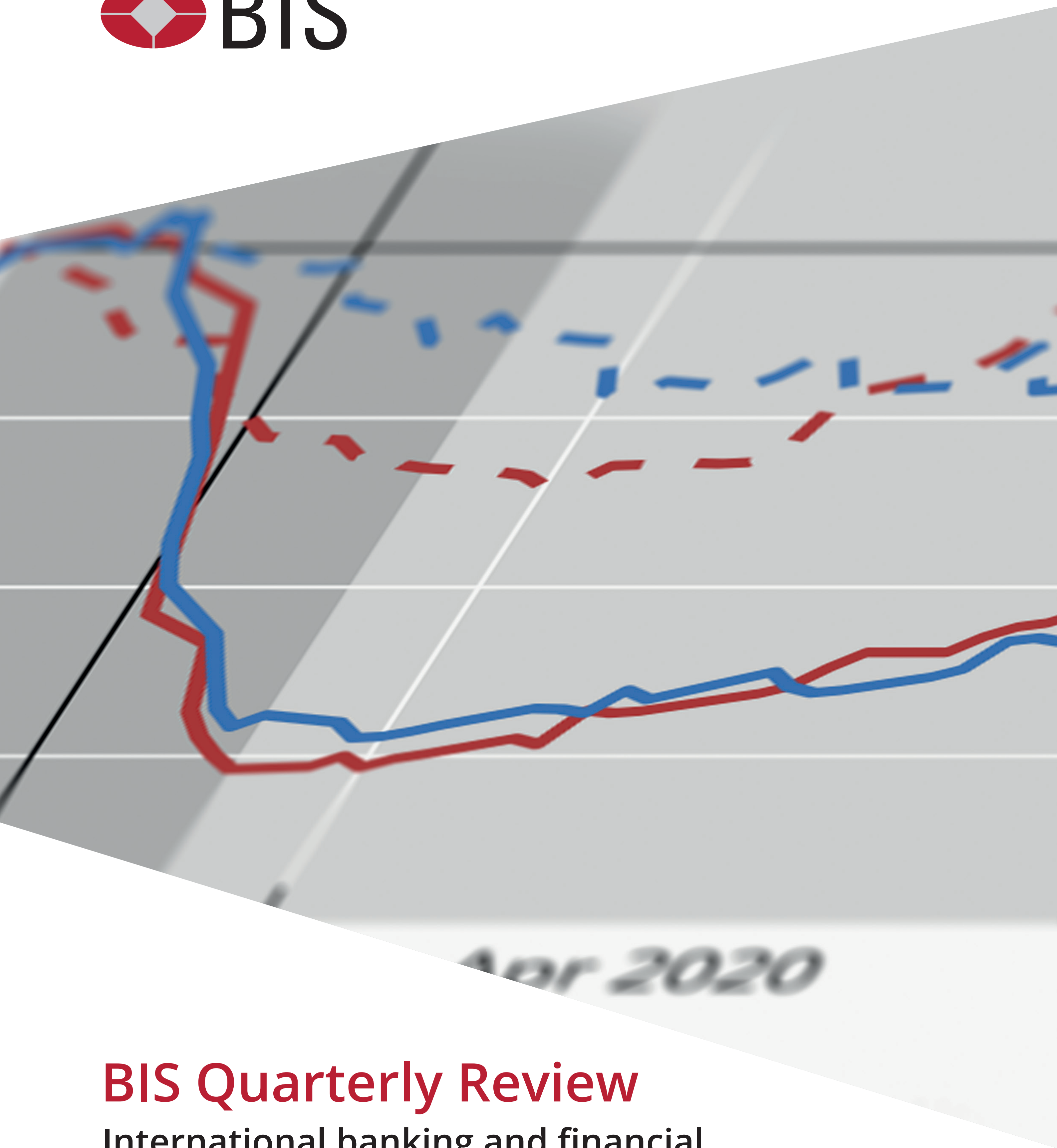

BIS Quarterly Review

International banking and financial market developments

March 2021

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Promoting global monetary and financial stability

BIS Quarterly Review
Monetary and Economic Department

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Special features

Notations used in this Review

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

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

Abbreviations

Currencies

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

Countries

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

Countries (cont)

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

Countries (cont)

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

Markets wrestle with reflation prospects

In the period under review,[1] policy support and overall positive, if uneven, pandemic-related developments benefited risky-asset valuations but also drove long-term bond yields up. Against the background of loose financial conditions and continued monetary accommodation, some asset prices reacted strongly to the prospect of fiscal expansion. Equities extended gains and credit spreads tightened further, with cross-country and sectoral differences reflecting delays in some vaccination programmes. While short-term sovereign yields remained firmly anchored, rising market-based inflation expectations accompanied a steepening of the yield curve.

Stock prices continued their ascent in many jurisdictions, often exceeding pre-pandemic levels and, in some cases, setting all-time highs. Even as US corporate profitability improved, equity prices remained high relative to earnings on the back of low interest rates. In Europe, valuations in sectors more exposed to the pandemic lost some ground with vaccination delays.

Memories of the tech boom in the late 1990s resurfaced. Initial public offerings (IPOs) rose in number, and the rapid growth of conduits set up to scout for private firms and list them continued. In addition, retail investors took on record amounts of leverage, used options to speculate on individual stocks, and coordinated on social media platforms to put pressure on short-sellers. While cryptoasset funds are a new phenomenon, the flows they attracted reinforced the picture of strong risk appetite.

Credit markets remained buoyant after a remarkable recovery. Corporate bond spreads widened briefly in late January after months of steady decline, but remained well below long-run norms. Issuance was strong, particularly in the lower-rated segments. In the background, bankruptcies were stable at a low level in the United States and below five-year averages in Europe, thanks in part to lender leniency and policy measures to soften the pandemic's blow. Unfazed by the risk that these conditions might change, investors kept default risk premia compressed.

Importantly, the reflation trade gathered strength. Long-term government bond yields rose quickly, even as short-term rates were pinned at historically low levels. The increasing likelihood of a strong US fiscal impulse – funded with new issuance at long maturities – was a key driver of this steepening of the yield curve, in both Europe and the United States. Aided by the Federal Reserve's revised monetary policy framework, the prospect of fiscal expansion led investors to price in higher inflation, without the dollar strengthening much against other advanced economy (AE) currencies. The rise of nominal long-term sovereign yields reflected a combination of rising term premia, an upturn in inflation expectations and higher compensation for inflation risk.

Global financial conditions turned less favourable for emerging market economies (EMEs) in 2021. As the dollar bounced back from its post-election slide in January on the prospect of US fiscal support, the currencies of EMEs more strongly stricken by the pandemic depreciated more. Local currency bond yields reversed their downward trend. Even so, the overall sentiment towards EME assets remained positive. Sovereign spreads for US-denominated bonds continued to compress. Portfolio flows gained momentum, consistent with investors searching for yield in Chinese bond markets and looking for growth in East Asia.

[1] The period under review extends from 1 December 2020 to 22 February 2021.

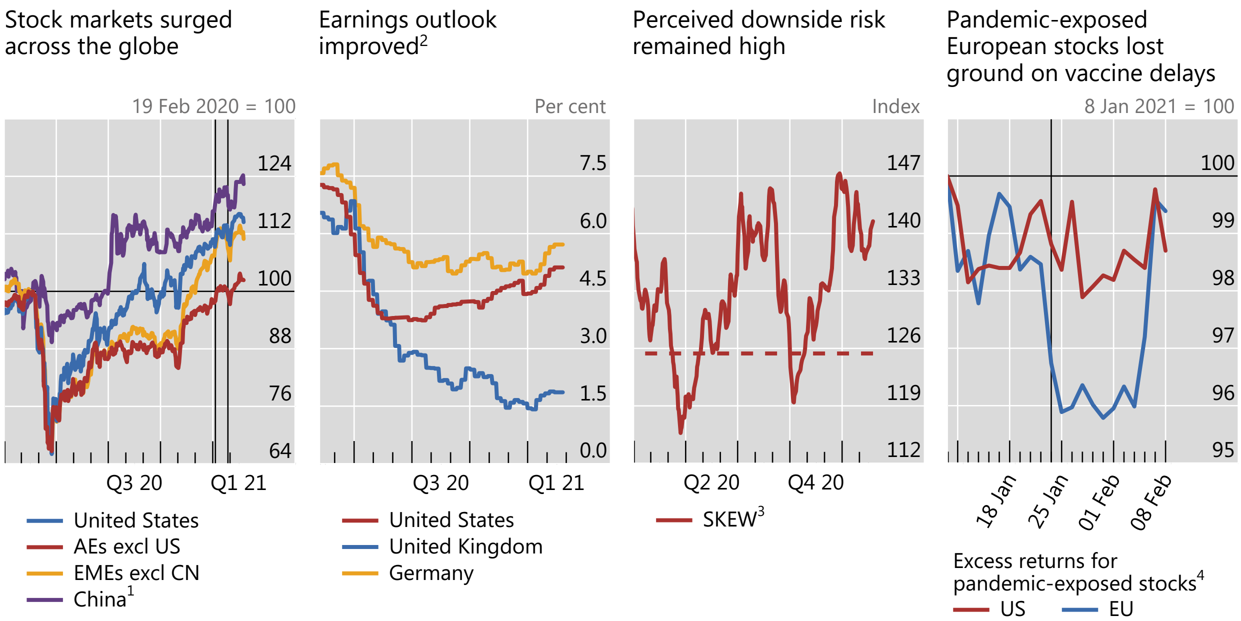
Key takeaways

- Equities and credit gained on the back of a brighter outlook and expectations of greater fiscal support, with signs of exuberance reflected in the behaviour of retail investors.
- Sovereign yield curves steepened as fiscal expansion lifted term premia and inflation compensation.
- Sentiment towards EME assets remained favourable, and investors' appetite for East Asian assets rose.

Risky assets extend gains, but tail risks remain

With monetary policy remaining very easy, global equity markets rose in response to indications of stronger fiscal policy support, notably in the United States, and a brightening earnings outlook. The increase in stock prices was broad-based, but particularly strong in EMEs other than China and in selected AEs such as Japan (Graph 1, first panel). Over time, equity indices waxed and waned in line with the prospect of a major US fiscal package (vertical lines). Later in the review period, the run-up in US stock prices paused just as the reflation trade gained momentum (see below). In the background, earnings forecasts continued to improve in the United States but stayed rather flat in Europe (second panel). Actual earnings also largely surprised on the upside, with about three quarters of US companies exceeding analysts' estimates for Q4 2020.

Stock markets rose further; downside risks remained elevated — Graph 1



The vertical lines in the first panel indicate 5 January 2021 (Georgia senatorial election runoff) and 27 January 2021 (US House Majority Leader starts the process for possible non-bipartisan approval of fiscal expansion). The vertical line in the fourth panel indicates 22 January 2021 (AstraZeneca announces delays in EU vaccine delivery).

The dashed line in the third panel indicates 2010–current median.

[1] Shanghai composite equity index. [2] Expected earnings per share growth between end-2019 and estimated end-2023. [3] Five-day moving average. SKEW index: 100 means that downside risk is fully offset by upside risk; higher values indicate that downside risk is more pronounced than upside risk. [4] Cumulative return difference between Travel & Leisure vs Industrial stocks.

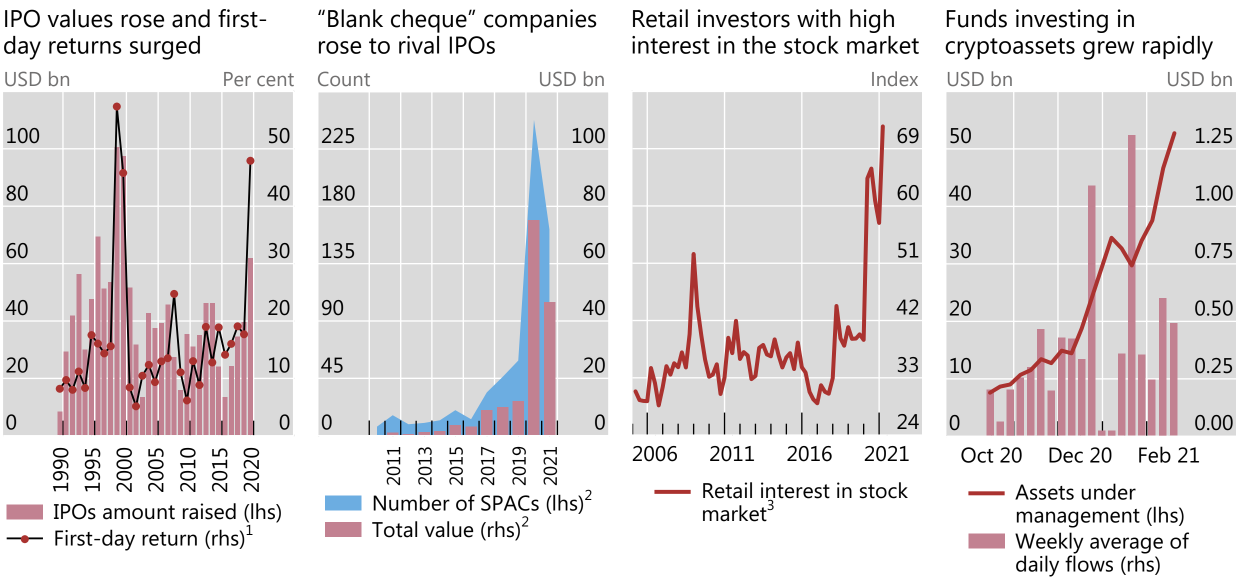
Sources: IMF; Bloomberg; Datastream; BIS calculations.

That said, investors did not seem to neglect tail risks altogether. Their concerns were visible in the historically high levels of the SKEW index, which measures the price of insurance against large negative stock returns (Graph 1, third panel). Delays in vaccine rollouts were possible manifestations of such risk. Indeed, the prices of European stocks most exposed to the pandemic lost ground suddenly, if only temporarily, when delays in the EU vaccination programme emerged in mid-January (fourth panel).

Low long-term interest rates have been critical in supporting valuations. Since recent US price/earnings ratios were among the highest on record, they suggest stretched valuations if considered in isolation. However, assessments that also take into account the prevailing low level of interest rates indicate that valuations were in line with their historical average. Box A investigates the drivers of stock returns, suggesting that equity prices are particularly sensitive to monetary policy in environments akin to the current one, featuring high price/earnings ratios and low interest rates.

Even if equity valuations did not appear excessive in the light of low rates, some signs of exuberance had a familiar ring. Just as during the dotcom boom in the late 1990s, IPOs saw a major expansion and stock prices often soared on the first day of trading (Graph 2, first panel). The share of unprofitable firms among those tapping equity markets also kept growing. In addition, strong investor appetite supported the rise of special purpose acquisition companies (SPACs) – otherwise known as "blank cheque" companies (second panel). These are conduits that raise funds without an immediate investment plan.

Equity issuance patterns echoed the 1990s; flows into cryptoassets were strong — Graph 2



[1] Calculated as percentage change in capitalisation between end and beginning of first trading day. [2] Partial-year data for 2021. [3] Average Google Trends score for two stock market indices (S&P and NASDAQ), two news outlet (CNBC and Yahoo Finance) and the two largest US discount brokerages with names different from common-use words (Schwab and Ameritrade). A Google Trends score of 100 indicates highest popularity. Data starting from January 2005.

Sources: J R Ritter, "Special purpose acquisition company (SPAC) IPOs through 2020", December 2020; J R Ritter, "Initial public offerings: underpricing", December 2020; Federal Reserve Bank of St Louis, FRED; American Association of Individual Investors; CoinShares; Refinitiv Eikon; BIS calculations.

Box A

The news sensitivity of high equity prices when long-term rates are low

Sirio Aramonte and Fernando Avalos[1]

While low interest rates may help explain high equity prices, they also change the relative importance of alternative drivers of stock returns. In this box, we first document that the current low rates, rather than corporate earnings, assuage concerns about froth in the equity markets. We then argue that, in such an environment, equity valuations are particularly sensitive to monetary policy news, much more so than to macroeconomic news. Besides increasing the present value of future cash flows, accommodative monetary policy can help to boost economic activity and can also, to some extent, limit downside risks. Overall, the findings underscore the pivotal role that central banks are playing in influencing stock prices at the current juncture.

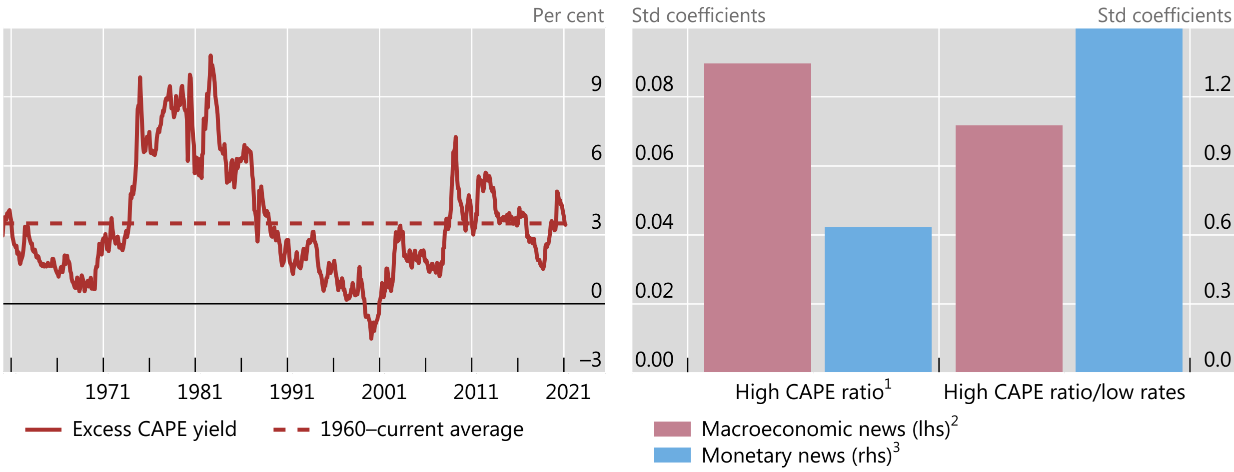
Equity valuations reflect both corporate profitability and the level of interest rates. In an asset-pricing model, the price of a stock is the discounted present value of future profits, with the discounting factor dependent on the profile of interest rates at short and long horizons. Measures that abstract from interest rates and compare equity prices only with corporate profitability conclude that stocks are at present trading at a substantial premium. One of the most common such measures, the cyclically adjusted price/earnings ratio (CAPE) of the S&P 500, is at its highest apart from a brief period in the late 1990s. Once interest rates are taken into account, however, stocks appear more reasonably priced. The excess CAPE yield, which takes the inverse of the S&P 500 CAPE ratio and subtracts real (inflation-adjusted) interest rates, is currently not far from its long-term average (Graph A, left-hand panel).

High valuations and low rates change stock return drivers and risks

Graph A

Earnings yields were in line with long-run average

Stock returns respond more strongly to monetary news when rates are low



[1] Periods of low valuations (rates) are those with average quarterly CAPE (10-year Treasury rate) below the median. [2] Based on changes in the index developed in C Scotti, "Surprise and uncertainty indexes: real time aggregation of real-activity macro-surprises", *Journal of Monetary Economics*, September 2016. [3] Based on M Jarociński and P Karadi, "Deconstructing monetary policy surprises – the role of information shocks", *American Economic Journal: Macroeconomics*, April 2020. Monetary policy news is based on the behaviour of interest rates with maturity between one month and one year around Federal Open Market Committee announcements. Positive monetary policy news indicates higher bond yields, hence a policy tightening. Coefficients on monetary policy news are multiplied by minus 1.

Sources: Jarociński and Karadi (2020); Scotti (2016); R Shiller, www.econ.yale.edu/~shiller/data.htm; Bloomberg; BIS calculations.

An environment of low interest rates is conducive to particularly high sensitivity of stock returns to monetary policy news. When interest rates are below their median, monetary policy news, measured with changes in short-term interest rates around Federal Open Market Committee announcements, has a stronger effect on S&P 500 returns than when interest rates are above their median. In contrast, the corresponding impact of macroeconomic news, proxied by deviations of scheduled macroeconomic releases from consensus forecasts, is actually lower at low interest rates.[2]

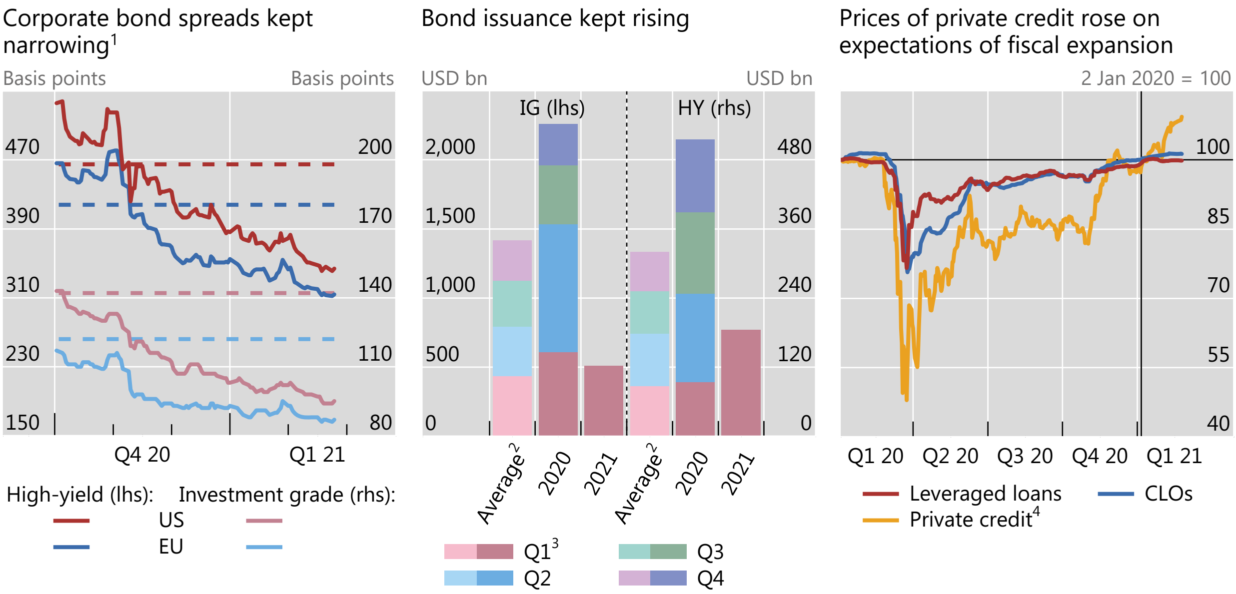
In principle, there could be a mechanical effect at play. Monetary policy news that induces changes to interest rates at low levels has a substantially larger impact on the discount factor, which translates into a similarly large impact on stock returns. For the results we report in Graph A (right-hand panel), we seek to strip out these effects.③ Likewise, all else the same, macroeconomic news could have mechanically a stronger impact on returns when the discount factor is lower. Our findings indicate that this effect does not drive outcomes. Namely, the reported sensitivities to macroeconomic news (red bars) are actually lower at low interest rates.

Through what channels – other than that of the discount factor – do low interest rates strengthen the responsiveness of stock returns to monetary policy news? Such interest rates reduce corporates' debt servicing costs and encourage economic activity, thus leading to higher expected profits and ultimately higher equity valuations. Moreover, if low interest rates are the symptom of accommodative monetary policy that seeks to reduce the likelihood of steep losses on the equity market, then they would go hand in hand with low risk premia and, thus, high valuations. Overall, to the extent that corporate profitability and investors' attitude to risk are predicated on monetary policy, stock valuations would respond strongly to news about this policy.

① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② We observe similar patterns in the corporate bond market. The effect of monetary policy on exchange rates is also higher when interest rates are low. See M Ferrari, J Kearns and A Schrimpf, "Monetary policy's rising FX impact in the era of ultra-low rates", *BIS Working Papers*, no 626, April 2017. ③ Concretely, in our empirical analysis, we estimate separately the effect of news on stock returns that depends on the interest rate level and the effect that does not. In Graph A (right-hand panel), we report only the latter effect.

The increasing footprint of retail investors and the appeal of alternative asset classes also pointed to brisk risk-taking. An index gauging interest in the stock market on the basis of internet searches surged, eclipsing its previous highest level in 2009 (Graph 2, third panel). This rise went hand in hand with the growing market influence of retail investors (Box B). In a sign of strong risk appetite, funds investing in the main cryptoassets grew rapidly in size following sustained inflows (fourth panel), and the prices of these assets reached all-time peaks.

Corporate credit remained buoyant; private credit caught up in late 2020 — Graph 3



CLOs = collateralised loan obligations.

The dashed lines in the left-hand panel indicate 2005–current median. The vertical line in the right-hand panel indicates 5 January 2021 (Georgia senatorial election runoff).

[1] Option-adjusted spreads. [2] Average quarterly issuance over the 2010–19 period. [3] For 2021, issuance data up to 22 February 2021, extrapolated to full quarter. [4] Value-weighted index of 47 US Business Development Companies.

Sources: Bloomberg; Dealogic; ICE BoAML indices; Refinitiv Eikon; BIS calculations.

Box B

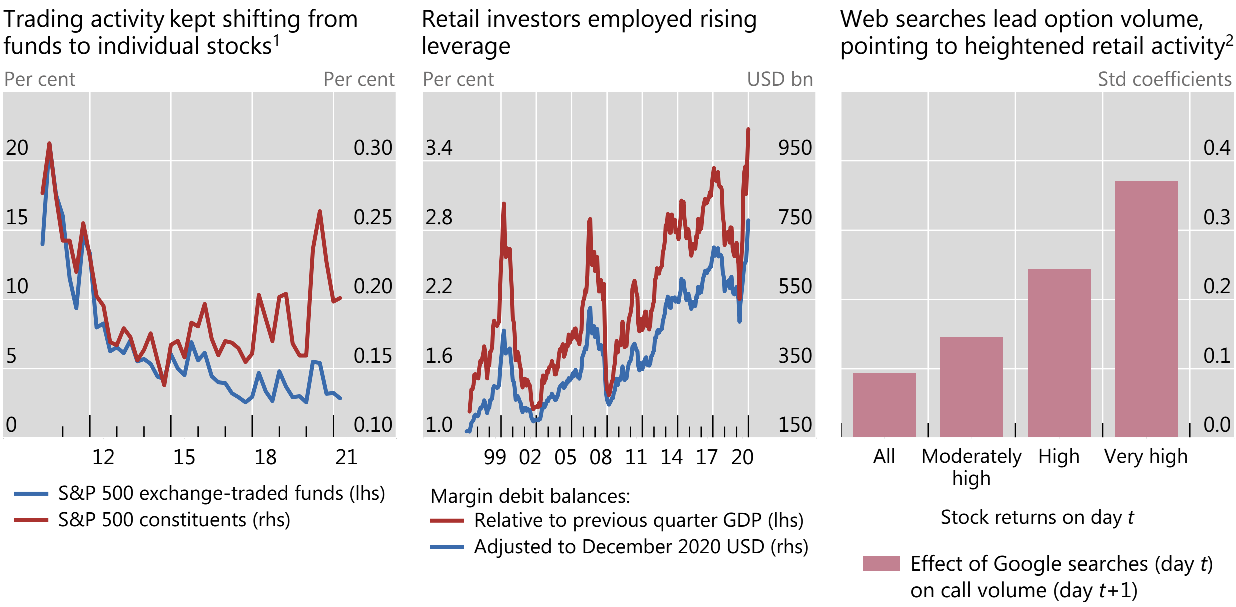
The rising influence of retail investors

*Sirio Aramonte and Fernando Avalos*①

Recent events have drawn attention to the growing role of retail investors in equity markets. In addition to fuelling a rise in trading volumes, these investors use leverage, buy and sell options to speculate on individual companies, and rely on social media platforms to coordinate their portfolio strategies. This box documents the footprint of retail traders and discusses its impact on market functioning.

Telltale signs of retail investors' growing activity emerged from patterns in equity trading volumes and stock price movements. For one, small traders seem to be often attracted by the speculative nature of single stocks, rather than by the diversification benefits of indices. Consistent with such preferences gaining in importance, share turnover for exchange-traded funds (ETFs) tracking the S&P 500 has flattened over the past four years, while that for the S&P 500's individual constituents has been on an upward trend over the same period, pointing to 2017 as the possible start year of retail investors' rising influence (Graph B, left-hand panel). In addition, retail investors are more likely to trade assets on the basis of non-fundamental information. During the late 1990s tech boom, for instance, they sometimes responded to important news about certain companies by rushing to buy the equity of similarly named but distinct firms. Comparable patterns emerged in early 2021 – for instance, when the value of a company briefly quintupled as investors misinterpreted a social media message as endorsing its stock.

The influence of retail investors continued to increase — Graph B



¹ Average value of daily turnover within a given quarter divided by market value at the end of the previous quarter. Exchange-traded funds include S&P 500 trackers from (tickers in parentheses): iShares (IVV), State Street Global Advisors (SPY) and Vanguard (VOO). ² Shows coefficients from regressions of call option volume for Amazon, Apple, Google, Facebook and Tesla on lagged values of Google Trends' "Interest over time". These values are obtained from searches of the expression "X options", where X is one of the five companies above. Returns are "moderately high/high/very high" if they are 0.5/1/1.5 standard deviations higher than the mean.

Sources: Bloomberg; FINRA; Google; Refinitiv Eikon; BIS calculations.

