BIS

BIS Quarterly Review

International banking and financial market developments

December 2022

BIS Quarterly Review
Monetary and Economic Department

General queries concerning this commentary should be addressed to Nikola Tarashev (tel +41 61 280 9213, e-mail: nikola.tarashev@bis.org), queries concerning specific parts to the authors, whose details appear at the head of each section.

This publication is available on the BIS website (http://www.bis.org/publ/qtrpdf/r_qt2212.htm).

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

BIS Quarterly Review

December 2022

International banking and financial market developments

Special features

A technical annex containing detailed explanations for the graphs and tables is included at the end of each chapter.

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

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

Countries

AE	United Arab Emirates	CY	Cyprus
AF	Afghanistan	CZ	Czechia
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
BW	British West Indies	GH	Ghana
BY	Belarus	GN	Guinea
BZ	Belize	GQ	Equatorial Guinea
CA	Canada	GR	Greece
CD	Democratic Republic of the Congo	GT	Guatemala
CF	Central African Republic	GW	Guinea-Bissau
CG	Republic of Congo	GY	Guyana
CH	Switzerland	HN	Honduras
CI	Côte d'Ivoire	HK	Hong Kong SAR
CL	Chile	HR	Croatia
CM	Cameroon	HT	Haiti
CN	China	HU	Hungary
CO	Colombia	ID	Indonesia
CR	Costa Rica	IE	Ireland
CV	Cabo Verde	IL	Israel

Countries (cont)

IN	India	MX	Mexico
IO	International organisations	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	UY	Uruguay
TO	Tonga	UZ	Uzbekistan
TR	Turkey	VC	St Vincent and the Grenadines
TT	Trinidad and Tobago	VE	Venezuela
TW	Chinese Taipei	VG	British Virgin Islands
TZ	Tanzania	VN	Vietnam
UA	Ukraine	ZA	South Africa
US	United States	ZM	Zambia

Markets swayed by inflation and growth prospects

Changes in the anticipated monetary stance and in the economic outlook continued to shape financial markets in the review period.[1] The interplay of shifting inflation dynamics and deteriorating growth gave rise to two phases. In the first, from mid-September to mid-October, inflation readings came in stronger than anticipated, pushing up expectations of policy rates in the near future. In the second, through November, lower than expected inflation and weakening economic activity led markets to reassess downward the extent of policy tightening ultimately needed to contain inflation. These developments kept asset price volatility elevated in the context of poor liquidity conditions across market segments, contributing to swings in global financial conditions.

Markets tracked the synchronised rise in expected policy rates through mid-October. As a result of the inflation surprise in September, investors' expectations of policy rates started rising rapidly in core markets. This pushed yields upwards amid low liquidity, supporting the US dollar and weighing on risky assets.

In late October and especially in November, market dynamics reflected investors' perception of a decline in terminal rates. As the US yield curve inverted further, the US dollar fell vis-à-vis most currencies from multi-decade highs, alleviating pressures in funding markets. Equities recouped losses, thanks in part to easing energy concerns in Europe, while poor earnings weighed on the technology sector. Corporate bond spreads compressed slightly but remained wide in Europe. Issuance continued to be limited in the investment grade (IG) segment and was minimal for high-yield (HY) bonds.

Commodity prices eased in most markets, despite clouds on the horizon. The decline was especially sharp for natural gas in Europe, but crude oil also fell markedly. However, lingering supply disruptions showed up in the markups for refined products, and long-term energy concerns persisted.

Assets in emerging market economies (EMEs) largely tracked those in AEs. Sovereign yields rose at a quick clip early in the review period and then trended down as the dollar weakened and financial conditions eased. China was an exception in October, as persistent stresses in the real estate sector and weakness in consumer demand weighed heavily on equities, including those of trading partners, and drove outflows from bonds, especially those issued offshore. Policy actions supported Chinese assets in November.

[1] The period under review extends from 13 September 2022 to 25 November 2022.

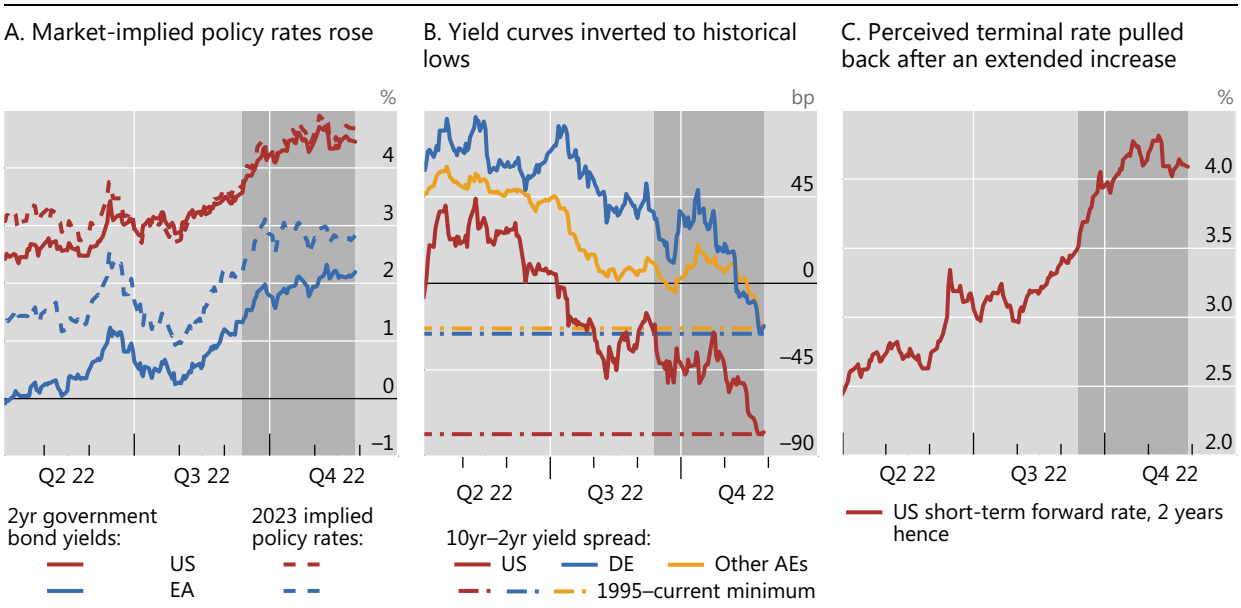
Key takeaways

- Investors stayed focused on central banks' inflation fight and on growth risks. After rising amid poor liquidity, core yields pulled back and the US dollar weakened from historical highs as inflation slowed.
- Equities experienced bouts of elevated volatility and proved particularly sensitive to the monetary policy outlook. Corporate bond spreads remained wide in Europe, and issuance contracted overall.
- EMEs generally appeared resilient, although weakness in China spilled over to trading partners. The real estate sector weighed on China's growth outlook but was supported by policy.

The monetary policy outlook shaped core bond markets

Shifting market expectations for the monetary policy outlook set the tone for yield curves over the review period. In September, expected policy rates for 2023 rose across all major advanced economies (AEs) after surprisingly high inflation readings. Subsequently, the evolution of these rates diverged somewhat, but they largely stabilised in November after US inflation surprised on the downside (Graph 1.A). In parallel, short-term sovereign yields rose steadily and then plateaued in the United States and Germany. As long-term sovereign yields dropped, yield curve slopes inverted further in the United States and turned negative in Germany and other AEs (Graph 1.B). Together with nominal yields, US forward interest rates rose on net but fell in November, as market participants reassessed downward the terminal policy rate (Graph 1.C).

Short-term yields climbed in anticipation of tighter monetary policy[1] Graph 1



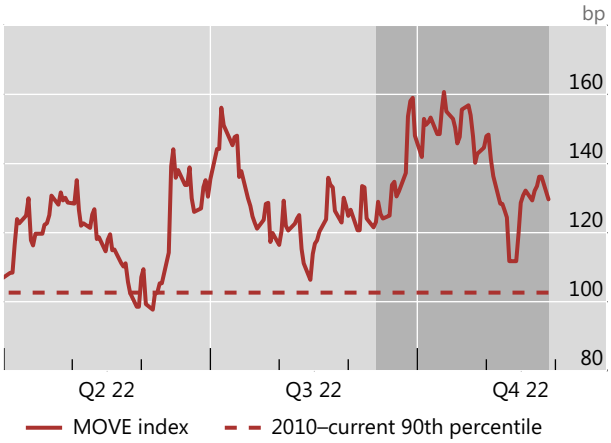
The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

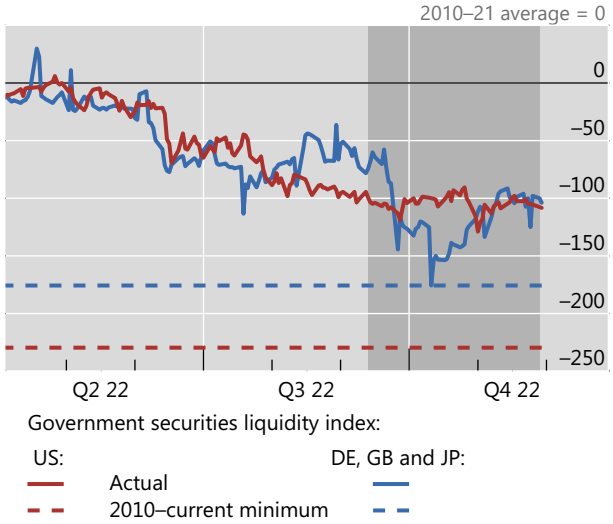
Sources: Board of Governors of the Federal Reserve System; Bloomberg; BIS.

As rates uncertainty remained high, liquidity conditions deteriorated[1] Graph 2

A. Implied volatility for Treasury yields was elevated



B. In many core bond markets, liquidity worsened



The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

Sources: Bloomberg; Datastream; BIS.

The interest rate outlook was uncertain, and bond market liquidity deteriorated in most AEs. Despite some swings, option-implied volatility for US rates remained very elevated throughout the review period (Graph 2.A). As rates climbed rapidly and volatility increased, bond markets turned progressively less liquid. For instance, a common liquidity measure based on bond prices[2] worsened markedly and reached its lowest level since the Great Financial Crisis (GFC) for a group of AEs (Graph 2.B). In the United States, liquidity conditions had started deteriorating during the summer and were stable over the review period, remaining noticeably worse than during the March 2020 episode of Treasury market dysfunction. Across AEs, these conditions improved somewhat after mid-October as market expectations of rate volatility fell. That said, liquidity appeared fragile in some market segments, such as those supporting US mortgage credit (Box A).

The market for long-dated UK government bonds came under severe stress in late September. The initial increase in yields followed the Bank of England's monetary policy decision and the announcement of a fiscal plan that included tax cuts and energy subsidies. Subsequently, yields rose further on the back of rapid sales by leveraged investment vehicles that pension funds employ (Box B; Graph 3.A). Illiquidity compounded these self-reinforcing dynamics. Eventually, following targeted and temporary central bank bond purchases aimed at restoring market functioning, yields retraced most of their increase.

[2] Based on deviations of bond prices from a smooth theoretical yield curve.

Liquidity risk in MBS markets

*Sirio Aramonte and Phurichai Rungcharoenkitkul*①

There are emerging signs of fragility in the markets for agency mortgage-backed securities (MBS). As MBS trading volumes declined in 2022, their yield spreads over US Treasuries became unusually volatile compared with those over the past 35 years (Graph A1.A). By examining transaction patterns across key intermediaries in the $10 trillion MBS market, this box discusses the risk of liquidity disruptions.②

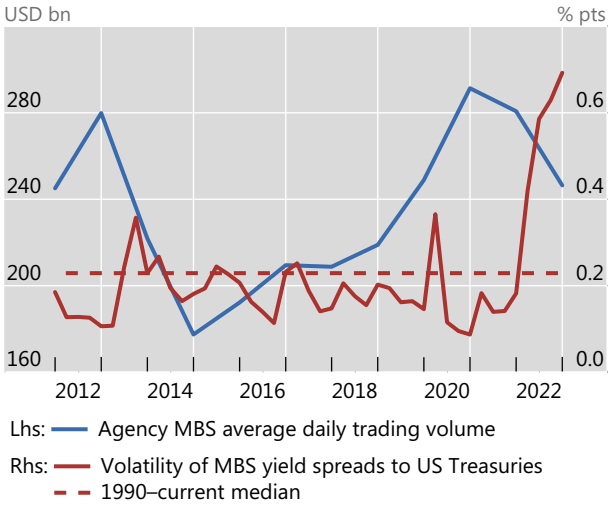
MBS demand from banks and the central bank proved an important stabilising force in two major stress episodes prior to 2022. During the Great Financial Crisis (GFC) and early in the Covid-19 pandemic, banks purchased large volumes of MBS, amounting to about 30% of transactions in each instance. The Federal Reserve was also an active buyer to support market functioning, absorbing roughly 10% in both cases (Graph A1.B).③ In contrast, other MBS investors were less reliable sources of demand. In particular, small investors and leveraged funds purchased significant amounts during the GFC but little in the midst of the Covid-19 crisis.

A shift in the composition of MBS buyers in 2022 could be a sign that the market has become more prone to bouts of volatility. Small investors and leveraged funds have become the main buyers, and they have been traditionally less forthcoming than banks in providing liquidity in times of stress. At the same time, monetary policy priorities may make it challenging for the Federal Reserve to backstop the MBS market, should the need arise. In this environment, surges in selling pressure could be particularly disruptive.

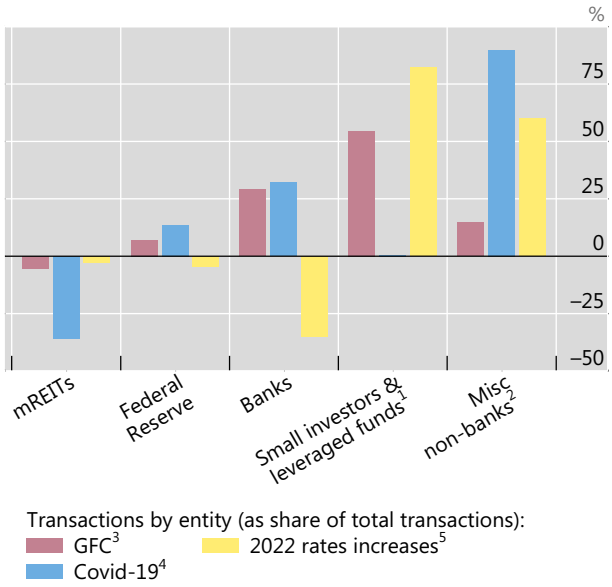
Liquidity worsened and the investor base changed in 2022

Graph A1

A. MBS liquidity deteriorated



B. Banks and the Fed stepped back



[1] This corresponds to the "households" flow of funds category. [2] Includes other intermediaries in Table F.211 of the Z.1 statistical release (eg insurers, mutual funds, pension funds). [3] Q3 and Q4 2008. [4] Q1 2020. [5] Q2 2022.

Sources: Board of Governors of the Federal Reserve System; Bloomberg; FINRA; SIFMA; authors' calculations.

Among key market participants, closed-end funds known as mortgage real estate investment trusts (mREITs) are relatively prone to selling rapidly in times of stress. Large amounts of debt – often in the form of short-term repos – allow mREITs to pay out double-digit yields, even if they mostly invest in low-risk securities. High leverage and maturity mismatches imply that mREITs can be an important source of fire sales, even though they hold a small share of MBS outstanding (between 1.5% and 5% over the past 10 years).③,④ In fact, early in the Covid-19 pandemic, mREITs were behind a substantial fraction of overall MBS sales. In this instance, purchases by banks and the Federal Reserve provided the backstop, just as they did during the GFC.

With a history of high liquidity demand in times of stress, mREITs remain a potential source of market dysfunction, especially if banks and the central bank continue to pull back.

Liquidity disruptions in the MBS market could have material systemic implications. First of all, MBS play a crucial role in facilitating credit to the US real estate sector. In addition, since MBS are near substitutes for US Treasuries, liquidity strains could reverberate more broadly in financial markets. The role of leverage and maturity mismatches in shaping fire sale risk in MBS markets, together with potential wide-ranging ramifications, is a reminder of the policy challenges in containing risk in non-bank financial intermediation.⑤

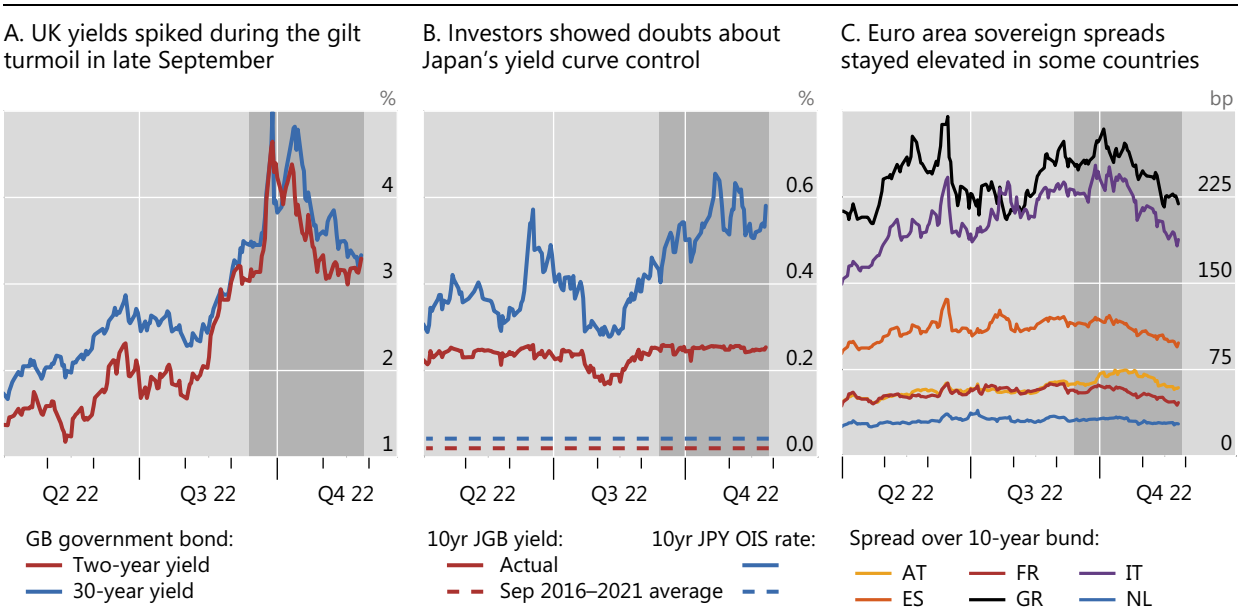
① The views expressed are those of the authors and do not necessarily reflect the views of the BIS. ② A Fuster, D Lucca, J Vickery, "Mortgage-backed securities", Federal Bank of New York *Staff Reports*, no 1001, 2022. ③ S Pellerin, D Price, S Sabol and J Walter, "Assessing the risks of mortgage REITs", Federal Reserve Bank of Richmond *Economic Brief*, no 13-11, 2013. ④ K Pence, "Liquidity in the mortgage market: How does the COVID-19 crisis compare with the global financial crisis?", *Real Estate Economics*, vol 50, no 6, 2022. ⑤ A Carstens, "Non-bank financial sector: systemic regulation needed", *BIS Quarterly Review*, December 2021, pp 1–6.

In Japan, investors continued to wager that the yield curve control policy would eventually be relaxed. This policy caps the yield on 10-year Japanese government bonds at 25 basis points. However, corresponding rates in derivatives markets, which the Bank of Japan does not target directly, rose rapidly to exceed cash yields by a wide margin (Graph 3.B). In parallel, the yen depreciated, prompting foreign exchange (FX) interventions.

Similar to the evolution of long-term core bond yields, sovereign bond spreads in the euro area widened through October but compressed thereafter. The narrowing was especially pronounced for Greek and Italian bonds. That said, the spreads on these bonds remained much wider than for other euro area members and, in the case of Italy, were markedly higher than early in the year (Graph 3.C).

Euro area sovereign spreads compressed amid dislocations in other AEs

Graph 3



The shaded areas indicate 13 September–25 November 2022 (period under review).

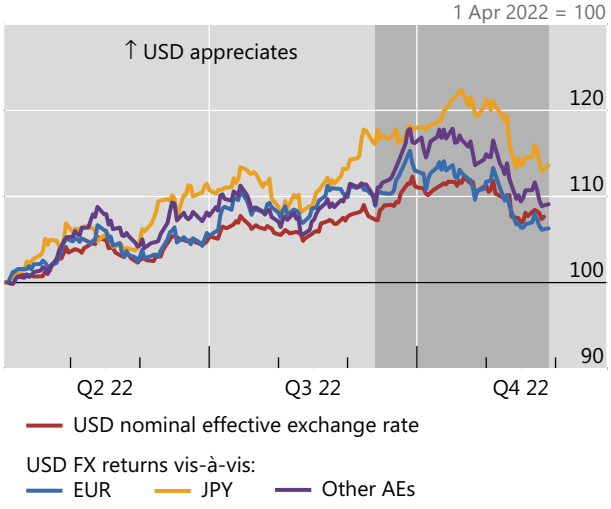
Sources: Bloomberg; BIS.

After extended gains that led to multi-decade highs, the US dollar paused and then weakened. The dollar's nominal effective exchange rate fell by about 2% following the lower than expected CPI release in November, as market participants reassessed the outlook for interest rate differentials (Graph 4.A). In particular, the US dollar weakened against the euro and the yen over the review period as a whole. Against the backdrop of relatively poor liquidity in major FX markets, option-implied FX volatility climbed further to reach post-Covid-19 highs in most cases. More broadly, signs of significant strains in dollar funding markets emerged as year-end approached but then eased when the dollar weakened (Graph 4.B).

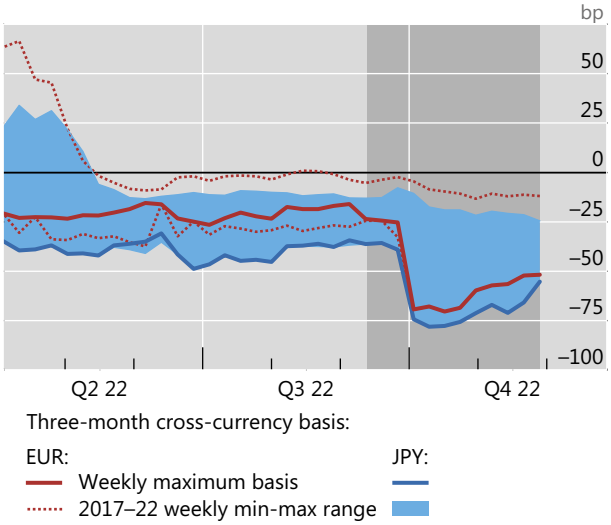
The US dollar pulled back[1]

Graph 4

A. The US dollar depreciated from October



B. Dollar funding pressures built ahead of year-end



The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

Sources: Bloomberg; BIS.

Box B

Leverage and liquidity backstops: cues from pension funds and gilt market disruptions

*Sirio Aramonte and Phurichai Rungcharoenkitkul*①

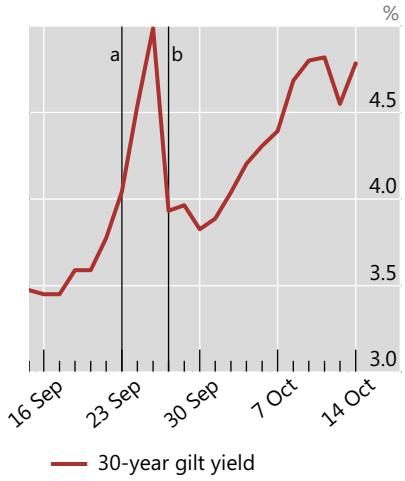
The market for UK sovereign bonds (gilts) experienced significant turmoil in late September. A sharp rise in yields, set off by the then announced change in the UK fiscal stance, was amplified by forced selling due to rapid deleveraging by investment vehicles used by pension funds. This box reviews the dynamics that led to the disruptions and highlights factors that could set off similar episodes in other markets and jurisdictions.

Liquidity in the gilt market started to worsen on 22 September 2022, when the Bank of England announced a 50 basis point rate hike, and deteriorated rapidly the following day (Graph B1.A). A surge in yields was precipitated by plans for an expansionary fiscal programme featuring tax cuts and energy subsidies. In addition, the gilt market witnessed unusually large trading volumes, a sharp widening of bid-ask spreads and a significant depreciation of sterling. Markets returned to normal only when the Bank of England committed to purchase large amounts of long-dated gilts on 28 September. To encourage timely deleveraging, the commitment was for a limited period.

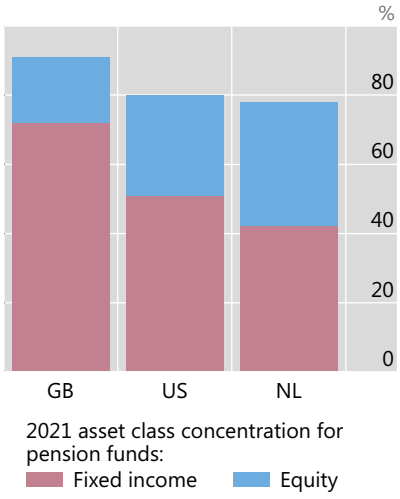
Pension funds and risks of market disruptions

Graph B1

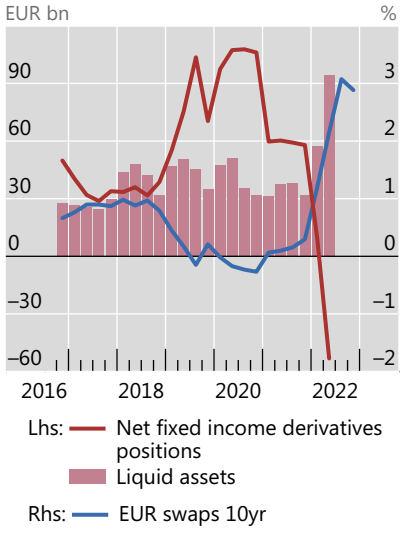
A. Gilt yields spiked as pension funds hurried to deleverage



B. UK pension funds hold relatively more fixed income securities



C. Dutch pension funds quickly raised cash to cushion losses in Q2 2022



[a] "Mini" Budget announced. [b] Gilt purchases by the Bank of England.

Sources: Netherlands Bank; EIOPA; Pension Protection Fund; Bloomberg; Milliman; authors' calculations.

Liability-driven investment (LDI) funds played an important role in the late September events. These legally separate investment vehicles help defined benefit pension funds hedge long-lived liabilities towards future retirees. A hedging strategy could in principle simply entail purchasing long-term sovereign bonds, similar to asset-liability duration matching by insurance companies.② But, over the years, a shortage of such physical bonds led UK LDIs to obtain the desired asset side duration via leverage, which increases the sensitivity of asset returns to long-term interest rates. LDIs had levered up by funding bond holdings with repurchase agreements (repos) or, to a smaller extent, by partial collateralisation of interest rate swaps.

As gilt yields rose rapidly in September, LDI funds came under severe pressure, in contrast to pension funds themselves. The yields' rise generated losses for LDIs' leveraged positions and triggered calls for additional collateral. To meet these calls, LDIs needed cash infusions, which pension funds failed to provide promptly enough. The infusions were particularly slow to come for "pooled LDIs", which manage assets on behalf of

multiple pension funds. In this case, individual pension funds had less incentive to step in, as the benefits would have been shared by all participants but the costs borne privately. As their solvency positions worsened, LDI funds had to deleverage by selling gilts, putting further upward pressure on yields and setting off a full-fledged spiral.③ These yield moves might have also been amplified by other intermediaries attempting to maintain matched duration across assets and liabilities. From a system-wide perspective, the cause of market dysfunction was predominantly a liquidity problem. Pension funds' overall net worth actually improved with the higher interest rates: given incomplete hedging, the decline in the present value of marked-to-market liabilities more than offset the corresponding asset losses.

In principle, the mechanism that led to the UK turmoil could be at work in other jurisdictions. Key determinants of potential disruptions are: (i) leverage, which raises the risk of forced sales to prevent a default; (ii) lack of portfolio diversification, which forces funds to sell similar assets; (iii) small market size for the assets being sold, which raises the price impact of forced sales; and (iv) reliance on pooled LDI funds, which are slow to raise liquidity.

On the basis of these criteria, other large defined benefit pension systems, notably in the Netherlands and the United States, appear less vulnerable to the risk of fire sales than those in the United Kingdom. To begin with, US pension funds reportedly seldom use leverage, in part because the shorter duration of their liabilities limits their need to hedge with long-duration investments.④ Likewise, Dutch pension funds rely less on leverage than their UK counterparts, as they only hedge less than 60% of their interest rate risks on average.⑤ They also often use over-the-counter derivatives for hedging, with flexibility to post margins with certain securities rather than cash. As for diversification, portfolios of US and Dutch pension funds are less concentrated in fixed income instruments than those in the United Kingdom (Graph B1.B).⑥ In addition, compared with the United Kingdom, the sovereign bond holdings of US and Dutch pension funds represent a smaller share of the total outstanding amounts of US Treasury and euro area sovereign debt, respectively. Lastly, US and Dutch pension funds rely less on pooled LDI funds and can readily use own fund-wide cash and liquid assets when the value of leveraged positions fluctuates. Indeed, as interest rates rose sharply in the second quarter of 2022, Dutch pension funds were able to quickly raise liquidity to cushion against the falling value of interest rate derivatives positions (Graph B1.C).

The stress episode in the gilt market holds broad lessons for non-bank financial intermediaries (NBFIs).⑦ Financial stability risks from high leverage and inadequate market liquidity are not confined to the pension fund sector. Indeed, long periods of low interest rates have incentivised a reach for yield and leverage build-up by financial institutions across the spectrum, including more innovative forms of securitisation, such as those of private equity funds. With rapid increases in interest rates and receding liquidity in core markets, simultaneous deleveraging can generate liquidity demand pressure, which could lead to market dysfunction. In addition, strategies that involve duration matching could create similar pressures, eg when a sharp rise in interest rates shortens liability duration, and prompts asset sales in a falling market. When these risks materialise and the attendant economic costs are substantial, there will be pressure on central banks to provide backstops – as market-makers of last resort. While justified, this can contrast with the monetary policy stance and encourage risk-taking in the longer run.⑧ Such dilemmas highlight the urgency of implementing systemically oriented regulation that addresses structural vulnerabilities in the NBFI sector.⑨

① The views expressed are those of the authors and do not necessarily reflect the views of the BIS. ② D Domanski, H S Shin and V Sushko, "The hunt for duration: not waving but drowning", *IMF Economic Review*, March 2017. ③ Bank of England, "Letter to the Chair of the Treasury Committee, House of Commons", 5 October 2022. ④ R Ratkowski, "Four structural differences to know about the UK and US LDI markets", NISA *Perspectives*, 20 October 2022. ⑤ Netherlands Bank, individual pension fund statistics. ⑥ JPMorgan, "Flows & liquidity", 20 October 2022. ⑦ S Aramonte, A Schrimpf and H S Shin, "Non-bank financial intermediaries and financial stability", *BIS Working Papers*, no 972. ⑧ Markets Committee, "Market dysfunction and central bank tools", May 2022. ⑨ A Carstens, "Non-bank financial sector: systemic regulation needed", BIS Quarterly Review, December 2021, pp 1–6.

Risky assets fluctuated as uncertainty rose

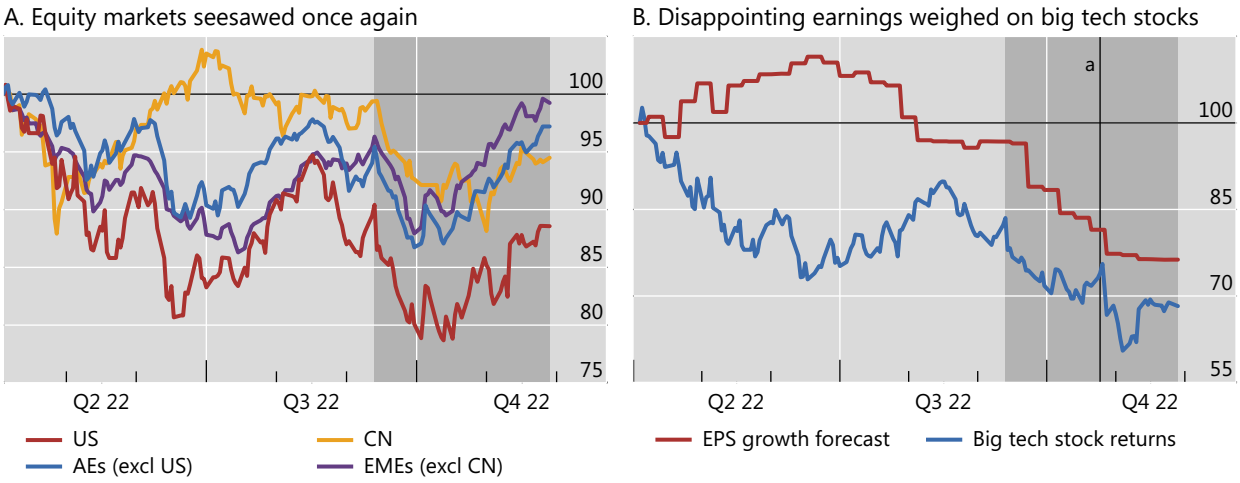
Equity prices were attuned to the monetary policy outlook and saw pronounced swings. In October and especially in November, stocks were bolstered by investors' downward reassessment of ultimate policy tightening, even as expectations of near-term policy rates changed little and corporate earnings proved weak (Graphs 5.A and 5.B). The closing of short positions probably contributed to spikes in stock prices in early October and mid-November. Chinese equities were under pressure for most of the review period due to economic weakness but rose in November on expectations of less stringent pandemic management.

