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Definitions and Conventions

As used in this report, the term "country" does not in all cases refer to a territorial entity that is a state as understood by international law and practice. As used here, the term also covers some territorial entities that are not states but for which statistical data are maintained on a separate and independent basis.

In this report, the following groupings are used:

- "ASEAN-5" comprises Indonesia, Malaysia, Philippines, Singapore and Thailand.
- "AE" refers to advanced economies comprising Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.
- “Emerging Asia” comprises Asian economies such as China, Hong Kong, India, Indonesia, Malaysia, Singapore, South Korea and Thailand.
- “EM” refers to emerging economies comprising EM Asia economies as well as Argentina, Brazil, Chile, Columbia, Czech Republic, Hungary, Mexico, Poland, Russia, Saudi Arabia, South Africa and Türkiye.
- “Eurozone” comprises Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain.

Abbreviations used for financial data are as follows:

- Currencies: Australian Dollar (AUD), British Pound (GBP), Chinese Yuan (CNY), Euro (EUR), Hong Kong Dollar (HKD), Indian Rupee (INR), Japanese Yen (JPY), Korean Won (KRW), Malaysian Ringgit (MYR), New Taiwan Dollar (TWD), New Zealand Dollar (NZD), Singapore Dollar (SGD), Thai Baht (THB), US Dollar (USD).

Other abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>AE</td>
<td>Advanced Economy</td>
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<td>BCBS</td>
<td>Basel Committee for Banking Supervision</td>
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<td>BIS</td>
<td>Bank for International Settlements</td>
</tr>
<tr>
<td>BoE</td>
<td>Bank of England</td>
</tr>
<tr>
<td>CAPE</td>
<td>Cyclically Adjusted Price-to-earnings Ratio</td>
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<tr>
<td>CAR</td>
<td>Capital Adequacy Ratio</td>
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<td>Credit Bureau Singapore</td>
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<td>Central Counterparty</td>
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<td>CET1</td>
<td>Common Equity Tier 1</td>
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<td>Collective Investment Scheme</td>
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<td>CO</td>
<td>Commodity</td>
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</tr>
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<td>Credit</td>
</tr>
<tr>
<td>DDSR</td>
<td>Depository Trust &amp; Clearing Corporation Data Repository (Singapore) Pte Ltd</td>
</tr>
<tr>
<td>DeFi</td>
<td>Decentralised Finance</td>
</tr>
<tr>
<td>Acronym</td>
<td>Full Form</td>
</tr>
<tr>
<td>---------</td>
<td>-----------</td>
</tr>
<tr>
<td>DOS</td>
<td>Singapore Department of Statistics</td>
</tr>
<tr>
<td>D-SIB</td>
<td>Domestic Systemically Important Banks</td>
</tr>
<tr>
<td>EBITDA</td>
<td>Earnings Before Interest, Tax, Depreciation and Amortisation</td>
</tr>
<tr>
<td>ECB</td>
<td>European Central Bank</td>
</tr>
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<td>EDB</td>
<td>Economic Development Board</td>
</tr>
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<td>EM</td>
<td>Emerging Markets</td>
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<td>EME</td>
<td>Emerging Market Economy</td>
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<td>EPG</td>
<td>Economic Policy Group</td>
</tr>
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<td>EQ</td>
<td>Equity</td>
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<td>ESG</td>
<td>Enterprise Singapore</td>
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<td>FCI</td>
<td>Financial Conditions Index</td>
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<td>Financial Institution</td>
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<td>Financial Stability Board</td>
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<td>FSR</td>
<td>Financial Stability Review</td>
</tr>
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<td>FVI</td>
<td>Financial Vulnerability Index</td>
</tr>
<tr>
<td>FX</td>
<td>Foreign Exchange</td>
</tr>
<tr>
<td>FY</td>
<td>Fiscal Year</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GFC</td>
<td>Global Financial Crisis</td>
</tr>
<tr>
<td>GLS</td>
<td>Government Land Sales</td>
</tr>
<tr>
<td>HDB</td>
<td>Housing Development Board</td>
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<td>HHI</td>
<td>Herfindahl-Hirschman Index</td>
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<tr>
<td>ICR</td>
<td>Interest Coverage Ratio</td>
</tr>
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<td>IG</td>
<td>Investment Grade</td>
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<td>IMF</td>
<td>International Monetary Fund</td>
</tr>
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<td>IOSCO</td>
<td>International Organization of Securities Commissions</td>
</tr>
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<td>IPCC</td>
<td>Intergovernmental Panel on Climate Change</td>
</tr>
<tr>
<td>IR</td>
<td>Interest Rate</td>
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<td>IWST</td>
<td>Industry-Wide Stress Test</td>
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<td>LCR</td>
<td>Liquidity Coverage Ratio</td>
</tr>
<tr>
<td>LGD</td>
<td>Loss Given Default</td>
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<tr>
<td>LTD</td>
<td>Loan-to-deposit Ratio</td>
</tr>
<tr>
<td>LTV</td>
<td>Loan-to-value Ratio</td>
</tr>
<tr>
<td>MAS</td>
<td>Monetary Authority of Singapore</td>
</tr>
<tr>
<td>MLA</td>
<td>Minimum Liquid Asset</td>
</tr>
<tr>
<td>MSD</td>
<td>Macroprudential Surveillance Department</td>
</tr>
<tr>
<td>NBFI</td>
<td>Non-bank Financial Institution</td>
</tr>
<tr>
<td>NCD</td>
<td>Negotiable Certificate of Deposit</td>
</tr>
<tr>
<td>NFC</td>
<td>Non-financial Corporate</td>
</tr>
<tr>
<td>NGFS</td>
<td>Network for Greening the Financial System</td>
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<tr>
<td>NIM</td>
<td>Net Interest Margin</td>
</tr>
<tr>
<td>NPL</td>
<td>Non-performing Loan</td>
</tr>
<tr>
<td>NUS-CRI</td>
<td>National University of Singapore Credit Research Initiative</td>
</tr>
<tr>
<td>O&amp;G</td>
<td>Oil &amp; Gas</td>
</tr>
<tr>
<td>OCR</td>
<td>Outside of Central Region</td>
</tr>
<tr>
<td>OECD</td>
<td>Organisation for Economic Co-operation and Development</td>
</tr>
<tr>
<td>OIF</td>
<td>Offshore Insurance Fund</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-------------</td>
</tr>
<tr>
<td>OTC</td>
<td>Over-the-counter</td>
</tr>
<tr>
<td>PD</td>
<td>Probability of Default</td>
</tr>
<tr>
<td>PSTASSA</td>
<td>Professional, Scientific, Technical, Administrative, Support Service Activities</td>
</tr>
<tr>
<td>q-o-q</td>
<td>Quarter-on-quarter</td>
</tr>
<tr>
<td>RBC 2</td>
<td>Revised Risk Based Capital Framework</td>
</tr>
<tr>
<td>RHS</td>
<td>Right Hand Side</td>
</tr>
<tr>
<td>ROA</td>
<td>Return on Assets</td>
</tr>
<tr>
<td>RWA</td>
<td>Risk-weighted Assets</td>
</tr>
<tr>
<td>SGS</td>
<td>Singapore Government Securities</td>
</tr>
<tr>
<td>SGX</td>
<td>Singapore Exchange</td>
</tr>
<tr>
<td>SIF</td>
<td>Singapore Insurance Fund</td>
</tr>
<tr>
<td>SME</td>
<td>Small and Medium-sized Enterprise</td>
</tr>
<tr>
<td>SORA</td>
<td>Singapore Overnight Rate Average</td>
</tr>
<tr>
<td>STI</td>
<td>Straits Times Index</td>
</tr>
<tr>
<td>TDSR</td>
<td>Total Debt Servicing Ratio</td>
</tr>
<tr>
<td>URA</td>
<td>Urban Redevelopment Authority</td>
</tr>
<tr>
<td>y-o-y</td>
<td>Year-on-year</td>
</tr>
</tbody>
</table>
Preface

The Monetary Authority of Singapore (MAS) conducts regular assessments of Singapore’s financial system to identify potential vulnerabilities and review its resilience to potential shocks and risks. The analyses and results are published in the annual Financial Stability Review (FSR), which aims to contribute to a better understanding of issues affecting Singapore’s financial system among market participants, analysts and the public.

Section 1 of the FSR provides a discussion of the risks in the external environment. This is followed by an analysis of the Singapore corporate and household sectors in Sections 2 and 3 respectively. A review of the financial sector is then provided in Section 4. The final section features specific topics on financial stability.

The production of the FSR is coordinated by the Macroprudential Surveillance Department (MSD) team of the Economic Policy Group (EPG) that comprises Ang Wei Han, James Cui, Fan Jia Rong, Cheryl Ho, Khoo Ye-Min, Koh Zhi Xing, Sherwin Lau, Eugene Lee, Wendy Lee, Leou Jie Dong, Aloysius Lim, Kalena Lim, Low Yen Ling, Lye Royii, Ng Heng Tiong, Desmond Ong, Alex Phua, Edward Robinson, Scott Roger, Celine Sia, Tan Shu Yan, Tan Siang Meng, Tan Yii Ling, Teoh Shi-Ying and Davis Yep. Box E was done in collaboration with the BIS Innovation Hub Singapore Centre. Special Feature 3 was prepared in consultation with Professor Amit Seru, the Steven and Roberta Denning Professor of Finance at the Stanford Graduate School of Business.

The FSR also includes contributions from other MAS departments including Banking Departments I & II, Capital Markets Intermediaries Department II, Economic Analysis Department, Economic Surveillance & Forecasting Department, Enterprise Knowledge Department, Insurance Department, Markets Policy & Infrastructure Department, Payments Department and Prudential Policy Department.

The FSR may be accessed in PDF format on the MAS website:

Overview

Global financial stability risks have intensified amid tighter financial conditions and the worsening growth-inflation nexus

Risks to the global financial stability outlook have intensified, as economies contend with tighter financial conditions, higher inflation and slowing growth. Heightened geopolitical tensions and the attendant impact on supply chain disruptions, as well as economic and financial fragmentation, add further downside risks to the conjuncture.

The most immediate risk is a potential dysfunction in core international funding markets and cascading liquidity strains on non-bank financial institutions that could quickly spill over to banks and corporates. Tighter financial conditions and highly volatile markets could give rise to liquidity imbalances that central banks and fiscal authorities need to adequately address to avoid precipitating a disorderly liquidation of assets.

With a less favourable macrofinancial backdrop, debt sustainability of vulnerable households and corporates could come under stress, leading to a deterioration in banks’ asset quality. Increasing global risk aversion could cause a further pullback of external financing for emerging market economies. However, compared to previous crises, both banks and Emerging Asia are generally better positioned to manage these risks.

Vulnerabilities associated with physical and transition risks from climate change have continued to materialise. At the same time, notwithstanding the currently limited systemic impact, vulnerabilities in the global crypto-asset ecosystem remain pertinent.

Domestic indicators of financial vulnerabilities have edged up, as Singapore confronts a trifecta of risks to financial stability

Amid weakening external demand, the Singapore economy is projected to slow to a below-trend pace in 2023. Inflation is expected to remain elevated, underpinned by a strong labour market and continued pass-through from high imported inflation. The ongoing tightening in financing conditions further increases the debt servicing burden for borrowers. This trifecta of risks could be amplified upon interaction with prevailing vulnerabilities, posing liquidity and credit risks to the financial system.

Domestic indicators of vulnerability for the corporate, household and financial sectors have edged higher, mostly due to the unwinding of pandemic-induced precautionary buffers. Credit demand and loans extended have also picked up with the recovery from the COVID-19 downturn.
The Financial Vulnerability Index (FVI) is calibrated according to deviations from its historical distribution and divided into five coloured bands, which reflect varying degrees of y-o-y change. An increase/decrease in the FVI indicates that vulnerability has risen/fallen over the previous year.

<table>
<thead>
<tr>
<th>Sector</th>
<th>y-o-y change as of</th>
<th>2021</th>
<th>2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Corporate FVI</td>
<td>Q2(^1)</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Overall Household FVI</td>
<td>Q3</td>
<td>→</td>
<td>↓</td>
</tr>
<tr>
<td>Overall Banking FVI</td>
<td>Q3</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

Corporate vulnerability to shocks has increased slightly. While this partly reflects the normalisation of precautionary liquidity balances, maturity risk of debt has also edged up. Nonetheless, firms have sufficient liquidity reserves to cover short-term liabilities. Leverage risk has eased as corporate sector debt as a share of GDP has fallen. Foreign currency mismatch risk has remained stable as Singapore firms continue to avoid overreliance on foreign currency borrowings.

Household vulnerabilities have risen moderately over the past year. As households took on more property loans, leverage risk rose slightly but remained within the same distributional band as the previous year. Maturity risk increased as households accumulated more short-term debt (proxied by credit card borrowings) given the pick-up of discretionary spending with the re-opening of the economy.

Overall banking vulnerability has increased over the past year, largely driven by rising leverage vulnerabilities as banks’ balance sheets expanded alongside the recovery in economic activity. While liquidity vulnerabilities edged up slightly due to a decline in excess buffers held during the worst of the pandemic, maturity vulnerabilities remained low. Fund managers have weathered heightened market volatility and have been able to meet redemptions in an orderly manner.

The economy’s overall resident credit-to-GDP ratio declined from 179% in Q3 2021 to 169% in Q3 2022, driven primarily by an increase in nominal GDP levels. Accordingly, the resident credit-to-GDP gap remained negative in Q3 2022. MAS will maintain the Countercyclical Capital Buffer (CCyB) at 0% for 2023.

Singapore’s corporate, household and financial sectors should stay vigilant in the face of more challenging macrofinancial conditions

MAS’ stress tests suggest that the corporate and household sectors are resilient to macrofinancial shocks. The strengthening of firms’ financials during the recovery from the pandemic should help to cushion the impact of these shocks, while Singapore’s household sector is assessed to have sufficient positive equity and liquidity to mitigate downside risks in the event of falling asset values and rising debt servicing costs.

\(^1\) Based on latest available data.
However, there are small specific segments that are more leveraged or have weaker cashflows, and they may encounter difficulties in servicing their debt. Corporates and households should maintain heightened vigilance and prudence in the management of their cashflows and balance sheets. Firms should continue to ensure adequate buffers, including having sufficient liquid assets and efficiently managing the maturity of their debt. Households should be prudent with their finances, especially when committing to large financial obligations such as mortgage loans, to have some cushion against the further tightening of financial conditions that is expected in the coming quarters.

Banks in Singapore have emerged from the pandemic with strong capital positions. The results of stress tests underscore that they would remain resilient to adverse macrofinancial shocks from a sharp tightening of monetary policy amid a global economic downturn. Nevertheless, banks should actively monitor and manage their credit risk as tighter financial conditions faced by firms and households could place pressure on banks’ asset quality. Banks and fund managers should also strengthen their liquidity profiles to guard against the risk of liquidity frictions that arise from imbalances in key funding markets.

Macroprudential Surveillance Department, Economic Policy Group
Monetary Authority of Singapore
25 November 2022
1 Global Macrofinancial Environment

A worsening growth-inflation nexus confronts the global economy. Growth is expected to slow sharply over the next year, while inflation is likely to remain significantly above many central banks’ targets. The ongoing Russia-Ukraine war continues to generate uncertainty in the outlook for commodity prices and supply chains.

Most central banks have tightened their policy stances decisively to counter domestic inflation pressures and spillovers from commodity price shocks. Policy interest rates have risen sharply in most countries, and the US dollar has appreciated strongly.

Firms, households, fiscal authorities, and financial markets are having to contend with significantly higher inflation and interest rates than have been seen for many years, as well as a weaker and uncertain macroeconomic outlook. In the near term, the greatest risks to financial stability may centre on the operations of financial markets and non-bank financial institutions (NBFIs) that are less closely regulated. The functioning of key financial markets could be impaired if liquidity imbalances, due to sharply tightened financial conditions or heightened risk aversion, are not adequately addressed. Disorderly deleveraging or sales of assets could result, reinforcing the deterioration in market conditions. NBFIs, especially those with significant leverage or liquidity mismatches, are more vulnerable to such shocks, and could amplify the destabilising effects, increasing systemic risk.

The risk that inflation and interest rates could be higher for longer than previously expected will exacerbate the debt burdens of vulnerable households and businesses, putting stresses on banks. However, banks are better positioned than in the Global Financial Crisis (GFC) to manage these credit risks and absorb losses.

Emerging markets (EMs) are not insulated from the exceptionally global macroeconomic shocks. Accordingly, they may be particularly vulnerable to increases in risk aversion and a further pullback of financing in world markets. In recent months, there has already been evidence of investment outflows arising from the faster pace of monetary policy tightening in advanced economies (AEs), and pressures could intensify as global activity and EM export revenues weaken. Generally, EM Asia has stronger foreign exchange reserves, better-capitalised banks and more developed debt markets to weather market volatility than during the GFC.

These financial stability risks have not developed into systemic stresses. Nevertheless, it is important to be prepared for these stress events and watch for shocks that could trigger them. An even more protracted tightening of monetary policy to lower inflation runs the risk of a deeper, longer economic downturn globally, which would amplify financial stresses for households, firms, governments and financial institutions (FIs). There is also a possibility that risk aversion could induce liquidity shortfalls in key financial markets and a cascading sequence of financial disruptions. These events could be compounded by an intensification of ongoing physical and transition risks associated with climate change, as well as further
fragmentation or deglobalisation of financial markets, supply chains, and international trade. Vulnerabilities in the global crypto-asset ecosystem also remain pertinent, notwithstanding their limited systemic impact currently.

Authorities will need to remain vigilant and be ready to use the tools at their disposal to support the orderly functioning of markets, address undue volatility in capital flows, or provide targeted support for those most adversely affected by an economic downturn. Credible fiscal and macroeconomic policies are key to ensuring sovereign debt sustainability, maintaining market confidence and anchoring financial stability.

1.1 Global financial developments and vulnerabilities

Global financial markets are adjusting to higher interest rates amid heightened uncertainty over the economic outlook

Since the 2021 FSR, global financial conditions have generally tightened (Chart 1.1). In response to sharp increases in inflation, most central banks, particularly outside of EM Asia, have raised policy rates rapidly to above pre-pandemic levels (Chart 1.2).

The shift in monetary policy stances globally, as well as the uncertainties and risks associated with the Russia-Ukraine war, has significantly affected global financial markets. Widespread repricing of assets across markets has followed both the rise in interest rates and increased investor risk aversion arising from greater uncertainty over the macroeconomic outlook. Market volatility across equity, bond, and foreign currency markets has risen and remains elevated relative to historical trends (Chart 1.3). The cyclically adjusted price-to-earnings (CAPE) ratios of AE and EM Asia equity indices have sharply declined, reflecting the fall in equity prices, though valuations in AEs remain somewhat above their long-term average (Chart 1.4). Corporate bond spreads have widened since the start of the year, but their measured increase thus far suggests room for further correction if more pronounced credit concerns arise (Chart 1.5). Meanwhile, the rapid pace of monetary policy tightening in AEs has induced capital outflows from EMs and a significant weakening of their currencies this year (Chart 1.6).

Higher interest rates, falls in asset prices, increased risk premia, and an exceptionally uncertain outlook for global macroeconomic, geopolitical, and financial conditions will adversely affect sovereign, corporate, and household borrowers. This poses potentially systemic financial stability risks. However, reforms made over the 15 years since the GFC have greatly strengthened the resilience of systemically important banks worldwide. Of principal concern at this juncture is the vulnerability of financial markets and NBFIs, which have played a major role in intermediating risk in recent years.
**Chart 1.1** Financial conditions have tightened in the past year…

Financial conditions indices

- US
- Eurozone
- Other AEs
- EM Asia ex-China
- Latin America
- EM Europe

Source: International Monetary Fund (IMF)

**Chart 1.2** … amid higher policy rates

Central bank policy rates

Source: Haver Analytics, MAS estimates

Note: Data are simple averages of central bank policy rates in each region. EM Asia excludes Singapore.

**Chart 1.3** Market volatility remains above historical averages

Market volatility indices

- Equity
- FX
- Bonds (RHS)

Source: Bloomberg

Note: VIX index is used for equity market volatility, JPMorgan FX volatility index for FX volatility, and MOVE index for bond market volatility. Dashed lines indicate the averages over 2008–2022.

**Chart 1.4** Equity CAPE ratios have fallen, alongside the sharp repricing in equities

MSCI equity indices: CAPE ratio

Source: Bloomberg

Note: Dashed lines indicate the averages over 2008–2022.
Global Macrofinancial Environment

Market funding dysfunction could arise from liquidity pressures

The confluence of heightened uncertainty about the economic outlook and geopolitical-related risk aversion will continue to test the resilience of key funding markets. Market functioning could be adversely affected in the event of a disorderly retrenchment in risk appetite, brought about by increased demand for collateral and heightened risk aversion between counterparties.

As major central banks pursue rate hikes and balance sheet normalisation, there has been an attendant draining of liquidity from domestic money markets. A key financial stability concern is the potential scarcity of reserves due to the unwinding of asset purchase programmes in some countries, which is taking place at an unprecedented scale amid heightened market volatility (Chart 1.7). Banks may not have sufficient reserves to effectively intermediate core funding markets and continue to provide credit lines to NBFIs and corporates. The functioning of underlying asset markets may also be impaired with the loss of central banks as a major source of demand. Stressed market conditions could further impair core market functioning. This self-reinforcing downward spiral could lead to a disruptive tightening of financing conditions for the real economy.