In the United States, retail investors' sustained risk-taking has been channelled through brokerage accounts, the main tool they have to manage their non-retirement funds. Brokerage accounts allow owners to take leverage in the form of margin debt. In December 2020, the amount of that debt stood at $750 billion, the highest level on record since 1997, both in inflation-adjusted terms and as a share of GDP. Its fast growth in the aftermath of March 2020 exceeded 60% (Graph B, centre panel). There is evidence that retail investors are currently taking risky one-way bets, as rapid surges in margin debt have been followed by periods of stock market declines.

In seeking exposure to individual companies, retail investors trade options. Call (put) options pay off only when the price of the underlying stock rises (falls) past a preset value, with gains potentially amounting to multiples of the initial investment. In this sense, options have embedded leverage that margin debt magnifies further. Academic research has found that option trading tends to be unprofitable in the aggregate and over longer periods for small traders, not least because of their poor market timing.②

Reports in early 2021 have suggested that the surge in trading volumes for call options – on both small and large stocks – has indeed stemmed from retail activity. For example, internet searches for options on five technology stocks – a clear sign of retail investors' interest – predicted next-day option volumes. This link was particularly strong for searches that took place on days with high stock returns, suggesting that option activity was underpinned by bets on a continuation of positive returns (Graph B, right-hand panel).

Equity prices rose and fell as retail investors coordinated their trading on specific stocks through social media in January 2021. While online chat rooms were already a popular means of information exchange in the late 1990s, the trebling of the number of US internet users and the rise in no-fee brokerages since then has widened the pool of traders who can combine their efforts. In a recent episode, retail investors forced short-sellers to unwind their positions in distressed companies. A similar move in the more liquid silver market floundered a few days later. These dislocations were short-lived, not least because, in response to collateral requests from clearing houses, some brokerages limited their customers' ability to trade. Even so, it has become clear that deliberate large-scale coordination among small traders is possible and can have substantial effects on prices.

Certain actions of retail investors can raise concerns about market functioning. Sudden bursts of trading activity can push prices far away from fundamental values, especially for less liquid securities, thus impairing their information content. In a move that underscored the materiality of this issue, the US Securities and Exchange Commission suspended trading in the shares of companies that had experienced large price movements on the back of social media discussions.

Even without deliberate coordination, retail investors' inclination to use options for speculative trading can amplify market volatility. The reason is that option sellers hedge their exposure by trading in the underlying stocks, typically buying when the prices of these stocks rise and selling when they fall. This hedging strategy adds to price swings.

① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② See R Bauer, M Cosemans and P Eichholtz, "Option trading and individual investor performance", *Journal of Banking and Finance*, April 2009.

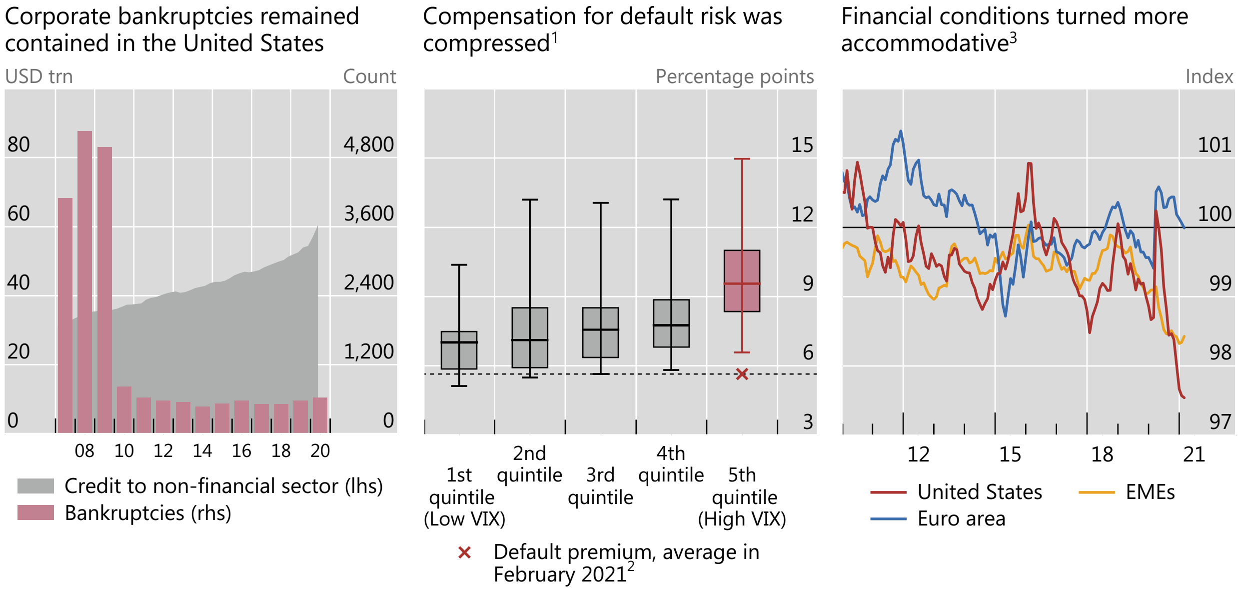
Signs of strong risk appetite were also visible in credit markets. Corporate bond spreads continued to decline steadily through early January, across rating grades and geographies, and remained firmly below historical averages (Graph 3, left-hand panel). Especially in the high-yield (HY) segment, the high issuance volume that characterised the first quarter of 2021 was more than twice the first quarter average from 2010 to 2019 (centre panel).

In the leveraged finance market, prices kept rising. The increase benefited all types of securities, including leveraged loans, collateralised loan obligations (CLOs) and private credit, which refers to loans made to smaller companies by alternative asset managers with little bank participation (Graph 3, right-hand panel). Similarly to equities, private credit proved particularly sensitive to rising expectations of US fiscal expansion in early January. Survey data from 2020 indicate that private credit volumes were likely to stay close to those observed in the previous record year.

Pricing in credit markets reflected upbeat sentiment on the back of low levels of realised risk. The number of corporate bankruptcies barely inched up in the United States (Graph 4, left-hand panel) and actually fell below 2015–19 averages in France and Germany, thanks to forceful public support programmes, looser filing requirements and lender leniency. Compressed spreads mirrored, in part, these developments. Bonds issued by distressed companies offered only a modest spread over yields of the lowest-rated investment grade firms. This spread, which is a proxy for default premia, was remarkably tight in the light both of banks' loan loss provisions in the course of 2020 (Box C) and of perceived market risk (Graph 4, centre panel).

Generally loose financial conditions underscored the buoyant mood in financial markets. In the specific index shown in Graph 4, the tightening effect of rising long-term sovereign yields (see below) was typically offset by increasing stock prices and declining corporate funding costs. In EMEs and the United States, financial conditions were more accommodative at the beginning of 2021 than at any point over the previous 10 years (Graph 4, right-hand panel). While they had not fully retraced the tightening that occurred in March, financial conditions in the euro area stood at relatively neutral levels.

Low bankruptcies appeared to validate positive sentiment in credit markets — Graph 4



[1] The difference between CCC and BBB corporate bond yields. Boxplots show medians, interquartile ranges, and 5th and 95th percentiles. The sample covers 1 January 2010 to 22 February 2021. [2] The relevant VIX quintile for February 2021 is determined using the average of daily VIX values from 1 to 22 February. [3] Goldman Sachs financial conditions indices; monthly averages.

Sources: Federal Reserve Bank of St Louis, FRED; Bloomberg; Datastream; S&P Capital IQ; BIS calculations.

Fixed income markets and the "reflation trade"

Government bond markets in AEs reflected the improved macroeconomic outlook around the turn of the year. With the continuous backdrop of vigorous monetary policy support and brighter pandemic prognoses, the stiffening prospect of a US fiscal spur unleashed a so-called "reflation trade": yield curves steepened and inflation break-evens rose.[2] Moreover, the US dollar bounced back from its post-election slide.

[2] Inflation break-even rates for a given maturity are calculated as the difference between the yields of nominal bonds and inflation-linked bonds of the same maturity.

Box C

Bank loan loss provisioning during the Covid crisis

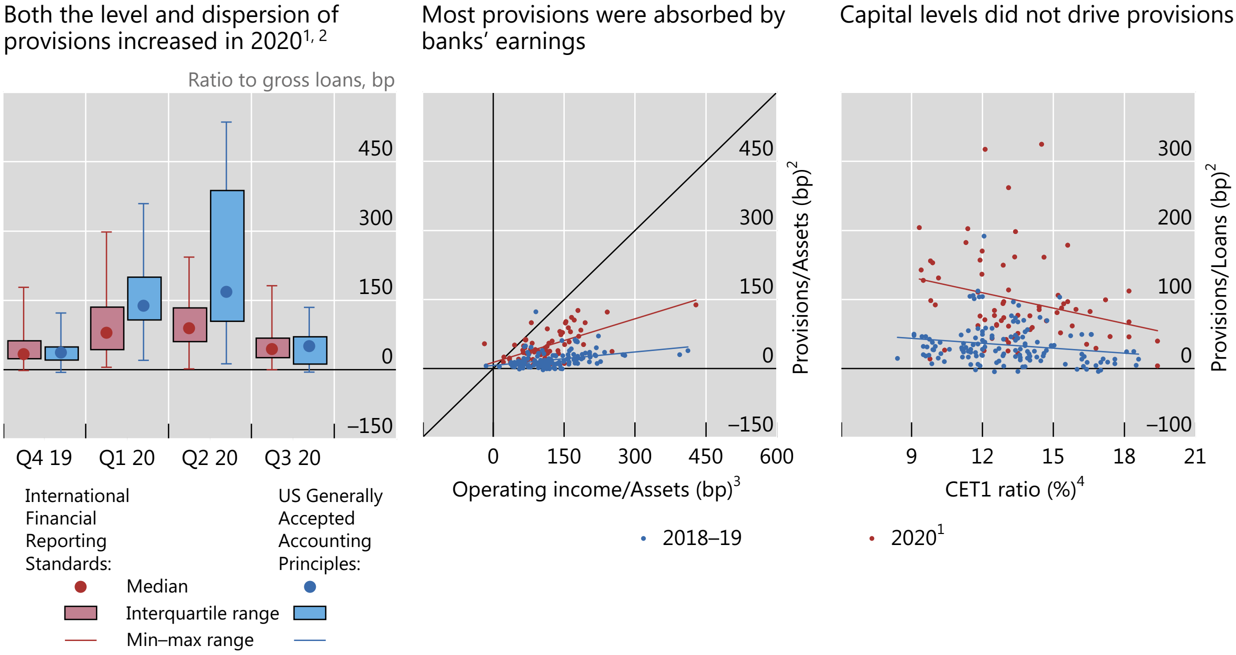
Douglas Araujo, Benjamin Cohen and Pamela Poglianí[①]

The Covid-19 crisis prompted a re-evaluation of banks' asset quality under conditions of extreme uncertainty. The crisis also represents the first major test of the newly introduced accounting standards for expected credit loss (ECL) provisioning. How have banks and supervisors approached these challenges?

ECL provisioning standards mandate that banks and other firms take provisions against expected credit losses on assets that are not accounted for at fair value. The expectations are based on a number of inputs, including model-based forecasts, historical experience and current conditions as well as bank management's judgment. As part of the standards and related regulatory guidance, global banks have also enhanced their qualitative and quantitative disclosures. The ECL standards replace the earlier incurred loss (IL) approach, under which banks only set aside provisions upon actual evidence that the borrower will not (or is strongly unlikely to) repay. Developed in the aftermath of the Great Financial Crisis of 2007–09, these standards are part of the IFRS 9 "Financial Instruments" standard under International Financial Reporting Standards (IFRS), and are known as Current Expected Credit Loss (CECL) under the United States Generally Accepted Accounting Principles (US GAAP). IFRS 9 was mandated for IFRS reporters from the first quarter of 2018, and CECL from the first quarter of 2020 for the largest banks subject to US GAAP.

In response to the uncertainties introduced by the Covid crisis, authorities granted banks greater leeway as to how to implement ECL provisioning. International standard setters have reiterated the inherent flexibility in the standards, emphasising the key role of judgment, and have stressed that banks should take account of the positive effects from policies to support the economy during the pandemic.[②] National supervisors have conveyed similar messages. Standard setters have also acted to alleviate the impact of the transition from IL to ECL on capital.[③]

Loan loss provisions during the Covid-19 crisis | Graph C



In the centre and right-hand panel the positive and negative relationships are significant at the 95% level in both 2018–19 and 2020.

[1] Annualised figures. [2] Does not include the effect of US GAAP banks applying expected credit loss provisioning to existing loans in Q1 2020. [3] Pre-provision operating income. [4] Common Equity Tier 1 (CET1) ratio as of end-December 2018 and 2019 (blue dots) and end-September 2020 (red dots).

Sources: Bloomberg; public disclosures; authors' calculations.

The initial Covid-19 shock triggered significant upward revisions to banks' forward-looking assessment of credit losses. For a sample of 70 large, internationally active banks reporting under ECL accounting, provisions totalled $161 billion in the first half of 2020, compared with $50 billion in the second half of 2019. Relative to loans, the median of annualised provisions rose from 35 basis points in the second half of 2019 to 105 basis point in the first half of 2020.[④] Along with this higher level, the Covid crisis brought more dispersion across banks in provisions as a share of loans. Provisions were somewhat higher as a share of loans for US GAAP banks than for IFRS reporters (Graph C, left-hand panel), perhaps reflecting the use of lifetime credit risk in determining provisions under the US GAAP framework rather than one-year risk for most loans in the IFRS approach.[⑤]

Provisions in 2020 were significantly higher for banks with higher pre-provision earnings but were not strongly related to bank capital (Graph C, centre and right-hand panels, red dots). The positive relationship between announced provisions and earnings had been weaker in 2018–19 (blue dots). This relationship strengthened in 2020 when, faced with a substantial increase in credit risk, banks may have felt more comfortable taking larger provisions if this still left them with positive net earnings. Another possible reason is that higher interest margins could have been earned on riskier loans that subsequently required higher provisions in bad times. Contrary to the relationship between provisions and earnings, banks with higher capital ratios did not take more provisions in 2020; if anything, the relationship was slightly negative (right-hand panel). This suggests that, to the extent that strategic concerns affected provisioning in 2020, they did not relate to capital preservation, possibly reflecting the banks' initially strong capital positon. It could also be that those banks that took higher provisions in 2020 had entered the crisis with relatively riskier loan portfolios, and hence higher risk weights and lower risk-weighted capital ratios.

As the economic outlook improved in the second half of 2020, banks reduced their quarterly provisions, and some even took negative provisions. In the third quarter, the total provisions of the banks in our sample declined to $29.5 billion, approaching pre-Covid levels. Dispersion across banks also fell. At the end of the year, the 57 banks that had published fourth quarter financial data at the time of writing took an aggregate of $20 billion in provisions, with the median provisions-to-loans ratio across institutions amounting to 29.7 basis points. Six of these banks announced negative provisions, ie a reduction in loan loss reserves. These reductions remained substantially smaller than the amount of loan loss reserves added during the previous three quarters.

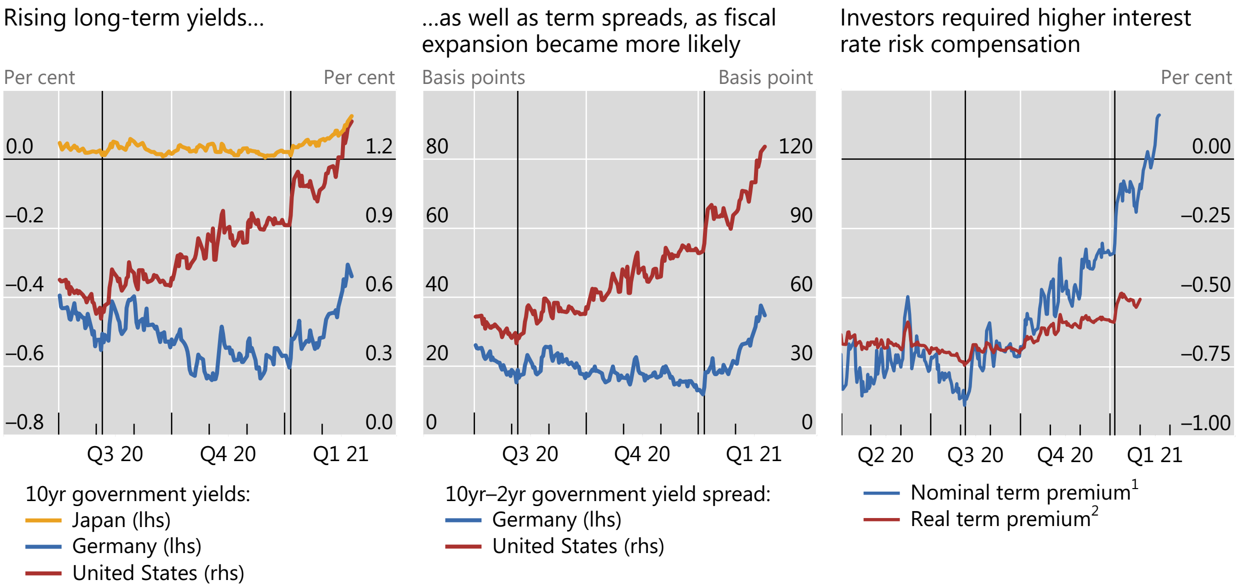
① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② See Basel Committee on Banking Supervision, *Measures to reflect the impact of Covid-19*, April 2020; and International Accounting Standards Board, "IFRS 9 and Covid-19", 27 March 2020. ③ The transition arrangements had been set out in Basel Committee on Banking Supervision, *Regulatory treatment of accounting provisions – interim approach and transitional arrangements*, March 2017. In 2020, the Basel Committee allowed banks more flexibility in phasing in the capital impact of the new frameworks. ④ A portion ($18.5 billion) of the 2020 increase in provisions by the 19 US GAAP banks in this group included the one-time impact of the application of the ECL approach to existing loans on 1 January 2020. All findings in the box exclude this increase. ⑤ For differences between the IFRS 9 and CECL frameworks, see B Cohen and G Edwards, "The new era of expected credit loss provisioning", *BIS Quarterly Review*, March 2017, pp 39–56.

Central banks across the globe continued to maintain a very accommodative stance. Policy rates stayed unchanged across most AEs and EMEs, and some central banks increased the size or pace of their asset purchase programmes. In the core jurisdictions, policymakers maintained forward guidance of continued strong accommodation, despite inflation figures that surprised on the upside in December and January. Their stance reflected concerns that economic activity had not fully recovered, that economic scars could linger, that new lockdowns heralded further weakness, and that the factors behind higher inflation figures were temporary. In contrast, some EME central banks broadcast a more cautious message as inflationary pressures continued to build up during the second half of 2020.

Long-term yields surged in core markets during January and February, and yield curves steepened as short-term rates remained pinned at historically low levels. The rotation was most pronounced in the United States, where 10-year yields resumed the trend initiated in August when the Treasury announced large increases in the issuance of long-term bonds (Graph 5, left-hand panel). In parallel, short rates plunged in February as the Treasury unveiled its plan to drastically curtail its cash holdings, which may result in a large reduction in the amount of bills outstanding.

The resulting steepening of the yield curve was roughly mirrored in other major economies (centre panel).

Sovereign yield curves steepened in advanced economies in early 2021 Graph 5



The vertical lines indicate 5 August 2020 (US Treasury announces increased issuance of long-term bonds) and 5 January 2021 (Georgia senatorial election runoff).

[1] Based on T Adrian, R Crump and E Moench, "Pricing the term structure with linear regressions", *Journal of Financial Economics*, October 2013. [2] Based on S D'Amico, D Kim and M Wei, "Tips from TIPS: the informational content of Treasury Inflation-Protected Security prices", *Journal of Financial and Quantitative Analysis*, February 2018.

Sources: Adrian et al (2013); D'Amico et al (2018); Bloomberg; BIS calculations.

The steepening of yield curves in core markets mirrored the increase in market measures of interest rate risk and inflation compensation.[3] Continuing their trend after a turning point in early August, term premia climbed gradually throughout the review period (Graph 5, right-hand panel). In turn, US inflation compensation, as reflected in 10-year break-even rates, picked up pace in late November, and rose by about 40 basis points by late February. This stemmed, in part, from a substantial upward revision of investors' inflation expectations, which are almost back to pre-pandemic levels. Moreover, the inflation risk premium has been high, which appears closely connected to conditions in the US Treasury market (Box D). In Germany, inflation break-evens also rose, yet their levels were still far below those in the United States.

A close examination of the inflation break-even rates reveals that investors were expecting inflation to flare up in the medium term and to ease subsequently. This is the message of five-year US break-evens surpassing and rising above the corresponding 10-year benchmarks since early January (Graph 6, left-hand panel). In a qualitatively similar development, the spread between the corresponding German break-evens dropped by about 10 basis points during the review period.

[3] Inflation break-even rates are a common measure of inflation compensation. Such compensation is made up of two components: market expectations of average inflation during the life of the bonds, and an inflation risk premium to compensate investors for holding nominal bonds, which expose them to inflation risk.

Box D

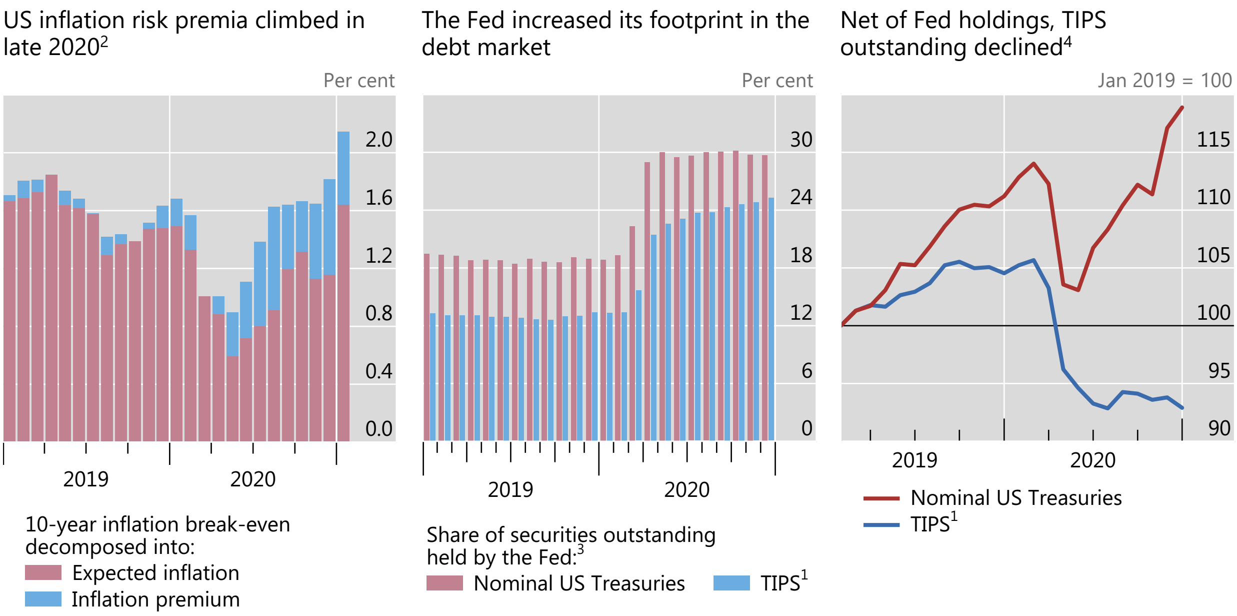
What drove the recent increase in the US inflation break-even rate?

Sirio Aramonte and Fernando Avalos[1]

Inflation break-even rates indicate how investors' perceptions of future inflation translate into pricing decisions. For the United States, this rate can be measured as the spread between the yields on nominal US government bonds (Treasuries) and on Treasury Inflation-Protected Securities (TIPS). In this box, we use a model of the term structure of interest rates to decompose the US break-even rate into its two elements: inflation expectations and what is known as "inflation risk premium". In so doing, we find that inflation expectations have increased substantially since mid-2020, and that the measured inflation risk premium has also contributed materially. The latter seems to reflect, in part, the funding policy of the US Treasury and its interaction with asset purchases by the Federal Reserve.

Since the end of March 2020, the break-even rate has increased by almost 130 basis points, to 2.16% in late February 2021, surpassing its pre-pandemic watermark. Much of this reflects the rise in inflation expectations between May and October 2020.[2] Expected inflation then levelled off in November and December before a step increase in January, as the prospect of a large fiscal impulse consolidated (Graph D, left-hand panel, red bars). In parallel, the inflation risk premium increased by about 50 basis points (blue bars), helping to take the break-even rate to the highest level seen since early 2019.

Inflation risk premia rose as the net supply of TIPS[1] dwindled vs US Treasuries — Graph D



[1] TIPS = Treasury Inflation-Protected Securities. [2] The decomposition of the 10-year nominal yield according to an estimated joint macroeconomic and term structure model; see P Hördahl and O Tristani, "Inflation risk premia in the euro area and the United States", *International Journal of Central Banking*, September 2014. Yields are expressed in zero coupon term. [3] Ten-year equivalent; ratio of Federal Reserve's System Open Market Account (SOMA) holdings to total outstanding value. [4] Ten-year equivalent; weighted sum of total outstanding debt, net of SOMA holdings.

Sources: Board of Governors of the Federal Reserve System; Federal Reserve Bank of St Louis, FRED; US Treasury; Bloomberg; Refintiv Eikon; JPMorgan Chase; BIS calculations.

The overall increase in the break-even rate is likely to have reflected a variety of indications that US inflation could be higher in the near term. On the back of the Federal Reserve's new monetary policy framework, progress in the distribution of vaccines, higher commodity prices and a potentially substantial fiscal impulse were likely drivers of higher inflation expectations. But what could have contributed to the high inflation risk premium?

In a simple textbook setting, the inflation risk premium would only reflect the compensation that investors demand for holding nominal Treasuries, over and above the compensation for expected inflation. In this case, the only drivers of the risk premium would be investors' perceptions of risk and their risk appetite. In practice, however, the measured inflation risk premium can also reflect a variety of additional drivers. In the US case, these include imbalances between the demand for and supply of Treasuries and TIPS, or the relative liquidity of the underlying markets.

The net supply of Treasuries and TIPS to private investors stems from the interaction of US Treasury issuance patterns and Federal Reserve purchases. As the US central bank swiftly expanded its holdings of TIPS and Treasuries in response to the Covid-19 emergency, the corresponding bond amounts available to investors dropped substantially in the first quarter of 2020 (Graph D, centre panel). From mid-2020, however, issuance of Treasuries picked up, with auction sizes increasing by between 20% and more than 50% by the end of 2020, depending on the tenor. At the same time, the auction sizes of TIPS remained stable. Since the Federal Reserve maintained a relatively large and steady pace of purchases that somewhat exceeded TIPS issuance but not the expanded issuance of Treasuries, the amount of Treasuries available to investors recovered quickly (Graph D, right-hand panel, red line), while the corresponding TIPS volume stagnated (blue line).

This combination of higher supply of Treasuries and lower supply of TIPS is likely to have contributed to the higher measured inflation risk premium. To the extent that the appetite for inflation hedging remained constant or rose, which appears likely given the macroeconomic and policy backdrop, investors would bid down the yield on the limited amount of TIPS available. The relatively low liquidity of the TIPS market would amplify this effect. At the same time, investors would ask for an increasingly higher compensation to hold the quickly expanding amount of Treasuries. All these mechanisms would contribute to the rise of the break-even rate for given inflation expectations, thus boosting the measured inflation risk premium.

① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② For the estimates of expected inflation and the inflation risk premium, we use the model from P Hördahl and O Tristani, "Inflation risk premia in the euro area and the United States", *International Journal of Central Banking*, September 2014. We confirm that our findings are qualitatively similar to those of S D'Amico, D Kim and M Wei, "Tips from TIPS: the informational content of Treasury Inflation-Protected Security prices", *Journal of Financial and Quantitative Analysis*, February 2018. Indeed, earlier studies have found that these frequently used empirical models tend to deliver estimates with similar time profiles. See B Cohen, P Hördahl and D Xia, "Term premia: models and some stylised facts", *BIS Quarterly Review*, September 2018, pp 79–91.

A number of factors seem to have been at work. Probably the most important one was central banks vowing to be patient and allow full economic recovery before tightening policy – and to do so even if that meant moderate overshoots of their targets in the short and medium term, as clearly stated in the new Federal Reserve framework. This makes it more likely that the more expansionary fiscal policy and the recent rally in oil and other highly cyclical commodity prices will have an inflationary impact. By the end of the review period, the prices of grains and industrial metals had surpassed their pre-pandemic levels by about 25% (Graph 6, centre panel, blue and yellow lines). And while oil prices have not staged a similar recovery, they increased by roughly 35% during the review period (red line).

In line with the prevailing high risk appetite, European sovereign spreads relative to German bunds narrowed up to the end of the year. This reflected, in part, a relatively smooth completion of Brexit. In January, European sovereign spreads fluctuated in response to setbacks in vaccine procurement and swinging perceptions of political risk in Italy (Graph 6, right-hand panel).

