholesale funding adjustments are consistent with implementation differences

Dependent variable: wholesale funding as a percentage of total funding[1]

Table A

	Baseline	Excl switching banks	Quarterly data	Expanded sample
	(1)	(2)	(3)	(4)
US × G-SIB × post-2012[2]	–7.14**	–7.77**	–9.63**	–11.10***
G-SIB × post-2012[3]	5.45***	6.08***	8.07***	7.24***
Number of observations	231	215	522	4,073
R-squared within	0.07	0.09	0.05	0.01
Bank fixed effects (FE)	Yes	Yes	Yes	Yes
Country × year FE	Yes	Yes	No	No
Country × quarter FE	No	No	Yes	Yes

*/**/*** indicates statistical significance at the 10/5/1% level. Standard errors are clustered at bank level.

[1] All columns are based on the regression: $wf_{ijt} = \tau + \alpha_i + \beta_{jt} + \gamma_1 D[1.Post2012]_t \times D[1.GSIB]_{ij} + \varepsilon_{ijt}$, with wf_{ijt} representing the wholesale funding ratio of bank i from country j at time t. Column (1) uses annual data on US and EU banks from the assessment sample, of which there are 20 G-SIBs. Column (2) restricts the sample to only those G-SIBs that kept this status throughout 2012–17. In column (3), we use quarterly data for the assessment sample banks. In column (4), we expand the sample to the US and EU banks from the sample of 500 banks used in the PD model (Table 2). All columns contain a constant and $bank$ and $country \times time$ fixed effects. [2] *US* is a dummy variable that takes value one if the bank is from the United States; *G-SIB* is a dummy variable that takes value one for the 33 banks that were designated as G-SIBs during 2012–17; *post-2012* is a dummy variable that takes value one for all years from 2012 to 2017. [3] The coefficient estimates imply that G-SIBs, on average, reduced their reliance on wholesale funding by less than their non-G-SIB peers did. This result is driven by the EU G-SIBs. US G-SIBs, by comparison, reduced their wholesale funding ratio by more than other US banks did, consistent with the incentives provided by the US implementation of the G-SIB framework.

Sources: BCBS; FSB; bank disclosures; SNL; authors' calculations.

Systemic importance through the G-SIB framework's lens

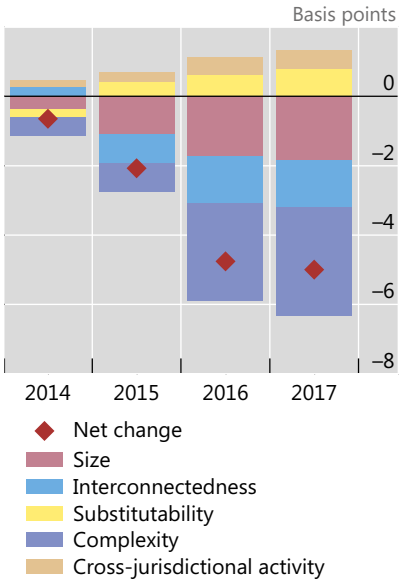
Having established that G-SIBs have become more resilient, we now ask how their systemic importance has evolved. To do so, we rely on the evolution of the G-SIB scores for several reasons. First, the scores are designed to capture many dimensions of banks' systemic footprint, based on the lessons drawn from the GFC and other crises. Second, since the score determines banks' capital surcharges, it is a natural starting point for assessing the G-SIB framework's impact on banks' balance sheet adjustments.

Overall, G-SIBs' average score declined relative to that of non-G-SIBs in several – but not all – dimensions of systemic importance (Graph 3, left-hand panel). First, G-SIBs grew more slowly than non-G-SIBs. Second, G-SIBs' regulatory proxies for complexity diminished due to a decline in their over-the-counter derivatives books and securities holdings – both in absolute terms and relative to those of non-G-SIBs. Third, proxies for G-SIBs' interconnectedness with the financial system declined, driven mainly by their falling share of intra-financial liabilities.

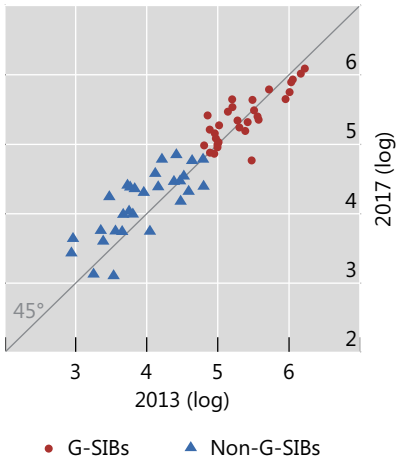
Systemic importance trending down for G-SIBs – on average

Graph 3

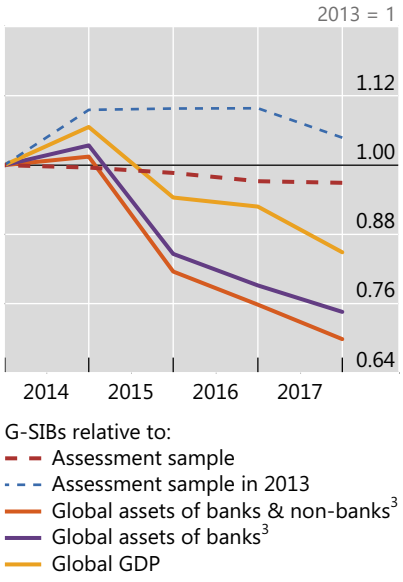
Reduced complexity driving decline in G-SIBs' scores[1]



Scores fell for the most systemic G-SIBs, but rose for other G-SIBs



Relative systemic importance trending down[2]



[1] Decomposition of the average changes in the G-SIBs' scores relative to 2013, based on the five indicator categories. A G-SIB is any bank designated as such at least once during 2013–17. [2] All calculations are in euros. The dashed red line indicates G-SIBs' scores as per the BCBS assessment. The dashed blue line fixes the denominator in the score calculation to its 2013 value. The solid lines adjust the 2013 denominator by the growth rate of the respective items listed in the legend. [3] Based on banks and non-banks in the 29 economies covered in the Financial Stability Board's *Global Monitoring Report on Non-Bank Financial Intermediation*.

Sources: FSB, *Global Monitoring Report on Non-Bank Financial Intermediation*, various years; BCBS; World Bank; CreditEdge; IHS Markit; SNL; authors' calculations.

An opposing force, however, is an increase in G-SIBs' relative contribution to cross-jurisdictional activity.[8] Since the scores are based on the relative shares of banks in the assessment sample, the mirror image of reduced scores for G-SIBs is an increase in the average score of non-G-SIBs.

Individual bank results provide a more nuanced view on how G-SIBs' scores have evolved since the introduction of the framework (Graph 3, centre panel). A number of G-SIBs did see a rise in scores, reflecting, among others, regional differences in financial sector growth (BCBS (2019)). Yet scores have typically come down for the banks with the *highest* ones in 2013, consistent with the incentives provided by imposing higher surcharges on these banks (Table 1).

One drawback of the G-SIB assessment methodology is that trends affecting the entire assessment sample can remain hidden below the supervisory radar screen. For example, if each bank were to double each of its indicator values, the scores would be unchanged, even though the systemic importance of the banks in the assessment sample relative to the *broader* economy would undoubtedly increase.[9]

We thus assess how G-SIBs' scores have evolved relative to alternative benchmarks. We start by comparing the evolution of G-SIBs' scores against those of the assessment sample in 2013.[10] Using this conservative yardstick, we find that G-SIBs' systemic importance rose initially, but has stabilised since 2014 and, more recently, fallen (Graph 3, right-hand panel). Broader trends in economic or financial activity provide alternative benchmarks. We therefore adjust the 2013 reference values by the annual growth rate of global GDP, of the global banking sector's assets, and of the global financial assets of banks and non-banks, respectively. Each of these measures points to a downward trend in the relative systemic importance of G-SIBs (Graph 3, right-hand panel).[11] This conclusion is also supported by popular proxies for systemic risks, such as SRISK (Brownlees and Engle (2016)), which declined by roughly 17% for G-SIBs from 2013 to 2017.

These trends may reflect a broader cyclical decline in G-SIBs' risk-taking, and not necessarily be driven by introduction of the G-SIB assessment methodology and the phase-in of the capital surcharges. Indeed, Adrian et al (2018) highlight that banks' balance sheet management has undergone profound changes since the GFC. This reflects the need of many major banks to bring leverage – which had spiked in the run-up to the crisis – back to sustainable levels. On top of that, broader challenges to banks' profitability, such as low interest rates and new non-bank competitors, required decisive changes to banks' business models. Teasing out the

[8] The observed increase in G-SIBs' scores in the *substitutability* category is due to the imposition of a maximum score ("cap") in that category. Excluding the effect of the cap would reduce G-SIBs' substitutability-related scores. In its next review of the G-SIB assessment methodology, the BCBS will consider alternatives to the application of the cap (BCBS (2018)).

[9] Since the scores are based on banks' relative shares, they – in principle – always add up to 100%. Technically, year-on-year differences in scores do not net out exactly across the banks in the assessment sample due to the cap on scores in the substitutability category.

[10] This comparison is based on normalising a bank's indicator by the sum of all the banks' indicator values in 2013, the first year of observation.

[11] One driver of this result is the fact that, between 2013 and 2017, the global assets of banks and non-banks – in the 29 economies covered in the Financial Stability Board's *Global Monitoring Report on Non-Bank Financial Intermediation* – grew at an average annual rate of more than 10%. By comparison, G-SIBs' total assets grew by around 5% annually.

effect of regulatory reforms among these other business developments is a daunting task.

To make some progress in this regard, we look for shifts in G-SIBs' balance sheet adjustments relative to those of non-G-SIBs. This analysis requires both pre- and post-crisis data. G-SIB scores, however, have been available only since 2013. Thus, we use banks' balance sheet disclosures to proxy some components of the score.

We adopt a difference-in-difference approach, distinguishing between three phases: (i) the run-up to the GFC, 2005–07 ("pre-crisis"); (ii) the GFC and its immediate aftermath, 2008–11 ("post-crisis"); and (iii) the years since the framework's introduction, 2012–17 ("post-reform"). This approach lets us assess shifts in G-SIBs' adjustments relative to those of non-G-SIBs from one phase to another (Table 3). In particular, shifts in banks' relative adjustments from the post-crisis to the post-reform phase help us assess the role of the framework.

In line with previous research (Violon et al (2017)), we find that several adjustments accord with the incentives that arise from the framework.

First, G-SIBs had already been growing more slowly than other banks in the aftermath of the GFC (Table 3, first row, column (1)). Yet the wedge widened after the introduction of the framework (third row, column (1)).

Second, relative to their peers, G-SIBs cut their securities holdings by more post-crisis (first row, column (2)). Again, the difference in G-SIBs' adjustment became more pronounced after the framework was introduced (third row, column (2)). To examine how G-SIBs rebalanced their asset mix, we perform the same comparative analysis for banks' cash holdings and loans (as a share of total assets). We find that G-SIBs raised their cash holdings by relatively more post-crisis (first row, column (3)), but no additional effect arises after the regulatory reform (third row, column (3)). For loans, the estimates do not suggest that G-SIBs reduced

Balance sheet adjustments accelerate after the G-SIB framework was introduced[1] Table 3

	Dependent variable:				
	Log total assets (TA)	Securities/TA	Cash/TA	Loans/TA	Deposits from banks/total liabilities
	(1)	(2)	(3)	(4)	(5)
Adjustment:					
from pre-crisis to post-crisis (γ_1)	–0.15*	–3.47*	3.41***	0.55	–4.01**
from pre-crisis to post-reform (γ_2)	–0.41***	–7.53***	4.51***	2.85	–7.87***
from post-crisis to post-reform[2] ($\gamma_2 - \gamma_1$)	–0.25***	–4.06***	1.10	2.30	–3.85***
Number of observations	830	827	825	820	800
R-squared within	0.15	0.08	0.06	0.02	0.02

*/**/*** indicates statistical significance at the 10/5/1% level. Standard errors are clustered at bank level.

[1] Estimates from regressions such as: $y_{ijt} = \tau + \alpha_i + \beta_{jt} + \gamma_1 D[1.post\text{-}crisis]_t \times D[1.GSIB]_{ij} + \gamma_2 D[1.post\text{-}reform]_t \times D[1.GSIB]_{ij} + \varepsilon_{ijt}$. All columns contain bank (α_i) and country x time (β_{jt}) fixed effects. $GSIB$ is a dummy variable that takes value one for the 33 banks that were designated as G-SIBs at least once during 2012–17. A categorical variable indicates the three phases of adjustment: pre-crisis (2005–07), post-crisis (2008–11) and post-reform (2012–17). Therefore, γ_1 and γ_2 are to be interpreted as changes from pre-crisis to post-crisis and from pre-crisis to post-reform, respectively. [2] Test for significance in difference in coefficients γ_2 and γ_1.

Sources: BCBS; FSB; SNL; authors' calculations.

their lending by more than their peers did since the GFC or after the introduction of the reform (column (4)).

Third, G-SIBs reduced the share of uncollateralised borrowing from banks in their overall funding mix relative to non-G-SIBs. This development started off post-crisis (first row, column (5)), but again became more pronounced after the framework was put in place (column (5), third row). This result tallies with the overall reduction in G-SIBs' interconnectedness scores, which encompass intra-financial liabilities (Graph 3, left-hand panel).

The above findings are suggestive that the framework has encouraged G-SIBs to reduce their systemic importance. Yet several qualifications remain. One is the effect of confounding factors, such as macroeconomic policies or structural changes in the market environment (Adrian et al (2018)), which could blur the framework's impact.[12] Quantitative easing, for example, may have affected G-SIBs' balance sheets differently than it did those of their peers. Another possibility is strategic adjustments by banks along dimensions that help to reduce the G-SIB scores. This could include raising risk-taking along other dimensions that are less constrained by regulation, or by compressing their balance sheets around the end-of-year disclosures (Aldasoro et al (2019), Behn et al (2019)). If this is the case, the systemic importance of G-SIBs might be understated.

Conclusion

This special feature finds that G-SIBs have become more resilient in recent years, thanks to a build-up in capital buffers and a shift to more stable sources of funding. Weak profitability, however, has hindered further improvements. G-SIBs' systemic importance, as approximated by the BCBS assessment methodology, has declined on average over this period, relative to other banks and also the broader financial system. Overall, banks' post-crisis balance sheet adjustments tally with the incentives provided by the G-SIB capital surcharges.

The systemic risk posed by a bank depends on its systemic importance and resilience. Our findings thus point to a general decline in such risks. Post-crisis reforms to establish effective resolution regimes, not covered in this feature, are likely to have further supported this trend. Yet the measurement of systemic risk remains subject to uncertainty despite the contributions of academic research and supervisors. For one, measures of systemic risk may underestimate the impact of complex interlinkages in the banking sector, particularly during episodes of stress (Acemoğlu et al (2015)). Moreover, risks may be migrating outside the traditional banking sector and thus outside the scope of the G-SIB framework.

These considerations call for continued monitoring by supervisors, and highlight the value of strengthened cross-border resolution arrangements (FSB (2015)). They also underscore the benefits of cooperative efforts to gather and analyse detailed information on globally active banks, such as through the International Data Hub (FSB-IMF (2018)).

[12] Another confounding factor is the anticipation effect, ie banks may frontload their response to regulation before it enters into force.

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Green bonds: the reserve management perspective[1]

Central banks' frameworks for managing foreign exchange reserves have traditionally balanced a triad of objectives: liquidity, safety and return. Pursuing these objectives involves explicit trade-offs. Recently central banks have shown interest in incorporating environmental sustainability objectives into their reserve management frameworks. Rather than a triad, central banks may analyse (and weigh) a tetrad of reserve management objectives in allocating part of their foreign exchange reserves to green bonds.

JEL classification: E58, F31, G11, G17.

Central banks are playing an increasingly active role in promoting the move towards a sustainable global economy (Carney (2015), ECB (2019)). A pertinent example is the recently established Network for Greening the Financial System (NGFS), which brings together around 40 central banks, supervisory agencies and international financial institutions to develop a coordinated response to climate-related risks in the global financial system (NGFS (2019), Pereira da Silva (2019)).[2]

Central banks can use various tools to support the greening of the financial system. These range from disclosure requirements and the provision of data to the integration of climate-related risks into financial stability assessments (Volz (2017)). In addition, central banks can help mobilise funds to contribute to the large-scale public sector investment required to reach the goals of the Paris Agreement on climate change. In this context, a key tool is the portfolios of assets that central banks have been entrusted to manage in the context of their countries' exchange rate policies: foreign exchange (FX) reserves.[3]

[1] The authors are staff members of the BIS Banking Department, which offers financial products, including investment pools dedicated to green bonds, to central bank clients. The views expressed in this article are the authors' and do not necessarily reflect those of the BIS. We thank Claudio Borio, Pierre Cardon, Stijn Claessens, Torsten Ehlers, Ulrike Elsenhuber, Kumar Jegarasasingam, Frank Packer, Jean-François Rigaudy, Hyun Song Shin, Philip Wooldridge and Peter Zöllner for comments, and Nicolas Lemercier for excellent research assistance.

[2] The NGFS is a voluntary, consensus-based forum collaborating to develop climate- and environment-related risk management practices in the financial sector and to mobilise mainstream finance to support the transition towards a sustainable economy.

[3] Another possibility is central banks' pension fund portfolios, where portfolio managers tend to enjoy some flexibility regarding asset allocation (Elsenhuber and Skenderasi (2019)). Other portfolios (eg those accumulated in the context of unconventional monetary policies), in contrast, would tend to be dedicated solely to fulfilling monetary policy objectives, limiting the scope for active portfolio allocation decisions (NGFS (2019)).

Key takeaways

- Central bank reserve managers are considering how to incorporate environmental sustainability objectives into their portfolios.
- Sustainability as a reserve management objective needs to be balanced against liquidity, safety and return.
- Green bonds' safety and return support their incorporation into reserve portfolios, but their accessibility and liquidity currently pose some constraints.

In this feature, we explore how environmental sustainability objectives might fit within central banks' reserve management frameworks. This requires expanding the usual triad of reserve management objectives – liquidity, safety and return – into a tetrad. Using the example of green bonds, we find that sustainable investments can be included in reserve portfolios without forgoing safety and return, although their accessibility and liquidity currently pose some constraints. The results of an illustrative portfolio construction exercise suggest that adding both green and conventional bonds can help generate diversification benefits and, hence, improve the risk-adjusted returns of traditional government bond portfolios.

The feature is organised as follows. The next two sections explore how sustainability considerations can be integrated into the reserve management framework. The following section examines green bonds' liquidity, safety and return and assesses their diversification benefits. The final section concludes.

Reserve management process

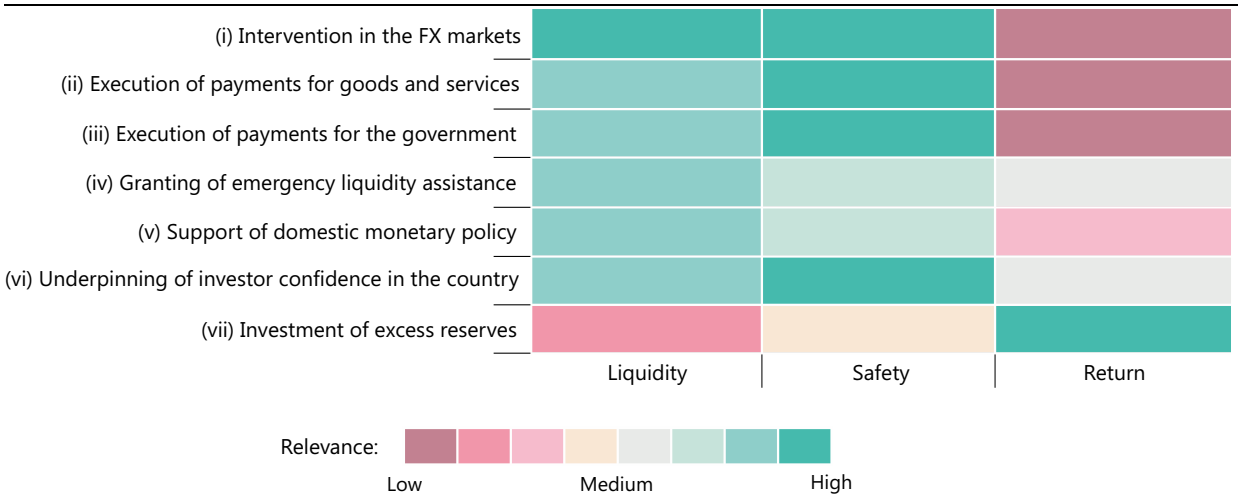
Any debate about whether FX reserves can be employed to pursue sustainability objectives traces back to a discussion of the purposes for holding reserves. Historically, the objective behind reserve accumulation has been to assure markets that the national authorities can meet their external financial obligations and, more generally, to instil confidence in the domestic economy. Reserve managers, in turn, have traditionally emphasised their ability to mobilise reserves (eg for FX intervention purposes), prioritising the liquidity and safety (or capital preservation) of reserve assets in their asset allocation decisions.

More recently, however, reserves are widely perceived as exceeding the levels indicated by standard adequacy metrics, at least for some countries (IMF (2016)). According to IMF data, total reserves increased by about 10% annually over the 2000–18 period, reaching about $11.5 trillion at end-2018. This growth was mostly a by-product of central banks' monetary and exchange rate policies rather than for explicit adequacy purposes. Anecdotal evidence suggests that the resulting "excess" levels of reserves have led reserve managers to place more emphasis on achieving adequate returns, for example by diversifying the asset and currency composition of their portfolios.

This suggests a direct link (or "mapping") between the seven economic uses of reserves that are usually identified in the literature (Borio et al (2008)) and the triad of objectives (ie liquidity, safety and return) commonly pursued by reserve managers. We express the relevant trade-offs by way of a 7 x 3 matrix (Graph 1), with different

Mapping between economic uses of reserves (rows) and reserve management objectives (columns)[1]

Graph 1



[1] For illustrative purposes.

Source: Authors' elaboration.

colour codes illustrating the possible weights that reserve managers are likely to give to their various objectives.

Graph 1 suggests that different economic uses are likely to lead to different portfolio allocations. For example, a reserve manager who needs to regularly smooth liquidity conditions in the FX market vis-à-vis the euro (Graph 1, row (i)) will tend to favour assets providing sufficient liquidity and safety (in terms of both credit and market risk; green shading). This suggests large allocations to short-dated, high credit quality, euro-denominated securities, even for low- or negative-yielding returns on those funds (red shading). Yet, when investing the portion of the reserves considered "excess" from an adequacy perspective (row (vii)), the same reserve manager will tend to more strongly emphasise return (green shading), probably yielding more risky and diversified portfolios. This would entail some costs in terms of liquidity (red shading) and, to a lesser extent, safety (beige shading).[4]

Of course, the trade-offs between the various objectives are not one-to-one, and the economic uses of reserves are not mutually exclusive. In practice, therefore, central banks will look across several objectives, as specified in their mandates, to set liquidity, safety and return requirements accordingly.

In the portfolio construction exercise, this is often done as part of a hierarchical tranching approach that divides the reserve portfolio into sub-portfolios: a liquidity and/or working capital tranche and a separate investment tranche. That is, parts of the portfolio are reserved exclusively for assets that meet a specific threshold requirement for liquidity, limiting the extent to which FX reserves may be invested in assets considered "less liquid". Then safety requirements are set, which may be reflected in market and credit risk investment targets or guidelines (eg a volatility objective or asset class and currency exposure limits) – this limits the extent to which FX reserves may be invested in assets considered "less safe". Finally, the reserve

[4] A key aspect of these decisions is the choice of the appropriate unit of account (numeraire) for the reserve portfolio. See McCauley (2008) for details.

manager would find the portfolio that maximises return subject to these constraints. At this stage, the "excess" reserves not needed for liquidity or working capital purposes would be allocated more freely as part of the investment tranche. Under an alternative approach, the manager first sets liquidity requirements, but then trades off safety and return jointly in the portfolio optimisation process.[5]

Introducing sustainability: objectives and tools

There are two – not mutually exclusive – ways for central banks to include sustainability in their reserve management process: explicit and implicit integration. The choice of approach mainly depends on governance considerations and, in particular, central bank mandates.

Explicit integration can be achieved by central banks that are able to specify sustainability as one of the policy purposes for holding reserves. In Graph 1, this would entail adding one or more rows, representing new economic uses of reserves (eg supporting the transition to a low-carbon economy) to guide portfolio choice. In practice, this would imply changing the central bank's statutes or other key governance documents, which may face legal or political constraints.[6] To the best of our knowledge, no central bank has yet taken this step, even though some already aim for sustainability as part of their current, general statutory mandate.[7]

Implicit integration involves introducing sustainability into the pursuit of the traditional economic uses of reserves. This requires recognising the indirect ways in which sustainability (or the lack thereof) affects central banks' existing policy objectives. One key factor is risk management. Central banks using their FX reserves as a means to underpin investor confidence in the country (Graph 1, row (vi)), for example, may decide to tilt their reserve portfolios towards assets deemed less exposed to possible long-term financial losses arising from climate risks.[8]

Irrespective of the chosen approach, including sustainability in the reserve management process introduces additional trade-offs. In the context of Graph 1, this would involve expanding the triad of liquidity, safety and return to a *tetrad*, with sustainability as the fourth reserve management objective. In practice, this would then be reflected in changes to the central bank's investment and/or risk management guidelines.[9]

[5] In the mean-variance approach, for example, this would mean finding the portfolio with the highest risk-adjusted return, regardless of the absolute level of volatility.

[6] There are also questions about the appropriate assignment of explicit sustainability objectives in the broader policymaking context, which could also be vested with sovereign wealth funds.

[7] In an analysis of central bank mandates, Dikau and Volz (2019) find that the goal of supporting sustainable growth is directly included in at least a dozen central banks' mandates, and indirectly in the mandates of many others.

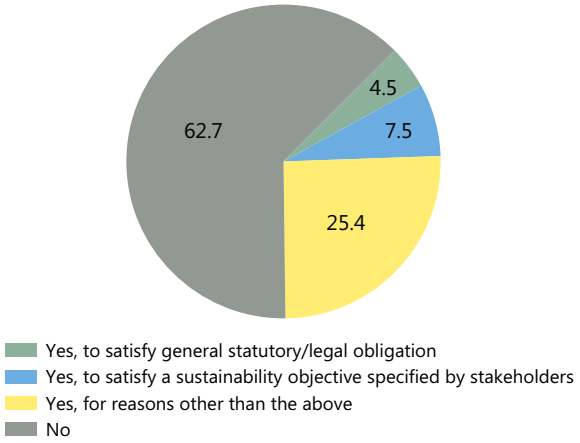
[8] An example of this type of analysis, applied to central bank bond purchases, is Monnin (2018).

[9] Examples include the Bank of France and the Netherlands Bank, which recently took the pioneering step of adopting responsible investment charters for their own funds and, in the latter case, also for their FX reserves. See Bank of France (2018) and Netherlands Bank (2019).

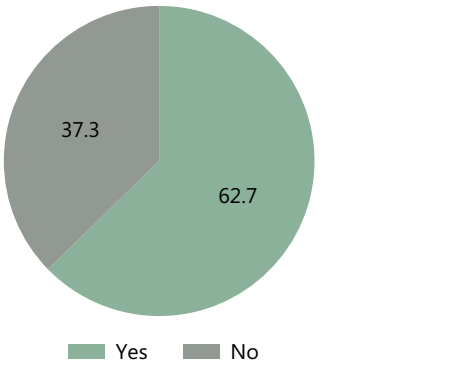
Sustainability and central bank policy objectives

Percentage of respondents[1] Graph 2

Does your central bank include sustainability considerations in the pursuit of its policy objectives?



Do you think there is scope to include sustainability as a reserve management objective?



[1] Number of respondents = 67.

Sources: Authors' survey of reserve managers and official institutions; authors' calculations.

Survey results suggest that most central banks do not currently include sustainability considerations in the pursuit of their policy objectives (Graph 2, left-hand panel).[10] And those which do include them do not necessarily aim to satisfy a general statutory or legal obligation. Indeed, over half of the institutions in the sample consider that there is scope to include sustainability as a fourth reserve management objective without necessarily adjusting mandates and, hence, the stated uses of their reserves (right-hand panel).

As regards the choice of tools, central banks' preference seems to be green bond investments, followed by the use of criteria encompassing social and governance considerations in addition to environmental ones (Box A).[11] Focusing on green bonds allows them to finance green projects in a potentially meaningful way, while staying within the fixed income asset class that is the core of their reserve portfolios. As the market is still evolving, green bond investing also offers central banks the opportunity to help develop standards and practices (eg in the context of the certification of green bonds according to their likely environmental or climate-related effects).

[10] Authors' July–August 2019 survey of reserve managers from 67 central banks and other national authorities.

[11] In the survey, 76% of respondents identified green bonds as their tool of choice for including sustainability considerations in reserve management activities, followed by 51% of respondents who indicate using metrics such as environmental, social and governance criteria in investment decision-making.

Box A

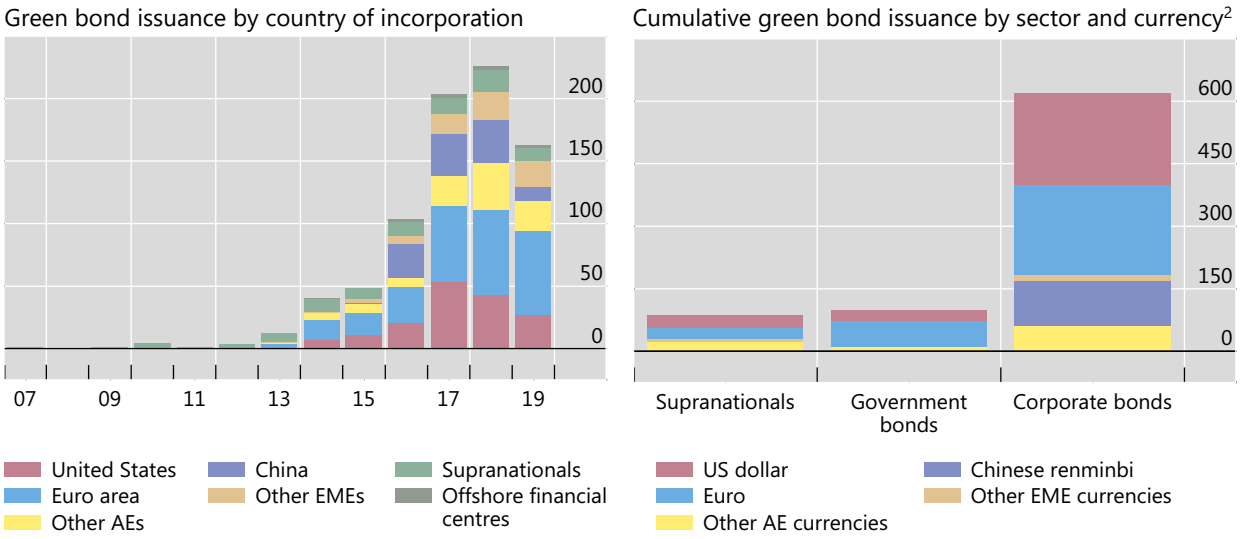
Green bonds: features and trends

Green bonds are fixed income securities whose proceeds are used to finance new or existing eligible green projects, eg projects to combat pollution, climate change or the depletion of biodiversity and natural resources (Ehlers and Packer (2017), BIS (2019)). They are either asset-backed or asset-linked, and issuers must declare the types of green projects eligible to receive funds at issuance. Green bonds are the biggest part of the broader universe of socially responsible investments, which include bonds and equities from issuers identified by so-called environmental, social and governance (ESG) standards.①

Issuance has grown rapidly in recent years, rising from less than $50 billion in 2014 to close to $230 billion in 2018 (Graph A, left-hand panel). A key catalyst for market development was the 2014 introduction by the International Capital Market Association (ICMA) of the Green Bond Principles (GBPs). The GBPs govern: (i) the use of proceeds; (ii) the process for project evaluation and selection; (iii) the management of proceeds; and (iv) reporting. Bonds meeting the GBPs or the Climate Bond Initiative's (CBI) Climate Bonds Standard (CBS) are eligible for green bond certification by either third-party providers or the CBI. Certification gives comfort to investors that the bonds confer environmental or climate-related benefits, helping to safeguard against "greenwashing".②

Rapid growth in green bond issuance since 2014[1]

In billions of US dollars — Graph A



[1] Up to June 2019. [2] Bonds with unspecified sector are excluded from the sample.