Broader liquidity imbalances could arise as market makers pull back from the provision of liquidity in response to heightened risk aversion, macroeconomic uncertainty, and tighter financial conditions. Spikes in liquidity demand, for example triggered by market volatility to meet margin calls, may give rise to disorderly deleveraging or liquidation of assets by market participants, exacerbating risk aversion and market volatility. In turn, this would result in lower market liquidity and greater hedging costs for the real economy. The outbreak of the Russia-Ukraine war, for example, disrupted global trade in commodities, leading to extreme volatility and price surges for certain commodities. The resulting sharp increase in energy prices in

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Please see “Special Feature C: Liquidity Dependence” of the October 2022 Issue of MAS’ Macroeconomic Review for further discussion.
Europe meant that many energy producers faced significant margin calls on their derivative hedges, leading to systemic concerns of insufficient liquidity at these firms. While prices have moderated to some extent since, commodity markets generally remain volatile (Chart 1.8). Lingering economic uncertainty and continued geopolitical tensions raise the risk of further bouts of volatility in commodity markets.

**Chart 1.7** Liquidity has worsened across government bond markets

Bloomberg sovereign bond liquidity indices

<table>
<thead>
<tr>
<th>Index</th>
<th>US Treasuries</th>
<th>UK Gilts</th>
<th>Japan JGBs</th>
<th>German Bunds</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>2020</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>2021</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>2022</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>Nov</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

Source: Bloomberg

**Chart 1.8** Commodity prices have moderated to some extent but remain volatile

Selected commodity prices

<table>
<thead>
<tr>
<th>Index (Jan 2019=100)</th>
<th>Brent</th>
<th>Natural Gas</th>
<th>Wheat</th>
</tr>
</thead>
<tbody>
<tr>
<td>2019</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>2020</td>
<td>150</td>
<td>150</td>
<td>150</td>
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<tr>
<td>2021</td>
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<td>200</td>
<td>200</td>
</tr>
<tr>
<td>2022</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Nov</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
</tbody>
</table>

Source: Bloomberg

Amid this backdrop of heightened risk, understanding the role of NBFIs has grown in importance. As noted in the Financial Stability Board’s (FSB) 2021 Global Monitoring Report on Non-Bank Financial Intermediation, NBFIs’ share of global assets represented 48% of the global financial system’s assets as of end-2020, up from 42% as of end-2008. Recent events in financial markets, such as the “dash-for-cash” episode in March 2020, the failure of family office Archegos, and the stress in the UK government bond market driven by pension funds engaging in liability-driven investing, have highlighted the vulnerabilities across a variety of markets and non-bank market participants.

One key risk is the liquidity mismatch faced by open-ended funds, which offer end-investors greater liquidity than that of the assets in which they invest. This liquidity mismatch can exacerbate the risk of runs in times of stress, incentivising end-investors to make redemptions early without necessarily bearing the cost of this enhanced liquidity. In addition, many types of NBFIs, especially funds, engage in derivatives trading to achieve varying degrees of leverage and enhance returns. Derivatives trading increases liquidity risk through the need to post margin, and volatile markets can create “doom-loops” of margin calls and asset sales. MAS continues to develop its toolkit to assess these risks (see Box A “Monitoring Financial Stability Risks in the Over-the-counter Derivatives Markets”).

Should liquidity stresses emerge that threaten severe disruption to core funding markets, central banks should step up as market makers of last resort. Targeted and temporary interventions aimed at smoothing volatility would help avoid a breakdown in market functioning, without obstructing the necessary tightening of monetary policy to deal with the inflationary pressures in the economy.
Banks’ vulnerability to corporate and household financial stresses is mitigated by stronger risk management

A key source of risk for banks is the vulnerability of corporates and households to adverse shocks. Financial strains on households and businesses present credit risks for banks through rising non-performing loans (NPLs). Such risks may be mitigated by diversifying lending portfolios, careful risk assessment, and maintaining ample capital buffers. Since the GFC, banks have been adhering to stricter Basel regulatory standards, improving their risk management practices, devolving risky non-core business lines, and increasing their capital buffers, thus significantly strengthening their resilience. The adoption of higher and more forward-looking financial reporting standards for banks and corporates, under the International Financial Reporting Standards 9 (IFRS9), also strengthened risk monitoring. Nonetheless, banks remain exposed to the fortunes of corporates and households, particularly in current circumstances where the global nature of supply shocks and the synchronisation of monetary policy responses limits the benefits of portfolio diversification.

Corporate borrowers are vulnerable to a loss of earnings and deterioration in cash positions, as tighter monetary conditions dampen demand, and business costs rise due to increased input and labour costs. Further, the cost of funding for corporates could be accentuated by higher credit risk premia. Companies heavily dependent on market-sourced liquidity could also be vulnerable to disruption in those markets.

Highly leveraged companies are particularly vulnerable, as are those with unhedged currency mismatches between production and sales, or those exposed to ongoing supply chain problems or geopolitical fragmentation of demand. Small and medium-sized enterprises (SMEs) may also be more vulnerable than larger borrowers, as they are likely to have weaker buffers and hence more likely to encounter loan repayment difficulties in the event of short-term cash flow shocks.

While credit to corporate borrowers has remained fairly stable in AEs since the GFC, there has been a substantial increase in corporate borrowing in EMs over the same period (Chart 1.9). Corporate borrowers in EMs are facing more rapid increases in borrowing costs than in AEs, as some loans are denominated in USD (Chart 1.10).
Banks are also exposed to a deterioration in the financial positions of households. Household cashflows are already being pressured by sharp increases in food and energy prices, as well as higher borrowing costs. Monetary policy tightening is likely to lead to higher unemployment and a dampening of wage growth in some countries, putting additional pressure on households’ ability to service their debts. Banks in AEs are more vulnerable to household financial distress than in EMs, but the gap has narrowed significantly over the past decade, especially for Asian EMs (Chart 1.11).

A particular concern at this juncture is the potential for a sharp correction in property prices in some jurisdictions. Underpinned by low interest rates, house prices have increased dramatically over the past decade in both AEs and EMs, and have driven housing affordability to historic lows in many countries. However, prices have weakened since early 2022 (Chart 1.12), as higher borrowing costs and a more uncertain economic outlook have weighed on property demand. A substantial decline in property prices would reduce the creditworthiness of households. Additionally, it could have important negative wealth effects on household consumption, accentuating the economic downturn. Lower property prices also generally have an adverse impact on the construction sector and its access to bank financing, as seen during the GFC and more recently in China.
To assess the vulnerability of banks to potential financial distress among their corporate and household customers, many authorities have worked with FIs to stress test their loan portfolios. At the same time, some governments have also deployed fiscal packages targeted at supporting vulnerable segments while avoiding adding to inflationary pressures.

The significant buffers built up by banks would help to mitigate the impact of a deterioration in asset quality, limiting the spillovers to the broader financial system (Chart 1.13). Bank asset quality has improved in recent years, with their NPL ratios below historical averages (Chart 1.14). Banks have also reported improvements in interest income, supported by rising interest rates. That said, in an adverse scenario where banks experience significant credit losses on their loan exposures, there could be a sharp withdrawal in lending, further adding to the slowdown in global economic activity.
Fiscal sustainability concerns could spill over into broader financial instability

After soaring during the COVID-19 pandemic, public debt in many economies has stabilised at rates well above those prior to 2020 (Chart 1.15). At the same time, sovereign borrowing costs have risen rapidly this year (Chart 1.16). Going forward, the combination of high debt levels and interest rates will place further strains on public finances. Slower growth and additional fiscal measures required to address cost-of-living pressures could also further weaken sovereign debt sustainability. A worsening of debt sustainability beyond critical thresholds could trigger increases in sovereign credit risk premia, and could spill over to private sector borrowing costs. Moreover, as seen earlier this year in the UK, concerns with the financing of large fiscal deficits can also lead to sharp market adjustments. Such volatility may trigger a surge in liquidity demand arising from the need to post more collateral for derivatives, leading to one-sided markets and disorderly liquidation of assets by market participants to the detriment of market functioning.
Capital outflows and weakening currencies risk exacerbating EMEs’ debt vulnerabilities

As EM economies are heavily reliant on external funding, continued outflows of non-resident capital and attendant weakening of their currencies could lead to higher default risks. Weaker domestic currencies would increase the local currency cost of unhedged foreign currency denominated debt and diminish debt servicing capabilities, particularly if there are currency mismatches between revenues and liabilities. Depreciation of their currencies would also lead to higher imported inflation. To mitigate these risks, EM central banks may be compelled to tighten monetary policy more aggressively beyond domestic considerations alone. The resulting increases in interest rates and slowing of growth will further strain balance sheets.

The volatility of capital flows to EM economies could be exacerbated by the growing role of NBFIs. NBFIs, and investment funds in particular, represent a significant share of non-resident portfolio holdings (i.e. foreign holdings of equities and bonds) in EM markets. A growing body of literature has been studying the links between investment funds and capital flows to EM economies. Although causation is difficult to establish, empirical evidence suggests that a greater presence of investment funds in EM markets is associated with capital flows driven more by global financial sentiment than by local factors. For example, sudden global shocks could trigger fire sales of EM assets by fund managers looking to cover end-investor redemptions in AE markets.

In EM Asia, countries’ external vulnerabilities are partially mitigated by the accumulation of strong foreign currency reserve positions that can be deployed in foreign exchange intervention during periods of stress. The use of other policy tools, such as macroprudential...
and appropriate capital flow measures, when necessary, may also reduce the need for EM Asia central banks to tighten monetary policy aggressively to mitigate external vulnerabilities. More generally, the development of local currency debt markets and better-capitalised banking systems in the years since the GFC have also increased economies’ resilience to capital flight. That said, the external macrofinancial environment remains highly challenging, putting buffers under continuing pressure. Credible and sustainable macroeconomic policy responses, and adequate foreign exchange reserves to meet short-term liabilities, will be key in anchoring market confidence and safeguarding financial stability.

1.2 Emerging global vulnerabilities from climate change, deglobalisation and crypto-assets have increased

There has been encouraging progress made in assessing the financial stability implications of climate change

The Intergovernmental Panel on Climate Change (IPCC) recently highlighted in its Sixth Assessment Report that climate change has already caused “substantial damages and increasingly irreversible losses” and that approximately 3.3 to 3.6 billion people “live in contexts that are highly vulnerable to climate change”. This is a timely reminder to policymakers to give sufficient policy attention to the existential threat posed by climate change, amid the heightened near-term macroeconomic and financial stability risks.

Central banks, supervisors and FIs have made significant efforts to improve their climate risk assessment capabilities. This year, MAS conducted a climate scenario analysis exercise for selected key banks and insurers as part of the 2022 Industry-Wide Stress Test (IWST). Drawing on proprietary and regulatory datasets, MAS also conducted an internal analysis of the potential implications of climate risks for non-financial corporates (NFCs) under the scenario pathways featured in the IWST (see Special Feature 1 “Assessing the Impact of Climate Change on Financial Stability”).

Deglobalisation, or fragmentation, has grown in importance and could be financially disruptive

In recent years, there has been a political backlash against globalisation of trade in goods and services, largely reflecting concerns of its effect on wages, employment, and the environment. Increasingly, the pushback against globalisation has been compounded by the desire to strengthen national resilience of supply chains and more broadly national security, especially since the Russia-Ukraine war. Deglobalisation or fragmentation could include sustained unravelling of international financial linkages and trade integration, and the introduction of new uncertainties into international economic relationships and rules. Moves in these directions could prove to be profoundly disruptive for businesses as well as for financial markets and FIs, with adverse consequences not only for global growth, but also for financial stability.
Vulnerabilities in crypto-assets and the global crypto ecosystem are increasingly pertinent

Crypto-asset markets have fallen precipitously this year, with their market capitalisation falling from a peak of USD2.8 trillion in November 2021 to USD900 billion in October 2022. Recent events, including the collapse of crypto exchanges, have also highlighted how the failure of a key international crypto entity can lead to contagion within the global crypto-asset ecosystem. While these developments have not significantly affected the broader global financial system due to its limited linkages to crypto-assets, they have demonstrated some of the fragilities in the global crypto-asset ecosystem. Given the crypto-asset ecosystem’s potential for rapid growth, its associated vulnerabilities and their implications for global financial stability warrant continued close monitoring and commensurate regulation (see Special Feature 2 “Financial Stability Implications of the Global Crypto-asset Ecosystem”).
2 Singapore Corporate Sector

Economic activity in Singapore expanded modestly in the third quarter of 2022, with the re-opening of the economy boosting industries which were laggards in the recovery. As of Q3 2022, domestic GDP was 7% above its pre-COVID level in Q4 2019, and had returned to its pre-pandemic trajectory, i.e., the level of GDP envisaged before the onset of COVID-19 in January 2020. As such, firms have continued to see improvements in earnings.

However, the challenging macroeconomic environment is increasing pressures on corporates worldwide. Firms, including in Singapore, are contending with a trifecta of risks—a more rapid tightening of financing conditions, a sustained rise in input costs, and a sharp slowing in growth—which could weigh on their cash flows as well as profit margins, thus weakening their debt servicing ability.

Firms’ vulnerability to shocks—as measured by the corporate sector FVI in Q2 2022—has risen slightly. This was partly due to the unwinding of some of the previous precautionary liquidity balances built up during the pandemic. Maturity risk of their debt has also edged up, although firms continue to hold sufficient liquidity to cover short-term liabilities. Leverage risk has eased as corporate debt as a share of GDP has fallen from its elevated levels during COVID-19. Foreign currency mismatch risk has remained stable as Singapore firms continue to avoid overreliance on foreign currency borrowings.

Looking ahead, the macroeconomic risks are likely to continue into 2023. Domestically, projected growth outcomes across sectors are also likely to remain uneven amid a slowdown. Nevertheless, the strengthening of firms’ financials over the past year would provide some cushion should risks materialise. MAS’ stress tests also suggest that generally, firms would still have adequate buffers to mitigate the impact of shocks to revenue, input costs and cost of financing. However, corporates with highly leveraged positions and smaller firms with weaker cash reserves would be at risk if they face continuing cost pressures as their revenue growth slows.
2.1 Financing conditions in Singapore

Domestic financing conditions have tightened over the past year

Domestic financing conditions have tightened over the past year in tandem with global trends, as major central banks hiked interest rates aggressively to bring down inflation (Chart 2.1). In Singapore, the 3-month Compounded Singapore Overnight Rate Average (SORA) rose sharply in 2022 from decade-low levels in 2021. Spreads of investment-grade corporate bonds issued by Singapore-based firms also widened in 2022. Bank credit to corporates has remained strong, though lending conditions are expected to tighten in the coming months. Banks have expressed concerns that rising interest rates and inflationary pressures could affect firms’ cashflows and hence their debt servicing abilities. Conversely, equities prices continued to rise over the past year, with the Straits Times Index (STI) surpassing pre-pandemic levels as of Q3 2022 (Table 2.1).

Against this backdrop, the corporate sector’s debt-to-GDP fell from 156% in Q2 2021 to 149% in Q2 2022 (Chart 2.2). While corporate debt increased by 5.7% from Q2 2021 to Q2 2022, nominal GDP rose at a faster pace of 11.2% y-o-y in the same period.

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4 MAS conducted a survey of banks in September 2022 to seek their views on the prevailing credit conditions and expectations over Q4 2022 and Q1 2023.
### Table 2.1 Indicators of domestic financing conditions

<table>
<thead>
<tr>
<th></th>
<th>Q4 2019</th>
<th>Q1 2020</th>
<th>Q3 2021</th>
<th>Q3 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Domestic FCI (standard deviation from mean)</td>
<td>−0.52</td>
<td>0.45</td>
<td>−0.32</td>
<td>0.07</td>
</tr>
<tr>
<td>3-month Compounded SORA (%)</td>
<td>1.37</td>
<td>1.15</td>
<td>0.13</td>
<td>1.45</td>
</tr>
<tr>
<td>10-year SGS yields (%)</td>
<td>1.74</td>
<td>1.57</td>
<td>1.42</td>
<td>2.92</td>
</tr>
<tr>
<td>STI (index)</td>
<td>3188.7</td>
<td>3004.4</td>
<td>3117.9</td>
<td>3210.1</td>
</tr>
<tr>
<td>CEMBI investment-grade + SG spread* (bps)</td>
<td>113.0</td>
<td>120.7</td>
<td>101.8</td>
<td>139.1</td>
</tr>
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</table>

Source: MAS, Bloomberg, J.P. Morgan Markets

Note: Figures are quarterly averages.

* This measure is computed by J.P. Morgan Markets as the spread of the yield of USD corporate bonds over the yield of the US Treasury bond.

### 2.2 Assessment of vulnerabilities

Leverage risk has eased marginally with the continued improvement in corporate profitability

Leverage risk eased marginally over the past year with a further broad-based recovery in corporate earnings. However, firms’ profit margins could decline in the period ahead amid challenging macroeconomic conditions. Corporate profitability of Singapore Exchange (SGX)-listed firms, measured by their return on assets (ROA), continued to recover with externally-oriented firms exceeding pre-pandemic levels and domestic-oriented firms approaching pre-pandemic levels (Chart 2.3). The improvement was broad-based across sectors, with the exception of the hotels & restaurants and construction sectors (Chart 2.4). Nevertheless, the hotels & restaurants sector is expected to be boosted by further increases in visitor arrivals, including a pick-up in Meetings, Incentives, Conventions and Exhibition (MICE) activities. While supply-side constraints continue to weigh on the construction sector’s growth, activity is likely to pick up further in the second half of 2022 and into 2023, supported by a strong pipeline of projects. In particular, contracts awarded in the civil engineering and residential segments have returned to pre-COVID levels since 2021.

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5 Average monthly air passengers carried more than tripled in Q2 2022 from Q1 and rose further by 41% in Q3. This represented a significant increase from Q1 2022 having 15% of pre-COVID (Q4 2019) average monthly air passengers carried, to 76% in Q3 2022. Hotel occupancy rates also rose by 12 percentage points to 73% in Q2 2022 from Q1, and further to 80% in Q3 2022.
Debt servicing ability of firms are generally healthy, with most sectors having sufficient financial buffers

Alongside the improvement in corporate profitability, the debt servicing ability of firms, measured by their interest coverage ratio (ICR), has remained healthy. The median ICR of all SGX-listed firms rose from 2.8 in Q2 2021 to 3.3 in Q2 2022, indicating that firms had comfortable buffers to service their annual interest payments (Chart 2.5).

In view of higher interest rates and slower growth, the debt servicing ability of firms could weaken somewhat in the coming quarters, though the ICR of firms are expected to remain well above one. This indicates they have sufficient operating profits to cover their interest expenses.
Chart 2.5 Debt servicing ratios remained healthy

Median ICR of SGX-listed firms

<table>
<thead>
<tr>
<th>Year</th>
<th>Construction</th>
<th>Hotels &amp; Restaurants</th>
<th>Property</th>
<th>Overall</th>
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<tbody>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2017</td>
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<tr>
<td>2022</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Thomson Financial, MAS estimates

Liquidity risk rose slightly while maturity risk was kept manageable

The liquidity risk of the corporate sector, measured by the median current ratios and median cash coverage ratios of all SGX-listed firms, edged up this year as firms normalised the precautionary cash buffers that they built up during the pandemic (Charts 2.6 and 2.7). Specifically, the increase was due to a lower median cash coverage ratio, which had eased from the high levels seen in 2021. Firms continued to maintain adequate cash balances to cover their short-term liabilities—as at Q2 2022, the median cash coverage ratio remained considerably higher than pre-pandemic levels. However, these buffers could be reduced going forward under continuing cost pressures and waning revenue growth, such that firms with weaker balance sheets could come under further liquidity stresses.

Liquidity profiles of firms varied across sectors, reflecting their mixed performance. While liquidity ratios in most sectors are currently at or exceeding pre-pandemic levels, the liquidity ratios of the hotels & restaurants, construction and property sectors have yet to fully recover.

Maturity risk increased marginally, as the proportion of short-term debt to total debt rose, although still remaining below pre-pandemic levels of 43% in Q4 2019 (Chart 2.8). Further, the bond maturity profile of Singapore firms also remained well termed out, with bonds due by 2023 making up less than 10% of total outstanding bonds as of Q3 2022.
**Chart 2.6** Current ratios have normalised and stayed adequate in 2022...

Median current (current assets to current liabilities) ratios of SGX-listed firms

Source: Thomson Financial, MAS estimates

**Chart 2.7** ...as have cash coverage ratios

Median cash coverage (cash to short-term debt) ratios of SGX-listed firms

Source: Thomson Financial, MAS estimates

**Chart 2.8** Short-term debt to total debt ratios have risen marginally in 2022

Median short-term debt to total debt ratios of SGX-listed firms

Source: Thomson Financial, MAS estimates
Foreign currency mismatch risk remained stable

As a share of total bonds issued in Singapore, the foreign currency denominated proportion has remained around 60% since 2018, indicating a stable risk profile. Further, such foreign currency bond issuances were by firms with global operations, which are naturally hedged for foreign currency exposure. A sizeable proportion of such firms’ revenues are denominated in foreign currency, while their foreign currency liabilities would generally reflect the need to fund their operations in other countries or support transactions that are typically priced in the major currencies. For firms with less diversified business lines or those needing to hedge their foreign exchange risks, they have been able to rely on the deep and liquid FX market in Singapore to hedge their FX exposure. Based on the 2022 Bank for International Settlements (BIS) Triennial Central Bank Survey, Singapore’s FX daily average turnover with non-financial customers in April 2022 was about USD24 billion. This is equivalent to about USD6 trillion in annual terms, or about five times the value of total annual trade (export and import of goods and services) in 2021.