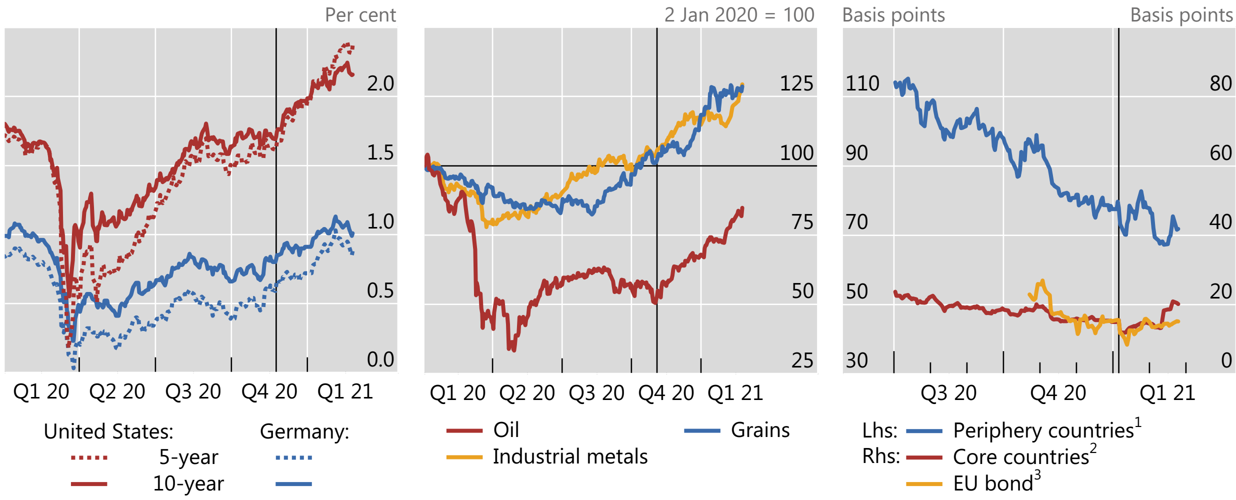
The US dollar picked up somewhat during the review period, following a post-election slide. The currency tentatively strengthened from early January, as the US outlook improved relative to the rest of the world (Graph 7, left-hand panel). Fiscal support and a relatively successful rollout of the vaccination campaign in the United States contrasted with a global picture beset by evidence of procurement setbacks, new virus strains and relatively limited fiscal space.

The greenback still faced significant headwinds. It is possible that the expansionary tilt of the new Fed strategy has muted the appreciation pressure. Falling

"Reflation" lifted medium-term inflation expectations and core European sovereign spreads

Graph 6

Five-year inflation break-evens rose faster than 10-year | Oil and cyclical commodities have surged in recent months | EU sovereign spreads widened from early January



The vertical line in the left-hand panel indicates 23 November 2020 (US General Services Administration begins presidential transition process). The vertical line in the centre panel indicates 3 November 2020 (US presidential election day). The vertical line in the right-hand panel indicates 5 January 2021 (Georgia senatorial election runoff).

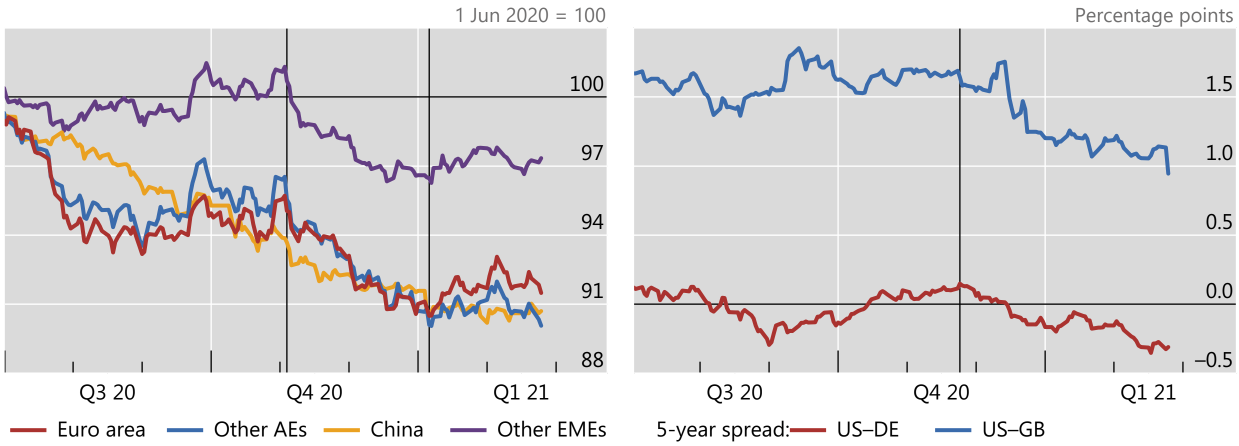
[1] Simple average of ES, IT and PT. [2] Simple average of AT, FR and NL. [3] Ten-year EU bond issued under the SURE (Support to mitigate Unemployment Risk in an Emergency) programme.

Sources: Bloomberg; BIS calculations.

Dollar depreciation was halted as prospects of fiscal support consolidated

Graph 7

US dollar post-election slide halted...[1] | ...but support from US real yield spreads faltered



The vertical lines in the left-hand panel indicate 3 November 2020 (US presidential election day) and 5 January 2021 (Georgia senatorial election runoff). The vertical line in the right-hand panel indicates 23 November 2020 (US General Services Administration begins presidential transition process).

[1] Simple averages. A decrease indicates US dollar depreciation.

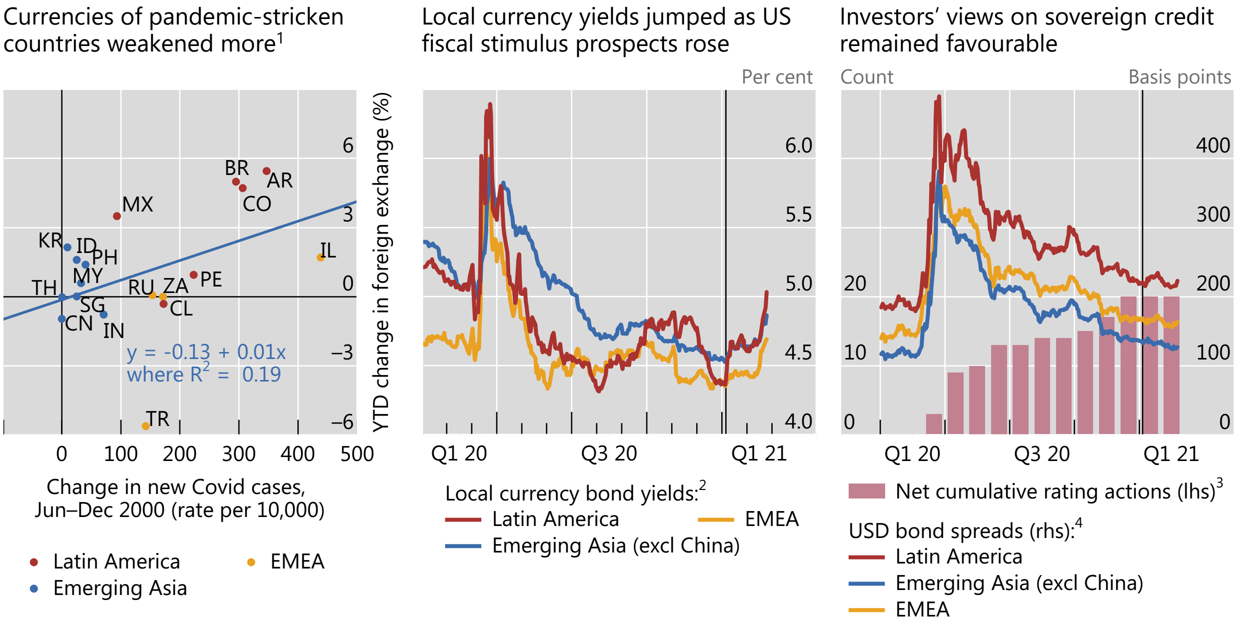
Sources: Bloomberg; BIS calculations.

inflation-adjusted yield spreads have been gradually eroding the advantage of US dollar assets, and a global upswing in real yields late in the review period did not change that trend (Graph 7, right-hand panel). Going forward, as the fiscal stimulus is rolled out, the likely increase in US current account deficits may put downward pressure on the dollar, especially if US yields remain relatively restrained by monetary policy.

Positive sentiment towards EMEs, amid challenges

EME assets saw heightened volatility in January as global vaccination efforts hit various roadblocks. When the dollar strengthened, it did so most against the currencies of the EMEs most affected by the pandemic. Sentiment towards EME assets as a whole remained generally favourable throughout most of the review period, although differentiation appeared to increase across some dimensions.

EME currencies and assets reflected the impact of the pandemic — Graph 8



EMEA = Europe, Middle East and Africa. YTD = year-to-date.

The vertical lines in the centre and right-hand panels indicate 5 January 2021 (Georgia senatorial election runoff).

[1] Regression coefficient significant at 90% confidence level. [2] Simple averages of JPMorgan Chase GBI Global sub-indices, traded yields. [3] Calculated as cumulative total negative actions (credit rating downgrades and negative outlook revisions) net of total positive actions (credit rating upgrades and positive outlook revisions), based on ratings decision by Fitch, Moody's and S&P. [4] Simple averages of JPMorgan Chase EMBI Global sub-indices, stripped spreads.

Sources: IMF; Bloomberg; JPMorgan Chase; Our World in Data; BIS calculations.

Pandemic management and associated monetary policy actions showed through in exchange rates. As the dollar appreciated somewhat after December, countries with higher infection rates during H2 2020 saw their currencies depreciate more (Graph 8, left-hand panel). In particular, currencies fell the most in South America, where looser monetary policies were needed to cushion the blow of higher infection rates. Policy rates in the region had dropped by 200 basis points on average, substantially more than in most other EMEs. In contrast, the currencies of Asian countries, which sustained lower infection rates, proved more resilient.

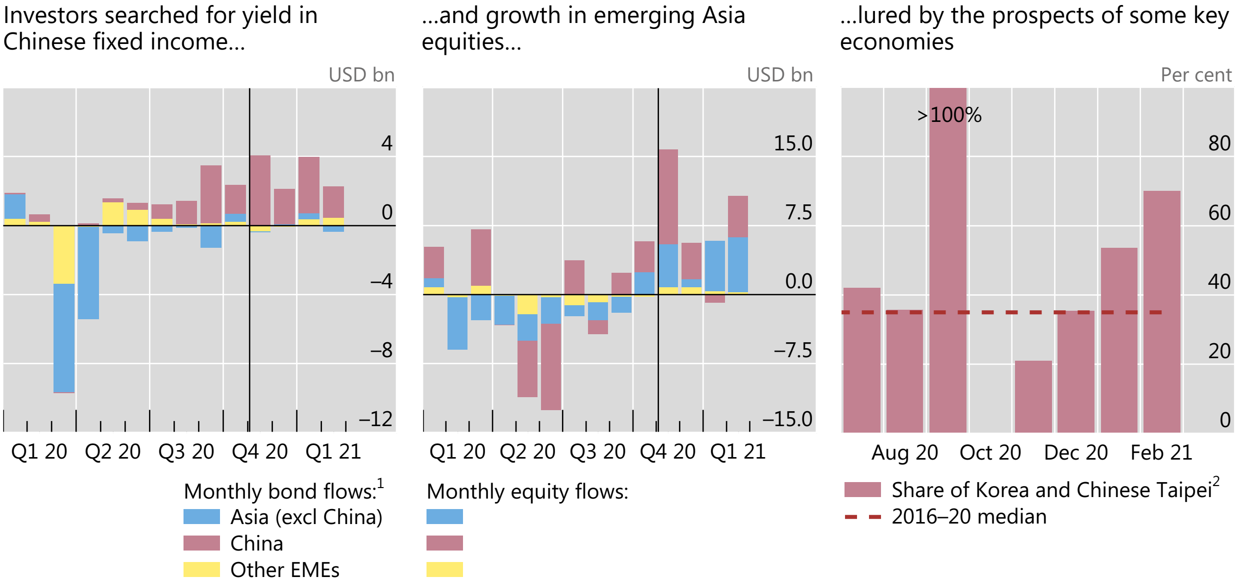
Some of the largest EMEs had seen inflation escalating since mid-2020. During the review period, monthly inflation figures surpassed central bank targets of those economies. Substantially higher food prices, as stated earlier, added to inflationary pressures. Central banks may thus face challenging trade-offs, with inflation prompting them to tighten monetary conditions pre-emptively, before economic activity has fully recovered from the pandemic shock. In this context, favourable global financial conditions would provide valuable room for manoeuvre.

Government bond yields, however, met a turning point in January. Going into the end of 2020, local currency-denominated bond yields had continued to fall on the back of investors' relentless search for yield (Graph 8, centre panel). As the "reflation" trade scenario shaped up in early January, yields began to rise again, and then jumped up towards the end of the review period, together with AE yields. The increase in yields was sharpest for Latin American countries, possibly revealing investors' higher inflation and depreciation expectations for the region.

Overall, investors maintained a sanguine view of EME government credit. Spreads on US dollar-denominated debt continued to tighten up to the end of the review period (Graph 8, right-hand panel, lines), irrespective of the jitters in local currency yields. Sovereign spreads were approaching early 2020 levels at the regional level, even though EMEs' credit ratings had worsened since the outbreak of the pandemic (right-hand panel, bars). That said, investors differentiated across individual jurisdictions. EMEs with higher credit ratings at the end of the review period (BBB+ or better) faced credit default swap spreads about 100 basis points lower than other EMEs (with ratings BBB– or worse).

Portfolio flows through the review period also revealed a positive tilt towards some EMEs. Flows into bond funds strengthened after the US election, and investors focused their search for yield on China (Graph 9, left-hand panel). In early 2021, portfolio equity flows rotated towards emerging Asia (centre panel), consistent with investors pursuing growth in some key economies in the region (right-hand panel).

Sentiment towards EME assets remained positive, but tilted towards East Asia — Graph 9



The vertical lines in the left-hand and centre panels indicate 3 November 2020 (US presidential election day).

[1] Flows to local currency bond funds. [2] Three-month lagging aggregate equity portfolio flows. Share of equity flows to emerging Asia going to Korea and Chinese Taipei. The bar for October 2020 is omitted because flows are of opposite sign.

Sources: EPFR; BIS calculations.

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Investor size, liquidity and prime money market fund stress[1]

Massive redemptions at money market funds (MMFs) investing primarily in high-quality short-term private debt securities were an important feature of the market dislocations in March 2020. Building on previous studies of the underlying drivers, we find that large investors' withdrawals did not differentiate across prime institutional MMFs according to these funds' asset liquidity positions. We also find that, faced with large redemptions, the managers of these funds disposed of the less liquid securities in their portfolios, marking a departure from their behaviour in tranquil times. This is likely to have exacerbated market-wide liquidity shortages. After the Federal Reserve's announcement of the Money Market Mutual Fund Liquidity Facility, all funds strengthened their liquidity positions, with those hardest-hit by outflows attempting to catch up with peers.

JEL classification: G23, G28, E58.

Key takeaways

- In March 2020, prime institutional money market funds serving large investors experienced withdrawals irrespective of the liquidity of underlying assets.
- During the massive withdrawals, fund managers mostly disposed of less liquid assets, which may have exacerbated market-wide liquidity shortages.
- Once policy relief set in, fund managers rebuilt liquidity buffers, with the funds hardest-hit by outflows strengthening their liquidity positions most aggressively.

As the Covid-19 shock gathered momentum in March 2020, large withdrawals beset money market mutual funds (MMFs) investing primarily in high-quality short-term private debt securities (prime MMFs). Since these funds are major global providers of short-term dollar funding to banks and non-financial corporates, their stress had system-wide repercussions (Eren, Schrimpf and Sushko (2020a,b)).

This run on prime MMFs was different from other prominent financial runs in history. The bank runs during the Great Depression and the 2008 run on the very

[1] We thank Stefan Avdjiev, Claudio Borio, Stijn Claessens, Ingo Fender, Ulf Lewrick, Benoît Mojon, Andreas Schrimpf, Hyun Song Shin and Nikola Tarashev for helpful comments and suggestions. We are also grateful to Giulio Cornelli and Albert Pierres Tejada for excellent research assistance. The views expressed are ours and do not necessarily reflect those of the Bank for International Settlements.

same MMF sector were triggered by concerns about the *credit* quality of the intermediaries' portfolio of assets. In March 2020, credit quality was not an obvious concern, partly reflecting the strengthened requirements introduced by MMF regulatory reforms in the aftermath of the 2008 crisis.

Previous studies of MMF stress have pointed to concerns over funds' *liquidity*. Li et al (2020) find that prime institutional funds with relatively weaker liquidity positions suffered more pronounced outflows.[2] Cipriani and La Spada (2020) note that the funds' investor base also played a role: while funds' liquidity was relevant for prime institutional funds, it was not for their retail counterparts. One complicating factor in these assessments is that prime institutional and retail funds are subject to different regulatory rules, making it hard to disentangle the effect of the investor base from that of regulation.

To further investigate the role of the investor base, we focus on prime institutional MMFs. Focusing on funds facing identical regulations allows us to study other determinants of redemption patterns. To distinguish investor types, we differentiate between funds with large and small minimum investment sizes, as they tend to cater to large and small institutional investors, respectively. Other studies have shown that these two groups of funds behaved differently during past stress episodes (eg Schmidt et al (2016), Gallagher et al (2020)).

We find that investor size was an important determinant of the pattern of redemptions from prime institutional MMFs in March 2020. Possibly owing to their own cash needs, large investors massively redeemed fund shares, paying little attention to the liquidity of the funds' asset portfolios. By contrast, the liquidity of funds' positions was relevant for small institutional investors. However, to the extent that the characteristics of funds' assets were not the sole driver of redemptions, this was not a classic run.

In the second part of this feature, we shift the focus from the behaviour of investors to that of the fund managers. We find that managers disposed of the less liquid assets in their portfolios. Such sales may have exacerbated market-wide liquidity shortages during the heightened market stress in the first half of March. This stress eased after the Federal Reserve announced its Money Market Mutual Fund Liquidity Facility (MMLF) in mid-March, which stemmed withdrawals. Managers proceeded to rebuild their liquidity buffers, raising them to higher than pre-pandemic levels. Ultimately, funds that had experienced larger withdrawals saw a stronger subsequent build-up of liquidity buffers.

This feature proceeds as follows. In the next section, we present a brief introduction to the MMF sector and survey attendant developments during the March 2020 stress, both at the sector and the fund levels. In the second section, we focus on liquidity positions and investor size as potential drivers of the March stress at US prime institutional MMFs. The third section studies such MMFs' liquidity management before, during and after the stress episode. The last section concludes.

2 This stood in contrast to studies of a similar event in 2008: Strahan and Tanyeri (2015) and Schmidt et al (2016) did not find significant connection between the severity of the 2008 MMF run and fund-level liquidity conditions.

An overview of MMFs in the March market turmoil

Institutional background

MMFs are mutual funds that invest in short-term assets of high credit quality. Their function as intermediaries is to offer a cash management tool to investors, while providing short-term funding to governments, financial institutions and corporates (Aldasoro, Eren and Huang (2021)). As of the end of 2019, the MMF sector had assets under management (AUM) in excess of $7 trillion globally, mainly in the United States (57%) and the euro area (20%) (FSB (2020b)).[3]

Following the stress suffered by the sector in 2008, authorities introduced sweeping regulatory reforms in the main jurisdictions.

In terms of their set of eligible assets, US MMFs are broadly classified as government, prime and tax-exempt. Government MMFs invest most of their assets in US Treasuries, US agency securities and repurchase agreements collateralised by US Treasuries. Prime MMFs mainly invest in private sector securities such as certificates of deposit and financial or non-financial commercial paper. Tax-exempt funds primarily hold municipal securities.

As regards US prime MMFs – which are the main focus of our analysis below – regulation differentiates between retail and institutional funds. Only individuals (natural persons) can access prime retail MMFs. There are no access restrictions for prime institutional MMFs, but they typically cater to large non-financial investors such as corporate treasuries, or financial institutions such as pension funds. Retail and institutional funds also differ in their share pricing rules. While the former maintain constant net asset values (NAVs), prime institutional MMFs mark their portfolios to market so that they have floating NAVs. All prime funds may impose redemption gates or liquidity fees, ie suspend redemptions or make them costlier, when their weekly liquid assets (WLA) fall below 30% of their total assets.[4] These regulatory guidelines are intended to provide fund managers with liquidity management tools to address redemption pressure.[5]

In Europe, shares in MMFs are almost exclusively held by institutional investors.[6] Based on their share pricing rules, European funds are categorised into constant net asset value (CNAV), low volatility net asset value (LVNAV) and variable net asset value (VNAV) MMFs. CNAV funds are similar to US government MMFs in that they hold mostly government securities. But in contrast to US government MMFs and similar to US prime MMFs, European CNAV funds can introduce redemption gates and liquidity fees. While LVNAV and VNAV MMFs are comparable to US prime funds in terms of

3 The size of the MMF sector has stagnated in the United States and the euro area since the Great Financial Crisis of 2007–09, as their AUM were almost the same at end-2019 as at end-2008 (Baba et al (2009)). In contrast, AUM have grown from almost nil to about $1.8 trillion in the rest of the world, spearheaded by local currency-denominated funds.

4 On any given reporting day, WLA generally include cash, US Treasury securities, other government securities with remaining maturities of 60 days or less and securities that mature within one week.

5 Tax-exempt MMFs broadly follow the same regulatory provisions as prime MMFs. Government MMFs, on the other hand, offer constant NAVs, are not required to separate retail and institutional investors, and do not impose gates or fees.

6 See Bouveret and Lorenzo (2020).

portfolio composition, only LVNAV funds are subject to MMF regulatory guidelines on gates and fees on investor redemptions.[7]

Developments in the MMF sector in March 2020

In early March 2020, the initial sanguine reaction of investors to the threat posed by Covid-19 gave way to a frantic "dash-for-cash".[8] Prime institutional MMFs saw 20 consecutive days of outflows between 6 and 26 March 2020 (henceforth, the run or stress period). The redemption dynamics in the midst of this acute market turmoil diverged widely across MMF types.

Government MMFs saw massive inflows over the course of March 2020 as investors fled to safety in both the United States and Europe. By the end of the month, US government MMFs had notched up investor inflows of around $800 billion (Graph 1, first panel, red line), increasing their pre-stress AUM by almost a third. Similarly, European dollar-denominated CNAV funds saw almost a 70% increase in their AUM, with inflows around $80 billion (third panel, red line).

At the same time, most other MMF classes experienced outflows. US prime institutional MMFs and European dollar-denominated LVNAV funds underwent a run-type event, with withdrawals reaching roughly $100 and $90 billion, respectively (Graph 1, first panel, green solid line, and third panel, yellow line). Daily outflows from US prime institutional MMFs exceeded 2% of the previous-day AUM for eight trading days in a row, an extraordinary event from a historical perspective. European dollar-denominated LVNAV funds had a similar experience.[9]

Within the prime institutional MMF universe, the experience of individual funds was highly uneven. During the run, cumulative redemptions ranged from 5 to 40% of pre-run AUM for half of the funds, with a quarter of the funds faring much worse (Graph 1, second panel).[10] By contrast, some funds recorded gains of up to 20% of pre-run AUM. In Europe, one half of the fund-level redemptions were within a comparable range of 0–30% of pre-run AUM (fourth panel).

In response to the market strains, a number of programmes were rolled out to provide liquidity support. In the United States, the Federal Reserve established the Money Market Mutual Fund Liquidity Facility (MMLF) on 18 March.[11] This programme allowed banks to borrow from the Federal Reserve by pledging a wide range of assets purchased from prime and tax-exempt MMFs. Eligible assets included the most distressed ones, such as commercial paper and certificates of deposit. The loans to the participating banks were given on a non-recourse basis (ie banks did not bear credit risk) and were exempt from regulatory capital requirements.[12] The facility

7 LVNAV funds are expected to preserve a constant NAV. If the marked-to-market value of their portfolio falls below a regulatory threshold, LVNAV funds are obliged to turn into VNAV funds.

8 See FSB (2020a) for a detailed review of market developments during the 2020 March market turmoil. See Aldasoro. Cabanilla, Disyatat, Ehlers, McGuire and von Peter (2020) regarding dollar liquidity demand ("dash-for-dollar") during the episode.

9 Euro-denominated VNAVs also suffered outsize withdrawals during this period (IOSCO (2020)).

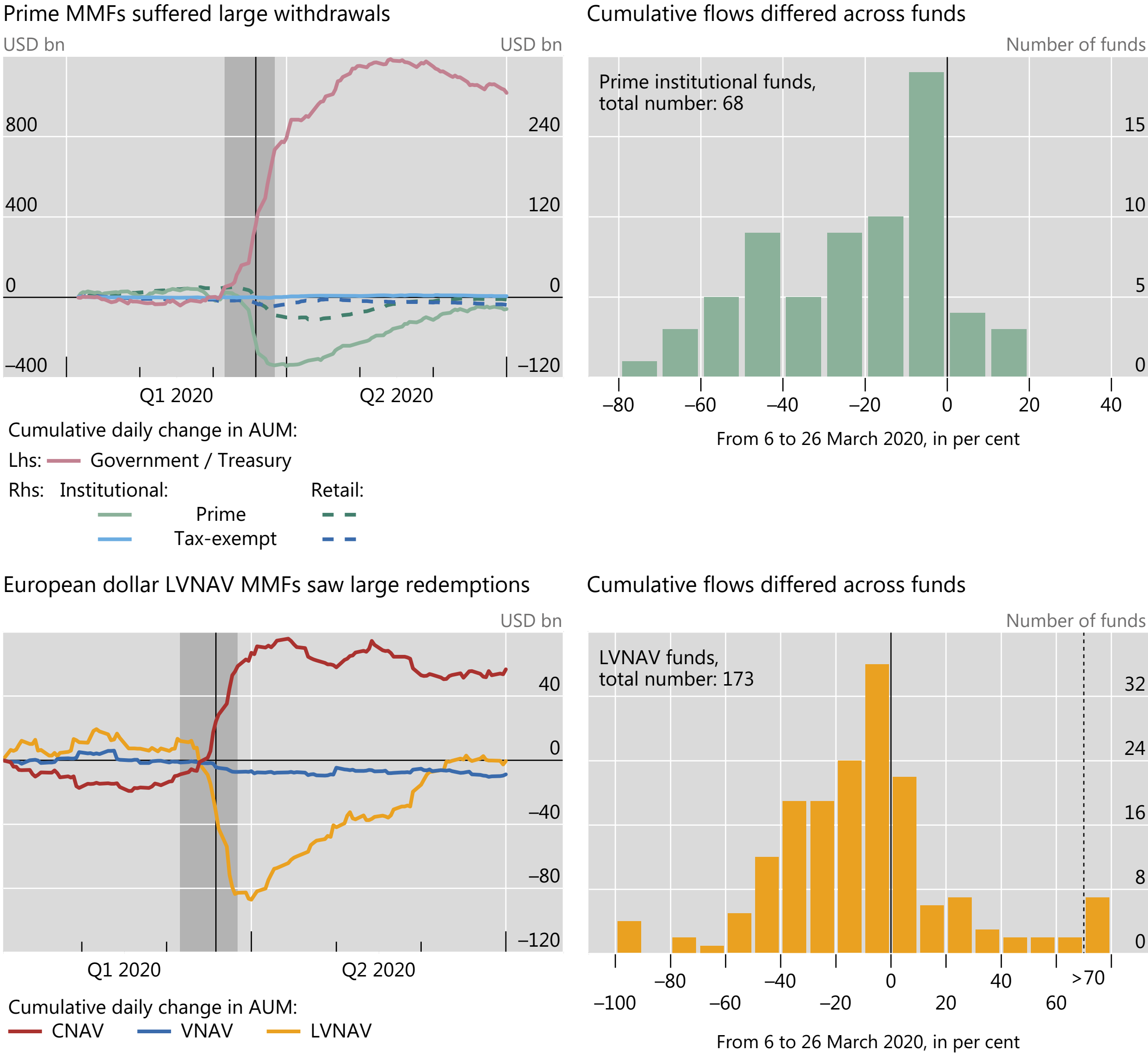
10 These bounds correspond to the interquartile range of cumulative fund-level outflows between 6 and 26 March 2020.

11 The Federal Reserve also established two other programmes to ease short-term funding market strains, the Commercial Paper Funding Facility and the Primary Dealer Credit Facility, both on 17 March 2020.

12 The US Treasury provided credit protection to the Federal Reserve.

eased the stress by making banks willing buyers of illiquid assets, thus providing liquidity to MMFs to meet redemptions. In so doing, it reduced investors' pre-emptive withdrawals.

Overview of the March 2020 MMF run[1] Graph 1



The vertical lines in the first and third panels indicate 18 March 2020 (Federal Reserve unveils the MMLF programme and the ECB introduces the PEPP, which included non-financial commercial paper). The shaded areas in the first and third panels indicate 6–26 March 2020 (period of consecutive outflows).

AUM = assets under management; CNAV = constant NAV; LVNAV = low-volatility NAV; VNAV = variable NAV.

[1] The sample includes money market funds as classified by CRANE (the top panels) and Informa iMoneyNet (bottom panels).

Sources: CRANE; Informa iMoneyNet; authors' calculations.

Likewise, the ECB announced on 12 March a new instalment of long-term refinancing operations that provided immediate liquidity to the European financial system. The ECB's US dollar operations, anchored to the swap lines with the Federal Reserve announced on 15 March, provided dollar liquidity support. Moreover, on 18 March the ECB's Governing Council included non-financial commercial paper in its

Pandemic Emergency Purchase Programme. As in the United States, these measures contributed to easing the stress of European funds.