Corporate bond markets showed some signs of strain. Yield spreads over sovereign bonds widened in September and October, ending the review period at and above historical norms in the United States and Europe, respectively, after a tightening in November (Graph 6.A). Average spreads in Q4 2022 appeared broadly in line with the economic backdrop (Graphs 6.B). In the background, perceived default risk picked up and was somewhat elevated for IG firms (Graph 6.C). In this context, issuance dried up in the HY segment, until a tentative reprise in November, and declined sharply for IG firms, approaching its lowest levels since the GFC (Graph 7.A).

Leveraged loans, which tend to be more sensitive to rising interest rates due to their floating coupons, were also under some pressure. Notably, syndicate underwriters engaged in large sales. While significant discounts attracted purchases by collateralised loan obligations (CLOs), the demand from traditional buyers for these securitisations – notably for their senior tranches – remained limited.

Equity prices fluctuated with the policy outlook, while profitability deteriorated[1]

1 April 2022 = 100 Graph 5



The shaded areas indicate 13 September–25 November 2022 (period under review).

[a] Start of the week in which big tech firms reported Q3 earnings.

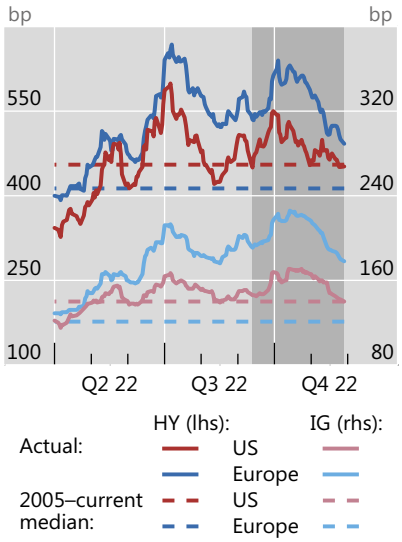
[1] See technical annex for details.

Sources: Bloomberg; Datastream; BIS.

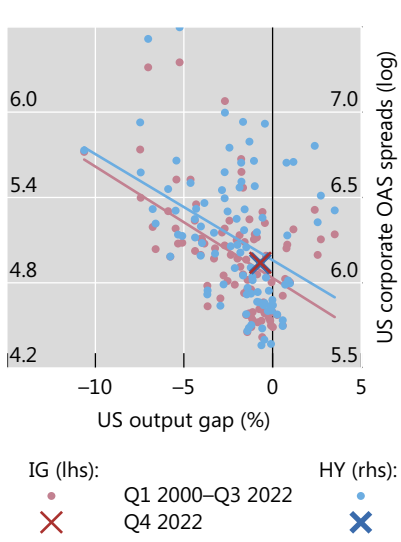
European credit spreads remained wide despite recent compression

Graph 6

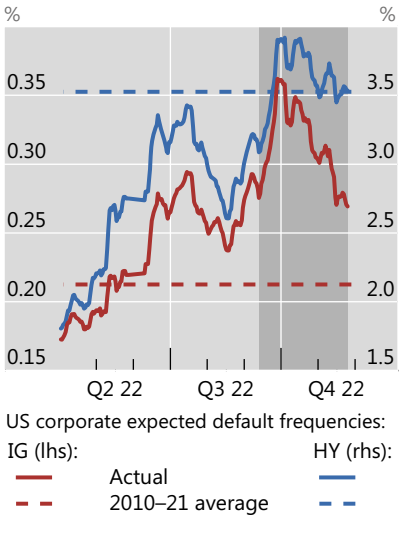
A. Spreads changed little on net, staying wide in Europe



B. US spreads were in line with the macro backdrop



C. Perceived default risk climbed



The shaded areas indicate 13 September–25 November 2022 (period under review).

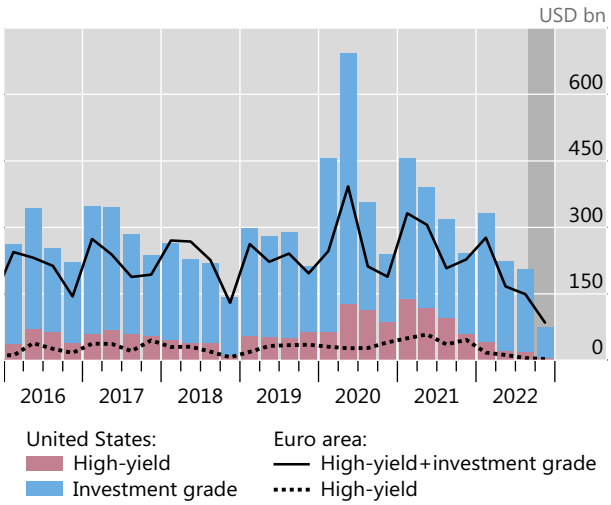
Sources: ICE BofAML; Moody's; national data; BIS.

Financial conditions tightened somewhat in AEs. The initial change was particularly marked in the United States, mostly driven by rising long-term rates and declining equities (Graph 7.B). In October, US financial conditions became more restrictive than the long-term average for the first time since April 2020. However, they eased as risky assets gained ground in November, ending the period under review at a similar level as at the start. Other AEs also saw a tightening, but it was more contained than in the United States because of a more limited increase in long-term rates.

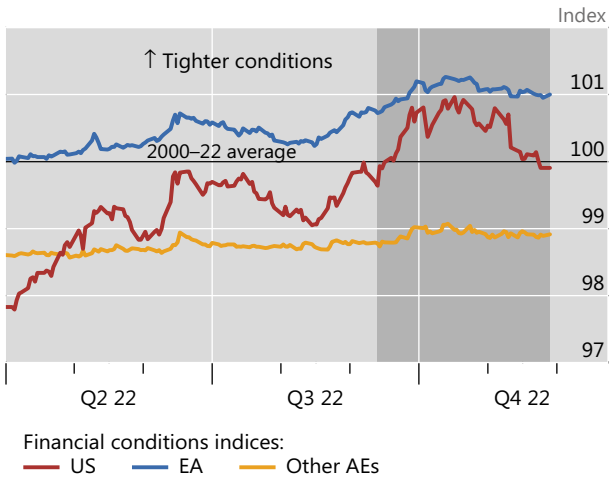
Bond issuance fell sharply, financial conditions tightened on net[1]

Graph 7

A. Bond issuance touched decade lows[1]



B. Financial conditions tightened slightly in AEs



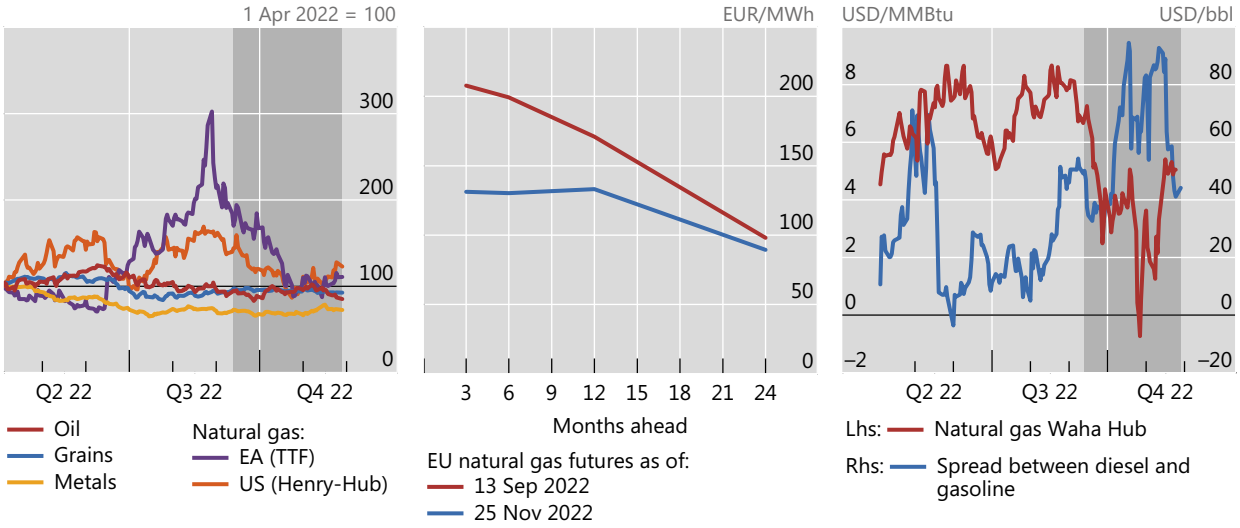
The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

Sources: Bloomberg; Dealogic; BIS.

The near-term energy outlook for Europe improved

Graph 8



The shaded areas indicate 13 September–25 November 2022 (period under review).

Sources: Bloomberg; Datastream; BIS.

In commodity markets, futures prices signalled lingering concerns about long-term natural gas supply in Europe. Spot natural gas prices fell sharply, especially in Europe (Graph 8.A). The drop was partly due to unusually warm weather and ample storage before winter. However, investors fretted about long-term imbalances, leaving futures prices two years ahead unchanged over the review period, even as prices three months ahead fell sharply (Graph 8.B). Some energy markets still experienced supply issues. For instance, technical constraints that curbed shipments from a US pricing hub for natural gas resulted in briefly negative prices there (Graph 8.C, red line). In addition, limited refining capacity kept diesel prices relatively high compared with other fuels, even as oil prices fell (Graph 8.C, blue line).

EMEs were relatively resilient, but not without fragilities

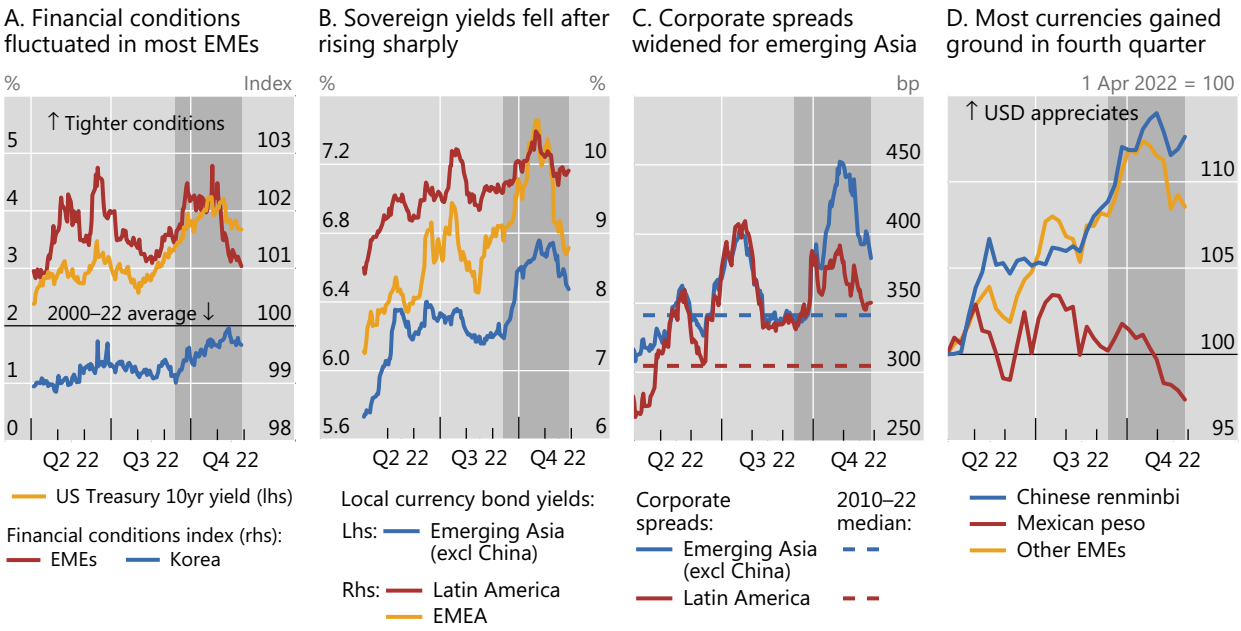
Dynamics in AEs influenced financial conditions in EMEs. In line with AE risky assets and long-term core bond yields, conditions tightened significantly early in the review period before easing sharply in November (Graph 9.A).

EMEs' local currency sovereign yields largely tracked those in AEs. In September, they rose especially quickly in Asia (excluding China) and in EMEA,[3] but the increase was notable in Latin America as well (Graph 9.B). The subsequent reversal was smaller in Asia. Local currency spreads over US Treasuries held up, suggesting that the bulk of yield adjustments owed to higher Treasury yields.

[3] Europe, the Middle East and Africa.

EMEs were generally resilient, with some fragilities[1]

Graph 9



The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

Sources: Bloomberg; JPMorgan Chase; BIS.

Corporate bond spreads picked up in some EMEs, especially in emerging Asia excluding China (Graph 9.C). At the end of the review period, they remained somewhat wider than historical standards. Notably, in Korea short-term corporate funding costs increased rapidly as credit quality concerns emerged. Corporate spreads widened significantly, as companies struggled to refinance maturing debts. Authorities acted as buyers of last resort to restore orderly market functioning. That said, financial conditions kept tightening in Korea due to rising short-term rates (Graph 9.A).

Most EME currencies continued to depreciate against the US dollar through October, before strengthening in November (Graph 9.D). The key determinants of exchange rates continued to be cross-country differences in inflation and monetary policy outlooks as well as exposure to external and terms-of-trade shocks.

In China, the growth outlook was clouded through October by weakness in the real estate sector and by persistent Covid restrictions. The perception that real estate developers would need to further restrict activity to meet balance sheet prudential ratios cast a shadow on the near-term outlook. As a result, the sector's stocks contributed to the decline of a broad equity index up to end-October (Graph 10.A). Covid-related restrictions put pressure on consumption, adding to headwinds from real estate. Overall, slowing activity in China weighed on the equity returns of its trading partners, particularly those most reliant on Chinese exports (Graph 10.B).

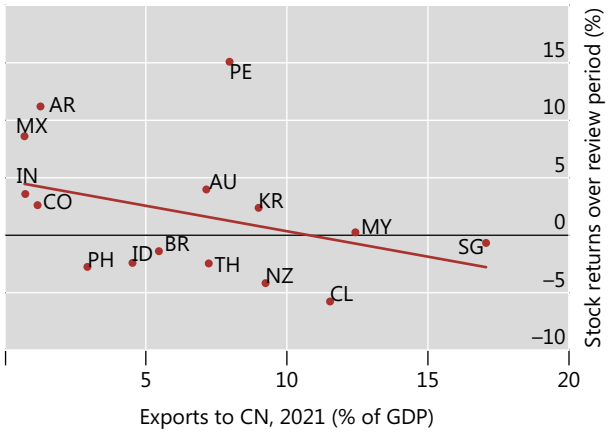
New policies aimed at easing credit flows offered some respite to risky assets in early November. Chinese equities rose sharply, led by the real estate sector. In parallel, the renminbi appreciated against the US dollar, while the credit default swap spread on Chinese sovereign bonds fell after doubling midway through the review period (Graph 11.A). While outflows from Chinese bonds quickened somewhat, they remained below early 2022 levels (Graph 11.B)

The growth outlook remained clouded in China

Graph 10

A. Concerns were visible in real estate equities

B. Trade links with China weighed on EMEs



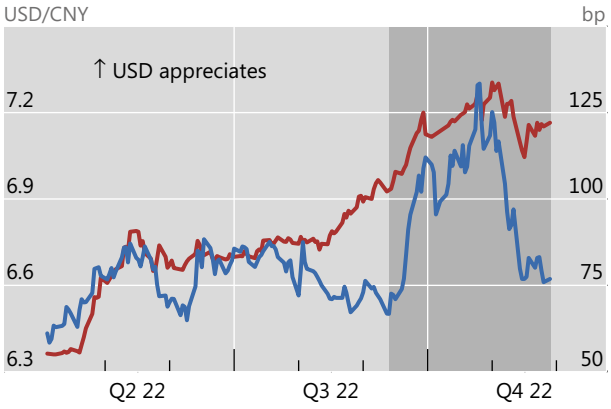
The shaded areas indicate 13 September–25 November 2022 (period under review).

Sources: UN Comtrade; Bloomberg; Datastream; BIS.

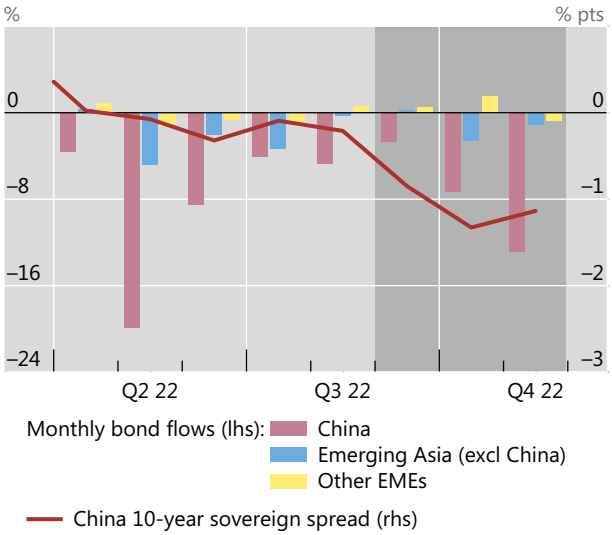
Policy actions in China provided some support to investor confidence[1]

Graph 11

A. Renminbi depreciation and sovereign risk reversed



B. Outflows from Chinese bonds picked up



The shaded areas indicate 13 September–25 November 2022 (period under review).

[1] See technical annex for details.

Sources: Bloomberg; EPFR; BIS.

Technical annex

HY = high-yield; IG = investment grade; JGB = Japanese government bond; OIS = overnight indexed swap; YCC = yield curve control policy.

Graph 1.A: For US, federal funds rates implied by futures maturing in December 2023. For EA, rates implied by ESTR futures maturing in December 2023.

Graph 1.B: "Other AEs" is based on data for AU, CA, DK, GB, JP, NZ and SE.

Graph 1.C: US instantaneous forward rate two years hence, adjusted for risk premium. Based on the model of D Kim and J Wright, "An arbitrage-free three-factor term structure model and the recent behavior of long-term yields and distant-horizon forward rates", *FEDS Working Papers*, no 2005-33, 2005.

Graph 2.B: Bloomberg government securities liquidity indices, defined as the average yield error for government securities with more than one year of remaining maturity. The indices are displayed on an inverted scale.

Graph 4.A: "Other AEs" is based on US dollar exchange rates for AUD, CAD, CHF, GBP, NZD, NOK and SEK.

Graph 5.B: Expected earnings per share growth between end-2021 and estimated end-2023. As to big tech returns, this is calculated as the simple average of Apple, Microsoft, Amazon, Alphabet and Meta cumulative stock returns.

Graph 7.A: For Q4 2022, issuance data up to 25 November 2022, extrapolated to full quarter.

Graph 7.B: Goldman Sachs Financial Conditions Index (FCI): a weighted average of country-specific risk-free interest rates, exchange rates, equity valuations and credit spreads, with weights that correspond to the estimated impact of each variable on GDP. A value of 100 indicates average conditions. A higher (lower) value indicates tighter (looser) conditions.

Graph 9.A: See entry for Graph 7.B.

Graph 9.B: Simple averages of JPMorgan Chase GBI Global sub-indices, traded yields.

Graph 9.C: Simple averages of JPMorgan Chase CEMBI sub-indices, stripped spreads.

Graph 9.D: "Other EMEs" is based on US dollar exchange rates for BRL, CLP, COP, CZK, HKD, IDR, ILS, INR, KRW, MYR, PHP, PLN, RUB, SAR, SGD, SOL, THB, TRL, TWD and ZAR.

Graph 11.B: Monthly bond flows: flows to local currency bond funds, scaled by previous month's assets. The 10-year rate differential is the monthly average of the difference between the 10-year local currency sovereign bond yield and the 10-year US Treasury yield.

Patrick McGuire
patrick.mcguire@bis.org

Andreas Schrimpf
andreas.schrimpf@bis.org

Nikola Tarashev
nikola.tarashev@bis.org

OTC foreign exchange and interest rate derivatives markets through the prism of the Triennial Survey[1]

Five articles in this special edition of the BIS Quarterly Review *provide new insights about foreign exchange (FX) and over-the-counter derivatives markets by drawing on the data compiled in the 2022 BIS Triennial Central Bank Survey. In the FX space, an accelerating shift towards less "visible" trading venues and bilateral trading may reduce the information content of prices and the network benefits of integrated markets. Trading of emerging market economy currencies has become more internationalised, increasingly resembling that of advanced economy currencies. At the same time, the incidence of settlement risk has remained obstinately high, and FX swap positions point to a growing volume of "missing" US dollar debt. In interest rate derivatives markets, the reform of benchmark interest rates has altered the risk landscape, giving rise to new types of derivatives as well as new challenges for risk management.*

JEL classification: F31, G15, G23

The BIS Triennial Central Bank Survey of Foreign Exchange (FX) and Over-the-counter (OTC) Derivatives Markets is the most comprehensive source of information on the size and structure of these markets.[2] This special issue of the *BIS Quarterly Review* draws on the data compiled by the 2022 edition of the Triennial Survey.

The five articles in this issue discuss a number of structural financial trends and their implications for the risk landscape. One trend is the migration of FX trading to less visible venues, which reduces the social benefits of integrated markets and adds to gaps in information on the scale and geography of dollar funding risks. Another relates to the heft of emerging market economy (EME) currencies, which are increasingly traded internationally, but with an elevated incidence of settlement risk. Finally, the reform of benchmark interest rates, which has transformed the interest rate derivatives markets, has reduced risks inherent to the Libor era but also introduced new risk management challenges that stem from the plethora of new reference rates.

[1] The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

[2] The BIS coordinates the Triennial Survey, conducted every three years since 1986, in cooperation with central banks worldwide under the guidance of the Markets Committee and the Committee on the Global Financial System. More than 1,200 dealers (mainly banks) located in 52 jurisdictions participated in the 2022 survey. Data were collected in two stages: OTC trading of FX spot, FX derivatives and interest rate derivatives was surveyed in April 2022, and the outstanding notional amounts and gross market values of all OTC derivatives were surveyed at end-June. For more information about the Survey and to explore the data, see www.bis.org/statistics/rpfx22.htm.

Key takeaways

- The 2022 BIS Triennial Central Bank Survey reveals a continued shift towards less "visible" FX trading venues, a large and growing volume of "missing" US dollar debt and a trend towards internationalising EME currencies.
- Risk management challenges identified by the Survey relate to reduced information in FX pricing, an obstinately high incidence of FX settlement risk and differences in the risk profiles of new benchmark interest rates.

FX market repositioning amidst high volatility

The latest Survey collects data for April 2022, a month that featured exceptionally volatile FX market conditions. Evolving perceptions about the future path of interest rates for major currencies, rising commodity prices and the war in Ukraine generated much volatility. The resulting risk-off environment led to a cautious approach to international investment and brought FX risk management to the fore.

Against this backdrop, turnover in FX markets continued its upward march at the global level but some key underlying trends came to a halt. Overall, turnover averaged $7.5 trillion per day in April 2022 – a volume 30 times greater than daily global GDP and 14% higher than in early 2019. At the same time, there was a pause in the decade-long rise of dealer banks' trading with "other financial institutions", eg asset managers and principal trading firms (PTFs). Drehmann and Sushko (2022) show evidence that asset managers' FX trading and hedging needs declined along with their international investments. Similarly, after having gained market share at the expense of bank dealers in previous years, PTFs did not make further inroads.

The 2022 Survey also confirmed the trend towards greater fragmentation in FX trading. This trend stemmed from bilateral forms of electronic execution replacing the "visible" trading on electronic limit order books. One driver is dealers' continued success in attracting trades to their proprietary platforms, which typically offer low trading costs. Another is dealers' increased capacity to manage inventory risk by matching offsetting customer trades and through trading with related parties. While it has not hampered market functioning so far, the fragmentation can impair price formation and undermine network synergies inherent to transparent markets. In the extreme, the available information may be simply insufficient for proper analyses of market conditions and financial vulnerabilities.

A key source of vulnerability is the dollar borrowing embedded in foreign exchange markets. Unlike most other types of derivatives, FX swaps, forwards and currency swaps involve the exchange of principal, and thus give rise to payment obligations equal to the full amount of the contract. Globally, dollar obligations amounted to over $80 trillion in mid-2022. Importantly, since these obligations are reported off-balance sheet, standard debt statistics fail to capture them. Such dollar debt is, in this sense, "missing".

The feature by Borio et al (2022) shows that the magnitude of missing dollar obligations is staggering. Among non-banks, those outside the United States had an estimated $26 trillion in off-balance sheet obligations at end-June 2022, or double

their on-balance sheet dollar debt. For their part, non-US banks, with limited access to credit from the Federal Reserve, had an estimated $39 trillion in such obligations, compared with "only" $15 trillion on their balance sheets.

Out of sight, however, should not mean out of mind. FX swap markets are vulnerable to funding squeezes, given the short-term maturity of the off-balance sheet obligations. In the Great Financial Crisis and the market turmoil of March 2020, swap markets emerged as flash points, prompting extraordinary policy actions in the form of central bank swap lines. In both episodes, policymakers were operating with little information about the scale and geography of the dollar rollover needs.

Internationalisation of EME currencies

Trading of EME currencies has become increasingly international, ie comprising transactions in which at least one party resides outside the currency-issuing jurisdiction. For example, the renminbi is now the fifth most actively traded currency largely because of greater trading with entities outside China. More generally, Caballero et al (2022) show that the share of international transactions in the overall trading of EME currencies has approached that for advanced economy (AE) currencies. A driver is a shift in the composition of capital flows to EMEs, from bank lending to portfolio investment.

The greater internationalisation of EME currencies poses policy challenges. For one, it implies that monetary policy transmission is increasingly influenced by conditions in markets abroad and by the behaviour of non-resident intermediaries, which are more difficult to monitor and steer. Central bank cooperation through data gathering efforts (such as the Triennial Survey) and higher-frequency monitoring initiatives (eg the BIS Innovation Hub's Project Rio) help overcome these gaps.

Financial deepening would improve EMEs' resilience to international spillovers. In this respect, Caballero et al (2022) find an indication that EMEs still need to catch up with AEs along one dimension. Specifically, trading of EME currencies remains subdued relative to economic activity, reflecting EMEs' smaller domestic investor base and less than full integration in global markets.

Greater internationalisation of EME currencies also underscores the importance of FX settlement risk, ie the risk that one party to a trade fails to deliver the currency owed. As Glowka and Nilsson (2022) show, trading of major currency pairs typically involves mechanisms that minimise settlement risk, notably payment versus payment. For many EME currencies, however, such mechanisms are not available or are prohibitively costly, despite public and private initiatives to broaden their adoption.

Benchmark reform reshapes fixed income markets

The reform of benchmark interest rates generated a seismic shift in the market for OTC interest rate derivatives. In a policy drive to establish benchmarks that accurately reflect market forces, London interbank offered rates (Libor) – survey-based estimates of funding costs – gave way to "nearly risk-free rates" (RFRs). While three- and six-month term Libor rates were most popular, RFRs are largely based on overnight transactions. The reform has altered the risk landscape and has brought a new mix of

traded instruments to the fore. With some instruments now redundant, the global turnover of interest rate derivatives has dropped by some 20% since the 2019 Survey.

Huang and Todorov (2022a) trace these shifts to the reduction of "fixing risk". This is the risk that long and short positions will not be well matched over an extended period if they refer to term Libor rates fixed on different dates. The transition to overnight RFRs reduced the relevance of this risk and hence the need to hedge it with forward rate agreements (FRAs). Trading of FRAs thus dropped by almost 75% between the 2019 and 2022 Surveys.

The drop had a significant impact on both the currency composition and geographic distribution of turnover in OTC interest rate derivatives. With trading in US dollar FRAs all but vanished, the two main jurisdictions that hosted it – the United States and the United Kingdom – saw their shares in global turnover decline. By contrast, the euro area gained share. This is partly because of a post-Brexit relocation of activity, but also because trading desks there use the reformed Euribor, which preserves the relevance of fixing risk and thus supports demand for euro FRAs.

The post-Libor era has generated new challenges for risk management. For one, as Huang and Todorov (2022b) discuss, the plethora of RFRs can give rise to various "bases" – ie differences between the floating rates that assets and liabilities reference. The differences can be material when short-term interest rates trend up or down, the evolution of interest rates surprises markets or perceived credit risk spikes. While the turnover of new types of basis swaps has picked up, the jury is still out on whether these instruments deliver effective hedges for the prevailing basis risks. Another challenge relates to the strong anchoring of OTC interest rate derivatives markets in RFRs that do not incorporate term, liquidity and credit risk premia. As these rates may not co-move closely with funding costs, financial intermediaries would need to rely on new risk management practices to hedge funding risks.

References

Borio, C, R McCauley and P McGuire (2022): "Dollar debt in FX swaps and forwards: huge, missing and growing", *BIS Quarterly Review,* December, pp 67–73.

Caballero, J, A Maurin, P Wooldridge and D Xia (2022): "The internationalisation of EME currency trading", *BIS Quarterly Review,* December, pp 49–65.

Drehmann, M and V Sushko (2022): "The global foreign exchange market in a higher volatility environment", *BIS Quarterly Review,* December, pp 33–48.

Glowka, M and T Nilsson (2022): "FX settlement risk: an unsettled issue", *BIS Quarterly Review,* December, pp 75–81.

Huang, W and K Todorov (2022a): "The post-Libor world: a global view from the BIS derivatives statistics", *BIS Quarterly Review,* December, pp 19–32.

——— (2022b): "Hedging fixing risk in IRS contracts using FRAs", *BIS Quarterly Review,* December, pp 23.

Wenqian Huang
wenqian.huang@bis.org

Karamfil Todorov
karamfil.todorov@bis.org

The post-Libor world: a global view from the BIS derivatives statistics[1]

The transition from Libor to "nearly risk-free" rates (RFRs) has led to structural changes that have reshaped the trading and hedging behaviour of participants in fixed income markets. Using the BIS Triennial Survey statistics, we document four major changes in the instrument mix and geographical distribution of the global turnover of OTC interest rate derivatives between 2019 and 2022. First, forward rate agreements (FRAs) became largely obsolete because of reduced fixing risk. This led to a decline in FRA trading, which dragged down overall turnover. Second, trading in swaps referencing RFRs increased. Third, the UK and US shares in global turnover dropped, whereas the share of the euro area rose. Finally, new instruments emerged to manage morphing basis risks in the post-Libor world.

JEL classification: E43, G12, G21, G23.

The latest BIS Triennial Central Bank Survey revealed four key changes between April 2019 and April 2022. First, the global turnover of over-the-counter (OTC) interest rate derivatives fell 19% to $5.2 trillion. This decline reflected a 74% drop in trading of forward rate agreements (FRAs), a type of OTC contract that allows investors to fix interest rates in advance. Second, overnight index swaps (OIS) – contracts that swap a fixed rate for an overnight rate – gained share in the turnover of interest rate swaps (IRS) for the Swiss franc, the Japanese yen and the pound sterling. Third, the United Kingdom and the United States remained the largest trading locations for OTC interest rate derivatives, but their shares in global turnover declined, whereas that of the euro area increased. Fourth, new types of basis swap (ie IRS contracts that swap different floating rates) emerged, while existing types gradually disappeared.

The transition from the London interbank offered rate (Libor) to "nearly risk-free rates" (RFRs; FSB (2014)) – henceforth the "benchmark rate reform" – is arguably the main driver of these structural changes for four reasons. First, the phase-out of Libor-based IRS limited the use cases for FRAs, thus reducing their turnover. Second, as publications of Libor in CHF, JPY and GBP ceased at end-2021, an increasing amount of IRS denominated in these currencies had to switch to the new RFRs. Since RFRs are based on overnight rates, the share of OIS in IRS turnover rose.