Sources: Climate Bonds Initiative; Dealogic; Environmental Finance Bond Database; authors' calculations.

Supranationals and advanced economy issuers initially dominated the market. Corporates (mainly from the financial, utility and industrial sectors), municipals and emerging market issuers, particularly from China, then gained market share. Issuance was typically in the borrower's local currency, predominantly in euros and US dollars, but other currencies, in particular the Chinese renminbi, recently gained in volume (Graph A, right-hand panel). As a result, the green bond market has gone from being predominantly supranational and euro-based to representing a more broadly diversified universe in both issuer and currency terms.

① ESG investing is based on the notion that ESG factors are drivers of a company's long-term value, risk and return, and that they signal how sustainable the company is over the long term. ② Many jurisdictions have developed their own national taxonomies of what constitutes eligibility as a green bond.

Green bond eligibility as a reserve asset

Within this reserve management framework, a key question is how well green bonds meet the desirable liquidity, safety and return characteristics. We look at each of these characteristics in turn and then discuss potential diversification benefits.

Green bond liquidity

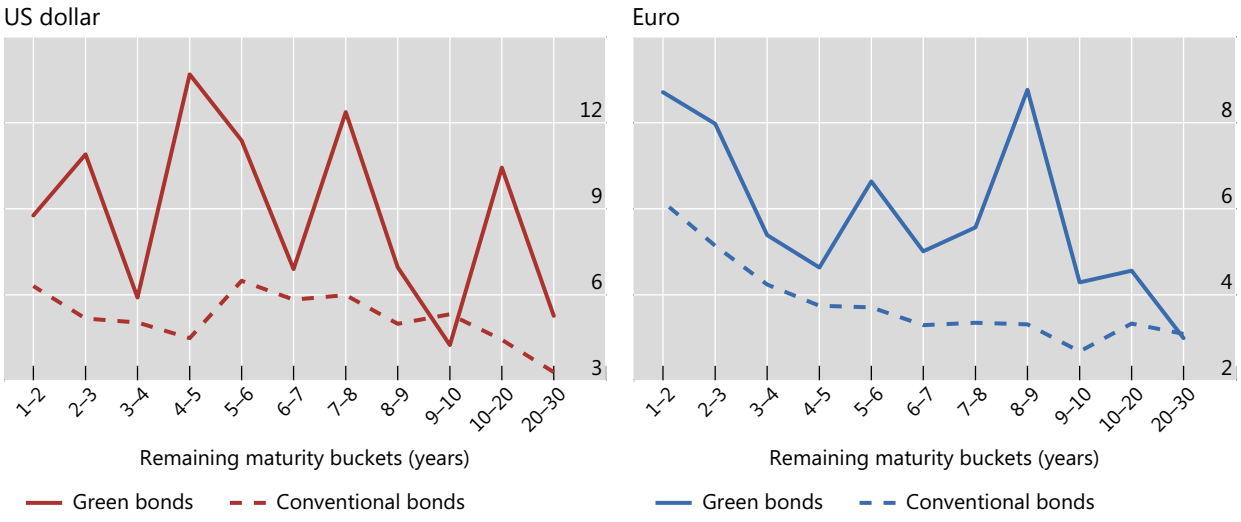
An instrument is said to be liquid if transactions in it can take place rapidly and with little impact on price (Borio et al (2008)). On this basis, eligibility of green bonds as a reserve asset will depend on at least two considerations.

The first concerns the stock of instruments available for investment. Both the size and diversity of the green bond market have grown considerably over time (Box A). However, at current levels, the US dollar and euro segments each represent only about 6.5% of global FX reserves, limiting the scope for investments. Outstanding amounts also continue to be small relative to their conventional comparators, with $750 billion worth of green bond volumes compared with almost $120 trillion worth of conventional securities. The same is true for key market segments relevant for reserve managers, such as government bonds and those issued by international organisations. Given large oversubscriptions in primary markets (CBI (2018)) and low secondary market turnover, accessibility of green bonds will tend to be limited, especially if investors hold these bonds to maturity. The flip side, however, is that if strong demand persists, it should make it easier for investors to offload their bonds, if required.

The second consideration concerns the cost of trading, which is inherently difficult to measure. One proxy is bid-ask spreads. Graph 3 reports median bid-ask

Term structure of bid-ask spreads for green and conventional bonds[1]

In basis points — Graph 3



[1] Supranational and agency bonds; median bid-ask spread in July 2019, by remaining maturity bucket.

Sources: Bloomberg; authors' calculations.

spreads for US dollar- and euro-denominated green bonds and their conventional counterparts from supranational and agency issuers, organised by maturity bucket. The resulting bid-ask term structures suggest that green bonds tend to be more costly to buy and sell, trading with wider spreads than their conventional counterparts. Results are similar across the entire market.

As a result, green bonds may not be eligible for the liquidity or working capital tranches of central banks' reserve portfolios. Inclusion in investment tranches, in turn, is constrained by the market's still limited size. Central banks would thus have to limit the size of their allocations.

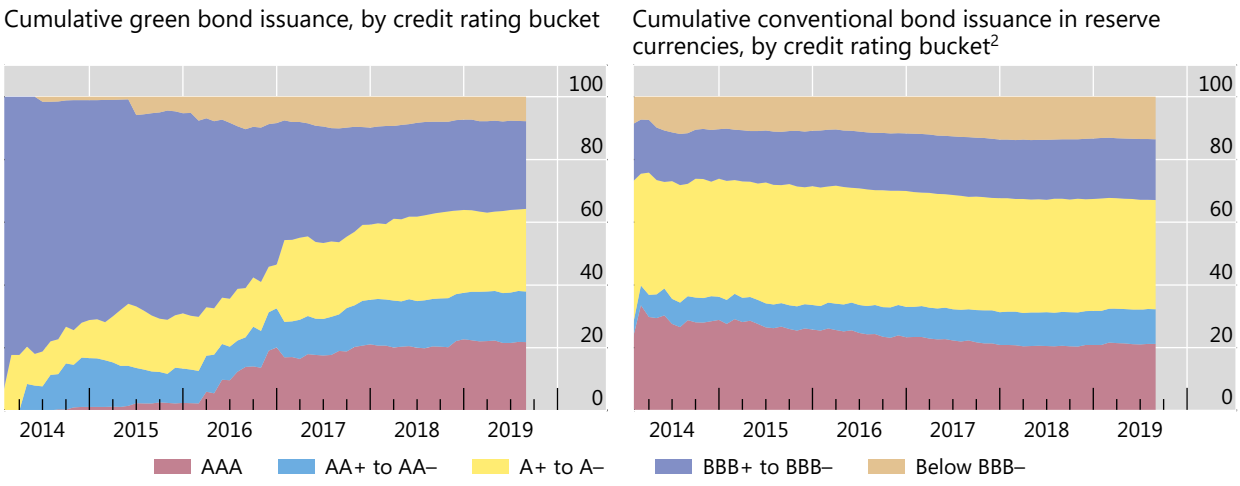
Green bond safety

To assess the eligibility of green bonds from a credit risk perspective, we investigate the credit ratings of newly issued green bonds by issuance year, and compare these with those of conventional bonds. While the concept of safety goes well beyond credit ratings, central banks typically constrain the credit quality of their reserve portfolios by imposing rating requirements on their investments. For example, a common requirement is to exclude bonds with ratings of BBB+ and below. Green bonds are mostly backed by the full balance sheet of the issuer, and not only by the cash flows related to the climate-friendly project financed from the proceeds (Ehlers and Packer (2017)), allowing direct comparisons across both market segments.

We find that the ratings compositions of green and conventional bond markets have broadly converged, supporting eligibility. Although green bond at-issuance ratings in 2014 were more concentrated in the lower end of the investment grade spectrum, this predominance has gradually waned (Graph 4, left-hand panel). This puts high-graded green bonds (above BBB+) at about 65% of new issuance by 2019, broadly comparable to the conventional comparator market (right-hand panel). Recent data for total amounts outstanding at the sectoral level appear to confirm this

Credit ratings at issuance; green vs conventional bonds[1]

Percentage of amount issued — Graph 4

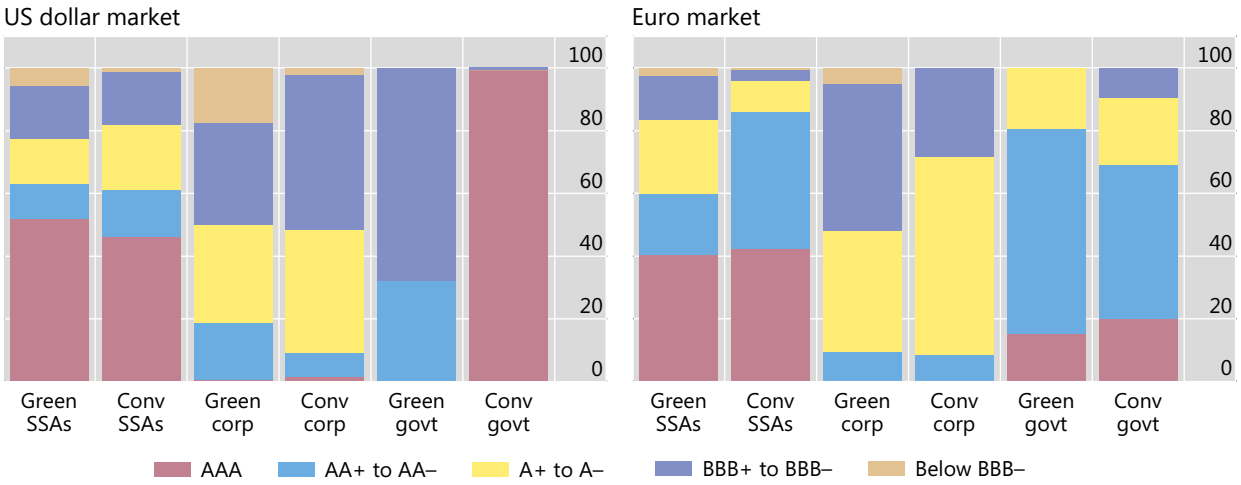


[1] Fitch, Moody's and S&P credit ratings average; expressed in S&P credit ratings. [2] Reserve currency issuance includes all government, quasi-government and corporate bonds issued in the SDR basket of currencies (USD, EUR, GBP, JPY and CNY), since 2014.

Sources: Bloomberg; authors' calculations.

Green and conventional bond credit rating distribution by type of issuer[1]

Percentage of amount outstanding Graph 5



Conv corp = conventional corporate bonds; conv govt = conventional government bonds; conv SSAs = green supranational and agency bonds; green corp = green corporate bonds; green govt = green government bonds; green SSAs = green supranational and agency bonds.

[1] Amount outstanding included in green and conventional bond market benchmarks. Only includes rated securities; as of end-July 2019.

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

observation. Across sectors, credit quality is broadly similar for both green and conventional markets (Graph 5). The main exception is government bonds, where credit quality in green-labelled instruments tends to be lower, particularly in the US dollar market, in part because only a few countries have so far issued in this space.

Green bond return

The third aspect of eligibility is return. Evidence from both primary and secondary markets points to a small and negative yield premium ("greenium").[12] However, much of this evidence is at the security level, which restricts the analysis to a relatively small sample of matched bonds. The more relevant question for reserve managers is how a portfolio of green bonds is likely to behave vis-à-vis one composed of conventional bonds with similar characteristics. We thus take the analysis to the asset class level and focus on relative returns for fixed income indices.

To control for differences in index composition, we compare two "matched" indices: one for green and the other for conventional bonds. Given limited availability of green bonds, we select an available green bond index as our reference portfolio. We then build a portfolio of conventional bonds that matches its characteristics in terms of sectors, rating composition and duration.[13] To do this, we dissect the green

[12] Zerbib (2019) provides a comprehensive literature review. He finds, controlling for liquidity, an average green bond premium of –2 basis points. This suggests that, on average, holding such bonds to maturity yields a lower return.

[13] Bloomberg Barclays MSCI indices are used as a basis for the green bond universe and ICE BofAML indices for the conventional bond market. The underlying sectors used are: agencies, corporates, governments, municipals and covered bonds. The underlying credit rating brackets are: AAA, AA+ to AA–, A+ to A–, and BBB+ to BBB–.

bond index (in US dollars or euros) into each issuer sector i and credit rating bucket j. Then, we construct a synthetic conventional portfolio that matches this breakdown, by applying the green index's sector and rating weights to individual conventional bond indices for each combination of sector i and credit rating bucket j. We also ensure that the conventional indices closely track the green portfolio's duration. We then compare index performance, assuming rebalancing costs to be zero for both portfolios. Of course, the issuer and rating composition of the two portfolios will change over time, which must be taken into account when the indices are rebalanced.

On this basis, the yield to maturity of the portfolio of the conventional index (in either US dollars or euros) at every month-end t is:

$$y_t^{Conv.} = \sum_i w_{i,t}^{Green} * (\sum_j w_{j,t}^{Green} y_{(i,j),t}^{Conv.})$$

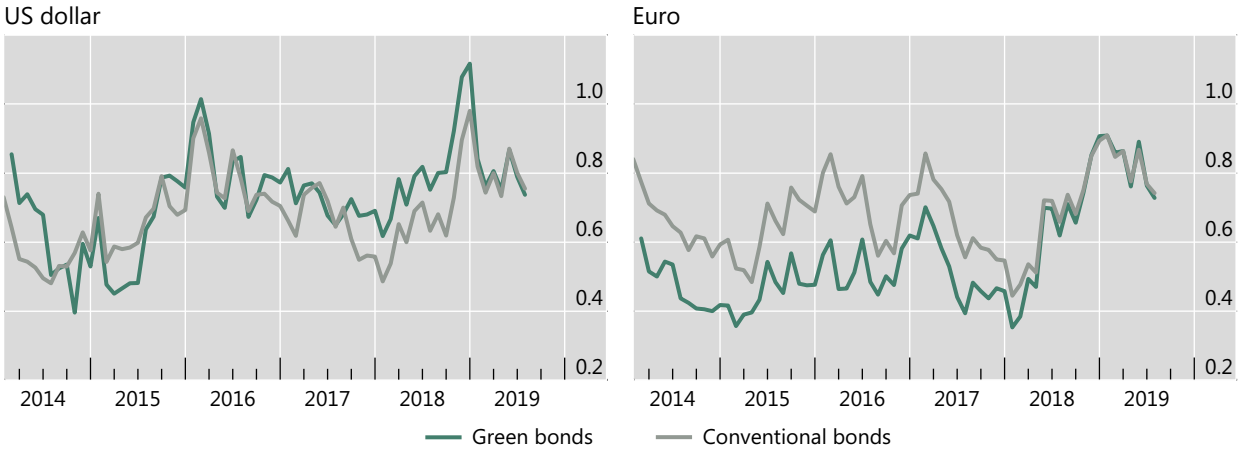
where $w_{i,t}^{Green}$ and $w_{j,t}^{Green}$ are the weights that sector i and rating bucket j have at month t in the green benchmark, $y_{(i,j),t}^{Grey}$ is the yield to maturity of the conventional index of sector i and rating bracket j, and $y_t^{Conv.}$ is the yield to maturity of the complete conventional bond portfolio. This can then be contrasted with the yield of the green portfolio. In line with established practice, in order to isolate the compensation of green and conventional bonds relative to their risk-free benchmark, we remove the risk-free component of the yields to maturity by subtracting the zero coupon yield of the government instrument with equivalent duration.[14]

Our results (Graph 6) suggest that green bonds compare reasonably well with their conventional peers. Based on our approach, a US dollar investor tracking the green index would have enjoyed a spread 4 basis points above that of the conventional benchmark (positive "portfolio greenium"), while the euro-based investor would have earned 12 basis points less than the comparator market (negative portfolio greenium). However, this greenium estimate has varied

Green and conventional bond spreads to the reference curve[1]

In percentage points

Graph 6



[1] Yield curve factor model for the reference curve uses monthly data since 1953 for US Treasuries from the Board of Governors of the Federal Reserve System and monthly data since 1974 for German bunds from the Bundesbank (see Box B for details).

Sources: Board of Governors of the Federal Reserve System; Deutsche Bundesbank; Bloomberg; ICE BofAML indices; authors' calculations.

[14] The reference curve for this purpose is obtained by applying the shadow short rate approach for modelling the term structure of interest rates (Bjorheim et al (2018) and Box B).

Asset class summary statistics[1]

In per cent

Table 1

	US dollar assets			Euro assets		
	Government bonds	Green bonds	Conventional bonds	Government bonds	Green bonds	Conventional bonds
Average return	0.19	0.26	0.24	0.34	0.36	0.39
Volatility	0.88	0.76	0.67	1.3	1.18	1.17
VaR return (97.5%)	–1.39	–0.97	–0.82	–2.17	–2.23	–2.18
Expected shortfall (97.5%)	–1.82	–1.55	–1.44	–2.37	–2.68	–2.69
Probability of negative return	52.31	35.38	36.92	38.46	30.77	29.23
Duration (years)	5	5	5	9	9	9

[1] Historical statistics using monthly returns from January 2014 to July 2019.

Sources: Board of Governors of the Federal Reserve System; Deutsche Bundesbank; Bloomberg; ICE BofAML indices; authors' calculations.

considerably over time, due in part to differences in issuer composition across benchmarks, even when credit rating and sector breakdowns are set equal. It also appears that the portfolio greenium narrowed over time as the green bond market developed, with the spread between conventional and green returns closing as of 2019.

Absolute returns paint a similar picture. Table 1 reports summary statistics comparing the risk-return properties of green and conventional bonds. A couple of points stand out. First, both types of portfolios possess broadly comparable historical returns. For example, between 2014 and mid-2019 US dollar green bonds had an average monthly return of 0.26%, while the conventional benchmark returned 0.24% over the same period. Second, we observe that, in both the US dollar and euro cases, the volatility and tail risk of the conventional and green instruments are broadly similar, slightly favouring green bonds. This confirms the point that, from a safety perspective, investment in green bonds would not seem to subject reserve managers to higher risk than their conventional alternative. This holds regardless of whether safety is defined in terms of price volatility, performance in extreme scenarios or the probability of facing a negative return.

Diversification benefits

Having established the eligibility of green bonds as reserve assets – at least outside reserve managers' liquidity tranches – does it make sense to add green bond allocations from a portfolio perspective? Answering this question involves trading off green bonds' safety and return in a portfolio context, after taking the portfolio's liquidity requirements into account. To assess this, we conduct an illustrative portfolio construction exercise. The results suggest that adding both green and conventional bonds can help generate diversification benefits and, hence, improve the risk-adjusted returns of traditional government bond portfolios (Box B).

Box B

Diversification benefits of green bonds: illustrative asset allocation exercise

Do green bond investments generate diversification benefits relative to their conventional peers? To answer this question, we construct simple, illustrative reserve portfolios comprising three assets: zero coupon government bonds, and the green and conventional bond portfolios built for the earlier analysis of returns. We explore any potential diversification benefits in green bonds by running separate asset allocation exercises for US dollar- and euro-denominated portfolios. We do this for both prospective and historical returns.

Methodology

Following a hierarchical approach to portfolio construction, we begin by setting liquidity requirements by means of a constraint of 40% to be invested in government bonds. Then we use a standard mean-variance optimisation algorithm to trade off safety and return, combining conventional and green bonds to obtain the best possible pairs of expected return and volatility. To derive prospective risk and return measures of bonds of different maturities, we employ a forward-looking, factor-based approach to asset allocation performed in three steps: (i) factor identification and projection; (ii) return projection; and (iii) portfolio optimisation.

First, we identify and estimate the underlying statistical factors of government bond yield curves. To achieve this, we use a dynamic Nelson-Siegel term structure model, modified slightly from the version proposed by Diebold and Li (2006). The model decomposes historical yields into three factors: the short rate, slope and curvature, which are then projected forward.① For the purposes of this study, we rely on a simple autoregressive model that generates projected paths for all three factors over the next five years.② For green bonds and their conventional counterparts, additional spread factors, representing compensation for risks beyond those embedded in the government yield curve, are estimated and projected using the same autoregressive approach.

Second, we use our yield curve factor estimations to project the zero coupon term structure of interest rates for each period in our projection horizon. For green bonds and their conventional counterparts, we add the relevant spread factor projections to identify the prospective yields of each asset. Armed with these simulated yield distributions, we can then estimate a prospective return distribution for each generic asset class, from which forward-looking summary statistics – such as the expected return (mean), volatility (standard deviation) and other risk metrics – are derived. As implementation considerations typically come at a later stage of the FX reserve management process, the derived prospective return distributions do not include transaction costs.

To keep the analysis simple, we assume equal expected returns for green and conventional bonds. Specifically, we restrict the paths of green and conventional bond spreads to be, on average, equal and constant over time and close to their current levels. This reflects the empirical evidence of small and possibly vanishing greenium effects (Graph 6) as well as results from our survey, in which a majority of reserve managers saw no meaningful difference between green and conventional bond returns.③

Finally, we estimate an expected return vector and a variance-covariance matrix from the prospective asset return distributions. On this basis, a standard (Markowitz) mean-variance algorithm is applied to derive a frontier of efficient portfolios, including the global minimum variance portfolio.

Results

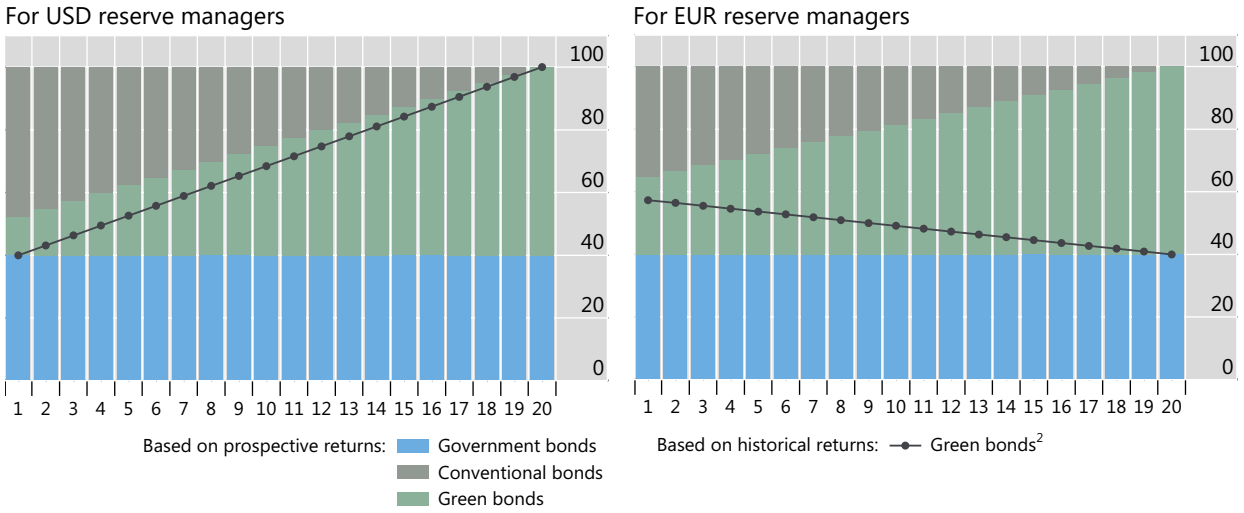
Our results are shown in Graph B. Portfolios further along the frontier, which are denoted by increasing portfolio numbers on the x-axis, imply higher volatility. The results based on prospective returns (coloured bars) suggest that, even though green and conventional bonds are assumed to have equal returns on average, including both in the illustrative reserve portfolio helps improve the risk-adjusted returns of government bonds, once liquidity requirements at the overall portfolio level are taken care of. For example, in the minimum risk portfolios (labelled "1" in both panels), we find that green and conventional bonds are both present, illustrating diversification benefits. The same applies to the maximum risk portfolio (labelled "20").

Results based on historical returns (over the January 2014–July 2019 period) are also generated for comparison purposes. The results are qualitatively similar to those based on prospective returns (Graph B; black lines). For US dollar and euro portfolios, green bonds are present in all but one of the portfolios along the efficient frontier. This is despite the history of greenium effects (Graph 6), particularly in the euro-denominated market, which reduces green bond allocations relative to the prospective return case. Allocations in the minimum risk portfolios are anchored by the relative size of historical return volatilities observed for both green and conventional bonds.

Of course, real world asset allocation exercises would tend to involve a wider range of eligible assets as well as additional constraints. This will change the resulting portfolio weights for the overall FX reserves. Nonetheless, our illustrative exercise suggests that, when deciding their portfolio allocations, reserve managers can reap diversification benefits from even subtle differences in risk-return properties between green and conventional bond portfolios.

Composition of the portfolios on the efficient frontier[1]

Percentage of each portfolio — Graph B



[1] Efficient frontiers for illustrative reserve portfolios, based on monthly returns. Historical returns are calculated from a sample from January 2014 to July 2019; prospective returns are calculated based on five-year-ahead projections as described in Box B. Sovereign bond investment imposed at 40% for all exercises. Portfolios on the frontier are sorted from lower to higher volatility. Minimum risk portfolios are labelled "1"; maximum risk portfolios are labelled "20". [2] Sum of the fixed government bond allocation (40%) and the resulting green bond allocation.

Sources: Board of Governors of the Federal Reserve System; Deutsche Bundesbank; Bloomberg; ICE BofAML indices; authors' calculations.

① Departures from the original Nelson-Siegel model and the methodology for factor projection are described in more detail in Bjorheim et al (2019)). ② This is for illustrative purposes. In practice, reserve managers would choose their own model to link what they believe are the drivers of future returns to their underlying factors. For example, in a macroeconomic-based approach, variables such as real GDP growth and year-on-year inflation may be used to predict the yield curve. ③ In our survey, 57% of reserve managers responded that there is no meaningful return difference between green and conventional bonds, while 37% replied that they provide lower returns and 6% higher returns.

Conclusion

While central banks are playing an increasingly active role in promoting green finance, comparatively little attention has been paid to how they might integrate sustainability into their policy frameworks – specifically for their FX reserves.

Sustainability might be integrated into the reserve management process either *explicitly* by articulating sustainability as a defined purpose for holding reserves, or *implicitly* as a supporting aspect of existing policy purposes. Central banks' choice between either of these approaches will depend primarily on their legal and governance frameworks. In both cases, however, it will involve additional trade-offs, turning the classical triad of liquidity, safety and return into a tetrad of reserve management objectives.

Analysing the asset class properties of green bonds enables us to explore how well a sustainability objective might coexist with the classical triad. Reserve managers evaluating the potential eligibility of green bonds as an asset class may find that their accessibility and liquidity currently pose some constraints. This is one reason reserve managers may wish to limit the total volume of green bonds held, particularly in the light of the relatively small (but rapidly growing) size of the market. The extent of this limit will depend on the priority a reserve manager gives to sustainability in its reserve management objectives.

Overall, however, we find that sustainability objectives can be integrated into reserve management frameworks without forgoing safety and return. The results of an illustrative portfolio construction exercise suggest that adding both green and conventional bonds can help generate diversification benefits and, hence, improve the risk-adjusted returns of traditional government bond portfolios. To the extent that central bank involvement helps to establish minimum standards and practices in a still developing market, this would tend to confer additional benefits: for example, by guarding against greenwashing (BIS (2019)).

Of course, instruments such as green bonds are only one tool for implementing sustainability objectives. Some central banks – particularly those with abundant FX reserves, which are more likely to hold less traditional reserve assets – may have more options for doing so, for example by making sustainable investment choices in the corporate bond or equity parts of their portfolios, or by adding new asset classes (such as green infrastructure). After all, there is more than one way to go green.

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Financial conditions and purchasing managers' indices: exploring the links[1]

Purchasing managers' indices (PMIs) have found a place in global conjunctural analysis and quarterly GDP nowcasting, serving as reliable concurrent indicators of real economic activity. They also closely mirror changes in equity prices and corporate bond spreads. More surprisingly, PMIs react to changes in the dollar index, and do so in a way that runs counter to a trade competitiveness explanation. We show that the financial variables help predict PMIs and explain a significant proportion of their variation. The two seem to be linked through shifts in macroeconomic sentiment and global financing conditions.

JEL classification: C53, E27, F31, F47.

Purchasing managers' indices (PMIs) are monthly economic surveys of companies in which senior managers overseeing operations answer questions on business activity and its recent trends. The questions cover output, employment, new orders, prices, costs and other aspects of business activity. Due to their timeliness and breadth of coverage, PMIs are among the business surveys most closely watched by analysts and commentators. PMIs also add power to forecasting models and are being used to derive real-time estimates ("nowcasts") of GDP.[2] In early 2018, PMIs came under the spotlight as they started to foreshadow weaker export orders and industrial output growth well before a slowdown in global economic activity became more visible in hard data during the first half of 2019.

This special feature explores the links between financial conditions and PMIs, highlighting empirical findings that shed light on the economic mechanisms at work. As it is well known that real activity and financial conditions tend to mirror each other (Stock and Watson (2003), Andreou et al 2013)), we would expect PMIs and financial conditions to mirror each other as well. Not surprisingly, we find that global and country PMIs are correlated with equity prices and corporate credit spreads (Graph 1, left-hand panel). Equity indices largely reflect market participants' assessments of future economic activity, while credit spreads also incorporate measures of financing conditions (see Gilchrist and Zakrajšek (2012)).

[1] The authors would like to thank Ana Aguilar, Claudio Borio, Stijn Claessens, Piti Disyatat, Emanuel Kohlscheen, Benoît Mojon, Christian Upper and Philip Wooldridge for helpful comments. The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

[2] For example, the New York Federal Reserve Bank Staff nowcasting model uses PMIs (Bok et al (2018)).