Liquidity and investor size as drivers of the run

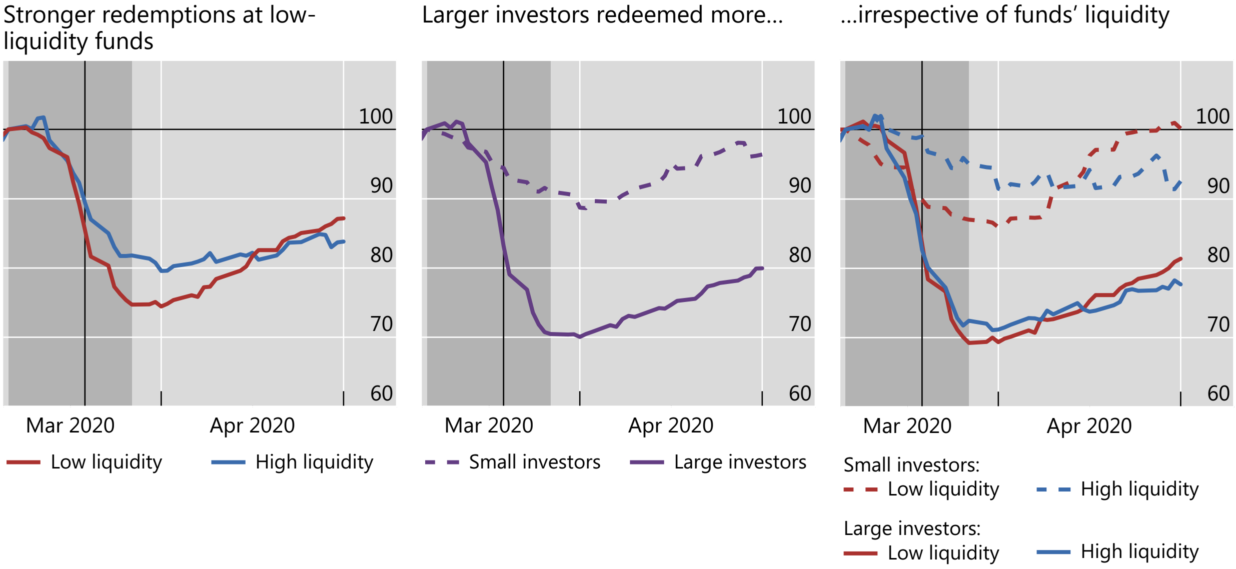
What characteristics of US prime institutional MMFs influenced the run in March?

Previous literature has identified the liquidity of funds' portfolio as an important driver of redemptions. As a fund's WLA decline towards the regulatory threshold that triggers gates and fees, investors' incentives to redeem their shares pre-emptively increase. This is because gates and fees make redemptions impossible or costlier, which reduces the value of the investments.

Consistent with previous evidence, we observe that aggregate outflows during the stress episode in March were higher – even if only slightly – for prime institutional MMFs with weaker liquidity positions. We sort funds on the basis of their average WLA ratios in January and February 2020 and split them evenly into low- and high-liquidity categories. The cumulative outflow from low-liquidity funds was on average 7% larger than that from high-liquidity funds (Graph 2, left-hand panel).

Large investors ran on prime institutional MMFs without regard for fund liquidity[1]

Average AUM; 5 Mar 2020 = 100 Graph 2



The vertical lines indicate 18 March 2020 (Federal Reserve unveils the MMLF programme). The shaded areas indicate 6–26 March 2020 (period of consecutive outflows).

AUM = assets under management; WLA = weekly liquid assets.

[1] Prime institutional funds as classified by CRANE. Funds (portfolios) are split evenly into the low/high groups based on the average of their minimum investment amount (left-hand and right-hand panels) or WLA (centre and right-hand panels) relative to AUM during January–February 2020.

Sources: CRANE; authors' calculations.

Previous literature has also found that investor features closely associated with size played an important role in driving previous MMF stress. In principle, large investors are likely to be more responsive to early signs of stress. As they have access to more sizeable resources for data gathering, market intelligence and analysis than smaller investors, they can identify and respond to risks more quickly.[13]

In addition, large investors may be subject to constraints that make them particularly averse to potential capital losses. For instance, corporate treasurers, who temporarily park excess liquidity earmarked for payrolls in prime funds, may be sensitive to potential capital losses and are likely to promptly redeem when signs of stress at these funds first appear. Also, large investors may take leveraged risky positions. When such positions turn sour, these investors are likely to redeem in response to margin calls, or in anticipation of them. In other words, they would react to sources of liquidity stress that are unrelated to the features of the MMFs in which they invest.

We find that outflows of larger investors from prime institutional MMFs were more severe during the March episode. Since we do not have direct information on investors' size, we use the proxy of the size of the funds' minimum investments.[14] Funds with a minimum investment above the median (henceforth, funds with large investors) experienced on average higher redemptions (Graph 2, centre panel). In fact, cumulative outflows during the run differed by almost 20% between large- and small-investor funds.

More importantly, we find that large and small investors differed starkly in their response to funds' liquidity positions. To support this conclusion, we combine the two previous classifications and form four groups of funds. Up to end-March, outflows from funds, for both high- and low-liquidity segments, with large investors were much more intense than those from funds with smaller investors (Graph 2, solid lines vs dashed lines). Moreover, among the funds with large investors, withdrawals were roughly of the same intensity regardless of the funds' underlying liquidity (Graph 2, red vs blue solid lines). By contrast, among funds with smaller investors, those with low liquidity saw larger withdrawals (red vs blue dashed lines). Overall, these results are consistent with large investors redeeming because of their own liquidity needs, while smaller investors appeared more concerned with the liquidity of the funds' assets.

A panel regression analysis quantifies more formally the above results (Box A). Funds with larger investors experienced 1.7% higher daily outflows – that is, 26% higher cumulative run outflows over the stress period. Further, large investors' daily outflows did not differ materially (0.3%) between high- and low-liquidity funds, either in terms of economic or statistical significance. Finally, small investors did withdraw more forcefully from low-liquidity funds, to the tune of 0.8% higher daily outflows (or more than 10% higher cumulative run outflows).

Funds' liquidity management over the episode

MMF managers could respond to the large redemptions in two alternative ways. They could sell off their most liquid assets, in an attempt to minimise transaction costs, particularly under conditions of acute market illiquidity. But by so doing, they would

13 To the extent that large investors concentrate in specific funds, each one knows that other similarly informed investors stand ready to redeem strategically. In the presence of a first-mover advantage, this increases the incentive to withdraw swiftly at the sign of trouble (Schmidt et al (2016)).

14 In our sample, minimum investment sizes range from a single US dollar to $5 billion, with a median of $1 million and an interquartile range between $77,500 and $10 million.

Box A

Quantifying the role of liquidity and investor size in MMF run risk

We employ panel regression to formally study the role of liquidity and investor size in runs on US prime institutional funds. We first examine the effects of each factor separately and then turn to joint effects.

We start by estimating the following equation over the run period 6–26 March 2020:

$$outflow_{i,t} = \beta_{WLA} \times 1_{low\ WLA,i} + \beta_{MI} \times 1_{high\ MI,i} + \gamma \times X_{i,t-1} + a_t + u_{i,t},$$

where $outflow_{i,t}$ is the daily outflow from fund i at time t calculated as the daily percentage change of AUM; and $1_{low\ WLA,i}$ and $1_{high\ MI,i}$ are dummy binary variables, the first one taking value 1 if the fund i's average WLA during January–February 2020 was less than the cross-sectional median, and 0 otherwise, and the second taking the value 1 if the minimum investment for fund i was higher than the cross-sectional median, and 0 otherwise.① $X_{i,t-1}$ are control variables that include lagged AUM (in logarithms) and the gross 30-day yield of each fund, and a_t is a time fixed effect. In this context, β_{WLA} and β_{MI} measure how the intensity of the run varied on average with the pre-stress fund characteristics.

The role of liquidity and investor sophistication during the March 2020 run

Table A

	Outflow (% change in fund's AUM)			
	(1)	(2)	(3)	(4)
β_{WLA}	0.594*		0.474	
	(1.669)		(1.350)	
β_{MI}		1.747***	1.709***	
		(4.872)	(4.778)	
β_{LH}				2.255***
				(4.765)
β_{LL}				0.782*
				(1.752)
β_{HH}				1.958***
				(4.135)
$\beta_{LH} - \beta_{HH}$				0.297
				(0.598)
$\beta_{LL} - \beta_{HL}$				0.782*
				(1.752)
$\beta_{HH} - \beta_{HL}$				1.958***
				(4.135)
$\beta_{LH} - \beta_{LL}$				1.472***
				(2.893)
Other controls[1]	Y	Y	Y	Y
Time fixed effects	Y	Y	Y	Y
Number of observations	1,020	1,020	1,020	1,020
R-squared	0.063	0.079	0.080	0.081

t-statistic calculated with robust standard errors in parentheses; ***/**/* indicates statistical significance at the 1/5/10% level. The sample includes prime institutional funds as defined by CRANE in the period 6–26 March 2020.

[1] Includes the lagged logarithm of AUM and the lagged 30-day simple annualised yield.

Sources: CRANE; authors' calculations.

The results are as follows. When estimated separately, β_{WLA} and β_{MI} are both positive and statistically significant, confirming that funds with weaker liquidity conditions and larger investors would face larger withdraws all else equal (Table A, columns (1) and (2)). On average, weaker-liquidity-condition funds face 0.6% higher daily outflows, which translates into close to 10% higher cumulative run flow. The corresponding difference between funds with larger and smaller investors is 1.7% for daily outflow and more than 20% for cumulative run outflow. Joint estimates of β_{WLA} and β_{MI} are of similar magnitudes (column (3)), suggesting that the two factors complement each other in affecting run intensity. That said, the WLA dummy becomes not significant in the presence of the minimum investment dummy.

To examine how liquidity and investor size interact with each other in affecting run vulnerabilities, we employ a modified version of the above regression. To that end, we first partition funds into groups similar to those shown in the right-hand panel of Graph 2: low WLA and low minimum investment (LL), low WLA and high minimum investment (LH), high WLA and low minimum investment (HL), and high WLA and high minimum investment (HH). Then, we assign a binary dummy variable to each group. Finally, we replace $1_{low\ WLA,i}$ and $1_{high\ MI,i}$ with this new set of dummies.

The results reveal that the liquidity position of the fund is irrelevant for the redemption decision of large investors (Table A, column (4)). The difference between β_{LH} and β_{HH} is small in magnitude (0.3%) and not statistically significant.② The liquidity condition of the fund, however, does matter for small investors, with low liquidity funds experiencing 0.8% higher outflows all else equal ($\beta_{LL} - \beta_{HL}$). Comparing larger with smaller investors, the former always withdrew more aggressively, by 2% ($\beta_{HH} - \beta_{HL}$) and 1.5% ($\beta_{LH} - \beta_{LL}$) in terms of daily outflows for high- and low-liquid funds, respectively.

① The median for the minimum investment is calculated across funds. The median for the average WLA is calculated across portfolios. This is because sometimes several funds (akin to share classes) invest in a single portfolio. As a result, liquidity measures are identical for all funds that share the same portfolio. ② We also rerun the analysis using continuous measures of liquidity and investor sophistication. The message is robust to this modification.

weaken their liquidity positions, bringing them closer to the regulatory thresholds and potentially triggering further withdrawals. Alternatively, they could choose to also reduce their less liquid security holdings, in order to preserve the fund's liquidity position. This, however, could lead to larger price discounts and thus higher capital losses.[15]

How did managers actually respond? At the beginning of the run episode, managers of funds suffering larger withdrawals prioritised preserving their WLA. In fact, such funds tended to increase their WLA ratios (Graph 3, left-hand panel, red line across the grey area). Funds suffering lower outflows also increased their WLA, but to a lesser extent (blue line).

Weighted average maturity (WAM),[16] another measure of portfolio liquidity, followed the opposite path at the beginning of this episode. Initially, this measure increased significantly – pointing to reduced liquidity – for high-outflow funds (Graph 3, right-hand panel, red line), in contrast with the upswing in WLA. The pattern was similar for low-outflow funds, even though the magnitudes were smaller (blue line).

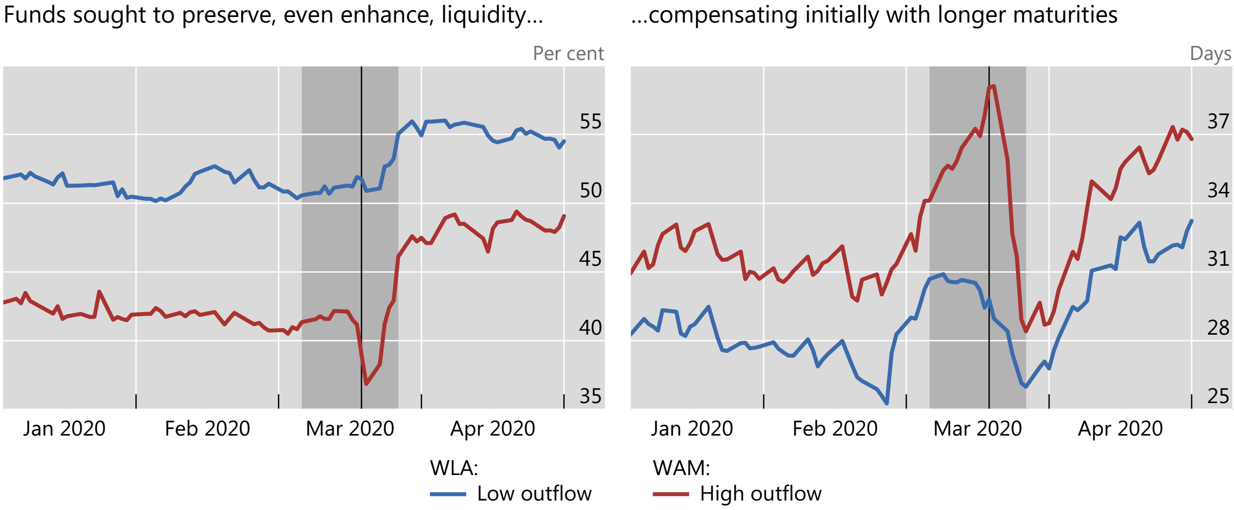
Thus, the asset managers of prime institutional MMFs may have added to the liquidity stress in financial markets prior to the MMLF announcement. Considered together, the WLA and WAM paths suggest that these managers substituted short-term private debt securities for longer-tenor US Treasuries and other government obligations. In this way, they could preserve WLA while at the same time enhancing

[15] Under conditions of market stress, disposing of illiquid assets turns particularly expensive, as bid-ask spreads usually turn much wider (see eg Ma et al (2020)). See Bouveret and Lorenzo (2020) and Ma et al (2020) for discussions on similar trade-offs facing European MMFs and other mutual funds.

[16] WAM – which is not a regulatory ratio – is based on the number of days to maturity or to coupon resetting (whichever is lower) for the various securities in the portfolio. Assets with higher holdings in the portfolio are weighted proportionately more.

yield. These trades were procyclical, as they took place when private debt was already under selling pressure and cash-like government instruments were in high demand.

Liquidity management at prime institutional MMFs during the March turmoil[1] Graph 3



The vertical lines indicate 18 March 2020 (Federal Reserve unveils the MMLF programme). The shaded areas indicates 6–26 March 2020 (period of consecutive outflows).

WAM = weighted average maturity; WLA = weekly liquid assets.

[1] Prime institutional funds as classified by CRANE. Low (high) outflow funds are the ones whose cumulative outflows during 6–26 Mach 2020 are below (above) the median outflow in the cross section of funds.

Sources: CRANE; authors' calculations.

After the Federal Reserve unveiled the MMLF on 18 March 2020, market conditions started to normalise and all funds began to replenish their liquidity buffers. Managers aggressively disposed of less liquid assets, such as commercial paper and certificates of deposit, at now lower liquidation costs and rotated their holdings towards more liquid ones. Concretely, funds tended to both increase their WLA and reduce their WAM. Funds that had experienced stronger redemptions and were thus left with weaker liquidity positions quickly caught up with their peers, cutting the gap in WLA ratios from about 14 percentage points initially to about 7 percentage points by end-March (Graph 3, left-hand panel). The concurrent drop in the WAM gap was equally sizeable, from about 10 days to less than two days (right-hand panel).

Formal econometric analysis confirms the picture painted by the graphs, providing some additional quantitative insights (Box B). In particular, managers of funds that had seen larger outflows prior to the announcement of the MMLF increased WLA at a faster pace on average. Specifically, a fund experiencing 22% (or one standard deviation) larger outflows tended to raise its WLA by 0.8% more in a day, or by 8% more over the rest of March.

Conclusions

The inability of prime institutional MMFs to provide liquidity on demand in March 2020 called for central bank intervention (FSB (2020a)). Unlike banks, which proved to be useful elastic nodes during the pandemic-induced turmoil (Shin (2020)), the funds' dash for liquidity added to the stress across financial markets. Thus, the provision of central bank liquidity was pivotal in restoring calm (CGFS (2011)).

The events of March 2020 have left an indelible mark. They echoed those during the Great Financial Crisis in September 2008, when the MMF sector suffered a comparable massive seizure and also required central bank assistance. Our findings are offered as a contribution to the ongoing debate about the policy measures that could enhance the resilience of MMFs.

Box B

Assessing the response of liquidity measures to redemptions

In this box, we conduct panel regressions to assess MMFs' liquidity management in response to the run, differentiating pre-stress behaviour from behaviour during the initial stress phase, before the MMLF and post-MMLF.

Specifically, for each of the three periods, we assess the impact of outflows on various liquidity gauges:

$$\Delta Liq_{j,t} = \phi_1 Outflow_{j,t} + \phi_2 Outflow_{j,t-1} + \phi_3 Run_{Outflow_j} + \phi_4\, Liq_{j,t-1} + \gamma\, X_{j,t-1} + \epsilon_{j,t},$$

where $\Delta Liq_{j,t}$ denotes the daily change in a liquidity measure (WLA or WAM) for portfolio j at time t; $Outflow_{j,t}$ represents daily outflows from portfolio j at time t; and $Run_{Outflow_j}$ reports the cumulative outflow experienced by fund j during the run period and before the announcement of the MMLF. The latter variable is only included in the post-MMLF period to capture the effect of portfolio-level run stress on liquidity management.① Finally, we include the same set of control variables $X_{j,t-1}$ as in the previous section but recalculated at the portfolio level.

Panel A of Table B presents the results for the pre-run period (17–28 February). On normal days, investors' outflows are met with liquid asset sales, which typically cause a drop in liquidity as measured by both WLA and WAM. This is revealed by a positive and statistically significant coefficient of outflows for WAM and a negative, albeit non-significant coefficient for WLA (line (1)). The impact of outflows is transient, as previous outflows have no bearing on current liquidity measures (line 2)).②

Panel B of Table B characterises managers' decisions during the run period, and before the MMLF was announced (6 to 18 March).③ There are several differences relative to normal times. First, the outflow coefficient for the WLA measure is not statistically different from zero (line (3)). This suggests that, during the run, managers tried to preserve liquid assets in the face of outflows. This "leaning against the outflows" by portfolio managers has limited scope, however: the coefficient of past outflows is negative and significant, suggesting that persistent outflows decrease managers' ability or willingness to preserve WLA (line (4)). By contrast, the contemporaneous coefficient of outflows for WAM is still positive and significant, as in the previous period.

Finally, panel C of Table B presents the results for the first two weeks after the announcement of the MMLF (19 March to 3 April). During this period, managers gained the possibility of introducing large changes in their portfolios at low cost (as the Fed underwrote their assets on a cost basis). In that context, they started accumulating liquid assets and did so at a brisker pace the larger their cumulative outflows during the preceding run (both coefficients on line (7)).

① Sometimes several funds (akin to share classes) invest in a single portfolio. As a result, liquidity measures are identical for all funds residing within the same portfolio. ② All measures exhibit a statistically significant "reversion to the target" as indicated by a large negative coefficient in front of lagged liquidity variables (not reported): deviations of liquidity from the previous day (presumably close to the fund manager's target for the vehicle) are met with a compensating move the following day. ③ The announcement of the MMLF was made late in the evening on 18 March. Therefore, we include 18 March in the pre-MMLF period.

Liquidity management before and during the run

Table B

	Δ(WLA)	Δ(WAM)
	Panel A: pre-stress (17–28 Feb 2020)	
(1) Outflow	–0.101	0.333***
	(–1.642)	(12.27)
(2) Lagged outflow	–0.0786	0.011
	(–1.335)	(0.991)
Other controls[1]	Y	Y
Portfolio fixed effects	Y	Y
Time fixed effects	Y	Y
Number of observations	315	315
R-squared	0.297	0.746
	Panel B: run, pre-MMLF (6–18 Mar 2020)	
(3) Outflow	0.0421	0.175***
	(1.456)	(5.322)
(4) Lagged outflow	–0.222***	0.008
	(–5.384)	(0.261)
Other controls[1]	Y	Y
Portfolio fixed effects	Y	Y
Time fixed effects	Y	Y
Number of observations	315	315
R-squared	0.470	0.475
	Panel C: MMLF (19 Mar–3 Apr 2020)	
(5) Outflow	–0.0548	0.122**
	(–0.864)	(2.248)
(6) Lagged outflow	–0.180***	–0.0637
	(–2.777)	(–1.108)
(7) Pre-MMLF outflow	0.0381**	–0.0308**
	(2.325)	(–2.582)
Other controls[1]	Y	Y
Portfolio fixed effects	N	N
Time fixed effects	Y	Y
Number of observations	404	420
R-squared	0.181	0.232

t-statistic calculated with robust standard errors in parentheses; ***/**/* indicates statistical significance at the 1/5/10% level. The sample includes prime institutional portfolios as defined by CRANE.

[1] Includes the lagged logarithm of AUM and the lagged level of the liquidity metric.

Sources: CRANE; authors' calculations.

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Dollar funding of non-US banks through Covid-19[1]

Non-US banks' on-balance sheet dollar liabilities rose in 2020 despite the decline in funding from US and offshore money market funds (MMFs). Other non-bank financial institutions were behind this increase, as they drove the strong rise in deposits booked inside and outside the United States. Non-US banks' issuance of international debt securities in US dollars remained resilient in 2020. Additionally, the currency composition of banks' total bond issuance tilted towards the dollar after March. Overall, our findings point to changes in funding relationships that could have long-lasting effects on the functioning of dollar funding markets.

JEL classification: G15, F30, G21.

The "dash for cash" episode during the height of the Covid-19 crisis in March led to severe strains in dollar funding markets (FSB (2020), BIS (2020)). A prompt and forceful policy response by central banks through emergency lending programmes and central bank swap lines averted a dollar funding crisis (Cetorelli et al (2020)). Subsequent developments indicate that this episode triggered large shifts in how non-US banks source funding in US dollars.[2]

On-balance sheet dollar liabilities of non-US banks reached record levels over the first three quarters of 2020.[3] At end-Q3 2020, they stood at $12.4 trillion – $800 billion above their pre-pandemic level at end-2019. This is in contrast with the Great Financial Crisis (GFC), when these liabilities declined substantially and in a sustained manner. To show the sectors and instruments that drove these headline numbers, this article combines the BIS banking and international debt securities statistics, money market funds' (MMFs) portfolio holdings, bank balance sheet data and central counterparty (CCP) disclosures.

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2 For a comprehensive overview of US dollar funding markets prior to the pandemic and during the March turmoil, see CGFS (2020).

3 This article focuses on on-balance sheet dollar funding. Data limitations hinder the analysis of off-balance sheet liabilities such as FX swaps (Borio et al (2017)). Estimates of FX swap dollar funding for non-US banks ranged from $630 billion to $855 billion as of end-2019 (Aldasoro, Ehlers, McGuire and von Peter (2020)).

Key takeaways

- Non-US banks' sources of US dollar funding shifted from US and offshore money market funds (MMFs) to other non-bank financial institutions during 2020.
- Funding from MMFs did not recover between March and December 2020, with Japanese and Canadian banks – the largest recipients before the crisis – experiencing the biggest declines.
- International debt securities issuance in US dollars remained resilient and banks increased the share of dollar-denominated bond issuance after the March 2020 market turmoil.

The rest of the article is organised as follows. We first provide a bird's eye view of the evolution of non-US banks' on-balance sheet dollar liabilities over 2020. We then zoom in on three key segments of dollar funding: (i) that provided by MMFs, both in the United States and offshore; (ii) deposits by non-banks, with a focus on the booking location and the sector of the funding provider; and (iii) dollar debt securities issuance, relative to issuance in other currencies. Two boxes document emerging developments since the pandemic: one on the balance sheets of the US affiliates of non-US banks, and another on CCPs' dollar deposits at banks.

On-balance sheet dollar liabilities of non-US banks

Non-US banks' dollar liabilities grew substantially in 2020.[4] At end-Q3 2020, they stood comfortably above their pre-pandemic level (Graph 1). Deposits booked inside and outside the United States[5] – which as of end-Q3 2020 accounted for 24% and 49% of dollar liabilities, respectively – explained most of the rise in 2020. Debt securities issuance, which also made up a significant share (23%), remained largely unchanged in 2020.

To better understand the terms and stability of funding, we leverage detailed information about funding providers and instruments. BIS banking and international debt securities statistics give a high-level overview and offer splits by instrument and by sector. In addition, wherever possible, we refine our analysis using detailed MMF portfolio holding data and individual bond issuance data. These are contained in the aggregate figures reported in Graph 1. For example, MMF funding through repos and certificates of deposit is part of non-bank deposits in the BIS locational banking statistics. In turn, MMF funding through commercial paper and bond issuance enter the BIS debt securities statistics.

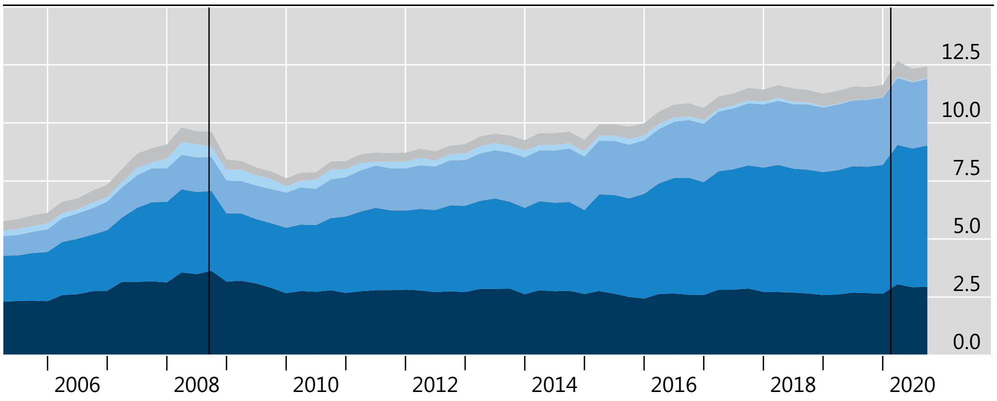
[4] Dollar liabilities represent about a quarter of non-US banks' total liabilities (including in domestic currency) and close to 57% of their foreign currency liabilities. The Covid-19 crisis did not materially affect these shares.

[5] Irrespective of where the deposits are booked, the holders may reside anywhere, including the United States.

On-balance sheet dollar funding of non-US banks[1]

Amounts outstanding; in trillions of US dollars

Graph 1



The vertical lines indicate 15 September 2008 (the collapse of Lehman Brothers) and 19 February 2020 (the start of market turmoil due to Covid-19).

[1] Consolidated on-balance sheet liabilities of banks headquartered outside the United States; this assumes claims and liabilities among unrelated non-US banks net to zero. Includes positions reported by China and Russia, both of which started reporting locational banking statistics in Q4 2015. Local dollar deposits in China are estimates from national sources from Q1 2015. [2] Local liabilities plus cross-border liabilities of non-US banks' affiliates in the United States to non-banks; local liabilities are sourced from the BIS consolidated banking statistics on an immediate counterparty basis. [3] Issuance by non-US public and private banks; includes bonds, medium-term notes and money market instruments.

Sources: Datastream; BIS international banking statistics on an immediate counterparty basis; BIS debt securities statistics; BIS locational banking statistics (by residence and by nationality); authors' calculations.