[1] The authors thank Sirio Aramonte, Chris Barnes, Luis Bengoechea, Claudio Borio, Stijn Claessens, Branimir Gruić, Bryan Hardy, Simonetta Iannotti, Patrick McGuire, Elena Nemykina, Andreas Schrimpf, Hyun Song Shin, Vladyslav Sushko, Nikola Tarashev, Toby Williams and Philip Woodridge for helpful comments and discussion, as well as Anamaria Illes, Alessandro Barbera, Ann Neale and Nicolas Lemercier for excellent research assistance. The views expressed in this article are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

Key takeaways

- The benchmark rate reform led to structural changes in OTC interest rate derivatives markets, driving up the share of instruments referencing overnight rates in overall turnover.
- The reform reduced hedging needs for Libor-related risks, which led to a material drop in FRA trading and a shift in the geographical distribution of OTC turnover.
- The benchmark reform reduced some basis risks but gave rise to new ones, stemming from the variety of reference rates in the post-Libor world and driving the rise in new types of basis swap.

Third, the different effects of the benchmark rate reform across jurisdictions led to a shift in trading locations.[2] Lastly, since the reform gave rise to multiple reference rates, it created the need for new swaps that help manage new "basis risks" – ie the risks of loss when assets and liabilities reference different floating rates.

This special feature studies these main implications of the Libor transition on fixed income markets, with a special focus on OTC derivatives. The rest of the feature is organised as follows. The first section briefly describes the benchmark reform and explains the main differences between Libor and RFRs. The second examines how the Libor transition changed risks in interest rate markets. The third uses Triennial Surveys and additional data sources to analyse four major implications of the reform for derivatives markets. The final section concludes.

Fixed income markets transition from Libor to RFRs

RFRs have started replacing Libor as key interest rate benchmarks in major currencies. Libor in GBP, EUR, CHF and JPY ceased as of end-2021, and USD Libor is scheduled to be discontinued in June 2023. The main reason for the Libor cessation is that the rate is based on surveys and is therefore prone to manipulation (CFTC (2012), FSA (2012)). The same problem was common among other interbank offered rates (IBORs) (IOSCO (2013)). To address it, authorities, together with the private sector, developed new benchmark rates – called RFRs by market convention – based on transactions in active and liquid overnight lending markets (FSB (2014)). In addition, some existing IBORs (eg Euribor) were reformed with more robust methodologies and have remained in use (EMMI (2019)). Depending on the availability of the reformed IBORs for trading, some jurisdictions (eg the United Kingdom) adopted RFRs faster than others (eg the euro area).

The transition from Libor to RFRs became evident in fixed income instruments. New issuance of Libor-based bonds nearly stopped in 2022 (Graph 1.A, dark red bars), whereas issuance of RFR-based bonds increased substantially (dark blue bars). Similarly, new loans referencing Libor dropped materially in 2022 (light red bars), as they were replaced by RFR-based loans (light blue bars).[3] Turning to derivatives, the

[2] Other factors may also play a role. For example, Brexit and the attendant regulatory restrictions on trading venues probably also contributed to the shift away from the United Kingdom.

[3] New issuance of loans could be tranches from a pre-existing deal. As it is hard to modify loans' contractual terms, their switch to RFRs has been slower than for bonds.

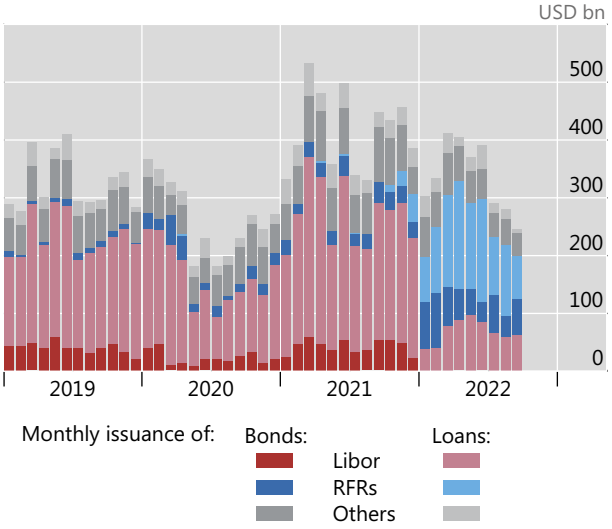
majority of exchange-traded futures in US dollars referenced RFRs in 2022. Almost 100% of futures contracts in sterling and Swiss francs referenced RFRs (Graph 1.B).[4]

There are two key differences between Libor and RFRs. The first relates to credit risk sensitivity. Libor was initially constructed to measure banks' unsecured term funding costs. The popular tenors – three and six months – incorporated compensation for term liquidity and credit risk (Michaud and Upper (2008)).[5] By contrast, RFRs are *far less sensitive* to credit risk, as they are overnight, tightly linked to policy rates and in certain currencies – eg USD and CHF – reflect *secured* lending.[6] In sum, while Libor facilitated linking the coupon of a fixed income instrument to bank borrowing costs, overnight RFRs are not suited for this. Second, Libor is an estimation of the interest rates over a future period, whereas RFRs track the evolution of *actual* interest rates. Libor is fixed and known at the start of the contract period. Since it reflects banks' expected borrowing costs, it is called a "forward-looking" term rate. In contrast, the coupon of RFR-based instruments refers to the average of actual overnight rates, known only at the end of the relevant period.[7] This "backward-looking" approach is called compounding in arrears. Henceforth, for brevity we use RFRs to refer to both overnight RFRs and compounded RFRs. The key differences between old and new benchmark rates have major implications for fixed income markets.

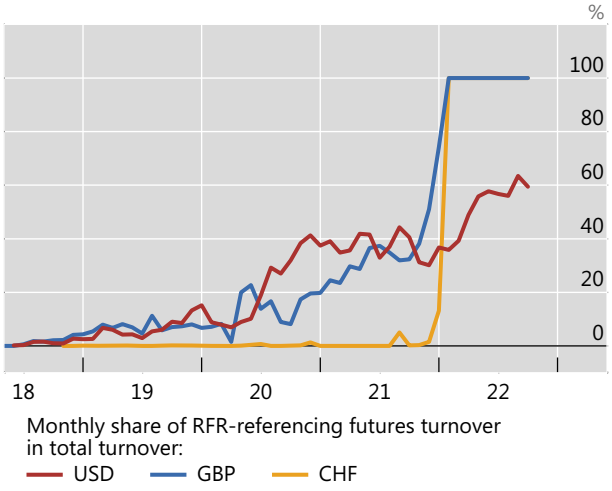
Fixed income instruments switching from Libor to RFRs[1]

Graph 1

A. Libor bond issuance nearly came to a halt in 2022



B. Share of RFR-based futures jumped



[1] See technical annex for details.

Sources: Clarus Financial Technology; Dealogic; authors' calculations.

[4] RFR-based futures for EUR and JPY were not developed as of September 2022.

[5] Libor has seven different maturities from overnight to one year. However, the overnight Libor was very thinly traded in derivatives markets. By contrast, the three-month tenor was deemed attractive to bank treasurers for asset-liability risk management (McCauley (2001)).

[6] Unsecured overnight rates are not entirely free from credit risk, despite the short tenor. That said, historical data reveal that these rates are almost insensitive to credit risk even in times of stress. For example, EFFR (one of the main traded USD unsecured overnight rates) did not spike during the Great Financial Crisis, in contrast to term Libor.

[7] Another averaging method is based on compounding daily values of past overnight rates. The corresponding rate is called "compounded RFR in advance" and is known at the start of the coupon period. In interest rate derivatives, such rates are used less often than compounded RFRs in arrears.

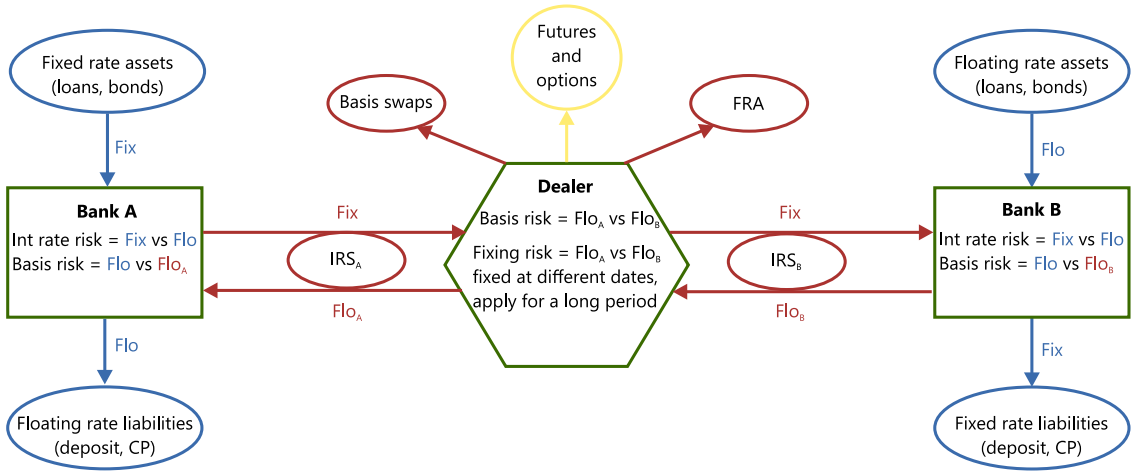
The transition changed risks in interest rate markets

The ecosystem of fixed income markets includes mainly banks, institutional investors and corporates trading in cash securities and derivatives. Typically, large global banks act as dealers in the derivatives segment and make the market for smaller banks and other agents. Cash securities (eg bonds and loans) are widely used for borrowing and lending. In turn, derivatives (eg IRS, FRAs and futures) are used mainly to transfer risk related to fluctuations in interest rates (Duffie and Stein (2015)).

IRS contracts – the most actively traded OTC interest rate derivatives – allow counterparties to swap different types of interest rate. To illustrate the mechanics of IRS, suppose bank A's asset is a bond paying a fixed coupon "Fix" (Graph 2), which is funded by a floating rate commercial paper (CP) with a coupon of size "Flo" (eg Libor). The bank then faces interest rate risk: if Flo increases above Fix, the bank suffers a loss. To hedge that risk, bank A enters into an IRS_A with a dealer and receives a floating rate Flo_A while paying Fix.

Dealers who intermediate in the IRS market face fixing risk and basis risk. In the example above, the dealer can offset the IRS_A exposure by entering into an opposite IRS_B with bank B. If the terms of the two swaps are identical, the dealer is hedged. However, when the starting dates of the two swaps are different – eg IRS_B starts later than IRS_A – the dealer could face a loss if the two floating rates are fixed at different levels: $Flo_A \neq Flo_B$ (eg Flo_A = Libor today, Flo_B = Libor tomorrow). This risk is called "fixing risk". Alternatively, if the two floating coupons are fixed on the same day but reference different rates – eg Flo_A = Libor, Flo_B = RFR – the dealer faces the risk that a wedge between these rates would generate a loss. This risk is called "basis risk". To hedge fixing risk, the dealer could enter into FRAs, which fix the values of Flo_A and Flo_B today (Box A). To hedge basis risk, the dealer could enter into a basis swap, which swaps Flo_A for Flo_B (Box B).

Stylised illustration of the ecosystem of fixed income markets — Graph 2



"Flo" and "Fix" indicate floating and fixed coupons, respectively.

Source: Authors' elaboration.

Box A

Hedging fixing risk in IRS contracts using FRAs

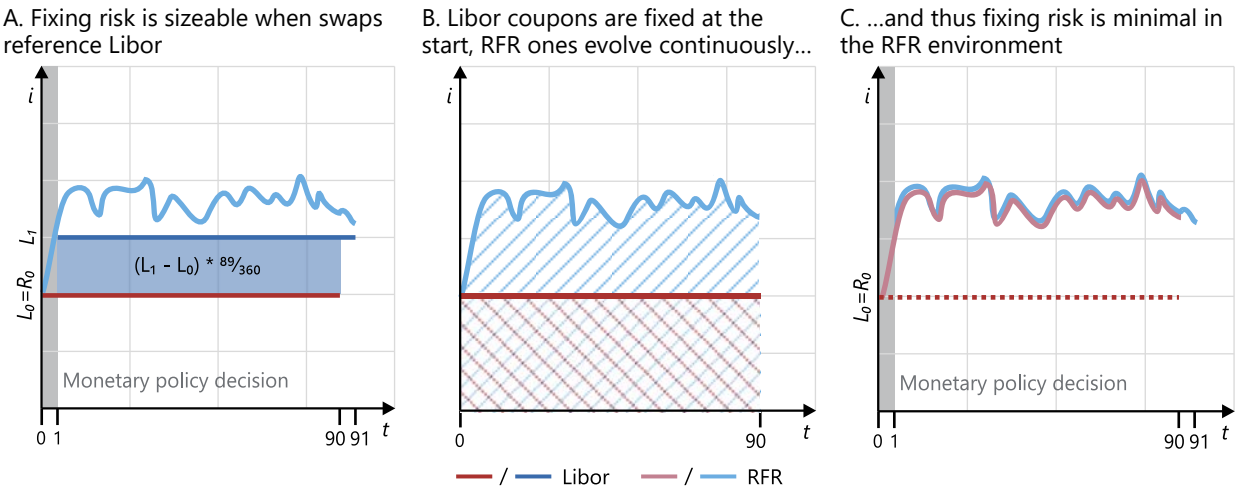
This box provides a stylised example of the fixing risk in Libor-based swaps and illustrates how swaps referencing risk-free rates (RFRs) reduce this risk.

Suppose that a dealer has two offsetting swaps, referencing three-month Libor with the same notional: one starting today (day 0), and another starting tomorrow (day 1), with coupon rates fixed for three months (90 days). In the first swap, the dealer receives three-month Libor (L), in the second she pays it. So overall, the dealer has a matched position except the one-day lag between the coupon payments. During the overlapping days of the two swaps, the difference between the dealer's coupon payments is $(L_0 - L_1) * (90 - 1)/360$ (Graph A1.A, blue shaded area). The dealer thus bears the risk that the Libor fixing today L_0 will be lower than the fixing tomorrow L_1, eg because of a monetary policy decision. To hedge this fixing risk, the dealer enters into a forward rate agreement (FRA) starting in one day, fixing L_1 on day 0 and eliminating the uncertainty.

In an RFR world, fixing risk becomes negligible since coupons are calculated by compounding the daily value of overnight rates (Graph A1.B). Consider the same two swaps in the example above but referencing RFR (R) instead of Libor. The floating coupon is now "fixed" for one day instead of 90 days, since it tracks overnight rates. Thus, the dealer faces no difference in coupons during the 89 (= 90 – 1) overlapping days of the two swaps. Since this materially reduces the fixing risk (Graph A1.C), the use case for FRA is much smaller.

Fixing risk in Libor and RFR environments

Graph A1



Source: Authors' elaboration.

The Libor transition fundamentally changed both fixing risk and basis risk. First, the use of RFRs as benchmark rates reduced fixing risk significantly. As the floating coupons in RFR-based swaps capture the daily realisation of overnight rates, they are "fixed" every day. This is structurally different from Libor-based swaps, in which the floating coupons are fixed typically for three or six months. Thus, the fixing risk in RFR-based swaps is an order of magnitude smaller than that in Libor-based swaps. Box A provides a simple example to illustrate the underlying mechanics. It also shows how FRAs can be used to hedge fixing risk in the Libor environment and why that hedging need is reduced in the new RFR environment.

Second, the transition to RFRs gave rise to a coexistence of multiple reference rates, which created new basis risks. In addition to the RFRs discussed above, other

Summary of different reference rates Table 1

Rate	Based on	When known	Backward- or forward-looking	Examples
Libor	Quotes	At the start	Forward-looking	*Unsecured:* USD/EUR/GBP/JPY/CHF Libor
O/N RFR	Transactions			*Unsecured:* ESTR, SONIA, TONA *Secured:* SOFR, SARON
Compounded RFR in arrears	Transactions	At the end	Backward-looking	
Compounded RFR in advance	Transactions	At the start	Backward-looking	
Term RFR[1]	Quotes and transactions	At the start	Forward-looking	*Secured:* CME Term SOFR
Other term rates	Quotes and transactions	At the start	Forward-looking	*Unsecured:* Euribor, Tibor, BSBY, Ameribor
Other O/N reference rate	Quotes and transactions			*Unsecured:* EFFR, EONIA

O/N = overnight.

[1] By market convention, only forward-looking term RFRs based on derivatives are referred to as "term RFRs".

Source: Authors' elaboration.

types of reference rate have been emerging to fulfil different market needs (Schrimpf and Sushko (2019)). For one, "term RFRs" are based on RFR derivatives and capture expectations of future rate moves. For another, credit-sensitive term rates – such as reformed IBORs – are based on *unsecured* short-term borrowing markets and arguably better reflect the term borrowing costs of banks (Table 1). The new basis risks that arise in the RFR environment are especially important for financial intermediaries like banks which are both lenders and borrowers. Box B reviews basis risks in the Libor and the RFR worlds.

Libor reform footprint in the data

Given the structural changes outlined above, we expect to see four main implications of the Libor transition for OTC interest rate derivatives. First, given the reduced fixing risk in the RFR environment, the turnover of FRAs should decrease. Second, as benchmark rates shift from term Libor to RFRs based on overnight rates, an increasing share of IRS should be OIS. Third, to the extent that the reform affects jurisdictions differently, the geographical distribution of OTC derivatives turnover, as well as the attendant currency composition, would change. Finally, the emergence of new basis risks should increase the turnover of corresponding basis swaps.

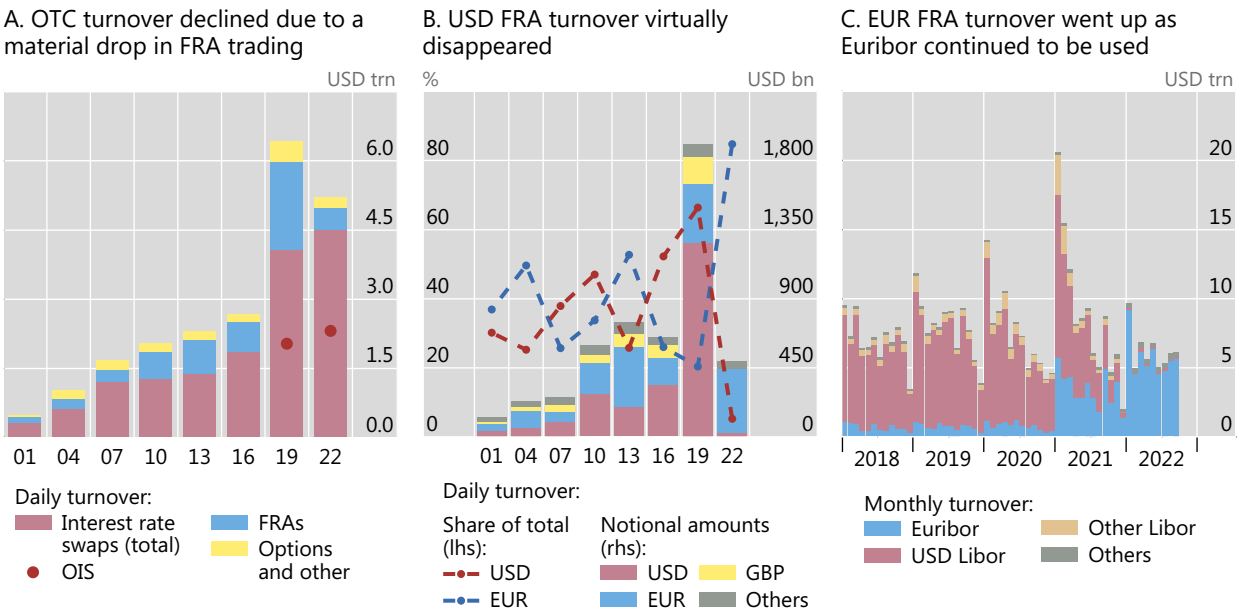
FRA turnover slumped

The material decline in FRA trading is a clear hallmark of the Libor transition. On the one hand, the need to use FRAs to hedge fixing risk in IRS positions became negligible in the RFR environment. On the other hand, the scope for speculation with FRAs became limited. Since these contracts need to reference a forward-looking term rate

that is known at the start of the period, they are incompatible with RFRs.[8] As a result, the daily turnover of FRAs dropped significantly, from $1.9 trillion (30% of global turnover) in 2019 to only $0.5 trillion (10%) in 2022, leading to a 19% decline in total OTC derivatives turnover (Graph 3.A). The turnover of USD-denominated FRAs had the most sizeable decline: from $1.3 trillion in 2019 to just $0.03 trillion in 2022 (Graph 3.B). This decline reflected the shrinking activity in FRAs referencing USD Libor, as shown by data reported to the Depository Trust & Clearing Corporation (DTCC) (Graph 3.C). FRAs denominated in GBP, JPY and CHF also virtually ceased trading, declining by more than 90% each.

The only exception from the overall decline in FRA trading was EUR-denominated FRAs. The turnover of these contracts expanded from $387 billion (20% of total FRA turnover) in 2019 to $421 billion (85%) in 2022. This expansion reflected the increasing trading activity of FRAs referencing Euribor, which is a reformed IBOR that will continue to be used (ECB (2020)). Since Euribor is a forward-looking term rate like Libor, swaps referencing Euribor give rise to fixing risk and the need to use FRAs to hedge this risk.[9] In addition, the expansion of Euribor FRAs could also stem from hedging or speculating on future Euribor values.

FRA trading ground to a halt except for euro-denominated contracts[1] Graph 3



[1] See technical annex for details.

Sources: BIS Triennial Central Bank Survey; DTCC, *Swap Data Repository*; authors' calculations.

[8] To speculate on future interest rate movements in the new RFR world, investors can use a one-period OIS that takes effect on a future date (ie a forward-starting OIS) as a replacement for an FRA. Alternatively, investors could resort to exchange-traded futures but only to the extent that the standardised maturity dates fit their purpose.

[9] Swaps referencing term RFRs or other credit-sensitive term rates can also give rise to fixing risk, similar to Libor. However, these instruments are thinly traded, probably due to regulation. For example, inter-dealer trading of term SOFR is currently prohibited in the United States to promote adoption of SOFR in derivatives (ARRC (2021), Bartholomew (2022)).

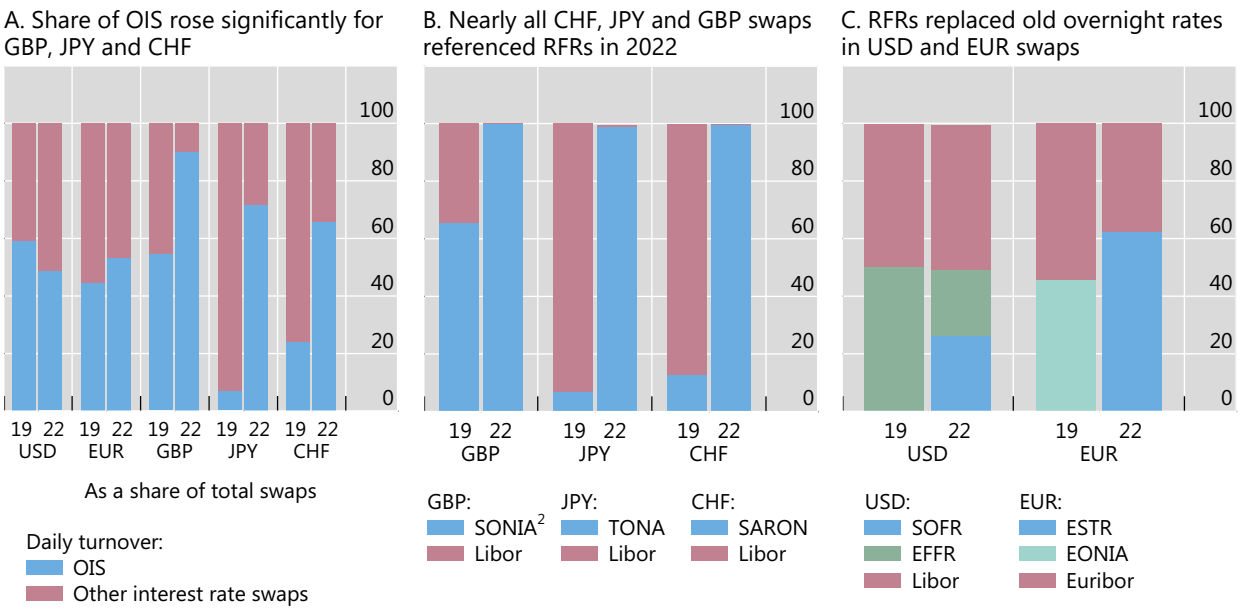
Turnover of OIS gained traction

Given the increasing adoption of RFRs, which are based on overnight rates, the share of OIS in total IRS turnover increased in 2022 for the currencies most affected by the benchmark reform, such as the Swiss franc, the yen and sterling. This share increased to above 90% for GBP, and above 60% for JPY and CHF contracts (Graph 4.A). The increase was mainly driven by the nearly full adoption of RFRs for swaps in these currencies, as revealed by DTCC data (Graph 4.B). This is a significant change compared with 2019, when the share of RFR-based contracts was less than 15% for the Swiss franc and yen, and less than 70% for sterling.[10]

In the case of USD and EUR contracts, the share of OIS in IRS turnover remained relatively stable (Graph 4.A). Despite the increasing adoption of RFRs in these currencies (Graph 4.C, blue bars), they mainly replaced existing overnight rates – ESTR took over EONIA for EUR contracts and SOFR partially replaced EFFR for USD ones.[11] The share of IRS referencing credit-sensitive term rates remained sizeable. More than 50% of USD swaps referenced Libor in 2022, and roughly 40% of EUR swaps referenced Euribor. USD Libor swaps were probably used to run down legacy positions given the planned cessation of Libor in June 2023.[12] The sizable turnover

Share of OIS went up significantly for currencies most affected by the reform[1]

As a percentage of total notional by currency/year pair — Graph 4



[1] See technical annex for details. [2] GBP share includes old SONIA contracts.

Sources: BIS Triennial Central Bank Survey; DTCC, *Swap Data Repository*; authors' calculations.

[10] The share of GBP RFR contracts includes both the reformed and the old SONIA. This explains the high share back in 2019.

[11] These trends reflect the part of the benchmark rate reform that concerned the development of robust overnight RFRs. See detailed discussions in Schrimpf and Sushko (2019).

[12] Supervisory guidance in the United States encouraged "... banks to cease entering into new contracts that use USD *LIBOR* as a reference rate as soon as practicable and in any event by December 31, 2021" (Board of Governors of the Federal Reserve System et al (2020)).

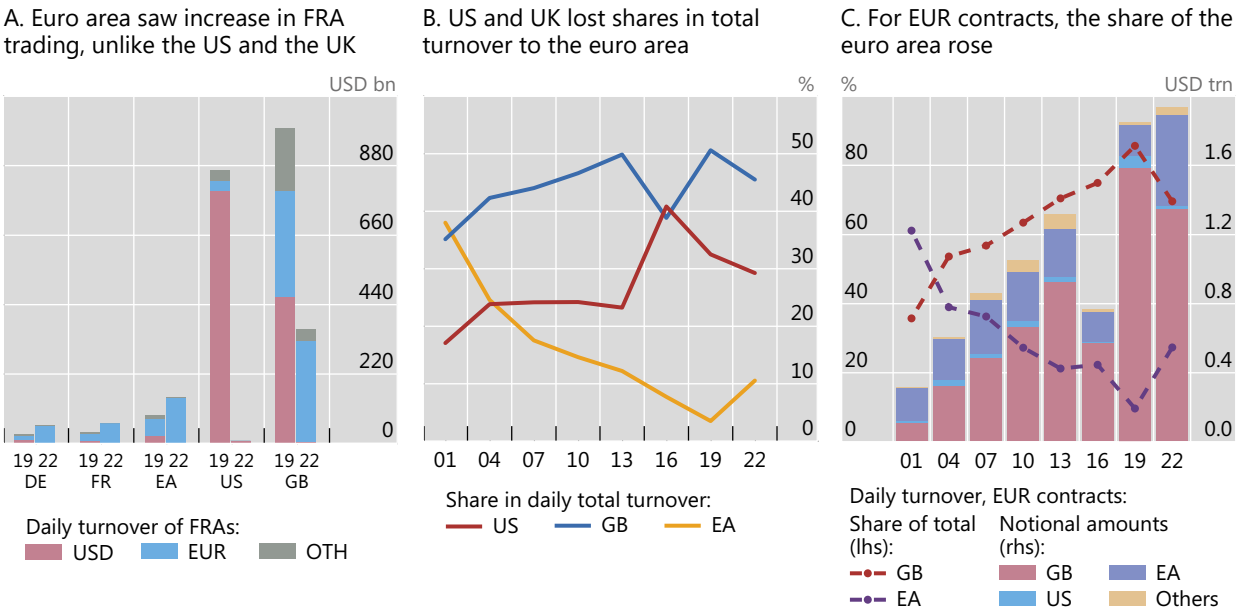
of Euribor swaps could reflect market participants' demand for credit-sensitive term rates.

The geographical distribution of turnover shifted

The different approaches to the benchmark rate reform across regions led to a shift in trading locations of FRAs. Jurisdictions without reformed IBORs are strict with the "RFR only" approach (eg the UK and the US), while others allow RFRs and reformed IBORs to coexist (eg the euro area). Consistent with the sizeable drop in USD-denominated FRAs, trading of FRAs by sales desks in the US almost disappeared, with daily turnover dropping by 99% between 2019 and 2022 (Graph 5.A). Similarly, FRA turnover in the UK declined by more than a half over the same period. In contrast, FRA turnover increased by 65% in the euro area[13] – mainly in Germany and France – reflecting the expansion of Euribor-based FRAs.

The uneven decline of FRA trading across jurisdictions contributed to changes in the geographical distribution and the currency composition of overall turnover. The share of the UK (the largest trading location for OTC derivatives) in global turnover declined from 51% in 2019 to 46% in 2022 (Graph 5.B). The share of the second largest trading location for OTC derivatives – the US – dropped from 32% in 2019 to 29% in 2022. In contrast, the share of the euro area increased. The respective currencies also saw similar trends, with the shares of the dollar in global turnover shrinking to 44% in 2022 (from 51% in 2019) and the euro expanding to 34% (from 25%) (BIS (2022)).

Libor transition led to shifts in currency composition, geographical distribution[1] Graph 5



[1] See technical annex for details.

Sources: BIS Triennial Central Bank Survey; authors' calculations.

[13] This comprises all euro area countries that reported to the BIS Triennial Surveys.

Notably, the share of the euro area in total EUR contracts bounced back to 27%, interrupting a long-term downward trend since 2004 (Ehlers and Hardy (2019)) (Graph 5.C). Apart from the uneven evolution of FRA turnover across regions, the migration of EUR contracts to the euro area could also reflect the impact of Brexit.[14]

New basis swaps emerged

The phasing-out of Libor led to a reduction in existing basis risks and a drop in the turnover of associated basis swaps. As Libor in major currencies other than the US dollar ceased as of end-2021, basis swaps referencing Libor in these currencies essentially disappeared thereafter (Graph 6.A, blue bars). In contrast, turnover of basis swaps that referenced legacy USD Libor (but not RFRs) remained sizeable in 2022 at around $500 billion per month (red bars). These swaps were probably used to hedge old basis risks like those stemming from different tenors of Libor, eg three-month and six-month Libor. This type of basis risk does not apply for RFRs as they track daily value of overnight rates continuously (Box B). In addition to Libor-only swaps, basis swaps between RFRs and Libor reached a peak at end-2021 and declined afterwards (yellow bars).

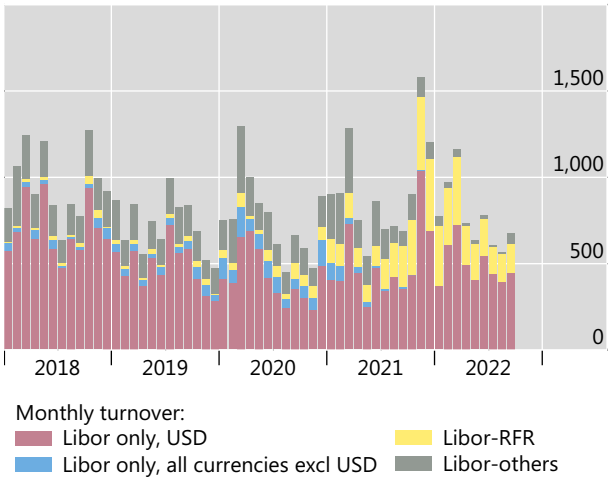
New basis swaps emerged as a tool for hedging basis risks stemming from the new reference rates. Turnover of basis swaps referencing RFRs and rates other than Libor expanded significantly in 2022 (Graph 6.B, purple bars), reaching above $300 billion per month in late 2022. This expansion reflects the hedging of new basis risks stemming from the coexistence of multiple benchmark rates (Box B).