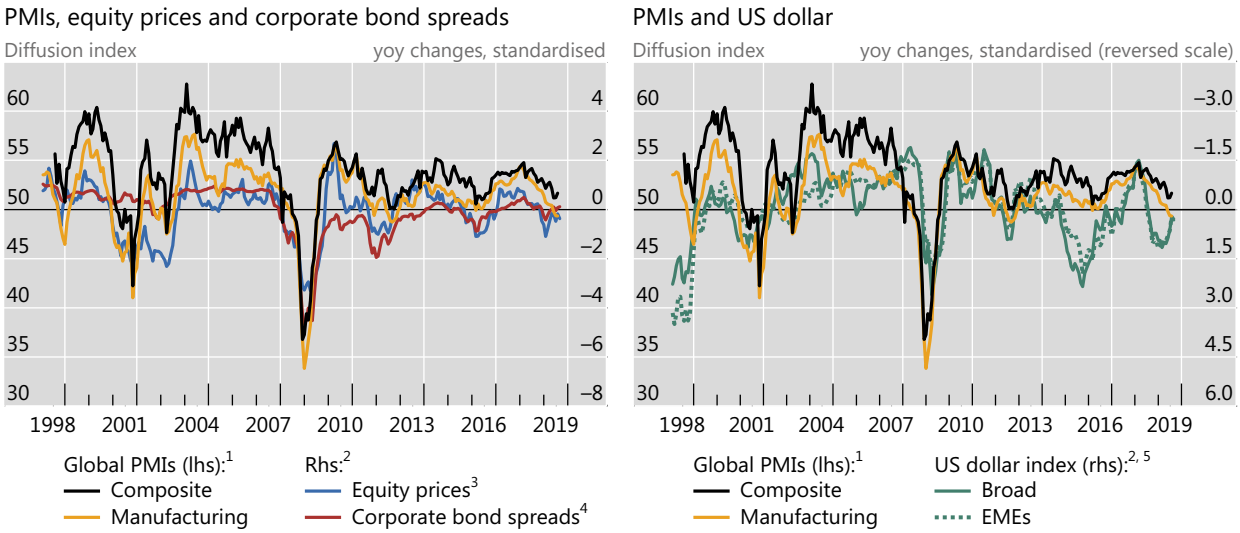
Key takeaways

- Purchasing managers' indices (PMIs) mirror changes in both real economic activity and financial conditions.
- Changes in equity prices, corporate bond spreads, and US dollar indices help predict PMIs, and explain a large share of variation in PMIs and GDP.
- The link between PMIs and the dollar runs counter to what trade competitiveness predicts, suggesting a role for the dollar as an indicator of global financing conditions.

Perhaps more surprisingly, we find that PMIs also correlate with the strength of the US dollar, as reflected in broad indices of the dollar exchange rate (Graph 1, right-hand panel). The correlation with PMIs outside the United States goes against an explanation based on trade competitiveness: it is when the dollar is strong that PMIs outside the United States are weak, contrary to the view that a strong dollar should stimulate activity through gains in trade competitiveness. A full explanation of this empirical finding is not attempted here, but we mention some possible lines of inquiry.

We first describe PMIs and briefly examine their statistical properties. We then study how selected indicators of global financial conditions track the PMIs, and conclude by discussing mechanisms that might underpin the empirical relationships.

PMIs track economic activity, financial indicators track PMIs — Graph 1



[1] A value of 50 indicates that the number of firms reporting output expansion is greater than the number of those reporting output contraction. [2] Year-on-year changes in monthly averages (computed as the average of daily observations from the 16th day of the previous month to the 15th day of the current month). Standardised to have zero mean and unit standard deviation. For corporate bond spreads, standardised monthly averages multiplied by −1. [3] MSCI All Country World Index, local currency. [4] ICE BofAML Global Corporate Index, investment grade, option-adjusted spread. [5] Negative values (upper part of the graph) indicate depreciation of the US dollar. Federal Reserve Board trade-weighted nominal dollar index, broad, based on goods trade. For EMEs, other important trade partners.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

PMIs and economic activity

PMI surveys ask a range of questions that bear directly on real economic activity.[3] A typical question for manufacturing output would be: "Is the level of production/output at your company higher, the same or lower than one month ago?" and for services output: "Has your business activity (in units) risen, fallen, or stayed unchanged over the past month?". The net balance of survey responses is converted into a diffusion index, which is seasonally adjusted. An index reading above 50 shows that the variable has increased since the previous month, below 50 that it has fallen. The broadest family of PMI surveys is conducted by IHS Markit, which samples some 26,000 firms worldwide.[4] The sample is stratified by size (small, medium and large firms) and sector (15 manufacturing and 12 service sectors in the composite index), with country PMIs aggregated into regional and global ones.

As business activity indicators, PMIs have several advantages over traditional statistical data such as industrial production, retail sales, or exports and imports. One is their timeliness: PMI readings are released immediately after the end of the reference month.[5] By comparison, industrial production data are published in many cases five to seven weeks after the end of a reference month, which can be problematic for assessments of conjunctural developments and decision-making in real time. Another advantage is the breadth of PMIs' coverage. By surveying managers who order intermediate products, decide on inventory levels or set prices, PMIs should accurately capture the vagaries of business conditions. This is especially the case when the surveyed firms are engaged in international trade and are thus exposed to shifts in global conditions. Moreover, by putting the same (or a very similar) set of questions to companies around the world, PMI surveys provide a data set that is comparable across countries and sectors. Such standardisation and comparability are not always guaranteed between national statistical surveys.

Numerous studies have confirmed that PMIs are reliable concurrent indicators of real activity. Harris (1991), Koenig (2002) and Peláez (2003) were early to document the ability of PMIs to beat naïve benchmarks and deliver accurate GDP nowcasts. Godbout and Jacob (2010) and Rossiter (2010) established that PMIs could be useful in nowcasting global macroeconomic aggregates. Strong properties of PMIs in tracking real GDP growth were also established for many individual economies, the euro area, and for country panels.[6]

[3] For manufacturing PMIs, these are typically output, employment, new orders, backlogs of work, purchases of intermediate goods, stocks of inputs and finished goods, suppliers' delivery times, input and output prices, and expected business activity. For services and composite indices, these are new and outstanding business, employment, input costs, prices charged and expected business activity.

[4] IHS Markit adapted the US PMI methodology in the early 1990s, and gradually extended it to almost 40 countries. The US family of PMIs, compiled by the Institute of Supply Management, was developed during the Great Depression in the 1930s, also a period of intense interest in economic barometers.

[5] Surveys are collected from around the 10th/12th to the 20th/22nd of the reference month.

[6] See eg Chudik et al (2016) and De Bondt (2018). Relatedly, work with PMIs challenged the notion that economic forecasters should focus on data dimension enlargement rather than reduction (Lombardi and Maier (2010), Duarte and Süssmuth (2018)).

PMIs and financial indicators

PMIs show the direction of change in business conditions, but say little about the drivers of that change. One possible source of such information is comments that purchasing managers give to explain or add nuance to their responses. However, these comments are anecdotal and cannot be easily structured for empirical research.

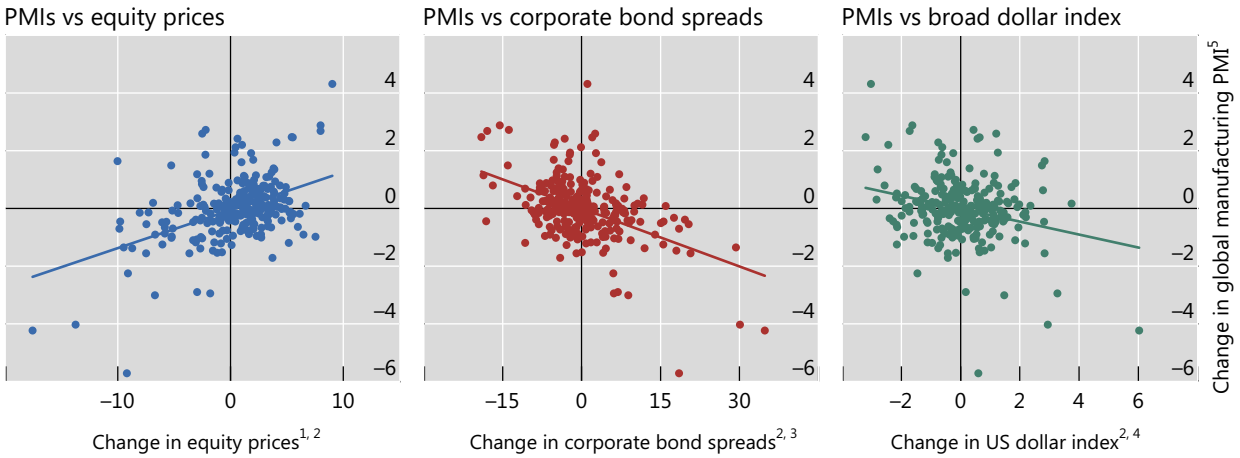
More informative are the correlations between the PMIs and other high-frequency data, notably financial variables. One reason is that these variables tend to reflect the financing conditions faced by the respondent firms; this information is, in turn, likely to affect purchasing managers' responses to questions about economic activity, both present and future. Likewise, financial variables tend to reflect current economic activity and, as forward-looking variables, the economic outlook too. Business sentiment plays a key role in both respects.

Changes in PMIs are indeed closely correlated with equity indices and corporate bond spreads. Over the past two decades, a 1 percentage point increase in local currency equity prices has been associated with a 0.13 point increase in manufacturing PMIs globally (Graph 2, left-hand panel). Wider corporate bond spreads have been negatively correlated with the PMIs (centre panel). As equity indices and corporate spreads incorporate forward-looking information on future economic activity and profitability as well as on current lending conditions, it should not be surprising that both are correlated with PMIs.

Perhaps more remarkable is the finding that the dollar index is also correlated with PMIs. More notably still, the dollar index is correlated with PMIs in a way that argues against a straightforward trade competitiveness explanation. It is when the dollar is strong that global PMIs are weak, in spite of any gain in trade competitiveness. This is especially visible for manufacturing PMIs, which declined on

Changes in PMIs and financial indicators are closely linked

Graph 2

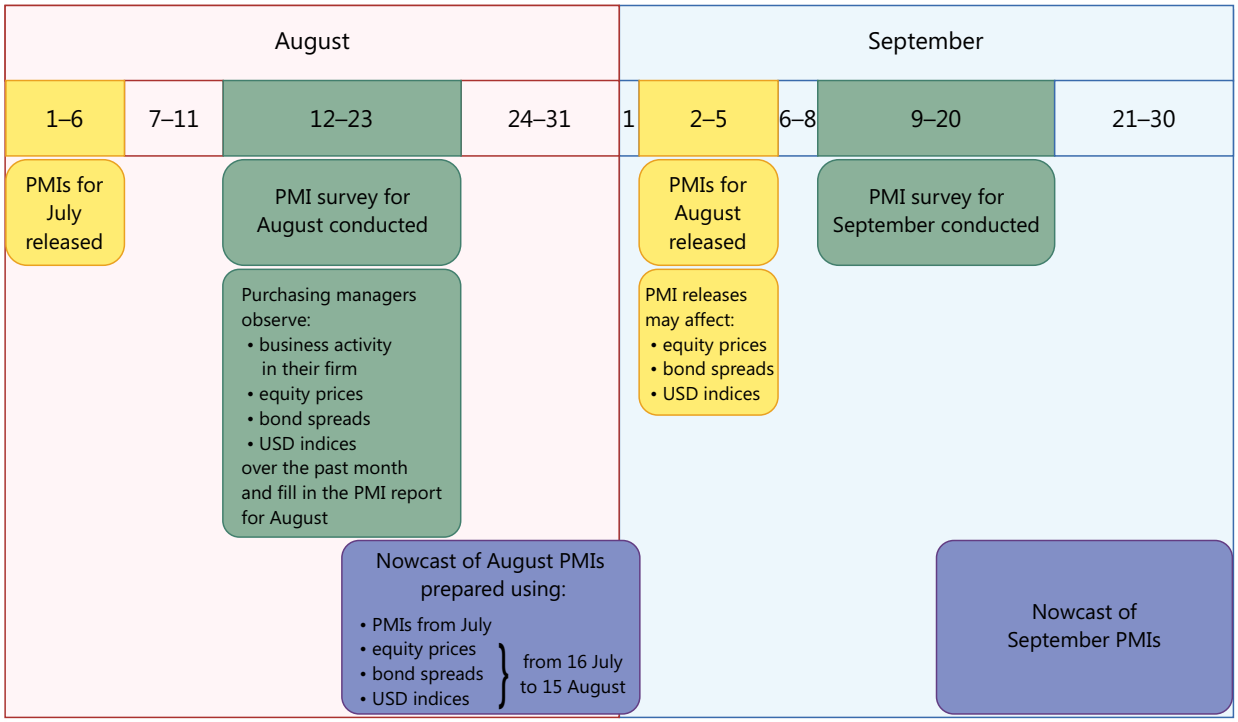


The sample includes monthly data from February 1998 to July 2019. The R-squared from regressions in the panels is 0.21, 0.23 and 0.07; the slope coefficients are 0.13, −0.07 and −0.22, respectively, and all are significant at the 1% level.

[1] MSCI All Country World Index, local currency. [2] Percentage change from previous month, monthly average of daily observations from the 16th day of the previous month to the 15th day of the current month. [3] For investment grade ICE BofAML global non-financial corporate index, option-adjusted spread. [4] Federal Reserve Board trade-weighted nominal dollar index, broad, based on goods trade. An increase indicates appreciation of the US dollar. [5] Change from previous month, index points.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

Schematic timeline of PMI surveys, nowcasts and releases[1] Graph 3



[1] Actual dates vary by month; this illustration is for 2019, for composite, manufacturing and services PMIs.

Source: IHS Markit.

average 0.22 points over a month whenever the trade-weighted exchange rate of the US dollar ("broad dollar index") appreciated by 1% (right-hand panel).

Before we suggest possible reasons for the empirical association between the dollar and PMIs, we examine more systematically how correlations between financial variables and PMIs show up in basic in-sample forecasting exercises. In particular, we ask how well current month (eg August) PMIs can be nowcast by relying on financial market information available up to the point the survey is conducted (ie until mid-August). In other words, we assume that business conditions reported at mid-month relative to the previous mid-month partly reflect the influence of financial variables on purchasing managers' decisions over that period (Graph 3).[7]

We then compare such a prediction with a naïve forecast relying only on past PMIs. Formally, we estimate the following monthly regression:[8]

$$PMI_t = \alpha + \beta \Delta s_t + \phi PMI_{t-1} + \epsilon_t \qquad (1)$$

where PMI_t is expressed in deviations from the benchmark of no change from previous month, and Δs_t is the percentage change of a given financial indicator

[7] In the illustrative timeline shown in Graph 3, PMI survey periods are shown as green areas, PMI releases as yellow, and nowcasts as blue ones. To match the polling period, we take average daily values of month-on-month changes in financial variables between the median days of polling periods (from the 16th day of the previous month up to the 15th day of the current one). For simplicity, we do not consider flash PMIs, which are released for only five economies (the euro area, France, Germany, Japan and the United States) around the 22nd/23rd of the reference month. Their revisions are very small.

[8] This framework is similar to that used by Gilchrist and Zakrajšek (2012).

computed over the 30 days between the dates the two polls are taken. This means that equation (1) seeks to predict the release of the PMI reading (the yellow square in Graph 3) with a two-week lead (blue square). We include financial variables one at a time: equity prices, corporate bond spreads, and trade-weighted dollar indices.

As regressors, we selected financial indicators with high visibility, global coverage and daily availability. This seems appropriate for nowcasting global PMIs, and works against us in nowcasting country-level PMIs, adding robustness to the results. We used MSCI equity price indices in local currency (All Country, World Industrials, Emerging Markets), and ICE BofAML corporate bond indices with option-adjusted spreads (Global Investment Grade, High-Yield, and Non-financial Investment Grade) (see Table A1 in the Appendix for details). For the dollar exchange rate, we used Federal Reserve Board indices based on goods trade: Broad (trade-weighted across 26 advanced and emerging market economy (EME) currencies); Other Important Trading Partners (19 major EME currencies); and Major Currencies (seven advanced economy currencies). For robustness checks, we also ran regressions with BIS effective exchange rates, an equity price volatility (VIX) index, and the first principal components of different combinations of these indicators. The results were very similar to those using the above variables.[9]

Empirical findings

The results of regressions using this setup suggest that the financial variables considered have valuable information content in nowcasting PMIs. Estimated coefficients from global PMI regressions have the expected signs and are statistically

Financial variables help nowcast global PMIs[1]

Table 1

	Global composite PMI				Global manufacturing PMI			
	Benchmark model	Model augmented with individual financial variables (Δs_t)			Benchmark model	Model augmented with individual financial variables (Δs_t)		
		USD[2]	Equity[3]	Spread[4]		USD[2]	Equity[5]	Spread[4]
PMI_{t-1}	0.930***	0.917***	0.905***	0.927***	0.954***	0.941***	0.947***	0.950***
Δs_t		–0.392***	0.176***	–0.064***		–0.310***	0.114***	–0.062***
R-squared	0.86	0.88	0.89	0.89	0.91	0.92	0.93	0.93
RMSE[6]	1.43	1.36	1.27	1.31	1.07	1.01	0.91	0.92
RMSE ratio[7]		0.95***	0.89***	0.92***		0.95***	0.85***	0.86***
RMSE gain[8]		4.7	11.0	8.0		5.5	14.6	13.7

***/**/* indicates statistical significance at the 1/5/10% level. Number of observations: 252 for composite, 258 for manufacturing PMI.

[1] Estimation results for $PMI_t = \alpha + \phi PMI_{t-1} + \epsilon_t$ (benchmark) and $PMI_t = \alpha + \beta \Delta s_t + \phi PMI_{t-1} + \epsilon_t$, where PMI_t is the deviation from 50 and Δs_t is the monthly change in the financial variables; estimated constant coefficients not shown. [2] Federal Reserve Board trade-weighted nominal dollar index, other important trading partners based on goods trade. [3] MSCI All Country World Index, local currency. [4] ICE BofAML Global High Yield Index, below investment grade, option-adjusted spread. [5] MSCI Emerging Markets Index, local currency. [6] Root mean square error (RMSE). [7] Ratio of RMSE from regression with financial variable / RMSE from benchmark regression. Statistical significance of superior in-sample predictive ability is determined according to the Clark and McCracken (2012) test. [8] Gain in RMSE from using financial variables in the regression, in per cent. Computed as (1 – RMSE ratio)*100.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

[9] Regressions with principal components generally had the best nowcasting properties. However, for ease of interpretation, we opted instead to show individual financial variables.

highly significant (Table 1).[10] Higher equity prices are associated with expanding business activity, and wider corporate bond spreads and a stronger dollar with dampening activity. This applies to nowcasting both composite and manufacturing PMIs, as well as their new export orders components (results not shown).

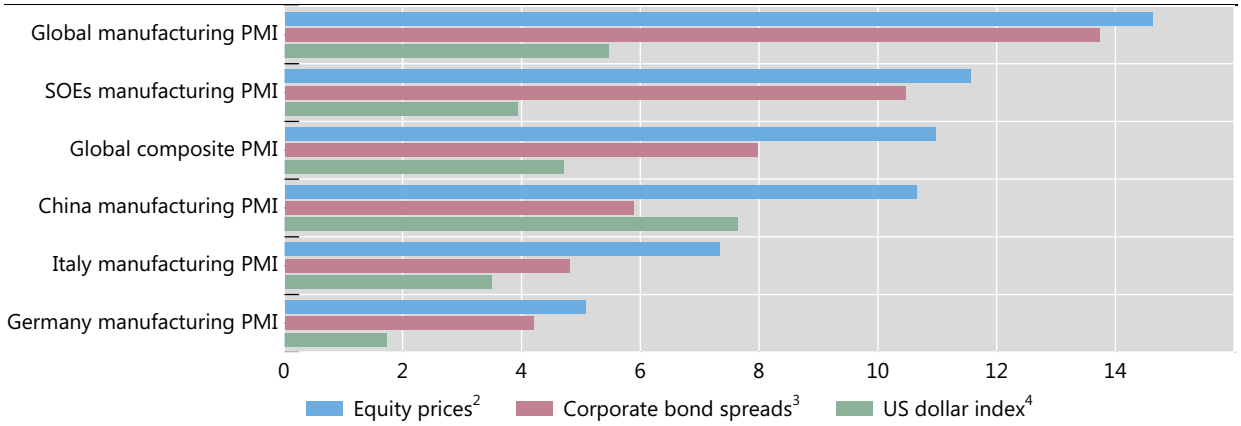
Importantly, adding financial variables improves the accuracy of PMI nowcasts. Root mean square errors (RMSEs) from regressions with a financial variable added to the lagged PMIs are lower than those from the naïve forecasting model that only contains lagged PMIs.[11] In terms of economic significance, gains in forecast accuracy from adding financial variables range up to 15% for equity indices, 14% for corporate bond spreads, and 8% for dollar indices (Graph 4).[12]

Country-level regressions indicate that financial variables are particularly well suited to nowcast PMIs in more open economies. For regressions on China, Germany, Italy and small open economies, for example, estimated coefficients on all dollar, equity and corporate bond indices are statistically highly significant (Table A2).

Financial variables improve PMI nowcasting accuracy[1]

In per cent

Graph 4



Small open economies (SOEs) = Austria, Chinese Taipei, the Czech Republic, Denmark, Ireland, Israel, the Netherlands, New Zealand, Poland and Switzerland.

[1] Improvement in nowcasting accuracy is measured in terms of gains in root mean square error (RMSE) from PMI nowcasts with and without financial variables, in per cent. Computed as (1 – RMSE ratio)*100, where RMSE ratio is given by RMSE from regression with financial variable / RMSE from benchmark regression. [2] MSCI All Country World Industrials Index, local currency. For global and China manufacturing PMIs, MSCI Emerging Markets Index. For global composite PMI, MSCI All Country World Index. [3] ICE BofAML Global High Yield Index, below investment grade, option-adjusted spread. For SOEs manufacturing PMI, ICE BofAML Global Non-financial Corporate Index, investment grade. [4] Federal Reserve Board trade-weighted nominal dollar index, other important trading partners, based on goods trade. For China manufacturing PMI, broad measure.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

[10] In the tables and graphs that follow, we show the estimates for individual variables with best statistical properties across global and country samples. These are by and large the same as those in Table 1.

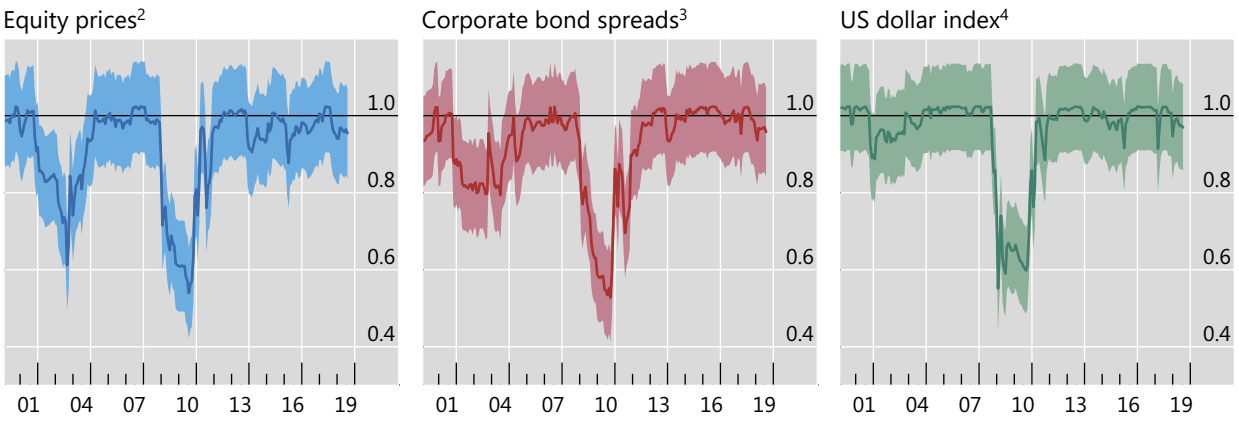
[11] A ratio of RMSEs from such regressions should be lower than 1 for financial variables to add statistically significant value to the nowcast that uses only past values of PMIs.

[12] The RMSE gain statistic used to assess the relative performance of financial indicators is defined as (1 – RMSE ratio)*100. By definition, the variable with the largest RMSE gain contributes the most to nowcasting the PMI.

Financial variables are strong predictors of PMIs in periods of financial turmoil[1]

Ratio

Graph 5



Results for manufacturing PMIs. The shaded areas indicate +/– 1 standard error.

[1] Ratio of the root mean square error (RMSE) estimated using $PMI_t = \alpha + \beta \Delta s_t + \phi PMI_{t-1} + \epsilon_t$ to that using $PMI_t = \alpha + \phi PMI_{t-1} + \epsilon_t$, where Δs_t is the monthly change in the financial variables; estimates over a two-year rolling window. [2] MSCI Emerging Markets Index, local currency. [3] ICE BofAML Global High Yield Index, below investment grade, option-adjusted spread. [4] Federal Reserve Board trade-weighted nominal dollar index, other important trading partners, based on goods trade.

Sources: Federal Reserve Bank of St Louis, (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

Interestingly, for China dollar indices outperform corporate spreads and are not far behind equity indices in terms of RMSE gains (Graph 4).[13]

The forecasting gains from the use of financial variables in nowcasting PMIs come mainly from periods of market turmoil, in particular the Great Financial Crisis (GFC), and, for equity prices and corporate spreads, the 2002–03 stock market downturn. This is evident when one looks at regressions based on rolling windows. The ratio of RMSEs from global manufacturing PMI regressions that use equity prices and bond spreads dropped sharply relative to the benchmark model during 2002–03 and, together with regressions using the dollar index, during 2008–09 (Graph 5). This finding is not surprising, as financial variables move strongly during periods of turmoil; it is also in line with findings on the role of financial variables in predicting GDP (Bańbura and Rünstler (2011), Espinoza et al (2012)). In the case of China, the forecasting power of the dollar index (as well as equity prices) also comes from the 2014–17 period, when domestic financial tensions spilled over globally. Interestingly, the relative ordering of financial variables in terms of RMSE ratios stays more or less unchanged over time, with equity and corporate bond spreads generally outperforming the dollar indices, but all three contributing to the accuracy of nowcasts relative to the naïve forecasting benchmark (results not shown).

Interpreting the results

What kind of economic relationships could help explain these statistical correlations?

In trying to answer this question, we first look at how shocks to different financial variables affect PMIs and GDP. The aim of this exercise is to understand what part of

[13] Dollar indices are also highly significant in predicting manufacturing PMIs in the Netherlands and the euro area as a whole, as well as in Brazil, India, Russia and Turkey (results not shown).

the observed dynamics in PMIs and GDP can be ascribed to the news that was already (and correctly) reflected in financial prices. We do so by resorting to a simple vector autoregression (VAR) model featuring, in order, equity returns, the dollar index, PMI and GDP.[14] This ordering choice can be rationalised with the help of the timeline in Graph 3: within a given month, as financial variables are predetermined with respect to PMIs, they are not allowed to react contemporaneously to PMI-specific shocks.

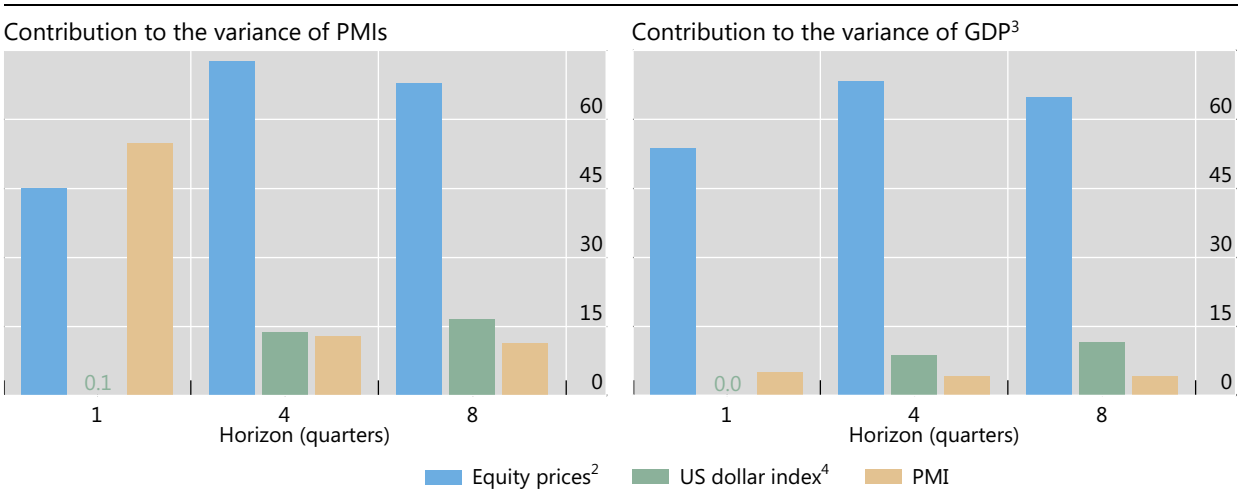
Based on this ordering, the first shock (associated with equity returns) can be interpreted as the continuous flow of news related to macroeconomic (as well as financing) conditions that financial market agents process and incorporate into equity prices at high frequency – before actual numbers for PMIs and GDP are released. Similarly, the second shock (associated with either the dollar index or corporate bond spreads) can be thought of as the additional information that is included in the dollar index (or corporate spreads). The third shock (associated with PMIs) can then be interpreted as the change in PMIs that was not already priced into financial variables, and can therefore be related to private information available to survey respondents during the polling period.

Both financial shocks explain quite a large proportion of the fluctuations in PMIs and GDP. Over a one-year horizon, the shock related to equities explains more than 60% of the variance of global manufacturing PMIs (Graph 6, left-hand panel) and global GDP (right-hand panel). This confirms that equity prices effectively incorporate news related to the macro environment and future profitability. What is more surprising is that the additional information conveyed by the dollar index significantly contributes to PMIs on top of equities: the dollar index explains on its own around 15% of the total variance in PMIs and about 10% of the variance in GDP.

Shocks to financial variables contribute to PMI and GDP dynamics[1]

In per cent

Graph 6



[1] Based on a vector autoregression (VAR) analysis of equity prices, dollar index, global manufacturing PMI, and global GDP growth, all with four lags. The sample includes quarterly data from Q2 1999 to Q1 2019. [2] MSCI Emerging Markets Index, local currency. [3] Weighted average of 34 economies based on GDP and PPP exchange rates. [4] Federal Reserve Board trade-weighted nominal dollar index, other important trading partners, based on goods trade.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; IHS Markit; MSCI; authors' calculations.

[14] We also run a VAR in which the USD index is replaced by corporate bond spreads. Results were qualitatively similar.

The significant contribution of the dollar index highlights its ability to convey useful information on financing conditions on top of that already included in equity prices. It is also remarkable that, if one replaces global GDP growth with the growth of global trade in goods, the results are broadly similar: the dollar still accounts for around 15% of the variance in trade, as compared with equities, which explain about 60%.