Corporate NPL ratio has continued to fall over the past year⁶

Overall asset quality remains healthy, with the banking system’s corporate NPL ratio falling from 3% in Q3 2021 to 2.3% in Q3 2022. By sector, the transport & storage and construction sectors have continued to register relatively higher NPL ratios of 7.0% and 6.3%, respectively, although this is an improvement from last year.

Firms’ probability of default have been relatively low and stable

As introduced in the 2021 FSR, MAS adopted the Probability of Default (PD) indicator as a more market-relevant and timely metric to enhance corporate surveillance.⁷ The PDs of Singapore corporates have remained relatively stable around their long-term averages in 2022 (Chart 2.9). This suggests that the vulnerability of Singapore corporates is not an immediate and material concern, even though estimated PDs have shown a slight rising trend in recent months.

Focusing on sectors of interest, the utilities and oil & gas (O&G) firms were significantly affected by soaring commodities prices caused by the Russia-Ukraine war. This resulted in a steep rise in their PDs earlier this year. Although their PDs have moderated slightly in recent months, they remain more volatile than other sectors (Chart 2.10). Construction firms, which continue to be plagued by supply-side challenges, have also been experiencing a rising trend in their PDs.

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⁶ For more details, see Chapter 4 “Singapore Financial Sector”.
⁷ For more details, see “Special Feature 3: Enhancing Corporate Surveillance with Probability of Default Model” in MAS’ 2021 FSR.
2.3 Analysis of SMEs’ financial position

Smaller firms in sectors experiencing a more protracted recovery are more vulnerable

MAS has enhanced its analysis of the financial position of corporates, covering both SGX-listed firms and unlisted firms, the latter of which comprise mostly SMEs. The focus of corporate surveillance has shifted from a short-term liquidity perspective (taken during the pandemic) to also include the longer term debt servicing ability of firms, which is especially pertinent given the rising interest rate environment. Specifically, the assessment of firms’ financial resilience considered three measures: debt servicing ability, cash relative to ongoing operational costs (or “cash buffers”), and cash to current liabilities (or “cash cover”).

MAS found that the proportion of SMEs that are vulnerable is 30 percentage points more than that for large firms. This finding was similarly observed over the past two years. By sector, the accommodation and retail sectors have a higher proportion of vulnerable SMEs. Notwithstanding the tailwinds from the re-opening of the economy, the recovery of these two sectors remains incomplete. Smaller firms in these sectors could still come under pressure, given their smaller balance sheets and relatively limited access to capital markets amid the challenging macroeconomic environment.

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8 MAS also conducted a more detailed and holistic firm-level analysis on the financial and productivity performance of corporates in Singapore. A key finding was that the overall corporate landscape was dominated by financially resilient firms. About 80% of the firms in Singapore were assessed to be financially resilient based on a similar set of thresholds relating to their debt servicing ability, cash cover and cash buffer. For more details on this analysis, please see Section 2.3 of the October 2022 Issue of MAS’ Macroeconomic Review.

9 A firm is assessed to be vulnerable if all three ratios—debt servicing ability (profit before tax over liabilities), cash cover and cash buffer—are below EPG-MSD’s internal threshold.

10 Compared to the rest of the economy, these sectors have a higher proportion of vulnerable firms (by about 5–7 percentage points), with significantly lower liquidity ratios.
Although the majority of the firms in Singapore are financially resilient, risks posed by non-resilient firms still warrant close monitoring. The latent vulnerability of such firms, though limited, could increase amid the ongoing headwinds of rising interest rates, higher input costs and slower economic growth.

**Bank lending to SMEs remained supportive in 2022**

Bank loans to SMEs expanded over the past year by 8.7% as of Q3 2022. This is faster than the overall corporate sector loan growth of 3.3% (see Chart Panel 2A “Small and Medium-sized Enterprise Financing Conditions”).

The NPL ratio for SMEs has also fallen over the past year. However, banks recognise the headwinds from interest rate rises and persistent inflation, which could increasingly affect the profitability of firms—particularly SMEs, which typically have leaner buffers.¹¹

## 2.4 Outlook

**The business outlook is mixed across sectors**

Singapore’s economic growth is likely to stay restrained in the coming quarters. The economy is projected to slow further to a below-trend pace in 2023, weighed down by the externally-oriented sectors amid weaker global demand conditions. This is reflected in the sentiments among manufacturing firms. In the Q4 2022 Business Expectation Survey by the Economic Development Board (EDB), a net weighted balance of 20% of manufacturers anticipated a less favourable business situation for October 2022 to March 2023 compared to the third quarter of 2022 (Chart 2.11). Sentiments have worsened from the net weighted balance of −8% recorded in the previous survey (for July to December 2022) and +16% for the same period last year (October 2021 to March 2022).

Within the manufacturing sector, the transport engineering cluster is the most optimistic, with a net weighted 36% of firms expecting an improved operating environment, led by strong demand in the aerospace segment, as well as improved sentiments in the land transport segment. However, the rest of the clusters have a less sanguine view as firms continue to face supply chain challenges and operational cost pressures from the Russia-Ukraine war and COVID-19 measures in China, amidst overall weaker macroeconomic conditions. The electronics sector is the most pessimistic, with a net weighted balance of 37% of firms projecting business conditions to weaken in the period October 2022 to March 2023, compared to conditions in the third quarter of 2022. This comes as the global electronics cycle enters a downturn, with consumer demand for electronic devices in Singapore’s top two final-demand markets—China and the US—already contracting, and the domestic semiconductor industry also grappling with higher energy costs.

In comparison, the Q4 2022 Business Expectations Survey by the Singapore Department of Statistics (DOS) found that business expectations among firms in the services sector

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¹¹ Based on the same survey as set out in footnote 4.
continued to be positive for the period of October 2022 to March 2023, with a net weighted balance of 9% of firms predicting a favourable business situation (**Chart 2.11**).

Within the services sector, all segments except wholesale trade and real estate expressed optimism in business conditions in the coming months. The near-term prospects for the domestic-oriented and travel-related sectors remain strong amid the re-opening of the economy and the recovery in tourist arrivals. At the same time, wholesalers cited declining demand, notably for computers, computer peripheral equipment and software, while real estate developers were concerned about the impact from the latest round of property cooling measures, in addition to rising interest rates.

**Chart 2.11** The outlook for Services is net positive in the six months ending March 2023, while that for Manufacturing has turned net negative

General business outlook for Manufacturing & Services sector (net weighted balance*)

Source: DOS, EDB

Note: The latest data point (based on surveys conducted from September to October 2022) refers to the business outlook for October 2022 to March 2023.

* "Net weighted balance" is the difference between the weighted percentages of respondents with a positive outlook and those with a negative outlook. A positive percentage indicates a net positive outlook and a negative percentage indicates a net negative outlook.

**MAS’ enhanced stress test suggests that Singapore’s corporate sector as a whole would be resilient against more severe shocks**

In view of the challenging macroeconomic environment, MAS’ corporate stress test has been enhanced to incorporate a more adverse stress scenario consisting of three concurrent shocks to firms’ interest expense and earnings—higher interest rates, higher input costs, and a fall in demand due to weak GDP growth.

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12 A 400bps increase in interest rates from Q2 2022 levels was assumed in the stress scenario, based on the trajectory of the rising rates.

13 To assess the impact of input price shocks, sensitivity of firms’ margins to these input prices were first calibrated based on the economic linkages captured in DOS’ 2019 Input-Output tables. The shocks—a 20% rise in energy prices and continued strong wage growth from recent trends—were then applied to the sectors to obtain the impact on earnings. The derived earnings shocks were then applied to firms’ earnings before interest, tax, depreciation and amortisation (EBITDA).

14 A uniform 10% fall in earnings (EBITDA) across sectors was assumed as an impact of the demand shock assumption, similar to the economy-wide decline in past crises.
Overall, even under more adverse stress conditions, MAS’ enhanced stress test on the balance sheets of SGX-listed firms suggests that most corporates would still be resilient in the face of interest rate and earnings shocks, with cash reserves providing additional buffers. The percentage of firms-at-risk (defined as having a ratio of EBITDA to interest expense of less than one) increases from 26% to 35% of all corporates, and their share of debt-at-risk increases from 5% to 33% (Chart 2.12). However, after taking net cash reserves and hedging into consideration, the shares of firms-at-risk and debt-at-risk drop to 13% and 6% respectively.

Chart 2.12 Most Singapore corporates would withstand simultaneous adverse shocks on interest rate and earnings

Firms with ICR below one, as shares of total corporate debt and of total firms

However, highly leveraged firms should remain vigilant to downside risks amidst the challenging macroeconomic environment.

Although Singapore-listed corporates’ balance sheets have largely remained healthy, firms’ profit margins are expected to be squeezed as rising input costs weigh on corporate profitability amid the slowdown in growth. Tightening financing conditions on top of weakened profitability could impair firms’ debt servicing ability, with highly leveraged firms especially vulnerable.

Against the heightened uncertainty, firms should ensure adequate buffers to mitigate various risks. This includes efficiently managing the maturity of their debt obligations, reducing leverage and increasing liquidity buffers. Increased financial resilience would help firms tide over the challenging macroeconomic environment ahead.
Chart Panel 2A  Small and Medium-sized Enterprise Financing Conditions

Lending conditions for SMEs have remained supportive with growth in both the number and amount of loans extended over the past year.

Chart 2A1 SME loans outstanding

Chart 2A2 SME customers

Source: MAS

The Property and Development of Land sector accounts for the largest share of SME loans.

Chart 2A3 SME loans by sector (as of Sep 2022)

Source: MAS

The share of outstanding SME loans secured by property has fallen.

Chart 2A4 Outstanding SME loans by type of collateralisation

Source: MAS survey

Despite the uncertain macroeconomic environment, the SME NPL ratio has fallen over the past year.

Chart 2A5 SME NPL ratio

Source: MAS survey

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15 The new MAS Notice 610/1003 was implemented in July 2021 as part of changes to MAS’ regulatory reporting requirements. As data definitions have shifted, certain indicators are not comparable with historical periods (pre-July 2021) and the new MAS Notice 610/1003. MAS’s survey results have been aligned to match the revision in definitions. Please refer to the Data Annex in MAS’ 2021 FSR for details.
3 Singapore Household Sector

Household sector balance sheets in Singapore strengthened further in the first three quarters of 2022. Healthy net wealth positions (assets less liabilities) and liquidity buffers (cash and deposits less liabilities) were supported by continued robust employment gains and strong wage growth. However, with higher interest rates and increased downside risks to growth, the resilience of more leveraged households could be tested in the period ahead.

Household financial vulnerabilities—as measured by the FVI—increased in Q3 2022. Maturity risk was higher relative to the previous year as households took on more short-term debt (proxied by credit card borrowings). Household leverage risk also rose slightly but remained within the same band as last year.

<table>
<thead>
<tr>
<th>Household sector FVI (y-o-y changes)</th>
<th>Q3 2021</th>
<th>Q3 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Household FVI*</td>
<td>→</td>
<td>↗</td>
</tr>
<tr>
<td>Leverage risk</td>
<td>→</td>
<td>→**</td>
</tr>
<tr>
<td>Maturity risk</td>
<td>↓</td>
<td>↗</td>
</tr>
</tbody>
</table>

*The extent of risk is classified by band thresholds.
**While leverage risk remained within the same band in Q3 2022, the level of the indicator was slightly higher due to sustained loan growth and the increase in property prices.

Looking ahead, Singapore’s household sector is assessed to have sufficient positive equity and liquidity to mitigate downside risks in the event of falling asset values and rising debt servicing costs. MAS’ stress test suggests that most households should remain financially resilient even under conservative scenarios of significant income losses and a full pass-through of sharp interest rate hikes. Non-performing mortgage loans are expected to remain low.

However, segments of vulnerabilities exist, with households that are more leveraged or have higher expenditures relative to income likely to face difficulties in debt servicing; such households tend to be in the lower income deciles and have limited financial buffers. Households should therefore exercise prudence in their finances, including mortgage loan obligations, to cushion against tightening financial conditions ahead.
3.1 Assessment of household sector balance sheet

Aggregate household net wealth is strong...

The household sector’s net wealth remained strong over the past year, rising by 7.5% y-o-y to SGD2.5 trillion in Q3 2022, supported by continued growth in residential property assets (Chart 3.1). Residential property assets contributed 5.3 percentage points to the overall 6.9% y-o-y growth of total household assets in Q3 2022 (Chart 3.2).

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**Chart 3.1** Aggregate household net wealth remained strong

![Net Wealth vs % of GDP over time](chart)

Source: DOS, MAS estimates

**Chart 3.2** Growth in household assets was driven by the increase in residential assets

![Percentage contribution of asset types](chart)

Source: DOS, MAS estimates

...although the normalisation in personal savings rates may moderate its rate of growth

The personal savings rate\(^{16}\) declined to 35% in Q3 2022 after peaking at 40% in Q1 2021 (Chart 3.3). This reflected the strong growth in private consumption expenditure with the easing of COVID-related restrictions. As noted in MAS’ October 2022 Macroeconomic Review, overall private consumption expenditure has returned to pre-pandemic levels.

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\(^{16}\) Personal savings refer to the amount of funds available after consumption and before the purchase of assets, and is derived from the difference between personal disposable income and personal consumption expenditure on goods and services.
3.2 Assessment of leverage risk

Household debt has grown over the past year, albeit at a slower pace following the property market measures implemented in December 2021

Household sector debt continued to grow, underpinned by sustained growth in housing loans. However, the y-o-y growth rate has slowed since hitting a peak of 7.4% in Q4 2021, (Chart 3.4), as the December 2021 property market cooling measures moderated the pace of increase in housing demand and concomitantly that of mortgages taken up. As a share of Personal Disposable Income (PDI), aggregate household sector debt eased further to 1.3 times in Q3 2022, driven by strong wage growth relative to the increase in household debt (Chart 3.5).

Chart 3.3 The personal savings rate has declined with the easing of COVID-related restrictions

Personal savings rate

Source: DOS, MAS estimates

Chart 3.4 Growth of household debt has moderated over the past few quarters

Household debt in Singapore

Source: DOS, MAS estimates

Chart 3.5 The ratio of household debt-to-PDI eased further in Q3 2022

Household debt-to-PDI in Singapore

Source: DOS, MAS estimates
Housing loans have seen sustained growth since 2021

Housing loans remained the key driver of the rise in household debt, contributing 2.7 percentage points to the overall 3.1% y-o-y growth in Q3 2022.

Outstanding housing loans have seen sustained growth since 2021, although it has remained broadly stable in recent months, following the tightening of the headline Total Debt Servicing Ratio (TDSR) threshold at end-2021 (Chart 3.6). Following the decline in Q1 2022, new housing loans have gradually picked up in subsequent quarters, mirroring transaction activity in the private residential property market (Chart 3.7).

Credit quality of housing loans has strengthened, while the low loan-to-value ratio provides buffer in the event of falling property valuations

The credit quality of housing loans has strengthened further over the past year even as mortgage relief schemes expired in September 2021. Housing NPL declined to 0.3%, a decade-low level (Chart 3.8). The number of foreclosures has also trended down since 2021 and has remained low at fewer than 30 units so far this year.

FIs and borrowers also have significant buffers against falling property valuations, given the low loan-to-value (LTV) ratios. As of Q3 2022, the average LTV has moderated to 43%, with property values significantly exceeding their loan amounts (Chart 3.9). This reflects in part the measures MAS has put in place over the years to limit the amount of borrowing for property purchases, including the recent adjustments to the TDSR framework.
3.3 Update on the private residential property market

The property market has been resilient despite rising interest rates

Notwithstanding the sharp increase in mortgage rates since early 2022, private residential property prices have continued to rise, reflecting firm underlying demand and strong purchasing power supported by resident wage growth. Property prices grew by an average of 2.7% in the first three quarters of 2022 on a q-o-q basis, slightly higher than the average gain of 2.6% in 2021 (Chart 3.10). While price gains were observed in all market segments, properties in the Outside of Central Region (OCR) registered the strongest pace of price increase (Chart 3.11).

Nominal resident wage growth remained above-trend in Q2 2022, increasing by 6.8% y-o-y in Q2 2022.
Transaction volumes fell from the recent highs in 2021, but were still above pre-COVID levels

Over the past year, the increase in property prices was supported by firm transaction volumes. While transaction volumes fell in Q1 2022 following the December 2021 cooling measures, they recovered over the subsequent quarters. The easing in property market-related safe management measures since Q2 2022 facilitated viewings of homes and developer sale galleries, contributing to the increase in sales. As of Q3 2022, the average quarterly transaction volume in 2022 was about 28% lower than in 2021, but remained 10% higher than pre-COVID levels in 2017–2019 (Chart 3.12).

Transaction activity continued to be driven by resident demand, with Singapore citizens and permanent residents accounting for nearly 96% of all transactions in the first three quarters of 2022. While the share of transactions by foreigners at about 4% remained below the pre-COVID level of 6% observed in 2017–2019 (Chart 3.13), foreign demand could pick up with the easing of travel restrictions.

Rentals rose sharply as the vacancy rate fell, but the tightness should moderate with upcoming supply

Amid strong leasing demand, the overall vacancy rate fell to 5.3% in Q1 2022. While the vacancy rate edged up to 5.7% in Q3 2022, it remained significantly below its average of 6.8% over the last 10 years (Chart 3.14). Correspondingly, rentals increased sharply, registering a cumulative gain of 20.8% in the first three quarters of 2022, with rises seen across all regions (Chart 3.15).

Looking ahead, the ramp-up in newly completed private residential units following the resumption of construction activity is expected to alleviate some tightness in the rental market. About 28,800 private residential units, including Executive Condominiums (ECs), are

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18 Safe distancing requirements and the capacity limit in developer sale galleries were lifted from 26 April 2022. The cap on the number of unique visitors per household (previously 10 at any one time) was also removed.
expected to be completed over 2022–2023, nearly three times the 10,400 units completed in 2020–2021.19

**Chart 3.14** Vacancy rate fell and remained significantly below historical average in 2022

Vacancy rate for private residential property

*Source: URA*

**Chart 3.15** The surge in rentals has been broad-based

Private property rental price indices by region

*Source: URA*

Inventory of unsold units has remained low, inducing developers to replenish their land bank

After 12 consecutive quarters of decline, the inventory of unsold units (excluding ECs) in the supply pipeline has increased from the trough in Q4 2021, reaching about 15,700 units in Q3 2022 (Chart 3.16). However, this was still about 9% lower than the unsold inventory a year ago, and 37% below the 10-year average. To replenish their land bank, developers continued to acquire land through both the Government Land Sales (GLS) Programmes and collective sales markets, albeit with some caution in recent land bids in view of rising economic uncertainties.

**Chart 3.16** Developers’ unsold inventory has inched up in recent quarters

Total number of unsold private residential units from projects with planning approvals

*Source: URA*

19 For more details, see URA’s release of the Q3 2022 real estate statistics: [https://www.ura.gov.sg/Corporate/Media-Room/Media-Releases/pr22-38](https://www.ura.gov.sg/Corporate/Media-Room/Media-Releases/pr22-38).
Macroeconomic uncertainties and higher interest rates could affect property demand in the period ahead

The private residential property market has remained resilient over the past year, reflecting to some degree the effects of the strong recovery from the COVID-19 pandemic and tight supply conditions. Nevertheless, elevated interest rates and increased downside risks to global growth could weigh on market sentiments in the coming quarters. At the same time, the ramp-up in the supply of private housing via the GLS Programmes in 2022 will help ease demand pressures when the development projects are ready for sale in 2023.

The government will be vigilant to market developments with the continuing objective of promoting sustainable conditions in the property market.

3.4 Assessment of maturity risk

Maturity risk has increased with the rise in short-term debt

Households’ short-term debt, as proxied by outstanding credit card balances, increased 16% y-o-y in Q3 2022. This was the strongest increase since 2011. Outstanding credit card balances as a percentage of PDI also rose slightly, to 4.1% in Q3 (Chart 3.17). Accordingly, household maturity risk has risen with the increase in unsecured credit, reflecting the boost in discretionary spending as the easing of COVID-related restrictions released pent-up demand.

Credit quality of short-term debt has remained healthy

As a share of PDI and total number of cardholders, rollover balances and number of revolvers have remained below their long-term averages, although they have edged up slightly to 2.1% and 20%, respectively, in Q3 2022 (Charts 3.18 and 3.19).
The credit card charge-off rate\(^\text{20}\) declined to 3.5% in Q3 2022 (Chart 3.20). The rollover balance increased by 11.2% y-o-y in Q3 2022, while the amount of bad debt written off has continually fallen since 2021. That said, the charge-off rate is likely to normalise to pre-crisis levels as the relief measures have been withdrawn.