New basis swaps have been emerging[1]

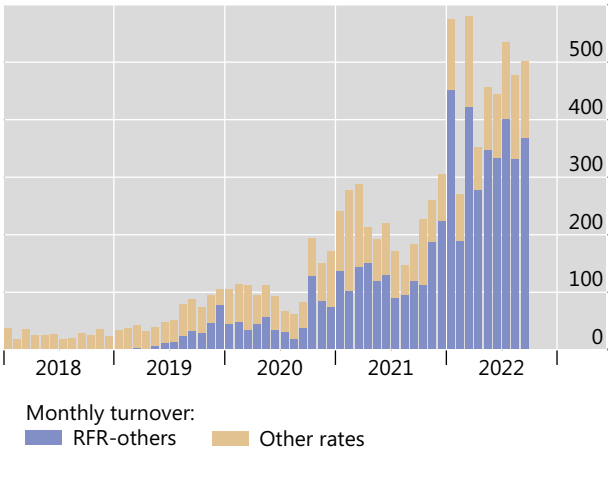
In billions of US dollars

Graph 6

A. Basis swaps referencing Libor were mainly USD contracts



B. Basis swaps referencing RFRs picked up



[1] See technical annex for details.

Sources: DTCC, *Swap Data Repository*; authors' calculations.

[14] The attendant regulatory changes after Brexit prohibited trading of some contracts on UK trading venues. See Article 28 of the EU Markets in Financial Instruments Regulation (MiFIR).

Interest rate basis risks in the Libor and RFR worlds

Wenqian Huang and Karamfil Todorov

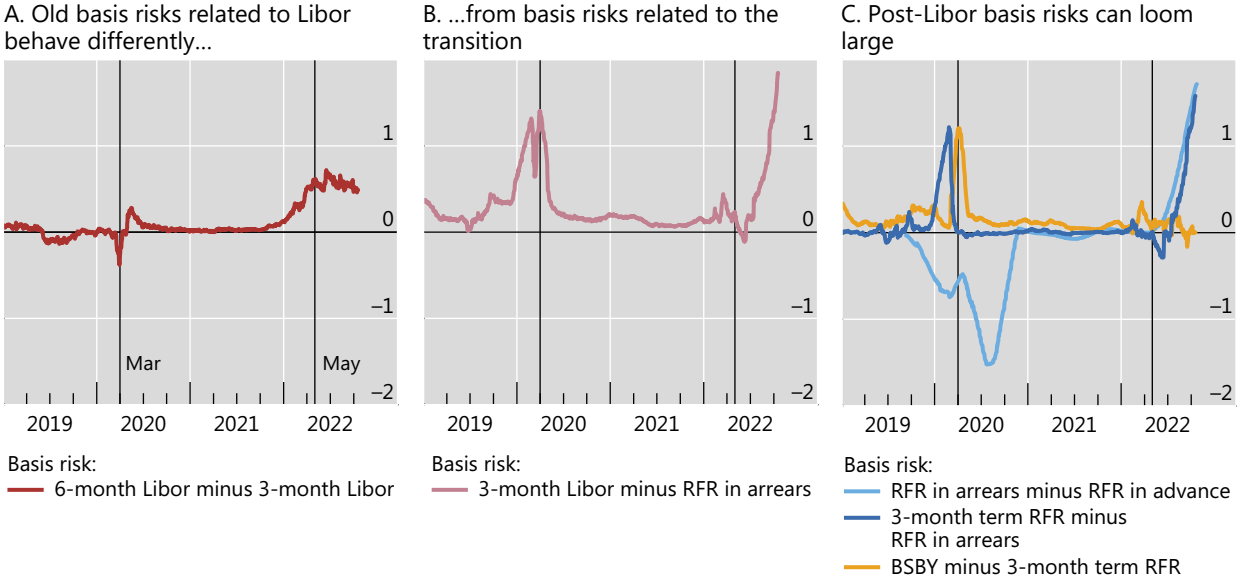
Basis risk arises when investors' assets and liabilities reference different floating rates. In this box, we first describe how the transition from Libor to the new risk-free rates (RFRs) changed Libor-related basis risks. We then explain how the differences between various reference rates in the RFR world give rise to new basis risks.

While mitigating Libor-related basis risks, the transition gave rise to Libor-RFR basis risks. One example of old Libor-related basis risks stems from different tenors of the reference rate: eg six-month Libor versus three-month Libor (Graph B1.A). Since RFRs track actual rates continuously, they eliminate this basis risk. However, basis risks can arise from the difference between Libor and RFRs when market participants have legacy Libor exposures. For example, suppose a bank has assets referencing Libor (eg legacy Libor loans) and liabilities referencing the standard averaged RFR, which compounds the overnight rates over the coupon period, ie "in arrears". The bank is then exposed to the basis between Libor and RFR in arrears. This basis could be substantial when the future path of interest rates is uncertain, as illustrated in the second half of 2022 (Graph B1.B).

New basis risks arise from the differences between the new reference rates and the standard RFR in arrears. The first type of new basis risk stems from the difference between RFR in arrears and in advance. RFR in arrears uses overnight rates prevailing during the *current* coupon period, whereas RFR in advance compounds *past* daily overnight rates. This difference creates a basis, which is positive when rates go up and is negative when rates go down (Guggenheim and Schrimpf (2020)). Using one of the standard market conventions for coupon calculation (three-month period), this basis reached about –150 basis points during the rate-cutting cycle in the second quarter of 2020 and +150 basis points during the rate-hiking cycle in the second half of 2022 (Graph B1.C, light blue line).

Basis risks in RFR and Libor world[1]

In percentage points — Graph B1



[1] Rates are based on USD markets. All bases take the perspective of an investor who is long the first rate and short the second.

Sources: Bloomberg; authors' calculations.

The second type of new basis risk arises from the difference between term RFR and RFR in arrears. In contrast to the backward-looking nature of RFR in arrears, term RFR is a forward-looking rate based on RFR derivatives such as futures (eg CME term SOFR). The basis between term RFR and RFR in arrears is thus related to the term premium: it is positive if expected future interest rates are higher than subsequent realisations, and negative otherwise. This basis spiked above 100 basis points when market participants expected monetary policy tightening before the Covid-19 shock in March 2020 and dipped into the negative domain when market participants temporarily foresaw a flatter policy rate path in May 2022 (Graph B.C, dark blue line).

The third type of new basis risks stems from the difference between credit-sensitive term rates and RFR in arrears. This basis is related to the evolution of banks' term funding costs. The credit risk component of the basis is typically positive and spikes in stress times, as illustrated by the Covid turmoil in March 2020 (Graph B1.C, yellow line).

① The views expressed are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

Conclusion

The benchmark rate reform led to structural changes in fixed income markets, especially in the OTC derivatives segment. The direct impact of the reform was a shift from fixed income instruments referencing Libor to those referencing RFRs. The reform also had profound indirect effects due to the fundamental differences between old and new reference rates. On the one hand, the reform reduced fixing risk as the new reference rates are based on the overnight tenor. On the other hand, the reform created new basis risks stemming from the coexistence of different types of reference rate.

As a result of these effects, the Libor transition significantly changed the instrument mix and the geographical distribution of OTC interest rate derivatives. Some instruments such as FRAs became less necessary, and their turnover declined. In contrast, turnover increased for basis swaps used to hedge the plethora of new basis risks.

On the back of regulatory recommendations to promote the adoption of RFRs, OTC interest rate derivatives markets have become strongly anchored in reference rates that are overnight and largely insensitive to bank funding costs. This could potentially lead to a lack of usable benchmarks that capture term liquidity premia and credit risk. Such factors could be important to financial intermediaries active in both borrowing and lending. Fine-tuning the balance between maintaining robust benchmark rates and developing new instruments that "complete the market" is an important next step to ensure the orderly functioning of fixed income markets in the new post-Libor world.

References

Alternative Reference Rates Committee (ARRC) (2021): "ARRC best practice recommendations related to scope of use of the term rate", www.newyorkfed.org/medialibrary/Microsites/arrc/files/2021/ARRC_Scope_of_Use.pdf.

Bank for International Settlements (2022): *OTC interest rate derivatives turnover in April 2022*, October.

Bartholomew, H (2022): "SOFR swap basis could pose 'systemic risk'", www.risk.net/derivatives/7954512/sofr-swap-basis-could-pose-systemic-risk.

Board of Governors of the Federal Reserve System, Federal Deposit Insurance Corporation and Office of the Comptroller of the Currency (2020): "Statement on LIBOR transition", 20 November, www.federalreserve.gov/newsevents/pressreleases/files/bcreg20201130a1.pdf.

Commodity Futures Trading Commission (CFTC) (2012): "CFTC orders Barclays to pay $200 million penalty for attempted manipulation of and false reporting concerning LIBOR and Euribor benchmark interest rates", www.cftc.gov/PressRoom/PressReleases/6289-12.

Duffie, D and J Stein (2015): "Reforming LIBOR and other financial market benchmarks", *Journal of Economic Perspectives*, May, vol 29, no 2, pp 191–212.

European Central Bank (ECB) (2020): *Report on preparations for benchmark rate reforms*, www.bankingsupervision.europa.eu/ecb/pub/pdf/ssm.reportpreparationsbenchmarkratereforms202007~bd86332836.en.pdf.

European Money Markets Institute (EMMI) (2019): *BMR authorisation for administration of Euribor® under hybrid methodology*, July.

Ehlers, T and B Hardy (2019): "The evolution of OTC interest rate derivatives markets", *BIS Quarterly Review*, December, pp 69–82.

Financial Services Authority (FSA) (2012): "Barclays fined £59.5 million for significant failings in relation to LIBOR and EURIBOR", www.fca.org.uk/news/press-releases/barclays-fined-%C2%A3595-million-significant-failings-relation-libor-and-euribor.

Financial Stability Board (FSB) (2014): *Reforming major interest rate benchmarks*, 22 July.

Guggenheim, B and A Schrimpf (2020): "At the crossroads in the transition away from LIBOR: from overnight to term rates", *BIS Working Papers,* no 891, October.

International Organization of Securities Commissions (IOSCO) (2013): *Principles for financial benchmarks*, July.

McCauley, R (2001): "Benchmark tipping in the money and bond markets," *BIS Quarterly Review,* March, pp 39–45.

Michaud, F-L and C Upper (2008)): "What drives interbank rates? Evidence from the Libor panel", *BIS Quarterly Review,* March, pp 47–58.

Schrimpf, A and V Sushko (2019): "Beyond Libor: a primer on the new benchmark rates", *BIS Quarterly Review*, March, pp 29–52.

Technical annex

Ameribor = American interbank offered rate; BSBY = Bloomberg short-term bank yield index; CME term SOFR = Chicago mercantile exchange term secured overnight financing rate; CP = commercial paper; EFFR = effective funds rate; EONIA = euro overnight index average; ESTR = euro short-term rate; Euribor = euro interbank offered rate; FRA = forward rate agreement; IRS = interest rate swap; Libor = London interbank offered rate; OIS = overnight indexed swap; OTC = over-the-counter; RFR = risk-free rate; SOFR = secured overnight financing rate; SARON = Swiss average rate overnight; SONIA = sterling overnight index average; Tibor = Tokyo interbank offered rate; TONA = Tokyo overnight average rate.

Graph 1.A: Syndicated loans.

Graph 3.A: Notional amounts, daily averages in April. Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. Overnight indexed swaps are included in total swap turnover. Data available only from 2019.

Graph 3.B: Notional amounts, daily averages in April. Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Graph 4.A: Notional amounts, daily averages in April. Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Graph 4.B: Based on DTCC data on fixed float and OIS interest rate swaps.

Graph 4.C: Based on DTCC data on fixed float and OIS interest rate swaps.

Graph 5.A: Notional amounts, daily averages in April. Adjusted for local inter-dealer double-counting, ie "net-gross" basis. Euro area defined as total "net-gross" for euro area reporting countries.

Graph 5.B: Notional amounts, daily averages in April. Adjusted for local inter-dealer double-counting, ie "net-gross" basis.

Graph 5.C: Notional amounts, daily averages in April. Adjusted for local inter-dealer double-counting, ie "net-gross" basis. Euro area defined as total "net-gross" for euro area reporting countries. EUR contracts.

Graph 6.A: Monthly turnover of basis swaps, by reference rate.

Graph 6.B: Monthly turnover of basis swaps, by reference rate.

Mathias Drehmann
mathias.drehmann@bis.org

Vladyslav Sushko
vladyslav.sushko@bis.org

The global foreign exchange market in a higher-volatility environment[1]

Turnover in global foreign exchange (FX) averaged more than $7.5 trillion per day in April 2022 amid a volatile market environment. Compared with the previous BIS Triennial survey in 2019, trading volumes were higher because of greater activity in short-maturity FX derivatives and more inter-dealer trading. By contrast, trading with customers stagnated, mirroring a slowdown in international investment in 2022. A greater share of trading was executed via various bilateral methods, rather than via multilateral platforms that make prices available to all participants, implying that the transparency of the FX market may have decreased further.

JEL classification: C42, C82, F31, G12, G15.

Turnover in global foreign exchange (FX) markets reached $7.5 trillion per day in April 2022 (Graph 1, panel A),[2] a volume that is 30 times greater than daily global GDP.[3] The Triennial Central Bank Survey of over-the-counter (OTC) foreign exchange turnover ("Triennial Survey") offers a glimpse into this vast FX market. This year in April, data collection coincided with heightened FX volatility due to a confluence of factors, such as changing expectations about the paths of future interest rates in major advanced economies, rising commodity prices and geopolitical tensions after Russia's invasion of Ukraine.

Global FX volumes were higher compared with the previous Triennial Survey in 2019, owing to two main drivers. First, more trading in short maturity FX derivatives, which mechanically increases turnover, under the assumption that many contracts are rolled over. And the greater use of short maturity derivatives may reflect market participants' aversion to taking on term risk in a more volatile environment. Second, more inter-dealer trading, which tends to rise with volatility. In fact, the rise in inter-dealer turnover was big enough to reverse the long-term trend of a declining inter-dealer share in global FX trading. By contrast, dealers' trading with financial customers stagnated, mirroring the slowdown in international financial investment activity.

[1] We thank Ryan Banerjee, Claudio Borio, Alain Chaboud, Stijn Claessens, Philippe Lintern, Benoît Mojon, James O'Connor, Frank Packer, Andreas Schrimpf, Hyun Song Shin, Nikola Tarashev and Goetz von Peter for useful comments. Jose Maria Vidal Pastor provided excellent research assistance. All errors are our own. The views expressed in this article are those of the authors and not necessarily those of the Bank for International Settlements.

[2] See Bank for International Settlements (2022a) for detailed survey results.

[3] Global GDP amounted to $96.1 trillion in 2021 or $0.26 trillion per day; see World Bank, World Development Indicators database, 1 July 2022.

Key takeaways

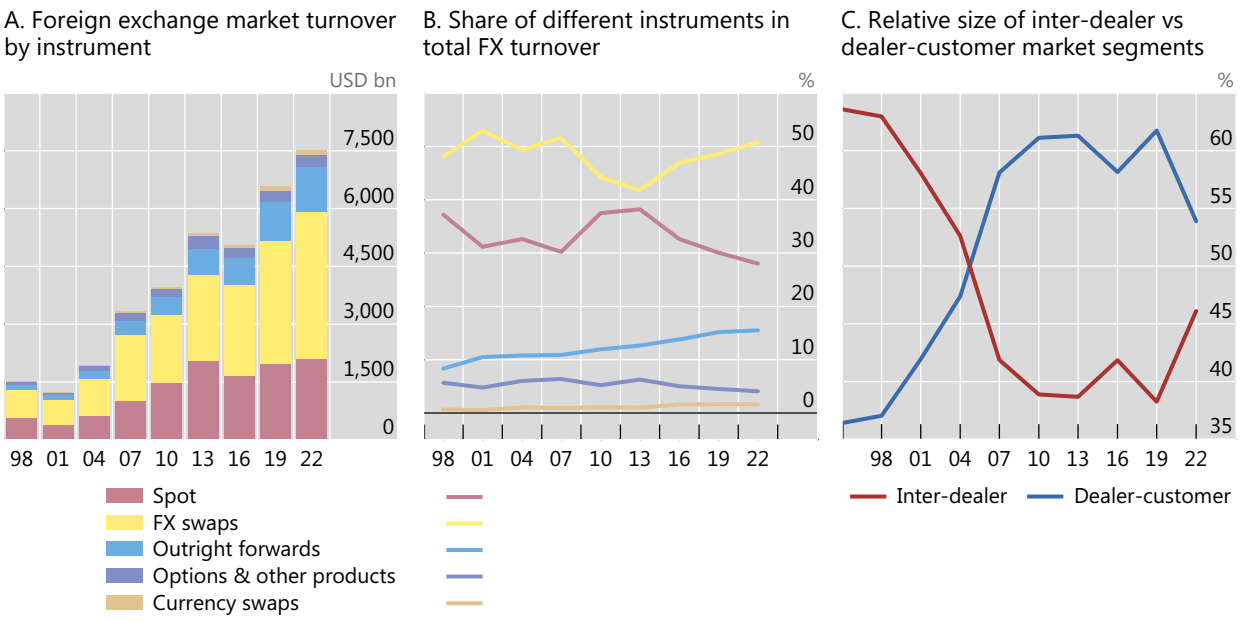
- Turnover in global foreign exchange markets reached $7.5 trillion per day in April 2022, in a market that was more volatile than during the previous survey in 2019.
- Inter-dealer trading increased, reversing a long-run trend. By contrast, trading by dealers with customers stagnated, partly reflecting a slowdown in international investment activity.
- Trading moved further away from multilateral platforms towards bilateral methods, where information remains private, suggesting that the transparency of the FX market may have decreased further.

Trading with hedge funds and principal trading firms (PTFs), and the associated prime-brokered turnover, also declined, suggesting some reduction in activity by non-bank financial intermediaries in the FX market.

The share of FX trading using various bilateral methods, where information about the trade remains private, has increased. This reflects both inter-dealer and dealer-customer trading shifting away from multilateral platforms. In the inter-dealer market, trading volumes executed via electronic brokers, where trade attributes such as prices can be seen by all participants, have thus continued to decline. The notable shift towards bilateral forms of trading in 2022 implies a continued reduction of "visible" trading and increased market fragmentation, suggesting that the transparency of the FX market may have decreased further.

The remainder of the feature starts with a bird's eye view of long-run trends. This forms the backdrop for discussing the Triennial results obtained this year amid more volatile markets than during previous surveys. The last two sections delve deeper into the dealer-customer and inter-dealer market segments.

Global FX trading volumes grow and some longer run trends reverse[1] Graph 1



[1] See technical annex for details.

Sources: BIS Triennial Central Bank Survey; BIS.

The global FX market – a bird's eye view of long-run trends

While more than 50 currencies trade globally, FX trading activity is concentrated in a few trading hubs and major currencies. The Triennial captures sales desk activity in 52 jurisdictions for 56 currencies. Yet, close to 80% of all FX trading takes place in the five FX trading hubs that are major financial centres. Furthermore, as the pre-eminent vehicle currency, the US dollar was on one side of around 90% of all FX trades in April 2022 (see Box A), a share virtually unchanged for decades.

FX trading involves both spot and derivatives, with the share of spot having been on a gradual decline over the last 10 years (Graph 1, panel B). FX swaps are the most traded FX instrument and their share increased from around 40% in 2013 to more than 50% in 2022. They are typically used by market participants to take positions, manage funding liquidity in different currencies and hedge currency risk.[4] Forwards are the third most traded instrument,[5] used mainly to hedge currency risk or to bet on future currency movements. Their market share has edged up gradually over time.

The FX market can be broadly characterised as consisting of a dealer-customer and an inter-dealer segment. Such a two-tier structure is typical of OTC markets, where dealers warehouse risk and serve as counterparties, ie provide liquidity, to end users. Inter-dealer trading volumes used to exceed trading volumes with customers until about two decades ago due to inter-dealer trading of inventory imbalances.[6] Thereafter, various structural changes resulted in relatively less inter-dealer trading (Graph 1, panel C). Examples include more efficient inventory risk management and "internalisation", whereby dealers match customer flows on their own books.

But the distinction between the core inter-dealer and dealer-customer market segments has become somewhat blurred over time. This reflects a proliferation of multilateral trading venues, a growing variety of execution methods, and some non-bank actors emerging as liquidity providers alongside dealers. Especially in spot markets, principal trading firms (PTFs) have become important. PTFs rely mostly on speed and automated trading strategies rather than balance sheet capacity to support their market intermediation activities. As they have morphed into liquidity providers to customers, PTFs have become an integral part of FX intermediation and a key determinant of liquidity conditions.

[4] Borio et al (in this issue) discuss the use of FX swaps as funding instrument in greater detail.

[5] Outright forwards include deliverable forwards and as well non-deliverable forwards (NDFs).

[6] Lyons (1996) coined the term "hot potato trading" in reference to the repeated passing of inventory imbalances among dealers. A single customer trade could generate a cascade of inter-dealer trades until the inter-dealer market would settle at a new equilibrium price.

Box A

Revisiting the international role of the US dollar

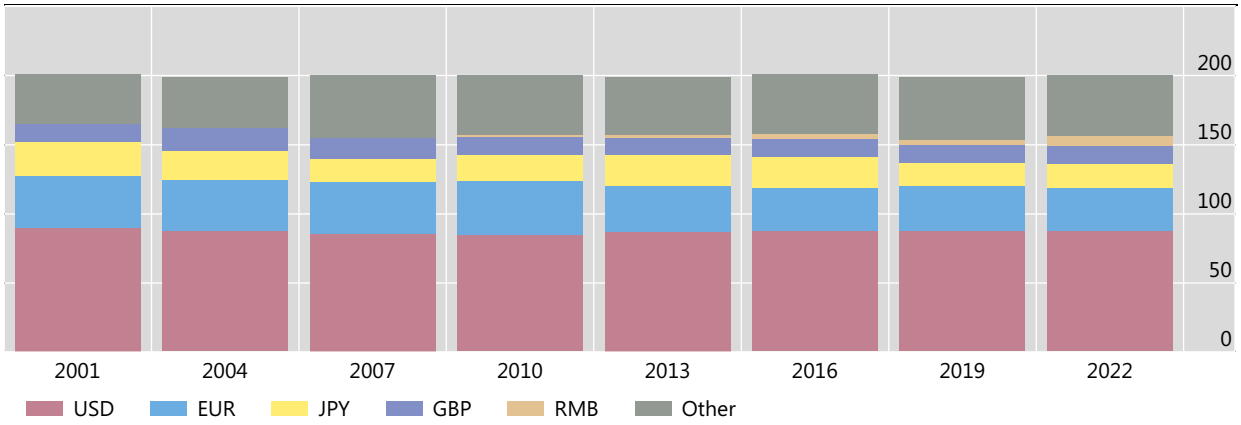
Bafundi Maronoti ①

The international role of the US dollar (USD) is unrivalled. However, there is at times speculation that its role may be challenged. The reasons cited include China's growing role in the global economy, developments in technology (eg cryptoassets) or geopolitical considerations.② This box provides an updated view of the international role of the USD, focusing mostly on its role in global financial markets.

The global FX market remains concentrated in a few currencies, with the USD dominating. The average turnover per day with the USD on one side of the transaction was $6.6 trillion – up 14% from $5.8 trillion in 2019 – in line with the change in total turnover. The USD was involved in nearly 90% of global FX transactions, making it the single most traded currency in the FX market (Graph A1). The dominance of the USD is evident across all FX instruments and counterparties. At least 85% of trading in the spot, forward and swap markets features the USD in one leg of the transactions.

Foreign exchange turnover by currency[1]

In per cent Graph A1



[1] As two currencies are involved in each transaction, the sum of shares in individual currencies will total 200%. Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April.

Source: BIS Triennial Central Bank Survey.

Other currencies lag well behind (Graph A1). The euro – the second most traded currency – has a share of only 31%, down from its peak of 39% in 2010. A similar trend can be observed for the Japanese yen, while the British pound has maintained a largely constant share. The shift from these major currencies has been matched by a rise in the role of emerging market economy currencies such as the renminbi. The latter's share in global FX turnover has increased from less than 1% 20 years ago to more than 7% now (see Box A in Caballero et al, in this issue).

The USD's dominance in global FX markets is linked to several factors. First, its use as a vehicle currency for FX transactions, meaning that non-US dollar currency pairs are not exchanged directly but via the dollar. According to some estimates, this role of the USD drives just under 40% of its turnover in FX markets.③

Second is the dollar's footprint in offshore funding markets, where financial market participants raise debt or obtain loans in foreign currency. About half of all international debt securities and cross-border loans issued in these offshore funding markets are denominated in USD (Graph A2, panel A). As of the second quarter of 2022, the amount of debt and loans denominated in USD where neither the issuer/borrower nor the lender is a US resident is estimated to be 88% of total international USD-denominated debt and 65% of total international USD bank loans (Graph A2, panel A).

Third is the currency's popularity in international trade and global payments. Approximately half of global trade is invoiced in USD, although this share varies widely across regions (Graph A2, panel A).④

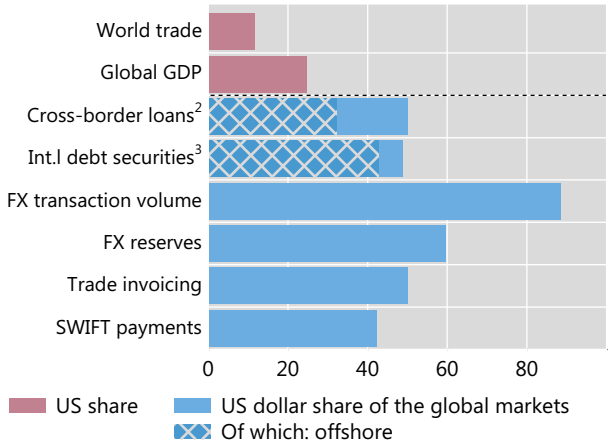
This disproportionately large reliance on the USD is in spite of the United States accounting for just over a 10th of global trade. These shares have hardly changed since 2019 (see CGFS (2020)).⑤

One area where the role of the USD has been shrinking to some degree is official foreign exchange reserves, even though it remains the foremost reserve currency. As of the second quarter of 2022, the USD accounted for less than 60% of official foreign exchange reserves (Graph A2, panel B). This is one of the lowest shares in the past 20 years and is well below the average of 65% for the period.

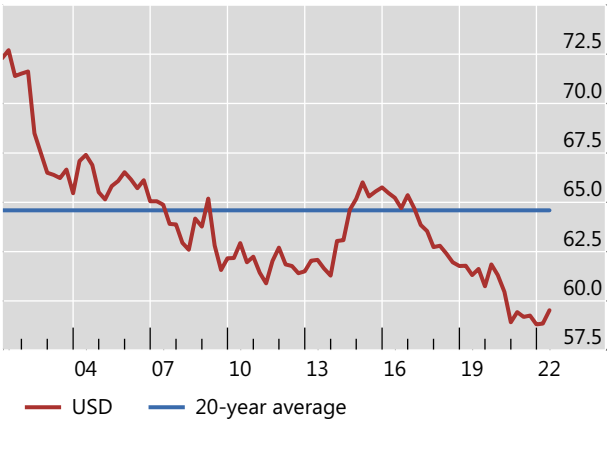
The international role of the US dollar

In per cent — Graph A2

A. International role of the US dollar[1]



B. US dollar share of official foreign exchange reserves



[1] Data refer to latest available value. [2] USD-denominated cross-border loans by banks to counterparties in all countries (excluding inter-office claims but including interbank claims on account of loans and deposits). Offshore refers to cross-border loans excluding loans from United States and on United States. [3] USD-denominated international debt securities by all issuers; these securities are issued outside the local market of the country where the borrower resides (eg eurobonds or foreign bonds). Offshore refers to USD-denominated loans/debt issued outside United States.

Sources: G Gopinath, "The international price system", *NBER Working Papers*, no 2164, 2015; IMF; Bloomberg; CPB World Trade Monitor; SWIFT; BIS debt securities statistics; BIS locational banking statistics; BIS Triennial Central Bank Survey.

① The views expressed are those of the authors and do not necessarily reflect those of the Bank for International Settlements ② Congressional Research Service, 15 September 2022. For the US dollar as the world's dominant reserve currency, see L Goldberg, R Lerman and D Reichgott, "The U.S. dollar's global roles: revisiting where things stand", Federal Reserve Bank of New York, *Liberty Street Economics*, 5 July 2022. ③ F Somogyi, "Dollar dominance in FX trading", University of St. Gallen, School of Finance Research Paper, no 2021/15. ④ The share of USD in trade invoicing is estimated to be higher in the Americas, but lower in Europe where trade invoicing is predominantly done in euros: see C Bertaut, C von Beschwitz and S Curcuru, "The international role of the U.S. dollar", Washington: Board of Governors of the Federal Reserve System, *FEDS Notes*, 6 October 2021. ⑤ Committee on the Global Financial System, "US dollar funding: an international perspective", *CGFS Papers*, no 65, June 2020.

Aggregate FX turnover in a higher-volatility environment

Comparing the results of the 2022 Triennial with the 2019 Survey is complicated by very different market environments. The 2019 Triennial covered a month in a period of subdued and falling volatility in FX markets. And ultra-low interest rates supported intermediation and liquidity provision in FX markets. The 2022 environment looks very different. Especially important for the FX market this year was the high and uncertain inflation path, driving rapid but globally diverging monetary tightening. The Russian invasion of Ukraine led to further uncertainty and market turbulence. These

developments had a profound effect on international capital flows and financial market volatility, including that in currency markets.

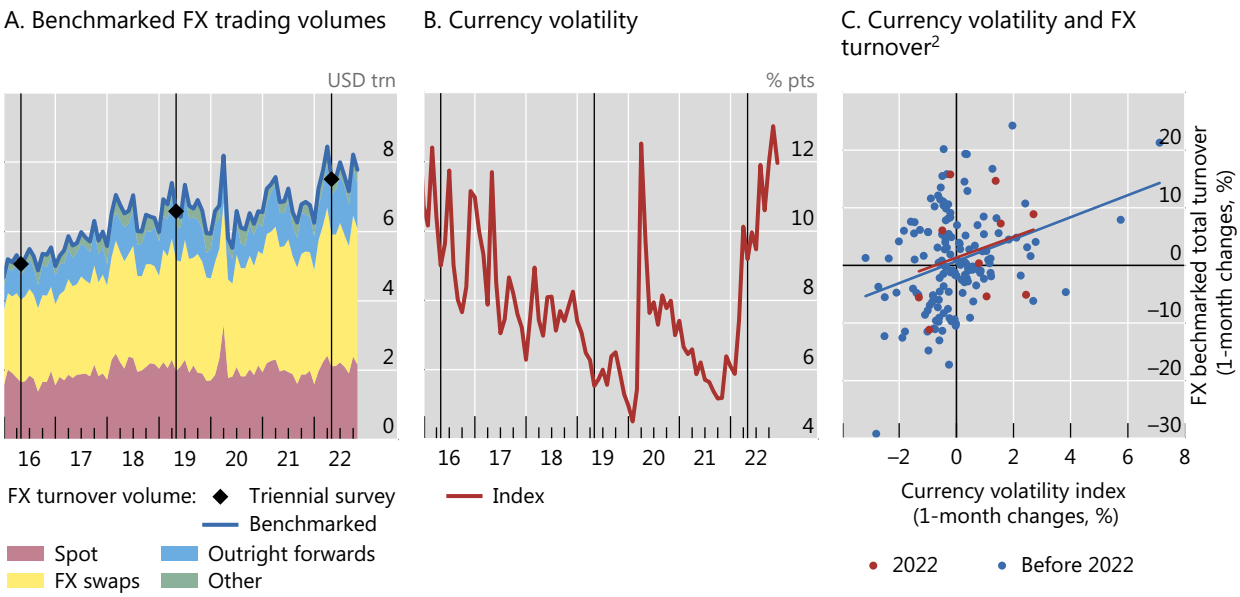
To get a better sense of the relationship of volatility and turnover in FX markets, we benchmark the Triennial with higher-frequency series.[7] This allows us to compare changes in turnover not only over three years but also on a month-by-month basis.

The higher-frequency benchmark shows that turnover increased in tandem with FX volatility in the early part of 2022 (Graph 2). At close to $8.5 trillion per day, turnover in March 2022 is estimated to have exceeded even the prior peak during the Covid-19 financial market turmoil in March 2020. In July and August this year, some divergence between volatility and turnover emerged when exchange rate volatility continued to rise while turnover did not.

The positive relationship between turnover and volatility is in line with historical relationships and not too surprising (Graph 2, panel C). In a higher-risk environment, market participants tend to adjust positions, shift towards hedging currency risk, or take more speculative positions – activities that all drive up turnover. A dispersion of beliefs about the future among investors will also drive trading volumes higher.[8]

FX trading volumes at a higher frequency follow volatility[1]

Graph 2



[1] See technical annex for details. [2] R-squared = 0.1; the fitted line remains upwards-sloping and significant when outliers are excluded.