Taken together, these findings suggest that the links between the financial and real variables operate through both shifts in broad macroeconomic sentiment and global financing conditions. The higher explanatory power and the forward-looking nature of equity prices point to the former. Yet the significance of the dollar index and corporate bond spreads might also point more directly to a channel operating through shifts in global financing conditions. As noted above, purchasing managers are likely to internalise these shifts when making input and output decisions at the firm level, which then aggregate into GDP outcomes.[15]

For the traditional financial market variables – equity and corporate bond indices – evidence of such links is reassuring. It would be odd if firms' output and orders were shrinking while global equity prices were rising, or if widening corporate spreads were not associated with slower firm-level activity.[16]

More intriguing is the role of the dollar as a concurrent indicator of real activity. One explanation is safe haven flows: when the global economy is doing poorly, the US dollar generally appreciates. The sharp dollar appreciation during the GFC – which apparently provides most of the information content to nowcasting with the dollar index – corroborates this view.[17]

Another link, as noted above, might be the important trade-related dynamics associated with global supply chains (BIS (2017)). Firms within such chains generally have large working capital requirements because they need to fund inventories of intermediate goods, and often accounts receivable when selling to other firms along the supply chain (Shin (2019)). When these financing requirements go beyond the firms' own resources, the necessary working capital is typically provided via short-term bank credit. Much of this credit tends to be supplied in dollars (Gopinath and Stein (2018)), which means that its cost is sensitive to the dollar exchange rate, notably when dollar cashflow and assets fall significantly short of dollar liabilities (Avdjiev et al (2019)).[18]

[15] Separately, single-equation regressions indicate that parameter estimates for current financial variables (Δs_t) retain statistical significance when lagged variables (Δs_{t-1}) are added to regressions; and that, in many cases, the latter are not significant. This suggests that purchasing managers seem to use mostly contemporaneous financial market information when making decisions, as past financial developments are likely to have been already incorporated in lagged PMIs.

[16] The absence of a significant relationship between the spreads and PMIs in some countries may indicate reliance of firms on self-financing, perhaps due to weak or expensive credit supply to private firms. Scatterplots of RMSE gains and financial development indicators, however, do not reveal any strong relationship.

[17] Much of the dollar appreciation in that period was due to the financial institutions' hedging operations linked to their US investments (McCauley and McGuire (2009)).

[18] Interestingly, our results show that it is the "other important trading partners", ie the EME dollar index that has the strongest correlation with the PMIs, and it is the PMIs of open, manufacturing-heavy economies in Europe that are most strongly correlated with the dollar index. However, there are also some surprises. Korea does not figure among the countries with highly significant coefficients on the dollar index, while India and Russia do. And, for China, it is the broad dollar index that does (marginally) better than the EME one.

With manufacturing and, increasingly, services being globally integrated, it is therefore not surprising that dollar credit conditions would have some impact on economic activity along global supply chains. Some empirical studies using annual accounting data have found evidence to support this hypothesis (Bruno et al (2018)). This special feature lends further support to this link, by showing that the dollar is relevant for nowcasting PMIs, especially in trade-intensive economies, and that it explains a fair proportion of the variation of PMIs and GDP.

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Appendix tables

List of financial variables

Table A1

US dollar trade-weighted nominal effective exchange rate indices, based on goods trade		
1	USD (1)	Broad (26 economies)
2	USD (2)	Other important trading partners (19 major EMEs)
3	USD (3)	Major currencies (euro area, Canada, Japan, the United Kingdom, Switzerland, Australia and Sweden)
Equity price indices		
4	Equity (1)	MSCI All Country World Index, local currency (2,844 constituents; large and mid-cap firms in 23 advanced economies and 26 EMEs: US (56%), Japan (7%), UK (5%), China (4%), France (3%), others (25%))
5	Equity (2)	MSCI All Country World Industrials Index, local currency (432 constituents)
6	Equity (3)	MSCI Emerging Markets Index, local currency (1,194 constituents)
7	Equity (local)	Equity price index of the major local stock exchange
Corporate bond spreads (option-adjusted)		
8	Spread (1)	ICE BofAML Global Corporate Index, investment grade (14,404 constituents)
9	Spread (2)	ICE BofAML Global High Yield Index, below investment grade (3,131 constituents)
10	Spread (3)	ICE BofAML Global Non-financial Corporate Index, investment grade (10,346 constituents)
11	Spread (4)	ICE BofAML Global Industrial Index, investment grade (8,430 constituents)
12	VIX	CBOE Volatility Index
13	PC (1)	First principal component of equity (1–3), VIX, spread (1–4)
14	PC (2)	First principal component of USD (1), equity (1–3), VIX, spread (1–4)

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; MSCI; authors' calculations.

Financial variables help nowcast manufacturing PMIs in major economies[1]

Table A2

	Germany				Italy			
	Benchmark model	Model augmented with individual financial variables (Δs_t)			Benchmark model	Model augmented with individual financial variables (Δs_t)		
		USD[2]	Equity[3]	Spread[4]		USD[2]	Equity[3]	Spread[4]
PMI_{t-1}	0.960***	0.955***	0.953***	0.967***	0.948***	0.942***	0.938***	0.951***
Δs_t		–0.276***	0.119***	–0.054***		–0.331***	0.124***	–0.051***
R-squared	0.91	0.92	0.92	0.92	0.90	0.91	0.91	0.91
RMSE[5]	1.62	1.59	1.54	1.55	1.41	1.36	1.31	1.35
RMSE ratio[6]		0.98**	0.95***	0.96***		0.97***	0.93***	0.95***
RMSE gain[7]		1.7	5.1	4.2		3.5	7.3	4.8
	China				Small open economies[8]			
	Benchmark model	Model augmented with individual financial variables (Δs_t)			Benchmark model	Model augmented with individual financial variables (Δs_t)		
		USD[2]	Equity[3]	Spread[4]		USD[2]	Equity[3]	Spread[4]
PMI_{t-1}	0.875***	0.837***	0.847***	0.857***	0.963***	0.952***	0.944***	0.974***
Δs_t		–0.351***	0.124***	–0.046***		–0.287***	0.135***	–0.070***
R-squared	0.79	0.82	0.83	0.81	0.92	0.93	0.94	0.94
RMSE[5]	1.19	1.1	1.06	1.12	1.21	1.16	1.07	1.08
RMSE ratio[6]		0.92***	0.89***	0.94***		0.96***	0.88***	0.90***
RMSE gain[7]		7.6	10.7	5.9		3.9	11.6	10.5

***/**/* indicates statistical significance at the 1/5/10% level. 258 observations for Germany and Italy; 183 for China; 182 for SOEs.

[1] Estimation results for $PMI_t = \alpha + \phi PMI_{t-1} + \epsilon_t$ (benchmark) and $PMI_t = \alpha + \beta \Delta s_t + \phi PMI_{t-1} + \epsilon_t$, where PMI_t is the deviation from 50, and Δs_t is the monthly change in the financial variables. Estimated constant coefficients not shown. [2] Federal Reserve Board trade-weighted nominal dollar index, other important trading partners, based on goods trade. For China, broad measure. [3] MSCI All Country World Industrials Index, local currency. For China, MSCI Emerging Markets Index. [4] ICE BofAML Global High Yield Index, below investment grade, option-adjusted. For SOEs, ICE BofAML Global Non-financial Corporate Index, investment grade. [5] Root mean square error (RMSE). [6] Ratio of RMSE from regression with financial variable / RMSE from regression with only PMI_{t-1}. Significance of superior in-sample predictive ability is determined according to the Clark and McCracken (2012) test. [7] Gain in RMSE from using financial variables in the regression, in per cent. Computed as (1 – RMSE ratio)*100. [8] Austria, Chinese Taipei, the Czech Republic, Denmark, Ireland, Israel, the Netherlands, New Zealand, Poland and Switzerland.

Sources: Federal Reserve Bank of St Louis (FRED); Datastream; ICE BofAML indices; IHS Markit; MSCI; authors' calculations.

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).

A Locational banking statistics

B Consolidated banking statistics

C Debt securities statistics

D Derivatives statistics

E Global liquidity indicators

F Statistics on total credit to the non-financial sector

G Debt service ratios for the private non-financial sector

H Property price statistics

I Effective and US dollar exchange rate statistics

J Credit-to-GDP gaps

K Consumer price indices

L Central bank policy rates

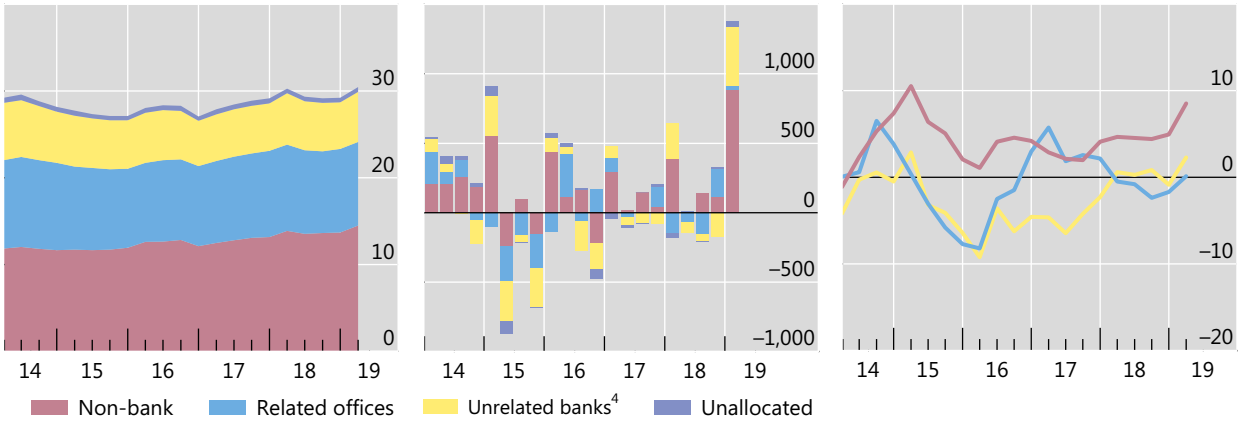
A Locational banking statistics

Cross-border claims, by sector, currency and instrument

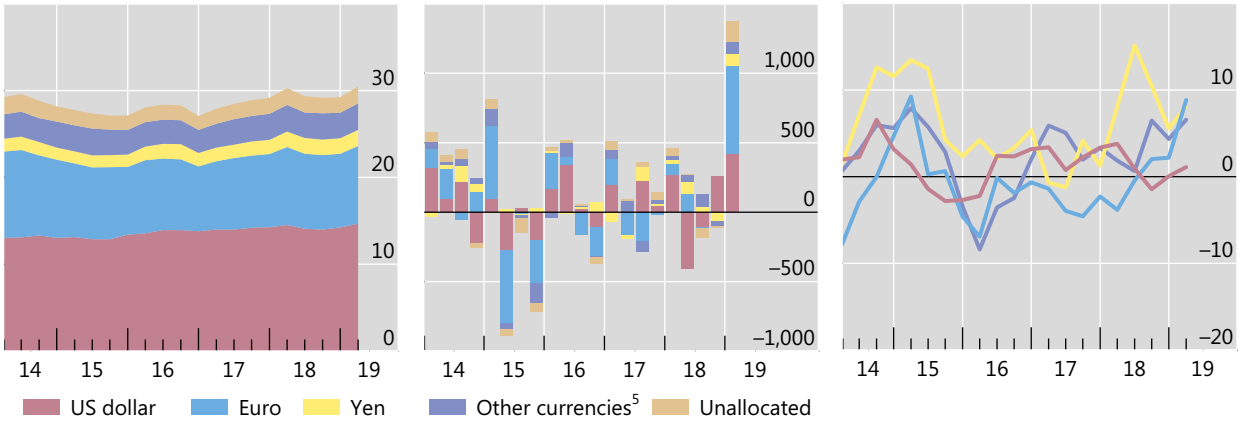
Graph A.1

Amounts outstanding, in USD trn[1] | Adjusted changes, in USD bn[2] | Annual change, in per cent[3]

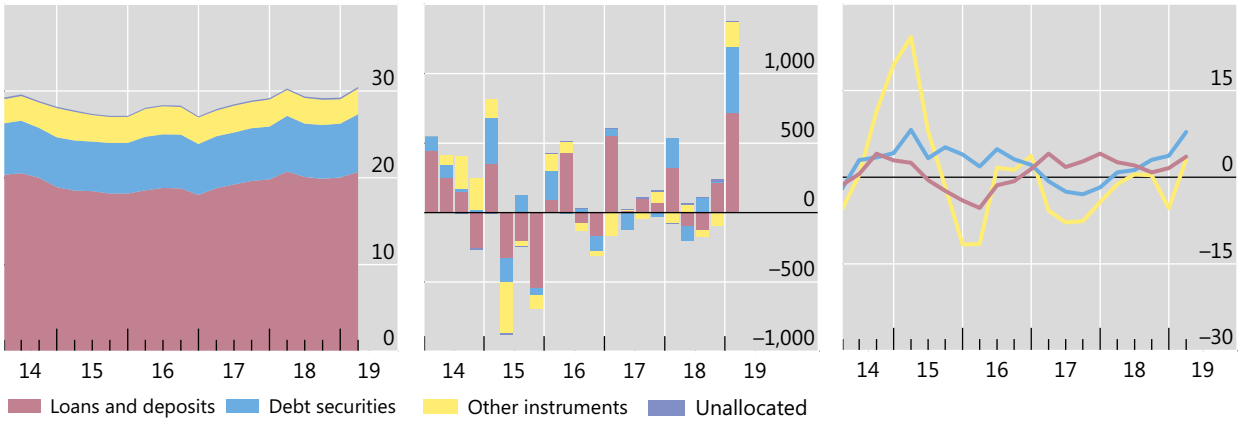
By sector of counterparty



By currency



By instrument



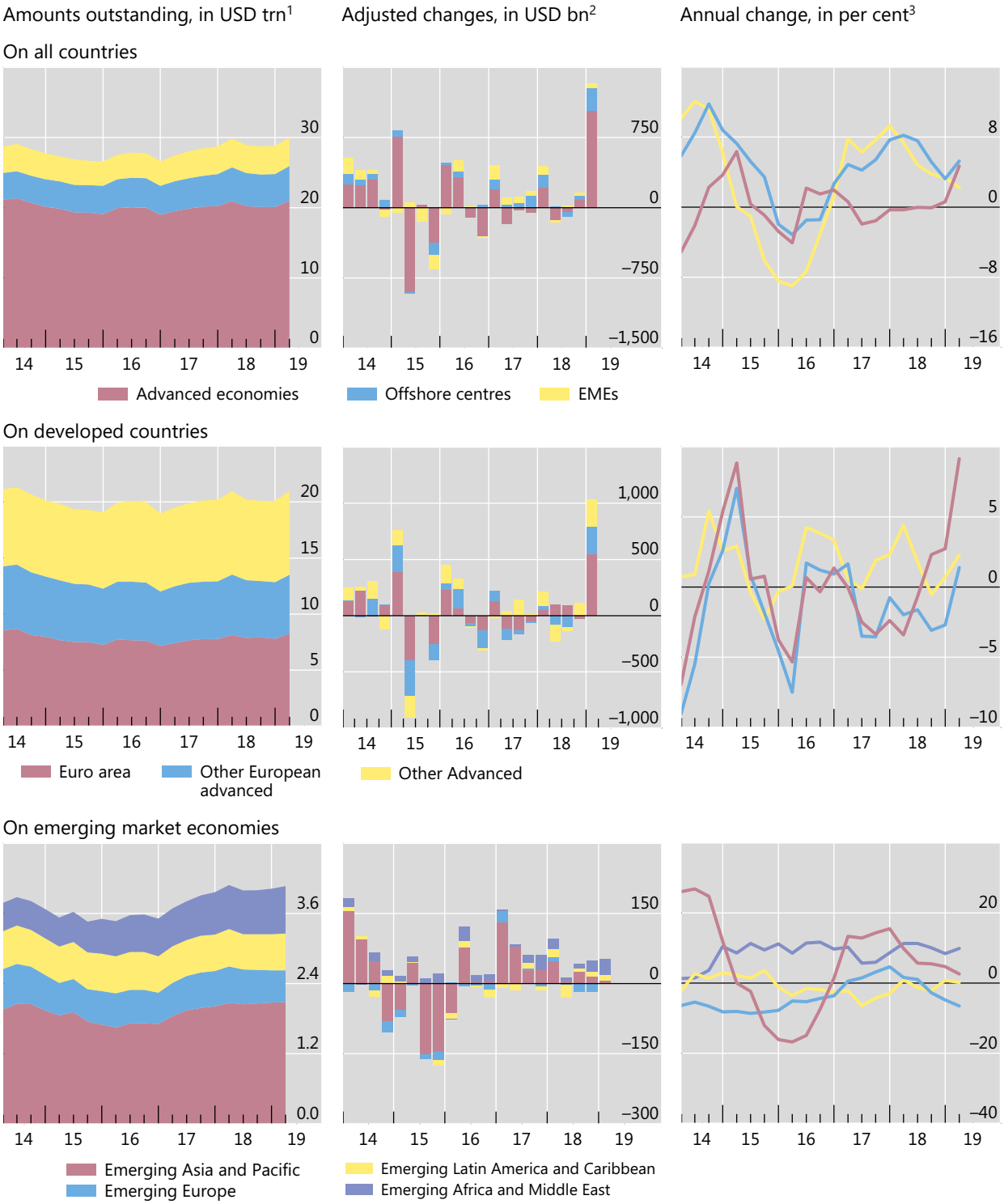
Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

[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



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.

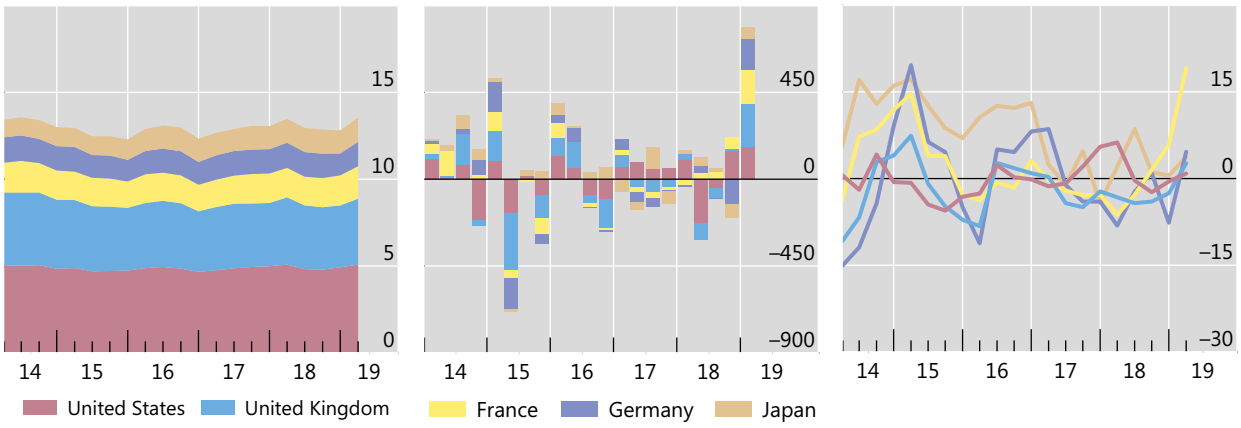
Source: BIS locational banking statistics.

Cross-border claims, by borrowing country

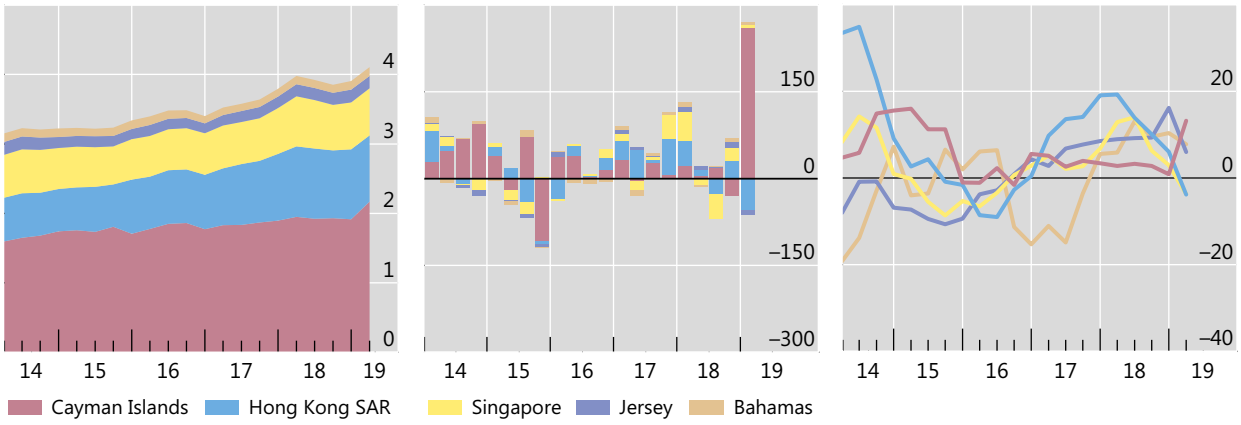
Graph A.3

Amounts outstanding, in USD trn[1] | Adjusted changes, in USD bn[2] | Annual change, in per cent[3]

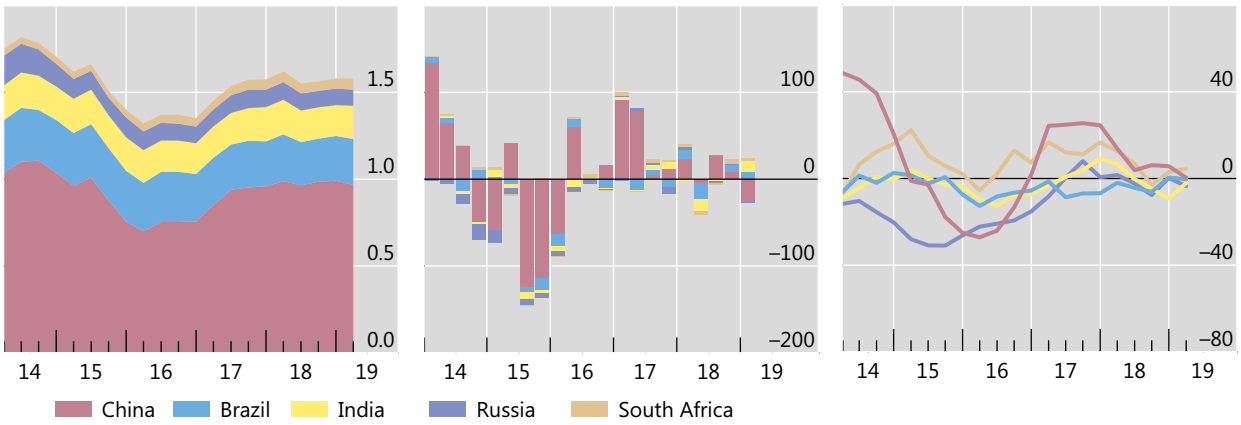
On selected advanced economies



On selected offshore centres



On selected emerging market economies



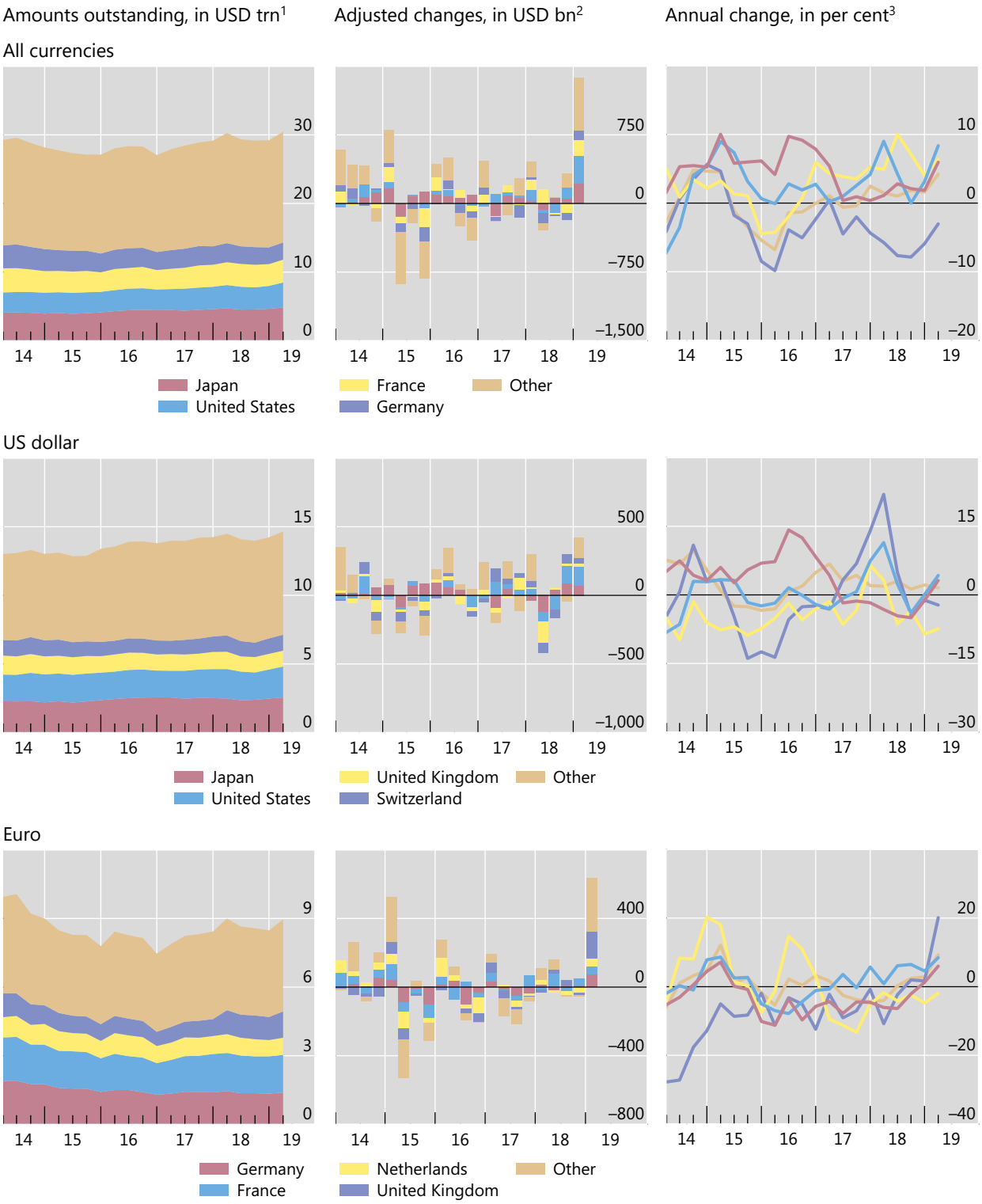
Further information on the BIS locational banking statistics is available at www.bis.org/statistics/bankstats.htm.

[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.

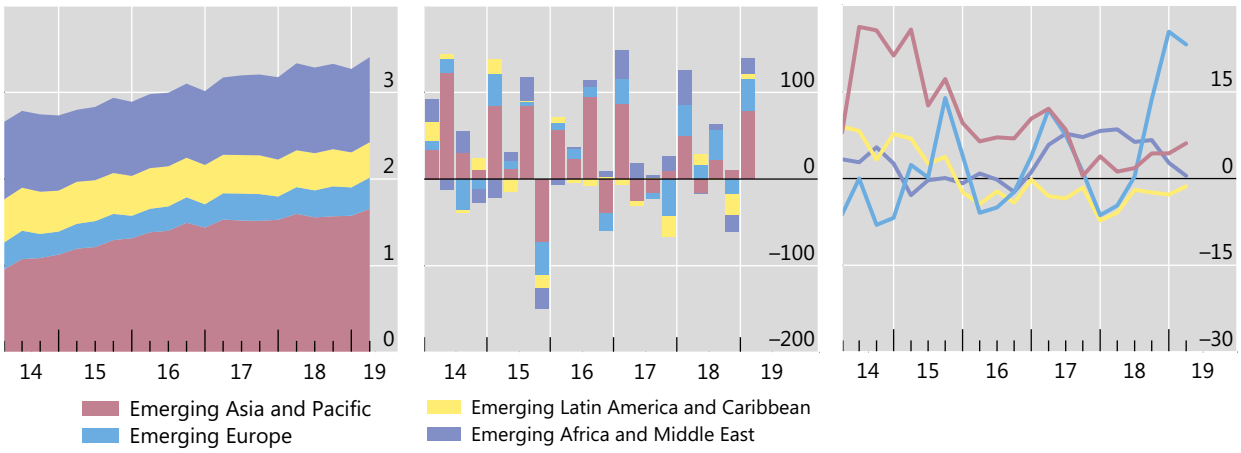
Source: BIS locational banking statistics.