### Chart 3.20 Credit card charge-off rate declined further in Q3 2022
Credit card charge-off rate

3.5 Assessment of household debt servicing

Households face higher borrowing costs, as domestic interest rates rise in tandem with global interest rates

Domestic SGD interbank interest rates, which are largely determined by global interest rates, have risen sharply in 2022. In particular, the 3-month Compounded SORA, which is a

\(^{20}\) Charge-off rate refers to the bad debts written off divided by the average rollover balance.
key reference for mortgage rates, increased from near-zero levels at the start of the year to about 2.6% in mid-November 2022. Correspondingly, mortgage rates for both floating rate and fixed rate packages have risen by about the same extent to around 3.5% and 4.5% respectively over the same period.

Market-based forward prices suggest that SORA-based mortgage rates could rise further in the coming months, before stabilising at levels that will still be significantly higher than the low rates seen in the last decade. Households will face higher loan repayments, with the magnitude of increase escalating with the size of mortgages.21

Most households should still be able to service their mortgages if interest rates increase further, but there are specific segments of vulnerabilities

The results of MAS’ stress test show that households’ debt servicing ratios remain manageable under a conservative scenario of a reduction in income (representing diminished debt servicing ability as expenditures rise due to inflation) on top of interest rate shocks. Specifically, even under the scenario of a simultaneous and immediate 400bps increase in interest rates, and a 10% reduction in income, most households are expected to be able to continue servicing their debt. In addition, the stress test conservatively assumes a full and immediate pass-through of sharp interest rate hikes, although the actual impact would be gradually phased in depending on the type of loan packages that borrowers have taken up.

As of Q3 2022, about 38% of mortgages extended for private residential property purchases by FIs were on floating rate packages that move in tandem with market interest rates, while the remaining 62% were either on (i) rates linked to board rates or fixed deposit rates, which track market interest rates but with some lag, or (ii) fixed interest rates over the first few years of their loan. Another conservative aspect of the stress test is that it also did not consider the financial buffers of households, where liquid assets such as cash and deposits continue to exceed total liabilities (Chart 3.21).

Chart 3.21 On aggregate, liquid assets continue to exceed total liabilities

Household cash and debt

Source: DOS, MAS estimates

21 For instance, if interest rates were to rise from 1.2% to 4.5% for borrowers that are refinancing a SGD1 million loan with a tenure of 30 years, the monthly repayment would increase by about SGD1,760, while the monthly repayment for a lower loan amount of SGD300,000 would result in a much smaller increase of only SGD530.
Further detailed analysis by MAS provided some perspective on the profile of vulnerable households, taking into account their consumption expenditure in addition to debt repayments. Specifically, households with larger outstanding mortgage loans (typically new borrowers) tend to be more leveraged and face greater risk of cashflow strains. Such households face even higher risks if they are of lower income with limited financial buffers as such households typically also have higher expenditure-to-income ratios. The tightened credit measures of the lower TDSR threshold and higher credit assessment interest rates would ensure that new borrowers continue to be financially prudent.

3.6 Outlook

Most households should remain financially resilient

Labour market conditions are expected to stay supported, and continued wage growth will help households with their recurrent expenditures including debt servicing. As of Q3 2022, the resident unemployment rate remained low at 2.9% (Chart 3.22).

Chart 3.22 The resident unemployment rate continues to be low

Resident unemployment rate (seasonally-adjusted)

All households should exercise prudence and be certain of their debt servicing ability before taking on additional financial commitments

With rising interest rates and increasing cost pressures amid uncertainty in economic growth prospects, segments of households are likely to face increasing stress and may encounter difficulties in servicing their mortgage debt. Households should therefore exercise prudence in managing their finances, including mortgage loan obligations, to cushion against tightening financial conditions in the coming months.

Based on DOS’ 2017/18 Household Expenditure Survey (HES), the average expenditure-to-income ratio for the bottom three household income deciles is approximately 2.6 times more than that of the top three deciles.
4 Singapore Financial Sector

The financial sector in Singapore emerged from the COVID-19 crisis in a strong position. The banking sector benefitted from the recovery in domestic economic activity which underpinned the steady improvement in asset quality over the past year. Banks have continued to maintain strong capital and liquidity buffers as they expanded their lending. Nevertheless, the challenging global environment and heightened economic uncertainties could impact credit quality in the quarters ahead, while tightening financial conditions and market volatility could result in liquidity strains. Banks should thus continue to manage credit risk prudently and strengthen their liquidity profiles to guard against the risk of liquidity imbalances in key financial markets. Similarly, the non-bank sector has continued to function normally thus far despite the heightened market volatility. Fund managers have been able to meet redemptions in an orderly manner, while the capital positions of insurers remain healthy. That said, FIs need to be prepared for further bouts of market volatility.

4.1 Banking sector

Banks emerged from the COVID-19 crisis with strong capital and liquidity buffers, and have set aside adequate provisioning buffers to cushion against possible credit losses. Over the past year, resident credit demand has remained strong alongside the recovery in domestic economic activity, while asset quality has improved steadily.

However, economic uncertainties arising from elevated geopolitical tensions, supply chain disruptions and a strong US dollar could pose challenges to banks’ credit risk management. Tightening financial conditions, amid some slowing in growth and higher costs, could weaken debt repayment capabilities of borrowers and adversely impact banks’ asset quality. It is thus important for banks to actively monitor loans extended to vulnerable borrowers and ensure that their provisioning coverage is sufficient.

Notwithstanding the increased risks from the weakening growth outlook, results of the IWST 2022 exercise show that banks would have adequate capital buffers to weather these downside risks (see Box B “Industry-Wide Stress Test of D-SIBs”).

<table>
<thead>
<tr>
<th>Banking sector FVI (y-o-y changes)</th>
<th>Q3 2021</th>
<th>Q3 2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall Banking FVI</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Resident leverage risk</td>
<td></td>
<td>↑</td>
</tr>
<tr>
<td>Non-resident leverage risk</td>
<td>→</td>
<td>↑</td>
</tr>
<tr>
<td>Liquidity risk</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>Maturity risk</td>
<td>→</td>
<td>→</td>
</tr>
</tbody>
</table>

y-o-y changes in FVI

- Decreased significantly
- Broadly unchanged
- Increased significantly
The overall banking FVI has increased over the past year, largely driven by rising leverage vulnerabilities as banks’ balance sheets expanded alongside the recovery in economic activity. Banks’ Common Equity Tier 1 (CET1) CAR has decreased slightly, reflecting the increase in risk-weighted assets (RWA) due to an expansion in non-bank credit. Nevertheless, banks have continued to maintain strong capital positions, with their CET1 CAR well above the regulatory minimum as of Q3 2022.

Meanwhile, banks’ liquidity positions remain strong and well above regulatory thresholds. The pick-up in the liquidity vulnerability measure reflected in part the easing of previous excess liquidity buffers built up over the course of the pandemic.

Robust credit growth was supported by resident non-bank and interbank lending, but tight financial conditions could weigh on credit growth

Overall credit growth has remained healthy over the past year, supported by an expansion in both non-bank and interbank loans (see Chart Panel 4A “Banking Sector: Credit Growth Trends”). Non-bank lending increased by 2.7% y-o-y in September 2022, underpinned by lending to residents in tandem with the recovery in the domestic economy.

Resident non-bank loan growth peaked at the end of 2021, before moderating to 4.3% y-o-y in September 2022. The firm growth in loans to residents has been supported by lending to property-related sectors, in line with the increase in property prices and normalisation of transaction activities post-pandemic. In contrast, lending to trade-related sectors has been weighed down by heightened uncertainty arising from the Russia-Ukraine war as well as tighter financial conditions in recent months.

In comparison, non-resident non-bank loan growth was flat at 0.3% y-o-y in September 2022, as declines in lending to Emerging Asia and Europe offset increases in other regions. While loan growth to Emerging Asia was weighed down by China’s strict pandemic control measures and policies aimed at deleveraging its property sector, loan demand from Europe was hindered by general cost and price pressures arising from significantly higher gas prices.

Based on a survey24 conducted by MAS, banks expect higher working capital needs to underpin demand for credit over the next six months, on the back of rising raw material costs and support for a pick-up in activity from sectors benefitting from the easing of pandemic measures in the region. Looking ahead, banks have indicated that they are well-placed to meet this demand while emphasising the importance of prudent underwriting standards given the risks posed by tight financial conditions, volatile commodity prices, and the uncertain economic outlook.

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23 MAS imposed additional capital requirements (in the form of increased RWA) on DBS Bank and OCBC Bank in Q1 and Q2 2022, respectively, following the identification of deficiencies in their operational systems and processes.
24 MAS conducted a survey of banks in September 2022 to seek industry views on credit conditions and expectations in Q4 2022 and Q1 2023.
Banks have healthy capital buffers and low NPL ratios, but there is a risk of some deterioration in asset quality from higher debt costs.

The banking system’s overall NPL ratio eased to 1.8% as of Q3 2022 (see Chart Panel 4C “Banking Sector: Asset Quality and Liquidity Indicators”). NPL amounts fell (Chart 4.1) largely due to recovery of past NPLs and the upgrading of borrowers to performing grades as the domestic economy picked up.

**Chart 4.1** NPLs have declined over the past year

Banking system NPLs

Source: MAS

Consumer-facing and travel-related industries registered an improvement in asset quality over the past year (Chart 4.2), as activity picked up on the easing of safe management measures and border restrictions. The NPL ratio for the transport and storage sector fell to 7.6% in Q3 2022 from 11.9% a year ago, partly due to write-offs and recovery from the sale of collaterals. Meanwhile, NPLs in the construction and manufacturing sectors have crept upwards over the past year, weighed down by high construction material costs and softening external demand respectively. Looking ahead, as central banks continue to tighten monetary policy amid a slowdown in economic activity, debt-related stresses could cause some weakening in banks’ asset quality.

Banks continue to maintain adequate provisioning against a decline in credit quality. The total provisioning coverage and specific provisioning coverage for the banking system have remained stable at 103.5% and 45.5% in Q3 2022, respectively. These buffers have been further augmented by general provisions held at the head offices of foreign bank branches.

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25 The banking system’s total provisioning coverage is the sum of general and specific provisions as a share of unsecured non-performing assets.
The results of the IWST 2022 exercise show that banks in Singapore would remain resilient to adverse macrofinancial shocks arising from a sharp tightening of monetary policy amid a global economic downturn. Overall, banks’ strong capital buffers and adequate provisions confirm that they would be well placed to weather potential downside risks.

However, as the global environment remains challenging, banks should continue to maintain sound underwriting standards and actively monitor loans extended to vulnerable firms, especially those who are highly leveraged or have thin profit margins. Banks should also continue to set aside prudent levels of provisions.

**Liquidity risks have increased, but the banking sector’s liquidity positions have continued to be strong**

The banking sector’s liquidity vulnerabilities have edged up from previously benign levels, while maturity vulnerabilities remain low.

The increase in liquidity vulnerabilities was driven by a slight decline in liquidity buffers, which was partly due to the easing of excess buffers built up since the onset of the pandemic, alongside the rise in non-bank deposits (see Box C “Banks’ Balance Sheets Through the Pandemic”). Nevertheless, Domestic Systemically Important Banks (D-SIBs) have continued to maintain healthy buffers over the all-currency and SGD minimum regulatory Liquidity Coverage Ratio (LCR) requirements.

Banks have sufficient liquidity to intermediate SGD and foreign currency loans. The banking system’s loan-to-deposit ratios (LTD) remained below 100% in September 2022, with

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26 The new MAS Notice 610/1003 was implemented in July 2021 as part of changes to MAS’ regulatory reporting requirements. As data definitions have shifted, certain indicators are not comparable between historical periods (pre-July 2021) and the new MAS Notice 610/1003. Please refer to the Data Annex in MAS’ 2021 FSR for details.
the foreign currency LTD falling to 74.9% as foreign currency deposit inflows outpaced foreign currency credit growth over the past year (see Chart Panel 4C “Banking Sector: Asset Quality and Liquidity Indicators”, Chart 4C).

Similarly, the USD LTD ratio kept below 100% across all bank types, indicating that USD deposits are more than sufficient to fund USD loans (Chart 4.3).

**Chart 4.3** USD LTD ratios are below 100%

Nonetheless, USD funding risk bears monitoring, given the heightened risks of liquidity imbalances in key international financial markets. MAS therefore encourages banks to continue efforts to strengthen their USD liquidity profiles. Banks should also manage their foreign currency risk prudently under a range of business conditions by diversifying foreign currency funding sources, conducting regular liquidity stress tests and having in place adequate liquidity contingency plans.

Local banking groups have expanded their loan books while maintaining healthy asset quality and provisioning coverage

Local banking groups’ loan books grew over the past year, underpinned by continued expansion in both resident and non-resident loans (Chart 4.4). Overall non-bank loans increased by 6.0% y-o-y in Q3 2022.

With rising interest rates, increased net interest margins (NIMs) have resulted in higher interest income, strengthening local banking groups’ net profits (see Chart Panel 4D “Banking Sector: Local Banking Groups”).

Overall asset quality of local banking groups has improved as well, with the NPL ratio falling to 1.3% in Q3 2022 and remaining below the overall banking system’s NPL ratio. In addition, local banks have continued to maintain healthy provisioning coverage, with total provisioning coverage of 216% as of Q3 2022.
Local banking groups continue to grow their loan books

Local banking groups’ y-o-y non-bank loan growth by residency

Capital and liquidity positions of local banking groups have remained robust

Local banking groups have maintained strong capital and liquidity positions (see Chart Panel 4D “Banking Sector: Local Banking Groups”), with aggregate CARs and all-currency LCRs well above regulatory requirements. The overall LTD ratio of local banking groups has remained below 100%, with the USD LTD ratio at a healthy 65% in Q3 2022 (Chart 4.5).

Strong capital buffers, supplemented by ample provisions, will ensure that local banking groups are well placed to withstand increases in credit losses due to the rising interest rate environment.

Overall, SGD and USD LTD ratios remain low

Local banking groups’ non-bank LTD ratios

Source: Local banking groups’ financial statements

Source: MAS, Local banking groups’ financial statements
4.2 Non-bank sector

Domestic markets continue to function in an orderly manner, and market participants have sufficient liquidity

Global financial markets, including those for commodity derivatives, have become increasingly volatile over the past year. Higher volatility can adversely impact the functioning of such markets and amplify liquidity strains. For example, the recent spike and volatility in global energy prices caused many energy producers, particularly in Europe, to face margin calls on their derivative hedges, leading to concerns that the demand for liquidity would trigger a systemic squeeze on funding.\(^\text{27}\)

The orderly functioning of the NBFI ecosystem depends on the continuous and efficient intermediation of liquidity to key market participants, as well as the capacity to adequately address liquidity imbalances during extreme market stresses. In this regard, domestic markets have functioned normally, and market participants have been able to access liquidity as needed over the past year.

Equity and derivatives markets, including on the SGX, have operated normally, and trading continues to be orderly. Approved clearing houses are well-collateralised, and have operated safely and efficiently amid the heightened market volatility. Internal stress tests, performed daily by these clearing houses, indicate that they continue to have adequate financial resources (including liquidity) to cover significant loss exposures in a stressed scenario, in line with MAS’ regulatory requirements.

MAS has outlined its surveillance framework on over-the-counter (OTC) derivatives, and analysed the linkages between market participants via trade repository data (see Box A “Monitoring Financial Stability Risks in the Over-the-counter Derivatives Markets”). A study of interconnectedness in Singapore’s OTC derivatives market shows that foreign banks and dealers play a prominent role in intermediating such transactions, with increases in interconnections seen amongst market participants over time.

For Collective Investment Schemes (CIS), the significant redemption\(^\text{28}\) volumes they faced over the past 12 months have remained relatively stable, except for a spike in March 2022 (arising from the Russia-Ukraine war) (Chart 4.6). The higher level of redemptions reported then was due to investors re-allocating or re-balancing their portfolios, liquidating their portfolios to meet operational needs, or exiting mandates. Fund managers have been able to meet all significant redemption requests in an orderly manner.

\(^{27}\) Central bank responses to concerns in energy markets have varied: the Bank of England (BoE) launched the EUR40 billion Energy Markets Financing Scheme in October 2022, while the ECB said that it could provide liquidity assistance only to banks and that energy firms should seek government assistance.

\(^{28}\) Significant redemption refers to aggregate net redemptions exceeding 5% or 10% of the total assets under management (AUM) of the fund depending on the dealing frequency of the fund and the timeframe of redemptions.
The capital positions of insurers remain healthy, but insurers should be vigilant amid continuing market volatilities

Insurers similarly face an uncertain environment. Higher interest rates are generally favourable to life insurers, as the duration of their insurance liabilities tend to exceed those of their assets. However, depressed equity markets and volatility of credit spreads have made for a challenging investment environment and lower returns. For general insurers, rising interest rates can be disadvantageous as they result in lower bond valuations while liabilities remain largely unchanged, given the short-term and lower interest rate sensitivity of their insurance products. Nonetheless, the capital adequacy ratio (CAR) of insurers remains healthy (see Chart Panel 4E “Insurance Sector”, Chart 4E1). Insurers should closely monitor their investment strategies and risks, while maintaining robust underwriting standards.

MAS conducted the IWST exercise to assess the resilience of significant insurers to economic stresses. IWST 2022 featured a Central scenario and an Adverse scenario over a three-year horizon. Under the Adverse scenario, which focused on stresses to equity prices, interest rates and credit spreads, insurers were impacted mainly from the lower valuation of assets arising from the fall in equity prices, higher interest rates and credit spread widening. However, in the case of life insurers, higher interest rates also decreased the value of long-term guaranteed liabilities which helped mitigate the negative impact. Insurers met the regulatory capital requirements after undertaking management actions such as reducing future bonus allocation for the policyholders of participating business and adjusting investment portfolio asset allocations.
Box A
Monitoring Financial Stability Risks in the Over-the-counter Derivatives Markets

OTC derivatives markets pose pertinent issues for financial stability

Post-GFC reforms have made meaningful progress in improving the resilience of derivatives markets, and have significantly reduced the risk of loss transmission and contagion during stress periods. Such reforms include the greater use of clearing through central counterparties (CCPs) as well as minimum margin and higher capital requirements for non-centrally cleared transactions. Another pillar of the reforms involved improving transparency for OTC derivatives transactions. Many jurisdictions, including Singapore, now require such transactions to be reported through trade repositories, giving supervisors and regulators access to considerable amounts of data. The FSB has been tracking the implementation of these reforms through regular progress reports.

Nevertheless, recent incidents have highlighted how derivatives markets continue to trigger concerns over financial stability. For example, the failure of US family office Archegos in 2021 led to multi-billion US dollar losses at large FIs. In March 2022, the spike in nickel prices arising from the Russia-Ukraine war meant that some market participants were not able to meet margin calls, with risks of spillovers to broader funding markets. Most recently, UK government bond prices entered a downward spiral as pension funds sold large amounts of gilts, again to meet margin calls on their derivatives and leveraged positions, ultimately requiring central bank intervention to calm markets.

MAS, like other regulators and international bodies, is developing capabilities to better monitor systemic risks stemming from derivatives markets. However, vulnerabilities in OTC derivatives markets are difficult to detect ex-ante. Financial markets and market participants’ exposures can shift very quickly. This implies that the robust monitoring of the build-up of risks and vulnerabilities depends on the timeliness and frequency of data. At the same time, the cross-border nature of derivatives markets and the global footprint of most market participants necessitate greater cooperation internationally, to share practices and information and build a holistic picture of market activity and practices.

In a 2021 note, the FSB highlighted margining as one of five key areas for further study. This was a response to the March 2020 market turmoil, where the procyclicality of margining practices was observed to contribute to spikes in liquidity demand and increased market volatility. Central banks and regulatory bodies suggested that further work is needed around

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29 BIS (2015), “Margin requirements for non-centrally cleared derivatives”.
understanding the drivers of liquidity supply and demand in stress. Subsequent FSB workstreams delved into the details of how trade repository data could better inform surveillance and analysis.

Potential vulnerabilities and transmission channels

To help frame the discussion around the systemic risks posed by OTC derivatives markets, this Box first considers the channels through which shocks could transmit to the real economy, and then identifies the vulnerabilities which could amplify such transmission channels and potentially cause more systemic stresses on the financial system.

There are two broad channels through which OTC derivatives markets can affect the financial system and hence the broader economy (Figure A1). In the first channel, a shock affects financial markets and leads to counterparty failures in the derivatives market. This in turn increases general risk aversion in the financial system; it induces a pullback in lending by banks and lowers the appetite for market-making activities by dealers, impairing liquidity conditions. In the second channel, a shock causes a spike in the volatility of financial asset prices. The large movement in asset prices typically has the effect of increasing the amount of margin that is required to be posted in a derivative transaction, both to cover the larger unrealised losses as well as to ensure that the collateral to the transaction remains sufficient to cover against the higher probability of default. If the counterparty does not have sufficient liquidity to meet the increased margin calls, it may be forced to seek funding through asset sales, in turn depressing asset valuations and reinforcing market volatility. Ultimately, this would transmit to the real economy through wealth effects.

Figure A1 Channels of risk transmission from derivatives markets to the real economy

Source: MAS

For example, see ESRB Expert Group on the Macroprudential Use of Margins and Haircuts (2020), “Mitigating the procyclicality of margins and haircuts in derivatives markets and securities financing transactions”.