Sources: Bech (2012); Semiannual FX Committee Surveys; CBOE; CLS; Refinitiv; BIS.

[7] The benchmarking follows Bech (2012) and complements the Triennial mainly with semiannual surveys of local FX committees and monthly data from the Continuous Linked Settlement Group.

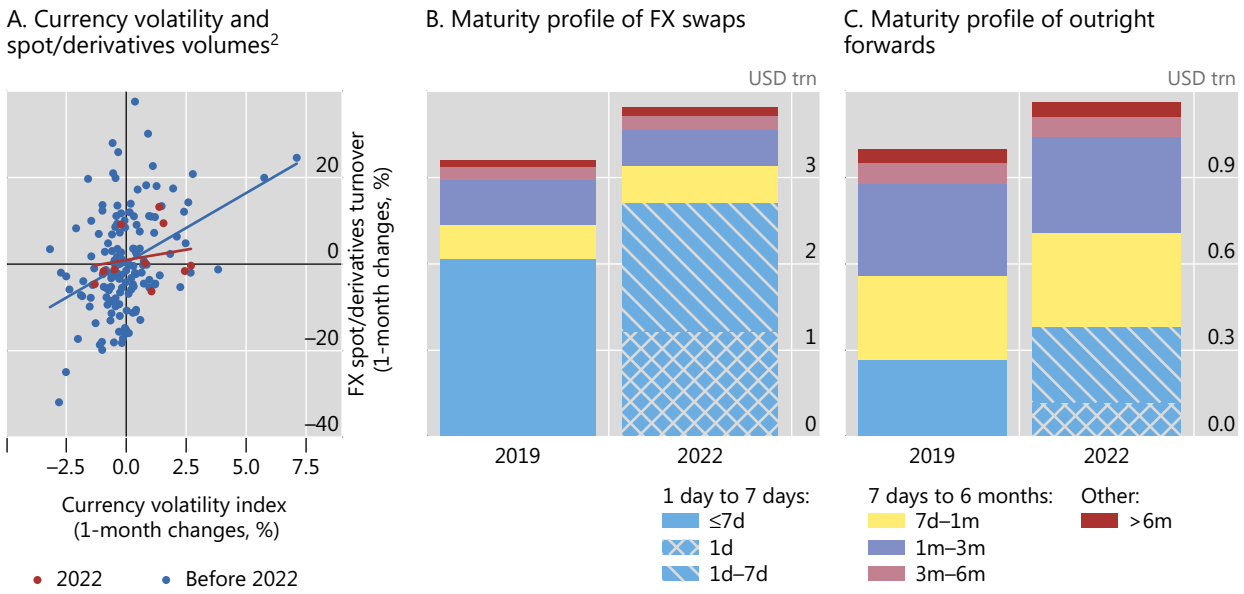
[8] The impact of disagreement on trading volume has been appreciated at least since Varian (1985).

That said, trading in spot did not outpace that in derivatives, as it did in previous high-volatility episodes. The monthly benchmark series spot and derivatives volumes show that, historically, it was spot trading that increased faster with volatility than derivatives trading. This is especially visible during the Covid-19 crisis in March 2020. Hence, the positive relationship of changes in volatility with changes in the ratio of spot to derivative turnover (Graph 3, panel A). This year, however, both spot and derivatives trading grew in tandem so that their ratio remained unchanged (red dots). This may reflect that in early 2022 market participants adjusted to changing expectations of a prolonged period of uncertainty.

The higher turnover in FX derivatives may reflect the increasing use of short maturities. A shift towards shorter maturities increases turnover mechanically, under the assumption that many contracts are rolled over. The more granular but lower-frequency data from the Triennial shows that the growth of turnover in FX swaps and forwards between 2019 and 2022 was due entirely to more trading in shorter tenors with maturities of one week or less (Graph 3, panels B and C). And the overnight segment, first split out in 2022, accounted for close to half of short-maturity swaps and almost a third of short-maturity forwards. As inter-dealer FX swap trading is predominantly in very short tenors, the higher inter-dealer share in 2022 is one factor behind the overall shortening of maturities.

Short-maturity FX derivatives turnover grows strongly[1]

Graph 3



[1] See technical annex for details. [2] Derivatives include outright forwards and FX swaps. R-squared = 0.146; the fitted line remains upwards-sloping and significant when outliers are excluded.

Sources: CBOE; CLS; BIS Triennial Central Bank Survey; BIS.

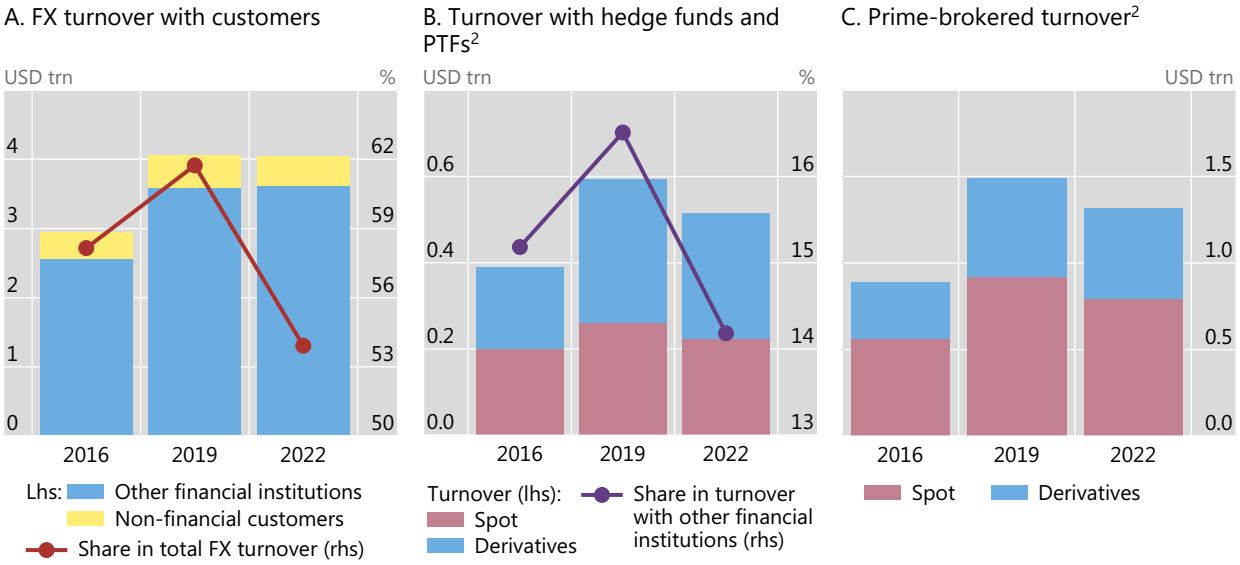
Dealers' trading with customers stagnates

At the broadest level, customers to reporting dealers are categorised into two groups. First, non-financial customers, such as global corporates, which make up only a small and shrinking fraction of dealer-customer turnover.[9] Second, other financial institutions – a customer group that includes non-reporting banks, hedge funds and PTFs, institutional investors, and official sector financial institutions.

Dealers' trading with customers has stagnated in dollar terms compared with three years ago (Graph 4, panel A). Given the overall growth of the market, the share of dealer-customer turnover therefore fell from 62% to 54%. Stagnant customer trading may partly reflect the risk-off environment. Contraction in international investment in early 2022 likely played a role as gross external portfolio positions contracted sharply in the first quarter of 2022.[10] And whenever international investment positions have fallen historically, FX market turnover with other financial institutions has fallen too.[11]

Across customer segments, there was a small shift away from trading with hedge funds and PTFs. Turnover with this segment declined both in spot and derivatives. Hence, the share of hedge funds and PTFs in total turnover with other financial

Customer trading volumes stagnate[1] Graph 4



[1] See technical annex for details. [2] Derivatives include currency swaps, FX swaps, outright forwards and options.

Sources: BIS Triennial Central Bank Survey; BIS.

[9] The share of non-financial customers in total FX turnover fell from 7% to 6% between 2019 and 2022.

[10] Data from the IMF Coordinated Portfolio Investment Survey (CPIS) show that gross (assets plus liabilities) international portfolio positions of residents in a sample of 25 advanced and emerging market economies contracted by $7 trillion between Q4 2021 and Q1 2022.

[11] Combining the IMF CPIS data with the BIS Triennial, we find a significant positive relationship between international investment portfolios and FX turnover, when regressing the three-year changes in FX turnover with other financial institutions in a currency of a specific jurisdiction on three-year changes in gross external portfolios (assets plus liabilities) of residents in that jurisdiction. Retrenchment of foreign portfolio investment also explains a lower level of turnover in EME currencies (Caballero et al (2022), in this issue).

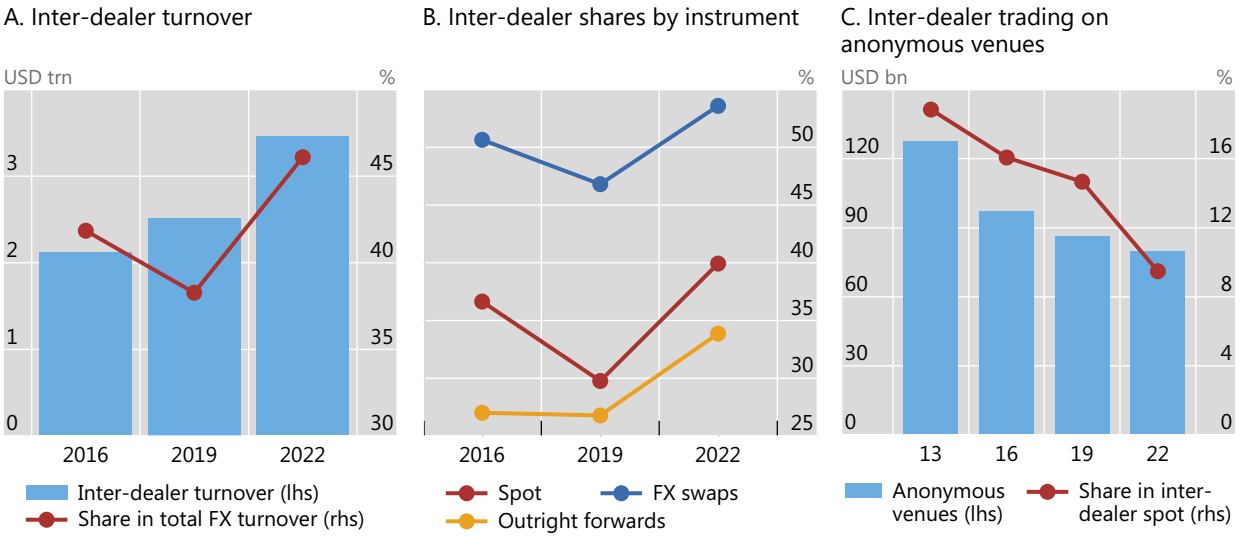
institutions declined from 17% to 14% (Graph 4, panel B). The associated prime-brokered turnover declined as well (Graph 4, panel C). Given high volatility, market sources suggest that hedge funds have been very active in April this year. Hence, the decline is most likely to reflect less turnover with PTFs. The *Euromoney* magazine rankings also show that the PTF share in (direct electronic) spot liquidity provision to clients has declined, from 32% to 28% between 2019 and 2022. The relatively more muted PTF activity could reflect a range of factors such as a reported shift by some PTFs from highly competitive and efficient FX markets to less efficient asset classes with greater arbitrage opportunities, such as crypto, dealers catching up technologically or the factors underpinning the resurgent inter-dealer market as discussed next.

A resurgent inter-dealer market

Reversing the long-run trend decline, the share of inter-dealer trading has grown significantly over the last three years, to account for more than 45% of all FX trading volumes in April 2022 (Graph 5, panel A). Such a share was last seen in the mid-2000s (see Graph 1, panel B). Inter-dealer activity gained relative ground across all three major instruments, to 40% in spot, 54% in FX swaps and 34% in outright forwards (Graph 5, panel B).

The relative rise in inter-dealer trading volumes may partly reflect the more volatile environment. Higher-volatility means greater need to offset inventory imbalances with other dealers and to engage in other risk management trades.

Inter-dealer trading rises across all major instruments[1] Graph 5



[1] See technical annex for details.

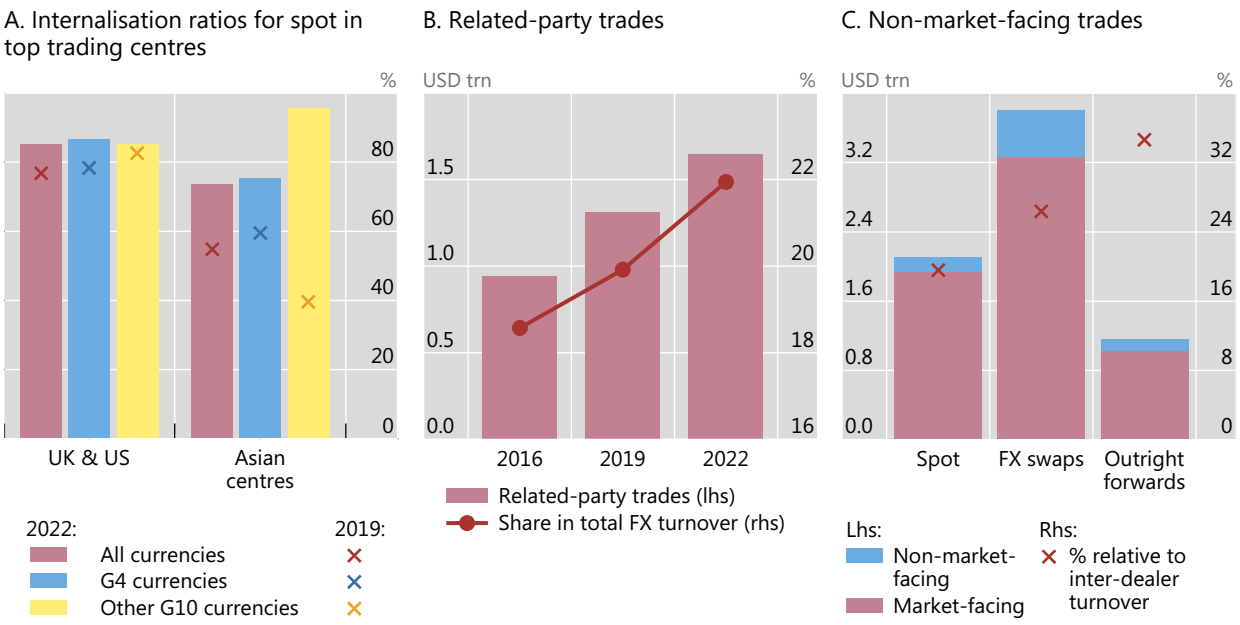
Sources: BIS Triennial Central Bank Survey; BIS.

Less inter-dealer trading is public

The inter-dealer market provides crucial information for ascertaining market conditions and obtaining reference prices for the wider FX market. The centralised structure of the electronic inter-dealer spot market has meant that this core activity and information was contained within two main inter-dealer electronic brokers (see Box B). These are organised as central limit order books (CLOBs), where information such as quantities and prices is visible to traders on the platform. And analogous to an exchange, trading on these multilateral venues is anonymous, ie the counterparty is unknown (hence they are classified as "anonymous venues" in the Triennial).[12] This contrasts with many other venues in the FX market, which trade by "direct" means. In these cases, dealers, for instance, respond bilaterally to requests from customers or stream prices electronically to specific customers. Hence, conditions of trades executed by direct means are known only to the two counterparties (see Box C).

The 2022 Triennial shows a further decline of trading on inter-dealer electronic brokers – a continuation of a long-run trend (Graph 5, panel C). Even as inter-dealer spot trading increased by 43% compared with 2019, the share of inter-dealer spot turnover traded via electronic brokers declined further, from 15% to 9%. Lower spot volumes on inter-dealer electronic brokers also go hand in hand with lower PTF trading activity, as PTFs account for a significant amount of trading activity on inter-dealer brokers.[13]

Internalisation and related party trading increase further[1] Graph 6



[1] See technical annex for details.

Source: BIS Triennial Central Bank Survey.

[12] The inter-dealer FX swap market is organised differently from spot. It has been highly fragmented for a long time; there is no anonymous trading in FX swaps, with electronic trading executed mainly via a "request-for-quote" trading protocol (see Ranaldo (2022)).

[13] Chaboud et al (2022) show that non-bank (eg PTF) trading volumes, executed algorithmically, accounted for more than 40% of all trading on EBS in mid-2021.

Several drivers are behind the trend decline in inter-dealer electronic brokers. First, more inter-dealer trading via disclosed and direct means, as, for example, in the fact that smaller dealers increasingly source liquidity from big dealers for their own customers in this form. Second, internalisation, whereby dealers match customer flows on their own books, continues to substitute for inter-dealer trading (Butz and Oomen (2018)). While major FX dealers have been internalising most of their customer flows for a long time, the recent Triennial shows a further increase in internalisation ratios, particularly on the part of dealers in Asian financial centres (Graph 6, panel A).[14] Third, related-party trades, ie trades between different organisational units of a single dealer, which have continued to rise to 22% of total turnover (Graph 6, panel B).[15] Relatedly, the 2022 Triennial first broke out "non-market-facing" trades. These amounted to $895 billion, and their shares in the different instruments ranged between 20 and 35% of inter-dealer turnover (Graph 6, panel C).[16] While internalisation and non-market-facing trades seem rather technical factors, in many cases they represent alternative choices to "going to the market", where they would have affected market conditions.

While less "visible" trading and greater market fragmentation have so far not hampered market functioning, this development may not be without downsides. Market participants have successfully used technologies to navigate a more fragmented market. For example, customers rely on smart order routing and execution algorithms to spread large orders over time and across multiple electronic venues (Markets Committee (2020)). Yet, less visibility for trades could harm price discovery for the market as a whole. It also hinders policymakers from appropriately monitoring FX markets (see Markets Committee (2018)).

[14] Data on internalisation ratios are likely to be less precise than the turnover figures as they are collected as a supplementary question.

[15] A variety of transactions can be related-party trades, such as an FX desk of a dealer bank conducting a risk transfer trade with its headquarters, which does consolidated risk management globally; a derivatives desk hedging risk resulting from a trade with a spot desk of the same institution; or a local affiliate raising foreign currency funding by entering an FX swaps transaction with its headquarters

[16] The Survey collected back-to-back and compression trades as part of non-market-facing trades. Back-to-back trades are deals that automatically follow trades with customers to shift risk across the sales desks of a dealer. Compression trades refer to portfolio optimisation by replacing existing contracts with new ones to reduce notional amounts while keeping net exposures unchanged.

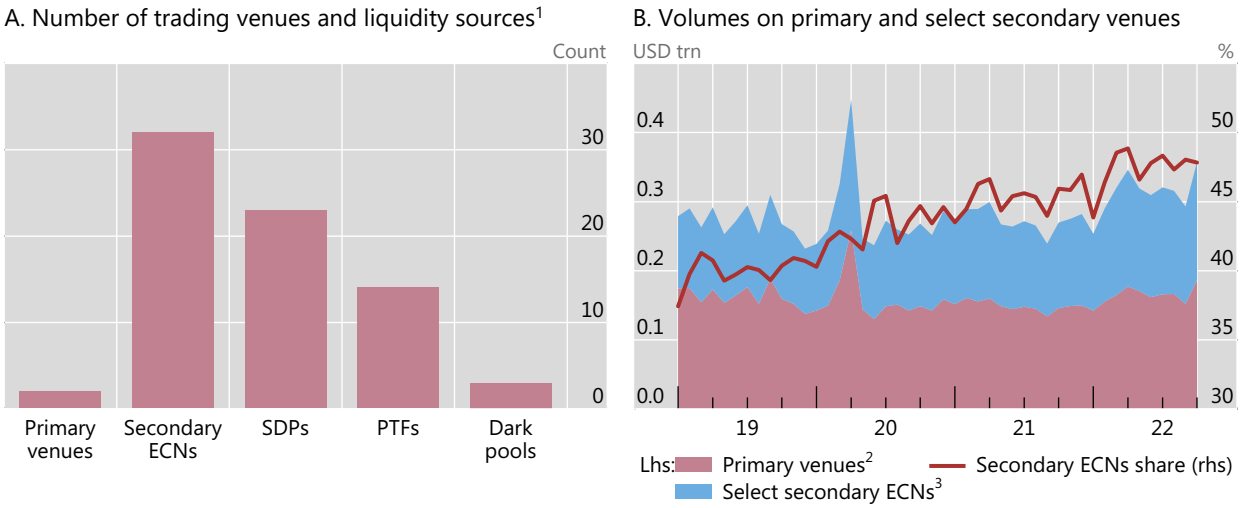
Dealer-customer and inter-dealer trading in a fragmented spot market

Mathias Drehmann and Vladyslav Sushko ①

Trading activity in the FX markets is fragmented across a range of venues and liquidity providers (Markets Committee (2018)).② Before the turn of the millennium, the FX market was a "plain vanilla" OTC market, with trading dominated by major dealers. While still retaining its OTC structure, a multitude of other venues and providers has emerged since then (see eg Chaboud et al (2022)).③ For three decades, two electronic brokers, Reuters (now Refinitiv) Matching and Electronic Broking Services (EBS) Market, have been especially important for the inter-dealer spot market. Often referred to as the "primary venues", they are organised as central limit order books (CLOBs). They have been the main sources of reference prices for the entire spot market.④ But there are also more than 30 secondary venues in the dealer-customer market segment, which has grown strongly in recent years, especially when compared with primary market activity (Graph B1). Customers can also trade directly with more than 20 dealers via proprietary single-dealer platforms (SDPs) or obtain direct prices streams from more than a dozen PTFs.

With further FX market fragmentation, volumes across platforms diverge

Graph B1



[1] Primary venues: CME/NEX EBS Market and Refinitiv/Reuters Matching; Secondary ECNs: a variety of anonymous and disclosed multi-dealer platforms; SDPs: proprietary single-dealer platforms of FX dealer banks; PTFs: principal trading firms. Dark pools: electronic venues where information about traders' orders is not revealed to other participants. [2] CME/NEX EBS and Refinitiv spot turnover (a proxy for trading volumes on EBS Market and Refinitiv/Reuters CLOBs). [3] 360T, Cboe FX (Hotspot); Euronext FX (Fastmatch); FXSpotStream.

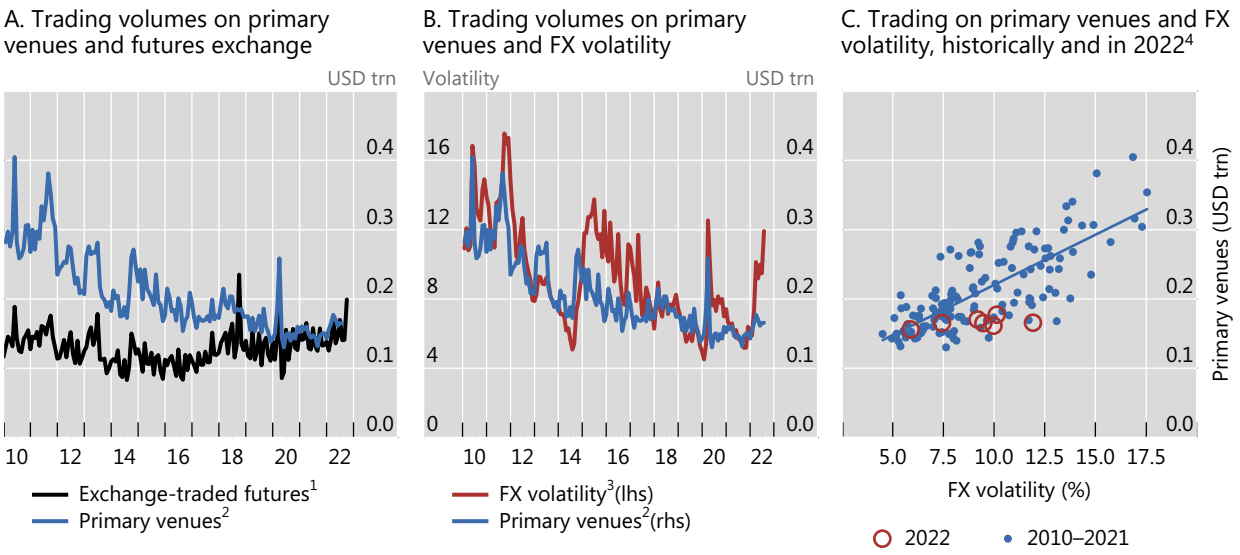
Sources: CBOE; CME; Deutsche Borse; Euronext; FXSpotStream; MarketFactory; Refinitiv; BIS.

Trading volumes on the primary venues have been declining for over a decade (Graph B2, panel A).④ One reason is more internalisation. Another is that dealers were weary of adverse selection by PTFs engaging in high-frequency trading strategies (HFTs) after PTFs gained access to these venues in mid-2000s. In an attempt to insulate bank dealers from what were perceived as "toxic" HFT strategies, primary venues have subsequently introduced "speed bumps" to level the playing field. A third reason is the greater use of execution algorithms that help users, including dealers, to slice orders into smaller pieces and to distribute these efficiently across different venues. In 2020, execution algorithms were estimated to account for 10–20% of global FX spot trading (Markets Committee (2020)).⑤ Last, PTFs often hedge the risk arising from liquidity provision to customers using futures rather than going to the primary venues. In part for this reason, futures markets have emerged as another locus for price discovery in currency markets alongside the primary venues (Chaboud et al (2021)).⑥

Despite their downward trend, volumes on primary venues have typically jumped with volatility but not so this year. Some inter-dealer trading volumes have typically gravitated back to primary venues during volatile conditions (Moore et al (2016)),⑦ so that volumes rose as volatility increased (Graph B2, panels B and C).④ After an initial rise of trading on primary venues in early 2022, trading volumes remained flat as volatility continued to rise. This divergence may reflect several factors, including stagnating customer volumes, some decline in PTF activity, including on primary venues, higher internalisation ratios, more risk management with related parties, and a greater share of direct electronic execution even among dealers.③

Volumes do not return to primary electronic brokers even as volatility spikes

In per cent — Graph B2



[1] Exchanged-traded currency futures turnover, all exchanges. [2] CME/NEX EBS and Refinitiv spot turnover (a proxy for trading volumes on EBS Market and Refinitiv/Reuters CLOBs). [3] Deutsche Bank USD volatility index (DBCVIX) average mid-price. [4] R-squared = 0.6.

Sources: Refinitiv; BIS exchange-traded derivatives statistics; BIS.

① The views expressed are those of the authors and do not necessarily reflect those of the Bank for International Settlements. ② Markets Committee, "Monitoring fast-paced electronic markets", report submitted by a Study Group, *Markets Committee Papers*, no 10, 2018. ⑤ A Chaboud, D Rime and V Sushko, "The foreign exchange market", in R Gurkaynak and J Wright (eds), *The Research Handbook of Financial Markets*, available on SSRN, 2022. ④ The time series shown in the graph overstate the turnover on primary venues because the publicly available data from EBS (CME/NEX Group) and Refinitiv include volumes traded on some of their other platforms. ⑤ Markets Committee, "FX execution algorithms and market functioning", report submitted by a Study Group, Markets Committee Papers, no 13, 2022. ⑥ A Chaboud, A Dao and C Vega, "What makes HFT tick? Tick size changes and information advantage in a market with fast and slow traders", available on SSRN, 2021. ⑦ A Moore, A Schrimpf and V Sushko, "Downsized FX markets: causes and implications", *BIS Quarterly Review*, December, 2016, pp 35–51.

Box C

FX trade execution through the lens of the Triennial

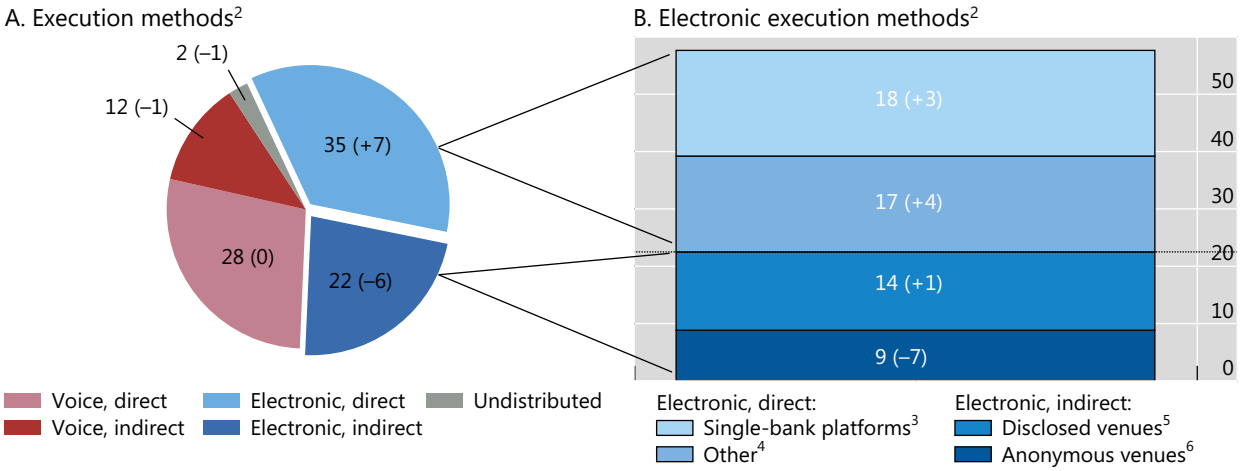
Mathias Drehmann and Vladyslav Sushko ①

The landscape of trade execution in the FX market is highly complex.② Market participants can execute trades directly with dealers but also on multiple venues that are organised very differently (eg anonymous central limit order books, such as the primary venues, or disclosed platforms where participants submit and respond to "requests for quotes") and with different counterparty segments (eg just inter-dealer platforms, platforms that are open to many dealers and customers, or dealer-owned platforms to match costumer trades). Trades can also be executed by voice (which includes messaging platforms) or electronically.

A key trend over recent decades has been increased "electronification", ie deeper penetration of the market by electronic and automated trade execution. The latest Triennial data suggest that the process of "electronification" may have steadied. The relative shares of voice and electronic execution in the FX market have not changed over the past three years (Graph C1, panel A). And around 60% of trades continue to be executed electronically.

Trade execution methods in April 2022[1]

As a percentage of the total turnover — Graph C1



[1] In brackets: change in percentage points since the 2019 Triennial. [2] Direct: trades not intermediated by a third party. Indirect: trades intermediated by a third party – either a voice broker or a third-party electronic platform. [3] Single-bank trading systems (eg Barclays BARX, Citi Velocity, Deutsche Bank Autobahn, UBS Neo). [4] Other direct electronic trading systems (eg direct electronic price streams). [5] Multibank dealing systems that facilitate trading on a disclosed basis or that allow for liquidity partitioning using customised tags (eg 360T, EBS Direct, Currenex FXTrades, Fastmatch, FXall OrderBook, Hotspot Link). [6] Electronic trading platforms geared to the non-disclosed interdealer market (eg EBS Market, Hotspot FX ECN, Reuters (Refinitiv) Matching).

Sources: BIS Triennial Central Bank Survey; BIS.

The 2022 Survey shows a marked shift towards direct forms of electronic trading, away from anonymous venues, including the primary venues (Graph C1, panel B). Specifically, there was a significant growth of direct electronic methods (+7% share), such as single-dealer platforms (SDPs) or direct price streams. This occurred mainly at the expense of indirect electronic trading on anonymous venues (–7%). Anonymous venues are trading platforms that are closest to an exchange, with counterparties not knowing who they are executing a trade with, but with the relevant information, such as prices, displayed to all the participants on the venue.

These developments imply that FX trading has gravitated further away from resembling trading on an exchange and more towards execution methods where counterparties know each other's identity, but with the trade information remaining private.

① The views expressed are those of the authors and do not necessarily reflect those of the Bank for International Settlements. ② A Schrimpf and V Sushko, "FX trade execution: complex and highly fragmented", *BIS Quarterly Review*, December 2019, pp 39–51.

References

Bank for International Settlements (2022): "Triennial Central Bank Survey of Foreign Exchange and Over-the-counter (OTC) Derivatives Markets in 2022", October.

Bech, M (2012): "FX volume during the financial crisis and now", *BIS Quarterly Review*, March, pp 33–43.

Borio, C, R McCauley and P McGuire (2022): "Dollar debt in FX swaps: huge, missing and growing", *BIS Quarterly Review*, December, pp 67–73.

Butz, M and R Oomen (2019): "Internalisation by electronic FX spot dealers", *Quantitative Finance*, vol 19, no 1, pp 35–56.

Caballero, J, P Wooldridge and D Xia (2022): "FX trading of EME currencies", *BIS Quarterly Review*, December, pp 49–65.

Chaboud, A, D Rime and V Sushko (2022): "The foreign exchange market", in R Gurkaynak and J Wright (eds), *The Research Handbook of Financial Markets*, available on SSRN.