The decline in MMF funding

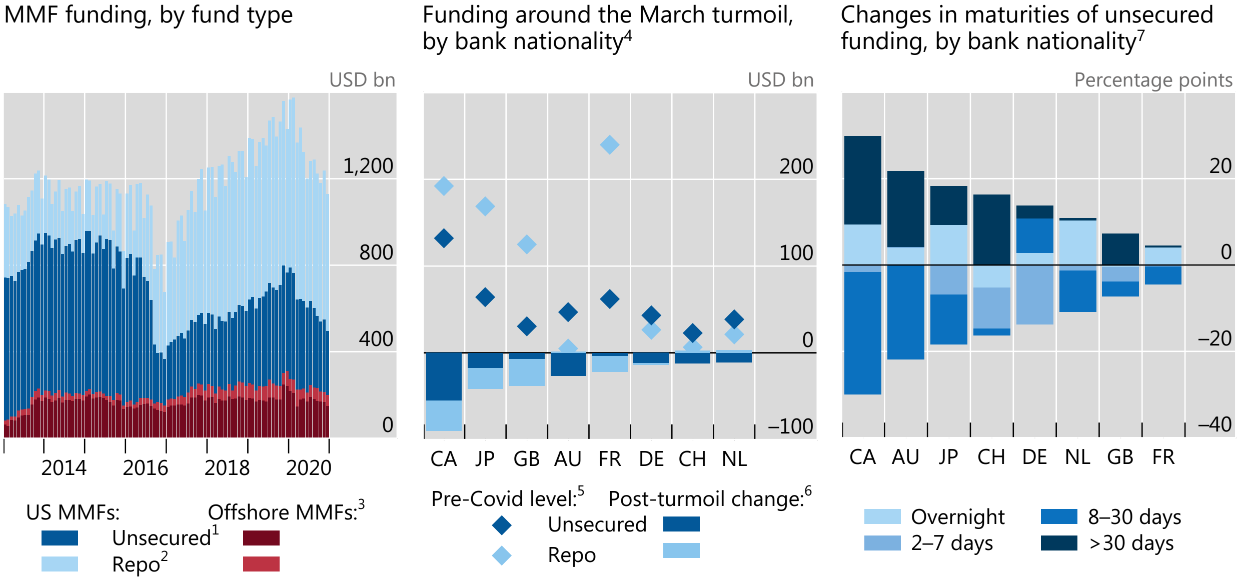
The March turmoil illustrated once again that MMFs are an important, yet flighty, dollar funding source. Non-US banks lost a substantial amount ($300 billion) of MMF dollar funding between end-2019 and end-2020 (Graph 2, left-hand panel).[6] Around 85% of the decline was unsecured funding, booked either inside or outside the United States.[7] The contraction was particularly intense during the "dash for cash" episode in February and March 2020, when MMFs reduced their dollar funding by around $207 billion – close to 2% of non-US banks' aggregate on-balance sheet dollar funding. MMF funding did not recover even as market conditions normalised.

Some national banking systems lost more funding than others. Unsecured funding contracted the most for Canadian, Japanese and Australian banks (Graph 2, centre panel, dark blue bars), all of which were among the largest recipients going into the pandemic (dark blue diamonds). In contrast, French banks faced only a

[6] With around $1.4 trillion, US and offshore MMFs represented around 12% of the on-balance sheet funding for non-US banks at end-2019.

[7] This decline reflects, in part, sustained investor redemption from US prime MMFs – funds that can invest in unsecured instruments but cannot offer stable net asset values to investors (see Avalos and Xia (2021) in this issue). It could also reflect a shift in banks' funding models and demand for MMF funding.

Amount and maturity of non-US banks' dollar funding from MMFs Graph 2



[1] Funding provided by prime funds. Includes certificates of deposit, commercial paper and other sources of funding. [2] Includes repos by government and Treasury funds (which can only do repos), as well as repos by prime funds (which can provide both unsecured and repo funding). Most of this category is accounted for by government and Treasury funds. [3] US dollar funding to non-US banks provided by MMFs domiciled in Bermuda, the Cayman Islands, Ireland and Luxembourg. [4] Includes both US and offshore MMFs. [5] Average monthly issuance over the period June–December 2019. [6] Change in average new monthly issuance between June–December 2019 and June–December 2020. [7] For US MMFs only. For each maturity, the change equals the difference between the share of new originations between June and December 2020 in total issuance minus the corresponding share for June and December 2019.

Sources: CRANE; Informa iMoneyNet; authors' calculations.

limited decline. While their repo borrowing declined somewhat, they remained the largest repo counterparties to MMFs among non-US banks (light blue diamonds).

The maturity structure of funding by US MMFs changed both during the March turmoil and later in 2020. At the peak of the market turmoil, the reduction in the volume of this funding went hand in hand with a maturity shortening (Eren, Schrimpf and Sushko (2020), Avalos and Xia (2021)). In the second half of 2020, banks were able to lengthen the maturity of some of the funding they obtained from US MMFs (Graph 2, right-hand panel, dark blue bars). Notably, however, the share of more flighty overnight unsecured borrowing also increased for many banks (light blue bars).

Non-bank deposits inside and outside the United States

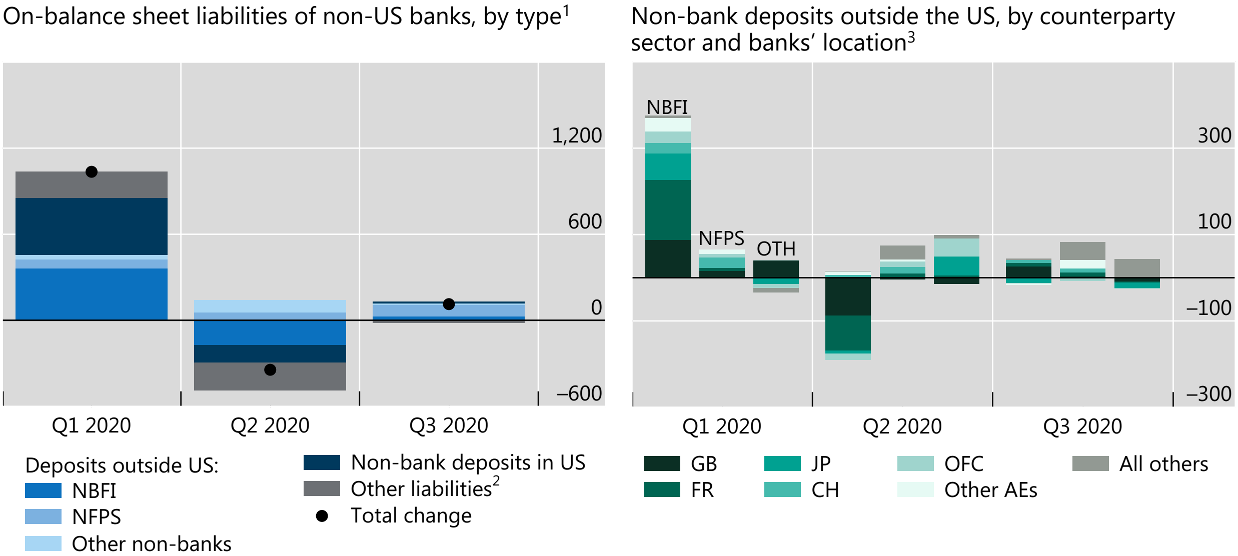
Even as MMFs retrenched, other non-banks increased their dollar deposits, driving the rise in non-US banks' dollar liabilities over the first three quarters of 2020. At $1 trillion, this rise was particularly stark in the first quarter (Graph 3, left-hand panel).

The sizeable growth in deposit funding could reflect the drawdown of committed credit lines, which mechanically leads to a grossing-up of balance sheets (Acharya and Steffen (2020)). In Box A, we estimate that credit line drawdowns accounted for 53% of the increase in loans granted by the US affiliates of non-US banks in Q1 2020. Such drawdowns are unlikely to lead to structural changes in funding for banks, as balance sheets contract when these loans are repaid. Indeed, as the extraordinary

Dollar deposits inside and outside the US account for most of the action in 2020

Quarter-on-quarter changes in stocks; in billions of US dollars

Graph 3



NBFI = non-bank financial institutions; NFPS = non-financial private sector (non-financial corporates plus households); OFC = offshore centres; OTH = other non-banks (government and unallocated by counterparty sector).

[1] See Graph 1 for definitions. [2] International debt securities and liabilities to US banks and to central banks. [3] Obtained from the BIS locational banking statistics by residence. Positions of US banks are stripped out by using the shares of US banks' liabilities to non-banks in total US dollar liabilities, by booking location, from the BIS locational banking statistics by nationality.

Sources: Dealogic; Euroclear; Thomson Reuters; Xtrakter Ltd; BIS consolidated banking statistics on an immediate counterparty basis, debt securities statistics and locational banking statistics (by residence and nationality); authors' calculations.

turbulence abated, the second quarter saw a partial reversal – indicating net credit repayment – and changes in the third quarter remained small (Graph 3, left-hand panel).

The increase in deposits could also stem from MMFs being replaced by other non-banks as dollar funding providers.[8] Because of data limitations, very little is known about these changes to dollar funding relationships and the attendant impact on the funding's maturity structure. That said, post-GFC regulatory reforms increased the transparency of one type of non-bank – CCPs. In Box B, we document that US and non-US CCPs' dollar deposits responded differently to the stress episode.[9]

The bulk of non-bank deposits were booked in a handful of advanced economies. Non-banks placed about $400 billion and $450 billion in non-US banks' affiliates inside and outside the United States, respectively. Banks located in France, the United Kingdom and Japan obtained much of the latter amount, despite reversals during the period (Graph 3, right-hand panel). The majority of this funding – which expanded sharply in Q1 and shrank in Q2 – was provided by non-bank financial institutions (NBFIs). In contrast, deposits by the non-financial private sector (NFPS) (ie corporates and households) were more evenly distributed across booking locations and, most importantly, did not exhibit the ups and downs observed for NBFI deposits.

[8] In the light of the decline in both US and offshore MMF funding documented earlier, the increase in non-bank funding documented in this section did not stem from positions with MMFs.

[9] CCPs accumulated a large amount of (dollar-denominated) liquid assets due to substantial initial margin calls during the March turmoil (Huang and Takáts (2020)). Their secured and unsecured deposits represent a small, but growing, share of banks' dollar funding from non-banks.

Box A

US branches and subsidiaries of non-US banks and the Covid-19 shock

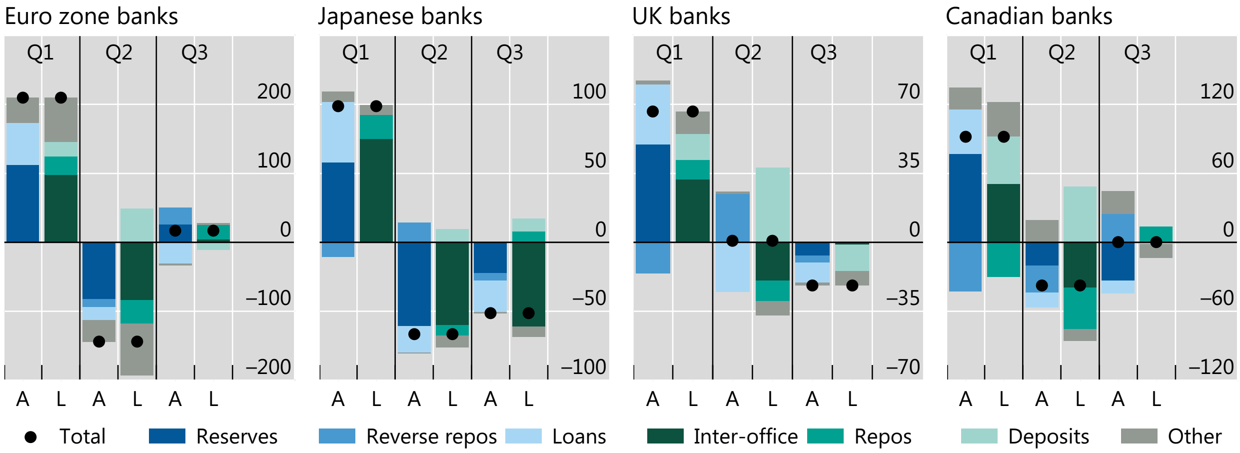
Iñaki Aldasoro, Torsten Ehlers, Egemen Eren and Wenqian Huang[1]

US affiliates play an important role in the management of non-US banks' US dollar operations. This box uses call report data to document how such affiliates responded to the Covid-19 shock.[2]

The balance sheets of the US affiliates of non-US banks expanded in the first quarter and reverted only partly afterwards (Graph A). On the asset side, reserves at the Federal Reserve increased overall but loans declined in Q2 and Q3, reflecting net credit repayment. The Senior Financial Officer Survey conducted by the Federal Reserve suggests a precautionary motive behind increased reserves during the first half of the year. Nearly all of the foreign banks surveyed said that "preparing for potential drawdowns of committed credit lines" was the most important reason behind reserve build-up (FRB (2020)). On the liability side, deposits account for most of the increase during 2020 – as foreshadowed by Graph 1 and the left-hand panel of Graph 3. Most of these deposits were vis-à-vis non-banks, including non-bank financial institutions. The increase in deposits was particularly large for Canadian banks (+$88 billion), which reduced their repos (–$53 billion). Euro zone, Japanese and Swiss banks, in turn, increased their repos (+48 billion combined).

Non-US banks' affiliates in the US during the pandemic

Quarterly changes by bank nationality, in billions of US dollars — Graph A



A = assets; L= liabilities.

Sources: US call reports (FFIEC002, FFIEC031/041, FR 2886b); authors' calculations.

Indeed, the drawdowns of contingent credit lines dominated balance sheet changes in the midst of the Covid-19 dollar funding crisis and its immediate aftermath. These drawdowns by non-banks lead to simultaneous increases in loans and deposits (Glancy et al (2020)). In the first quarter of 2020, they amounted to $101 billion,[3] out of a total of $189 billion in loans by non-US banks' US affiliates. For some of the largest banking systems a significant share of the change in loans during Q1 2020 can be accounted for by drawdowns: for euro zone, UK and Canadian banks, this share stood at 63.5%, 62.7% and 72.4%, respectively. The footprint of central bank swap line use was, in turn, visible in the changes in inter-office liabilities and reserves during the first two quarters of 2020 (Aldasoro, Cabanilla, Disyatat, Ehlers, McGuire and von Peter (2020)).

① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② Previous stress episodes left a visible trail in these balance sheets. Examples are the large shifts in inter-office claims and liabilities observed during the euro area sovereign crisis and the FDIC assessment of banks' managed liabilities in 2011, as well as when the branches and agencies of foreign banks in the US ran down their holdings of excess reserves at the Federal Reserve in the aftermath of the US MMF reform of 2016. ③ This reflects net drawdowns, or the change in unused commitments to provide liquidity. It combines information on drawdowns with changes in committed amounts.

Box B

Dollar deposits of central counterparties

Iñaki Aldasoro, Egemen Eren and Wenqian Huang[①]

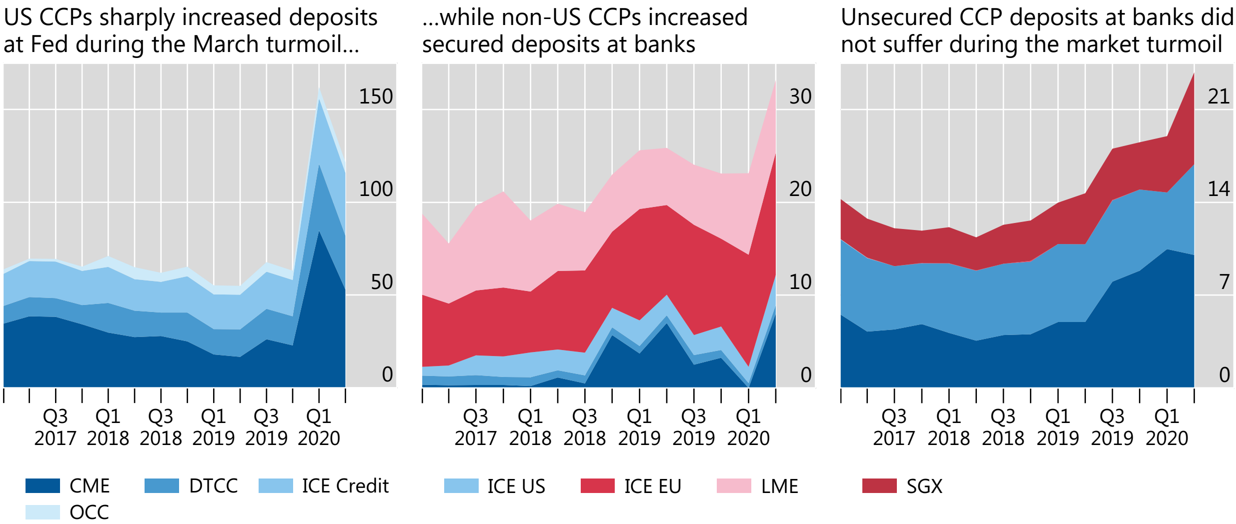
Central counterparties (CCPs) accumulated an extraordinary amount of liquid assets via initial margin calls amid the March 2020 turmoil. Global CCPs' initial margins increased by 50% in Q1 2020, reaching $831 billion at end-March 2020 (ISDA (2020)). For CCPs that clear US dollar-denominated products, a substantial part of these liquid assets are dollar-denominated.[②] All CCPs can deposit these assets at banks, in either unsecured or secured form, via reverse repos.[③] Alternatively, CCPs eligible for deposit accounts at the Federal Reserve can place their funds there. This box uses CCP quantitative disclosures to assess how their dollar deposits responded to the pandemic.

Deposits at the Fed by qualified US CCPs ballooned in Q1 2020, while their secured deposits at banks – mainly reverse repos – contracted significantly. The contrast was particularly stark for CME: its deposits at the Fed increased from $23 billion at end-2019 to $85 billion at end-March 2020 (Graph B, left-hand panel). At the same time, it halted its repo activity with banks, which recovered sharply thereafter (centre panel, dark blue area). Large yet less dramatic changes were observed for other US CCPs, such as DTCC, ICE Credit and ICE US.

Dollar deposits by major CCPs at the Fed and banks[1]

In billions of US dollars

Graph B



[1] The selected CCPs are those that publish quantitative disclosures and have substantial amounts of dollar-denominated liquid assets (excluding committed credit lines). Blue (red) areas indicate US (non-US) CCPs. The data are from disclosure item 7.1.

Sources: Clarus FT; authors' calculations.

Despite the decline in secured deposits by US entities, CCPs' overall secured deposits at banks remained unchanged in Q1 2020 at $23 billion. This is because non-US CCPs, which have no deposit accounts at the Fed, increased their secured dollar deposits at banks in Q1 2020 (Graph B, centre panel, red areas). In contrast to secured deposits, the changes in unsecured deposits were relatively small in Q1 2020 (right-hand panel).

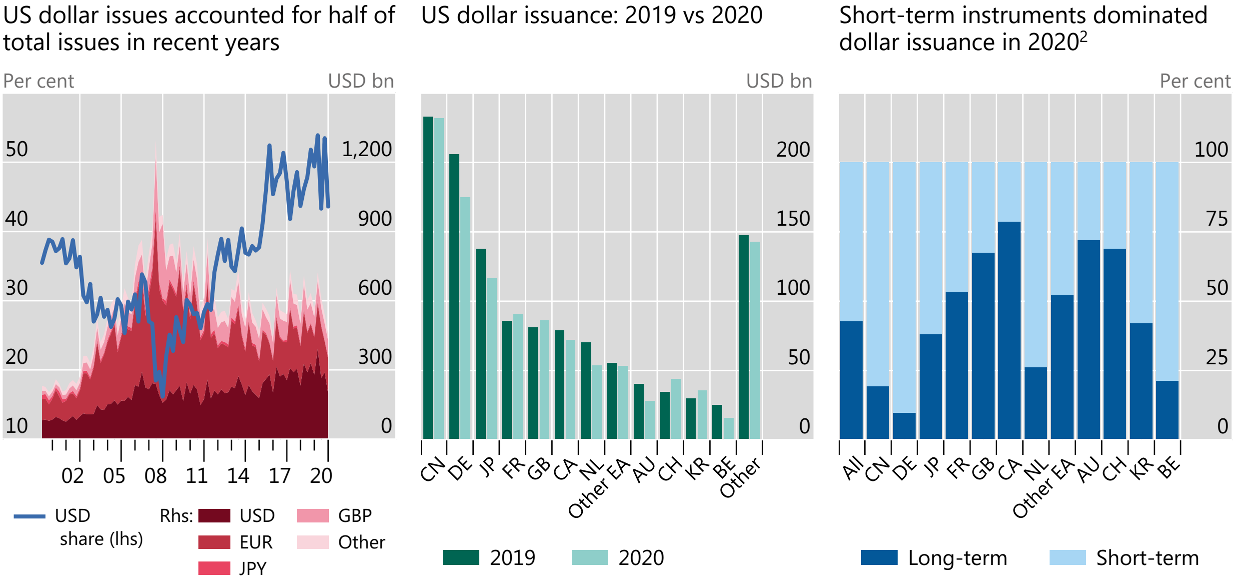
The substantial shift of US CCPs from secured deposits with banks towards deposits at the Fed underscores the importance of continuous monitoring of the interconnectedness between CCPs and other financial market participants. The shift in March could reflect multiple factors, including high volatility and low rates in repo markets – which were equal to the deposit rate at the Fed at end-March – as well as potential operational convenience (eg instantaneous settlement). The growing footprint of CCPs heightens the need to better understand these factors.

① The views expressed are those of the authors and do not necessarily reflect the views of the Bank for International Settlements. ② Eight CCPs in our sample have substantial dollar-denominated liquid assets. Five are US CCPs: Chicago Mercantile Exchange (CME), Depository Trust & Clearing Corporation (DTCC), Intercontinental Exchange Clear Credit (ICE Credit), Intercontinental Exchange Clear US (ICE US) and Options Clearing Corporation (OCC). The three non-US CCPs are: Intercontinental Exchange Clear Europe (ICE EU), London Metal Exchange (LME) and Singapore Exchange (SGX). ③ Some jurisdictional regulations restrict CCPs' unsecured deposits at banks.

Debt securities issuance

The debt securities market is another sizeable source of non-US banks' dollar funding (Graph 1). These banks' issuance of dollar-denominated international debt securities grew steadily in the past five years, driving the dollar share in total issuance from 38% at end-2015 to 44% at end-2020 (Graph 4, left-hand panel).[10]

International debt securities gross issuance by non-US banks[1] Graph 4



[1] International debt securities issued in a market other than the local market of the borrower's country of residence. In the BIS statistics, debt securities are classified as international if at least one of the following characteristics differs from the country where the borrower resides: registration domain (ISIN), listing place or governing law. Non-US banks include non-US private and public banks. [2] Share in total issuance; long-term instruments are medium-term notes and bonds; short-term are money market instruments.

Sources: Dealogic; Euroclear; Refinitiv; Xtrakter Ltd; authors' calculations.

Gross dollar debt securities issuance did not suffer significantly due to the March market turmoil. In aggregate, non-US banks issued $1.1 trillion in dollar debt securities in 2020, versus $1.2 trillion in 2019. The decline was driven largely by Japanese and German banks. For most banking systems, however, gross issuance in 2020 was on a par with that in 2019 (Graph 4, centre panel). For example, Chinese banks – currently the largest issuers of dollar-denominated debt securities[11] – issued $232 billion worth of such securities in 2020, in line with their 2019 issuance.

Short-term instruments dominated dollar debt issuance in aggregate, yet with substantial variation across nationalities. Such instruments accounted for 57% of the aggregate debt securities issuance in 2020 (Graph 4, right-hand panel). This share was higher than 70% for Chinese, Dutch and German banks. By contrast, short-term instruments accounted for less than 20% of the total issuance by Canadian and Australian banks.

[10] International debt securities in the BIS statistics are those issued in a market other than the local market of the country where the borrower resides, ie issued in any market by a non-resident. The data cover short-term (ie money market) and longer-term (ie medium term notes and bonds) instruments issued by public and private banks.

[11] In terms of amounts outstanding, banks headquartered in the United Kingdom account for the largest share (15.8% as of end-2020), followed by Chinese (9.5%) and Japanese (8.7%) banks.

While aggregate debt issuance data are useful, they could be driven by a few large issuers. In order to tease out how the Covid-19 episode affected banks' currency choice of bond issuance, we use bond-level data that include domestic and international issuance. We can thus take into account bond characteristics – such as issuance amount, maturity and investment grade status – as well as bank characteristics that do not vary over time.

Banks tended to issue more bonds in dollars after March 2020[1]

Results of a regression analysis between January 2019 and December 2020 Table 1

	(1) All banks	(2) All banks ex US	(3) All banks ex US and EA, only USD and EUR issuance
	1(USD)	**1(USD)**	**1(USD)**
1(Post-Covid)	0.031***	0.031***	0.060***
	(0.007)	(0.011)	(0.020)
Controls	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes
Observations	8,892	5,831	1,482
R-squared	0.711	0.481	0.379

[1] Results from regressing the dummy variable 1(USD), which equals 1 if a bond is denominated in dollars and 0 otherwise, on the dummy variable, 1(Post-Covid), which equals 1 if the issuance took place after April 1 2020 and zero otherwise, as well as other control variables such as the issuance amount, maturity, investment grade status and a bank fixed effect. *** denotes significance at the 1% level and robust standard errors are in brackets. The first column includes all banks and currencies. The second column includes all currencies and excludes US banks. The last column considers only US dollar and euro issuance by banks headquartered outside the United States and the euro area.

Sources: Dealogic; authors' calculations.

We find that, relative to the period between January 2019 and March 2020, the currency composition of banks' total bond issuance tilted towards the dollar between April and December 2020. This is a robust result: it holds true across all banks in the sample (Table 1, first column) as well as when we exclude US banks (second column). Furthermore, when we only compare the dollar and euro issuance of non-US and non-euro-area banks, the result is even more pronounced (third column).[12] On average, banks were 3–6 percentage points more likely to issue dollar bonds after March 2020.

Conclusion

Banks' dollar funding underwent substantial readjustments after the March 2020 market turmoil. Despite the decline in MMF dollar funding, non-US banks' total on-balance sheet dollar liabilities reached a peak of $12.7 trillion at end-Q1 2020. As of end-Q3 2020, they stood comfortably above their pre-pandemic level. Dollar deposits outside the United States – especially from NBFIs – and, to a lesser extent, inside the United States accounted for this rise. At the same time, debt securities issuance

[12] Eren and Malamud (2021) show similar issuance patterns for NBFIs and non-financial corporates. They argue that firms' currency choice depends on whether the currency depreciates in global downturns over typical debt maturities – hence providing the best hedge as the value of the nominal debt declines with the depreciation. They show that the dollar fits this description better than other major international currencies, both historically and during the Covid-19 episode.

remained resilient. Banks strengthened their preference for dollar bond issuance after the pandemic. Overall, these findings indicate that the dominance of the dollar in international finance and the attendant policy issues are likely to endure (CGFS (2020)).

It is too early to say if the shift of funding sources away from MMFs and towards other NBFIs will persist. If it does, further investigating the terms of the new funding and the specific NBFI sectors that it comes from will be essential. While its stability is still to be tested, this funding is currently more opaque than that from MMFs.

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The anatomy of bond ETF arbitrage[1]

Exchange-traded funds (ETFs) allow a wide range of investors to gain exposure to a variety of asset classes. They rely on authorised participants (APs) to perform arbitrage, ie align ETFs' share prices with the value of the underlying asset holdings. For bond ETFs, prominent albeit understudied features of the arbitrage mechanism are systematic differences between the baskets of bonds used to create and redeem ETF shares, and a low overlap between these baskets and actual asset holdings. These features could reflect the illiquid nature of bond trading, ETFs' portfolio management and APs' incentives. The decoupling of baskets from holdings weakens arbitrage forces but allows ETFs to absorb shocks on the bond market.

JEL classification: G11, G12, G23.

Key takeaways

- Bond exchange-traded funds (ETFs) have grown to manage more than $1.2 trillion of assets globally.
- The arbitrage mechanism, which keeps bond ETF prices aligned with the value of the underlying investments, operates differently from that of equity ETFs.
- This difference potentially makes it harder for investors to exploit price gaps but allows bond ETFs to absorb shocks and withstand market stress.

Exchange-traded funds (ETFs) are investment vehicles that allow retail and institutional investors to obtain exposure to a wide range of assets or asset strategies. To perform this function, ETF sponsors – typically, large asset managers – minimise *tracking error*, or the difference between the return on the ETF and that on its respective benchmark index. The first ETF was introduced in 1993 and tracked the performance of S&P 500. As of 2020, ETFs managed about $7 trillion of assets globally and invested in equity, bonds, commodities, currencies and volatility.

Recent trends and market developments call for a closer analysis of bond ETFs. First, bond ETFs have been growing steadily over the past few years and now manage more than $1.2 trillion of assets across the globe, compared with less than $10 billion in 2009. Second, the Federal Reserve's corporate bond purchase programme

[1] The author thanks Claudio Borio, Stijn Claessens, Andreas Schrimpf, Hyun Song Shin, Vladyslav Sushko and Nikola Tarashev for valuable comments, and Cornelius Nicolay for excellent research assistance. The views expressed are those of the author and do not necessarily reflect those of the BIS.

launched in 2020 involves interventions in the bond market through ETFs.[2] Third, the difference between ETF share prices and the net asset value (NAV) of the underlying holdings (ie *premium* or *discount*) fluctuated more strongly for bond than for equity ETFs during March-April 2020. This highlighted that features specific to the bond market can have an impact on the pricing of bond ETFs.

In general, ETFs rely on an arbitrage mechanism to keep their share prices aligned with NAV. This mechanism relies on a special type of investors – usually, large market-makers and broker-dealers – collectively known as authorised participants (APs), which can create or redeem ETF shares. Whenever ETF prices rise above NAV, APs have an incentive to step in and exchange a subset of the asset holdings (a "creation" basket) for ETF shares. This helps close the arbitrage gap. Likewise, when ETF prices fall below NAV, APs exchange a "redemption" basket for ETF shares. In March and April 2020, however, bond ETF prices deviated strongly from their NAVs and the resulting gap was not arbitraged away by APs.