32

33
Drawing on a review of recent literature and other central banks’ approaches, MAS has identified five key potential vulnerabilities: size, interconnectedness, crowded trades, liquidity and leverage (Table A1). A comprehensive view of systemic risks requires a holistic assessment of these vulnerabilities, which can be grouped into two categories: entity-level vulnerabilities and activity-level vulnerabilities.

Entity-level vulnerabilities consider leverage and liquidity profiles of market participants, including their ability to meet margin calls, which in turn helps identify where potential shocks within the derivatives market could propagate from, to the broader financial system and real economy.

Activity-level vulnerabilities consider the OTC derivatives market in aggregate. The size of the OTC derivatives market has a bearing on the severity of stress events, both within the financial system and in terms of potential spillovers to the real economy. In addition, the size of linkages between market participants would reflect the extent of bilateral trades and exposure to common underlying assets. Identifying these key linkages will help assess the risk of systemic contagion.

<table>
<thead>
<tr>
<th>Potential Vulnerabilities</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arising from entities participating in OTC derivatives markets</strong></td>
<td></td>
</tr>
<tr>
<td>Liquidity</td>
<td>Inability to meet margin calls in times of stress is the central systemic risk of derivatives markets.</td>
</tr>
<tr>
<td>Leverage</td>
<td>Derivatives typically increase an entity’s leverage, which raises the risk of failure under adverse market movements.</td>
</tr>
<tr>
<td><strong>Arising from activities in OTC derivatives markets</strong></td>
<td></td>
</tr>
<tr>
<td>Size</td>
<td>Identification of aggregate market size, largest players, etc. provides a first-order sense of systemic importance of the market.</td>
</tr>
<tr>
<td>Interconnectedness</td>
<td>Highly interconnected entities or groups of entities increase risk propagation across the network.</td>
</tr>
<tr>
<td>Crowded trades</td>
<td>Significant common exposures to underlying assets can lead to correlated failures.</td>
</tr>
</tbody>
</table>

Source: MAS

Chart Panel 4F “OTC Derivatives” presents charts on the trends in market size and composition over the past year. Additional charts covering indicators of counterparty concentration and interconnectedness have been included in this Review.

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A first look into interconnectedness in Singapore’s OTC derivatives market

A focused study of interconnectedness, one of the five key vulnerabilities identified above, involves the mapping of relationships between entities in the form of nodes (entities) and links (exposures) in a network. These linkages determine how interconnected entities are, and hence how interconnected the overall network is. Such a network analysis can also reveal nodes that are more “central” (typically more systemically important), and help with the identification of network characteristics (such as the presence of a core-periphery structure, clusters).

Following the implementation of MAS’ final phase of OTC derivatives reporting requirements in October 2021,35 trade repository data now provide a more comprehensive view of OTC derivatives market activity in Singapore across the five asset classes (Commodity (CO), Credit (CR), Equity (EQ), Foreign Exchange (FX) and Interest Rate (IR)). FX and IR OTC derivatives continue to account for the majority of notional amount outstanding (see Chart Panel 4F, Chart 4F1). In terms of interconnectedness, the FX and IR networks are larger and more connected, comprising more counterparties and with a higher degree36 (more linkages) on average (Table A2).

<table>
<thead>
<tr>
<th>Table A2 Network descriptive statistics by asset class (end-Sep 2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of unique counterparties</strong></td>
</tr>
<tr>
<td>~1,000</td>
</tr>
<tr>
<td>Average degree</td>
</tr>
<tr>
<td>Eigenvector centralisation</td>
</tr>
</tbody>
</table>

(a) Counterparties here exclude private individuals and other counterparties reported using internal client codes.

(b) Private individuals and other counterparties reported using internal client codes are consolidated as single entities when calculating these centrality measures.

Source: Depository Trust & Clearing Corporation Data Repository (Singapore) Pte Ltd (DDRS), MAS estimates

Market participants have seen an increase in number of interconnections over time

Just as the degree of each entity reflects how interconnected it is, the average degree37 of all entities in the network would broadly reflect how interconnected the entire network is. The average degree has risen over time across most asset classes (see Chart Panel 4F, Chart 4F7). This is likely reflective of a combination of factors: 1) increased market activity as new market participants start trading in Singapore; 2) existing counterparties diversifying trading

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35 This refers to the commencement of FX, CO and EQ OTC derivatives reporting by non-bank entities in October 2021. Banks have been reporting FX derivatives since May 2015, and CO and EQ derivatives since October 2018. Reporting of CR and IR derivatives commenced in 2014, similarly starting with banks, followed by non-bank entities.

36 In network analysis, the degree of a node refers to the total number of edges connected to it, or in other words, the number of connections it has to other nodes in the network.

37 Average degree refers to the average number of links per node in a network (i.e. the simple average of all nodes’ degrees).
relationships; and 3) greater transparency in trading activity as trade reporting requirements are fully implemented.

Eigenvector centrality is the measure used in this analysis to identify important entities in the network. It considers not only the absolute number of linkages an entity has, but also the value of each linkage. Linkages with well-connected entities are assigned a greater weight. In this regard, eigenvector centrality considers both direct and indirect connections between entities. Eigenvector centralisation—which provides an indication of the tendency of an entity to be more influential than all other entities in the network—is close to one for all asset classes (Table A2) in Singapore’s OTC derivatives market, implying the presence of a small subset of highly influential entities. That said, centralisation scores have remained relatively stable over time (see Chart Panel 4F, Chart 4F9), suggesting that amongst these key entities, no single entity has become significantly more important than others.

Foreign banks and dealers have a prominent role in Singapore’s OTC derivatives market

Reflecting Singapore’s status as an international financial centre, most of the activity in Singapore’s OTC derivatives market involves foreign banks and dealers (see Chart Panel 4F, Chart 4F2). The importance of these entities is corroborated by their eigenvector centrality rankings (Chart A1), as well as the composition of entities that form the “core” of the network.

Core entities in the network are distinguished from peripheral entities using k-core decomposition. Foreign banks and dealers form the bulk of entities in the core of the network (Figure A2), which shows a highly interconnected inter-dealer market connected to clients/end-users and peripheral dealers. This perspective is useful for identifying parties at greater risk of contagion from a known failure of a more interconnected party.

Turning to an analysis of market concentration, a Herfindahl-Hirschman Index (HHI) value of 0.022 indicates a low level of concentration amongst market participants. Among the five asset classes, the CR market is the most concentrated (see Chart Panel 4F, Chart 4F8). Concentration among the core banks and dealers is slightly higher, reflected in a HHI value of 0.049 (computed using the shares of core banks and dealers’ exposures to each other).

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38 Eigenvector centrality measures the transitive influence of nodes in a network. Eigenvector centrality scores can be normalised by dividing all scores with the largest eigenvector centrality value in the network. The node with a normalised eigenvector centrality score of one is the most “central” node in the network.

39 Eigenvector centralisation is a network-level centralisation measure based on the eigenvector centrality scores of each node (i.e. counterparty) in the network, and ranges from zero to one. A high centralisation score represents a highly centralised network where only few members hold the most central positions. It is calculated by the sum of the differences between the centrality score of the most central node and all other nodes in the network, normalised by dividing by the maximum theoretical score for a network with the same number of nodes.

40 The k-core of a network refers to the largest subgraph in the network in which every node has a minimum degree of k (i.e. at least k connections to other nodes in the subgraph). k-core decomposition recursively removes nodes with the fewest degree, until all nodes with less than k degree are removed.

41 HHI is often used as an indicator of market concentration. It is calculated as the sum of the squares of the market share (in decimals) of each firm in the market. It ranges from zero to one, with a higher value indicating a more concentrated market.
Bilateral exposures amongst these core entities are also generally diversified across different counterparties.

**Chart A1** Ranking by eigenvector centrality highlights the importance of foreign banks and dealers

Eigenvector centrality score against relative notional outstanding (end-Sep 2022), for all asset classes combined

![Eigenvector centrality chart](chart)

Source: DDRS, MAS estimates

Notes:

1. The y-axis presents eigenvector centrality scores normalised by dividing by the highest eigenvector centrality score in the network. This means that the entity with the highest eigenvector centrality in the network will have a score of one.

2. The x-axis presents the notional outstanding of each entity relative to the entity with the highest notional outstanding (excluding CCPs).

**Figure A2** Majority of core entities are foreign banks and dealers

Network diagram of core entities and their linkages, for all asset classes combined

![Network diagram](diagram)

Source: DDRS, MAS estimates
Notes:

1. A total of 40 core entities have been identified through k-core decomposition, with $k = 34$.
2. The Fruchterman-Reingold layout algorithm is used to construct this force-directed network diagram. Nodes with higher eigenvector centrality are situated in the centre.
3. Node size reflects the relative gross notional outstanding for each entity. Edge thickness corresponds to the gross notional outstanding between entities.
4. This diagram is based on outstanding positions across all asset classes as of end-Sep 2022.

Enhanced surveillance of risks arising from OTC derivatives

Network analysis and monitoring of network centrality metrics can aid with the understanding of the market structure and interconnectedness between participants in the OTC derivatives market. MAS will continue to strengthen its surveillance efforts and evaluate appropriate metrics to monitor key vulnerabilities identified in the framework. This would help to identify FIs that play an important role in OTC derivatives markets, as well as those that may warrant closer attention.
Box B
Industry-Wide Stress Test of D-SIBs

D-SIBs emerged from the COVID-19 crisis unscathed, and have continued to maintain strong capital positions.

The D-SIBs’ aggregate CET1 CAR remained well above the regulatory minimum as of Q3 2022 even as it eased by 0.8 percentage points over the previous nine months, reflecting banks’ expanded loan portfolios as economic activity picked up (Chart B1). D-SIBs have also set aside provisioning buffers that are above pre-pandemic levels, to cushion against potential credit losses that may arise amid tightening global financial conditions and the weakening growth outlook (Chart B2).

MAS’ latest IWST assessed D-SIBs’ resilience to a sharp hike in interest rates amid a deep domestic recession.

As part of the IWST 2022 exercise, D-SIBs were prescribed with two macroeconomic scenarios (Central and Adverse) over a three-year forecast horizon to assess the capacity of their capital buffers to withstand severe macrofinancial shocks. The shocks were applied on the Central scenario from the first year.

The Central scenario assumes a continued recovery in global economic and trade activity, supported by well-calibrated macroeconomic policies and a successful transition to COVID-19 endemicity. The Singapore economy continues to expand at an above-trend pace, as

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42 The dip in the aggregate CET1 CAR could also be partly attributed to MAS’ recent supervisory actions. MAS imposed additional capital requirements (in the form of increased RWA) on DBS Bank and OCBC Bank in Q1 and Q2 2022, respectively, following the identification of deficiencies in their operational systems and processes.
growth in the consumer-facing and trade-related sectors is supported by a pick-up in consumer confidence and trade activity.

The Adverse scenario features a global economic downturn as central banks tighten monetary policy sharply in response to heightened inflationary pressures. The significant increase in interest rates precipitates financial market disruptions, as the decompression of global risk premia drives up corporate bond spreads and triggers declines in stock markets. Meanwhile, the Russia-Ukraine war escalates further, disrupting commodities exports and intensifying inflationary pressures. In China, the economy slows sharply from disruptions caused by a resurgence in COVID-19 infections as well as increased stresses in its real estate sector. Regional economies are impacted extensively through the trade, confidence and financial channels, given their close economic ties with China.

In the face of external headwinds, the Singapore economy slips into recession in Year 1, with economic activity only recovering to Year 0 levels at the end of Year 2 (Chart B3). The resident unemployment rate peaks at 5.7% in Year 1 alongside weakening labour market activity, and remains elevated in Years 2 and 3. Meanwhile, interest rates in Singapore rise sharply in line with the increase in US interest rates, impacting corporates and households that are more highly leveraged. Borrowers face higher lending interest rates that reach up to 8% by the end of Year 1 as corporate credit spreads rise significantly. Increased debt servicing costs, lower corporate profitability and rising unemployment result in credit quality deterioration, which manifests as an increase in non-performing assets for banks.

**Chart B3** The Singapore economy slips into recession in Year 1 under the Adverse scenario

Singapore’s real GDP levels under IWST 2022 scenarios

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D-SIBs’ projected aggregate CET1 CAR remains well above minimum regulatory requirements even under the Adverse scenario

Under the Adverse scenario, D-SIBs’ projections indicate that their aggregate CET1 CAR would reach a trough of 9.7% in Year 1, remaining above MAS’ minimum CET1 regulatory

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43 The Year 0 starting point for the IWST 2022 exercise corresponds to the end-2021 conjuncture.
requirement of 6.5% and the combined CET1 and capital conservation buffer (CCB) regulatory threshold of 9.0% (Chart B4). Overall, the results of the IWST 2022 exercise show that D-SIBs would have adequate capital buffers to withstand such an adverse macrofinancial shock.

**Chart B4**  
D-SIB’s aggregate CET1 CAR would remain well above minimum regulatory requirements under the IWST 2022 scenarios

Projected D-SIBs’ aggregate CET1 CAR under IWST 2022 scenarios

Under the Adverse scenario, both corporate and retail loan credit quality would deteriorate significantly, giving rise to higher defaults and credit losses relative to the Central scenario. Increased debt servicing costs, rising input costs and a slowdown in economic activity reduce corporate profitability, which translates to a worsening in labour market conditions through a fall in wages and an increase in unemployment. Households that are more highly leveraged are at risks of a squeeze on both income and expenditures, through higher debt servicing costs and inflation.

The decline in asset quality of the D-SIBs’ credit portfolios is reflected in the significant increase in credit RWA and credit impairments. The increase in RWA is the main driver behind the deterioration of D-SIBs’ capital positions, accounting for a 3.4 percentage point decrease in the aggregate CET1 CAR (Chart B5). Credit impairments would lead to a further 1.3 percentage point decrease in CET1 CAR.

That said, D-SIBs’ aggregate capital positions would be partially bolstered by an increase in total revenues. While D-SIBs’ profitability would be affected by declining non-interest incomes due to weak macroeconomic and financial market conditions, net interest incomes would increase due to widening NIMs, with lending rates rising faster than deposit rates. The capital impact is also partially mitigated by lower dividend distributions. In line with reduced
net profits, D-SIBs would reduce dividend payouts in Year 1 by approximately 8.5% from Year 0 levels.

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**Chart B5** The decline in D-SIBs’ aggregate CAR is driven by increases in credit RWA and credit impairments

Decomposition of the impact of drivers on D-SIBs’ peak-to-trough decline in aggregate CET1 CAR

![Chart showing decomposition of impact drivers](chart)

Source: D-SIBs' submissions, MAS estimates

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**MAS augmented its stress testing approach by quantifying and assessing first and second-order domestic interbank contagion impacts**

Beyond assessing the resilience and soundness of individual banks, the incorporation of first and second-order domestic interbank contagion impacts in stress testing can facilitate identification of systemic risks. **Chart B6** provides a snapshot of the composition of the domestic interbank market as of September 2022, where cash and balances, and repurchase transactions, constitute the bulk of the exposures between Singapore banks.

As part of MAS’ efforts to further augment its stress testing approach to assess interbank contagion impacts, a two-layer multiplex network was constructed using more granular data collected under revised regulatory reporting requirements. The use of two network layers helps to account for the distinct dynamics that arise from collateralised and uncollateralised transactions. For instance, collateralised exposures are likely to reflect different loss given default (LGD) characteristics compared to uncollateralised exposures. For interbank exposures, repurchase transactions are considered collateralised transactions, with all other exposure types being uncollateralised transactions.

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44 From July 2021, banks were required to report information on a more comprehensive set of interbank exposures under the revised MAS Notice 610/1003, including cash and balances, repurchase transactions, loans, and debt securities.
MAS’ domestic interbank network analysis incorporates two regulatory thresholds (capital and liquidity) and models interbank contagion effects through three risk channels, namely counterparty defaults, liquidity stresses and fire sales. During the contagion simulations, banks that breach either their regulatory liquidity or capital thresholds (or both) are assumed to “default”. Creditor banks that are directly exposed to “defaulted” bank counterparties will incur capital losses on the non-recoverable portion of their exposures. Liquidity stresses are introduced by assuming that “defaulted” banks would withdraw all funding to their domestic debtor bank counterparties. Affected debtor banks would first draw down on their cash buffers before withdrawing interbank lending from their domestic bank counterparties to address these funding gaps. This would lead to knock-on second-order contagion impacts, as more banks start to pull back funding from each other to address liquidity shortages arising from sudden interbank funding withdrawals. Should the liquidity

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45 The methodology takes reference from the multiplex network framework developed by Gustavo Peralta and Ricardo Crisóstomo in “Financial contagion with spillover effects: a multiplex network approach” (2016).
46 These liquidity requirements would refer to either the Liquidity Coverage Ratio (LCR) or Minimum Liquid Asset (MLA) regulatory thresholds, depending on which regulatory regime each bank belongs to.
47 These capital requirements would refer to either the Asset Maintenance Requirement (AMR) or Total CAR thresholds, depending on which regulatory regime each bank belongs to.
shortages persist, banks would be required to conduct fire sales to obtain additional liquidity. Banks would thus incur further capital losses, as their more illiquid asset holdings are sold at larger haircuts below market valuations.

Network simulations suggest that contagion risks remain contained despite the incorporation of multiple exposure interconnections and risk channels

Contagion analysis was performed by assuming the “default” of each bank, one at a time, under each simulation, with the average impact across all simulations highlighted in Table B1. These simulations were conducted under a baseline and a stress contagion scenario. Under the baseline contagion scenario, the haircuts applied take reference from the prescribed haircuts in the LCR and minimum liquid asset (MLA) requirements. LGD values of 45% and 30% are used for uncollateralised and collateralised exposures respectively. For the stress contagion scenario, a 20 percentage point increase in haircuts was introduced across all liquid assets, while the LGD values for both collateralised and uncollateralised exposures were also increased by 20 percentage points.

The contagion simulation results suggest that liquidity stresses are likely to be more significant than capital stresses under the contagion mechanisms specified. Liquidity stresses are exacerbated as banks withdraw interbank funding from each other to address liquidity needs after cash buffers are depleted. Liquidity stresses also generate second-order feedback effects, as banks incur capital losses from the fire sale of assets to meet further funding shortfalls after deleveraging their interbank loans. In addition, sensitivity analysis suggests that contagion impacts are more sensitive to changes in haircuts compared to LGD assumptions, as higher haircuts can impact both capital and liquidity buffers. Banks would incur higher capital losses and simultaneously draw down more on their liquidity buffers to meet funding needs, as larger haircuts would lead to lower liquidation values.

Overall, contagion impacts are found to be contained even under a stress contagion scenario, as banks in Singapore have adequate capital and liquidity buffers to mitigate the propagation of shocks. The banking system would experience a drawdown in capital and liquidity buffers as well as a pullback in interbank funding amounting to less than 1% of its starting total buffers and domestic interbank exposures respectively, with approximately 0.4 to 0.6 banks breaching their regulatory thresholds on average across the two interbank contagion scenarios. Similarly, D-SIBs would experience a depletion of about 0.3% on average

48 A pecking order in the fire sales of firm assets is established with reference to the LCR and MLA requirements. For instance, banks are assumed to liquidate high quality liquid assets that are subject to little or no haircuts under LCR and MLA computations first before relatively illiquid assets are liquidated.

49 Based on the contagion analysis methodology, the trigger for contagion is a “default” arising from the breach of the Total CAR regulatory threshold. Results of the IWST solvency stress test did not reflect this additional contagion impact since all D-SIBs’ stressed Total CAR positions remained above regulatory thresholds under the Adverse scenario.

50 The LGD parameter values used took broad reference from the range of Basel LGD values that were prescribed under MAS Notice 637.

51 For example, an asset that is initially subject to a 10% haircut upon liquidation under the baseline contagion scenario will be subject to a 30% haircut in liquidation value under the stress contagion scenario.
to their starting capital and liquidity buffers. This decline in capital buffers would only lower the D-SIBs’ aggregate CET1 CAR by an additional 0.1 percentage points under the Adverse scenario.

**Table B1** MAS’ sensitivity analysis suggests that contagion impacts would remain contained under both the baseline and stress interbank contagion simulations

<table>
<thead>
<tr>
<th>Contagion Simulation Results (September 2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scenarios/Metrics</td>
</tr>
<tr>
<td>Breach in liquidity thresholds (A)</td>
</tr>
<tr>
<td>Baseline contagion scenario</td>
</tr>
<tr>
<td>Stress contagion scenario (+ 20% haircut, + 20% LGD)</td>
</tr>
</tbody>
</table>

Source: MAS estimates

1. Total average regulatory breaches (Column C) may be smaller than the sum of banks that breach their liquidity thresholds (Column A) or capital regulatory thresholds (Column B), as there are banks that breach both regulatory thresholds.

2. The baseline simulation assumes a 45% LGD for uncollateralised exposures and 30% LGD for collateralised exposures. Haircuts applied under the baseline follow the prescribed haircuts in the LCR and MLA requirements.

**Sum-Up**

D-SIBs have emerged from the COVID-19 crisis with strong capital positions. While the global macroeconomic outlook has weakened considerably since end-2021, results from the IWST 2022 exercise show that D-SIBs would have adequate capital buffers to weather potential downside risks arising from a global recession and a further tightening in financial conditions, with their aggregate CET1 CAR remaining well above MAS’ minimum regulatory requirements.