Euromoney (2022): *Foreign Exchange Survey 2022*.

Gopinath, G (2015): "The international price system", *NBER Working Papers*, no 21646.

Lyons, R (1996): "Foreign exchange volume: Sound and fury signifying nothing?", in J Frankel, G Galli and A Giovannini (eds), *The Microstructure of Foreign Exchange Markets*, University of Chicago Press.

Markets Committee (2018): "Monitoring fast-paced electronic markets", report submitted by a Study Group, *Markets Committee Papers*, no 10.

——— (2020): "FX execution algorithms and market functioning", report submitted by a Study Group, *Markets Committee Papers*, no 13.

Moore, M, A Schrimpf and V Sushko (2016): "Downsized FX markets: causes and implications", *BIS Quarterly Review*, December, pp 35–51.

Ranaldo, A (2022): "Foreign exchange swaps and cross-currency swaps", *Swiss Finance Institute Research Papers*, no 22-51.

Schrimpf, A and V Sushko (2019): "Sizing up global foreign exchange markets", *BIS Quarterly Review*, December, pp 21–38.

Varian, H (1985): "Divergence of opinion in complete markets: a note", *Journal of Finance*, vol 40, no 1, pp 309–17.

Technical annex

Graph 1: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April.

Graph 2.A: Triennial Survey data are adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April. See Bech (2012) for a methodological description of the benchmarking technique. Vertical lines indicate the BIS Triennial Surveys in April of 2016, 2019 and 2022.

Graph 2.B: Options price based Deutsche Bank US dollar currency volatility index (DBCVIX) average mid-price. Vertical lines indicate the BIS Triennial Surveys in April 2016, 2019 and 2022.

Graph 2.C: Triennial Survey data are adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April. See Bech (2012) for a methodological description of the benchmarking technique.

Graph 3A: FX spot/derivatives based on volumes settled via CLS.

Graph 3.B: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. One-day data were not collected in previous Triennial surveys.

Graph 3.C: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis. One-day data were not collected in previous Triennial surveys.

Graph 4: FX turnover adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April.

Graph 4.C: Prime-brokered turnover includes both (i) the transactions between prime brokers and their customers as well as (ii) the resulting "give-up" trades with reporting dealers. The associated customer turnover is anywhere between a half and two thirds of the total prime-brokered turnover. See Box A in Schrimpf and Sushko (2019a).

Graph 5: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April.

Graph 6: Adjusted for local and cross-border inter-dealer double-counting.

Graph 6.A: Volume-weighted averages using total customer spot turnover (for countries that did not report the underlying customer spot turnover, their share in total spot turnover was applied). Asian centres include Hong Kong SAR, Japan and Singapore.

Graph 6.C: Based on back-to-back and compression trades.

Julián Caballero julian.caballero@bis.org
Alexis Maurin alexis.maurin@bis.org
Philip Wooldridge philip.wooldridge@bis.org
Dora Xia dora.xia@bis.org

The internationalisation of EME currency trading[1]

The participation of non-residents in foreign exchange (FX) markets for emerging market economy (EME) currencies has increased to the point where these markets are almost as internationalised as those for advanced economy (AE) currencies. Nevertheless, the overall volume of trading in many EME currencies relative to economic activity remains much less than that in AE currencies. This reflects EMEs' smaller domestic investor base and lower degree of international financial integration.

JEL classification: F31, F36, G15.

In foreign exchange (FX) markets, the composition of trading in many emerging market economy (EME) currencies has largely converged with that in advanced economy (AE) currencies along one important dimension: the participation of non-residents. Until the late 2000s, trading with non-residents accounted for a much smaller share of FX activity in EME currencies than in AE currencies. This share has since progressively increased. By 2022, FX trading in all but a handful of EME currencies was overwhelmingly with counterparties abroad (Graph 1). In other words, the trading of EME currencies had become almost as internationalised as that of AE currencies.

Internationalisation is not the only dimension along which the composition of EME currency trading has become similar to that of AE currency trading. The importance of derivatives and the participation of a diverse range of financial customers have also largely converged. Indeed, from the perspective of the structure of FX markets, the currencies of a few countries categorised by the BIS as EMEs now closely resemble AE currencies.[2]

[1] The authors thank Iñaki Aldasoro, Claudio Borio, Stijn Claessens, Mathias Drehmann, Jon Frost, Branimir Gruić, Benoît Mojon, Frank Packer, Andreas Schrimpf, Hyun Song Shin, Vladyslav Sushko, Nikola Tarashev, Christian Upper and Sonya Zhu for valuable comments and discussion. The views expressed in this feature are those of the authors and do not necessarily reflect those of the Bank for International Settlements.

[2] The BIS categorises the following 11 economies as AEs: Australia, Canada, Denmark, the euro area, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom and the United States. All other economies are categorised as either EMEs or developing economies. These groupings are intended solely for analytical convenience and do not represent an assessment of the stage reached by a particular country in the development process.

Key takeaways

- FX trading in EME currencies is increasingly internationalised, meaning that most trades involve a counterparty that resides outside the country that issued the currency.
- The market structure for EME currency trading increasingly resembles that for AE currencies in terms of location, instruments and counterparties.
- Trading volumes for most EME currencies remain lower relative to GDP than for AE currencies because of a smaller domestic investor base and less international financial integration.

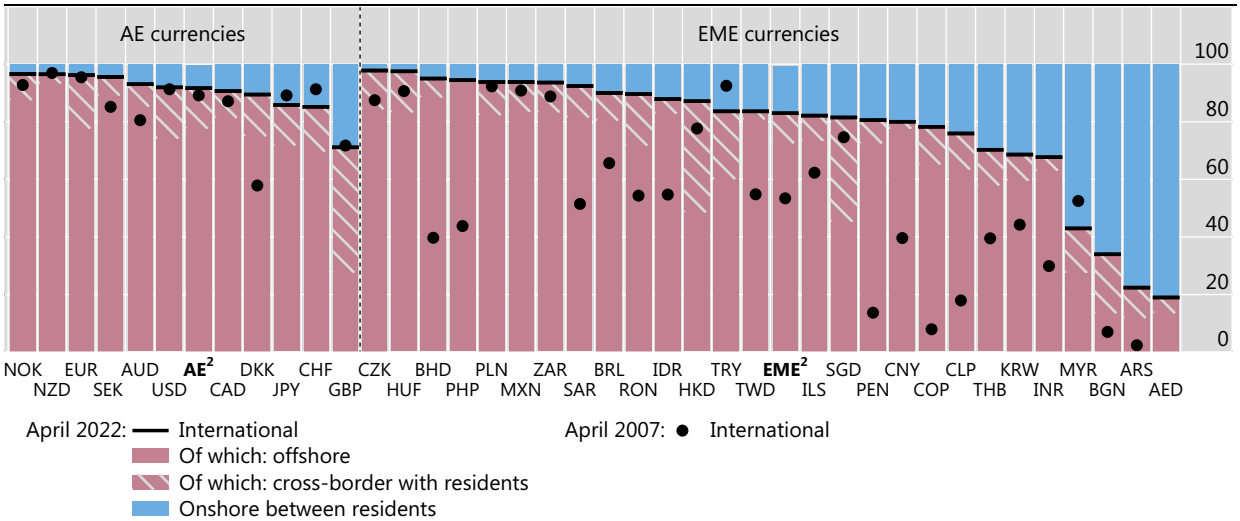
On the back of these trends, EME currencies' turnover almost tripled relative to GDP between 2007 and 2022. This growth was facilitated by increased portfolio investment and financial deepening. Despite this growth, the volume of FX trading in many, albeit not all, EME currencies remained low when benchmarked against underlying economic activity. EMEs' smaller domestic investor base and their lesser degree of international financial integration are important reasons why their FX trading remained relatively low.

The rest of this feature is structured as follows. The next section traces the rising internationalisation of EME currencies and its link to the growth of overall FX activity, drawing on the BIS Triennial Central Bank Survey of FX and over-the-counter (OTC) derivatives markets.[3] The feature then identifies the key factors behind these trends as well as the main drivers of FX turnover. The following section compares the structure of trading in EME and AE currencies. The concluding section highlights policy challenges arising from currency internationalisation. A box reviews FX trading in the Chinese renminbi (CNY), and another assesses the drivers of FX trading.

FX trading is mostly with non-residents outside the currency-issuing country[1]

In per cent of FX turnover

Graph 1



[1] See technical annex for details. [2] Median of AE/EME currencies.

Sources: BIS Triennial Central Bank Survey; authors' calculations.

[3] The Triennial Survey captures FX turnover in spot and OTC derivatives markets during the month of April. More than 1,200 banks and other dealers in 52 countries participated in the 2022 Survey. For details, see the BIS website, www.bis.org/stats_triennial_surveys/index.htm.

Trend towards currency internationalisation

Currency internationalisation refers to the use of a currency outside its country of issue. There are gradations of use, starting with the exchange of one currency against another for trade in goods and services and extending to the denomination of financial contracts in a currency foreign to the contracting parties (Kenen (2012)). Our focus is on the buying and selling of currencies by non-residents of the currency-issuing country, which are prerequisites for other international uses.

The internationalisation of FX trading can take two forms: transactions in foreign markets without the involvement of the issuing country's residents, referred to as offshore trades; and transactions between non-residents and residents of the issuing country, which we refer to as cross-border trades with residents.[4] The counterpart to these two forms of international trading is transactions between residents in their domestic market, referred to as onshore trades between residents.

AE currencies are all highly internationalised. Offshore trading accounts for the largest share of their FX turnover (Graph 1). Such trading is concentrated in a few major financial centres, foremost the United Kingdom followed by the United States, Singapore and Hong Kong SAR (BIS (2022a)). Cross-border trades with residents typically account for less than 10% of turnover. Among AE currencies, onshore trades between residents of the currency-issuing country are sizeable only for pound sterling (GBP), owing to London's pre-eminent place in the global FX market.

Among EME currencies, internationalisation has increased rapidly since the 2000s. For the median EME currency, the international share of trading rose from 53% in April 2007 to 83% in April 2022 (Graph 1). Offshore trading accounted for all of this increase; cross-border trading with residents of the issuing country actually declined as a share of overall trading. Onshore trades between residents remained large only for a few EME currencies, including Malaysian ringgit (MYR) and Argentine peso (ARS).

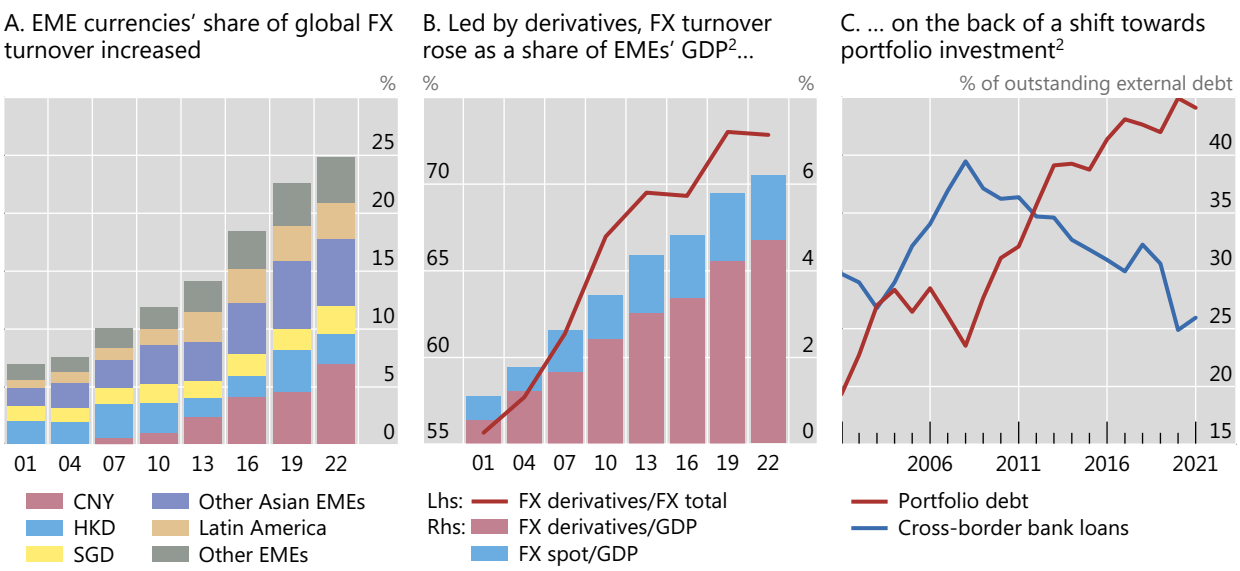
Owing to this expansion of offshore trading, the growth of turnover in EME currencies has greatly outpaced that in AE currencies since the mid-2000s, resulting in a near-tripling of their share of global trading (Graph 2, panel A). The CNY saw especially fast growth (see Box A). Moreover, EME currency trading rose faster than economic activity. Between April 2007 and April 2022, daily FX trading increased from less than 3% of the median EME's annual GDP to over 6% (panel B).

Internationalisation helped to propel overall FX turnover by facilitating diversification and innovation. Non-residents often have different preferences and constraints than residents. Their participation thus broadens opportunities for hedging and positioning by making it easier to find counterparties willing and able to take the other side of a trade. This in turn makes it more attractive for dealers to make markets, lowering transactions costs and, in the process whereby liquidity

[4] Data from the Triennial Survey overestimate offshore trading and underestimate cross-border trading with residents. Dealers who contribute to the Survey differentiate between transactions with residents and non-residents but do not report the geographic details that would be necessary to determine whether the customer resides in the currency-issuing country. Consequently, offshore trades include cross-border trades between dealers abroad and customers onshore. Estimates of international trading, which sum offshore trading and cross-border trading with residents, are unaffected by this potential misclassification.

Growth of EME currency trading[1]

Graph 2



[1] See technical annex for details. [2] Median of EME currencies.

Sources: IMF, *Balance of Payments Statistics*; IMF, *World Economic Outlook*; national data; BIS Triennial Central Bank Survey; authors' calculations.

begets liquidity, further boosting trading. Furthermore, non-residents often spearhead innovations that help to deepen markets. For example, the electronification of FX trading has boosted trading in major financial centres, especially London (Schrimpf and Sushko (2019)).

Accordingly, the internationalisation of EME currencies went hand in hand with a rise in the share of trading with a diverse range of financial customers, such as smaller (non-dealer) banks, institutional investors, hedge funds and proprietary trading firms. Such customers' collective share rose from about 30% of trading in the median EME currency in April 2007 to almost 50% in April 2022.

Financial customers tend to trade more heavily in derivatives markets than spot markets. Their rising prominence has thus boosted derivatives trading more than spot trading. For the median EME currency, derivatives trading rose from 61% of total FX turnover in April 2007 to 73% in April 2022 (Graph 2, panel B).

Box A

Renminbi turnover offshore surges

Among the 39 currencies covered in the BIS Triennial Survey, the Chinese yuan (CNY) saw the fastest growth in FX trading between April 2019 and April 2022. CNY trading rose by over 70% after adjusting for exchange rate movements, to $526 billion per day. This rapid growth elevated the CNY to the fifth most traded currency in the world. Even so, CNY turnover remained low relative to the size of China's economy: 3% of annual GDP, compared with 30% of GDP for USD and 6% for the median EME currency.

Increased CNY turnover largely reflected more active trading between counterparties outside mainland China. Such international turnover doubled between April 2019 and April 2022, to about 80% of all CNY trading (Graph A1, panel A). Hong Kong SAR remained the pre-eminent hub for trading CNY, but it lost market share to Singapore, the United Kingdom and the United Sates.

CNY trading onshore with residents of the mainland increased by only 4%, despite the Chinese government's continued efforts to open up domestic financial markets to foreign participants. The subdued growth of onshore trading was probably due to a city-wide lockdown in Shanghai between March and May 2022. Given the slowdown in international trade during the period and the city's status as China's main financial centre, the lockdown is likely to have weakened onshore trading in April, when the Triennial Survey was conducted.

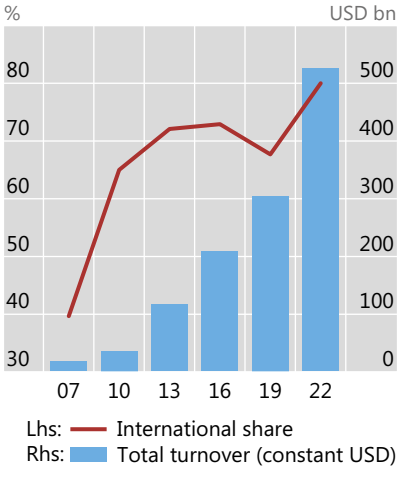
CNY growth was led by trading in options and with institutional investors, hedge funds and other non-bank financial customers. The shares of options in total turnover about doubled between 2019 and 2022, to 10%, as did the share of non-bank financial customers, to 18% (Graph A1, panel B).

Rising portfolio investment contributed to the growth of CNY trading. Cumulative inflows into local bond and equity markets rose strongly over several years through early 2022, when China subsequently saw outflows. In addition, the instrument and counterparty composition of trading suggests that heightened volatility contributed to the expansion of CNY trading in April 2022. The volatility of the CNYUSD exchange rate was high in April 2022, comparable with levels seen in late 2018 when China-US trade frictions escalated (panel C). Higher volatility typically leads to more active trading as hedging and speculation increase (Drehmann and Sushko (2022)). The impact is often more pronounced in options because their payoff is directly related to volatility.

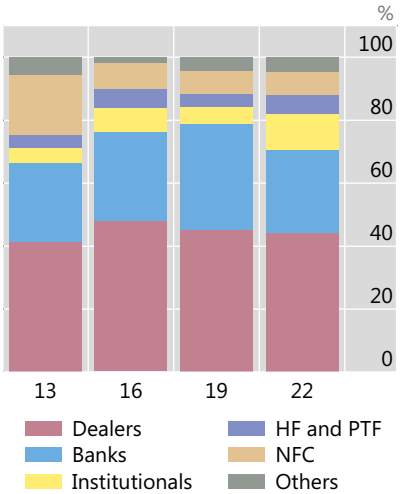
Rising volume and diversity of trading in Chinese renminbi

Graph A1

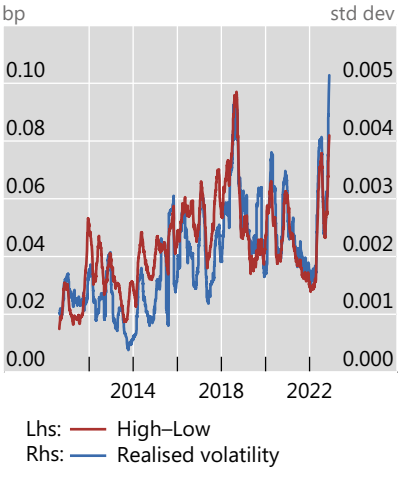
A. International trading surged in 2022[1]



B. More trading with institutional investors



C. Intraday fluctuations in CNYUSD rose in early 2022[2]



HF = hedge funds; NFC = non-financial corporations; PTF = proprietary trading firms.

[1] Constant exchange rates; April of each year. [2] Computed over a rolling 65-day window.

Sources: Bloomberg; BIS Triennial Central Bank Survey; authors' calculations.

Financial deepening boosts FX turnover

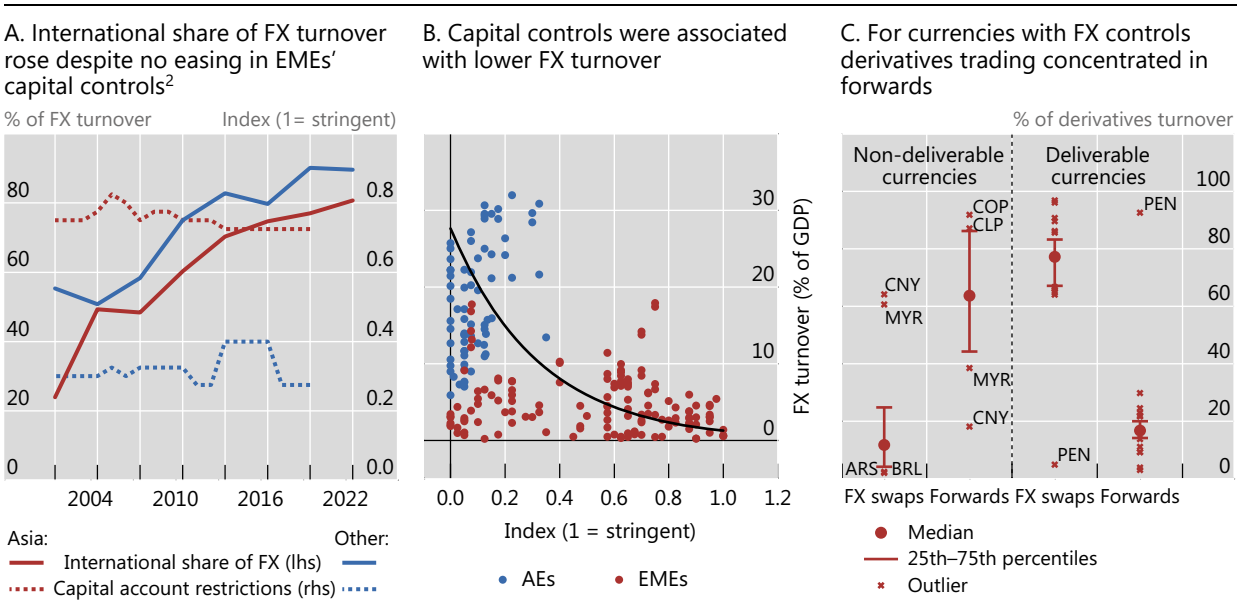
Notably, the rise in EME currencies' internationalisation and the growth of their overall FX trading were not precipitated by a significant easing of FX or capital controls. Instead, they were spurred by the changing composition of foreign investment and the deepening of local financial markets.

Many EMEs retain FX and capital controls. Indeed, since the Great Financial Crisis (GFC) of 2007–09, restrictions on capital movements in the median EME have not changed much (Graph 3, panel A). A number of EMEs, particularly in Asia, require FX transactions to be backed by underlying trade in goods and services or investments.

These controls hinder market liquidity by causing FX trading to fragment between onshore and offshore markets. Non-residents typically choose to trade offshore, beyond the reach of FX controls, rather than participate in the onshore market. Overall turnover is lower as a result. To be sure, there are many economies where FX turnover is subdued relative to GDP even though capital restrictions are low (Graph 3, panel B).[5] That said, where capital restrictions are high, FX turnover is invariably low.

Fragmentation between onshore and offshore markets is most noticeable in FX swaps and forwards. FX swaps require the exchange of principal and are thus inhibited by restrictions on their deliverability abroad. For deliverable currencies, FX swaps account for the largest share of derivatives trading (Graph 3, panel C). They are used by residents and non-residents alike to fund and hedge foreign investments (Borio et

Controls lead to the fragmentation of FX trading[1] Graph 3



[1] See technical annex for details. [2] Median of Asian EMEs/Other EMEs.

Sources: Fernández et al (2016); IMF, *World Economic Outlook*; BIS Triennial Central Bank Survey; authors' calculations.

[5] FX controls govern the buying and selling of the local currency, whereas capital controls regulate cross-border transactions in financial assets and liabilities. They tend to be liberalised together and thus capital controls can be seen as a proxy for FX controls. However, it is not uncommon for countries to remove all FX controls but maintain some restrictions on inward or outward investment.

al (2022). By contrast, for currencies with FX controls, FX swaps account for a very small share of derivatives trading and are predominantly traded onshore between residents. Instead, derivatives trading is concentrated in forwards, especially non-deliverable forwards (NDFs) traded offshore. NDFs do not require an exchange of currencies; they settle in the same currency, typically in US dollars. For a few currencies, FX controls permit limited deliverability outside the issuing country, which boosts their FX swap and overall trading. For example, this is the case for CNY, which can be cleared and settled in Hong Kong SAR and a few other major financial centres in the so-called CNH market.

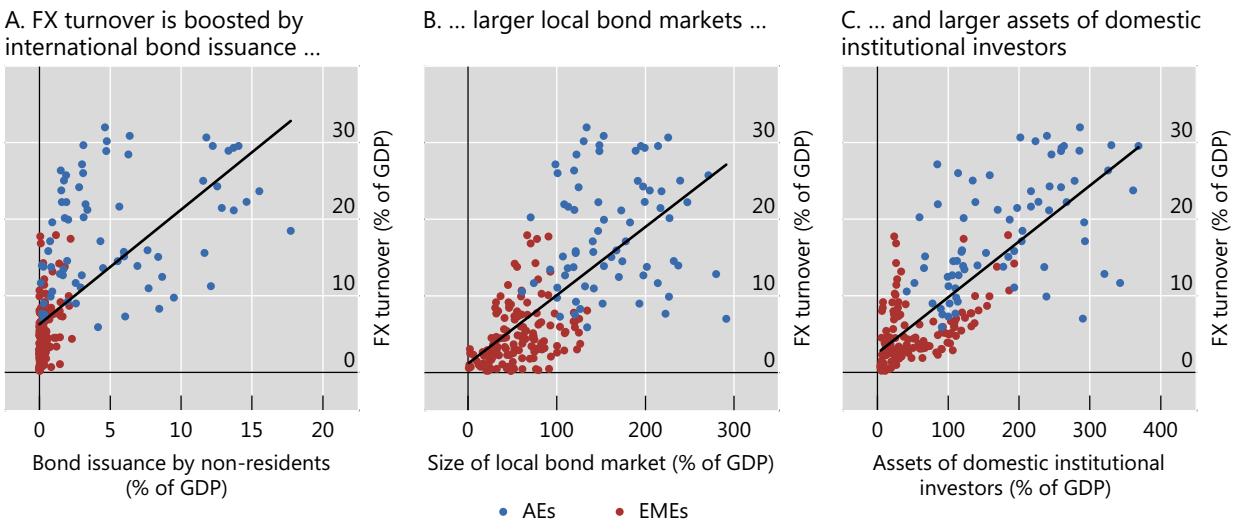
Rather than an easing of controls, what stimulated the trading of EME currencies, especially with non-residents, was a rise in portfolio flows. Following the GFC, the composition of debt inflows to EMEs shifted from bank lending to portfolio investment (Shin (2013); Graph 2, panel C). This shift generated demand for exchanging currencies and hedging FX risk. Whereas international loans were denominated mainly in US dollars and usually hedged at the time of borrowing if at all, foreign institutional investors, such as investment funds, often invested in bonds and other securities denominated in EME currencies and actively managed their FX exposures (CGFS (2021)). Furthermore, whereas loans were associated with infrequent payments, bonds and equities traded in secondary markets, generating frequent payments. Alongside inflows, portfolio outflows from EMEs increased too, in particular outward investment by domestic institutional investors, mainly pension funds and insurance companies (McGuire et al (2021)).

The relationship between portfolio flows and FX trading is evident in the issuance of international bonds. Foreign borrowers often swap the proceeds into another currency. Consequently, the larger such issuance, the higher is the ratio of FX turnover to GDP (Graph 4, panel A). International issuance of bonds denominated in Brazilian real (BRL), CNY, Turkish lira (TRY) and a few other EME currencies increased during the 2010s, which helped to boost FX trading in these currencies.

More generally, FX turnover was supported by financial deepening. The larger the stock of tradable debt and the more diverse the investor base, the more

Financial deepening drives differences in FX turnover[1]

Graph 4



[1] See technical annex for details.

Sources: IMF, *World Economic Outlook*; World Bank, *Global Financial Development Database*; BIS debt securities statistics; BIS Triennial Central Bank Survey; authors' calculations.

developed tends to be the ecosystem for trading debt and hedging the associated risks. Accordingly, FX turnover is positively correlated with the size of the domestic bond market (Graph 4, panel B) as well as the assets of domestic institutional investors (panel C). Regression analysis confirms the significant contribution of domestic investors to FX turnover, even after controlling for other factors (see Box B).

Trading volumes in EME currencies remain low

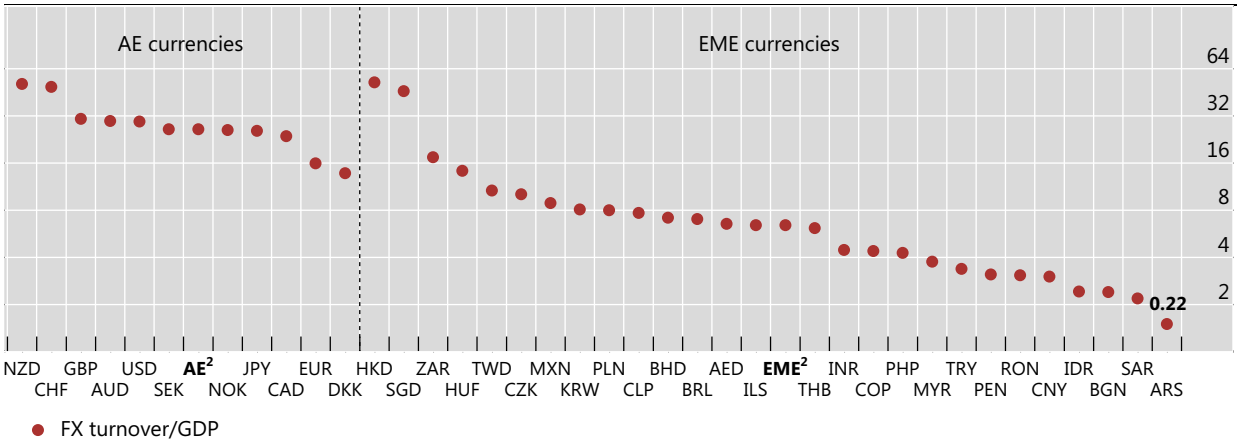
Despite the decade-long trend towards internationalisation and its role in propelling overall growth, the volume of FX trading relative to economic activity remained low for many EME currencies, much lower than for the typical AE currency. Daily FX turnover in April 2022 for the median EME currency was roughly 6% of annual GDP, well below the 26% for AEs (Graph 5). Aside from the Hong Kong dollar (HKD) and the Singapore dollar (SGD), the only EME currencies that came close to the median for AE currencies were the South African rand (ZAR) and the Hungarian forint (HUF).

The relatively low volume of FX trading partly reflects the modest size of financial markets in EMEs. In particular, the heft of domestic institutional investors is much smaller in EMEs. Assets held by institutional investors equalled about 38% of GDP in the median EME at end-2021, compared with 151% in the median AE (Graph 6, panel A).

The juxtaposition of greater currency internationalisation but low FX trading relative to economic activity also highlights the lesser degree of overall international financial integration in many EMEs. Countries with larger external positions – common proxies for financial integration – tend to have larger FX trading in their currencies (Graph 6, panel B). In particular, external debt tends to give rise to FX hedging demand (see Box B). The gross external debt position – outstanding external assets and liabilities that take the form of debt – of the median EME rose from 17% of GDP in 2007 to 28% in 2021 (panel C). Yet, it was still much smaller than the external debt position of the median AE, which was 98% of GDP in 2021.

For most EME currencies FX trading is low compared with GDP[1]

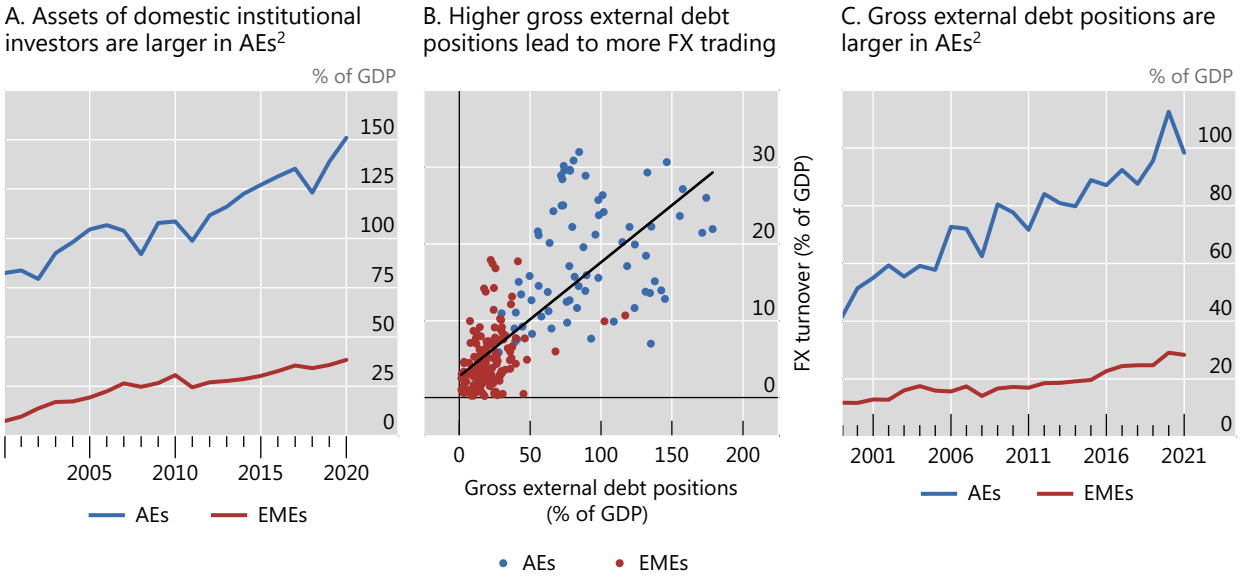
In per cent, $\log_{10}$ scale with axis labels in natural units — Graph 5



[1] See technical annex for details. [2] Median of AE/EME currencies.