This article explains and analyses a crucial but understudied aspect of ETF arbitrage that distinguishes equity ETFs from bond ETFs: the nature of ETF baskets. Whereas for equity ETFs baskets are usually almost identical to holdings, for bond ETFs they are systematically different and include a small share of the bonds in the actual holdings, eg less than 3% for the largest bond ETF. For bond ETFs, baskets also change significantly from day to day and creation baskets tend to have longer duration and higher liquidity than redemption baskets.

Several factors are behind this contrast between equity and bond ETFs. First, the nature of the underlying assets is different. Compared with equities, bonds are generally less liquid and trade in a market with fewer potential buyers and sellers. In addition, bonds mature, whereas equities do not. Second, the minimum trading amount of bonds is much larger than that of equities, which constrains the feasible trades. Given these specificities of the bond market, ETF sponsors need flexibility as regards the composition of baskets. Sponsors choose strategically which bonds to include among the available ones, with an eye on continuously matching key characteristics of the benchmark index. Likewise, APs influence the composition of baskets and could use them to accommodate demand from their own clients rather than to close arbitrage gaps.

The flexibility inherent in baskets' composition may allow ETFs to withstand episodes of market stress. In the face of panic selling (runs), which generates redemption pressure, ETF sponsors could tilt redemption baskets towards riskier or less liquid securities. This would decrease prices of ETF shares since shares are exchanged for a lower-quality subset of ETF holdings. Meanwhile, non-running investors would be better off given that the average quality of the bonds in the ETF portfolio has improved. This mechanism could reduce incentives to redeem, thus nipping runs in the bud.

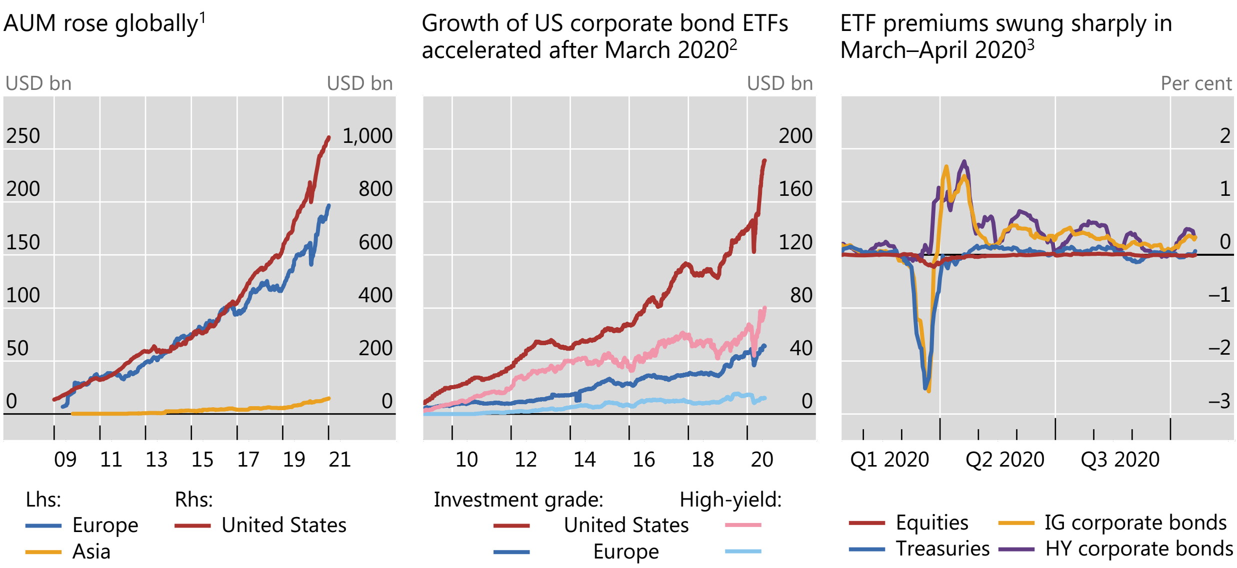
The remainder of this special feature is organised as follows. The first section describes recent trends in bond ETFs. The second analyses the ETF arbitrage mechanism, paying particular attention to key differences between bond and equity ETFs, and the incentives of ETF sponsors and APs. The third section reviews salient features of bond ETF baskets. The fourth considers the attendant implications for market functioning and financial stability.

2 The Secondary Market Corporate Credit Facility (SMCCF) was announced by the Federal Reserve on 23 March 2020 and was expanded on 9 April 2020 to include high-yield bond ETFs.

Recent developments in bond ETFs

Assets under management (AUM) of bond ETFs have risen spectacularly over the past decade. They increased from less than $10 billion in 2009 to more than $1.2 trillion in 2020 (Graph 1, left-hand panel), compared with the $5 trillion of equity ETFs' AUM. Among bond ETFs, US funds are the largest, with more than $1 trillion of AUM, followed by European funds, which manage around $200 billion. Asian ETFs are much smaller in size and manage less than $15 billion.

Recent trends and market development in bond ETFs — Graph 1



AUM = assets under management; ETF = exchange-traded fund; HY = high-yield; IG = investment grade.

[1] For sovereign and corporate bond ETFs, by country or region of domicile. [2] Based on the largest ETFs. [3] Two-week rolling average of the percentage difference between the share price and the corresponding NAV for the largest ETFs.

Sources: Bloomberg; EPFR; author's calculations.

ETFs invest in a variety of bond types, and those specialising in corporate bonds have grown strongly in the past decade. The AUM of US corporate bond ETFs increased more than 13 times over the past 10 years and reached $260 billion in 2020 (Graph 1, centre panel), or more than a quarter of the total size of all US bond ETFs. The increase accelerated most recently after the announcement of the Federal Reserve's bond ETF purchase programme in March 2020. The trends have been similar outside the United States. European corporate bond ETFs' AUM increased tenfold following the Great Financial Crisis of 2007–09, reaching $62 billion of AUM in 2020. In both the United States and Europe, the growth in investment grade (IG) bond ETFs exceeded that of high-yield (HY) ones.

Bond ETFs were not spared by the market turmoil during the Covid-19 crisis in March-April 2020. Within days, steep discounts of share prices relative to NAV transformed into large premiums (Graph 1, right-hand panel).[3] This set them apart from other funds, such as equity ETFs. In addition, the tracking error of bond ETFs

[3] The extraordinary dysfunction of the market for US Treasuries resulted in deep discounts for ETFs investing in these securities. These discounts subsided with the Federal Reserve's intervention on 23 March (Haddad et al (2020)).

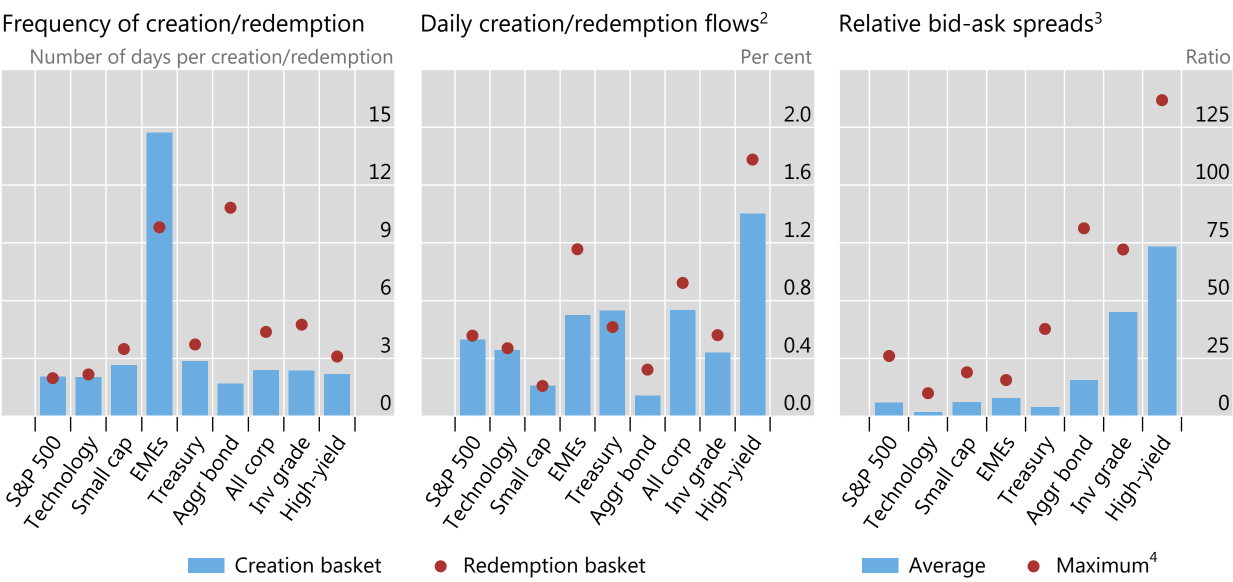
increased to above 200 basis points for some funds in March–April 2020, much higher than the historical average of 0.7 bp in the sector. These facts indicated impediments to the functioning of the arbitrage mechanism for bond ETFs.[4]

The concept of ETF arbitrage

The ETF ecosystem

For ETFs in general, a crucial aspect of the arbitrage mechanism is the interplay between primary and secondary markets for ETF shares. The primary market activity involves in-kind transfers between ETF sponsors and APs, which are the outcome of a negotiation between these two parties on the portfolio of assets that ETF shares are exchanged for.[5] The secondary market activity takes place on an exchange, where all investors – including APs – trade ETF shares among each other (Ramaswamy (2011)). The trading volume in the secondary market dwarfs that of the primary market, as it includes 90% of the overall daily activity in ETF shares (ICI (2015)).

Features of creations and redemptions and liquidity mismatches across ETFs[1] Graph 2



[1] Underlying period: January 2019–October 2020. The labels on the horizontal axes indicate ETFs that invest in: the S&P 500 index, US technology stocks, US small-cap stocks, emerging market stocks, US Treasuries, the aggregate US bond market, US corporate bonds, US investment grade corporate bonds and US high-yield corporate bonds. The sample comprises the largest ETFs in each category. For ETFs tracking Treasuries, all corporate bonds, and high-yield and investment grade corporate bonds, the average shares are AUM-weighted. [2] As a percentage of AUM; averages over time. [3] For each ETF type, the AUM-weighted average of bid-ask spreads of asset holdings divided by the bid-ask spread of the ETF share, averaged over time, is used. [4] Observed during the Covid-19 crisis, March–April 2020.

Sources: Bloomberg; Refinitiv Eikon; author's calculations.

[4] In March–April 2020, ETF prices may have incorporated information in a timelier manner than NAV (SEC (2020), BlackRock (2020), Avalos and Aramonte (2020)). Using intraday NAV calculations could give better estimates of the true ETF premium (Laipply and Madhavan (2020)) since NAV calculations can at times be based on stale quotes.

[5] Admittedly, for some ETFs, primary market creations and redemptions are in-cash and baskets are not negotiated. However, in-kind transfers and customised baskets are key characteristics of bond ETFs, which are the main object of analysis in this feature.

Each ETF sponsor signs special agreements with a set of APs that can then create or redeem shares. Usually, there are three to five active APs for each ETF. APs have the incentive to engage in creation-redemption activity whenever there is an arbitrage opportunity: a gap between the ETF price and the value of the underlying basket. However, given that APs are also usually major bond dealers, they could create or redeem ETF shares also in order to manage their own inventory (Pan and Zeng (2019)).

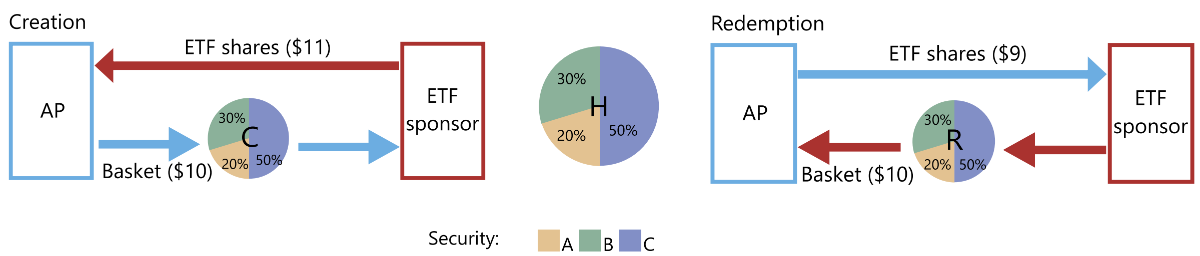
ETF creations or redemptions take place through baskets, ie sets of specific bonds or stocks[6] that are exchanged with the ETF sponsor for shares. Such a set is published by the ETF sponsor at the end of each trading day for reference on the next day and is publicly known. APs of bond ETFs could also propose bonds that are not in the published basket but facilitate their role as dealers. The ETF sponsors make the ultimate decision whether to accept such proposals or not. Actual creations and redemptions happen once every two to four days on average (Graph 2, left-hand panel).[7] The average size of creations and redemptions is typically small, ie below 1% of AUM for most ETFs (centre panel).

The ETF arbitrage mechanism

A key role of APs is to ensure that the ETF price (determined in the secondary market) is aligned with the NAV of ETF holdings (based on the prices of the underlying assets). While APs are not legally obliged to play this role, they have an incentive to do so, as eliminating deviations between ETF share prices and NAV generates profits.[8] The following example illustrates the ETF arbitrage mechanism in its simplest form, as well as its relationship with tracking error.

Suppose that a hypothetical ETF called *ABC* tracks a benchmark of three securities: A, B, and C worth \$2, \$3 and \$5, respectively (Graph 3). The benchmark weights are: 20% (A), 30% (B) and 50% (C). The ETF has one unit of each security, implying that NAV is equal to: \$10 = \$2 + \$3 + \$5. Assume that the ETF is trading at a *premium*: concretely, the ETF share price is \$11 > \$10. This premium creates an

ABC ETF: a stylised example — Graph 3



AP = authorised participant; C = creation basket; H = ETF holdings; R = redemption basket.

Source: Author's elaboration.

[6] Sometimes, also cash.

[7] Each transaction is usually done in units of 50,000 shares and incurs a small fee: typically, \$250–1,000, or less than 1 basis point of the creation/redemption size.

[8] ETF arbitrage can also be performed by other investors. For instance, APs can rent out their creation/redemption facilities to hedge funds (Laipply and Madhavan (2020)). These agents create/redeem ETF shares by submitting orders to APs to act on their behalf.

arbitrage opportunity but also reflects a tracking error – the ETF return is higher than that on the benchmark index.

An AP profits from the arbitrage opportunity as follows. It buys a creation basket consisting of one unit of each security for $10 on the secondary market, creates one ETF share by transferring the basket to the ETF sponsor in the primary market (Graph 3, left-hand panel) and sells that share for $11 on the secondary market. This generates an arbitrage profit of $11 – $10 = $1.[9] These transactions put downward pressure on the ETF price and upward pressure on the NAV. For future reference, suppose that closing the gap between the two requires the creation of 10 shares, ie a flow of $100. This flow would also eliminate the tracking error since, in the current stylised example, the creation basket is identical to ETF holdings.

The implications would be symmetric, if the ETF was trading at a *discount* at $9 < $10. In this case, the AP would buy one ETF share, redeem it for the basket of securities worth $10 in total (Graph 3, right-hand panel) and make a profit of $10 – $9 = $1. This would eliminate the discount by putting upward pressure on the ETF price and downward pressure on NAV.

ETF arbitrage can also be performed without transacting in the primary market. Investors such as hedge funds and high-frequency traders could exploit ETF mispricing by trading ETF shares and underlying assets in the secondary market. These investors can simply sell the expensive asset (an ETF share or a set of the underlying assets), buy the cheap one, and wait for the two prices to converge as the ETF premium becomes zero. Importantly, this type of activity is profitable only if the arbitrage mechanism works smoothly in the primary market and eliminates ETF premiums or discounts over the investment horizon of secondary-market investors.

Unique aspects of bond ETF arbitrage

While the above discussion captures well the nature of the arbitrage mechanism in the case of equity ETFs, it misses key features of bond ETFs. These features stem from the specifics of the underlying assets. First, bond ETFs need to transact in a less liquid and more concentrated market, with fewer potential buyers and sellers than in the equity market. Second, the minimum trading size of bonds is much larger than that of equities. Third, bonds have a finite maturity, whereas equities do not.

The illiquid nature of the asset class implies that, compared with equity ETFs, there is a more severe liquidity mismatch between the assets and liabilities (shares) of bond ETFs. The bid-ask spreads of the asset holdings of bond ETFs are 17 times greater than those of ETF shares. The corresponding number for equity ETFs is five (Graph 2, right-hand panel). To a large extent, bonds are illiquid because they usually trade over the counter (OTC) in a dealer-intermediated market, where not all desired securities are readily available (Hendershott and Madhavan (2015), CGFS (2014), CGFS (2016)). This is not an issue for equities, as they are predominantly traded on exchanges, which are open directly to a wide range of investors.

Moreover, the liquidity mismatch differs across market segments and can change materially over time. For instance, this mismatch is particularly pronounced for high-

[9] In reality, APs often first short-sell the ETF share in the secondary market and then deliver the newly created share to cover that short position in the event of creations. In the case of redemptions, APs would first short-sell the basket and then deliver the redeemed assets to cover the short position.

yield corporate bonds, with the measure of relative illiquidity equal to 75 on average. This measure reached 130 during the Covid-19 crisis (Graph 2, red dot).

The minimum trading amount of bonds is several orders of magnitude larger than that of equities. Typically, bonds trade in minimum amounts above $100,000. By contrast, for equities, these amounts can be as small as a fraction of a share, ie less than $5. Thus, bond ETF sponsors would need a much larger basket size than equity ETF sponsors in order to transact in the same number of instruments.[10]

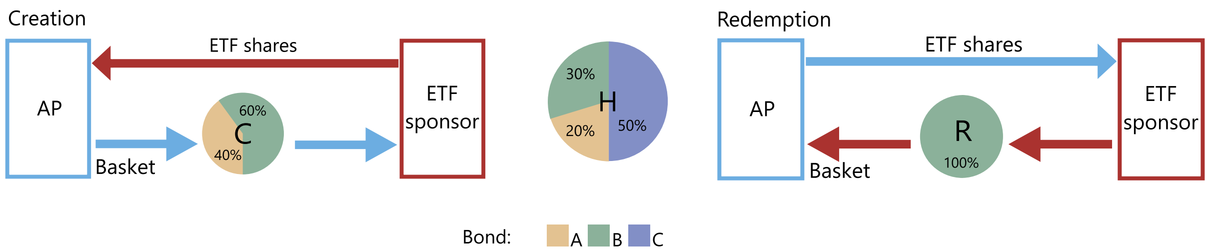
Lastly, bonds' finite maturity also necessitates portfolio rebalancing. In practice, most bond ETFs have a target maturity defined by their benchmark index.[11] Thus, bonds falling below the target maturity need to be replaced by bonds with longer maturity. Such rebalancing is irrelevant for equity ETFs.

Stylised example, revisited

These three specificities of the bond market call for modifications to the above stylised example of the *ABC* ETF when A, B and C stand for bonds. First, in line with the illiquidity of the market, let bond A be hard to locate. Second, to capture the large minimum trade size, let A, B and C be traded in 20 units or more. Third, to incorporate maturity considerations, assume that bond B is maturing soon.

These modifications weaken the arbitrage mechanism for the *ABC* ETF. The first modification implies that the ETF may choose to exclude bond A from the creation basket. The second modification means that, even though an inflow of $100 is needed to close the price gap (see above), such an inflow does not allow the ETF to buy all the underlying bonds. One feasible option is to buy 20 units of bond A, 20 units of bond B and none of bond C ($100 = 20 * 2 + 20 * 3; Graph 4, left-hand panel). The third modification suggests that the ETF could overweight bond B in a redemption basket in anticipation of its imminent maturity (right-hand panel). In each case, the difference between baskets and the underlying holdings prevents APs from putting adequate buying or selling pressure on bonds A, B and C. This weakens APs' capacity to close the ETF premium or discount.[12]

ABC ETF: a stylised example with bonds — Graph 4



AP = authorised participant; C = creation basket; H = ETF holdings; R = redemption basket.

Source: Author's elaboration.

[10] Often bond ETF benchmarks constitute hundreds or thousands of bonds. The average size of creation/redemption for the largest 300 US ETFs is approximately $20 million.

[11] This is similar to calendar rebalancing for commodity ETFs in Todorov (2019). Such rebalancing arises because the funds target a specific future's maturity and replace expiring short-term futures contracts with longer-term ones over time.

[12] The ETF premium calculated using NAV of the basket is often less severe compared with the usually measured ETF premium based on NAV of holdings (Shim and Todorov (2021a)).

Incentives of ETFs and APs

The specifics of the bond market shape ETF sponsors' and APs' incentives in a way that also contributes to the unique aspects of bond ETF arbitrage.

ETF sponsors' portfolio optimisation and their incentives to maintain a long-term relationship with APs can lead to differences between baskets and holdings and to changes in baskets over time. Sponsors would adapt the composition of baskets based on the availability of bonds and would choose a subset of bonds that minimises tracking error. In turn, when an AP cannot deliver a bond, such as A in the above example,[13] it could propose some similar new bond D that is easier to locate for the transaction and could even allow the AP to absorb a supply shock from its clients. While this bond is not part of the ETF holdings, a sponsor might accept the proposal if the new bond keeps the tracking error in check and helps maintain the relationship with the AP, whose market-making function provides valuable services to the sponsor. As the availability of bonds changes over time, similar transactions will translate into changes of ETF baskets.

ETF sponsors could use creations and redemptions to adjust their holdings according to certain liquidity or rating targets. These would be in addition to the maturity target affecting bond B in the *ABC* ETF example. For a sponsor, it is often more cost-effective to attain all these targets by transacting with APs on the primary market than by trading on the more illiquid bond market.

The actions of APs in their role as bond dealers can drive a wedge between creation and redemption baskets. APs could accommodate extraordinary supply of bonds from their bond clients by creating an ETF share. Symmetrically, they could accommodate demand by redeeming a share. In either case, APs' creations and redemptions do not target to reduce the size of an ETF premium or discount.

Empirical evidence

The three specificities of the bond market illustrated in the stylised example, combined with ETFs' and APs' incentives, translate into three aspects of the arbitrage process that are unique to bond ETFs. First, creation and redemption baskets would differ from actual holdings. Second, as the relative liquidity and availability of various bonds change over time, so will the composition of baskets. Third, creation baskets would differ from redemption baskets in terms of liquidity and maturity. The three unique aspects of the arbitrage process of bond ETFs surface clearly in the data.

Baskets versus actual holdings for bond ETFs

Creation/redemption baskets differ materially from holdings for bond ETFs but not for equity ETFs. This is illustrated by an alignment measure equal to the number of securities common to a basket and holdings, expressed as a share of the holdings.[14] For the largest equity ETFs, the alignment is almost 100% (Graph 5, left-hand panel). By contrast, bond ETFs' baskets are less aligned with holdings. For the largest bond

[13] APs usually do not hold the full set of bonds in ETF baskets in their inventory.

[14] Redemption baskets will be mechanically more aligned with holdings because ETFs can only redeem assets that are already in the holdings.

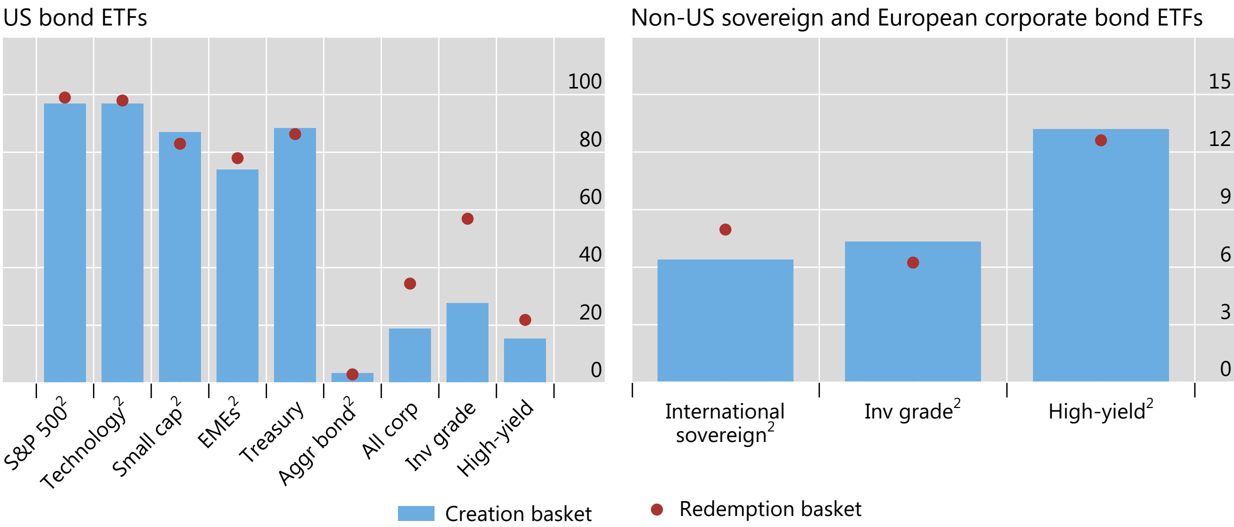
ETF, which tracks the aggregate bond market, baskets represent on average only 3% of holdings.

There is also a significant heterogeneity across bond market segments, reflecting the liquidity of the underlying assets. For US Treasuries, baskets are well aligned with holdings, similarly to equity ETFs. For US corporate bonds, creation baskets only cover about 20% of holdings, and redemption baskets 35%. The alignment is even smaller for bond ETFs that invest in non-US securities (Graph 5, right-hand panel). Both in the United States and in Europe, baskets of investment grade corporate bond ETFs are more aligned with holdings than those of high-yield ETFs.

Baskets are a small share of holdings[1]

Share of baskets in holdings, in per cent

Graph 5



[1] Based on changes in ETF holdings on days with creation/redemption. The labels on the horizontal axes indicate ETFs that invest in: the S&P 500 index, US technology stocks, US small-cap stocks, emerging market stocks, US Treasuries, the aggregate US bond market, US corporate bonds, US investment grade corporate bonds, US high-yield corporate bonds, international (ie non-US) government bonds, European investment grade corporate bonds and European high-yield corporate bonds. [2] Based on the largest ETFs.

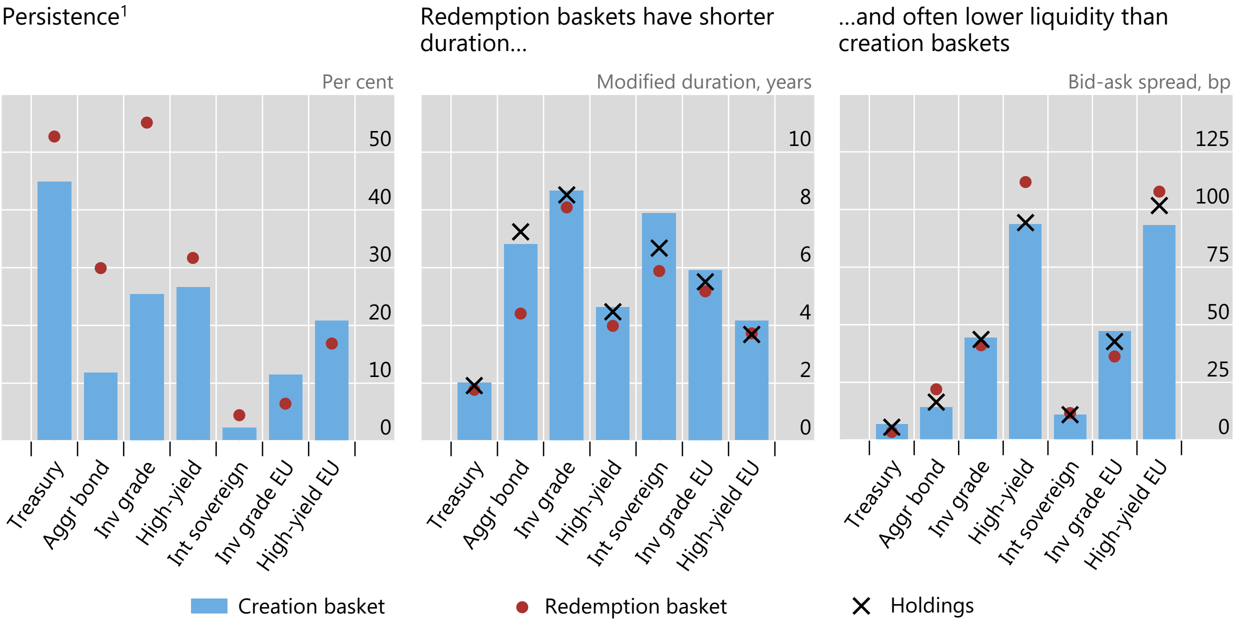
Sources: Bloomberg; author's calculations.

The variability of bond ETF baskets

The composition of bond ETF baskets changes frequently over time. The persistence of creation baskets – that is, the fraction of bonds that are in a basket in two consecutive periods – is 45% for ETFs that track Treasuries but only 12% for the largest bond ETF (Graph 6, left-hand panel). Baskets of European bond ETFs and international bond ETFs are even less persistent than those of US ETFs.

Creation baskets change more often than redemption baskets for most ETFs. This is particularly pronounced for ETFs tracking investment grade bonds and the aggregate bond market: these ETFs' creation baskets are more than twice less persistent than redemption baskets. The composition of creation baskets often depends on the availability of bonds in the underlying market, which can vary substantially. In contrast, redemption baskets always draw on bonds that are already part of ETF holdings and are thus less dependent on broad market conditions.