Beyond assessing direct macrofinancial impacts, MAS also made use of more granular regulatory data to better monitor and assess first and second-order contagion impacts arising from interconnections in the domestic interbank market. The simulation results show that contagion impacts are contained even under the stress contagion scenario, as banks have adequate capital and liquidity buffers to mitigate the propagation of shocks across the interbank network. MAS will continue to refine its stress testing capabilities to better quantify and assess first and second-order macrofinancial impacts arising from plausible adverse scenarios. This continued augmentation of capabilities will ensure that MAS’ stress tests remain useful and relevant as a tool for risk assessment and management.
Singapore’s banking system has weathered the COVID-19 pandemic well, having entered from a position of strength with strong capital and liquidity buffers. Nevertheless, the broader economic and financial effects of COVID-19 have induced shifts in banks’ lending and deposit trends, with attendant effects on their balance sheets. This box identifies these key shifts.

Singapore’s banking system experienced three distinct phases of balance sheet changes since the start of the pandemic

Banks in Singapore experienced balance sheet adjustments in three distinct phases over the pandemic (Chart C1), with each phase characterised by shifts in their portfolio asset composition.

**Phase 1: Initial COVID-19 shock (January 2020 – March 2020)**

The Singapore economy suffered both demand and supply-side shocks, as the pandemic and resultant mobility restrictions brought about severe disruptions to economic activity. For the Singapore banking system, the initial onset of the pandemic was accompanied by a surge in non-bank deposits (Chart C2), as significant economic uncertainty and constrained consumption opportunities led to a build-up in precautionary savings by corporates and households.

Against a backdrop of heightened financial market volatility and economic uncertainty, banks became concerned about a potential weakening of credit quality and exhibited a preference for shorter-term, more liquid assets. As a result, there was stronger growth in Negotiable Certificates of Deposits (NCDs) and interbank lending. Nevertheless, banks supported the economy’s credit needs through the continued supply of non-bank loans even as economic activity was being severely hit (Chart C3).

**Phase 2: Transitory phase (April 2020 – August 2021)**

Subsequently, Singapore entered a transitory phase, with the progressive re-opening of the domestic economy alongside a moderation in new infections globally. On the back of maturing NCDs and gradually improving risk appetites over this period, banks increased their equity investments, partly through strategic investments in other banks. 52 Meanwhile, sustained non-bank lending to meet corporates’ cashflow needs was supported by

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52 An example of such investments was the purchase of a stake in Shenzhen Rural Commercial Bank in October 2021 by DBS Bank.
government schemes and lower-than-market funding costs provided by MAS’ SGD Facility for Enterprise Singapore (ESG) Loans (Chart C3).\(^5\)

**Phase 3: Endemic phase (September 2021 – present)**

As the domestic economy moved towards an endemic phase of living with COVID-19 from September 2021 onward, Singapore’s banking system registered strong growth in assets. This balance sheet expansion was funded by a continued increase in non-bank deposits (Chart C2).

During this phase, banks in Singapore continued to expand their resident non-bank loan books, while shifting their portfolio asset composition towards credit assets such as government debt securities (Chart C3). Banks’ decisions were likely influenced by the safe haven status of such assets amid elevated geopolitical tensions, as well as higher interest rates in recent months. At the same time, interbank loans continued to see strong growth, benefitting from Singapore’s role as an international financial centre.

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**Chart C1** Banks experienced three phases of balance sheet growth in the pandemic...

**Chart C2** ... underpinned by a continued increase in non-bank deposits

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\(^5\) For instance, the government enhanced its risk share proportion and quantum for loans extended to corporates by FIs, under the ESG Temporary Bridging Loan Programme and Working Capital Loan scheme. Refer to Box B in the 2020 FSR for highlights of the measures.
A steady increase in non-bank lending took place throughout all three phases, driven by loans to residents

Across all three phases of the pandemic, non-bank loans have risen steadily, supported by strong growth of loans to residents, even as non-resident loan volumes remained relatively flat (Chart C4).

Non-resident lending experienced an initial boost in Phase 1, reflecting the financing needs of manufacturers in the region who were stockpiling. Non-resident loans have since fallen, driven by a decline in non-resident bills to trade-related sectors, including manufacturing, general commerce, and transport, storage and communication, which have been hard hit by both the pandemic as well as the Russia-Ukraine war.

In contrast, non-bank loans to residents saw healthy growth throughout the pandemic, with some acceleration in Phase 3 alongside the recovery in economic activity. Lending to residents has been underpinned by loans to property-related sectors, in line with the increase in property prices and higher transactions as the residential property market remained resilient. Lending to the financial and insurance sector helped to support resident loan growth as well, alongside the strengthening of Singapore’s position as a major financial centre in the region (Chart C5).
Sum-up

Over the course of the pandemic, the Singapore banking system’s balance sheet has expanded, funded by robust growth in deposits. Banks have also adjusted their portfolio asset composition over time, reflecting changes in their risk appetite and liquidity needs.

As Singapore moves into a post-pandemic phase and as the global macroeconomic and financial backdrop evolves, banks will have to remain watchful for new emerging financial stability risks even as they continue to provide credit on the basis of sound credit assessment frameworks.
Chart Panel 4A  Banking Sector: Credit Growth Trends

Overall loans grew by 8.0% y-o-y in September 2022, supported by growth in non-bank and interbank loans. Firm non-bank loan growth was underpinned by the recovery in domestic economic activity.

Source: MAS estimates

Resident non-bank credit growth was weighed down by declines in lending to the trade-related sectors in recent months, in line with the softening of external demand.

Source: MAS

The credit-to-GDP gap for Singapore has moderated further to −13.6% as of Q3 2022.

Source: MAS
Chart Panel 4B  Banking Sector: Cross-border Lending Trends

*Emerging Asia accounted for close to half of cross-border non-bank loans to non-residents. Meanwhile, interbank loans to Developed Asia and Europe have risen.*

**Chart 4B1** Cross-border non-bank loans by region

**Chart 4B2** Cross-border interbank loans by region

*Source: MAS*

*Banks in Singapore have been net providers of funds to Europe and Americas in recent months. Local banks have also maintained their lending to the region.*

**Chart 4B3** Net lending by region

**Chart 4B4** Net lending to Emerging Asia by bank nationality

*Source: MAS*

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The new MAS 610/1003 was implemented in July 2021 as part of changes to MAS’ regulatory reporting requirements. As data definitions have shifted, certain indicators are not comparable between historical periods (pre-July 2021) and the new MAS Notice 610/1003. Please refer to the Data Annex in MAS’ 2021 FSR for details.
Chart Panel 4C  Banking Sector: Asset Quality and Liquidity Indicators

The overall NPL ratio improved to 1.8% in Q3 2022. Total provisioning coverage remained stable, at 103.5% as of Q3 2022, and was further augmented by general provisions held at the head offices of foreign bank branches.

Banks’ liquidity positions have continued to be strong. Resident deposits are more than sufficient to fund resident loans. All LTD ratios remained below 100% as of September 2022.
Chart Panel 4D  Banking Sector: Local Banking Groups

*Local banking groups’ net profits increased, supported by higher interest income as NIMs picked up.*

**Chart 4D1** Local banking groups’ profit components

Source: MAS, Local banking groups’ financial statements

*Asset quality has improved, with the NPL ratio falling to 1.3% in Q3 2022. Local banking groups continued to maintain a healthy total provisioning coverage of 216% in Q3 2022.*

**Chart 4D3** Local banking groups’ NPLs

Source: MAS, Local banking groups’ financial statements

*Local banking groups maintained robust capital and liquidity positions, with aggregate CARs and all-currency LCRs remaining well above regulatory requirements.*

**Chart 4D5** Local banking groups’ CARs

Source: MAS, Local banking groups’ financial statements

**Chart 4D2** Local banking groups’ NIMs

Source: MAS, Local banking groups’ financial statements

**Chart 4D4** Local banking groups’ provisioning coverage

Source: MAS, Local banking groups’ financial statements

**Chart 4D6** Local banking groups’ all-currency LCR (Q3 2022)

Source: Local banking groups’ financial statements
The insurance industry in Singapore is well-capitalised. The average CAR for the direct life and direct general insurance industry are well above regulatory requirements.\(^{55}\)

**Chart 4E1** CARs of direct life and direct general insurers

New business premium of the direct life insurance industry fell slightly in 2022, largely driven by reduced sales of non-participating and investment-linked products. Net income in 2022 also fell due to unrealised investment losses.

**Chart 4E2** Direct life insurers: New business premiums

Gross premium of the direct general insurance industry increased in 2022 with growth in both SIF and OIF business. While the industry reported positive underwriting results, it also reported unrealised investment losses.

**Chart 4E3** Direct life insurers’ net income by source

**Chart 4E4** Direct general insurers: Gross premiums

**Chart 4E5** Direct general insurers: Operating results

\(^{55}\) With effect from Q1 2020, the valuation and capital framework for insurers in Singapore has been enhanced (revised Risk Based Capital framework, RBC 2). While the RBC 2 is not a major overhaul of the RBC, there are nonetheless some fundamental differences which make the CAR of the two regimes less directly comparable.
OTC derivatives activity in Singapore largely involves foreign banks and dealers. IR and FX remain the largest asset classes based on outstanding notional amounts.

**Chart 4F1** OTC derivatives market in Singapore by asset class and notional outstanding (end-Sep 2022)

- Interest Rate (IR)
- Foreign Exchange (FX)
- Credit (CR)
- Commodity (CO)

<table>
<thead>
<tr>
<th>Asset Class</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>IR</td>
<td>54%</td>
</tr>
<tr>
<td>FX</td>
<td>42%</td>
</tr>
<tr>
<td>CR</td>
<td>1%</td>
</tr>
<tr>
<td>CO</td>
<td>2%</td>
</tr>
</tbody>
</table>

Source: DDRS, MAS estimates

**Chart 4F2** Cross-sectoral breakdown of notional outstanding (end-Sep 2022) – All asset classes

<table>
<thead>
<tr>
<th>Sector</th>
<th>LCL BK</th>
<th>FGN B/D</th>
<th>NBFI</th>
<th>C/O</th>
<th>CCP</th>
<th>INDIV</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>0.5</td>
<td>4.3</td>
<td>0.6</td>
<td>0.3</td>
<td>2.5</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>38.3</td>
<td>18.3</td>
<td>2.0</td>
<td>28.1</td>
<td>1.2</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td></td>
<td>0.6</td>
<td>0.1</td>
<td>1.6</td>
<td>&lt;0.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.9</td>
<td>&lt;0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: DDRS, MAS estimates

Note: LCL BK = Locally incorporated bank; FGN B/D = Foreign bank or dealer; C/O = corporate or other non-bank entity

FX derivatives transactions in the Singapore market comprise mainly of forwards and swaps, with the majority being conducted in developed market currencies.

**Chart 4F3** FX derivatives by product: Monthly new trades

- Forwards and swaps
- NDF
- Spot
- Options
- Others
- Total Count (RHS)

Source: DDRS, MAS estimates

IR derivatives transactions in the Singapore market are mostly denominated in Asia-Pacific currencies, with the majority being IR swaps.

**Chart 4F5** IR derivatives by product: Monthly new trades

- Others
- Options
- Cross Currency Swap
- FRA
- Interest Rate Swap
- Total Count (RHS)

Source: DDRS, MAS estimates

**Chart 4F4** FX derivatives by currency: Monthly new trades

- USDJPY
- USDEUR
- USDSGD
- USDAUD
- USDCNY
- USDGBP
- USDHKD
- USDKRW
- USDINR
- USDTWD
- Others

Source: DDRS, MAS estimates

**Chart 4F6** IR derivatives by currencies: Monthly new trades (excluding cross-currency swaps)

- AUD
- JPY
- USD
- SGD
- KRW
- INR
- THB
- HKD
- NZD
- MYR
- Others

Source: DDRS, MAS estimates
Average degree per counterparty has increased over time for most asset classes. Concentration amongst counterparties has fallen over time across all asset classes except for CR.

Source: DDRS, MAS estimates

Note: Degree refers to the number of connections a counterparty has. Connections are counted based on outstanding positions.

The OTC derivatives network in Singapore is centralised among relatively few influential counterparties, as reflected by high centralisation values.

Source: DDRS, MAS estimates

Note: HHI is calculated based on the sum of the squares of the proportion of notional outstanding of each counterparty. Trades with CCPs have been excluded.
Special Features on Financial Stability
Special Feature 1

Assessing the Impact of Climate Change on Financial Stability

Introduction

Climate change is widespread and intensifying, and there is a rapidly narrowing window of opportunity for successful climate mitigation and adaptation. Accordingly, there has been a growing focus on the risks that climate change could pose for financial stability, both through the manifestation of physical and transition risks as well as amplification effects through the financial system. Last year, the FSB published a roadmap to help coordinate international efforts in addressing climate-related financial risks (henceforth “climate risks”), and has noted the encouraging progress made so far.

From a risk assessment perspective, there is significant uncertainty regarding the timing, frequency and severity of climate-related events and their associated risks. Scenario analysis has emerged as an important forward-looking tool for central banks, supervisors and FIs to assess the potential impact of climate risks. The Network for Greening the Financial System (NGFS) has played a key enabling role by developing climate scenarios for risk assessment purposes, preparing a guide on climate scenario analysis (NGFS, 2020) and publishing reports synthesising financial authorities’ experiences in conducting such analyses (NGFS, 2021; FSB and NGFS, 2022).

This year, MAS conducted a climate scenario analysis exercise for selected key banks and insurers as part of IWST 2022. The exercise was designed to raise awareness of the potential economic and financial implications of climate risks, and facilitate learning for both MAS and FIs as capabilities are developed in this area. It forms part of MAS’ multi-year iterative efforts to assess climate risks, building on MAS’ regular consultations with FIs as well as climate scenario analysis approaches used in other jurisdictions.

Additionally, to complement banks’ and insurers’ IWST 2022 submissions, MAS conducted an internal analysis of the potential implications of climate risks for NFCs under the same scenario pathways, drawing on both proprietary and supervisory datasets (see Box D “Impact of Climate Change on Non-financial Corporates”).

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56 As noted by the IPCC in its recent Sixth Assessment Report.
57 The FSB’s roadmap consists of four blocks, namely (i) firm-level disclosures, (ii) data, (iii) vulnerabilities analysis, and (iv) regulatory and supervisory practices and tools.
58 More information regarding MAS’ approach can be found in Figure S3.3 of Special Feature 3 in MAS’ 2020 FSR.
Climate scenarios featured in IWST 2022

MAS’ IWST 2022 climate scenarios take reference from the Phase II NGFS Scenarios published in June 2021, and have factored in the near-term impact of recent significant developments such as the Russia-Ukraine war. They sketch out three possible pathways over the period 2022–2050:

- The **Orderly Transition** scenario, based on NGFS’ Net Zero 2050 scenario, features an early and orderly transition towards a low-carbon future. Physical risks are limited given decisive actions taken by governments to meet Paris Agreement targets. Transition risks are relatively moderate as timely mitigation policies allow for a more gradual adjustment across economies and sectors. While these structural adjustments initially pose headwinds to the growth outlook and impose short-term costs, macroeconomic outcomes markedly improve by the end of the scenario horizon as the benefits of a successful transition (in terms of technological gains and avoided damages) are realised.

- The **No Additional Policies** scenario explores the potential implications of elevated physical risk over the short and long term. MAS performed an additional overlay on NGFS’ Current Policies scenario to incorporate an acute physical risk shock over the short term. Specifically, the ASEAN-5 economies experience a severe 1-in-200 year flooding event in the first half of 2022, followed by a muted recovery as post-flood reconstruction efforts are impeded by fiscal constraints. Meanwhile, over the long term, the world sees significantly warmer temperatures by 2050, as no new climate policies are introduced beyond those implemented by end-2021. The materialisation of acute and chronic physical risks results in a permanent impact on both labour and capital productivity, and consequently on economic output.

- The **Disorderly Transition** scenario, based on NGFS’ Delayed Transition scenario, features a delayed and disorderly transition towards a low-carbon future. Physical risks are slightly elevated relative to the Orderly Transition scenario, but remain limited overall. On the other hand, with concerted climate policy action commencing only in 2031, transition risks are heightened by abrupt structural shifts in the global economy, leading to sharp inflationary pressures and a slowdown in economic growth over the 2030s especially for emissions-intensive sectors.

A summary of key aspects of the IWST 2022 climate scenarios is provided in Table S1.1.
Table S1.1 Key aspects of MAS’ IWST 2022 climate scenarios

<table>
<thead>
<tr>
<th>Transition risks</th>
<th>Orderly Transition</th>
<th>Disorderly Transition</th>
<th>No Additional Policies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nature of transition</td>
<td>Moderate</td>
<td>Moderate to High</td>
<td>Limited</td>
</tr>
<tr>
<td>Range of shadow carbon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>prices(^61) globally in 2050 (2010 US$/tCO(_2)e)</td>
<td>600–900</td>
<td>500–1100</td>
<td>Below 30</td>
</tr>
<tr>
<td>Physical risks</td>
<td>Limited</td>
<td>Limited</td>
<td>High</td>
</tr>
<tr>
<td>Mean global warming</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>relative to pre-industrial times in 2050 (°C)</td>
<td>1.6</td>
<td>1.8</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Source: NGFS, MAS estimates

Assessing the potential impact of climate change on banks and insurers

The IWST 2022 climate scenario analysis exercise involved selected key banks and insurers, and focused on credit risk for banks and market/insurance risks for insurers. Participating banks represent over 70% of total domestic non-bank lending in Singapore, while participating insurers represent over 90% of total assets (for direct life and composite insurers) and over 70% of gross weighted premiums (for direct general insurers and reinsurers).

Key features of the exercise are summarised below:

- Banks and insurers conducted quantitative projections under the simplifying assumption that their balance sheets stay fixed over the scenario horizon, remaining as they stood at end-2021 (i.e., a static balance sheet approach). To complement these projections, banks and insurers also provided information on management actions\(^63\) that they would potentially undertake under each scenario pathway. This is in recognition that their business models are likely to change over time in response to climate risks.

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\(^{61}\) In the NGFS Scenarios, shadow carbon prices are a measure of overall climate policy intensity, and serve as a proxy for a range of fiscal and regulatory policies (e.g. carbon taxes). A higher price implies more stringent mitigation policy.

\(^{62}\) The temperature pathway used in this scenario is based on the 95\(^{th}\) percentile of the projected distribution of warming outcomes conditional on policy inaction, and was chosen to reflect the uncertainty surrounding temperature pathways and the assessment of associated damages.

\(^{63}\) These management actions were reported separately, and did not factor into banks’ and insurers’ quantitative projections.
On the assets side of the balance sheet, this exercise focused on banks’ and insurers’ exposures to six Climate Policy Relevant Sectors (CPRS) as developed by Battiston et al. (2017).\(^{64}\) as well as sovereign credit exposures. Chart S1.1 shows a breakdown of participating banks’ and insurers’ exposures to CPRS and sovereigns as at end-2021.

In terms of liabilities, this exercise examined insurers’ insurance policy claims across a range of general insurance business lines (e.g. property, liability and financial lines).

Chart S1.1 In terms of assets, the IWST 2022 climate scenario analysis exercise focused on banks’ and insurers’ exposures to CPRS and sovereigns

Breakdown of participating banks’ and insurers’ exposures as at end-2021

![Chart showing breakdown of exposures](chart.png)

Source: Banks’ and insurers’ submissions, MAS estimates

* The “Others” category includes banks’ and insurers’ exposures to non-CPRS corporates, as well as banks’ exposures to retail counterparties.

Projections of climate-related losses, especially over the long time horizons of the IWST 2022 climate scenarios, varied widely across banks and insurers. Such divergences reflect not just differences in the characteristics of portfolios and the methodologies used, but also the numerous limitations that FIs faced when conducting climate risk assessments.\(^{65}\) This, in turn, made it challenging to meaningfully aggregate submissions across FIs—thus, some of the projections in this section are reported as ranges, rather than aggregated point estimates.

\(^{64}\) The six CPRS are “Fossil Fuels”, “Utilities”, “Energy-intensive Manufacturing”, “Building & Construction”, “Transport”, and “Agriculture”. MAS had previously applied the CPRS classification to analyse the climate transition risk exposure of Singapore’s banking and insurance sectors (see “Special Feature 2: Climate Transition Risk Exposure of Singapore’s Banking and Insurance Sectors” in MAS’ 2021 FSR).

\(^{65}\) A recent report on climate scenario analysis exercises by financial authorities globally (FSB and NGFS, 2022) made similar observations regarding the high degree of variability across FIs’ estimates, and cited differences in data and methodologies as potential reasons. A more in-depth discussion of data and methodological limitations faced by banks and insurers for IWST 2022 is included in the next section of this Feature.
A severe flooding shock across the ASEAN-5 economies can give rise to material losses for banks and insurers

The 1-in-200 year flooding event in ASEAN-5 economies at the start of the No Additional Policies scenario results in significant disruptions to economic activity, with ASEAN-5 GDP lower by 5.1% in level terms by end-2022 relative to the No Flood pathway. The shock has a disproportionate impact on sectors heavily reliant on physical capital (e.g. manufacturing, construction), as firms cease operations temporarily due to inaccessibility, power failures and damaged equipment. Flood-related damage faced by businesses, as well as the disruption of supply chains, contribute to inflationary pressures across ASEAN-5 economies and their major trading partners.