Sources: IMF, *World Economic Outlook*; BIS Triennial Central Bank Survey; authors' calculations.

Low FX turnover reflects small markets and less international integration[1] Graph 6



[1] See technical annex for details. [2] Median of AEs/EMEs.

Sources: Lane and Milesi-Ferretti (2018); IMF, *World Economic Outlook*; World Bank, *Global Financial Development Database;* BIS Triennial Central Bank Survey; authors' calculations.

Evolving market structure for EME currency trading

Notwithstanding large differences between AE and EME currencies regarding the volume of FX trading, the structure of their trading is becoming increasingly similar. Besides the international share discussed above (Graph 7, panel A), the instrument and counterparty composition of FX turnover in EME currencies also increasingly resembles that of AE currencies. That said, there is still a higher degree of heterogeneity among EME currencies than in AE currencies, as indicated by the wide dispersion around the median shown in Graph 7.

FX derivatives markets in EME currencies have gained depth over time, and as a result spot trading now accounts for a similar share of total FX turnover in EME and AE currencies (Graph 7, panel B). In EME derivatives markets, FX forwards and futures have lost market share as FX swaps trading has expanded (panel C). While forwards and futures now account for similar shares of the median EME and AE currencies, the range is much larger for EME currencies because of the importance of NDFs for some.

Another dimension along which FX trading in EME and AE currencies has converged is the prominence of financial customers, in particular institutional investors and other non-bank financial institutions. During the 2010s, the share of these financial customers rose steadily for AE and EME currencies, but the share of AE currencies was persistently higher (Graph 7, panel D). In 2022, financial customers retreated from FX trading, with AE currencies experiencing a relatively larger decline

that brought financial customers' share of AE currency trading down to that of EME currencies.[6]

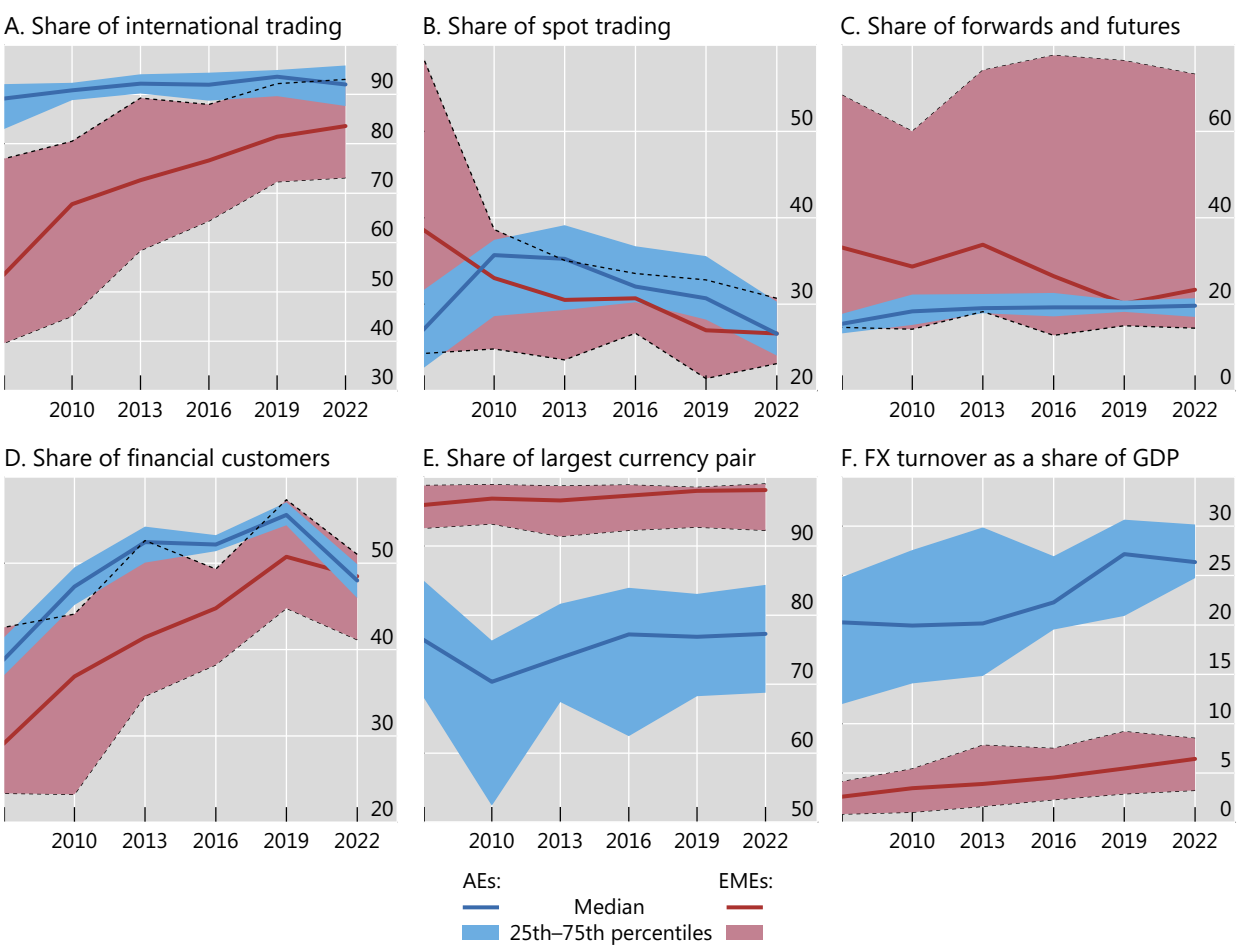
That said, there remain notable differences between EME and AE currency trading along several dimensions. The most important is trading volumes relative to GDP, as discussed above (Graph 7, panel F). Another is the diversity of currencies against which they trade. While EME currencies trade predominantly against either US dollar (USD) or euro (EUR), AE currencies generally trade against a broader set of currencies. Consequently, the largest currency pair accounts for 99% of trading in the median EME currency, but only 77% in the median AE one (panel E).

To assess the extent to which the market structure for EME currency trading has converged with that for AE currencies, we use cluster analysis to group currencies that have similar trading characteristics. Market structure is characterised by the six variables shown in Graph 7: international and spot shares of FX trading, share of

Structure of FX markets: comparison of AE and EME currencies[1]

In per cent

Graph 7



[1] See technical annex for details.

Sources: IMF, *World Economic Outlook*; BIS Triennial Central Bank Survey; authors' calculations.

[6] More generally, in 2022 trading by dealers with customers stagnated owing largely to a slowdown in international investment activity. At the same time, inter-dealer trading increased because of higher volatility (Drehmann and Sushko (2022)).

derivatives trading in forwards and futures, importance of financial customers, diversity of currency pairs, and FX turnover scaled by GDP.

The analysis results in two broad clusters, one of which consists exclusively of EME currencies (Table 1, cluster 1) and the other a mix of AE and EME currencies (cluster 2). Within cluster 1, there is a subcluster (1A) comprising currencies that have a high share of trading in forwards and futures. All but one of these currencies have FX controls, which boost the trading of NDFs. Even though PEN is deliverable, it stands out for having more active trading in NDFs than FX swaps (Graph 3C). There is a small subcluster of EME currencies (1B) comprising ARS and the Bulgarian lev (BGN), where onshore transactions between residents and spot trading dominate. Unlike ARS, BGN is not subject to FX or capital controls. Yet, its FX market is like that of ARS because Bulgarian residents seem to trade FX derivatives denominated in EUR rather than BGN, perhaps because of the currency board linking BGN to EUR.

Within cluster 2, there is a subcluster (2A) comprising only EME currencies, namely the Bahraini dinar (BHD), Romanian leu (RON) and Saudi riyal (SAR). This subcluster is closer to AE currencies than to the other EME subclusters because its constituent currencies have high international activity, limited spot trading and a low share of forwards and futures in derivatives trading.

A number of EME currencies cluster with AE currencies. FX trading in HKD and SGD resembles that in GBP, the New Zealand dollar (NZD) and the Swiss franc (CHF). This is mainly because their turnover is exceptionally large vis-à-vis their GDP. Several currencies of European EMEs, such as the Czech koruna (CZK), HUF and Polish zloty (PLN), are much closer to the currencies of European AEs than to other EME currencies (subcluster 2C). EUR and USD are also in this subcluster. They stand out from other AE currencies mainly because they trade against more than one currency.

Five EME currencies are in the same subcluster (2D) as the Australian dollar (AUD), Canadian dollar (CAD) and Japanese yen (JPY). The similarity of ZAR to AUD,

Structure of FX trading in some EME currencies resembles that in AE currencies[1] Table 1

Cluster by hierarchy		AE currencies	EME currencies			Key characteristics that differentiate clusters
			Asian currencies	Latin American currencies	Other EME currencies	
1	1A		IDR, INR, KRW, MYR, PHP, THB, TWD	BRL, CLP, COP, PEN		High share of forwards and futures
	1B			ARS	BGN	High share of spot trading Low share of international trading
2	2A				BHD, RON, SAR	Low share of forwards and futures
	2B	CHF, GBP, NZD	HKD, SGD			High ratio of FX turnover to GDP
	2C	DKK, EUR, NOK, SEK, USD			CZK, HUF, PLN	Low share of largest currency pair
	2D	AUD, CAD, JPY	CNY	MXN	ILS, TRY, ZAR	Close to the median for all characteristics

[1] Based on an agglomerative hierarchical clustering algorithm using Ward's method, which at each stage combines the two clusters with the smallest increase in the overall sum of squares. In other words, the process attempts to generate clusters to minimise the total within-cluster variance (sum of currencies squared Euclidean distance to the cluster mean). We chose the optimal number of clusters based on the hierarchical structure of the dendrogram.

Sources: IMF, *World Economic Outlook*; BIS Triennial Central Bank Survey; authors' calculations.

CAD and JPY is not surprising considering its high volume of trading and sophisticated derivatives markets. The Israeli shekel (ILS), Mexican peso (MXN) and Turkish lira (TRY) have much lower ratios of FX turnover to GDP than AUD, CAD and JPY, but their trading structure is similar in terms of location, instruments and counterparties. The CNY is a surprising addition to this subcluster, given that it is subject to much stricter FX and capital controls than other constituent currencies. By stimulating the development of the offshore CNH market, the partial deliverability of CNY has seemingly resulted in a market structure similar to that of deliverable currencies.

Conclusions

The structure of FX trading in many EME currencies increasingly resembles that in AE currencies, notably in terms of its internationalisation but also in terms of the range of instruments traded and the diversity of participants who trade them. This evolution in EME currencies' trading is a manifestation of broader trends that are blurring the distinction between AEs and EMEs. In particular, against the backdrop of better institutional frameworks and macroeconomic fundamentals in EMEs, investors have increasingly assessed EMEs on the basis of country-specific factors since the GFC, as they do for AEs (CGFS (2021)).

The trends towards currency internationalisation pose several challenges for EME policymakers. One is to improve their monitoring of FX trading abroad (BIS (2022b)). Offshore markets are often a locus for price discovery and volatility (Patel and Xia (2019)), yet information about them is not readily available. Central bank cooperation can help in this regard, such as through the Triennial Survey, and so too can tools for processing real-time financial data feeds, as prototyped in Project Rio by the BIS Innovation Hub.

Another policy challenge is to build on past success developing FX markets in a more challenging macroeconomic environment. For a decade after the GFC, a search for yield amidst abundant global liquidity boosted foreign investors' appetite for EME assets. That changed in 2022, when higher policy rates and mounting downside risks to economic growth led to a market-wide pullback in risk-taking. This retrenchment could cause liquidity conditions in EME currencies to deteriorate. Such a change might give urgency to further reforms to deepen FX markets, such as reducing obstacles to the integration of onshore and offshore markets.

The waning of foreign investors' appetite for EME assets puts the spotlight on the potential financial stability risks that greater international financial integration poses to EMEs. Policies that promote financial market deepening can help to reduce risks from international spillovers (CGFS (2019)). Key among these is the development of the local investor base. Local investors, particularly large institutional investors such as mutual and pension funds, play an important role in developing hedging markets and driving FX turnover. They should also help dampen volatility arising from the behaviour of non-resident investors (Carstens and Shin (2019)).

References

BIS (2022a): "OTC foreign exchange turnover in April 2022", *BIS Triennial Central Bank Survey*, 27 October.

——— (2022b): "Foreign exchange markets in Asia-Pacific", a report by a Study Group established by the Asian Consultative Council of the Bank for International Settlements, October.

Borio C, R McCauley and P McGuire (2022): "Dollar debt in FX swaps: huge, missing and growing", *BIS Quarterly Review*, December, pp 67–73.

Carstens, A and H S Shin (2019): "Emerging markets aren't out of the woods yet", *Foreign Affairs*, 15 March.

Committee on the Global Financial System (CGFS) (2019): "Establishing viable capital markets", *CGFS Papers*, no 62, January.

——— (2021): "Changing patterns of capital flows", *CGFS Papers*, no 66, May.

Drehmann, M and V Sushko (2022): "The global foreign exchange market in a higher-volatility environment", *BIS Quarterly Review*, December, pp 33–48.

Fernández, A, M Klein, A Rebucci, M Schindler and M Uribe (2016): "Capital control measures: a new dataset", *IMF Economic Review*, vol 64, pp 548–74. Updated data release of 12 August 2021.

Kenen, P (2012): "Currency internationalisation: an overview", *BIS Papers*, no 61, January.

Lane, P and G Milesi-Ferretti (2018): "The external wealth of nations revisited: international financial integration in the aftermath of the Global Financial Crisis," *IMF Economic Review*, vol 66, pp 189–222.

McGuire, P, I Shim, H S Shin and V Sushko (2021): "Outward portfolio investment and dollar funding in emerging Asia", *BIS Quarterly Review*, December, pp 53–67.

Mihaljek, D and F Packer (2010): "Derivatives in emerging markets", *BIS Quarterly Review*, December, pp 43–58.

Patel, N and D Xia (2019): "Offshore markets drive trading of emerging market currencies", *BIS Quarterly Review*, December, pp 67–80

Ramaswamy, S and R Scott (2005): "Managing a multi-currency bond portfolio", in F Fabozzi, L Martellini and P Priaulet (eds), *Advanced Bond Portfolio Management: Best Practices in Modelling and Strategies*, John Wiley and Sons.

Schrimpf, A and V Sushko (2019): "Sizing up global foreign exchange markets", *BIS Quarterly Review*, December, pp 21–38.

Shin, H S (2013): "The second phase of global liquidity and its impact on emerging economies", keynote address at the Asia Economic Policy Conference at the Federal Reserve Bank of San Francisco, November.

Upper, C and M Valli (2016): "Emerging derivatives markets?", *BIS Quarterly Review*, December, pp 67–80.

Wooldridge, J (2019): "Correlated random effects models with unbalanced panels", *Journal of Econometrics*, vol 211, no 1, July, pp 137–50.

Box B

Regression analysis of drivers of FX turnover

Many financial factors are closely correlated with FX turnover. To confirm which are the key drivers of differences in FX turnover across currencies and whether the correlations are meaningful, we estimate a multivariate regression that models FX turnover as a function of various proxies for trading and hedging demand. The regression results are largely consistent with the bivariate results of the plots as well as previous studies (Schrimpf and Sushko (2019), Upper and Valli (2016)). One novelty of our findings is that the assets of domestic institutional investors have a significant impact on FX turnover even after controlling for other drivers.

Our sample comprises 35 currencies – 11 from AEs and 24 from EMEs – and eight points in time, based on the Triennial Surveys from 2001 through 2022. FX turnover is measured as the sum of spot and derivatives trading in April of the given year, in OTC markets as well as on exchanges. While hedging demand is most closely related to derivatives activity, it can also give rise to spot trading – for example, a FX swap can be replicated with a spot and FX forward transaction – and so we focus on total turnover. To standardise variables across currencies, we scale turnover and other nominal variables by the GDP of the currency-issuing country.

One source of hedging demand is international trade, which we measure as the annual sum of exports and imports of goods and services. Another source is foreign currency borrowing. Resident borrowers might issue debt in a foreign currency and swap the proceeds to their local currency, while non-resident borrowers might do the opposite, issuing in resident investors' local currency and swapping to another currency. Indeed, such swap-covered borrowing accounts for a large share of foreign currency issuance (Munro and Wooldridge (2010)). Accordingly, we expect bond issuance by residents in foreign currency, as well as bond issuance by non-residents in investors' local currency, to be associated with higher FX turnover. The latter is likely to be more strongly associated with FX turnover than is the former because resident borrowers may have a natural hedge in the form of foreign currency revenues. Derivatives associated with such issuance tend to be one-off transactions, often with tenors equal to the maturity of the underlying bond, and so we proxy this by gross issuance over the six months prior to April of each Survey year.

More generally, FX turnover is expected to be positively influenced by international financial integration. A commonly used de facto measure of integration is external assets and liabilities (Lane and Milesi-Ferretti (2018)). Debt is more likely to be hedged than equity because the volatility of equity returns is much higher and open currency positions add volatility to bond portfolios without adding much return (Ramaswamy and Scott (2005)). Therefore, we focus on external assets and liabilities that take the form of debt.① An alternative de jure measure of financial integration is restrictions on cross-border movements of capital. The index compiled by Fernández et al (2016) increases in stringency from 0 to 1 and so it is expected to be negatively correlated with FX turnover.

Similarly, financial development is likely to give rise to more hedging and position-taking. Domestic institutional investors often have large and sophisticated hedging programmes to manage the currency risk associated with their foreign holdings. Thus, we expect FX turnover to be positively correlated with the size of assets managed by domestic mutual funds, pension funds, insurance companies and other institutional investors based in the currency-issuing country. Likewise, the larger the domestic bond market, the more developed the ecosystem for trading debt and hedging the associated risks tends to be.

Hedging demand and position-taking are also influenced by volatility (Drehmann and Sushko (2022)). Currencies that are fixed will tend to have lower FX turnover, and those that fluctuate a higher one. In the regression model, volatility is measured as the standard deviation of daily changes in the exchange rate against the USD over the three years prior to April of each Survey year. Turnover in higher-yielding currencies might also be boosted by carry trades, the attractiveness of which we measure using the carry-to-risk ratio. This ratio is calculated over the six-month period prior to each Survey as the difference between local currency and USD interest rates divided by the option-implied volatility of the exchange rate.

Finally, we include real GDP per capita to control for various structural characteristics that might be correlated with FX turnover or financial development in general, such as the strength of institutions and the rule of law. While higher income does not itself give rise to hedging demand, it has been shown to be associated with higher derivatives turnover (Mihaljek and Packer (2010), Upper and Valli (2016)). We also include a dummy to control for exceptionally high turnover in a few currencies, mainly the currencies of financial centres, the CHF, HKD and SGD, as well as NZD.

The regression analysis confirms the importance for FX turnover of financial variables. While trade has a positive impact on FX turnover, proxies for financial integration have a larger impact. An increase in residents' external debt liabilities by 10 percentage points of GDP increases FX turnover by 1.8 percentage points of GDP. An increase in residents' external debt assets by the same amount increases FX turnover by a smaller but still significant 1.3 percentage points. Local currency borrowing by non-resident issuers is also important: a 1 percentage point increase in issuance to GDP (which would be large compared with issuance of 0.4% of GDP in the median currency) boosts turnover by about 0.3 percentage points of GDP. The effect of capital account restrictions is not statistically significant in the full sample, but it does have a differential negative effect in EMEs when we allow its effect to vary in this country group relative to AEs – most of which have no restrictions.

Even after controlling for financial integration, some proxies for financial development are significant. An increase in domestic institutional investors' assets by 10 percentage points of GDP is associated with a 2 percentage point increase in FX turnover. However, the size of the bond market is not statistically significant. Volatility and the carry-to-risk ratio are also not statistically significant in our model.

Determinants of FX turnover[1] Table B1

	Baseline	Adding FX volatility and carry trade
Total trade (exports plus imports, % GDP)	0.056***	0.061***
Residents' issuance of foreign currency bonds (% GDP)	–0.134	–0.118
Non-residents' issuance of local currency bonds (% GDP)	0.349*	0.331*
Residents' outstanding external debt assets (% GDP)	0.133***	0.132***
Residents' outstanding external debt liabilities (% GDP)	0.176***	0.180***
Capital account restrictions (from 0=none to 1=stringent)	0.044	0.043
Assets of domestic institutional investors (% GDP)	0.023***	0.021***
Size of the local bond market (% GDP)	0.000	–0.006
Exchange rate volatility		0.008
Carry-to-risk ratio		–0.016
GDP per capita, in constant 2021 US dollars (logs)	0.048*	0.066**
Financial centre dummy	0.289***	0.295***
Constant	–0.184*	–0.146
Overall R-squared	0.856	0.862
Observations	245	223
Currencies[2]	35	32

[1] Estimated as correlated random effects panel model via OLS using the pooled sample. To control for possible correlation between a given covariate and the panel intercept, the mean of each covariate across the sample is included for each currency. For an explanation of this estimation approach, see Wooldridge (2019). ***/**/* denotes statistical significance at the 1/5/10% level. [2] AE currencies: AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, SEK and USD. EME currencies: ARS, BGN, BRL, CLP, CNY, COP, CZK, HKD, HUF, IDR, ILS, INR, KRW, LTV, MXN, MYR, PEN, PHP, PLN, SAR, SGD, THB, TRY and ZAR.

Sources: Fernández et al (2016); Lane and Milesi-Ferretti (2018); IMF, *World Economic Outlook*; World Bank, *Global Financial Development Database*; Bloomberg; Datastream Refinitiv; JP Morgan Markets; national data; BIS debt securities statistics; BIS Triennial Central Bank Survey; authors' calculations.

① Our preferred measure is portfolio debt, but data are not available for all years and countries in our sample.

Technical annex

For definitions of ISO currency and country codes, see Abbreviations at the beginning of the *BIS Quarterly Review*, https://www.bis.org/publ/qtrpdf/r_qt2212/r_qt2212_abbreviations.pdf.

Graph 1: Average daily FX turnover in spot and derivatives markets (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), excluding exchange-traded derivatives. National aggregates adjusted for local inter-dealer double-counting, ie "net-gross" basis.

Graph 2.A: Other Asian EMEs = IDR, INR, KRW, MYR, PHP, THB and TWD. Latin America = ARS, BRL, CLP, COP, MXN and PEN. Other EMEs = AED, BGN, CZK, HUF, ILS, PLN, RON, SAR, TRY and ZAR. All years are based on a constant exchange rate (April 2022). Turnover is adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Graph 2.B: Based on data for the 27 EMEs shown in Graph 1. Average daily turnover in April is scaled by annual GDP from the prior year and adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis.

Graph 2.C: Based on data for the EMEs shown in Graph 1, excluding AE and TW. Outstanding external debt is calculated as portfolio debt liabilities plus other debt liabilities. Cross-border loans include interbank deposits and deposits with own affiliates.

Graph 3.A: Capital account restrictions are based on data for the EMEs shown in Graph 1, excluding AE and TW. International share of FX turnover is based on data for the 27 EMEs shown in Graph 1.

Graph 3.B: Average daily FX turnover in spot and derivatives markets (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), including exchange-traded derivatives. The sample is based on data every three years from 2001 to 2022 (eight survey years) for AR, AU, BG, BR, CA, CL, CN, CO, CZ, DK, EA, GB, HU, ID, IL, IN, JP, KR, MX, MY, NO, PE, PH, PL, SA, SE, TH, TR, US and ZA. CH, HK, NZ and SG are excluded as outliers. For capital account restrictions, data for 2022 refer to 2019.

Graph 3.C: Non-deliverable currencies = ARS, BRL, CLP, CNY, COP, IDR, INR, KRW, MYR, PHP and TWD. Deliverable currencies = currencies shown in Graph 1 excluding the 11 non-deliverable currencies. Average daily FX turnover in derivatives markets (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), including exchange-traded derivatives. Forwards = FX forwards plus FX futures.

Graph 4: Average daily FX turnover in spot and derivatives markets (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), excluding exchange-traded derivatives. Based on data every three years from 2001 to 2022 (eight survey years) for AR, AU, BG, BR, CA, CL, CN, CO, CZ, DK, EA, GB, HU, ID, IL, IN, JP, KR, MX, MY, NO, PE, PH, PL, SA, SE, TH, TR, TW, US and ZA. CH, HK, NZ and SG are excluded as outliers. For bond issuance by non-residents, bond market size, assets of domestic institutional investors and GDP, data refer to the year before the survey year.

Graph 5: Average daily FX turnover in spot and derivatives markets in April 2022 (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), including exchange-traded derivatives. Turnover is scaled by annual GDP of the currency issuing country in 2021.

Graph 6.A: AEs = AU, CA, CH, DK, GB, JP, NO, NZ, SE, US plus euro area members (AT, BE, CY, EE, FI, FR, DE, GR, IE, IT, LV, LT, LU, MT, NL, PT, SK, SI and ES). EMEs = AE, AR, BH, BG, BR, CL, CN, CO, CZ, HK, HU, ID, IL, IN, KR, MX, MY, PE, PH, PL, RO, SA, SG, TH, TR, TW and ZA.

Graph 6.B: Average daily FX turnover in spot and derivatives markets (adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis), including exchange-traded derivatives. Based on data every three years from 2001 to 2022 (eight survey years) for AR, AU, BG, BR, CA, CL, CN, CO, CZ, DK, EA, GB, HU, ID, IL, IN, JP, KR, MX, MY, NO, PE, PH, PL, SA, SE, TH, TR, TW, US and ZA. CH, HK, NZ and SG are excluded as outliers. Gross external debt

positions are calculated as the sum of outstanding debt assets and debt liabilities and refer to the year before the survey year.

Graph 6.C: AEs = AU, CA, CH, DK, EA, GB, JP, NO, NZ, SE and US. EMEs = AE, AR, BH, BG, BR, CL, CN, CO, CZ, HK, HU, ID, IL, IN, KR, MX, MY, PE, PH, PL, RO, SA, SG, TH, TR, TW and ZA.

Graph 7: Based on data for the 11 AE currencies and 27 EME currencies shown in Graph 1.

Graphs 7.A, D–F: As a share of FX turnover in spot and derivatives markets, excluding exchange-traded derivatives.

Graph 7.B: As a share of FX turnover in spot and derivatives markets, including exchange-traded derivatives.

Graph 7.C: As a share of FX turnover in derivatives markets, including exchange-traded derivatives.

Claudio Borio
claudio.borio@bis.org

Robert McCauley
robertneilmccauley@gmail.com

Patrick McGuire
patrick.mcguire@bis.org

Dollar debt in FX swaps and forwards: huge, missing and growing[1]

FX swaps, forwards and currency swaps create forward dollar payment obligations that do not appear on balance sheets and are missing in standard debt statistics. Non-banks outside the United States owe as much as $25 trillion in such missing debt, up from $17 trillion in 2016. Non-US banks owe upwards of $35 trillion. Much of this debt is very short-term and the resulting rollover needs make for dollar funding squeezes. Policy responses to such squeezes include central bank swap lines that are set in a fog, with little information about the geographic distribution of the missing debt.

JEL F31, F34, F41.

Embedded in the foreign exchange (FX) market is huge, unseen dollar borrowing. In an FX swap, for instance, a Dutch pension fund or Japanese insurer borrows dollars and lends euro or yen in the "spot leg", and later repays the dollars and receives euro or yen in the "forward leg". Thus, an FX swap, along with its close cousin, a currency swap, resembles a repurchase agreement, or repo, with a currency rather than a security as "collateral".[2] Unlike repo, the payment obligations from these instruments are recorded off-balance sheet, in a blind spot. The $80 trillion-plus in outstanding obligations to pay US dollars in FX swaps/forwards and currency swaps, mostly very short-term, exceeds the stocks of dollar Treasury bills, repo and commercial paper combined. The churn of deals approached $5 trillion per day in April 2022, two thirds of daily global FX turnover.

FX swap markets are vulnerable to funding squeezes. This was evident during the Great Financial Crisis (GFC) and again in March 2020 when the Covid-19 pandemic wrought havoc. For all the differences between 2008 and 2020, swaps emerged in

[1] We thank Stefan Avdjiev, Stijn Claessens, Mathias Drehmann, Hyun Song Shin, Nikola Tarashev and Goetz von Peter for useful comments. Branimir Gruić provided excellent research assistance. All errors are our own. The views expressed in this article are those of the authors and not necessarily those of the Bank for International Settlements.

[2] FX swaps and outright forwards cannot be distinguished in stocks data. Currency swaps are FX swaps with a maturity longer than one year in which coupons are also exchanged. Ideally, we would exclude from our analysis non-deliverable forwards (NDFs), which entail just a fractional payment, but they are not identified individually in the stocks data. This is unlikely to weaken our conclusions, as turnover data show that NDFs account for less than 10% of the average daily turnover of FX swaps, forwards and currency swaps.

Key takeaways

- FX swaps, forwards and currency swaps give rise to dollar obligations that were backstopped in 2008 and 2020 by central banks acting on little information about who owed the debt.
- For non-banks outside the United States, dollar obligations from FX swaps, forwards and currency swaps have grown fast, reaching $26 trillion or double their on-balance sheet dollar debt.
- In mid-2022, non-US banks with direct access to Federal Reserve credit only in their US operations owed an estimated $39 trillion in dollars from FX swaps, forwards and currency swaps.

both episodes as flash points, with dollar borrowers forced to pay high rates if they could borrow at all. To restore market functioning, central bank swap lines funnelled dollars to non-US banks offshore, which on-lent to those scrambling for dollars.

This off-balance sheet dollar debt poses particular policy challenges because standard debt statistics miss it. The lack of direct information makes it harder for policymakers to anticipate the scale and geography of dollar rollover needs. Thus, in times of crisis, policies to restore the smooth flow of short-term dollars in the financial system (eg central bank swap lines) are set in a fog.

The missing dollar debt from FX swaps/forwards and currency swaps is huge, adding to the vulnerabilities created by on-balance sheet dollar debts of non-US borrowers. It has reached $26 trillion for non-banks outside the United States, double their on-balance sheet debt. Moreover, it has grown smartly since 2016, despite the often significant premium demanded on dollar swap funding (Borio et al (2016)). For banks headquartered outside the United States, dollar debt from these instruments is estimated at $39 trillion, more than double their on-balance sheet dollar debt and more than 10 times their capital.

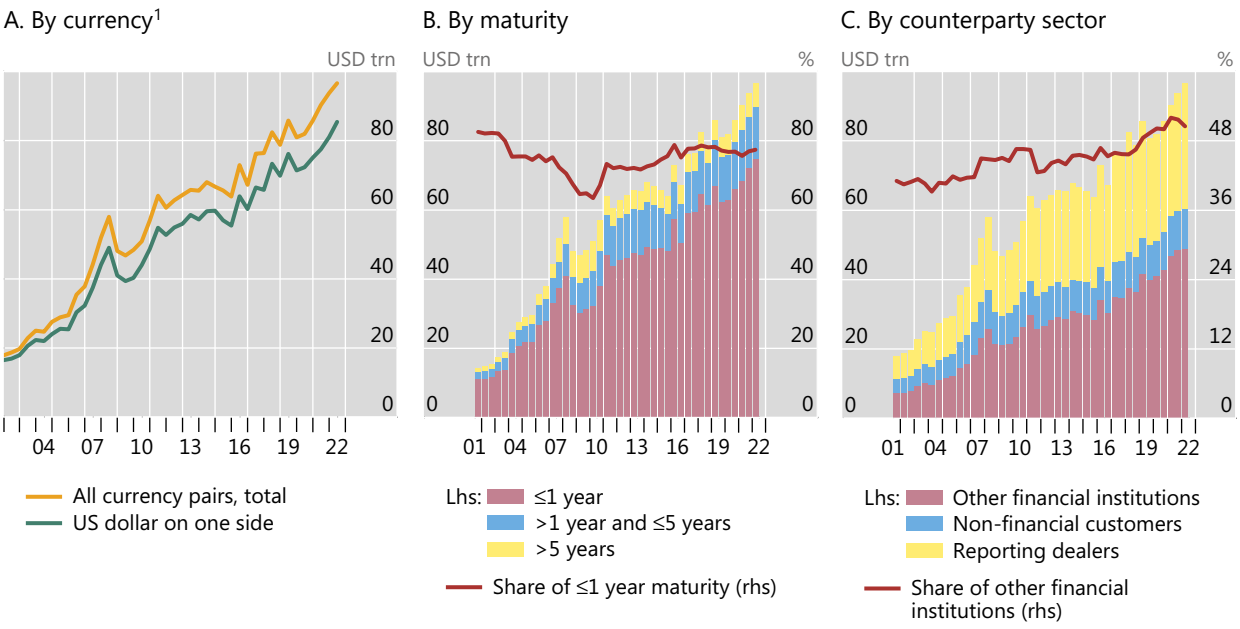
This feature revisits Borio et al (2017), drawing on the comprehensive data in the 2022 BIS Triennial Survey. First, it updates the stylised facts concerning FX swaps/forwards and currency swaps. Second, it measures the missing dollar debt for non-banks resident outside the United States, and for banks headquartered outside the United States. Third, it highlights policy challenges.