Cross-border liabilities of reporting banks

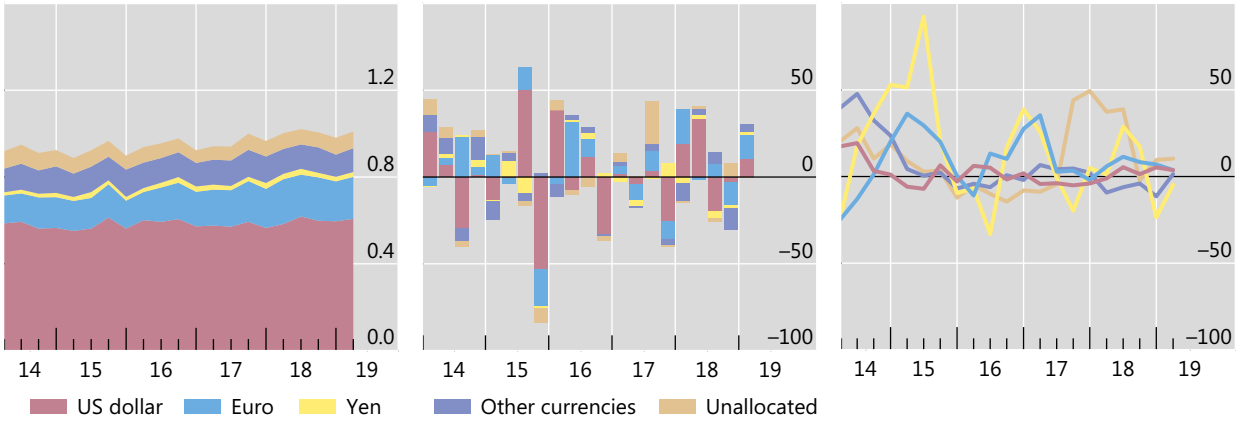
Graph A.5

Amounts outstanding, in USD trn[1] | Adjusted changes, in USD bn[2] | Annual change, in per cent[3]

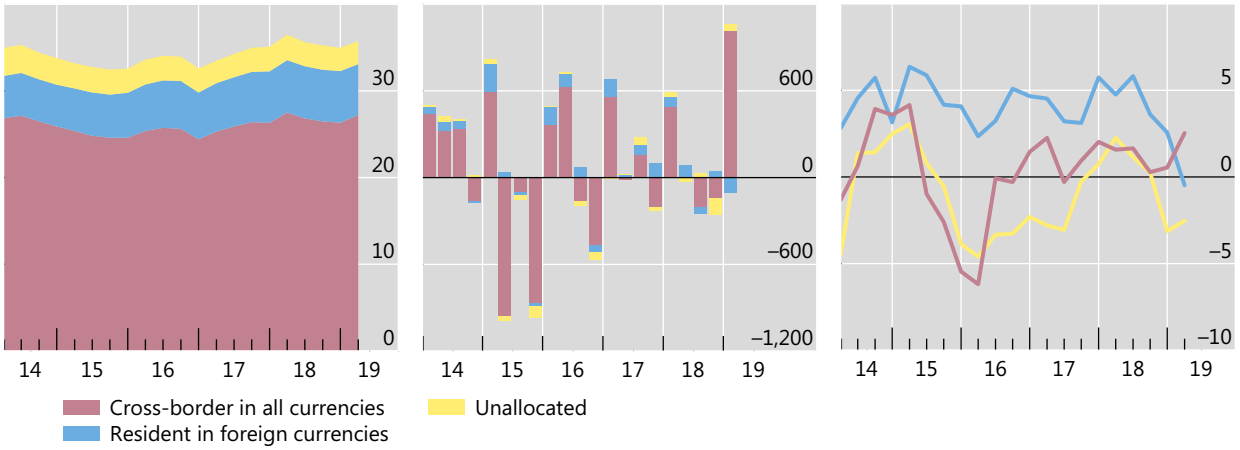
To emerging market economies



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

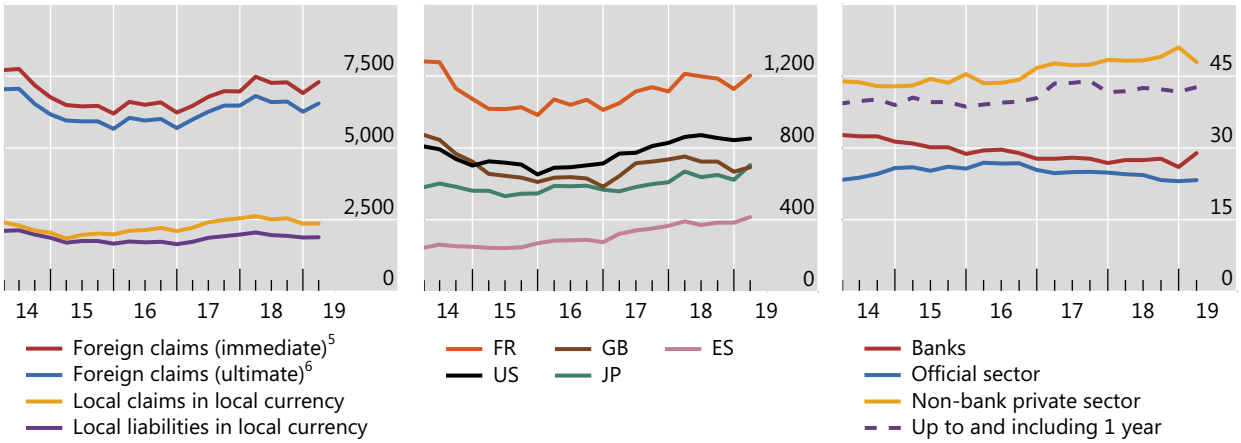
Graph B.1

Foreign claims and local positions, in USD bn[1, 2]

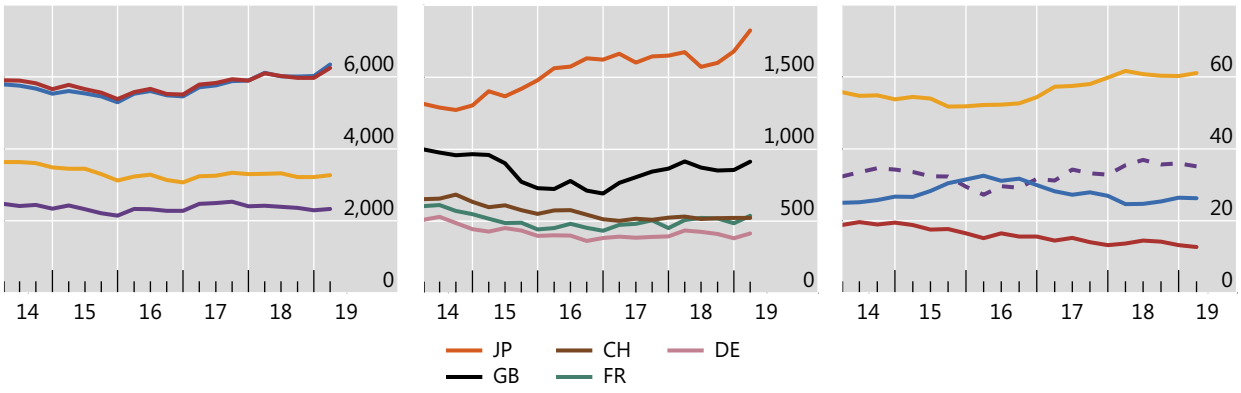
Foreign claims of selected creditors, in USD bn[1, 3]

International claims, by sector and maturity, in per cent[4]

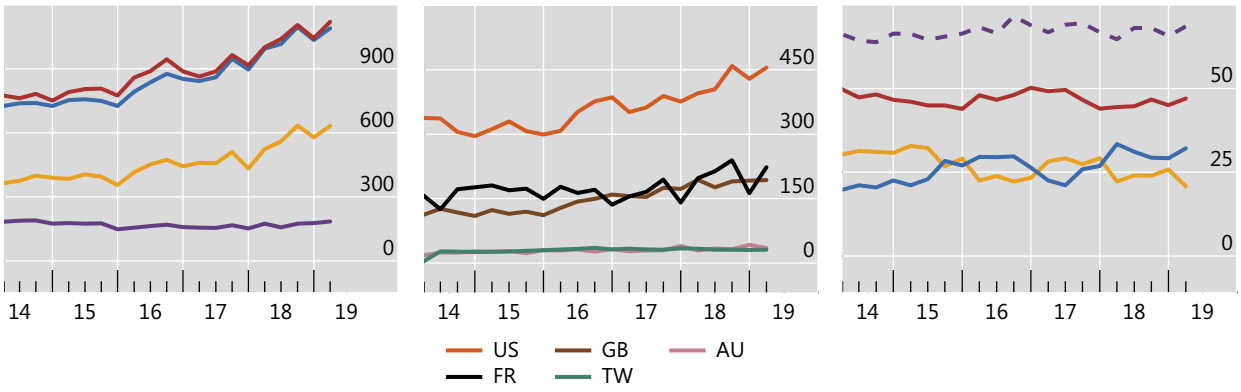
On the euro area



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

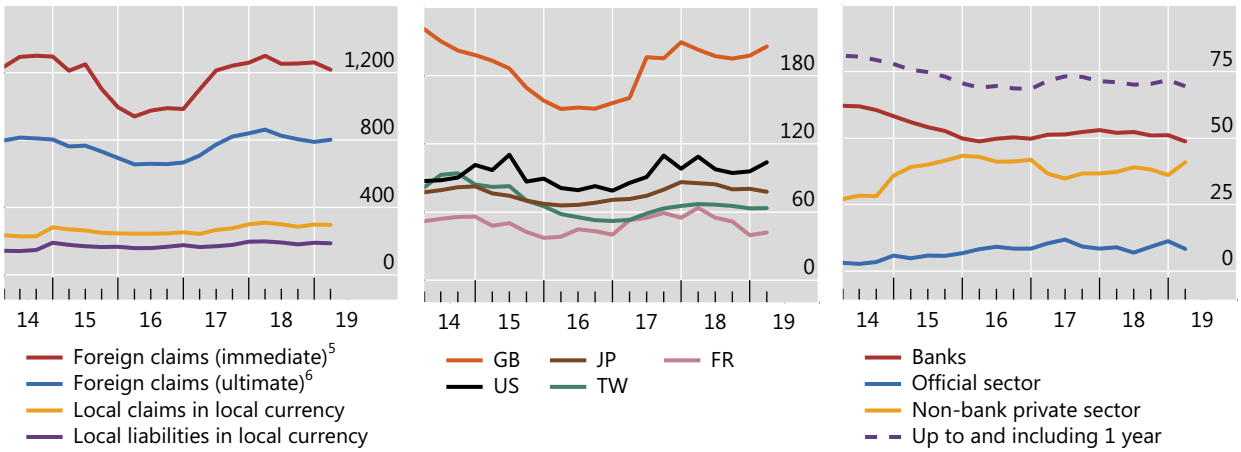
Graph B.2

Foreign claims and local positions, in USD bn[1, 2]

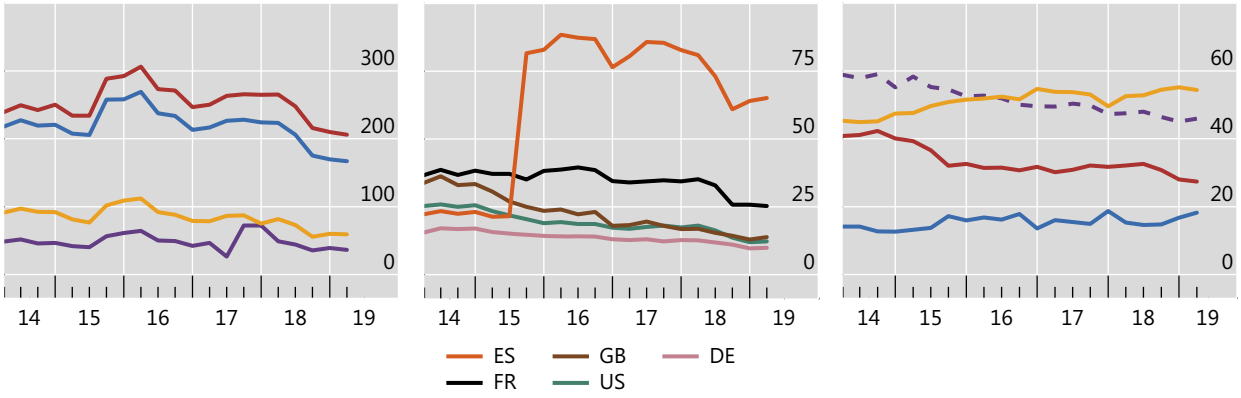
Foreign claims of selected creditors, in USD bn[1, 3]

International claims, by sector and maturity, in per cent[4]

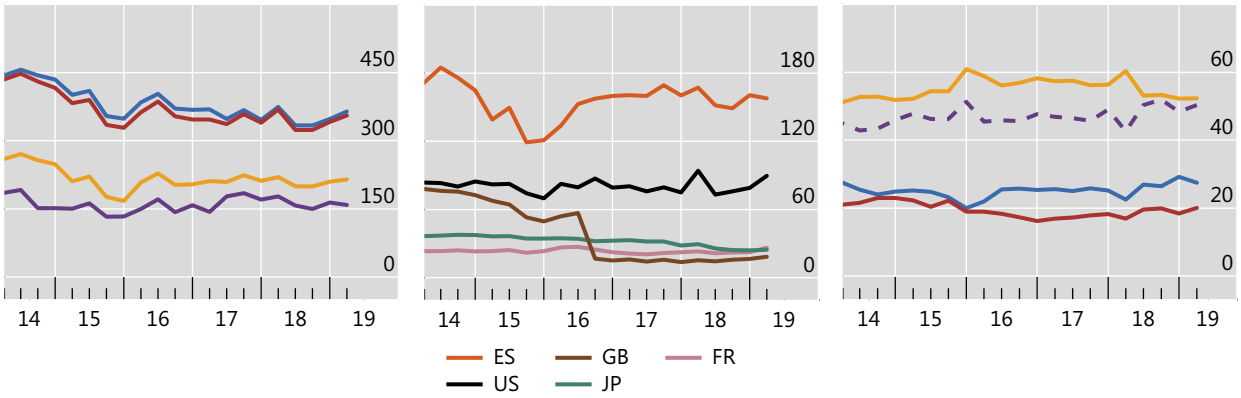
On China



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.

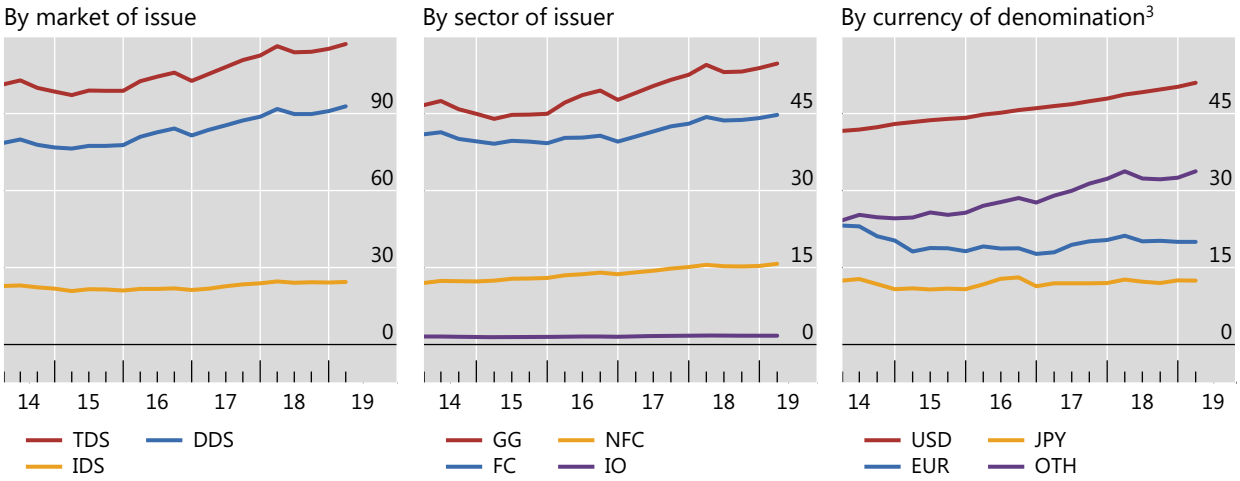
Source: BIS consolidated banking statistics (CBS).

C Debt securities statistics

Global debt securities markets[1]

Amounts outstanding, in trillions of US dollars[2]

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.

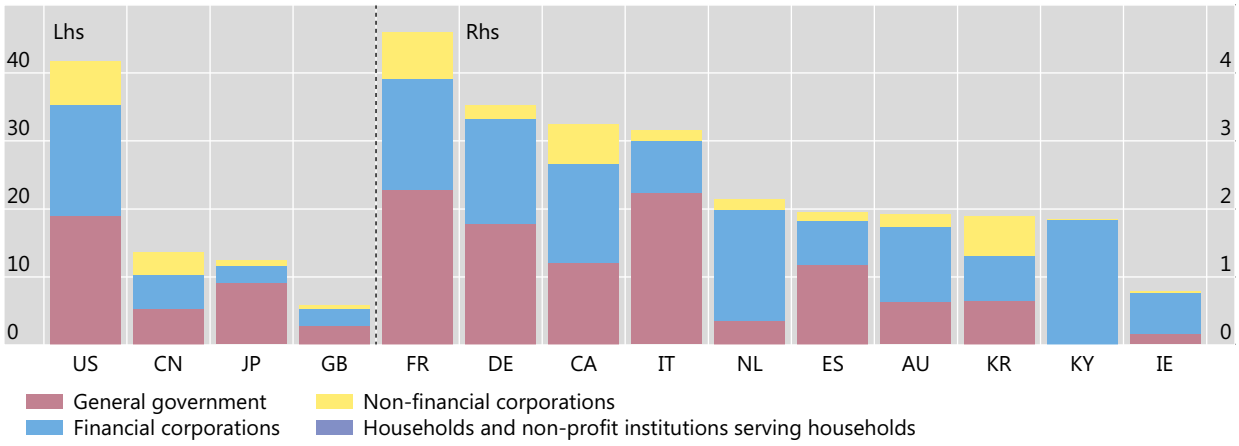
[1] Sample of countries varies across breakdowns shown. For countries that do not report TDS, data are estimated by the BIS as DDS plus IDS. For countries that do not report either TDS or DDS, data are estimated by the BIS as IDS. [2] At quarter-end. Amounts denominated in currencies other than the US 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; Refinitiv; Xtrakter Ltd; national data; BIS debt securities statistics; BIS calculations.

Total debt securities, by residence and sector of issuer[1]

Amounts outstanding for the latest available data, in trillions of US dollars[2]

Graph C.2



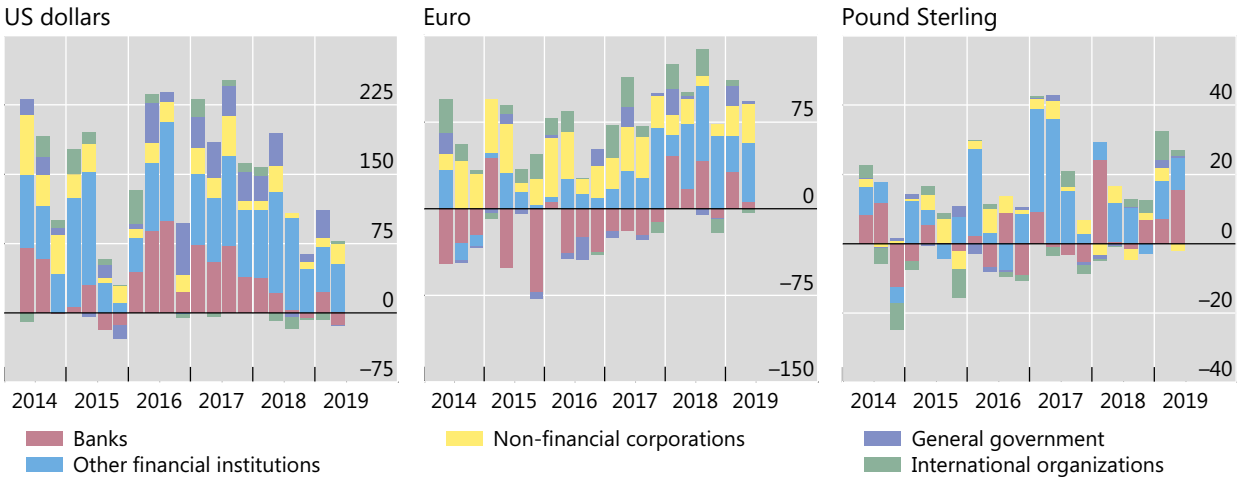
Further information on the BIS debt securities statistics is available at www.bis.org/statistics/secstats.htm.

[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

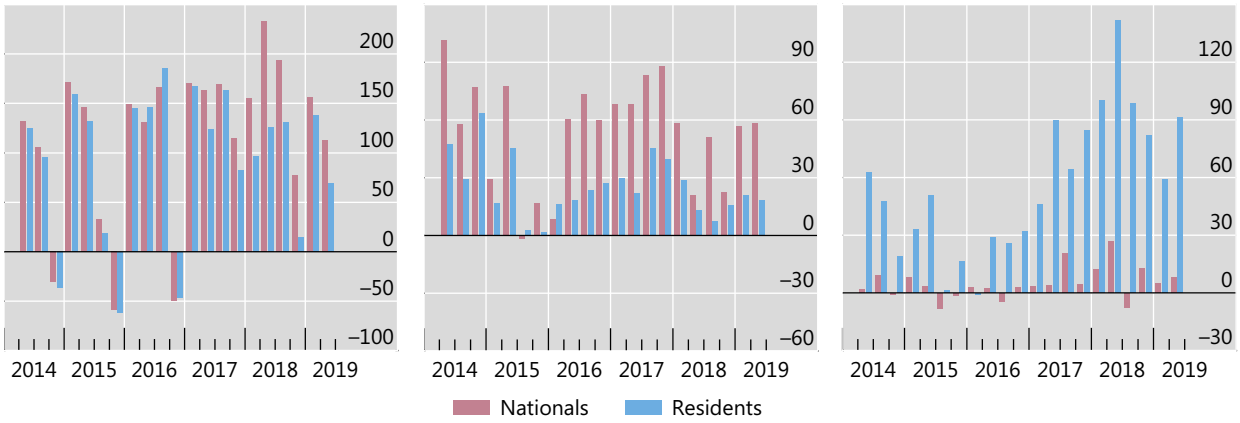


Further information is available at www.bis.org/statistics/secstats.htm.

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

International debt securities issued by financial and non-financial corporations[1]

Net issuance by region, in billions of US dollars[2] — 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; Refinitiv; Xtrakter Ltd; BIS debt securities statistics.

D Derivatives statistics

Exchange-traded derivatives

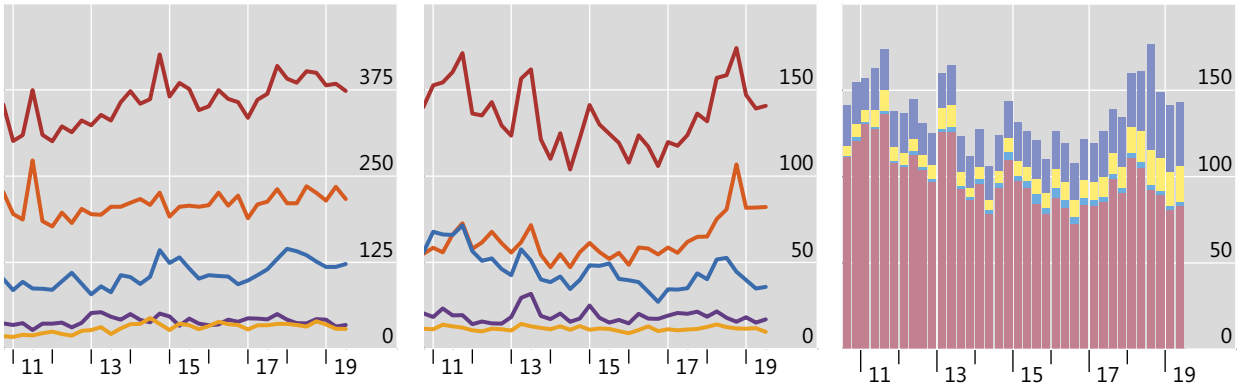
Graph D.1

Open interest, by currency[1]

Daily average turnover, by currency[2]

Daily average turnover, by location of exchange[2]

Foreign exchange derivatives, USD bn[3]



Interest rate derivatives, USD trn[3]

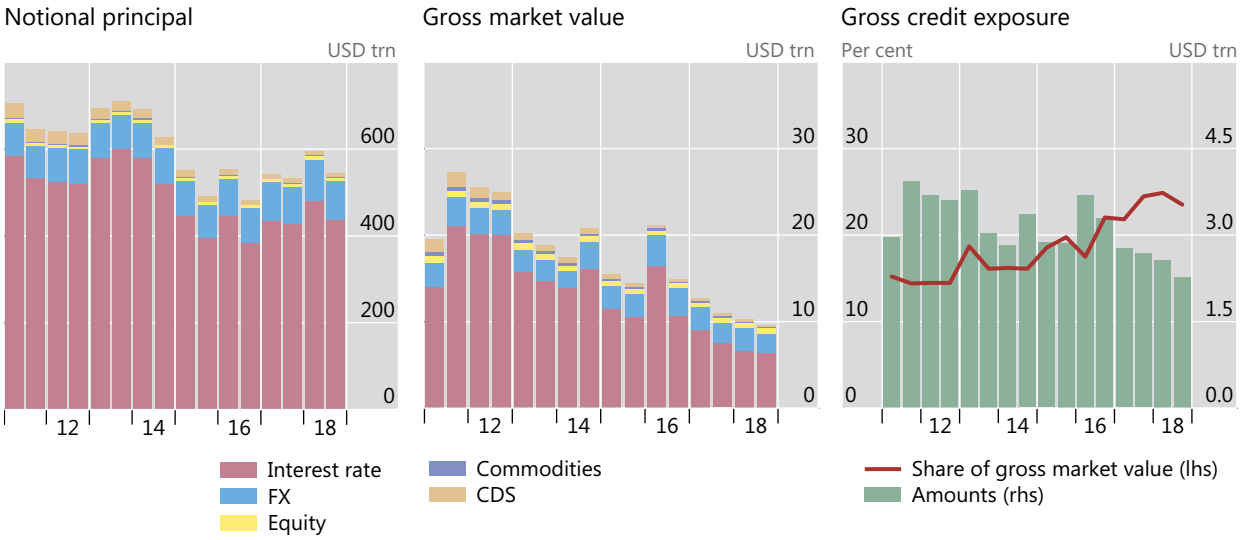
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/extderiv.htm. For definitions, see the online glossary.

[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 markets[1]

Graph D.2



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

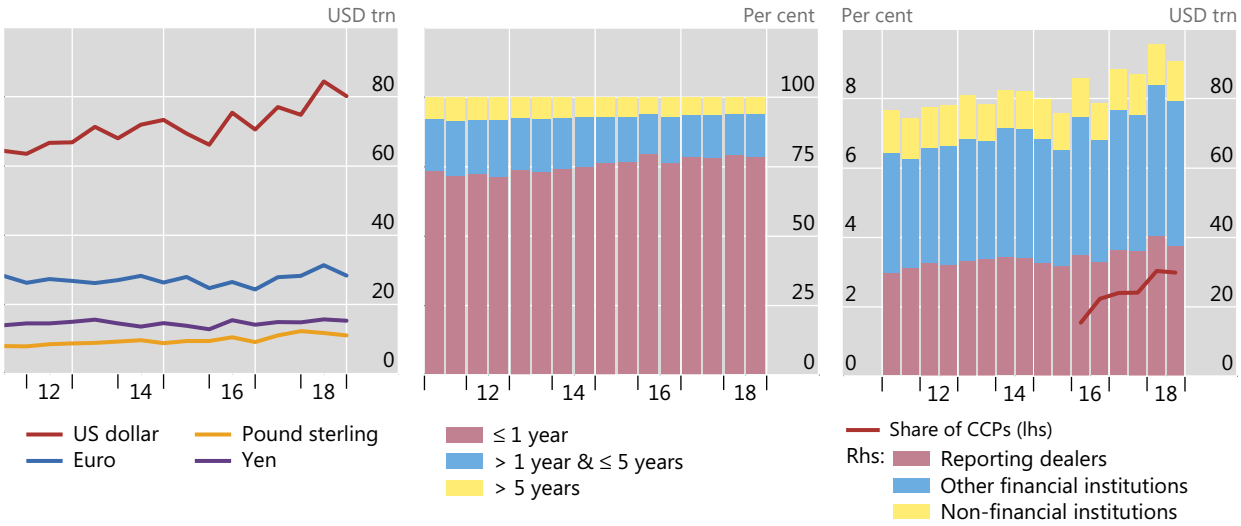
[1] At half-year end (end-June and end-December). Amounts denominated in currencies other than the US dollar are converted to US dollars at the exchange rate prevailing on the reference date.

Source: BIS derivatives statistics.

OTC foreign exchange derivatives

Notional principal[1]

Graph D.3



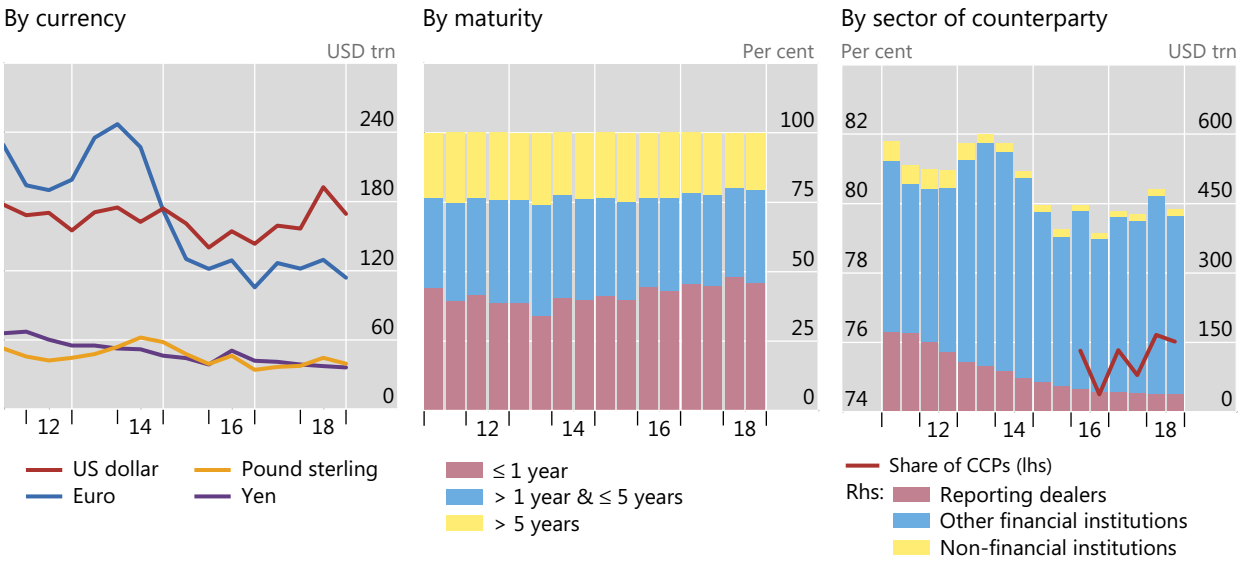
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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 principal[1] Graph D.4



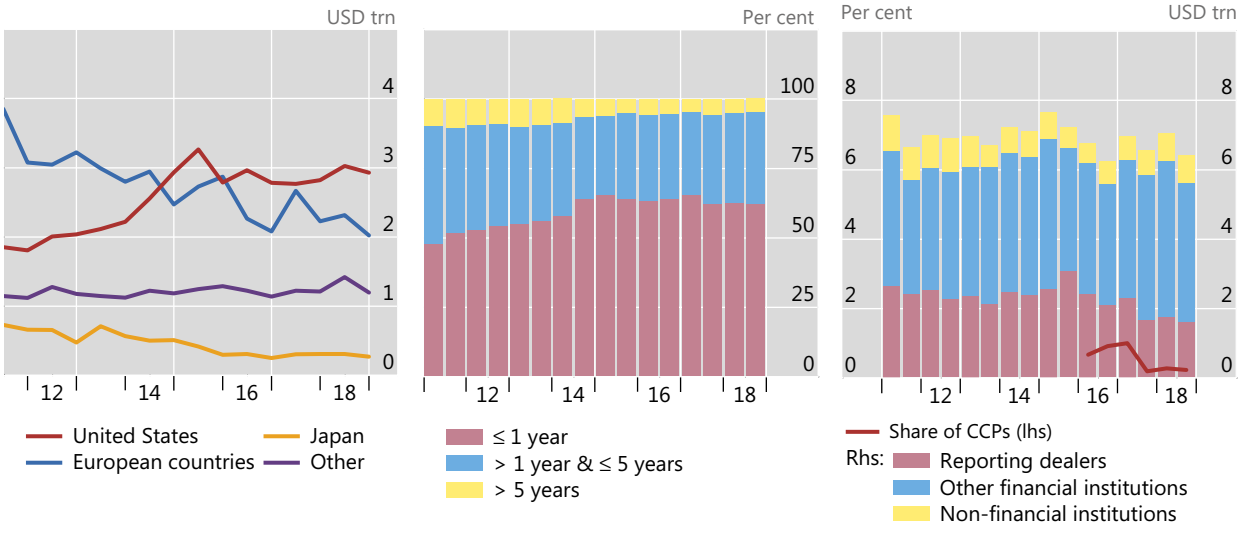
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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 principal[1] Graph D.5