Against this backdrop, banks projected that they would incur additional provisions to account for flood-related credit losses, leading to higher credit costs. This rise in credit costs was highly heterogenous across banks (Chart S1.2) given the variation in their business models and lending activities across the ASEAN-5 economies, reflecting locational differences in both the severity of the flood event as well as flood mitigation/adaptation measures across the region. On aggregate, banks projected that their flood-related credit losses in 2022 would amount to about 15% of their net profits.

Meanwhile, general insurers and reinsurers projected a significant increase in gross incurred claims in 2022 primarily due to the impact on their property business line (Chart S1.3), reflecting the effect of flood-related damage on residential and commercial property. While these projected gross incurred claims subsequently fall in 2023 and 2024, they remain slightly elevated relative to end-2021 levels.

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**Chart S1.2** Banks projected higher credit costs to cover losses from the ASEAN-5 flood...

Range and median of banks’ projected cumulative credit cost for ASEAN-5 credit exposures under the No Additional Policies scenario

**Chart S1.3** ...and insurers estimated a significant increase in property-related claims

General insurers’ and reinsurers’ projected gross incurred claims for property business line under the No Additional Policies scenario

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66 Credit costs are calculated by dividing total credit provisions set aside for a given period by the total credit exposure over the same period.

67 This estimate was computed with reference to banks’ FY2021 net profits.
Over the longer term, both physical and transition risks could potentially have a significant impact on banks’ and insurers’ balance sheets

For banks, PDs for their CPRS credit exposures were projected to increase over time across all three IWST 2022 climate scenarios, resulting in a rise in cumulative credit costs over the scenario horizon (Chart S1.4). These reflect elevated credit stresses arising from both transition and physical risks:

- In terms of transition risk, most banks projected a sharper increase in PDs by 2040 under the Disorderly Transition scenario compared to the Orderly Transition scenario, as a relatively abrupt increase in shadow carbon prices over the 2030s would adversely impact corporate profitability through rising production costs and the stranding of assets. This credit deterioration was most pronounced in relatively emissions-intensive CPRS, such as Fossil Fuels and Energy-intensive Manufacturing. Some banks estimated their total credit losses across the two transition scenarios to be quite similar by 2050, as the Orderly Transition scenario featured a higher shadow carbon price trajectory for many Asian economies and a comparatively longer transition period (compared to the Disorderly Transition scenario).

- Meanwhile, in terms of physical risk, a number of banks projected that their PDs would rise the most under the No Additional Policies scenario. Sharp temperature rises under this pathway lead to chronic changes in living conditions, affecting areas such as health, labour productivity, agriculture and sea levels, alongside changes in the frequency and severity of acute physical risk events. Many banks with relatively milder PD estimates under this scenario noted that methodological limitations in assessing physical risk could have contributed to a potential underestimation of losses or defaults, with some performing additional judgemental overlays to account for these limitations.

- Median estimates of banks’ cumulative credit costs for CPRS exposures by 2050 ranged from 587 to 609 basis points across the three scenarios (Chart S1.4). On an annualised basis, the associated credit losses amount to 8–9% of banks’ net profits each year, representing a persistent drag on banks’ profitability.

- These long-term projections are subject to uncertainty bounds and would depend on the modelling approach used. For example, some banks had projected PDs for CPRS exposures to remain relatively low across all three scenarios, as their modelled results were adjusted to account for potential government support (e.g. for state-linked firms). That said, projected losses could be more severe in reality, if climate-related shocks also lead to a deterioration in governments’ fiscal positions.

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68 One reason for the higher shadow carbon price trajectory is the more ambitious overall climate policy stance assumed under the Orderly Transition scenario (leading to a slightly reduced extent of global warming by 2050).

69 These estimates were computed with reference to banks’ FY2021 net profits.
**Chart S1.4** PDs for banks’ CPRS credit exposures were projected to increase over time across all IWST 2022 scenarios, resulting in a rise in cumulative credit costs

| Source: Banks’ submissions, MAS estimates |

For insurers, physical and transition risks were projected to adversely impact both assets and liabilities under the static balance sheet assumption:

- Insurers projected a decline in the market value of their CPRS and sovereign debt holdings for all three scenarios, due to a persistent rise in interest rates across the scenario horizon (Chart S1.5). While the increase in interest rates over the short term is largely a result of the current conjunctural of aggressive global monetary policy tightening, the gradual rise in interest rates over the longer term reflects policy responses to inflationary pressures arising from higher carbon prices and supply-side disruptions due to physical risk events. General insurers would experience a smaller decrease in the market value of their debt holdings, given that they typically hold bonds of shorter duration (that are less sensitive to changes in interest rates). Meanwhile, for life insurers, a rise in interest rates would also lead to a decline in their policy liabilities, partially mitigating the impact on their overall balance sheet positions.

- While insurers’ CPRS equities holdings were projected to broadly increase in market value over the scenario horizon due to continued economic growth, this increase varied considerably across scenarios (Chart S1.6). By 2050, the projected market value of insurers’ CPRS equities holdings was highest in the Orderly Transition scenario, followed by the Disorderly Transition scenario and then the No Additional Policies scenario, reflecting the adverse impact of elevated transition and physical risks on equity valuations. Such shocks were especially pronounced for insurers’ CPRS equities holdings over the period 2030–2035 in the Disorderly Transition scenario, as the abrupt and sharp rise in carbon prices results in the stranding of some carbon-intensive assets for firms in these sectors.

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70 In practice, the fall in policy liabilities may be larger than the fall in the market value of debt holdings, since the duration of insurers’ policy liabilities are typically longer than that of their assets.

71 Even within CPRS, there are marked differences across sectors; for instance, the market value of equities in the Fossil Fuels sector were projected to decline considerably over the Orderly Transition and Disorderly Transition scenarios.
On the liabilities side, general insurers and reinsurers projected the largest increase in unexpired risk reserves\(^{72}\) under the No Additional Policies scenario (Chart S1.7), reflecting the severe stresses associated with physical risk drivers such as rising temperatures and sea levels, as well as the higher frequency and severity of natural catastrophes. However, this projected increase is not expected to be significant, as insurers would be able to adjust premiums to offset the impact from changes in claims given the short-term nature of their contracts. Meanwhile, increases in projected unexpired risk reserves under the Orderly Transition and Disorderly Transition scenarios were both milder, reflecting the relatively limited physical risks under these pathways.

**Chart S1.5** Insurers projected a decline in the market value of their debt holdings under all three scenarios

![Projected market value of insurers' CPRS debt holdings](chart1)

Source: Insurers’ submissions, MAS estimates

**Chart S1.6** Climate risks can impact valuations of insurers’ CPRS equity holdings

![Projected market value of insurers’ CPRS equities holdings](chart2)

Source: Insurers’ submissions, MAS estimates

**Chart S1.7** Projected unexpired risk reserves are highest under the No Additional Policies scenario

![Projected unexpired risk reserves across all business lines](chart3)

General insurers’ and reinsurers’ projected unexpired risk reserves across all business lines

Source: Insurers’ submissions, MAS estimates

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\(^{72}\) Projected unexpired risk reserves represent the total value of expected future payments (i.e. payments for future claims and expenses) arising from future events insured. This is a useful metric to consider as it is a forward-looking assessment of the amount that needs to be set aside to meet future claims which might arise.
Overall, the high-level findings obtained from banks and insurers through this exercise are broadly comparable to those by other jurisdictions.\(^7\) For instance, climate scenario analysis exercises by financial authorities globally find that economic and financial losses arising from climate risks could be significant, highlighting the importance of further work to improve assessments of climate risk (FSB and NGFS, 2022).

A deeper understanding of potential systemic implications arising from climate change will be required

Given the wide-ranging impact of climate change across different geographies and sectors, there is a critical need to better understand potential risk amplification channels and their associated systemic implications. Doing so would require going beyond risk assessments for individual FIs, to consider interactions between climate risk drivers, the financial sector and the real economy. Banks’ and insurers’ submissions for this scenario analysis exercise have suggested some examples of such interdependencies:

- While most banks and insurers indicated that they planned to reduce their asset exposures to emissions-intensive sectors under the Orderly Transition and Disorderly Transition scenarios, a simultaneous withdrawal of credit or investment could lead to the premature stranding of assets, and in turn fuel further contagion including through asset fire sales. In fact, indiscriminate de-risking from such sectors could deprive firms of the necessary funds for them to decarbonise in an orderly fashion.

- Climate change can affect the availability and affordability of (re)insurance, leading to an increased protection gap. While some banks and insurers planned to purchase (re)insurance to hedge against physical risks for exposures in vulnerable geographical locations, some (re)insurers indicated that they would consider raising insurance premiums or stop offering some insurance products altogether.

Looking ahead, it will become increasingly important for banks and insurers to take such interdependencies into account, given their role in supporting climate risk mitigation and adaptation efforts through their financing and insurance services.

**Climate risk assessment capabilities of participating banks and insurers**

An important aspect of MAS’ exercise involved dialogue with participating banks and insurers on their progress in climate risk assessment. Overall, banks’ and insurers’ climate risk assessment capabilities remain at an early stage, with much scope for iterative refinement as challenges are gradually addressed.

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\(^7\) As the design of scenario analysis exercises vary widely across jurisdictions (e.g. due to differences in objectives), only high-level comparisons are possible currently.
Banks and insurers have made meaningful progress in addressing the data gaps identified

In their feedback, many banks and insurers highlighted that standardised and granular data relevant for assessing climate risks were either unavailable or difficult to obtain. For instance, banks and insurers noted extensive gaps in entity-specific data relevant for counterparty-level assessment, especially for smaller and non-listed counterparties—examples of such data fields include greenhouse gas emissions, locations of individual entities’ assets, and forward-looking information about entities’ transition plans. Additionally, even where entity-specific data was available, banks and insurers raised potential consistency and comparability issues due to the absence of standardised reporting or disclosure requirements.

Banks and insurers have undertaken a range of initiatives to address these data challenges. For instance, many banks have requested more entity-level information from their counterparties, including through the use of a standardised questionnaire. Some banks and insurers have also tapped proprietary databases to obtain data such as greenhouse gas emissions and physical risk scores of their counterparties.

Banks and insurers relied on a mix of in-house and third-party modelling capabilities...

Given the nascent stage of work in assessing climate risks, many banks and insurers were reliant on modelling frameworks developed by third parties. Such modelling frameworks were used for (i) the generation of additional scenario parameters beyond those provided by MAS or NGFS, and (ii) risk quantification, to assess the performance of their portfolios under these scenario pathways.

The selection of additional parameters to generate was largely driven by the modelling frameworks that banks and insurers used for risk quantification. Examples include macrofinancial variables such as changes in GDP and equity prices (for specific regions and sectors), transition risk variables such as emissions intensity, and physical risk variables such as localised estimates of the frequency or severity of natural hazards. Many banks and insurers noted challenges in generating these parameters, due to factors such as the long time horizons involved.

Meanwhile, in terms of risk quantification, banks and insurers highlighted that the impact of climate-related shocks are highly heterogenous and hence not well captured by conventional portfolio-level analyses. To address this, many banks used climate-adjusted credit risk models for a subset of key corporate counterparties, before extrapolating the estimated impact to other counterparties with similar risk profiles (e.g. those in the same region or sector). Similarly, some insurers focused their physical risk assessment efforts on projecting insurance claims for more material geographies and business lines, and then

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74 As an example of potential data collection approaches, some banks cited the Environmental Risk Questionnaire recently developed by Singapore’s Green Finance Industry Taskforce, which aims to provide a consistent baseline template for banks’ data gathering efforts from their customers.

75 Such counterparty-level credit risk models generally involve translating industry and market dynamics into financial impact (e.g. revenues, capital expenditure) at an individual firm level, before using them to compute risk metrics (e.g. PD, LGD).
extrapolating these estimates across other geographies and perils. A number of banks and insurers highlighted that having more granular data could help improve the accuracy of extrapolation approaches.

Many banks and insurers noted that approaches for assessing physical risk were relatively less developed compared to those for assessing transition risk. For example, while many banks' transition risk assessments factored in the impact to both counterparties and their supply chains, their physical risk assessments largely focused on the direct impact to counterparties only (e.g. damages to physical assets, disruptions to business operations). Another example involves general insurers and reinsurers, which have successfully used probabilistic catastrophe models to assess and monitor potential losses from major perils, but these models do not lend themselves well to making projections over multiple decades. Some insurers highlighted challenges in estimating projected claims for certain business lines and geographies due to the lack of commercially available catastrophe models, relying instead on analyses of historical claims and expert judgement in formulating input assumptions.

... and validation of these methodological approaches is ongoing

Beyond the limitations of the modelling frameworks used, banks and insurers highlighted difficulties in validating the methodologies they used for climate risk assessment. This reflected a lack of historical data to establish with some certainty the relationships between climate-related shocks and macrofinancial outcomes, as well as the longer time horizons involved when making projections. Furthermore, many of these methodologies rely on expert judgement in formulating input assumptions, making it hard to develop a strict quantitative threshold to validate model performance. Some banks and insurers also raised challenges in assessing data and models used by third parties, given the limited transparency and disclosure of such proprietary frameworks.

In recognition of these challenges, banks and insurers have been undertaking preparatory work for future validation efforts. Examples include undertaking additional data collection initiatives to facilitate backtesting of model estimates, and reviewing academic publications to inform the development of model validation standards. Over time, it would be important for banks and insurers to build internal expertise in climate risk assessment, so that they are better equipped to interpret and refine their assessment approaches.

Management actions, and their impact on banks and insurers’ performance, remain challenging to quantify

As part of this exercise, banks and insurers set out a range of management actions that they would potentially adopt under the various climate scenarios. For many banks and insurers, such management actions took reference from their existing sustainability or climate-related targets, and were not yet tailored to specific scenarios. Examples of these actions include: (i) sketching out business plans with clear quantitative targets and appropriate timeframes, (ii) establishing concrete strategies for counterparty engagement and data collection, (iii)
instituting clear lending, investment or underwriting policies with regard to climate risk, and
(iv) developing a framework or methodology to quantitatively size the impact of potential
management actions on balance sheets. Most highlighted challenges in quantifying both the
triggers for carrying out these actions as well as their projected impact on balance sheets.

Conclusion and next steps

MAS’ IWST 2022 climate scenario analysis exercise has served as an important learning
experience for both MAS and the industry. Through this exercise, participating banks and
insurers have started to incorporate climate-related considerations into their risk assessment
frameworks, building on both in-house and third-party expertise. More importantly, they have
also identified data and methodological gaps that will inform their future data collection and
model development work. MAS will continue to engage FIs on their efforts in implementing
climate scenario analysis, building on the lessons learnt from both this exercise as well as
similar initiatives by other central banks and supervisors.

Beyond our engagements with FIs, MAS will undertake further work to improve internal
capabilities in climate-related modelling and scenario analysis, and explore collaborations
with external stakeholders. For example, Project Viridis, a joint initiative by MAS and the BIS
Innovation Hub Singapore Centre, will integrate existing regulatory data with external data
sources to provide insights on climate risks (see Box E “Project Viridis: A Climate Risk Platform
for Financial Supervisors”). MAS will continue to work in partnership with industry, academia,
other regulators as well as international organisations to strengthen the resilience of the
financial system to climate risks.
Box D
Impact of Climate Change on Non-financial Corporates

MAS analysed the impact of climate risks on D-SIBs’ top NFC counterparties under the climate scenario pathways featured in IWST 2022. The scope of the analysis was extended to over 500 local and foreign NFCs, which accounted for about 75% of D-SIBs’ top NFC credit exposures. Several commercial and regulatory datasets were used to facilitate the analysis.77

Physical hazard risk scores were used to assess NFCs’ vulnerabilities to physical risks

Physical risk scores by Four Twenty Seven78 provided insights on the physical hazards relevant to banks’ top NFC counterparties by geographical location. For instance, NFCs located in low-lying areas in Southeast Asia and western Europe are relatively more vulnerable to floods,79 while NFCs located in certain coastal regions in North Asia are more susceptible to hurricanes and typhoons. On the Indian subcontinent, heat stress and wildfires are the more pertinent physical risk hazards (Chart D1).

There is also a significant number of counterparties that are vulnerable to multiple physical hazards. This is a concern as research80,81 shows that the impact of physical hazards can be interconnected or even amplified. For example, a typhoon could damage flood protection infrastructure and exacerbate the impact of floods on low-lying coastal areas.

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77 These included (a) firm-level financial information from the Orbis database, (b) corporates’ physical risk scores obtained from Four Twenty Seven, and (c) regulatory data on D-SIBs’ loan exposures to their top hundred NFC counterparties.

78 Four Twenty Seven, an affiliate of Moody’s, is a climate risk data firm that provides physical risk scores by geographical location.

79 An NFC would be regarded as being vulnerable to a physical risk hazard if it has physical risk scores that are classified as either “high risk” or “highest risk” based on Four Twenty Seven risk score thresholds.


The identification of physical risk drivers provides a basis for identifying banks’ vulnerability to physical risk through their credit exposures. Based on MAS’ estimates, about 58% of D-SIBs’ top credit exposures are to NFCs that are vulnerable to at least one physical hazard, while 29% are vulnerable to two or more. From a credit exposure angle, the hazard that D-SIBs’ top NFC counterparties are most prone to is floods (27%), followed by hurricanes and typhoons (20%) (Chart D2). These findings from this analysis further corroborate MAS’ choice of including a 1-in-200 year flooding event overlay in the IWST 2022 climate scenario analysis exercise.
Special Features on Financial Stability

MAS modelled how climate risks could affect NFCs’ financials under the climate scenarios featured in IWST 2022. Adapting the methods used by the European Central Bank (ECB)\(^82\) and various industry practitioners, the elasticities of firm-level financials (i.e. total assets, revenues and operating expenses) to historical GDP growth rates, inflation rates, and consumption tax rates\(^83\) were first estimated using panel regressions. The coefficient estimates were then used to project firm-level profitability by applying the climate scenarios’ forward-looking macroeconomic and financial parameters. **Figure D1** provides an overview of the transmission channels from climate risks to corporate profitability.\(^84\)

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**Chart D2** Flood risk features prominently in D-SIBs’ top loan exposures to NFCs

Proportion of D-SIBs’ top loan exposures to NFCs vulnerable to physical risk, by hazard type

![Chart D2](image)

Source: Banks’ submissions, Four Twenty Seven, MAS estimates

Note: Chart shows the proportion of top credit exposures to NFCs with physical hazard risk scores that are classified as either “high risk” or “highest risk” based on Four Twenty Seven risk score thresholds.

**MAS modelled the impact of climate risks on NFCs’ balance sheets**

MAS modelled how climate risks could affect NFCs’ financials under the climate scenarios featured in IWST 2022. Adapting the methods used by the European Central Bank (ECB)\(^82\) and various industry practitioners, the elasticities of firm-level financials (i.e. total assets, revenues and operating expenses) to historical GDP growth rates, inflation rates, and consumption tax rates\(^83\) were first estimated using panel regressions. The coefficient estimates were then used to project firm-level profitability by applying the climate scenarios’ forward-looking macroeconomic and financial parameters. **Figure D1** provides an overview of the transmission channels from climate risks to corporate profitability.\(^84\)

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\(^{83}\) Rising carbon prices are modelled as an increase in consumption tax rates.

\(^{84}\) The profitability metric used is ROA.
The impact of physical risk is reflected in the scenario pathways through GDP losses. To augment the analysis, Four Twenty Seven physical risk scores were used to estimate damage to individual NFCs’ physical assets. NFCs that are more vulnerable to various physical hazards would experience higher damage to their physical capital, which would result in reduced productive capacity and revenues.

The impact of transition risk is reflected in the scenario pathways through higher carbon prices, as well as slower GDP growth and higher inflation. NFCs would incur higher operating expenses as carbon prices rise, and register weaker revenues as growth slows due to structural transition-related adjustments in the economy.

Based on MAS’ analysis, the physical risk impact was found to be more significant relative to the transition risk impact, and the section below will focus on key findings for physical risks under the No Additional Policies scenario.

Projected physical risk impacts are potentially significant, and vary significantly across NFCs

Physical damage to NFCs’ assets is significant under the No Additional Policies Scenario, almost double that under the Orderly Transition scenario due to heightened chronic and acute physical risks that proliferate and manifest more severely (Chart D3). The impact of higher physical damage is reflected in lower revenues due to reduced production capacity. Correspondingly, the profitability for the median NFC would decrease by around seven percentage points relative to the Orderly Transition scenario in 2050 (Chart D4).85

Additionally, the impact on profitability could vary significantly across NFCs depending on their physical risk profiles. Under the No Additional Policies scenario, an NFC that is more

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**Figure D1** Schematic overview of the methodology used to estimate the impact of climate risk drivers on NFCs’ profitability

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85 Similar to ECB’s approach in Alogoskoufis, S, et al. (2021), MAS compares the impact of profitability for a firm under the No Additional Policies and Disorderly Transition scenario by using the Orderly Transition scenario as a counterfactual baseline.
susceptible to physical risk\textsuperscript{86} could experience lower profitability of 21 percentage points relative to the median NFC by 2050. The wide range of projected outcomes reflects the potentially outsized impact of physical risk due to accumulated physical damages, with vulnerable NFCs experiencing persistent deterioration in profitability over the scenario horizon.