FX swaps/forwards and currency swaps: some stylised facts

Payment obligations arising from FX swaps/forwards and currency swaps are staggering. Considering *all* currencies, outstanding amounts at end-June 2022 reached $97 trillion, up from $67 trillion in 2016 (Graph 1.A). This matched global GDP in 2021 ($96 trillion) and was three times global trade ($29 trillion). And it exceeded both global external portfolio investment ($81 trillion) and international bank claims ($40 trillion) at end-2021.

Dollar dominance is striking in this FX market segment, greater than in any other aspect of dollar use. As a vehicle currency, the US dollar is on one side of 88% of outstanding positions – or $85 trillion (Graph 1.A). An investor or bank wanting to do an FX swap from, say, Swiss francs into Polish zloty would swap francs for dollars and then dollars for zloty.

FX swaps, FX forwards and currency swaps outstanding Graph 1



[1] The gold line is the aggregate of FX swaps, FX forwards and currency swaps. The green line is contracts in which US dollars are exchanged.

Source: BIS OTC derivatives statistics.

The very short maturity of the typical FX swap/forward creates potential for liquidity squeezes. Almost four fifths of outstanding amounts at end-June 2022 in Graph 1.B matured in less than one year. Data from the April 2022 Triennial Survey show not only that instruments maturing within a week accounted for some 70% of FX swaps turnover, but also that those maturing overnight accounted for more than 30%. When dollar lenders step back from the FX swap market, the squeeze follows immediately (Correa et al (2020))

Financial customers dominate non-financial firms in the use of FX swaps/forwards. Non-bank financial institutions (NBFIs), proxied by "other financial institutions"[3] in Graph 1.C, are the biggest users of FX swaps, deploying them to fund and hedge portfolios as well as take positions. Despite their long-term foreign currency assets, the likes of Dutch pension funds or Japanese life insurers roll over swaps every month or quarter, running a maturity mismatch. For their part, dealers' non-financial customers such as exporters and importers use FX forwards to hedge trade-related payments and receipts, half of which are dollar-invoiced (Boz et al (2020)). And corporations of all types use longer-term currency swaps to hedge their own foreign currency bond liabilities (McBrady et al (2010), Munro and Wooldridge (2010)).

Missing dollar debt: mostly outside the United States

Just how large is the missing *dollar* debt from FX swaps/forwards and currency swaps? At end-June 2022, dealer banks had $52 trillion in outstanding dollar positions with

[3] The counterparty group "other financial institutions" comprises mainly non-bank financial institutions such as pension funds, insurance companies and hedge funds, but also includes non-reporting banks.

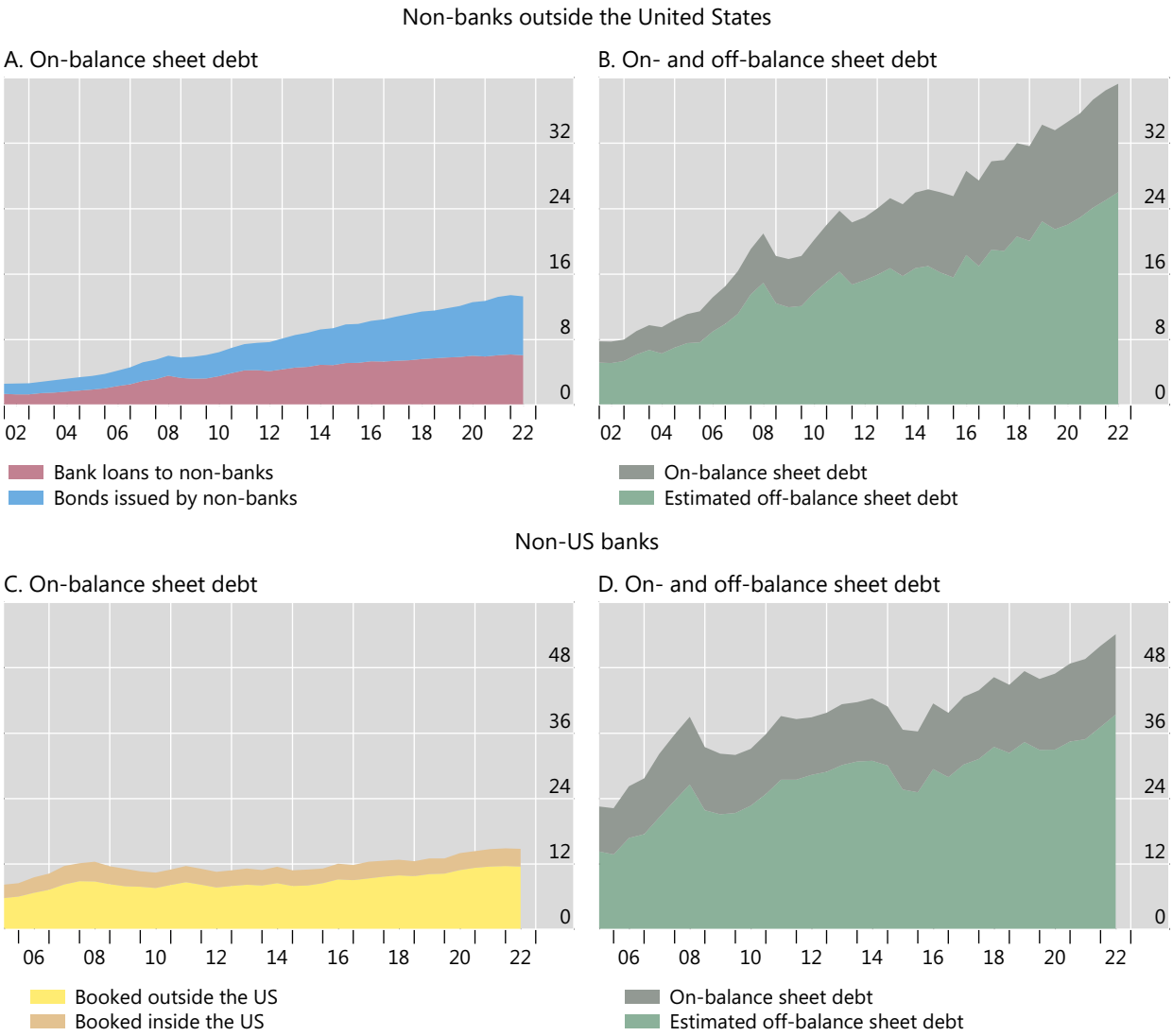
customers. Non-banks had dollar obligations of half of this amount, $26 trillion.[4] This sum has been growing strongly, from $17 trillion in 2016 (Graph 2.B).

This $26 trillion dollar debt is likely owed by entities *outside* the United States, for which the dollar is a foreign currency.[5] They borrow dollars largely to hedge their dollar receivables and investments in a world in which the dollar is the dominant international currency. By contrast, NBFIs in the United States hedge their modest foreign currency assets by *lending* – not borrowing – dollars via FX swaps.

US dollar-denominated debt[1]

In trillions of US dollars

Graph 2



[1] See technical annex for details.

Sources: US Office of the Comptroller of the Currency (OCC); Dealogic; Euroclear; Thomson Reuters; Xtrakter; national data; BIS consolidated banking statistics (CBS); BIS locational banking statistics (LBS); BIS OTC derivatives statistics (OTCD).

[4] We follow Borio et al (2017, 2020). Aldasoro et al (2020) shows that, at the global level, the banking sector is nearly balanced in FX swaps with a dollar leg. Since dealer banks and customers make up the entire market, a balanced banking sector implies that non-bank customers are balanced in dollars.

[5] BIS derivatives statistics do not have a counterparty country breakdown, and thus do not reveal the location of the non-bank users of FX swaps/forwards. See McGuire (2022).

And businesses in the United States have scant foreign currency payables to hedge by borrowing dollars off-balance sheet.[6]

The off-balance sheet US dollar debt of non-banks outside the United States substantially exceeds their on-balance sheet debt and has been growing faster. At end-June 2022, the missing debt amounted to as much as double the *on-balance sheet* component (Graph 2.B), which was estimated at "only" $13 trillion (Graph 2.A). Moreover, the missing debt was "only" 1.6 times larger in 2016.

For their part, banks headquartered outside the United States, including some dealers in FX swaps, have even larger missing dollar obligations.[7] These banks deserve focus because of their limited access to the Federal Reserve's discount window for dollars. Their estimated off-balance sheet dollar obligations of $39 trillion at end-June 2022 were much higher than the $15 trillion in on-balance sheet dollar debt (Graph 2.C) and almost half as big as their combined total liabilities.[8]

Policy challenges

The market turmoil during the GFC and in March 2020 highlighted the central role of the US dollar in the financial system. In each episode, disruptions in dollar funding markets led to an extraordinary policy response in the form of central bank swap lines, whereby the Federal Reserve channelled US dollars to key central banks.

These episodes point to a need for statistics that track the geography of outstanding short-term dollar payment obligations. Currently, in order to assess the level and maturity structure of foreign currency gross and net debt, analysts tend to rely on benchmark international statistical collections,[9] which generally cover only the on-balance sheet positions (McGuire (2022)). It is not even clear how many analysts are aware of the existence of the large off-balance sheet obligations. This makes it difficult to anticipate the scale and geography of dollar rollover needs.

Off-balance sheet dollar debt may remain out of sight and out of mind, but only until the next time dollar funding liquidity is squeezed. Then, the hidden leverage[10] and maturity mismatch in pension funds' and insurance companies' portfolios – generally supposed to be long-only – could pose a policy challenge. And policies to restore the flow of dollars would still be set in a fog.

[6] Non-banks in the United States had $866 billion in foreign currency debt in 2021 (US Treasury et al (2022)). About 5% of the $3.4 trillion in US imports were foreign currency-invoiced (Boz (2020)). Compared with $26 trillion in dollar debt, any borrowing of dollars in swaps/forwards to hedge these payables may be considered as a rounding error.

[7] Positions are corrected for inter-dealer double-counting. However, the figure does not factor in any bilateral netting of payment obligations allowable under supervisory and/or accounting methodologies, which could more than halve *net* interdealer payment obligations.

[8] Total liabilities were $92 trillion as reported by internationally active banks from 26 (of 31) jurisdictions that report the BIS consolidated banking statistics.

[9] These include the *International Investment Positions* (IIP) statistics, the *IMF Coordinated Portfolio Investment Survey* (CPIS), the *BIS locational banking statistics* (LBS) and the *BIS OTC derivatives* (OTCD) statistics, each of which has at least a partial currency breakdown.

[10] Dafermos et al (2022) argue that repos allow more leverage than swaps. Even so, the larger stock of swaps/forwards entails more dollar obligations than dollar repos.

References

Aldasoro, A, T Ehlers, P McGuire and G von Peter (2020): "Global banks' dollar funding needs and central bank swap lines", *BIS Bulletin*, no 27, July.

Borio, C, R McCauley, P McGuire and V Sushko (2016): "Covered interest parity lost: understanding the cross-currency basis", *BIS Quarterly Review*, September, pp 45–64.

Borio, C, R McCauley and P McGuire (2017): "FX swaps and forwards: missing global debt?", *BIS Quarterly Review*, September pp 37–54.

——— (2020): "Foreign exchange swaps: hidden debt, lurking vulnerability", VoxEU column, 13 February.

Boz, E, C Casas, G Georgiadis, G Gopinath, H Le Mezo, A Mehl and T Nguyen (2020): "Patterns in invoicing currency in global trade", *IMF Working Papers*, no 20/126, July.

Correa, R, W Du and G Liao (2020): "U.S. banks and global liquidity", *International Finance Discussion Papers*, no 1289, July.

Dafermos, Y, D Gabor and J Michell (2022): "FX swaps, shadow banks and the global dollar footprint", *Environment and Planning A: Economy and Space*.

McBrady, M, S Mortal and M Schill (2010): "Do firms believe in interest rate parity?", *Review of Finance*, vol 14, no 4, pp 695–726.

McGuire, P (2022): "FX swaps and forwards in global dollar debt: 'known knowns' and 'known unknowns'", *Japan and the World Economy*, vol 64, December.

Munro, A and P Wooldridge (2010): "Motivations for swap-covered foreign currency borrowing", *BIS Papers*, no 52, July, pp 145–85.

US Treasury, Federal Reserve Bank of New York, Board of Governors of the Federal Reserve System (2022): *Foreign portfolio holdings of U.S. securities as of June 30, 2021*, April.

Technical annex

Graph 2.A: Figures from the BIS Global Liquidity Indicators (GLI). Non-banks comprise non-bank financials, non-financial corporations, governments, households and international organisations.

Graph 2.B: Off-balance sheet liabilities estimated as one half of outstanding dollar FX swaps with non-banks; assumes that non-banks inside the United States are not dollar borrowers via these instruments.

Graph 2.C: The estimate of US dollar-denominated debt of banks headquartered outside the United States excludes intragroup positions but includes liabilities to other (unaffiliated) banks. From end-2015, it includes liabilities of banks in China and Russia; local positions of banks in China are estimated as 80% of local foreign currency deposits (national data).

Graph 2.D: Off-balance sheet debt estimated as (a) one half of global outstanding FX swaps with all counterparties (BIS OTCD statistics) less (b) one half of US banks' outstanding FX swaps (OCC data) plus (c) US banks' estimated net provision of US dollars via FX swaps (derived from the LBS and CBS; see Aldasoro et al (2020)).

Marc Glowka
marc.glowka@bis.org

Thomas Nilsson
thomas.nilsson@bis.org

FX settlement risk: an unsettled issue[1]

FX settlement risk, the risk that one party to a currency trade fails to deliver the currency owed, can result in significant losses and undermine financial stability. Netting and payment versus payment (PvP) mechanisms help to mitigate this risk. However, almost a third of deliverable FX turnover, or $2.2 trillion, was still at risk on any given day in April 2022, up from $1.9 trillion in April 2019. Settlement risk remains because existing PvP arrangements are unavailable, or unsuitable for certain trades, or market participants find them too expensive. Ongoing policy initiatives and private sector innovation aim to encourage PvP adoption for more currencies and market participants.

JEL classification: E42, F31, G15.

FX settlement risk, the risk that one party to a trade of currencies fails to deliver the currency owed, can result in significant losses for market participants, sometimes with systemic consequences. The failure of Bankhaus Herstatt in 1974, the best known example, eroded confidence in interbank relations and caused a freeze in money market lending (Galati (2002)). Recent examples include KfW Bankengruppe's €300 million loss when Lehman Brothers collapsed in 2008 (Hughes (2009)), and Barclays' $130 million loss to a small currency exchange in March 2020 (Parsons (2021)).

Almost 50 years after the Herstatt bankruptcy, nearly a third of deliverable FX turnover remains subject to settlement risk, according to new data from the 2022 BIS Triennial Survey. While this share is unchanged from the 2019 Survey, settlement risk has increased in absolute terms in line with the growth in FX turnover. That is, $2.2 trillion was at risk on any given day in April 2022, up from an estimated $1.9 trillion in April 2019 (see the Technical Annex).

This feature assesses the scale of FX settlement risk and the mechanisms in place to mitigate it.[2] We first document the current risk level and its components, drawing on expanded FX settlement risk data in the 2022 BIS Triennial Survey. Second, we highlight the reasons why risk remains. Third, we present ongoing policy initiatives and private sector innovations to mitigate this risk.

[1] We thank Claudio Borio, Stijn Claessens, Branimir Gruić, Jenny Hancock, Henry Holden, Thomas Lammer, Patrick McGuire, Tara Rice, Andreas Schrimpf, Takeshi Shirakami and Nikola Tarashev for useful comments. Anamaria Illes, Ilaria Mattei and Nolan Young Zabala provided excellent research assistance. All errors are our own. The views expressed in this article are those of the authors and not necessarily those of the Bank for International Settlements or the BIS Committee on Payments and Market Infrastructures.

[2] See also Galati (2002), Lindley (2008), Kos and Levich (2016) and Bech and Holden (2019).

Key takeaways

- In April 2022, $2.2 trillion of daily FX turnover was subject to settlement risk, up from an estimated $1.9 trillion in April 2019.
- FX settlement risk, the risk that one party in a currency trade fails to deliver the currency owed, remains because existing settlement arrangements to mitigate risk are unavailable, or unsuitable for settling certain trades, or market participants find them too expensive.
- Public and private sector stakeholders are working to reduce FX settlement risk for a broader range of currencies and market participants.

Mechanisms to reduce settlement risk

Market participants have two main options for mitigating FX settlement risk.[3] First, they can bilaterally offset their payment obligations to reduce the amounts that need to be settled (ie "pre-settlement netting"). Second, they can settle any remaining turnover via payment-versus-payment (PvP) arrangements or via the same clearer, termed "on-us". In a PvP mechanism, the final payment of one currency occurs if, and only if, the final payment of the other currency takes place. In on-us settlement, both payment legs settle across the books of a single institution. However, parties are protected against loss only if both legs settle *simultaneously* or if settlement is certain to occur within preauthorised credit lines (ie "on-us with loss protection").[4]

Pre-settlement netting reduced settlement risk in almost a fifth of deliverable turnover in 2022, unchanged from 2019 (Graph 1.A, blue bars). As turnover has grown, this amounts to pre-settlement netting of $1.3 trillion per day (Table 1), up from an estimated $1.1 trillion in 2019. The increase can be attributed to wider availability of automated netting services, driven also by market pressure to reduce funding costs.

In the remaining turnover to be settled, much settlement risk remains despite the broader adoption of PvP arrangements since 1997. In April 2022, $3.5 trillion of deliverable turnover was settled with risk mitigation (Table 1 and Graph 1.A, green bars). Of this, $2.5 trillion was settled via CLS, a global financial market infrastructure that provides for PvP in 18 currencies (see CPSS (2008), Annex 4, for details on CLS). Nearly $1 trillion was settled either via other PvP arrangements or via the same clearer or on-us with loss protection. The remaining $2.2 trillion was settled via on-us without loss protection or via other non-PvP arrangements and is therefore subject to risk.[5]

[3] Settlement risk is a general term used to designate the risk that settlement will not take place as expected. It comprises both credit and liquidity risk. In this feature, we focus on principal risk, a form of credit risk that arises for deliverable FX turnover, ie trades that settle with multiple payments between counterparties (eg spot trades, outright forwards, FX swaps and currency swaps). Principal risk is the risk that a counterparty loses the full value involved in a transaction. Loss of principal can occur if one party to an FX trade delivers its currency, but the counterparty does not.

[4] Simultaneous on-us settlement differs from PvP in that the two payments are timed to coincide but may settle unconditionally, ie one payment may settle even if the other payment does not.

[5] As data are not fully comparable over time, changes in settlement risk cannot be measured precisely. If the proportion of on-us settlement with loss protection was the same in 2019 as in 2022, the share of deliverable turnover without risk mitigation is unchanged at 31%.

Settlement of foreign exchange (FX) turnover in April 2022[1]

In billions of US dollars — Table 1

	All counterparties		Reporting Dealers		Other financial institutions		Non-financial customers	
Deliverable turnover[2]	6,988	100%	3,248	100%	3,348	100%	392	100%
Pre-settlement netting[3]	1,337	19%	591	18%	665	20%	82	21%
Turnover settled	5,651	81%	2,658	82%	2,683	80%	310	79%
with risk mitigation	3,495	50%	1,783	55%	1,563	47%	149	38%
via CLS (PvP)	2,518	36%	1,333	41%	1,125	34%	59	15%
via other PvP arrangements	257	4%	101	3%	127	4%	30	8%
via on-us with loss protection	720	10%	349	11%	310	9%	60	15%
without risk mitigation	2,155	31%	875	27%	1,120	33%	161	41%
via on-us without loss protection	550	8%	259	8%	231	7%	60	15%
via other non-PvP arrangements	1,606	23%	616	19%	889	27%	101	26%

[1] See technical annex for details. [2] Turnover settled with multiple payments between counterparties (eg spot trades, outright forwards, FX swaps and currency swaps). [3] Pre-settlement netting is calculated as the difference between deliverable turnover and turnover settled.

Source: BIS Triennial Central Bank Survey; authors' calculations.

The scale of FX settlement risk varies markedly across jurisdictions (Graph 1.B). In some locations with less trading, more than three quarters of deliverable turnover was subject to settlement risk. By contrast, in the locations with the largest trading volumes only 20–40% was, resulting in a global average of 31%. In general, a smaller share of trades is settled without risk mitigation in advanced economies (AEs) than in emerging market economies (EMEs).

Trades between reporting dealers tend to settle with risk mitigation; those with customers less so (Table 1). Relative to large global banks, smaller market participants often lack access to certain PvP arrangements or netting services.

Why settlement risk remains

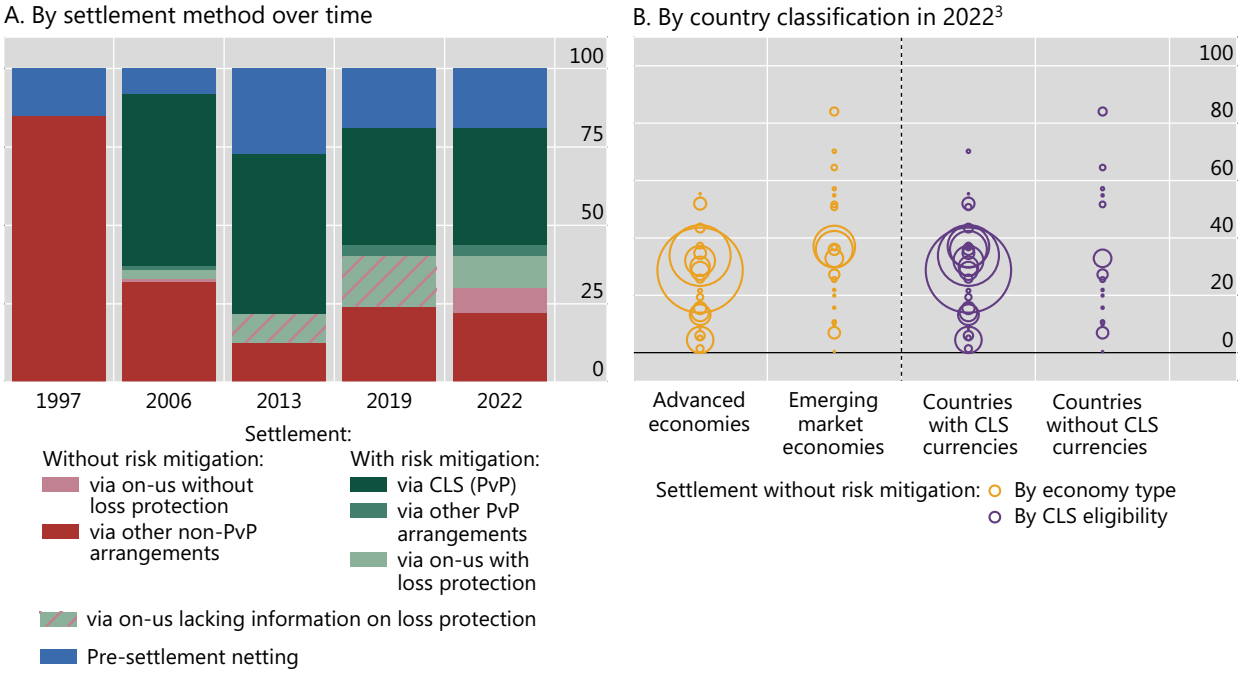
Recent industry engagement by the BIS Committee on Payments and Market Infrastructures (CPMI) has highlighted factors that limit the adoption of PvP settlement (CPMI (2022)). These industry outreach efforts formed part of the broader G20 programme to enhance cross-border payments.[6]

First is a simple cost-benefit calculus. Adoption of PvP or similar arrangements requires that market participants find the individual and systemic benefits of using the arrangement to outweigh the costs, which include transaction fees, monthly charges and investments associated with joining the service. Some smaller market participants have indicated that joining existing PvP arrangements, or indirectly accessing their services through a direct participant, is too expensive or not practicable for some trading activities.

[6] See www.bis.org/cpmi/cross_border.htm.

Settlement of foreign exchange turnover[1]

As a percentage of deliverable turnover[2] Graph 1



[1] See technical annex for details. [2] Turnover settled with multiple payments between counterparties (eg spot trades, outright forwards, FX swaps and currency swaps). [3] Each circle represents a country, and circle area is proportional to the deliverable turnover reported by that country.

Sources: CPSS (2008); Kos and Levich (2016); BIS Triennial Central Bank Survey; authors' calculations.

Second, non-PvP settlement may be the only option for some counterparties, currencies or time zones. Even though existing PvP arrangements support the most actively traded currency pairs (Graph 2.A), market participants are not always able to use them. For example, CHATS in Hong Kong SAR can settle offshore Chinese renminbi against the US dollar, but only institutions located in Hong Kong SAR, Malaysia, Indonesia or Thailand have access. In addition, existing PvP arrangements do not always allow market participants to adequately manage intraday liquidity. For example, a PvP arrangement may not operate within a time window that matches periods of peak liquidity. Turnover in unsupported currencies has also increased slightly since 2016. These are mainly EME currencies against the US dollar (Graph 2.B) that are not eligible for settlement in CLS. As a result, countries without CLS currencies report high rates of settlement risk (Graph 1.B).

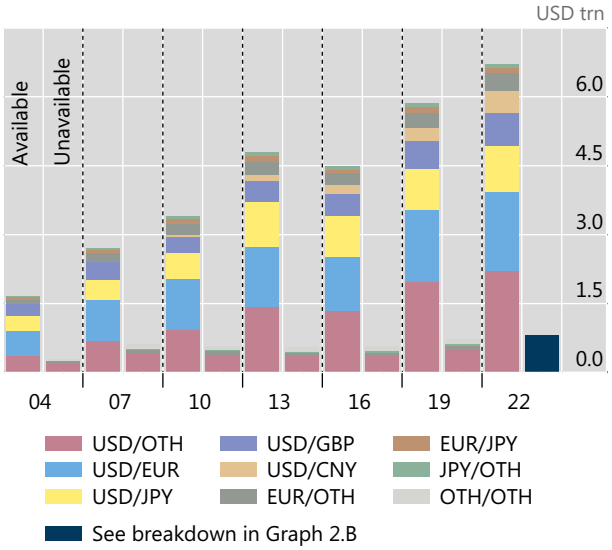
Policy measures and innovation to boost risk mitigation

Private and public sector stakeholders, including central banks, are collaborating to foster greater adoption of PvP. The Global Foreign Exchange Committee (GFXC), which comprises central banks and market participants, has strengthened its guidance on settlement risk in the FX Global Code, a set of principles of good practice in the FX market (GFXC (2021)). The code calls for market participants to use PvP if possible or reduce their risk exposures through other means such as netting and has the support of the Basel Committee on Banking Supervision (BCBS-CPMI (2020)).

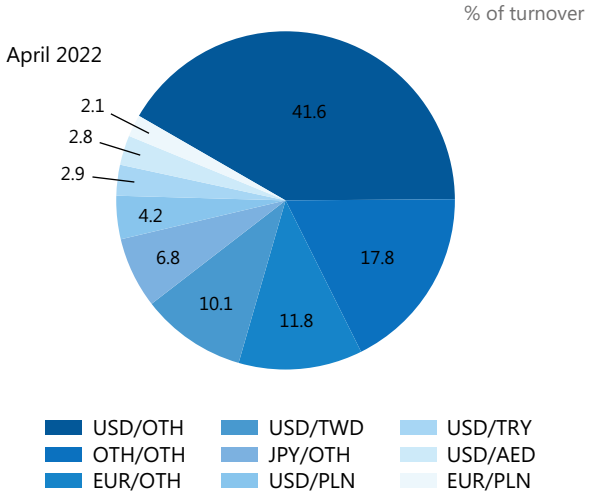
Availability of PvP settlement for foreign exchange currency pairs[1,2]

Graph 2

A. PvP is available for the largest currency pairs



B. Where PvP is unavailable, USD is often one leg



[1] See technical annex for details. [2] A PvP arrangement is available if a currency pair can be settled by either the B3 Foreign Exchange Clearinghouse (B3) in Brazil, the Clearing Corporation of India Limited's Forex Settlement (CCIL), the Clearing House Automated Transfer System (CHATS) in Hong Kong or CLS.

Sources: CPMI (2022); BIS Triennial Central Bank Survey; authors' calculations.

The CPMI has outlined potential roles for private and public sector stakeholders to increase PvP adoption (CPMI (2022)). For example, central banks could extend the opening hours of payment systems to expand the available window for PvP settlement across time zones. However, local money markets and nostro agents would similarly need to adjust their operating hours and procedures to take advantage of longer settlement windows. The CPMI will continue its work to engage with the private sector and address any regulatory and operational barriers to PvP adoption. It expects to publish a final report in 2023.

Private companies are also developing new services that complement existing PvP arrangements by targeting additional currencies and by providing more options for users to manage intraday liquidity. Incumbent PvP operators plan to expand their services to EME currencies, and small fintechs are looking at new ways to enable PvP settlement. For example, one new solution allows users to synchronise settlement on the accounts of multiple nostro providers using distributed ledger technology rather than settling over the accounts of a single institution (ie the CLS model). As the future of payments may involve the use of multiple central bank digital currencies (CBDCs), the BIS Innovation Hub and the New York Innovation Center have experimented with settling wholesale CBDC using PvP in Project Jura and Project Cedar, respectively (BIS (2021), FRBNY (2022)).

References

Bank for International Settlements (BIS) (2021): *Project Jura: cross-border settlement using wholesale CBDC*, December.

Basel Committee on Banking Supervision and Committee on Payments and Market Infrastructures (BCBS-CPMI) (2020): *Supervisory Guidance on managing FX settlement risk and the Global FX Code*, December.

Bech, M and H Holden (2019): "FX settlement risk remains significant", *BIS Quarterly Review,* December, pp 48–9.

Committee on Payments and Market Infrastructures (CPMI) (2022): *Facilitating the increased adoption of PvP – consultative report*, July.

Committee on Payments and Settlement Systems (CPSS) (2008): *Progress in reducing foreign exchange settlement risk*, May.

Federal Reserve Bank of New York (FRBNY) (2022): *Project Cedar – Phase One Report*, November.

Galati, G (2002): "Settlement risk in foreign exchange markets and CLS Bank", *BIS Quarterly Review*, December, pp 55–65.

Global Foreign Exchange Committee (GFXC) (2021): *FX Global Code*, July.

Hughes, J (2009): "Lessons on running a smooth settlement system", *Financial Times*, 20 August.

Kos, D and R Levich (2016): "Settlement risk in the global FX market: how much remains?", *CLS Insights*, 26 October.

Lindley, R (2008): "Reducing foreign exchange settlement risk", *BIS Quarterly Review,* September, pp 53–65.

Parsons, J (2021): "Regulators moot public utility to tackle FX settlement risk", *Risk.net*, 30 November.

Technical annex

The 2022 Triennial Survey has been expanded to include, inter alia, data on settlement by counterparty type. This enables us to adjust the data for local and cross-border inter-dealer double-counting, ie "net-net" basis. For comparison, we estimate net-net settlement data for 2019 by applying the unadjusted shares of each settlement method to net-net deliverable turnover. For example, we find that the unadjusted share of deliverable turnover without risk mitigation was 31% in 2019 (coincidentally the same as in 2022). As net-net deliverable turnover was $6 trillion in 2019, we calculate that $1.9 trillion was subject to settlement risk.

Table 1: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April; settled turnover may include trades that were executed before April but settled in April.

Graph 1.A: Adjusted for local but not cross-border inter-dealer double-counting, ie "net-gross" basis; daily averages in April; on-us settlement is where both legs of a trade are settled across the books of a single institution; respondents in 2013 and 2019 did not report whether on-us settlement was with or without loss protection.

Graph 1.B: Adjusted for local but not cross-border inter-dealer double-counting, ie "net-gross"; daily averages in April; a few countries reported greater settled turnover than deliverable turnover in which case we use settled turnover as the denominator.

Graph 2: Adjusted for local and cross-border inter-dealer double-counting, ie "net-net" basis; daily averages in April.