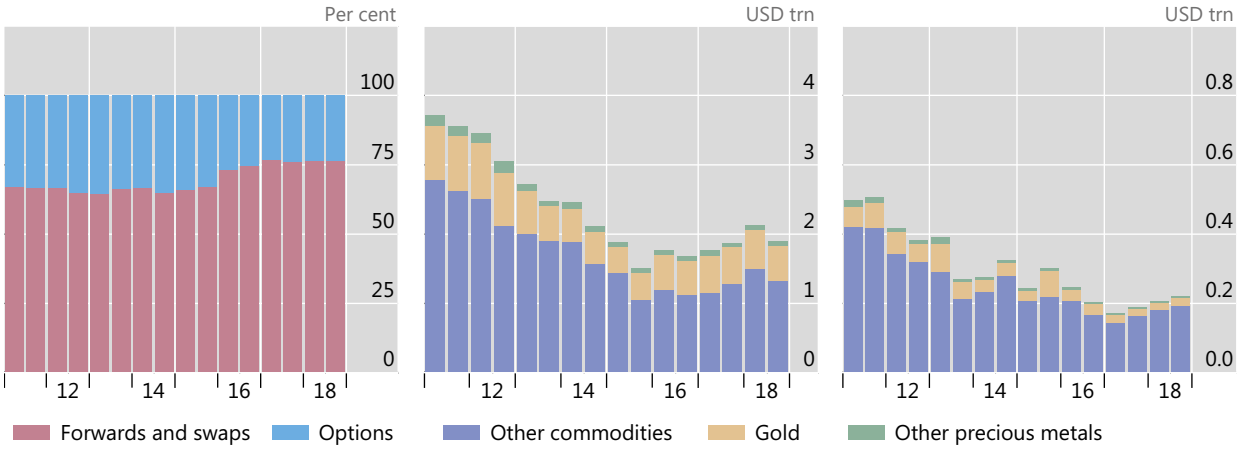
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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 derivatives[1]

Graph D.6



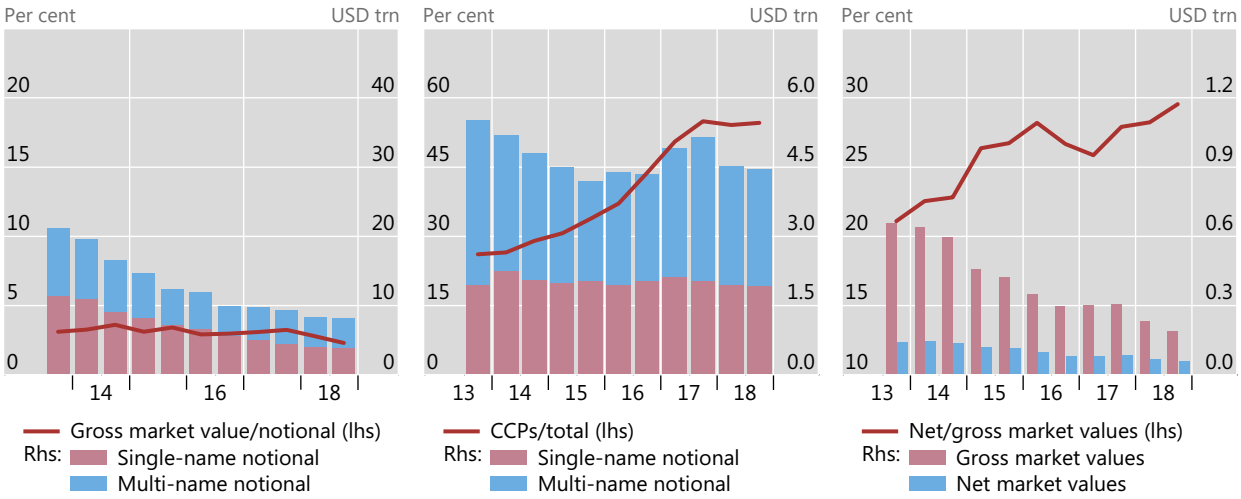
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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 swaps[1]

Graph D.7



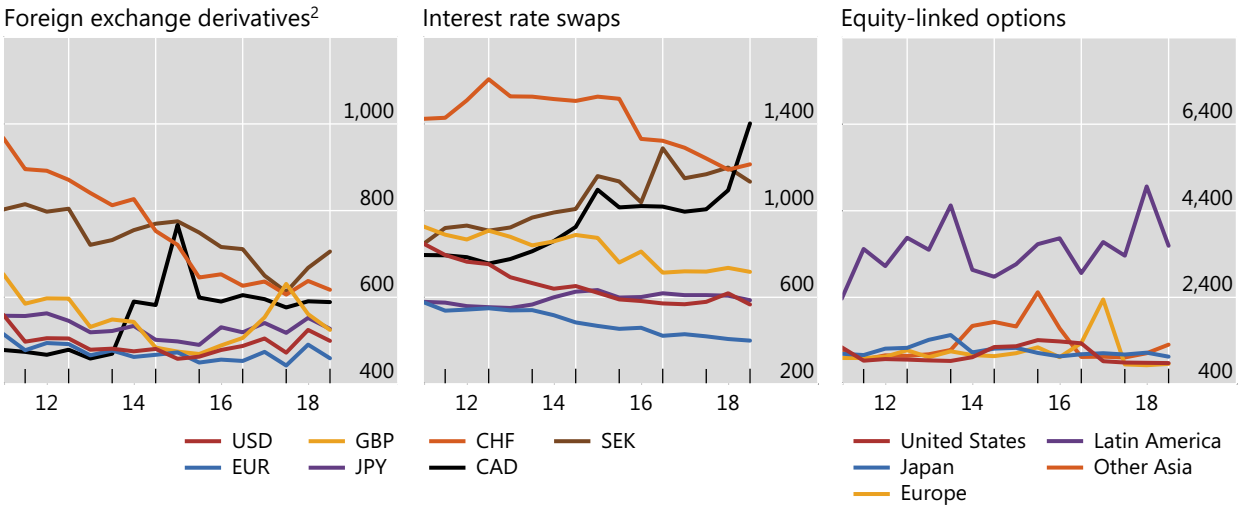
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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 index[1] Graph D.8



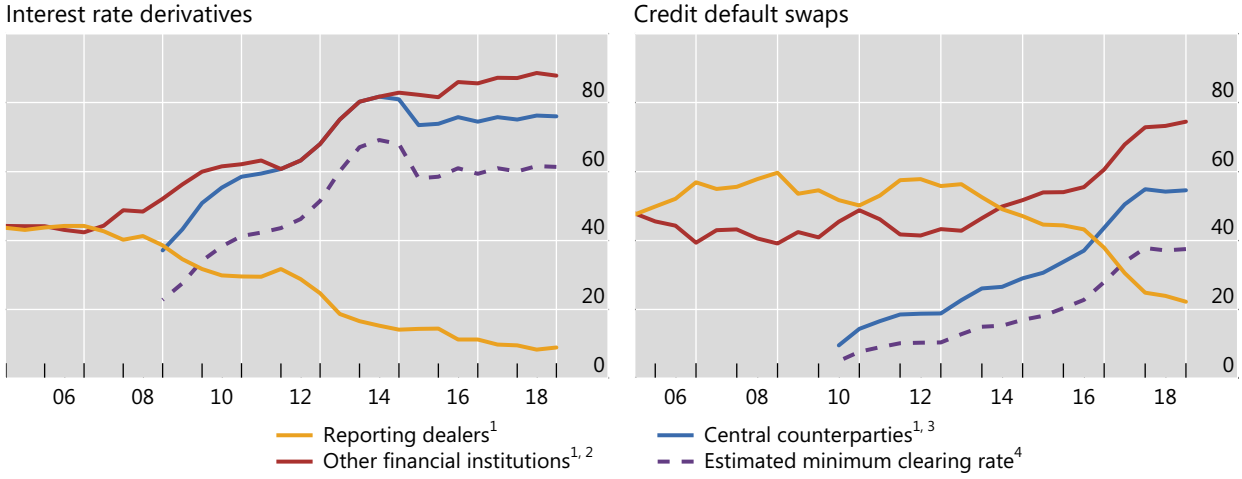
Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[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.

Growth of central clearing

Notional amounts outstanding by counterparty, in per cent Graph D.9



Further information on the BIS derivatives statistics is available at www.bis.org/statistics/derstats.htm. For definitions, see the online glossary.

[1] As a percentage of notional amounts outstanding against all counterparties. [2] Including central counterparties but excluding reporting dealers. [3] For interest rate derivatives, data for CCPs prior to end-June 2016 are estimated by indexing the amounts reported at end-June 2016 to the growth since 2008 of notional amounts outstanding cleared through LCH's SwapClear service. [4] Proportion of trades that are cleared, estimated as (CCP / 2) / (1 – (CCP / 2)), where CCP represents the share of notional amounts outstanding that dealers report against CCPs. CCPs' share is halved to adjust for the potential double-counting of inter-dealer trades novated to CCPs.

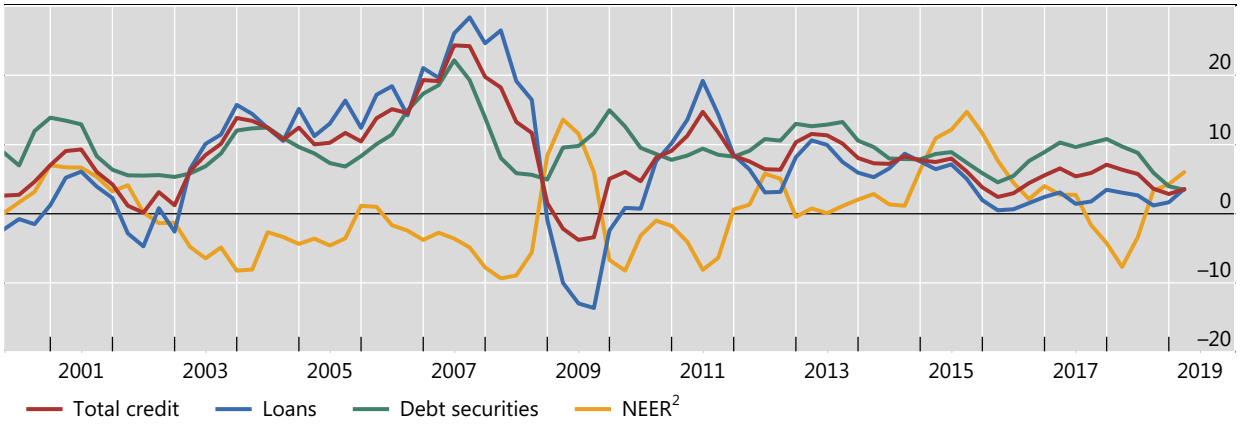
Sources: LCH.Clearnet Group Ltd; BIS OTC derivatives statistics (Table D7 and Table D10.1); BIS calculations.

E Global liquidity indicators

US dollar credit outside the United States[1]

Annual change, in per cent

Graph E.1



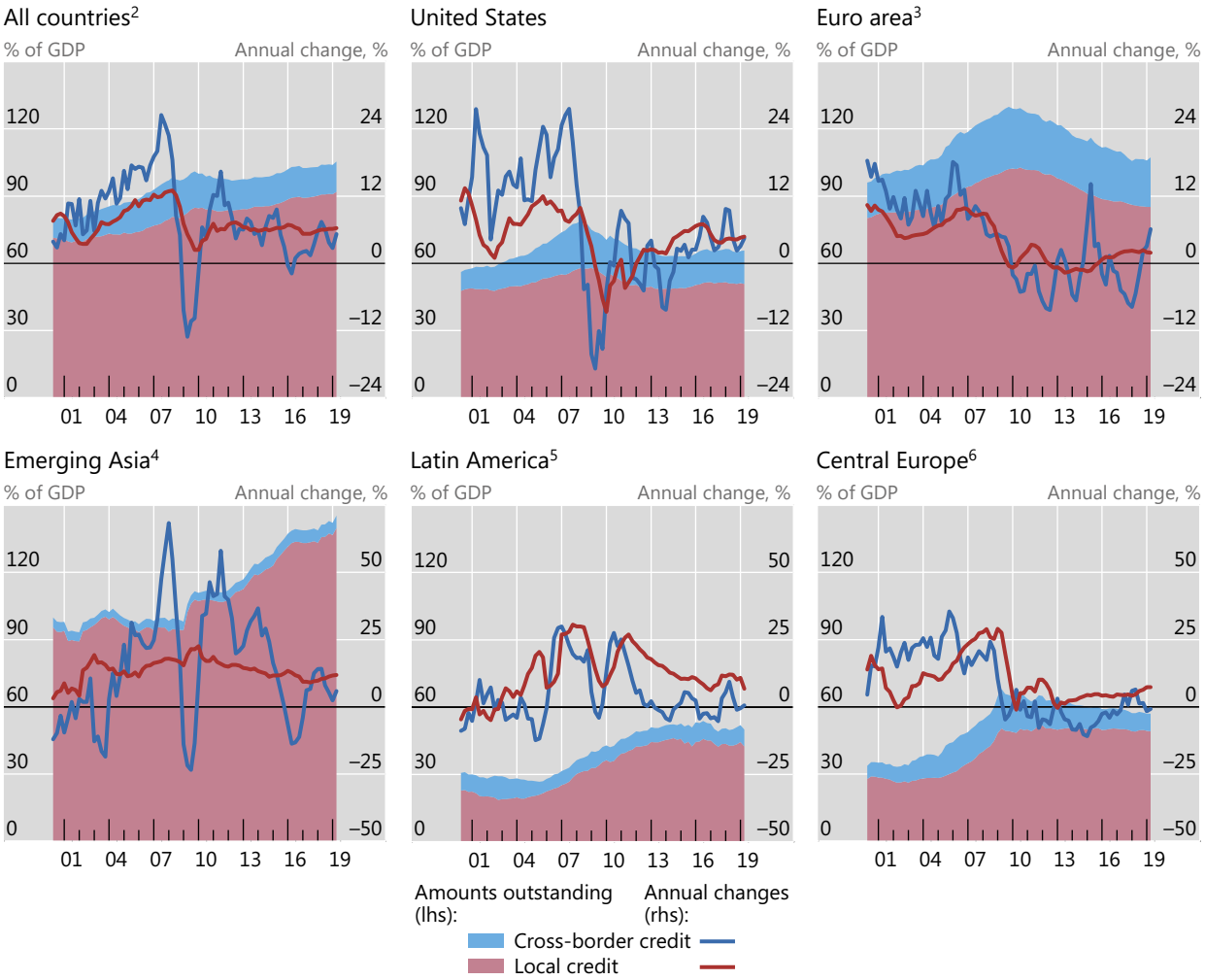
Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

[1] Annual growth of US dollar-denominated credit to non-banks outside the United States. [2] Annual growth of the US dollar nominal effective exchange rate.

Sources: Datastream; Dealogic; Euroclear; Refinitiv; Xtrakter Ltd; national data; BIS locational banking statistics; BIS effective exchange rate statistics; BIS calculations.

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

Banks' cross-border credit plus local credit in all currencies[1] Graph E.2



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

[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.

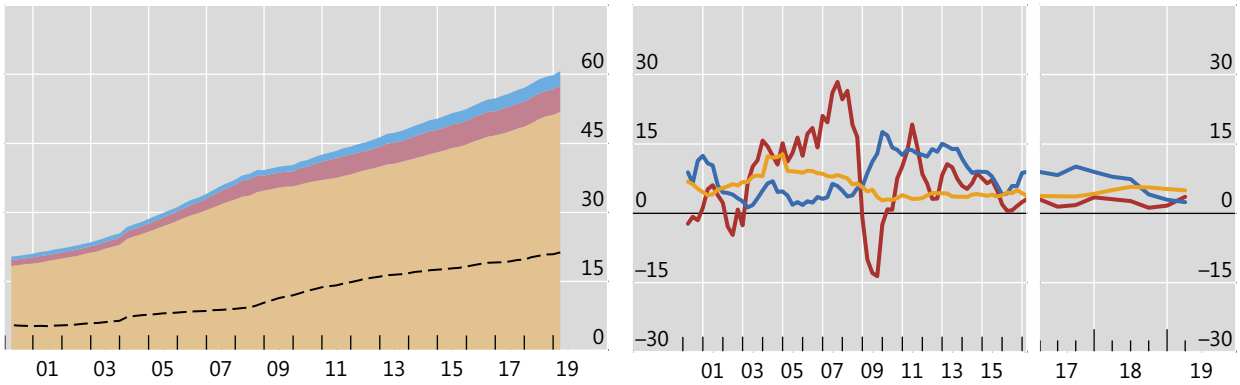
Global credit to the non-financial sector, by currency

Graph E.3

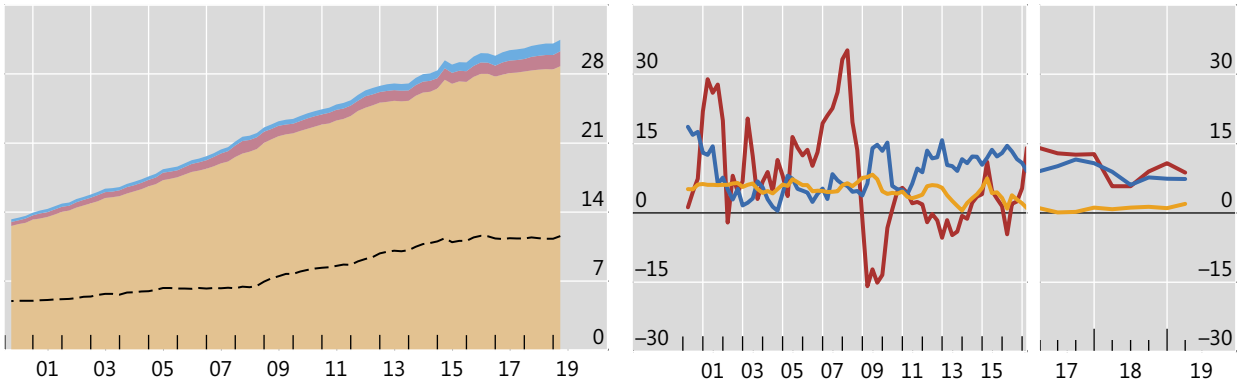
Amounts outstanding, in trillions of currency units[1]

Annual change, in per cent[2]

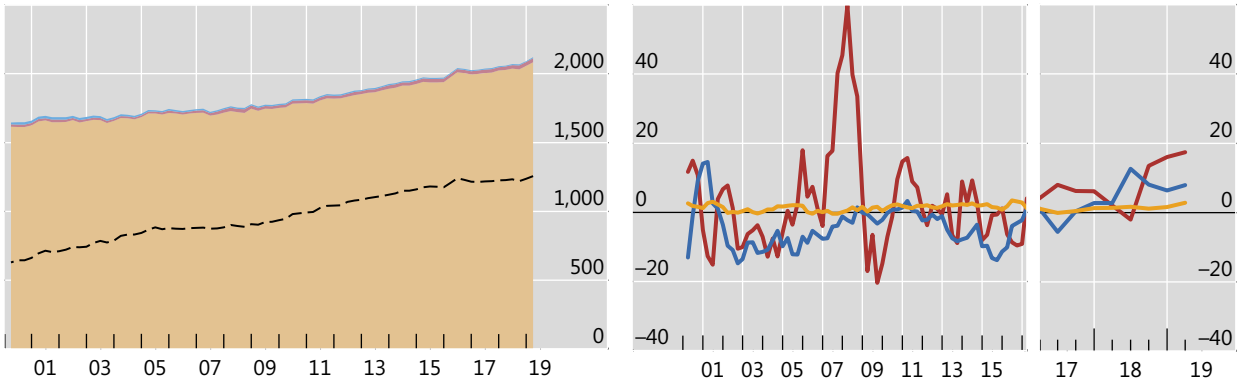
Credit denominated in US dollars (USD)



Credit denominated in euros (EUR)



Credit denominated in yen (JPY)



Credit to residents[3]
Of which:
Credit to government
Credit to non-residents:
Debt securities[4]
Bank loans[5]
Credit to residents[3]
Credit to non-residents:
Debt securities[4]
Bank loans[5]

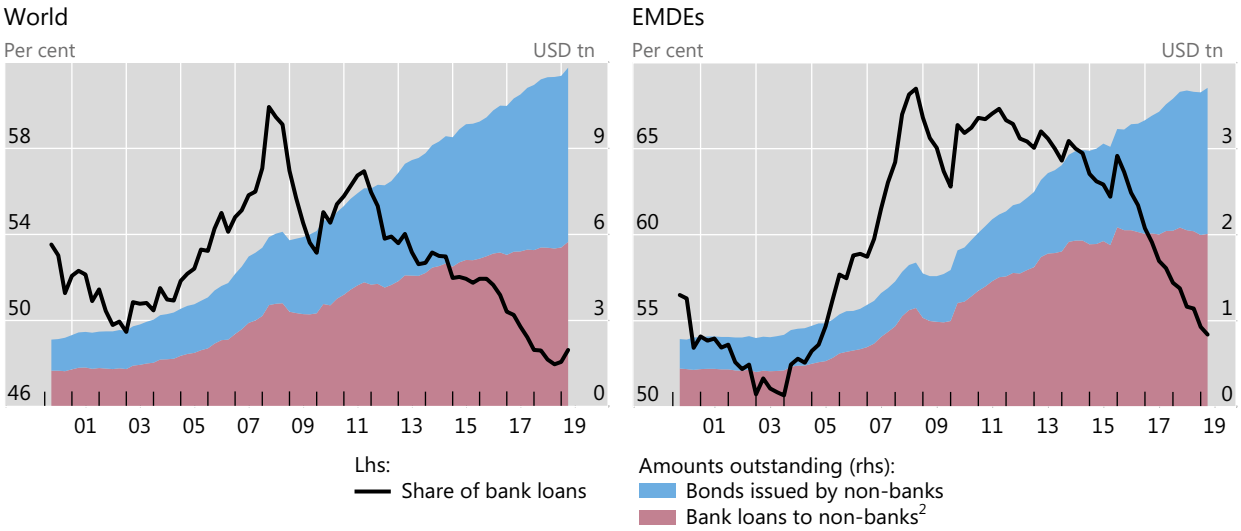
Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

[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; Refinitiv; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

US dollar-denominated credit to non-banks outside the United States[1]

Graph E.4



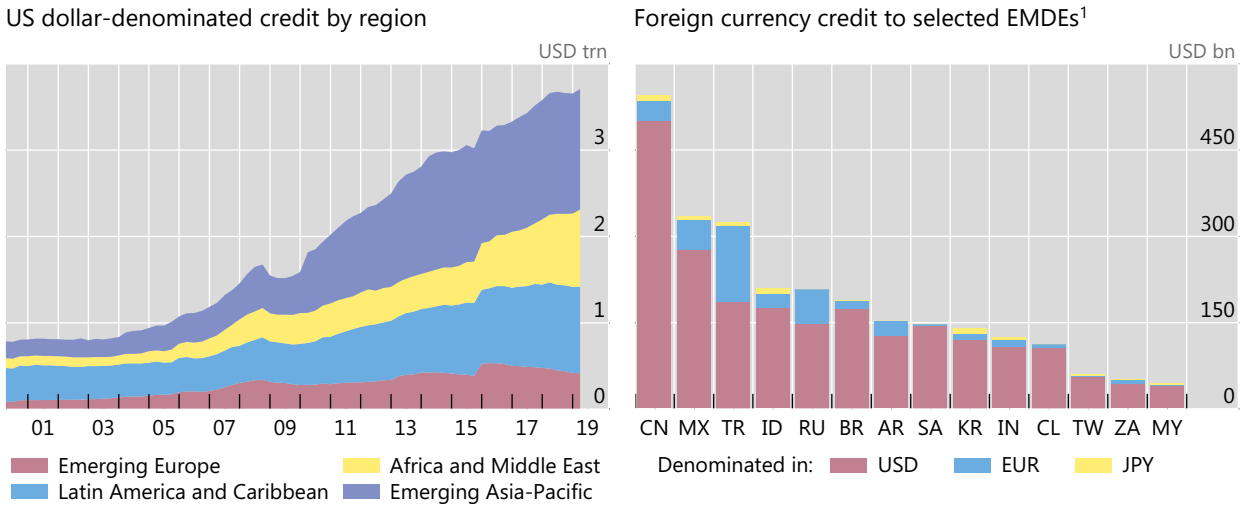
Further information on the BIS global liquidity indicators is available at www.bis.org/statistics/gli.htm.

[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; Refinitiv; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

Foreign currency credit to non-banks in EMDEs

Graph E.5



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.

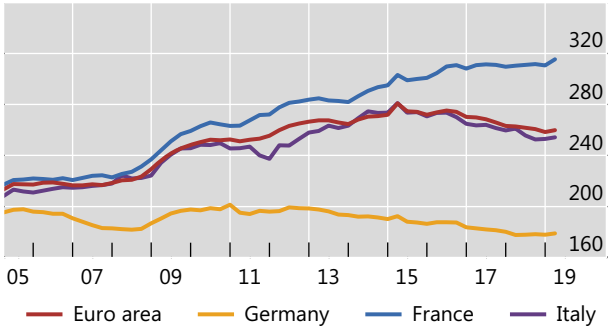
Sources: Datastream; Dealogic; Euroclear; Refinitiv; Xtrakter Ltd; national data; BIS locational banking statistics (LBS); BIS calculations.

F Statistics on total credit to the non-financial sector

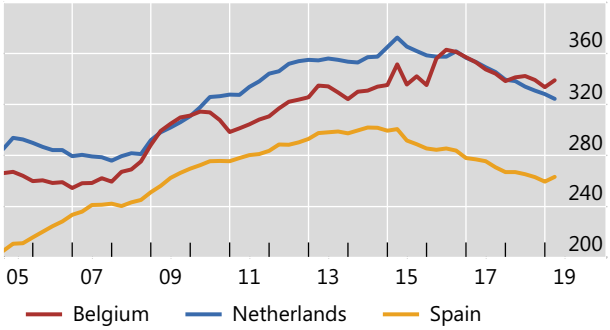
Total credit to the non-financial sector (core debt)

As a percentage of GDP — Graph F.1

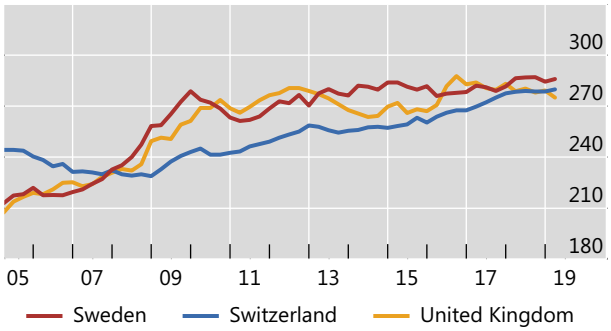
Euro area: aggregate and major countries



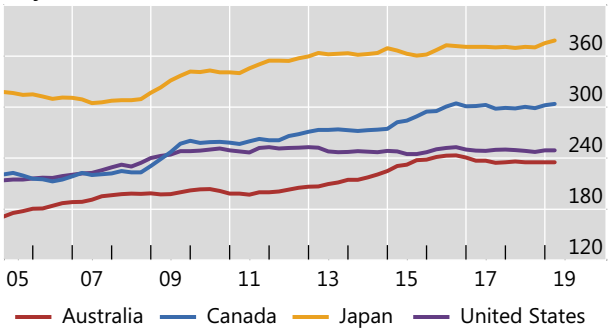
Euro area: other countries



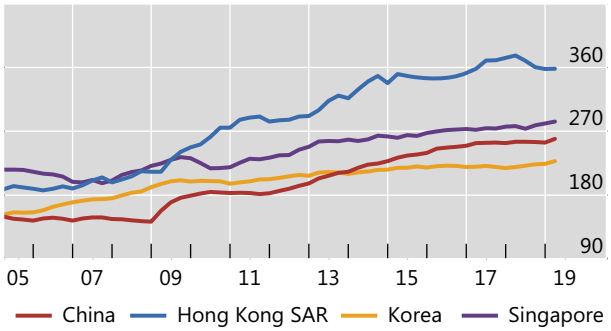
Other European countries



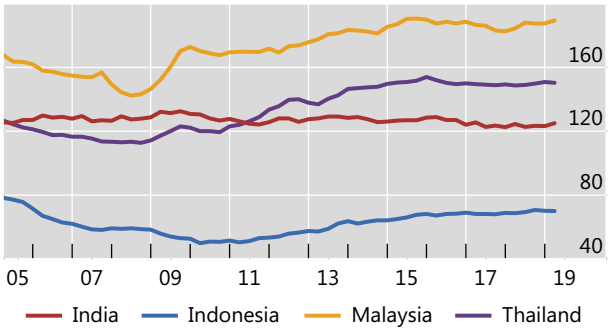
Major advanced economies



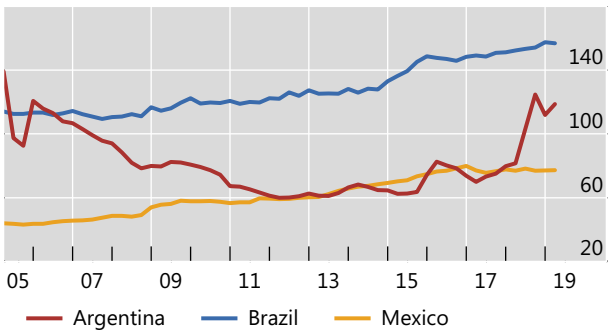
Emerging Asia



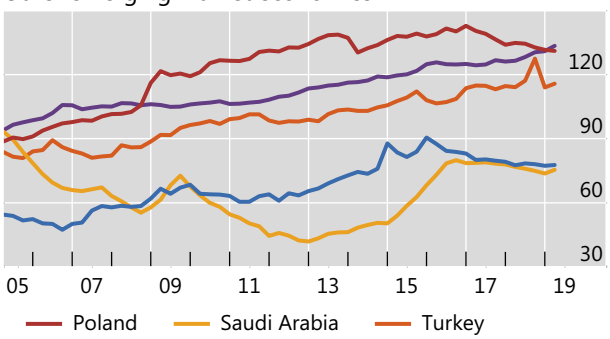
Other emerging Asia



Latin America



Other emerging market economies

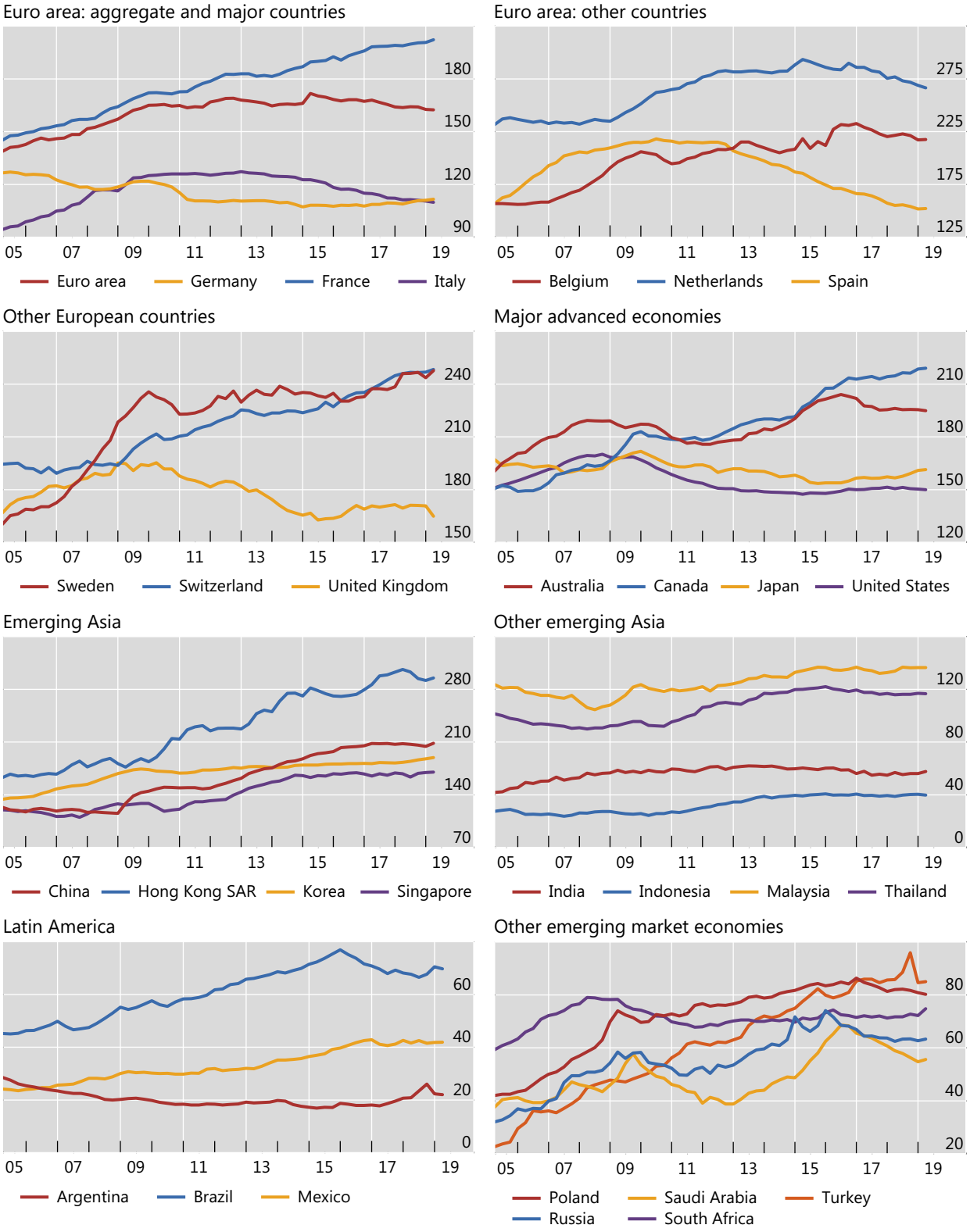


Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

Source: BIS total credit statistics.