Baskets change over time and differ from holdings	Graph 6



[1] Measured as the percentage of common bonds in two consecutive creation/redemption periods. The labels on the horizontal axes indicate ETFs that invest in: US Treasuries, the aggregate US bond market, US investment grade corporate bonds, US high-yield corporate bonds, international (ie non-US) government bonds, European investment grade corporate bonds and European high-yield corporate bonds.

Sources: Bloomberg; Refinitiv Eikon; author's calculations.

Redemption baskets are different from creation baskets

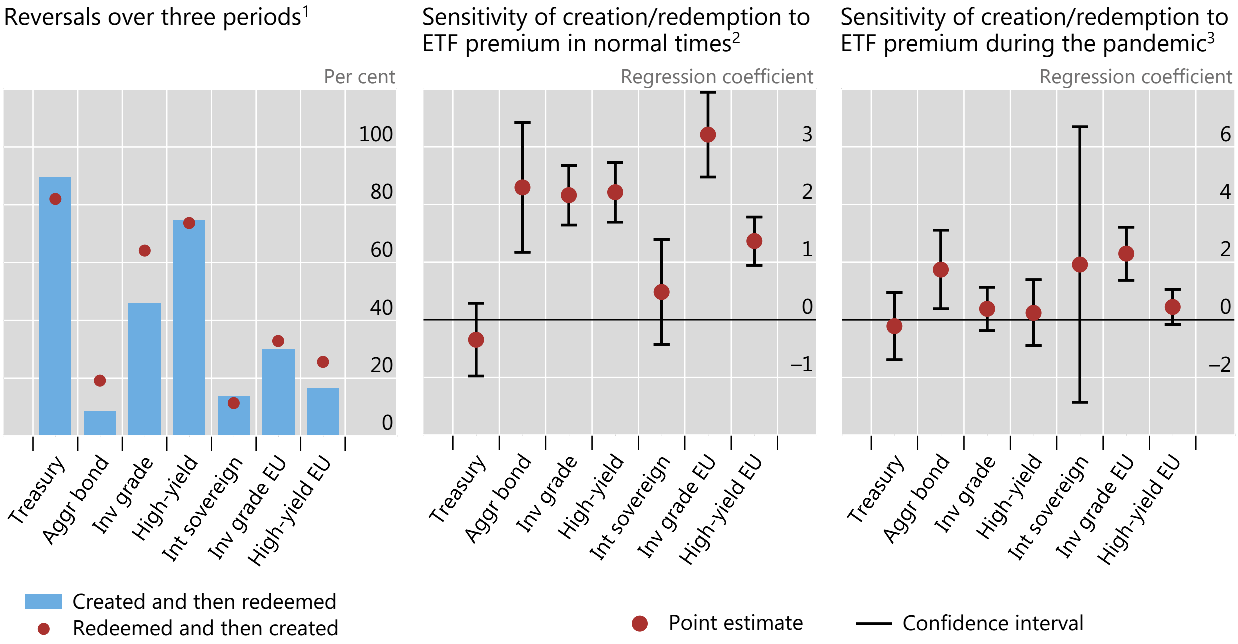
In line with ETFs' portfolio management, bonds in the redemption baskets tend to have shorter duration and slightly lower liquidity than holdings and creation baskets (Graph 6, centre and right-hand panels). In terms of duration, the differences are most pronounced for ETFs investing in the aggregate bond index and non-US sovereign debt. Liquidity differences – as measured by the average bid-ask spread – are largest for ETFs investing in the least liquid instruments: high-yield bonds.

There is evidence of additional drivers of baskets' composition. If ETFs' portfolio management was the sole driver of the composition of baskets, then redeeming a bond from the pool of holdings would tend to be irreversible, not least because bond maturity always declines.[15] The data reveal, however, that bonds often re-enter the pool of holdings shortly after their redemption (Graph 7, left-hand panel). Likewise, if closing arbitrage gaps was the main driving force of APs' actions, then creation and redemption activity would be consistently sensitive to the size of such gaps. This is the case for only some asset classes in normal times (centre panel) and even fewer asset classes in times of market stress (right-hand panel). This fact indicates the important role of APs' arbitrage-independent incentives.

[15] Bond ratings, another criterion for portfolio management, are extremely persistent and rarely exhibit reversals over a few days.

Other reasons behind creation/redemption

Graph 7



[1] The measure of reversal is based on the percentage of bonds created or redeemed in the next three periods after redemption or creation. A period is the average number of days between two consecutive creations or redemptions. The labels on the horizontal axes indicate ETFs that invest in: US Treasuries, the aggregate US bond market, US investment grade corporate bonds, US high-yield corporate bonds, international (ie non-US) government bonds, European investment grade corporate bonds and European high-yield corporate bonds. [2] Estimate of the coefficient on the ETF premium in a regression of the size of creation/redemption flows divided by the ETF's AUM. The regression is based on daily data from 1 January 2019 to 31 December 2020 and also accounts for the average bid-ask spread in the basket, the corresponding spread in the ETF holdings, VIX, and the product of VIX and the ETF premium. [3] Based on data from March–April 2020.

Sources: Bloomberg; Refinitiv Eikon; author's calculations.

Implications for market functioning and financial stability

The salient features of bond ETFs' creation and redemption baskets have implications for market functioning. While these features may weaken arbitrage forces, they also enhance the shock-absorbing capacity of ETFs and can help stabilise markets.

Arbitrage versus prevention of runs

Features of bond ETF baskets may weaken arbitrage forces not only directly (as discussed earlier) but also indirectly, by influencing the risk borne by APs and other traders. Until the negotiation with ETF sponsors is complete, APs are uncertain about the basket of bonds that they would be able to exchange for an ETF share. They are also unsure how this basket would compare with the one underpinning transactions on the following day. Likewise, investors performing an arbitrage on the secondary market (eg hedge funds) are uncertain about how the composition of the basket behind an ETF share would change between their entry into and exit from a trade. As this uncertainty reduces the risk-adjusted profits that could be extracted from a premium or discount, it weakens arbitrage forces.

That said, the uncertainty's flip side is flexibility for ETF sponsors to absorb shocks. By selecting the composition of baskets, ETF sponsors could discourage runs by influencing the desirability of redemptions (Shim and Todorov (2021b)). If there is excessive selling of ETF shares in the secondary market, which puts redemption pressure on APs, the ETF sponsor can include only the riskier or less liquid securities from the pool of holdings in the redemption basket. The lower-quality bonds that APs obtain after redeeming ETF shares would in turn reassure non-running investors that their shares are now backed with holdings of higher average quality. This would discourage further runs and lead to ETF discounts during run episodes. In fact, such a stabilisation mechanism was arguably in place during the March–April 2020 episode (Graph1, right-hand panel) when some ETFs traded at a discount while redeeming baskets that were more illiquid than the holdings.

Such a strategy can backfire in the long run, however, as it can hurt ETFs' reputation. If investors perceive an ETF as redeeming only low-quality bonds in stress times, they may withdraw from the ETF altogether. This, in turn, could lead to lower inflows to the ETF and, as a result, decrease ETF profits from management fees, which are based on the size of AUM.

Basket flexibility and bond market liquidity

The flexible composition of baskets allows for a more efficient primary market activity and may improve the liquidity of the bond market. Since baskets can differ across APs even on the same day, a large number of diverse APs – with different bond inventories and different client relationships – can participate in creating or redeeming ETF shares. Thus, even when there is a shortage of a particular bond for creation, the bond is still likely to be sourced from the inventory of one of the participating APs. And if the bond is impossible to find, it could be excluded from the basket altogether. Similarly, when there is demand from APs' clients for a particular bond, APs can add that bond to their inventory by redeeming shares. In effect, APs can use the creation/redemption mechanism to enhance their market-making activities (Shim and Todorov (2021a)).

Conclusion

This special feature reveals three novel facts about the arbitrage mechanism for bond ETFs. First, creation/redemption baskets are only a small subset of bond ETF holdings and have different characteristics than these holdings. Second, baskets' composition varies over time. Third, there are systematic differences between creation and redemption baskets in terms of the maturity and liquidity of the constituent bonds. These findings stem from the specifics of the bond market, ETFs' portfolio management and APs' own incentives. The differences between baskets and holdings could impact ETF premium and tracking error in stress times, but does not prevent ETF sponsors from tracking closely their benchmarks during normal times.

The decoupling of baskets from holdings can also be a shock absorber during volatile times. The partial convertibility that stems from the decoupling means that ETFs could be a stabilising force during runs and prevent fire sales. This mechanism is possible because of the predominantly in-kind nature of ETF redemptions, whereby shares are exchanged for securities. It is not available to other investment vehicles with cash redemptions such as mutual funds.

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How much stress could Covid put on corporate credit? Evidence using sectoral data

The economic downturn prompted by the Covid pandemic was historically deep and highly divergent at a sectoral level. We project corporate credit losses for the G7 economies, China and Australia until 2022 and find that they could be substantial for the sectors most affected by the pandemic. Yet, because those sectors account for a relatively small share of total corporate borrowing, aggregate corporate credit loss rates (ie losses in relation to the stock of corporate debt) could fall short of those sustained during the Great Financial Crisis of 2007–09.

JEL classification: E17, E44, G20.

Key takeaways

- This article provides a framework to translate sectoral macroeconomic scenarios into sectoral corporate credit losses, and applies it to the G7 economies, China and Australia.
- Because the pandemic has affected some sectors more severely than others, projected credit losses reflecting sectoral growth paths are very different from those based on projections of aggregate GDP growth alone.
- Despite substantial losses in the sectors most affected by the pandemic, total corporate credit loss rates (ie losses in relation to the stock of debt) could fall short of those during the Great Financial Crisis of 2007–09 because these sectors account for a smaller share of corporate borrowing than at that time.

Introduction

The Covid pandemic triggered the largest economic downturn since the Great Depression. Although the macroeconomic outlook is currently more favourable than it was at the peak of the crisis in the spring of 2020, the second wave of the pandemic is placing an additional strain on the recovery and reinforcing existing vulnerabilities, at least in some of the major advanced economies.

Non-financial corporate (NFC) bankruptcy rates remain fairly low in most countries, despite the sharp decline in economic activity (Banerjee, Cornelli and Zakrajšek (2020), IMF (2020a)). However, they are expected to rise as measures to support credit are wound back, new consumption habits and business practices accelerate the downsizing of specific sectors, and some firms run out of liquidity buffers (eg Banerjee, Illes, Kharroubi and Serena (2020)). The looming increase in corporate bankruptcies will generate credit losses that will need to be absorbed, either by the financial system or by taxpayers.

This article assesses potential corporate credit losses at the sectoral level for the G7 countries, China and Australia. On average, corporate credit accounts for slightly more than half of total private non-financial credit in these countries (ranging from 31% of total credit in Australia to 73% in China) and typically incurs larger credit losses during recessions than household credit.[1] As such, the outlook for corporate credit has a significant bearing on overall assessments of the health of the financial system. We project credit losses, defined as recognised impairments on bank and non-bank debt, until the end of 2022, assuming that the pandemic will have played out by then and its impact on credit losses will have materialised.[2]

We proceed in three steps. First, we construct sectoral economic projections for each of the nine economies in our sample following the approach in Rees (2020) (Box A).[3] Specifically, we use a macroeconomic model with a rich industry structure in both demand and production to estimate the economic disturbances ("exogenous shocks") that explain the path of activity since the start of the pandemic.[4] Conditional on assumptions of how these disturbances play out, we then use the model to project the evolution of sectoral output for each country up to 2023.

In the second step, we combine data on bonds and bank loans to derive corporate debt by sector for each of the G7 countries, China and Australia (Box B). The construction of sectoral corporate debt fills a data gap in the public domain.

In the third step, we draw on existing estimates from the literature on the GDP sensitivity of credit loss rates (ie losses in relation to the stock of corporate debt) for banks (Hardy and Schmieder (2013); see also Box C) to translate our sectoral output projections into projected credit loss rates. In doing so, we assume that the historical sensitivity of bank credit loss rates to aggregate GDP is the same across sectors as well as across bonds and bank loans. We then scale these sectoral credit loss rates using our estimates of sectoral debt to project total credit losses by sector and country.

We reach three key conclusions. First, corporate credit loss rates could rise substantially in sectors most affected by the pandemic. The sectoral dispersion in credit loss rates is likely to be wider than during the Great Financial Crisis (GFC) of 2007–09 because of unevenness in sectoral economic conditions as well as the tendency for credit losses to rise more than proportionally with output shortfalls. Second, aggregate corporate credit loss rates are likely to fall short of those sustained during the GFC, in large part because the sectors most affected by the Covid pandemic account for a comparably small share of total credit. Third, projected credit losses based on sectoral growth paths are larger than those based on aggregate GDP data alone. This highlights the importance of taking account of sectoral differences in economic conditions and credit exposures when estimating the implications of an uneven recession for corporate credit losses.

1 The Great Financial Crisis of 2007–09, which saw substantial losses on household credit in many countries, was unusual in this regard.

2 Hardy and Schmieder (2013) estimate that recognised credit losses typically lag declines in economic activity by six to 12 months.

3 Throughout this article, we use the terms "sector" and "industry" interchangeably.

4 On its demand side, the model allows for cross-industry substitution in consumption and investment. On its production side, the model allows for cross-industry spillovers through input-output linkages.

Box A

Projecting the economic recovery at a sectoral level

We construct the sectoral economic growth projections used in this article following the approach discussed in Rees (2020).

The core of the approach is a multi-sector dynamic stochastic general equilibrium (DSGE) model. As well as the standard nominal and real frictions (eg sticky prices) typically included in macroeconomic models to account for aggregate economic fluctuations, the model features a detailed set of interactions on its demand side (allowing for substitution between industries in consumption and investment) and on its supply side (allowing for spillovers through input-output linkages).①

For each economy, we first calibrate the parameters of the model to match key features of the economic landscape – for example, the share of each sector in gross value added – immediately prior to the Covid pandemic. We then estimate the aggregate- and industry-level supply and demand disturbances that explain economic outcomes in the first three quarters of 2020. These disturbances implicitly account for the behavioural responses to the pandemic as well as policy responses. As discussed in Rees (2020), accounting for supply and demand disturbances is important because the aggregate implications of sectoral disturbances depend upon their source. While lower demand in one sector frees resources for other sectors, lower productivity in one sector implies lower income which feeds into lower demand across all sectors of the economy.

Conditional on the estimated disturbances, we project the model forwards making two assumptions:

1. The aggregate disturbances and industry-specific disturbances outside of customer services industries that occurred in the first three quarters of 2020 decay at a rate of 50% each quarter.
2. The industry-specific disturbances that affected customer services industries remain in place at 50% of the intensity observed in Q2 2020 until a vaccine is widely distributed. We assume that this will occur in Q1 2022.

We also impose an additional series of aggregate and industry-level disturbances on economies in Europe and North America in Q4 2020 and Q1 2021 to account for the rising number of infections and renewed lockdowns that have occurred in those economies. We calibrate these to be 75% as large as the disturbances that occurred in Q2 2020 Although there are some differences in the pattern of quarterly growth rates, the model's aggregate GDP projections are broadly in line with those from market economists, central banks and international economic organisations. These alternative projections, however, do not typically provide information at the sectoral level.

Macroeconomic forecasts are inherently uncertain. Unforeseen developments, eg the emergence of new virus variants, or changed relationships between economic variables, eg because of pandemic-induced shifts in work practices, could cause actual outcomes to differ from the projections in this article. In principle, it is possible to characterise forecast uncertainty using "fan charts" based on repeated model simulations or historical forecast errors (eg Tulip and Reifschneider (2019)). However, these measures of uncertainty are of questionable value at present, given the unusual nature of the economic disturbances unleashed by the pandemic and the resulting changes in economic structure. Therefore, rather than attempt to quantify the uncertainty, we present a single set of projections based on a particular assumption of how the pandemic will evolve. We emphasise, however, that the range of plausible outcomes around our projections is likely to be wide.

Like all economic models, the one used in this article has a number of limitations. For example, it lacks a detailed modelling of interactions between the financial sector and the real economy that could be relevant if credit losses of the size discussed below materialise. And, while it allows for permanent changes in the *level* of GDP, it assumes that the effects of large crises on output *growth* will be transitory. Both of these factors could cause the model's projections to overstate GDP growth in the years ahead. At the same time, the projections assume that the amount of future monetary and fiscal policy support will be in line with historical norms. If the unusually large fiscal policy stimulus seen in many economies remains in place as economic conditions improve, the projections could understate the strength of the recovery.

In the online appendix accompanying this article, we provide the full set of aggregate and industry growth projections for each economy in our sample.

① The number of industries varies between economies, reflecting differences in data availability, but is generally around 12–15.

Our analysis builds upon previous work on the implications of the Covid pandemic for corporate credit (eg Deutsche Bundesbank (2020), Greenwood et al (2020), Gourinchas et al (2020), OECD (2020)). Relative to these papers, we cover a larger number of countries and/or a broader scope of credit (ie projecting losses for loans and bonds at the aggregate and at the sectoral level). However, the framework that we use to calculate credit losses is straightforward to implement and update. Supervisors and other institutions can easily reproduce our analysis based on their own sources of information about credit exposures and/or views about the evolution of economic conditions.

The rest of this article is organised as follows. The first section describes the macroeconomic scenarios that inform our projections of corporate credit losses. The second maps these macroeconomic scenarios into credit losses by industry and country. The final section discusses the policy implications of our results and concludes.

The Covid recession and recovery: a sectoral perspective

Our economic projections combine observed economic outcomes since the start of the pandemic with model-based projections of how sectoral economic conditions in each country could evolve over the coming years.

The Covid pandemic prompted a historically deep and globally synchronised recession.[5] Across the advanced economies (AEs) in our sample, GDP declined by twice as much in the first half of 2020 as it did in the GFC, which was itself an unusually deep global recession (Graph 1, left-hand panel). Although GDP grew sharply in Q3 2020, it remains well below its pre-pandemic level in all of these economies. Because of its faster trend growth rate, the output trajectory of China is markedly different. But even in China, the slowdown in the first half of 2020 was substantially greater than during the GFC and the recovery has also been slower.

The Covid recession has also been unusual at a sectoral level.[6] In most recessions, goods industries such as manufacturing and construction experience the largest contractions, while service industries are more resilient. This pattern was particularly striking in the GFC (Graph 1, right-hand panel). But the Covid pandemic has been felt most sharply in customer services industries such as recreation, transportation and, to a lesser extent, wholesale and retail trade (as indicated by the blue dots above the 45° line).[7] The output of most goods industries and business-focused service industries declined, but by less than customer services, and in the

5 According to World Bank (2020), a larger share of economies experienced contractions in per capita GDP in 2020 than in any year since at least 1870.

6 We construct economic projections for 12–15 sectors per country, with the exact number depending on data availability. The sectors broadly correspond to one-digit International Standard Industrial Classification (ISIC) categories. Where it aids presentational clarity, we combine our detailed sectoral projections into three broad categories: consumer services (eg recreation, trade and transport), goods (eg manufacturing, construction and utilities) and business & social services (eg information & communication, real estate, and professional and social services). Because our focus is on non-financial corporate credit, we exclude the finance sector from the credit loss analysis, although it is included in the economic projections.

7 Much of the effect of the pandemic on the retail sector came through shifts in spending patterns among retailers, rather than changes in overall retail spending or shifts in spending patterns between retail trade and other industries (eg Alfonso et al (2021), Broadbent (2021)).

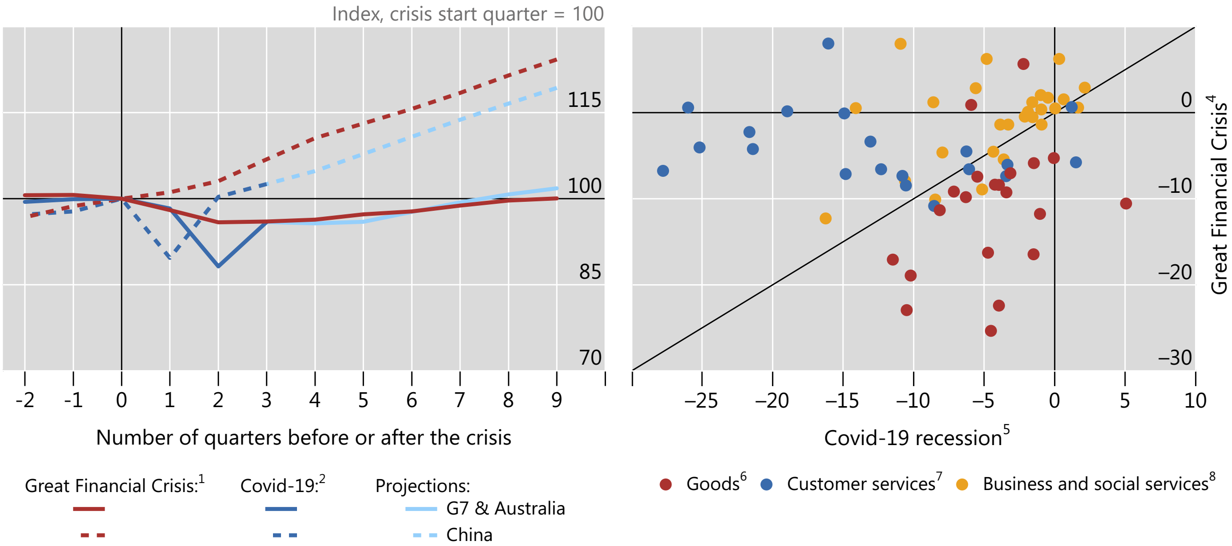
case of goods industries by less than it did in the GFC (as indicated by the red dots below the 45° line).

A large and uneven recession

Graph 1

Evolution of GDP in the Covid pandemic and the Great Financial Crisis

Sectoral gross value added growth in the Covid pandemic and the Great Financial Crisis[3]



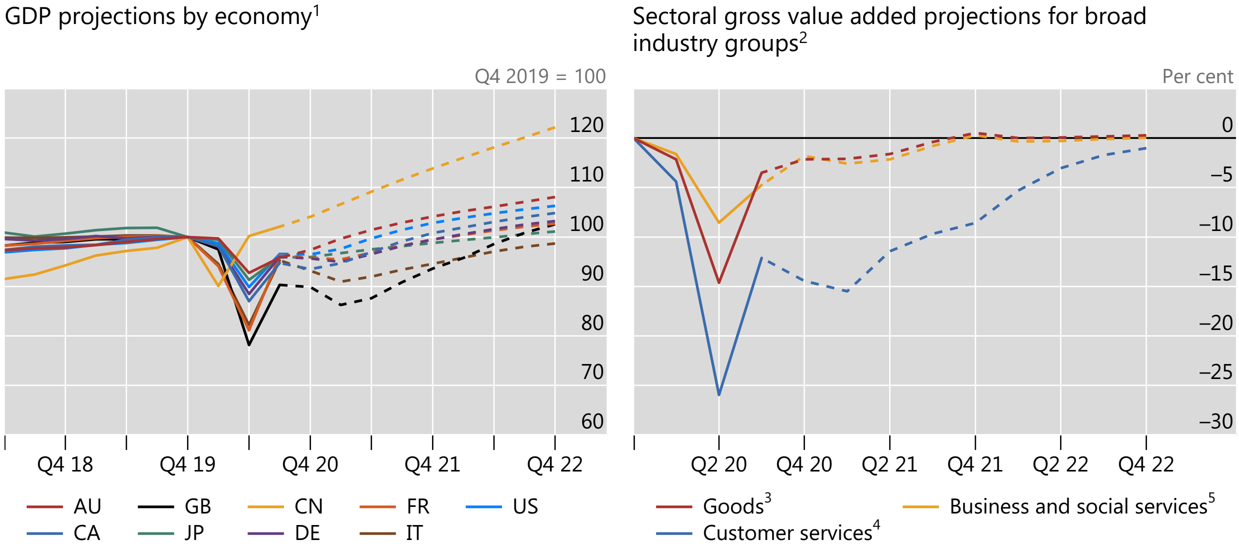
[1] Quarter 0 = Q3 2008. [2] Quarter 0 = Q4 2019; model projections starting in Q4 2020. [3] Dots above the 45° line indicate that a sector contracted by more in the Covid recession than in the GFC; dots below the line indicate that a sector contracted by more in the GFC than in the Covid recession. [4] Percentage change between Q1 2008 and Q2 2009. [5] Percentage change between Q4 2019 and Q3 2020. [6] Manufacturing, construction and utilities industries. [7] Trade, transport and recreation industries. [8] Information & communications, finance, real estate services, professional services and social services industries.

Sources: Eurostat; Australian Bureau of Statistics; Statistics Canada; Statistics Bureau of Japan; US Bureau of Economics Analysis; Datastream; authors' calculations.

These differences in sectoral economic conditions matter for two reasons. First, as emphasised by Baqaee and Farhi (2020) and Guerrieri et al (2020), the aggregate implications of economic disturbances concentrated on particular segments of the economy can differ markedly from those of economy-wide disturbances. Sectoral analysis is therefore key to understanding the economic consequences of the Covid pandemic and the trajectory of the recovery. Second, unevenness in economic outcomes across sectors, in conjunction with the tendency of credit losses to increase more than proportionally with the depth of recessions (Hardy and Schmieder (2013)), should translate into differences in financial distress. Sectoral economic projections are therefore essential for an accurate estimation of credit losses at both the sector and the aggregate level.

To account for the ongoing effects of depressed economic conditions on credit losses, we project the future path of economic activity for each country in our sample using the multi-sector macroeconomic model presented in Rees (2020). For each country, we first calculate the economic disturbances that explain the evolution of economic activity in the first three quarters of 2020, for which we have data about actual outcomes. We then project the model forward, assuming that aggregate constraints on economic activity gradually ease, but that some constraints specific to customer services industries remain in place until widespread vaccination contains the spread and the severity of the virus. For the sake of concreteness, we assume that all constraints are lifted by Q1 2022.[8] For the AEs, the aggregate GDP projections resemble the recovery from the GFC (Graph 1, left-hand panel). Box A describes the model in more detail and lays out the data and assumptions that inform the projections. The projections point to material divergences in the path of output across sectors and across countries over the coming years. The cross-country variation reflects differences in the sectoral composition of output as well as in the spread of infections and containment measures. In China, economic activity is projected to be just 1% below its pre-pandemic trend by early 2022 (Graph 2, left-hand panel). This is because customer services industries account for a relatively small share of output and the economic effects of the pandemic were felt earlier than in other economies. Among AEs, Australia is projected to experience the fastest recovery as low infection rates have allowed for the easing of most containment measures. Economies in Europe and North America are projected to recover more slowly, hindered by further waves of infections and renewed lockdowns. In such cases, output is projected to remain at least 3% below what it would have been in the absence of the pandemic throughout 2021, before gradually returning to its pre-pandemic trend as restrictions are lifted.

Projections of the recession and recovery by economy and sector — Graph 2



[1] Model projections after Q3 2020. [2] Deviation from no-pandemic baseline. [3] Manufacturing, construction and utilities industries. [4] Trade, transport and recreation industries. [5] Information & communications, finance, real estate services, professional services and social services industries.

Sources: Eurostat; Australian Bureau of Statistics; Statistics Canada; Statistics Bureau of Japan; US Bureau of Economic Analysis; Datastream; authors' calculations.

Differences in economic conditions between sectors could widen in the early stages of the recovery (Graph 2, right-hand panel). Taken together, the output of customer services industries is expected to remain at least 10% below its pre-pandemic trend until late 2021. Within that grouping, some industries would face particularly challenging conditions. The output of recreation industries, such as cafés,

[8] We impose additional disturbances on economies in Europe and North America to account for the second wave of infections and lockdowns that occurred in late 2020 and early 2021. While the "end" date of the pandemic could be further out than we assume, notably because of the challenges of eradicating the virus globally (IMF (2020b)) and the persistent effects of economic spillovers across economies (Kohlscheen, Mojon and Rees (2020)), shifting the date on which all constraints relax by one or two quarters has a negligible effect on our results.

restaurants and tourism, is projected to remain at least 20% below its pre-pandemic trend in most economies throughout 2021. The transport industry could also face an output shortfall of more than 10%. Even after constraints ease, recreation and transport activity should take time to recover; in most countries, the output of these industries is projected to remain 2–5% below its pre-pandemic trend at the end of 2022. In contrast, the outlook for retail trade would be somewhat more positive, with output losses of at most 5% at the end of 2021, reflecting less stringent lockdowns in this sector as well as a greater potential for activity to shift online.

In our projections, output losses in goods and business services industries are generally much smaller, notwithstanding lower demand for their products from customer services firms. In many countries, output in the manufacturing and construction industries is projected to be no more than 1% below its pre-pandemic trend by the end of 2021. Projected conditions in industries such as finance, information & communications and professional services, which offer the greatest scope for remote working, are even stronger.

Implications of the recession for sectoral credit

Sectoral credit exposures

Since data on corporate credit exposure by sector are not readily available, we construct a new database of such exposures for the nine countries in our sample using a combination of market- and bank-level data sources (Box B).