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

As a percentage of GDP — Graph F.2



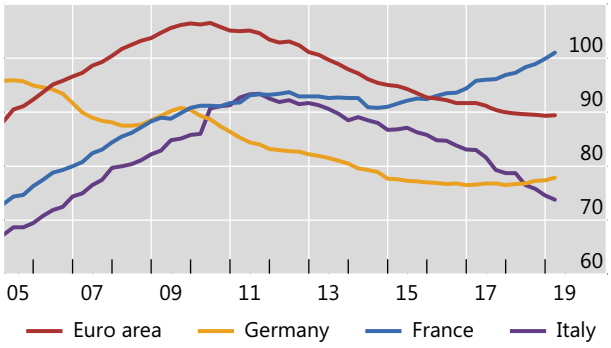
Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

Source: BIS total credit statistics.

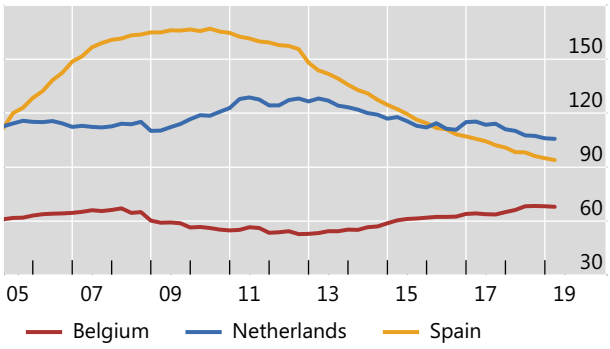
Bank credit to the private non-financial sector (core debt)

As a percentage of GDP — Graph F.3

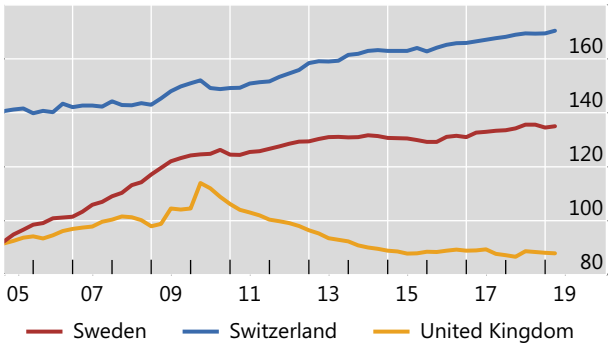
Euro area: aggregate and major countries



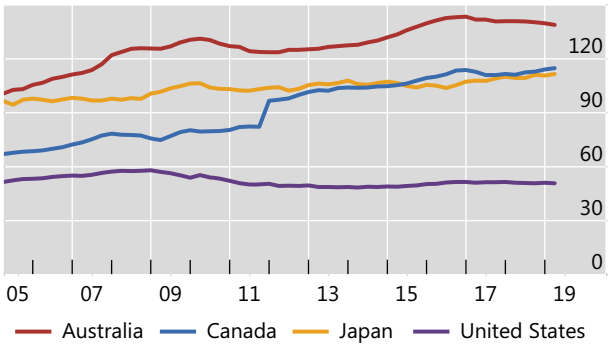
Euro area: other countries



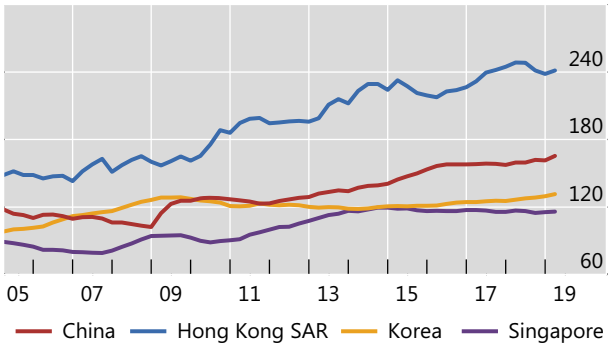
Other European countries



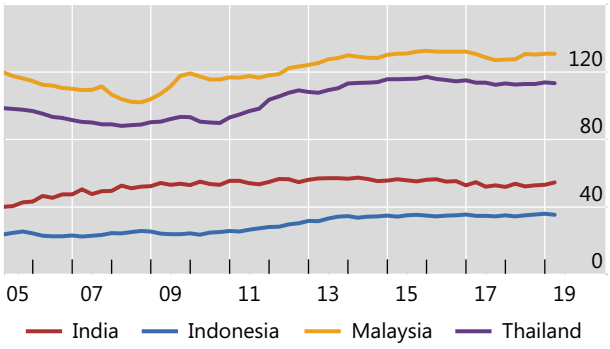
Major advanced economies



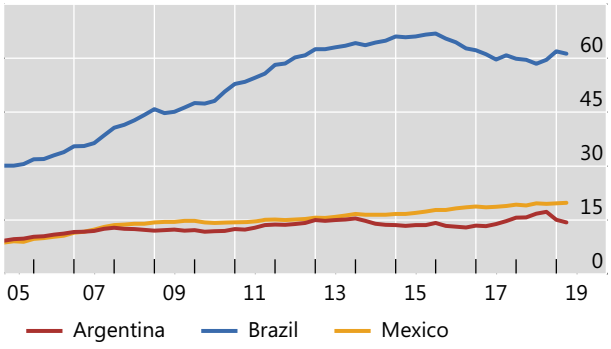
Emerging Asia



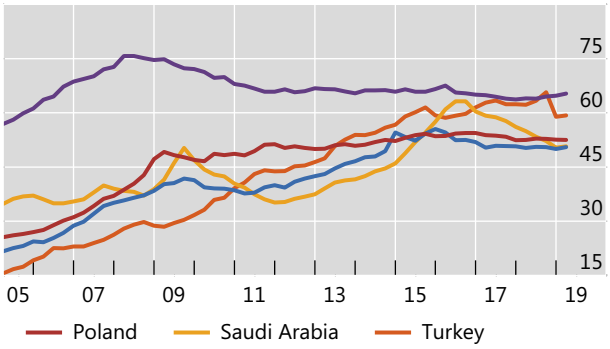
Other emerging Asia



Latin America



Other emerging market economies



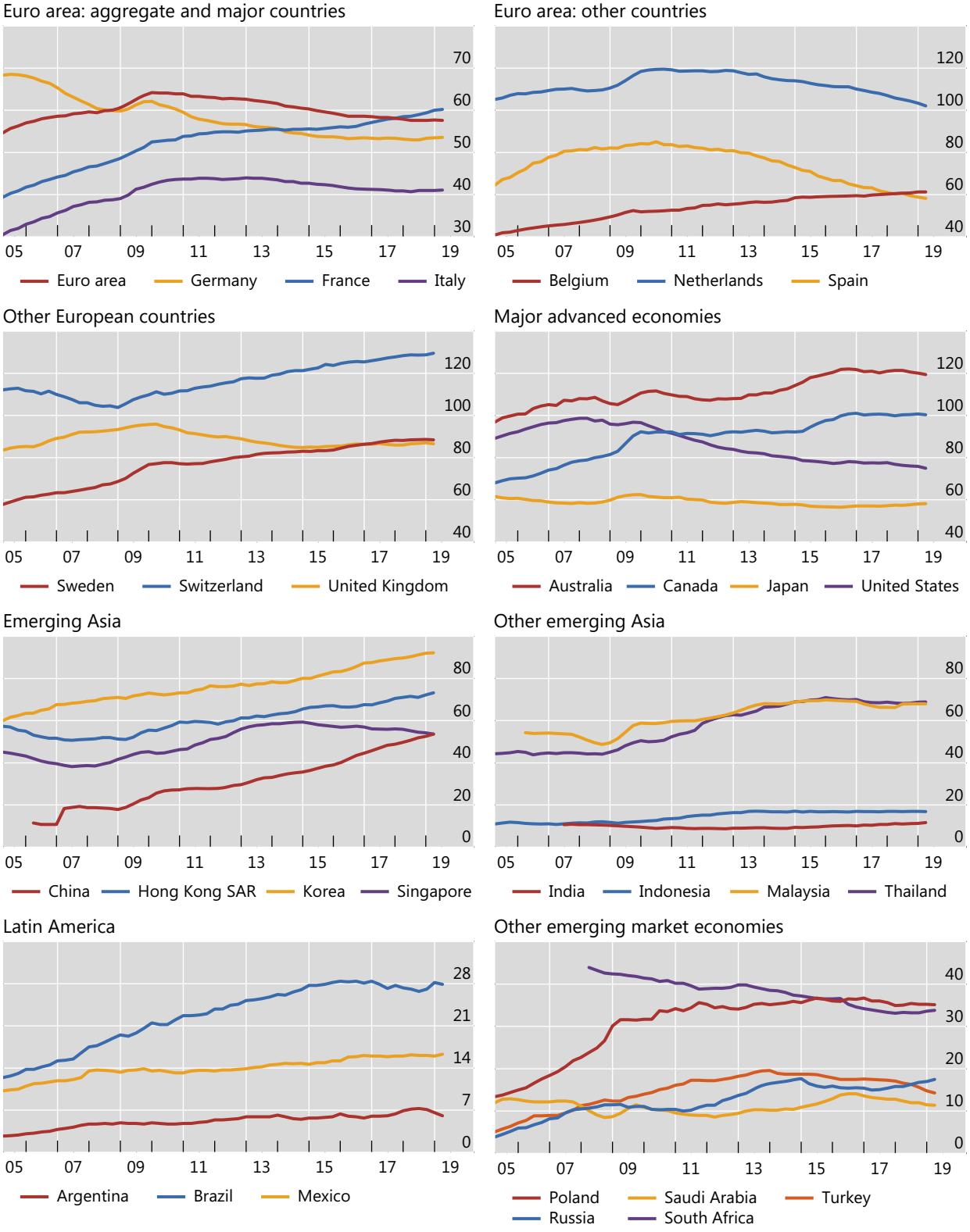
Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

Source: BIS total credit statistics.

Total credit to households (core debt)

As a percentage of GDP

Graph F.4



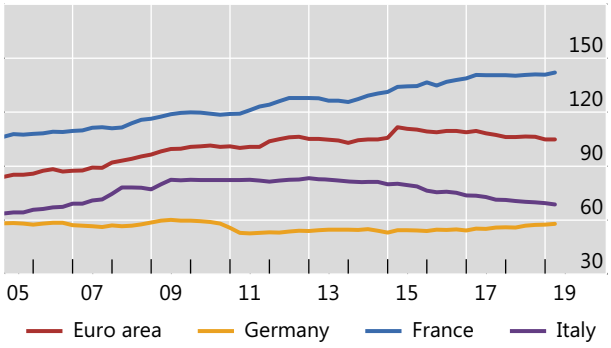
Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

Source: BIS total credit statistics.

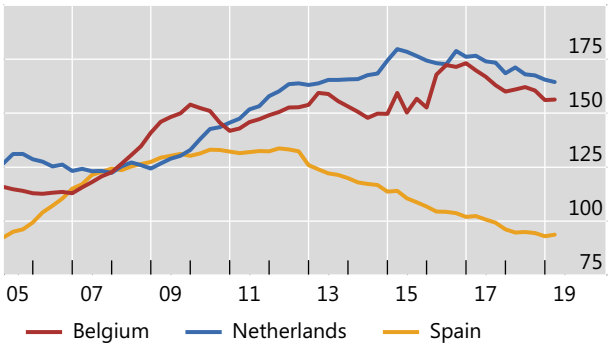
Total credit to non-financial corporations (core debt)

As a percentage of GDP — Graph F.5

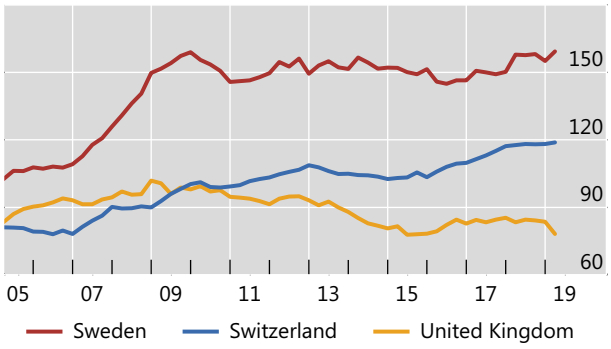
Euro area: aggregate and major countries



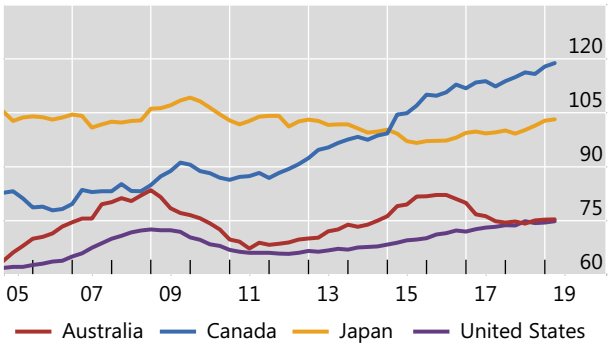
Euro area: other countries



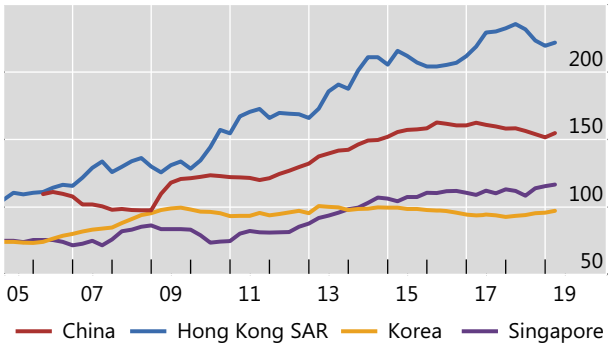
Other European countries



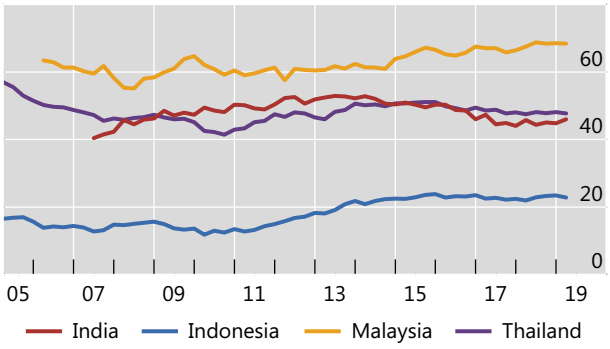
Major advanced economies



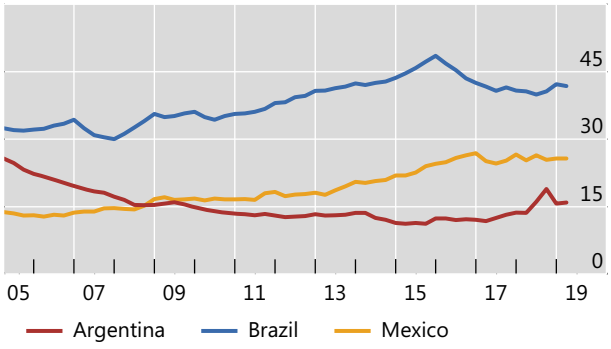
Emerging Asia



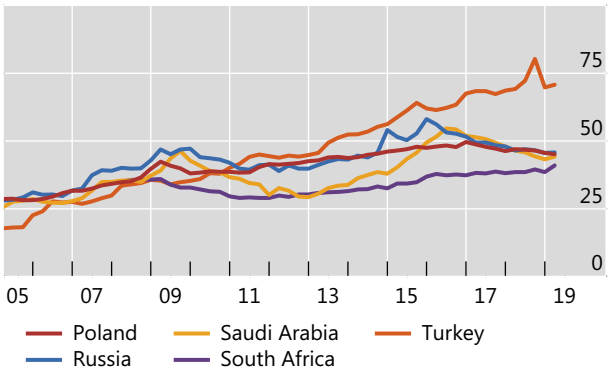
Other emerging Asia



Latin America



Other emerging market economies



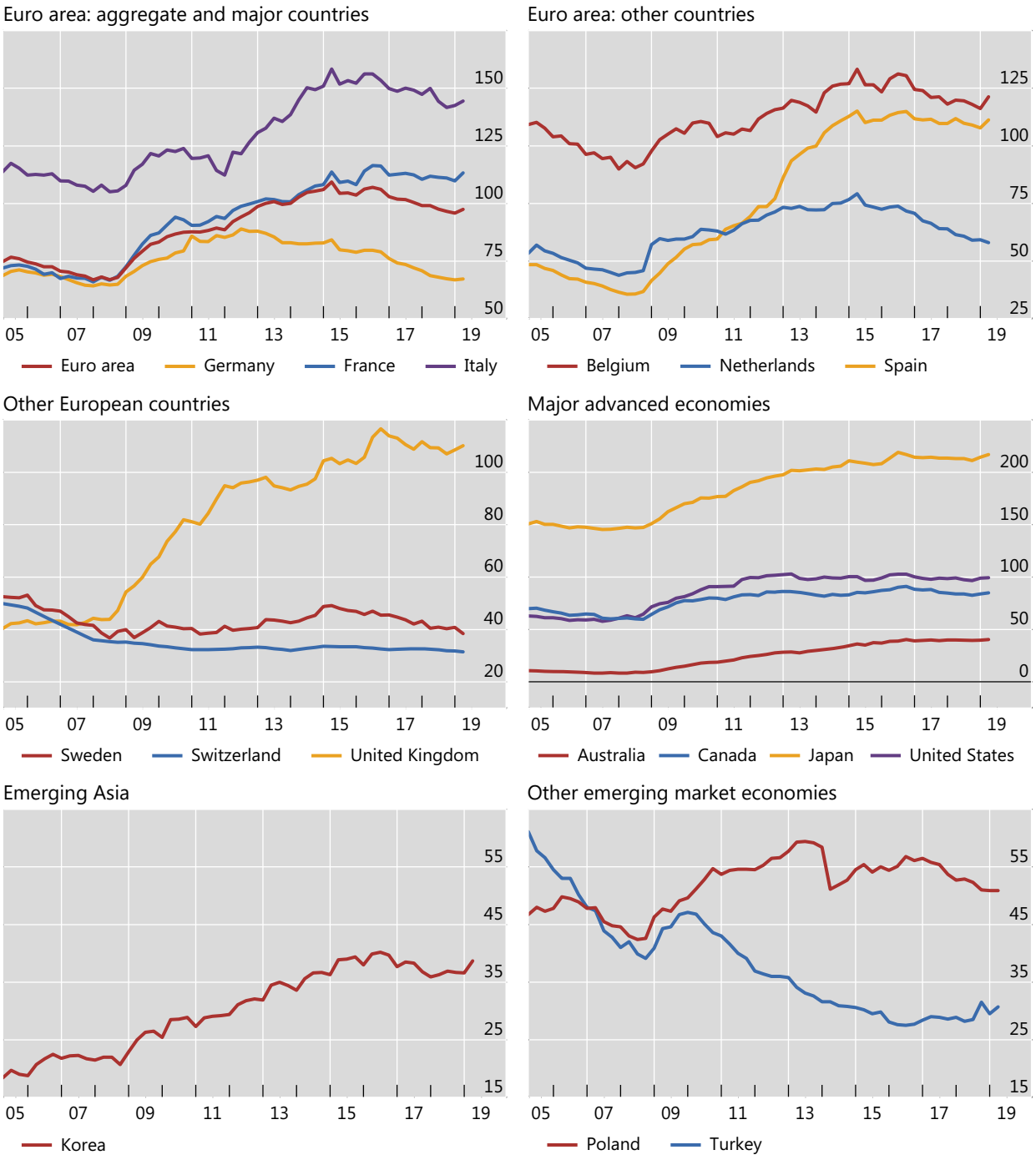
Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

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



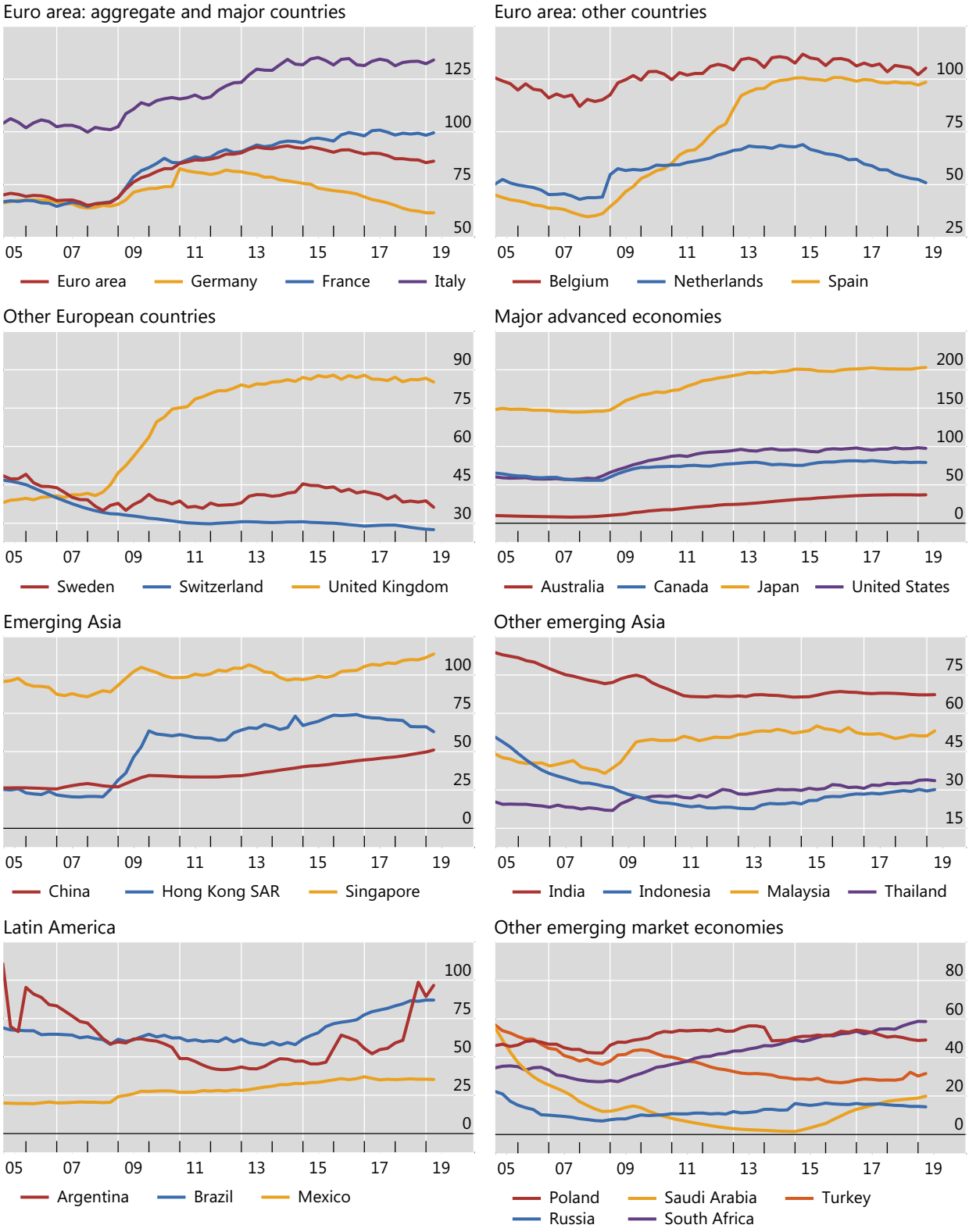
Further information on the BIS credit statistics is available at www.bis.org/statistics/totcredit.htm.

[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



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

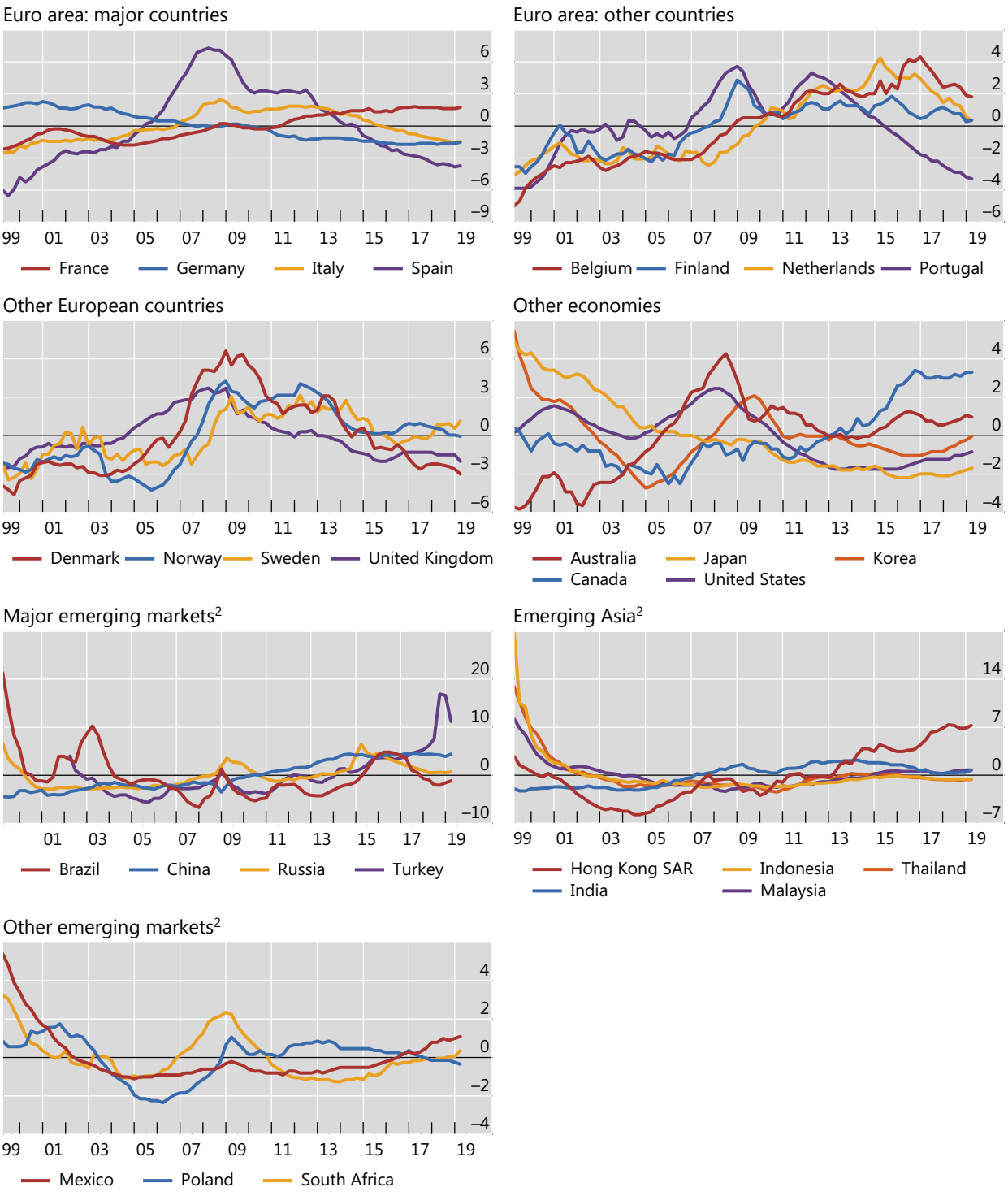
[1] Consolidated data for the general government sector; central government for Argentina, Indonesia, Malaysia, Mexico, Saudi Arabia and Thailand.

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 points[1] Graph G.1



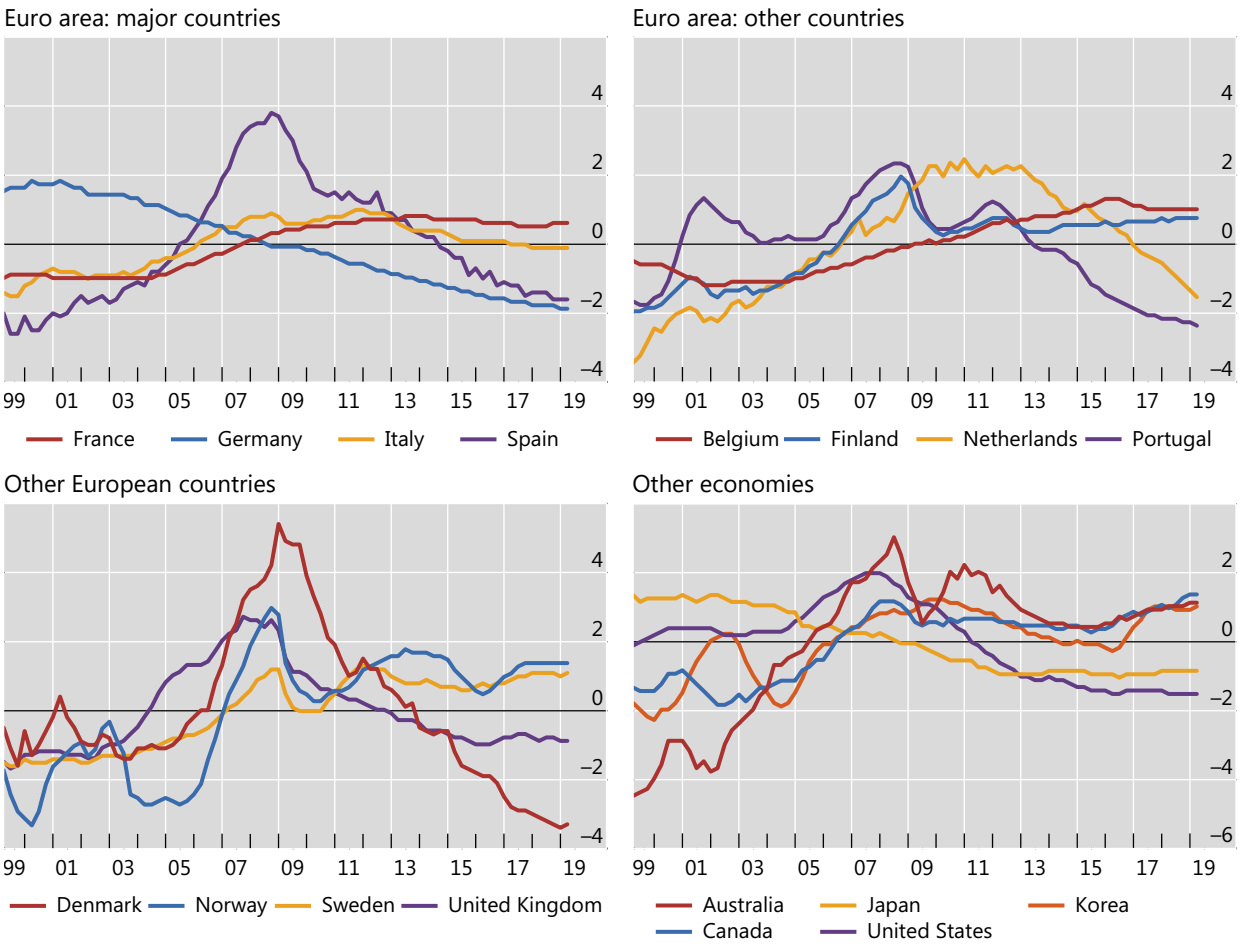
Further information on the BIS debt service ratio statistics is available at www.bis.org/statistics/dsr.htm.

[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 "Metholodogy 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 points[1] Graph G.2



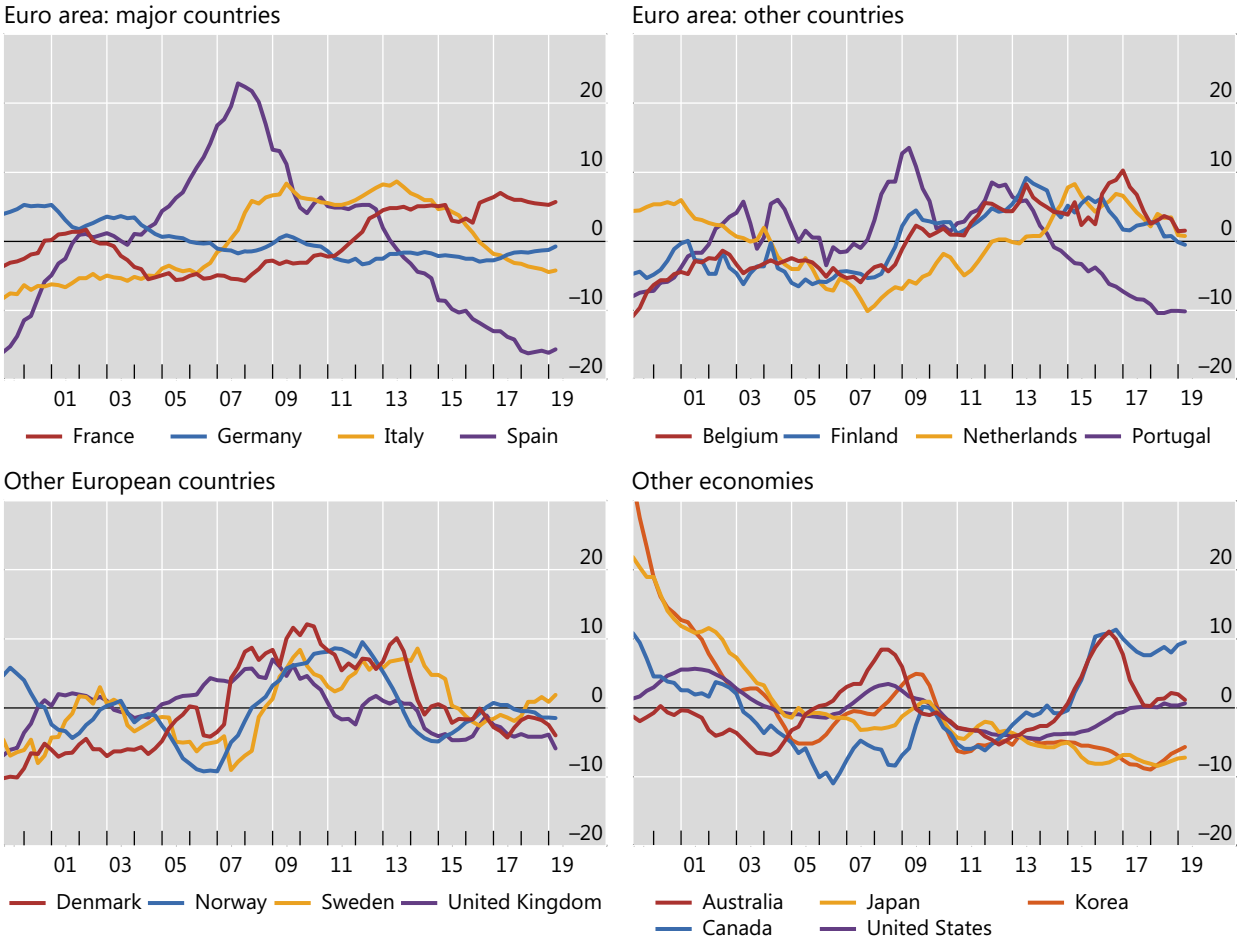
Further information on the BIS debt service ratio statistics is available at www.bis.org/statistics/dsr.htm.

[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 points[1] Graph G.3



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.

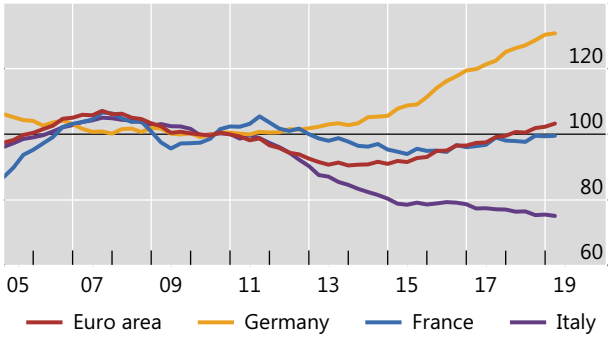
Source: BIS debt service ratios statistics.

H Property price statistics

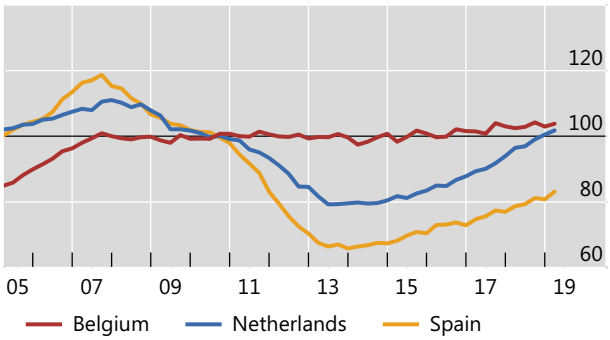
Real residential property prices

CPI-deflated, 2010 = 100 Graph H.1

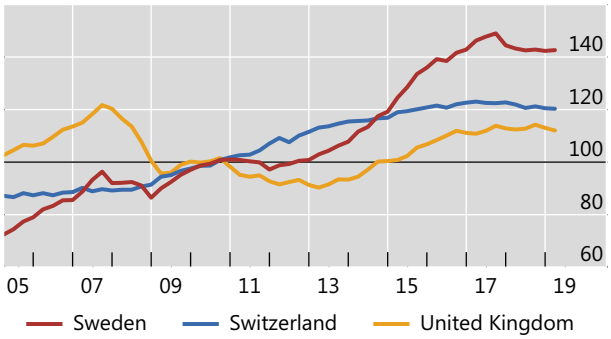
Euro area: aggregate and major countries



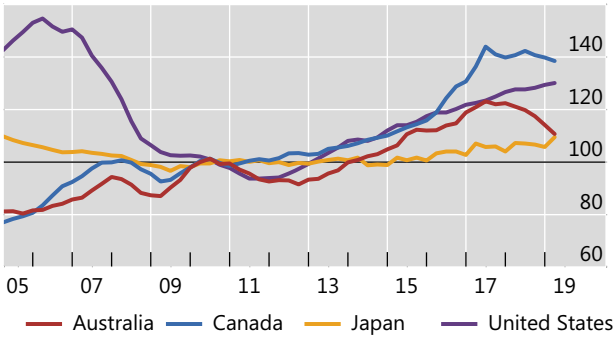
Euro area: other countries



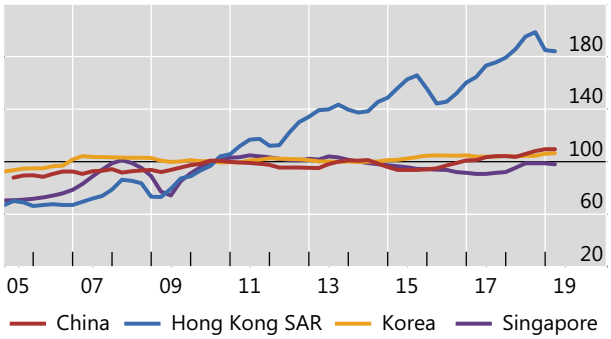
Other European countries



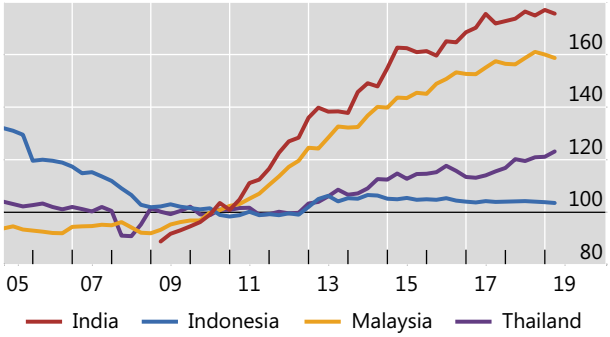
Major advanced economies



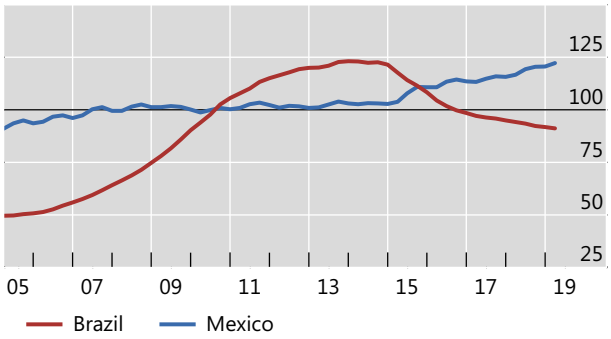
Emerging Asia



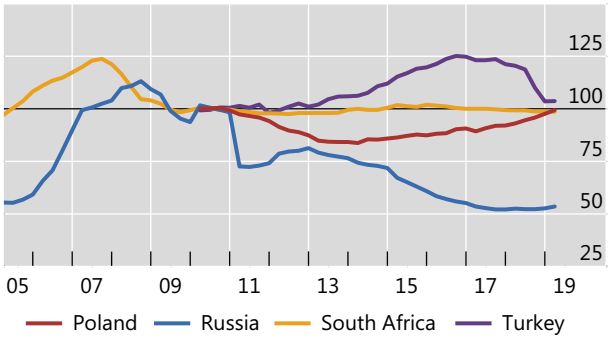
Other emerging Asia



Latin America



Other emerging market economies



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

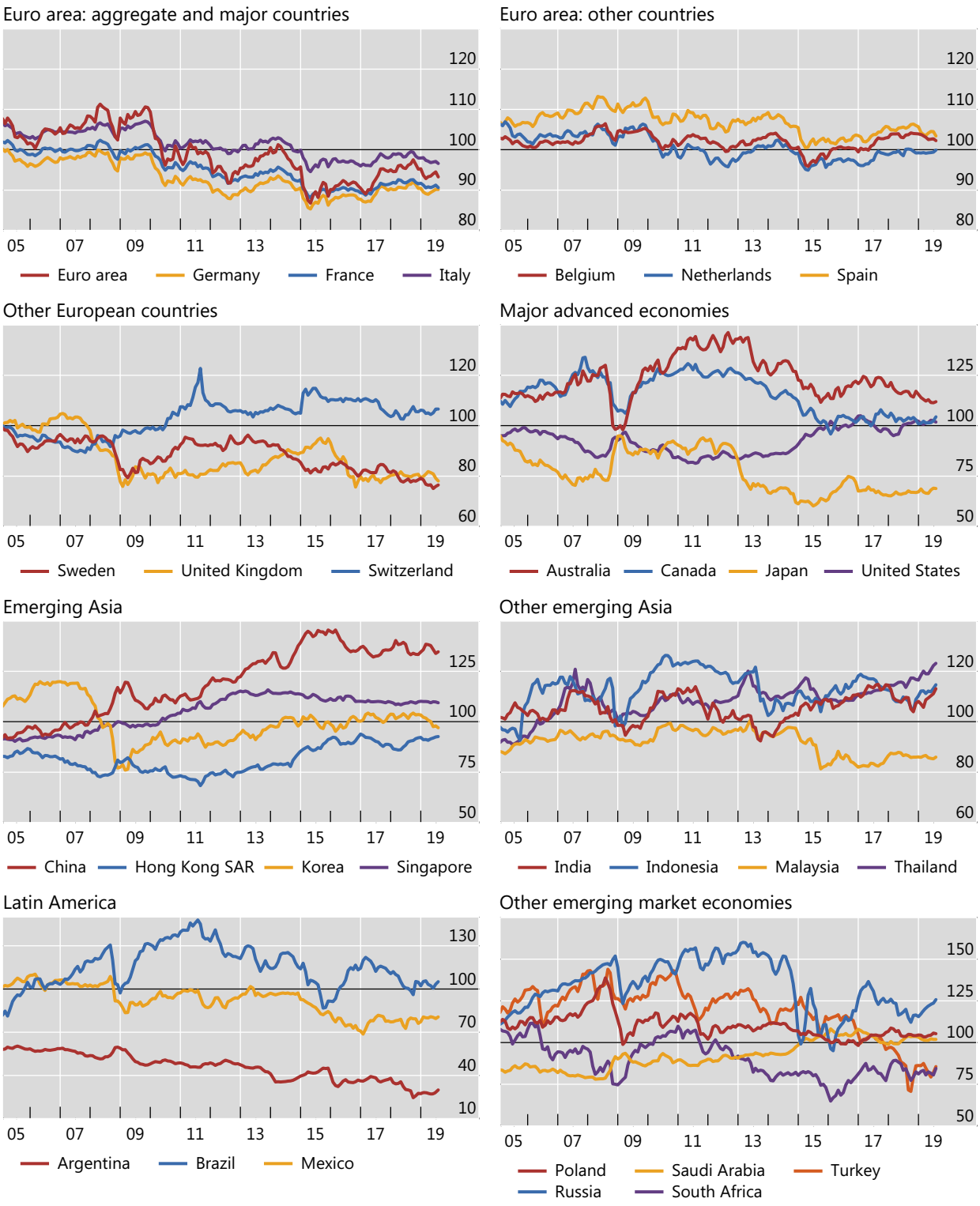
Source: BIS property prices statistics.

I Effective and US dollar exchange rate statistics

Real effective exchange rates

CPI-based, 1995–2005 = 100[1]

Graph I.1



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

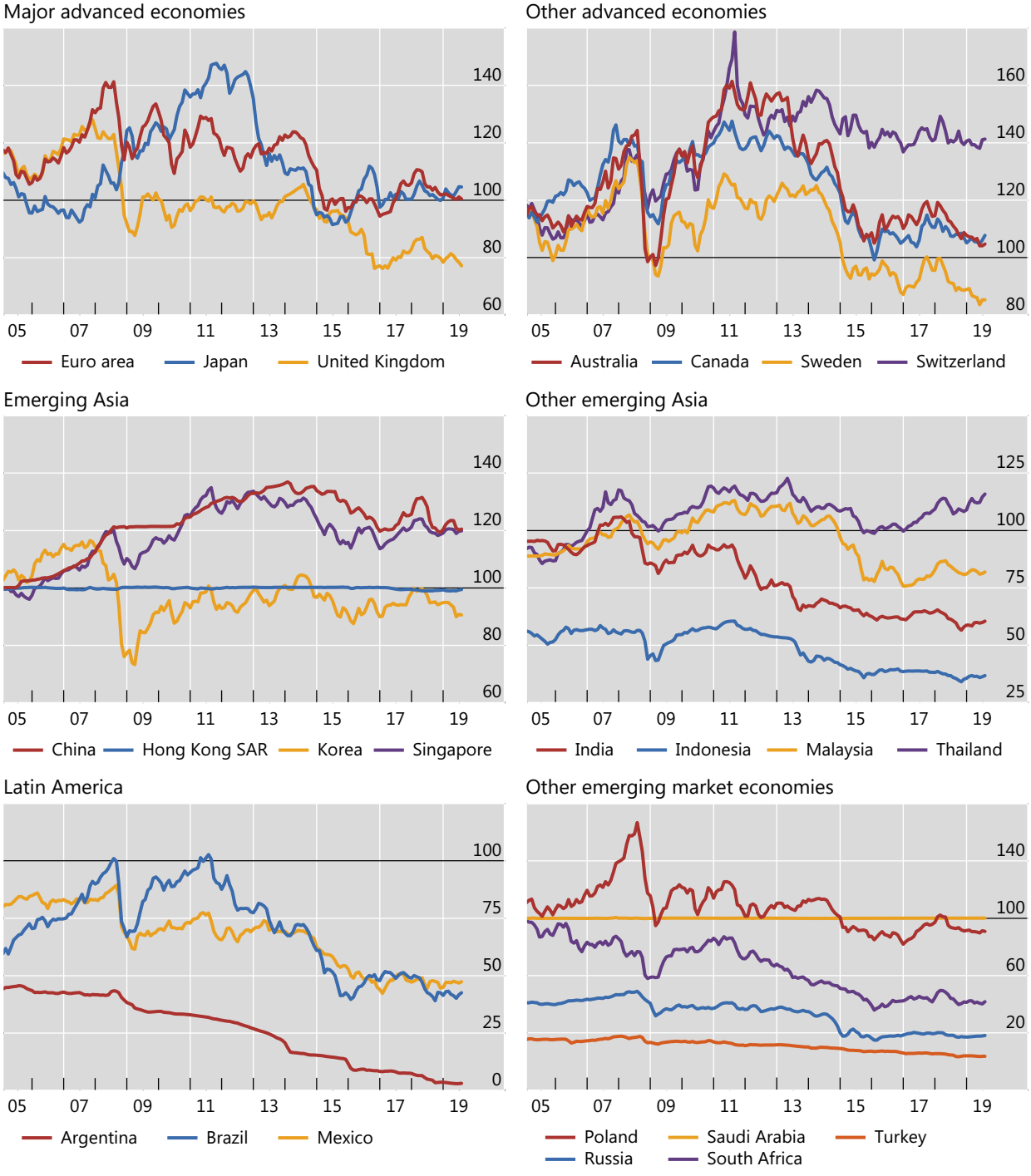
[1] An increase indicates a real-term appreciation of the local currency against a broad basket of currencies.

Source: BIS effective exchange rates statistics.

US dollar exchange rates

Indices, 1995–2005 = 100[1]

Graph I.2



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

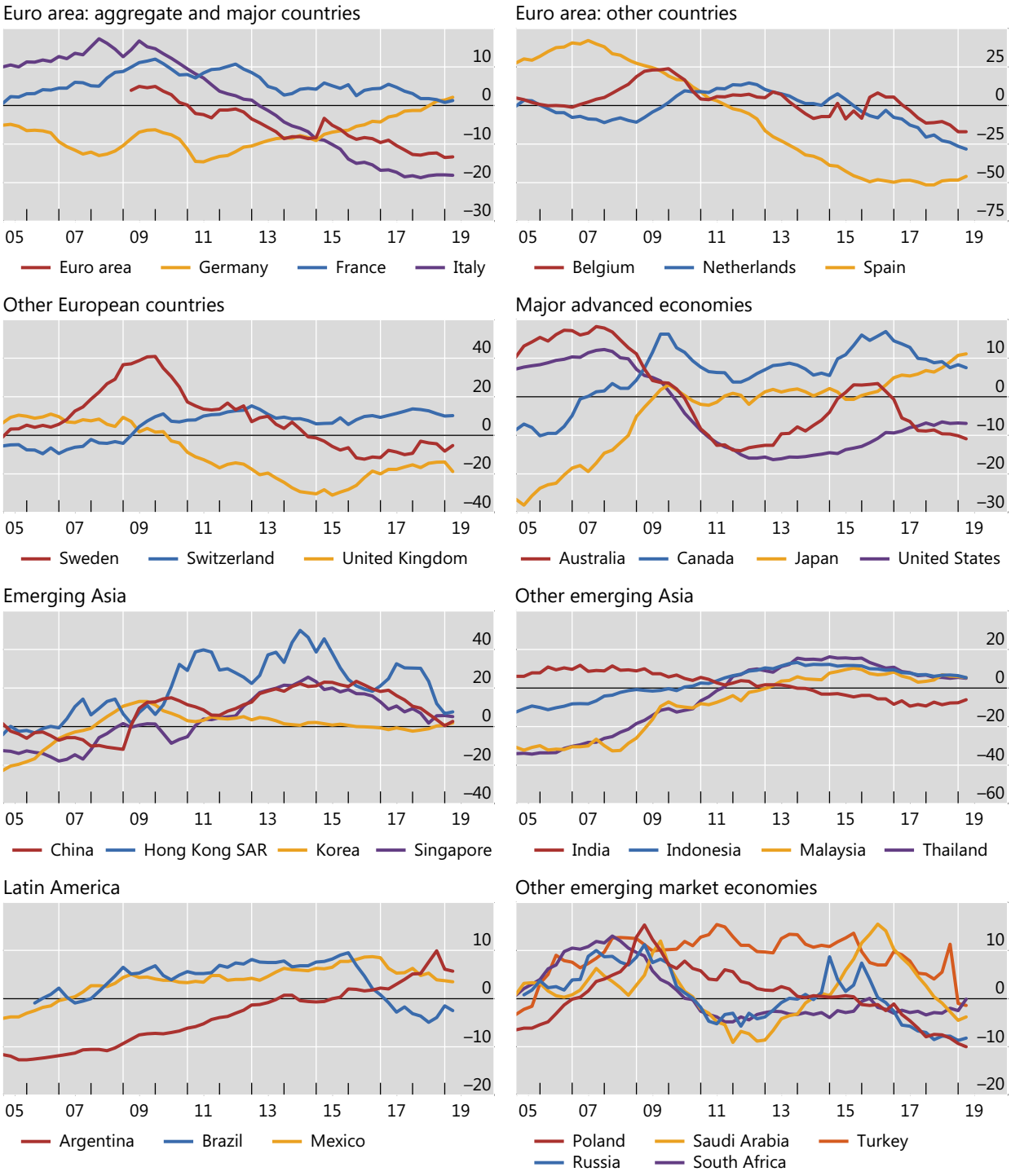
[1] An increase indicates an appreciation of the local currency against the US dollar.

Source: BIS US dollar exchange rates statistics.

J Credit-to-GDP gaps

Credit-to-GDP gaps

In percentage points of GDP — Graph J.1



[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.

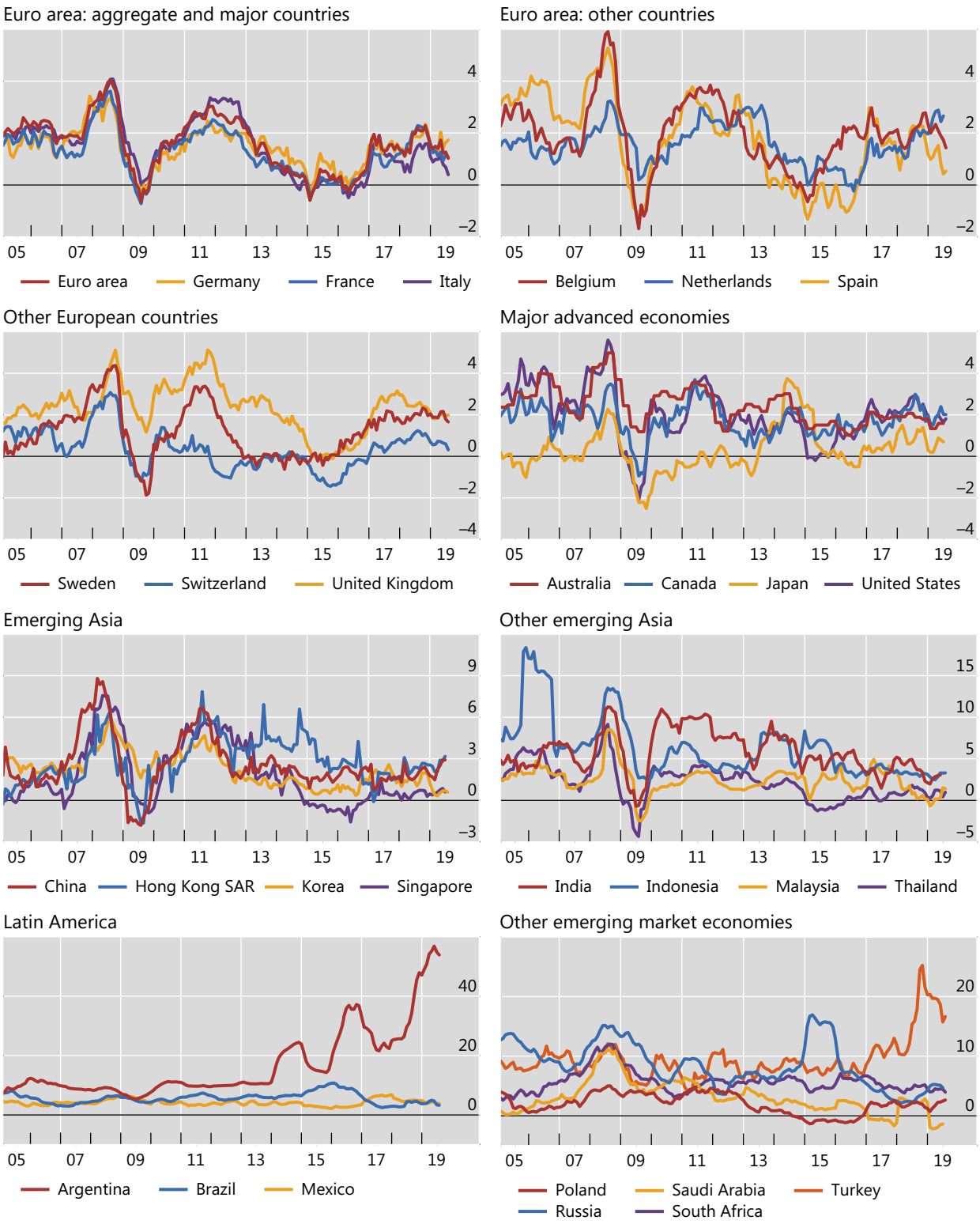
Source: BIS credit-to-GDP gaps statistics.

K Consumer prices

Consumer prices

Year-on-year percentage changes

Graph K.1



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

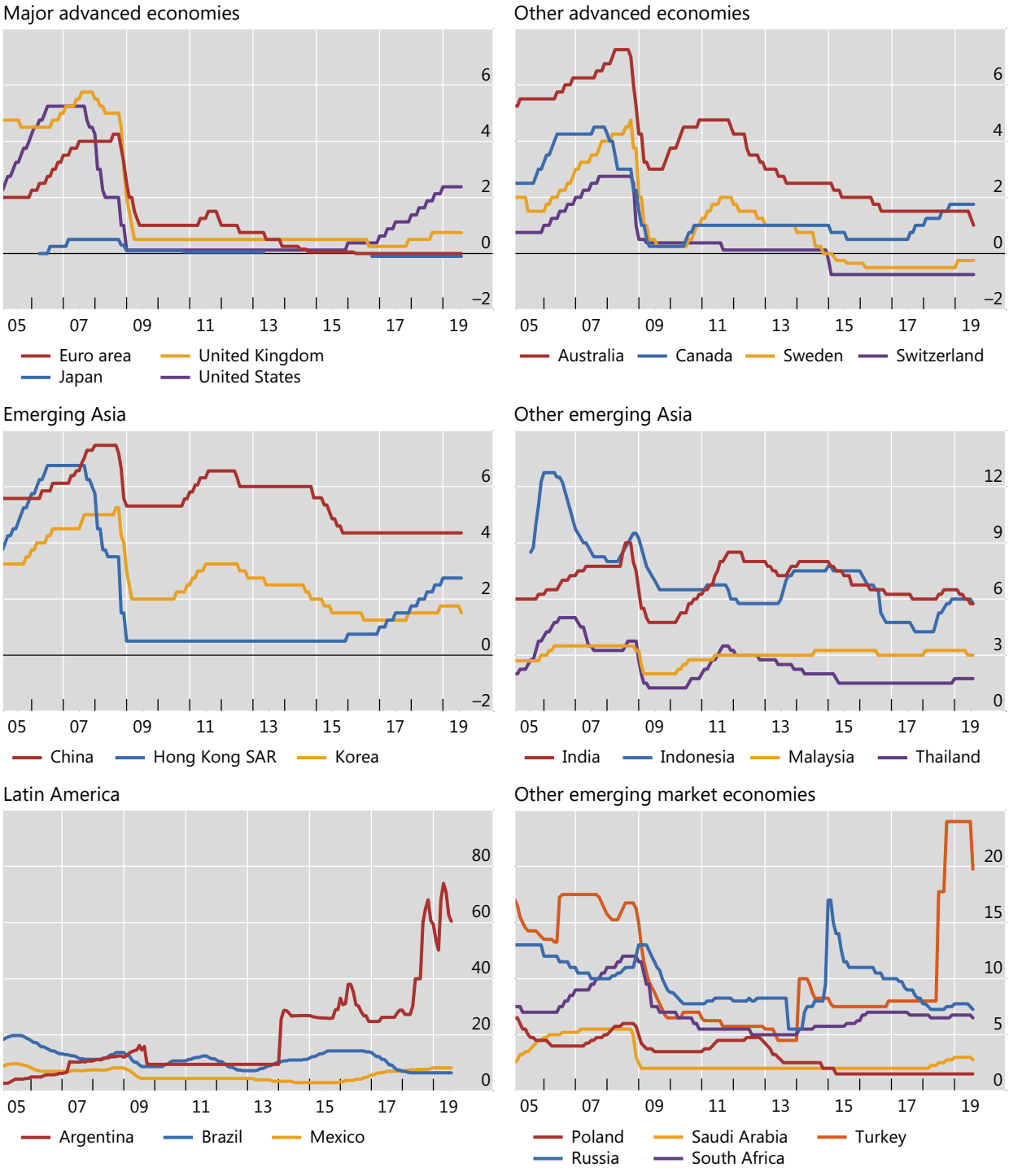
Source: BIS consumer price statistics.

L Central bank policy rates

Central bank policy or representative rates

Month-end; in per cent

Graph L.1



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

Source: BIS policy rates statistics.