Our database accounts for the bulk of NFC debt. To illustrate this, Graph 3 (left-hand panel) compares our constructed estimates of total NFC credit by country (red bars) with data from the financial accounts of non-financial firms, which should cover all sources of credit (blue dots).[9] Discrepancies between the two sources could arise if our database omits some types of credit (eg lending within the NFC sector or by non-bank financial intermediaries (NBFIs)) or misallocates lending by banks that operate in multiple jurisdictions. In net, however, the discrepancies are small. Our estimates account for more than 90% of total credit exposures for all economies except France and the United Kingdom, where the share is closer to 80%.[10] Reassuringly, our estimates also capture cross-country differences in corporate debt. As in the financial accounts data, they indicate that China, Canada and Japan have the highest levels of corporate credit, equivalent to more than 100% of GDP in each case. Those in other economies are lower, ranging from 75% in France to 45% in Germany.

9 Because our database is unlikely to capture lending within the NFC sector, in Graph 3 we compare our estimates with financial accounts aggregates calculated on a consolidated basis (ie comprising only lending between the financial sector and the NFC sector), where such data are available. The volume of lending within the NFC sector is equivalent to less than 10% of GDP for most of the countries in our sample. In France, however, lending between NFCs appears to exceed 60% of GDP according to national financial accounts data, although this encompasses intragroup trade credit and may therefore reflect a degree of double-counting (Sédillot (2013)).

10 There is no clear pattern to the discrepancies. For example, the omission of some lending by NBFIs could explain why we understate NFC credit in China. However, for the United States, where NBFIs are also an important source of credit, the estimate of total NFC credit in our database is similar to that from the US financial accounts.

Box B

Calculating credit exposures by sector

Since credit exposures by sector are not readily available on a cross-country basis, we construct a new database using a combination of market-based and bank-level data sources.

We measure corporate credit exposures as the sum of corporate bond capitalisation and bank loans. Sectoral bond data are available from a number of commercial data providers. For our database, we source corporate bond data from Wind and Bloomberg (for China) and Dealogic (for the other economies).

We construct bank loan exposures as follows. Where possible, we rely on information on corporate loans at a sectoral level published in the Pillar III reports which banks are required to file as part of their Basel III regulatory requirements. Where a sectoral breakdown of corporate loans is not available in Pillar III reports, we source this information from banks' annual reports or, for US banks, Securities and Exchange Commission 10K filings. We collect data for the 26 banks in the economies in our sample deemed to be global systematically important banks (G-SIBs) as well as domestic systematically important banks (D-SIBs) that account for at least 2% of total bank lending in their home jurisdiction. In total, we collect data for a sample of 62 banks, ranging in number from four for Australia to 10 for China.

Allocating bank-level exposures to countries and sectors requires a degree of judgment in three areas. The first is to allocate loans for banks that operate in more than one country. For the G-SIBs, we allocate corporate loans by country according to information on the geography of their total corporate loan portfolio, which is also published in their Pillar III reports. In doing so, we assume that the sectoral allocation of loans for each bank is the same in each economy in which it operates. For the D-SIBs, which typically have a smaller international footprint, we allocate all corporate loans to their home jurisdiction.

The second judgment is to allocate loans for banks that provide a less detailed sectoral breakdown than that used in our macroeconomic model. In cases where the sectoral breakdowns in Pillar III reports implicitly group a number of industries into a single residual category, often labelled "Other", we allocate these loans to all unreported industries according to those industries' shares of an economy's GDP. Similarly, in cases where the industry groups in the Pillar III reports are less detailed than those in the macroeconomic model (eg if a Pillar III report contains data for "Transport and trade"), we allocate the loans to the corresponding model-based industry categories according to the GDP shares of those industries

Third, we assume that the banks not covered in our sample behave proportionally to the average G- and D-SIBs, ie we assume that the uncovered portion of total assets in each banking system exhibits a similar sectoral credit allocation. As for D-SIBs, we allocate the loans of these banks entirely to their home jurisdictions.

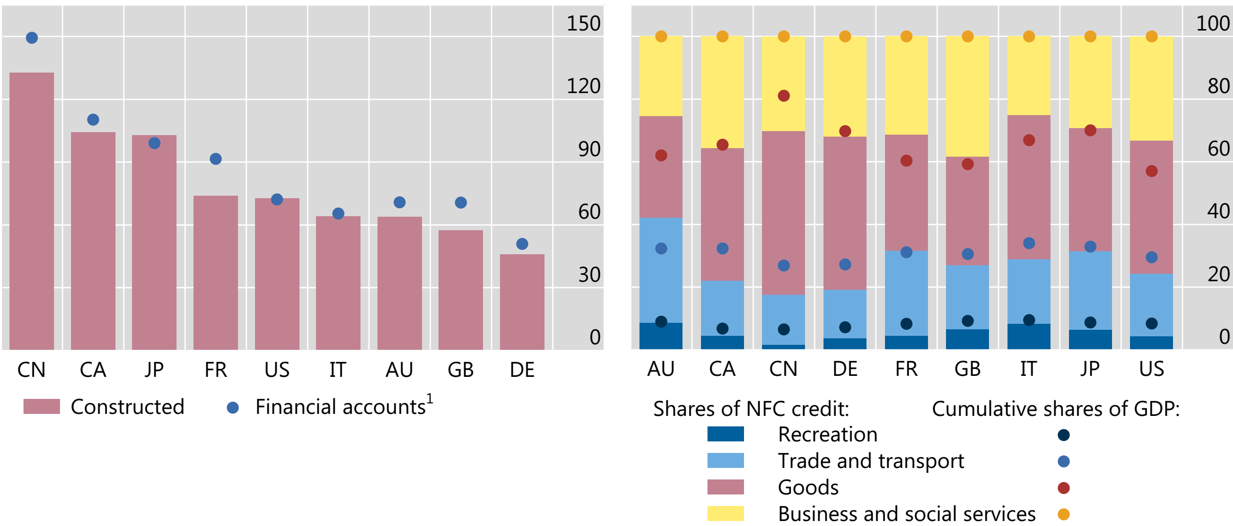
We verify the plausibility of the credit data that we have constructed in three ways. First, as discussed in the main text, the aggregate credit volumes that our database provides are comparable to those from national financial accounts data, which should capture all corporate borrowing in each economy.① Second, for France, Germany and Italy, we are able to compare our data with estimates of sectoral corporate liabilities from the Bank for the Accounts of Companies Harmonised (BACH) database from the European Committee of Central Balance Sheet Data Offices. Because the BACH data are constructed from firm balance sheets (ie debtors), they provide an independent cross-check on our estimates, which are constructed using information from markets and banks (ie creditors). For all three countries, the level and sectoral distribution of corporate liabilities in our database are similar to those in the BACH database. Third, for all nine countries we compare bank loans by industry in our database with data on bank loans from the balance sheets of listed firms, sourced from S&P. While the volume of bank loans in our database is somewhat larger than that from firm balance sheet data – as would be expected given that our data should also include borrowing by non-listed firms – the distribution of loans across sectors is very similar.

① Our aggregate estimates are also consistent with the private non-financial corporate credit data published by the BIS (Dembiermont et al (2013)) after accounting for the fact that the BIS data are recorded on a non-consolidated basis (ie include debt financing within the non-financial corporate sector), whereas our database considers only lending from the financial sector to the non-financial sector.

Corporate indebtedness varies across countries, but industry compositions are similar

As a percentage of GDP | Graph 3

Non-financial corporate credit | Share of corporate credit and GDP by broad industry groups



[1] For AU, DE, FR, GB and IT, NFC credit is calculated on a consolidated basis (ie excluding lending between NFCs). For CA, CN, JP and US, where consolidated data are not available, NFC credit is calculated on a non-consolidated basis.

Sources: OECD; BIS; authors' calculations.

At the sectoral level, the industries heavily affected by the pandemic account for a relatively small share of total debt (Graph 3, right-hand panel).[11] The recreation industry accounts for between 1.5 and 8% of NFC credit in the countries in our sample. Considering also the transport and trade industries raises the total share of customer services industries (ie the dark blue and light blue bars) to around 15–30% in most countries. This is lower than the share of credit exposure to goods industries, as well as business and social services industries, which both have generally been less affected by the pandemic than customer services.

The share of customer services industries in NFC credit is also smaller than their share of GDP in all countries other than Australia. Other things equal, this suggests that credit losses will increase by less following an economic downturn concentrated in customer services industries than they would if an economic downturn was concentrated in goods industries, whose share of total credit is typically larger than their share of overall GDP.

Our database also sheds light on the distribution of credit across financing instruments. With the exception of the United States and Canada, bank loans are the dominant source of NFC credit in the countries in our sample (Graph 4, left-hand panel). At the sectoral level, bank loans account on average for around 70% of financing for the recreation, transport and trade industries. This is larger than the share of bank loan financing for the manufacturing and utilities industries (below 60%), but lower than the shares for the construction and real estate industries

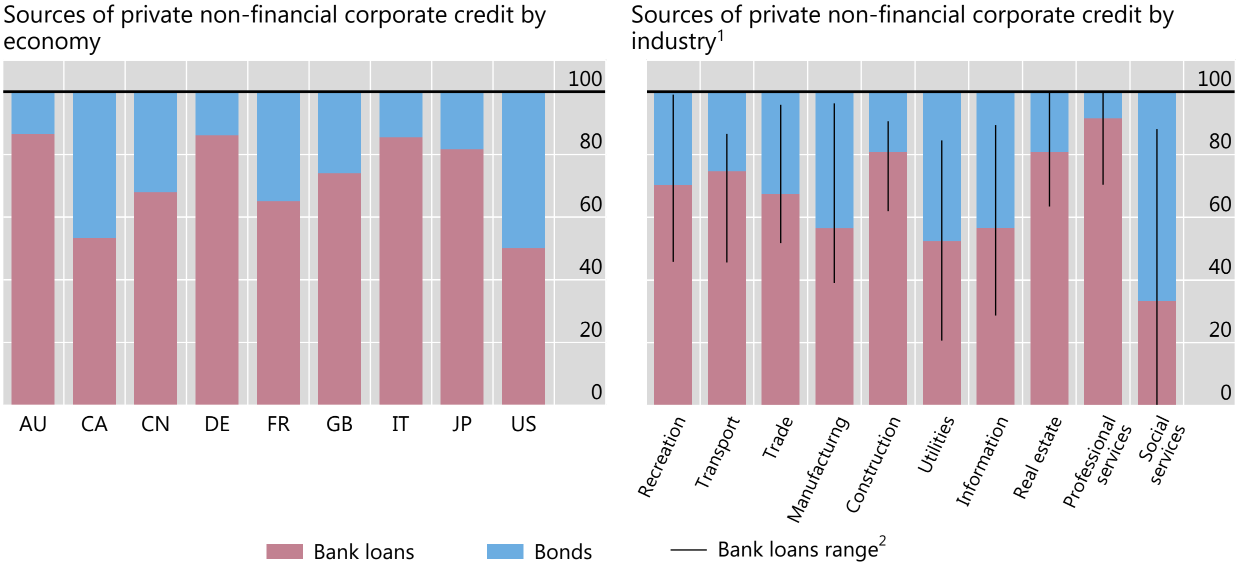
[11] In this graph, we separate "customer services industries" into recreation industries, which have been most severely affected by the pandemic, and tourism and trade, whose output declines have been smaller.

(around 80%). However, there are large differences across countries within each industry.

Sources of credit across countries and industries

In per cent

Graph 4



[1] Weighted average of the countries in the left-hand panel based on GDP and PPP exchange rates. [2] Maximum and minimum of bank loan share of total credit across countries.

Sources: Dealogic; authors' calculations.

Credit risk scenarios

We next assess the credit losses implied by our model's sectoral GDP paths. We base our calculations on estimates of the impact of economic activity on credit losses across a large sample of banking crises from the 1990s until the GFC by Hardy and Schmieder (2013) (see Box C for more information). That study documented that the GDP elasticities of credit loss rates (ie the percentage point change in credit loss rates for a 1 percentage point change in GDP paths during crises) increase with the depth of the recession. They also show that these elasticities tend to be fairly similar across advanced and emerging market economies. In this article, we assume that the elasticities are the same across industries.[12]

We take the average of two alternative GDP elasticities of credit loss rates put forth by Hardy and Schmieder (2013). The first purely reflects the depth of the Covid recession (ie the maximum drop of GDP relative to pre-pandemic levels, which is larger than during the GFC). The second also takes account of the cumulative

[12] Our calculations link sectoral credit loss *rates* exclusively to sectoral GDP paths and then use sectoral debt to transform these loss rates into aggregate credit losses. An alternative approach to account for the country- and sector-specific leverage of firms would be to use proportional changes of credit loss rates conditional on the changes in GDP growth, rather than using absolute changes (as we have in this study). While the two approaches deliver broadly similar estimates of credit losses at the aggregate level, some of the country and sectoral estimates differ. However, this alternative approach puts more emphasis on pre-crisis sectoral credit loss rates, for which no robust data are available (Box C).

Box C

Projecting credit losses

The credit loss projections are based on the estimates of the impact of output on credit loss rates reported in Hardy and Schmieder (2013, Table 4), applied to the sectoral output paths. These estimates are based on a sample of more than 10,000 banks from around 170 countries from 1990 to the GFC.

Hardy and Schmieder document that the effects of economic activity on credit loss rates are non-linear and can depend on both the depth of the recession and its cumulative severity. The following rule of thumb illustrates this non-linearity: in mild recessions (with a maximum drop of output growth of 2.4% relative to the baseline) each 1 percentage point drop in output growth implies roughly a 0.25 percentage point (ppt) increase in credit loss rates, while in severe recessions (with a maximum drop in output growth greater than 5 percentage points) this effect increases to around 0.5 ppt. The equivalent elasticities when applied to the cumulative change in GDP growth over four years are 0.125 ppt for a mild recession and 0.25 ppt for a severe recession. We apply the same elasticity of credit losses to both banks and bonds as well as to all sectors, using sector-specific output.

We use the depth of the recession to measure credit loss rates and set the elasticities on a continuous scale based on the change in output growth. To account for an unusually sharp bounce-back in activity of the Covid recession, in conjunction with substantial government support measures, we lower the elasticity to half way between the elasticities for the maximum drop in GDP growth and its cumulative deviation (eg around 0.375 for severe recessions). The resulting equation for the change in the credit loss rate is given by:

(1) $\Delta CreditLossRate_{i,j,t} = \Delta X_{i,j,t} \times \varepsilon\left(\Delta X_{i,j,t}\right)$

(2) $\Delta X_{i,j,t} = \frac{1}{2}\Delta Y_{i,j,t} + \frac{1}{2}\Delta Y_{i,j,t-1}$

where $\Delta CreditLossRate_{i,j,t}$ is the change in the credit loss rate in sector i in country j in year t, $\Delta X_{i,j,t}$ it the measure of output growth in the corresponding sector and $\varepsilon(\Delta X_{i,j,t})$ is the elasticity of credit loss rates, which is a function of output growth. Deeper drops in activity imply a higher elasticity. Equations (1) and (2) state that we project credit losses on the basis of the average growth rate of GDP (in a given sector and country) over the current and preceding year. This accounts for the observation that credit losses typically lag GDP by six to 12 months.

We calculate the change in credit losses by multiplying the projections of the change in credit loss rates by sectoral credit exposures. In addition to the sectoral credit loss rates, we calculate aggregate credit loss rates for each economy based on the aggregate output projections to put the sectoral data into perspective (Graph 6, right-hand panel).

In the online appendix accompanying this article, we provide the full set of aggregate and industry growth projections for each economy in our sample.

deviation of growth from trend (Box C).[13] As the Covid recession has been unusually deep but is likely to be fairly short-lived (conditional on policymakers (a) managing the distribution of vaccines and (b) containing the financial fallout), we balance the relative impact of depth and duration on the elasticity.[14]

Given sectoral output paths and loss rate elasticities, we proceed as follows. We assume that credit losses lag changes in GDP by six to 12 months, in line with evidence for bonds (eg Graph 6, left-hand panel) and bank credit (Hardy and Schmieder (2013)). We model the changes in sectoral credit loss rates that result from our projections of economic activity rather than the absolute levels of credit loss rates, as we do not have robust data on pre-pandemic credit loss rates at the sector level.

13 Hardy and Schmieder (2013) note that these two estimates are fairly aligned for many previous crises, since the depth of a recession is typically correlated with the cumulative deviation of growth from trend. The Covid recession is unusual in this regard, as much of the decline in activity that occurred in Q2 2020 was reversed in Q3 2020.

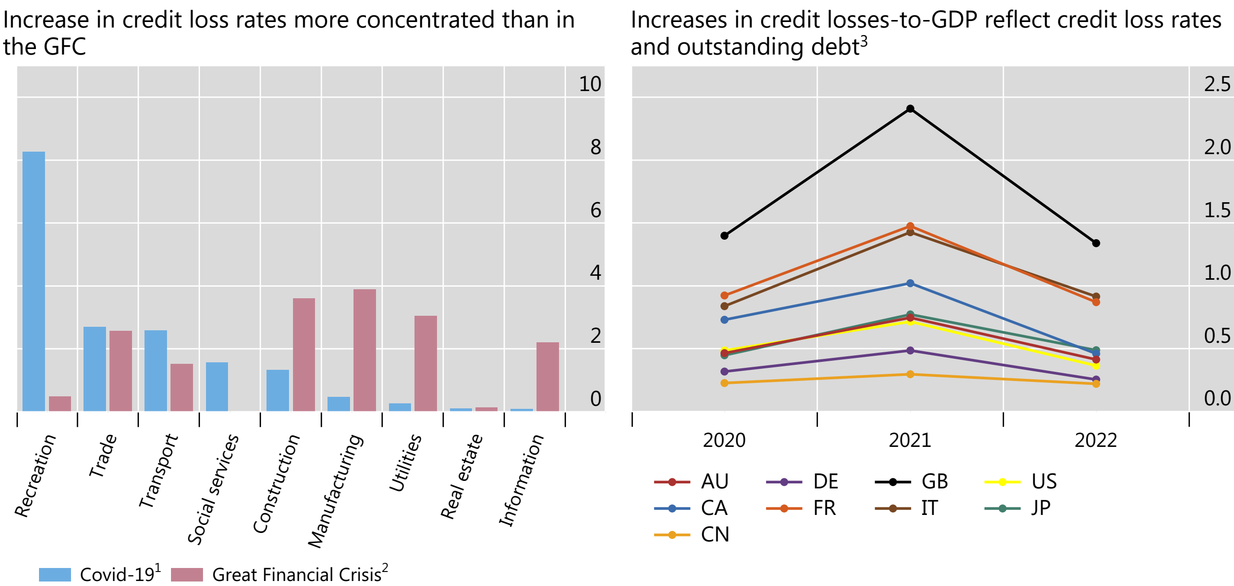
14 Using a lower elasticity is also a way to account for the cushioning effects of public policies that aim to support corporates and limit their financial distress.

Based on this method, the sectors whose activity contracts the most suffer the largest increases in credit loss rates. Credit loss rates in the recreation industry are projected to increase by more than 8 percentage points on average during 2020–22 compared with the pre-crisis period, while the trade, transport and social services industries are expected to see increases in loss rates of between 1.5 and 3 percentage points (Graph 5, left-hand panel, blue bars). In contrast, loss rates in the information & communications, real estate[15] and utilities industries are projected to increase by less than 0.2 percentage points.

The projected dispersion of credit losses across sectors is wider than our approach would have predicted during the GFC (given actual changes in sectoral output growth in that episode), when NFC credit losses were more balanced across industries (Graph 5, left-hand panel, red bars). Also, because credit losses increase more than proportionally with output shortfalls, the dispersion of loss rates by industry is projected to be wider than the dispersion in sectoral output growth.

Projected non-financial corporate credit losses by sector and country

In percentage points — Graph 5



[1] Increase of projected credit loss rates during crisis (average during 2020–22) from pre-crisis level (average during 2018–19) based on projected sectoral growth rates. Since we do not have actual bank losses for 2020 yet, we use projected loss rates for the entire year. [2] Increase of projected credit loss rates during GFC (average during 2008–10) from pre-GFC level calculated by applying Hardy and Schmieder (2013) elasticities to observed sectoral growth rates. [3] Sectoral credit losses weighted by the total indebtedness of the NFC sector as a percentage of GDP using the methodology described in Box C.

Source: Authors' calculations.

For individual countries, the unevenness of the crisis in terms of depth, timing and cumulative impact at the sectoral level (Graph 2) leads to different patterns of credit losses. Country-level credit losses as a share of GDP peak in 2021 at between 0.4 and 2.4 percentage points above their pre-Covid levels (Graph 5, right-hand panel) with an average increase of 1 percentage point. The estimated increase in credit losses is largest in the United Kingdom, followed by Italy and France, in line

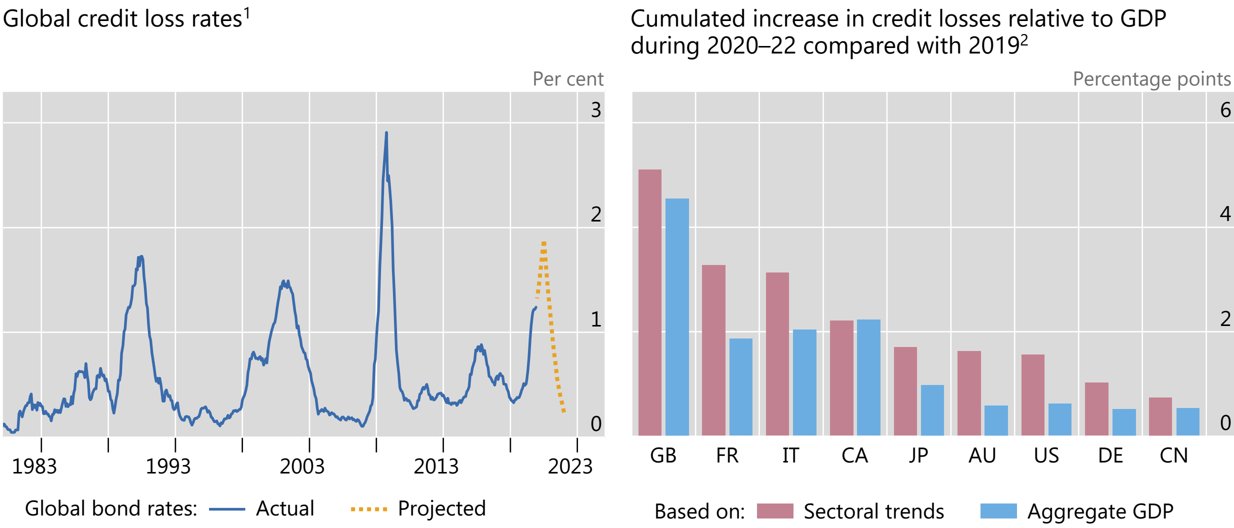
[15] In our analysis, the real estate sector captures the activities of firms involved in the sale, rental or management of real estate. Credit losses related to falls in real estate prices will be attributed to the sectors of the firms that own the property.

with their more adverse GDP paths (Graph 2, left-hand panel) and their high share of severely impacted sectors. The increase in credit losses is most contained in China. Cumulated over the 2020–22 period, the increases in credit losses due to the pandemic amount to between 0.7% of annual GDP in China and 5.1% in the United Kingdom.

Cross country variation in credit losses reflects differences in sectoral output paths and pre-existing credit exposures. For example, aggregate credit losses as a share of GDP are projected to be lower in Germany than in the US despite similar GDP paths, because credit exposures to customer service industries are smaller in Germany. Similarly, projected credit losses in the UK are larger than in France and Italy, despite similar initial sectoral credit exposures, because of the UK's less favourable output trajectory.

Despite the substantial increases in credit losses for some countries and industries, we estimate that *aggregate* credit loss rates could rise by less than during the GFC.[16] Graph 6 (left-hand panel) illustrates this, showing projected global aggregate credit losses for bonds[17] (for which we have a long time series, unlike for sectoral bond and bank credit). We project that credit loss rates for bonds will peak at 1.9% in 2021. These are below the levels that occurred at the height of the GFC (2.9%). Loss rates increase by less than during the GFC because the industries affected by the pandemic account for a relatively small share of total corporate borrowing[18]

Credit losses could increase by less than during than GFC, but more than aggregate GDP projections would imply — Graph 6



[1] Global bond loss rates (default rates times stressed losses-given-default, where LGDs are based on Hardy and Schmieder (2013)) available till end-November 2020 are projected forward to 2021 and 2022 based on the global GDP path (as of IMF WEO, October 2020) using the methodology described in Box C. [2] Cumulated increase of credit losses during 2020–22 compared with pre-crisis level based on sectoral credit losses (see also right-hand panel in Graph 5) and country-level aggregates.

Sources: IMF, *World Economic Outlook*; Moody's CreditEdge; Moody's Investor Service; S&P Capital IQ; authors' calculations.

[16] Our estimates suggest that total corporate credit *losses* as a share of GDP in the current episode could rise by less than during the GFC, although the difference is smaller than for loss *rates* because total corporate debt has increased over the intervening period.

[17] We refer to defaulted bonds rather than mark-to-market losses.

[18] The GFC saw large credit losses in industries such as manufacturing with relatively large credit exposures. In contrast, the industries most affected by the Covid pandemic have smaller credit exposures.

and because public support measures are likely to translate into a smaller increase in credit losses than is typically the case (Graph 3, right-hand panel) (Box C).[19]

Our estimates, which take sectoral developments into account, are larger than the ones obtained on the basis of country-level GDP forecasts (Graph 6, right-hand panel). This is because of the uneven nature of the recession at a sectoral level combined with the fact that credit losses increase more than proportionately with the depth of the recession. The use of aggregate numbers would hide potential vulnerabilities, particularly for Australia, Germany and the United States. These differences may be even more important at the level of individual banks or asset managers with particularly large exposures to the most severely hit sectors.

As with the sectoral output projections, our projected credit losses, which amount to about $1 trillion above what would have been expected in the absence of the pandemic, are subject to considerable uncertainty.[20] Because credit losses increase more than proportionally with GDP shortfalls, differences in macroeconomic outcomes could cause credit losses to be materially higher or lower than our estimates. There is also uncertainty about how economic outcomes will translate into credit losses, particularly given the substantial public support measures introduced early in the pandemic to limit business failures. We acknowledged these support measures,[21] as well as the unusually rapid recovery in activity in the second half of 2020, by applying lower GDP elasticities of credit losses (Box C). Without this adjustment, our credit loss projections would be roughly 50% greater.

Conclusion

Our analysis suggests that the effects of the Covid pandemic on corporate insolvencies and resulting credit losses are only starting to be felt. Based on our sectoral GDP projections, in a plausible central scenario we find that corporate credit losses during 2020–22 could be equivalent to about three times the pre-crisis level on average across the G7, China and Australia. The additional credit losses emerging from the crisis during the three-year period would cumulate to slightly above 2% of annual GDP or $1 trillion. Any such losses would be borne by financial intermediaries, investors or taxpayers.

Our scenario also suggests that, conditional on the assumptions underlying our analysis and abstracting from the fiscal support costs, corporate credit loss rates could remain below those observed during the GFC. This is because the current downturn is concentrated in corporate sectors that account for a smaller share of output and debt than those most affected by the GFC.

As is natural in any exercise of this type, our estimates come with a number of caveats, as they are based on some constraining assumptions, notably due to data

[19] We account for the effect of public support measures by lowering the elasticities of credit loss rates with respect to GDP.

[20] Our estimates of aggregate credit losses are broadly consistent with other studies that have estimated pandemic-induced increases in corporate losses, after accounting for differences in scope, timing and concept. S&P (2021) estimates global bank credit losses of about $1.8 trillion for 2020 and 2021 (ie about $0.4–0.5 trillion per year in aggregate for the countries in our sample), and Moody's (2020) projects similar corporate bond default rates to our estimates in Graph 6.

[21] The assessment of the cost and benefit of such measures and their legacy on public debt is beyond the scope of this article.

limitations. The only variable assumed to influence credit losses is GDP, so that the analysis does not consider factors such as the creditworthiness of firms, eg related to their leverage, or the structure of their debt, eg related to maturity (debt is purely a scaling factor), or the degree of possible overvaluation in asset prices, eg commercial real estate. Indeed, in contrast to the GFC, when household debt was at the core of the problems, on this occasion the signs of overstretched balance sheets are in the corporate sector, with strong increases in corporate indebtedness in conjunction with declining credit ratings in many key jurisdictions pointing to a reduction in creditworthiness (BIS (2020)). In addition, the estimates abstract from possible amplifying mechanisms within the financial sector: while banks are in better shape than at the time of the GFC, greater signs of risk-taking have been evident in market-based finance (eg Aramonte and Avalos (2019)). Relatedly, even though our estimates of the effect of GDP shortfalls on credit loss rates are applied to all forms of credit, they are based only on historical evidence from bank loss data. These limitations naturally make it harder to draw inferences.

The most important lesson of our exercise is that the design of top-down stress tests should take account of the sectoral profile of the recession. This is because credit exposures differ across industries and credit loss rates increase more than proportionately with output declines, our industry-based credit loss estimates are larger than estimates based on aggregate GDP data alone. The sectoral macroeconomic projections used in this article, which are available in an online appendix, could be useful inputs in this regard, and inform the level of loss projections. We intend to revise them periodically to account for economic developments as well as the ongoing race between vaccines and mutations of the virus. Our framework, which is straightforward to implement and update as new information arises, could be a useful complement to existing public stress testing exercises carried out periodically. It allows running sensitivity analyses that can account for both the dynamic nature of the crisis and for alternative policies that handle weaknesses in the corporate sector. Using better data, the approach could also be extended in a number of dimensions, along the lines mentioned above.

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