**Chart D3** Projected physical damage is higher under the No Additional Policies scenario

Projected physical damage as a percentage of total assets across climate scenarios for the median NFC

**Chart D4** An NFC that is more susceptible to physical risk could experience much lower profitability

Change in NFC profitability relative to the Orderly Transition scenario

Source: NGFS Scenarios, Orbis, Haver, Four Twenty Seven, MAS estimates

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**Sum-Up**

This analysis forms part of MAS’ continued efforts to improve its capabilities to assess financial sector risks arising from climate change. By using various regulatory and proprietary commercial datasets, MAS has obtained preliminary estimates of the impact of both transition and physical risks on NFCs’ financial performance at the granular firm level. Overall, the analysis suggests that physical risk impact could be relatively pronounced, and could vary significantly across NFCs depending on their physical risk profiles. Hence, it is important for FIs and NFCs to build capabilities in physical risk assessments as part of their broader efforts to strengthen their climate risk management practices. MAS will continue to work in partnership with FIs and the international community to address data and methodological gaps and support FIs’ capability development efforts, while also building internal capabilities to better assess and quantify NFCs’ vulnerabilities to climate risks and the potential resulting impact on FIs’ portfolios.

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\textsuperscript{86} In the context of this analysis, NFCs that are more susceptible to physical risk are defined as those which experience profitability impacts that are at the 90th percentile of the impact distribution or higher.
Box E

Project Viridis: A Climate Risk Platform for Financial Supervisors

Financial supervisors recognise that FIs and the financial system need to be resilient to climate risks. However, monitoring and analysing such risks is challenging because of the limited visibility into climate risks faced by FIs’ customers. Supervisors lack systematic access to information on the carbon footprint and geographical distribution of the corporates that banks are financing. There is an absence of consistent and comparable climate-related data.

Technological solution to produce timely insights on climate risk

MAS and the BIS Innovation Hub Singapore Centre have launched Project Viridis to help supervisory authorities identify and assess material climate risks. Project Viridis is a data and analytics platform that allows supervisors to search for and obtain information on climate risks to assess their impact on FIs and the financial system. By integrating existing regulatory data with available structured and unstructured climate data from newsfeeds and data providers, supervisors can connect climate risks to FIs’ customers, sectors and geographies. Supervisors can then conduct more effective follow-ups with FIs on climate-related issues.

Two design thinking workshops—one with climate-focused supervisors from MAS, and the other with participants from the financial industry and academia—were organised to scope the project. A desired set of indicators covering transition risk, physical risk, asset-level (e.g. plant or site) information and system-wide aggregates were identified for incorporation into the platform.

The first and current prototype of the Viridis platform is anchored on climate-related data of banks’ customers, such as their Scope 1, 2 and 3 emissions data, and the geographical location of the assets of such firms. The platform estimates the cost of emissions faced by each firm under scenarios featuring different carbon pricing trajectories to assess the financial impact of a climate transition. It also incorporates available data on physical hazards to highlight firms’ physical risk vulnerabilities, based on the geographical distribution of their assets.

Loan data of banks, at the counterparty level, are also displayed on the platform to show the exposures of banks to climate risks via their borrowers. For each FI, financed

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87 This article was jointly prepared by MAS and BIS Innovation Hub Singapore Centre.
88 The BIS Innovation Hubs aim to identify and develop deep insights on key technology trends affecting central banking, and develop public goods that improve the functioning of the global financial system. The Hubs also promote innovation amongst the central banking community. As of October 2022, the Hubs can be found in Hong Kong SAR, Singapore, Switzerland, London and Stockholm, while the BIS also has a strategic partnership with the Federal Reserve in New York.
89 Synthetic data are used for the purposes of the prototype.
emissions\textsuperscript{90} are reported by sector and by country, and these can be aggregated to get a system-wide view.

The platform also provides supervisors with real-time alerts on material climate-related developments, as a form of early warning. Text analytics is applied to news articles to identify specific climate risk drivers, like acute physical shocks or carbon tax changes, and the firms at risk, which are then matched to the banks who have exposures to such firms.

**Project Viridis makes clear the challenges in conducting climate risk analysis**

The Project Viridis prototype makes clear that there are still significant challenges confronting the effective monitoring and analysis of climate risks.

Data issues, including a lack of authoritative data sources, is a major difficulty. It was challenging to piece together data on physical hazards by geographical location systematically, and gaps remain. In addition, available Scope 1, 2 and 3 emissions data, which are key to understanding a firm’s exposure to transition risks, are not comprehensive. The emissions data are not sufficiently granular, and cannot be disaggregated by a firm’s assets, which can be in multiple jurisdictions, each with its own climate ambitions. Where such data are model-derived, they tended to be sensitive to the models used, making cross-comparisons across firms, sectors or jurisdictions difficult. Some of the estimation methodologies were “black-boxes”, which made outputs hard to interpret. Comparability was also an issue for ESG ratings, as each rating agency has its own ratings framework.

To address such issues, the Viridis platform draws data from different information service providers and presents related data together to facilitate comparison, interpretation, and analysis. Where available, information on methodologies and definitions are presented to help users better understand the various metrics.

**Next steps**

The Viridis prototype with an initial set of functionalities was presented to other financial supervisory/regulatory authorities at the Singapore FinTech Festival 2022 and the ECB’s Supervisory Innovators Conference, to seek feedback.

In the next phase of work, the Viridis platform will be finetuned based on the feedback received before it is released to interested central banks and financial supervisors through the BIS Open Tech initiative.\textsuperscript{91} The goal is ultimately to provide a tool to enable more targeted conversations between supervisors and FIs on the management of climate risks.

\textsuperscript{90} For Project Viridis’ purposes, financed emissions refer to the indirect as emissions attributable to FIs’ financing activities.

\textsuperscript{91} See https://www.bis.org/innovation/bis_open_tech.htm?m=3098. Financial authorities can contact the BIS Innovation Hub Singapore Centre, to share their views on how to improve the prototype, or to collaborate to further enhance the platform (with better data, analytics or functionalities).
**Figure E1** Dashboard providing a system-level view of exposures, by counterparty and industry

![Dashboard providing a system-level view of exposures](image1)

Source: Viridis platform

**Figure E2** Map capturing exposure of a borrower’s assets to specific physical hazards

![Map capturing exposure of a borrower’s assets](image2)

Source: Viridis platform
References


Network of Central Banks and Supervisors for Greening the Financial System (2021), “NGFS climate scenarios for central banks and supervisors”.

Special Feature 2

Financial Stability Implications of the Global Crypto-asset Ecosystem

Introduction

The global crypto-asset\textsuperscript{92} ecosystem has grown in size and sophistication in recent years, raising concerns about financial vulnerabilities and spillovers to the broader financial system. Stronger interconnections between the global crypto ecosystem and the traditional financial system increase the likelihood that shocks from the former propagate to the wider financial sector, and be amplified by leverage taken on by crypto market participants and FIs.

Another potential financial stability risk arises from new modes of financial intermediation and changes to the structure of the financial system due to the adoption of crypto-assets and its underlying technologies. Importantly, with the decentralised and permissionless manner in which financial activity is conducted, crypto-based financial services may bypass regulations that ensure market functioning, market integrity and resilience. These vulnerabilities and potential stresses are distinct from those created by linkages between the global crypto ecosystem and the traditional financial system.

This Feature examines these two aspects regarding the financial stability implications of crypto-assets. The types of crypto-assets and financial activities in the global crypto ecosystem, as well as their inherent vulnerabilities are sketched out first, before their financial stability implications are drawn out and discussed together with the approach to manage attendant risks.

Overview of crypto-assets and DeFi

Three sub-categories\textsuperscript{93} in the crypto-asset space are considered: (i) stablecoins; (ii) crypto-assets other than stablecoins (henceforth referred to as “other crypto-assets”); and (iii) decentralised finance (DeFi).

\textsuperscript{92} In this Feature, crypto-assets are defined as private sector digital assets that depend primarily on cryptography and distributed ledger or similar technology to store, record and transfer values across digital networks.

\textsuperscript{93} Digital assets issued by the public sector, such as central bank digital currencies (CBDC) and tokenised traditional assets (such as Sembcorp Industries’ tokenised sustainability-linked digital bond), are not within the scope of this Feature. For more information about MAS’ initial assessment of the economic case for a retail CBDC in Singapore, see “A Retail Central Bank Digital Currency (CBDC): Economic Considerations in the Singapore Context”, available at https://mas.gov.sg/publications/monographs-or-information-paper/2021/retail-cbdc-paper.
Stablecoins

Stablecoins are crypto-assets that aim to maintain a stable value relative to a specified currency, asset or basket of assets (i.e. asset-pegging, henceforth “pegs”), most commonly fiat currencies such as the USD. Given their stated aim, stablecoins serve as the de facto medium of exchange in the crypto ecosystem. Accordingly, the demand for stablecoins has grown in line with activity in the ecosystem (Chart S2.1). However, price data shows that stablecoins are in fact not that stable. Prices reflected on crypto exchanges regularly deviate from pegs, in certain cases to the point where the stablecoin persistently trades at a significant discount to the peg and ceases to function as a medium of exchange (Chart S2.2).

Most stablecoin issuers claim to back the total value of stablecoins in circulation with reserve assets. The composition and quality of these reserve assets can vary, with some issuers choosing to hold traditional financial assets such as cash deposits at banks, shares in money market funds, government bonds or other securities, while others may choose to hold crypto-assets. The extent of backing also varies, ranging from partially-backed to more than fully-backed with respect to the stablecoins in circulation. Stablecoin issuers that hold more high-quality liquid assets such as cash or cash-equivalent reserves, as well as those that are transparent about the reserve assets they hold, tend to generate more confidence in their ability to honour redemptions at face value, which has in turn typically resulted in smaller price deviations from the peg.

94 For example, as of end October 2022, the largest stablecoin by market capitalisation, Tether, held 43% of its total reserve assets in US Treasury bills, 13% in commercial paper and certificates of deposit, 10% in money market fund shares, 5% in corporate bonds, funds and precious metals, and 8% in other investments (including digital tokens), among other assets (Tether Operations Limited, 2022).

95 Examples of stablecoins that are partially backed by reserve assets include Frax. Stablecoins such as Tether and USD Coin are at least fully backed by reserve assets. Stablecoins that are more than fully backed by reserve assets include those generated by collateralised debt protocols, such as Dai.
Other crypto-assets

Other crypto-assets are held to pay blockchain utilisation fees ("gas fees") and more generally for portfolio diversification or speculative purposes. Notwithstanding their exceptional volatilities relative to fiat currencies and other risky assets (Chart S2.3), there is substantial interest in the trading of such crypto-assets and their derivatives on crypto exchanges (Chart S2.4).

Chart S2.3 The realised volatility of other crypto-assets is exceptionally high relative to fiat

Rolling 30-day volatilities

Source: Bloomberg

Chart S2.4 Trading volumes of other crypto-assets are substantial

Monthly trading volumes on crypto exchanges

Source: CoinMarketCap, Coingecko, MAS estimates

DeFi

DeFi is defined in this special feature as a set of financial applications that operate using crypto-assets and smart contracts, with limited or no involvement of centralised intermediaries. A key feature of DeFi applications is their use of smart contracts to define protocols of behaviour relating to financial transactions between different parties. Smart contracts therefore replace the role of FIs as intermediaries. Due to the decentralised nature of DeFi applications, their proper functioning relies on economic incentives to encourage users to carry out activities that would otherwise normally be undertaken by centralised intermediaries. For example, DeFi lending applications that rely on third parties to liquidate under-collateralised loan positions must ensure an adequate payoff to incentivise liquidators, or risk loan-level insolvencies.

96 A survey of hedge funds by PricewaterhouseCoopers found that the most common reason for investing in crypto-assets cited by hedge fund managers was "general diversification", followed by "market neutral alpha opportunities" and "long-term outperformance" (PwC, 2022).

97 Smart contracts are code that specify variables and conditions which determine whether pre-defined actions can or cannot be undertaken. They are not "smart" in the sense of being able to adapt code autonomously and in non-pre-defined ways, and they are not "contracts" in the sense of bearing legal significance.

98 For purposes of this Feature, centrally managed and operated entities using smart contracts are not considered examples of DeFi.
As a set of financial applications rather than an instrument or asset, DeFi can be viewed as platforms that facilitate lending, trading, exchange, payment, transfer, settlement and custody of stablecoins and other crypto-assets. DeFi has grown in size alongside that of crypto-assets, and encompasses a wide variety of financial activities (Charts S2.5 and S2.6).

**Vulnerabilities in the global crypto ecosystem**

The global crypto ecosystem is subject to exogenous shocks, similar to the traditional financial system. Vulnerabilities within the global crypto ecosystem increase the likelihood or impact of systemic disruption when shocks occur. While some of these vulnerabilities are similar to those in the traditional financial system, others stem from the use of new technologies, novel structures of organisation, or modes of financial intermediation that hew to the hallmarks of the crypto ecosystem.

**Vulnerabilities common across stablecoins, other crypto-assets, and DeFi**

**Technology, cyber and operational risk:** The proper functioning of the crypto ecosystem is contingent on the robustness of the underlying blockchain infrastructure. Should blockchain networks encounter operational disruptions, crypto-assets transactions cannot be recorded and completed. The use of stablecoins as mediums of payment and trading on crypto-asset markets will be disrupted. DeFi applications that run on blockchain networks, and financial intermediation facilitated by their protocols, likewise cannot proceed. More broadly, hacking and exploiting of software vulnerabilities can also impair the functioning of the crypto
ecosystem. While traditional finance is also subject to cyber risks, these are a relatively greater threat to the crypto ecosystem because of its comparatively higher level of technological intensity. Additionally, the open source nature of the technologies used in the crypto ecosystem makes unresolved cyber vulnerabilities more visible and, all else equal, more likely to be exploited than the proprietary technologies used in traditional finance.

Vulnerabilities of stablecoins and their issuers

**Liquidity mismatches and run risk:** The principal vulnerability of stablecoin issuers lies in the liquidity mismatches on their balance sheets. Stablecoin issuers’ promise of timely redemption makes their liabilities short term in nature, but to generate a positive margin over their costs, they may hold relatively illiquid assets to earn liquidity premiums.

As is the case for other traditional FIs, the occurrence of liquidity mismatches makes stablecoin issuers susceptible to runs. Should the value of redemptions exceed that of liquid assets, stablecoin issuers may be pressured into fire sales of reserve assets, potentially creating one-sided markets that result in substantial asset losses. Such losses undermine confidence in the ability of stablecoin issuers to honour further redemptions, leading to “death spirals” of more redemptions and losses. Left unaddressed, such runs on even one stablecoin can trigger wider contagion to others.

**Credit, currency, duration and market risk:** The absence of rules on the composition of reserve assets could lead to the build-up of other financial risks, such as credit, currency, duration, or market risk. The use of crypto-assets as reserve assets leaves issuers particularly exposed to market risk, given the high volatility in prices and other vulnerabilities (see next section). The complexities of these risks also increase if stablecoin issuers choose to engage in more sophisticated forms of financial intermediation, such as credit underwriting, or the use of leverage to finance activity. Losses incurred from exposures to these risks could undermine confidence in the solvency of stablecoin issuers, triggering runs by holders of stablecoins.

Vulnerabilities of other crypto-assets and their markets

**Susceptibility to price corrections:** The principal vulnerability of non-stablecoin crypto-asset markets lies in their susceptibility to price corrections. While it has been argued that crypto-assets could be gold-like safe havens or inflation hedges, data suggest the behaviour of these assets correlates more to that of riskier assets\(^{100}\) ([Chart S2.7]), especially during times of stress. More broadly, the absence of a fundamental value implies that much trading is speculative in nature and highly sentiment-driven, leaving crypto-asset markets more susceptible to large swings in prices than more conventional types of assets ([Chart S2.8]). This can also be observed from the earlier [Chart S2.3], where the realised price volatility in these markets has on average been seven times higher than for global equities.

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\(^{99}\) For example, as of October, hackers have stolen USD3 billion from DeFi applications in 2022 (Chainalysis, 2022). Several DeFi applications ceased to function after these incidents.

\(^{100}\) Studies by the IMF have found that Bitcoin and Ethereum returns had been positively correlated with equity and high-yield corporate bond returns, and negatively correlated with investment grade bond returns in 2020–2021 (IMF, 2022).
The returns of other crypto-assets have been increasingly correlated with those of risky assets

Rolling 90-day correlations of daily returns

Number of trading days

Source: Bloomberg, MAS estimates

Note: Daily returns are calculated from daily close prices.

Leverage: As is the case for traditional asset markets, the use of leverage also amplifies the market’s susceptibility to price corrections in crypto-asset trading. Leverage to fund trading can be obtained through several means, and can reach high levels. By multiplying the potential returns on investment, the use of leverage amplifies the respective positive and negative wealth and confidence effects arising from a rise and fall in prices. To the extent that leverage is secured with collateral, an unwinding of leverage can also trigger procyclicalities in crypto-asset markets. Specifically, liquidations of collateral may add further momentum to downward price movements that had initially triggered the unwinding of leveraged positions.

Interconnectedness and concentration risk: Another vulnerability of crypto-asset markets is the concentration of multiple financial services in the same entities. Not unlike traditional stock exchanges, crypto exchanges serve as critical infrastructure for trading. However, crypto exchanges also provide a greater range of services than traditional stock exchanges, such as custody and margin trading services. Some exchanges also perform additional payment functions by issuing stablecoins. The concentration of services in crypto

101 Margin trading services are offered by crypto exchanges, crypto derivatives products with implicit leverage are created by and traded on both crypto exchanges and traditional derivatives exchanges, and borrowing of crypto-assets or the financing of crypto-asset trading are available from traditional FIs or DeFi protocols. Margin trading on crypto exchanges can enable leverage of up to 20 times for spot positions and 125 times for derivatives positions.

102 These procyclical tendencies are exemplified by the recursive use of DeFi lending protocols to build leveraged exposures to crypto-assets. As DeFi lending protocols rely on over-collateralisation and timely liquidation of collateral to minimise credit losses, their smart contracts encourage liquidators to close outstanding loan positions and liquidate collateral when the value of the loan relative to the value of collateral drops below predefined—and generally very conservative—thresholds. The liquidation of collateral can be automatically triggered during times when market liquidity is poor. Liquidations during times of poor market liquidity can amplify price pressures that trigger further liquidations. While these practices are optimal for the DeFi lending protocol and its users, by encouraging procyclicality, their impact on the system may be suboptimal.
exchanges not only exposes them to a wider range of operational and financial risk, but also creates critical nodes of failure.

Recent events, including those associated with crypto exchanges,\(^{103}\) have highlighted the importance of crypto intermediaries having adequate risk management practices and sound governance to manage liquidity, credit, and market risks on their balance sheets. The failure of a systemically important crypto entity can cause contagion risks within the crypto ecosystem, triggering selloffs and significant broad-based declines in crypto-asset prices, and potentially create financial strains on other market participants.

Crypto-asset markets are also dependent on the functioning of stablecoins and their issuers. As the *de facto* medium of exchange, stablecoins are relied upon as a settlement instrument in the trading of other crypto-assets. This dependency means that stablecoin vulnerabilities are part of crypto-asset market vulnerabilities. A failure of a stablecoin could lead to a shortage of liquidity on crypto-asset trading markets and cause broader market dysfunction.

**Vulnerabilities of DeFi**

**Decentralised functioning and operational disruptions:** DeFi applications depend on smart contracts and decentralised blockchain networks to carry out their functions, which vary in complexity (e.g. from recording transactions to providing a bridge for the transfer of crypto-assets between blockchains). Cyberattacks, such as hacks or exploits of coding vulnerabilities, can therefore severely disrupt DeFi application operations. The decentralised governance of DeFi applications also increases the likelihood that such operational disruptions are not resolved in a timely manner. While most DeFi applications have in place governance structures\(^{104}\) capable of making operational or strategic decisions, there is uncertainty over whether operational disruptions can be rectified in a consistent and timely manner in the absence of entities legally responsible for ongoing oversight.

**Interconnectedness:** Another vulnerability common to all DeFi applications lies in the composable nature of smart contracts that enables the combination of several DeFi protocols to construct more complex applications. Dependencies between DeFi protocols create multiple points of potential failure that may be exploited by hackers, while a cyber-attack or operational disruption on a single DeFi application could affect the functioning of other DeFi applications. Interconnections across DeFi applications also increase the complexity of financial intermediation, which make it more challenging to track user activities.

Finally, the failure of a stablecoin as medium of exchange would remove a critical settlement instrument needed to facilitate activity on DeFi protocols.

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\(^{103}\) Such crypto entities can pose systemic risks as they often provide multiple services (e.g. custody, brokerage, lending and settlement), and have strong linkages with their affiliates (e.g. through related party transactions). These crypto groups have opaque structures and interdependencies, and could conduct intra-group transactions that create conflicts of interest and market integrity risks as they are not subject to prudential regulations or governance and market conduct rules.

\(^{104}\) Most DeFi applications’ governance structures revolve around smart contract developers and governance token holders. Smart contract developers can choose to propose changes to the code of existing smart contracts, and governance token holders reserve the right to approve or reject these proposals, not unlike corporate shareholders.
Financial stability implications

The financial system stability implications of stablecoins, other crypto-assets, and DeFi can be grouped into the two categories in Figure S2.1. The first arises from the vulnerabilities in crypto-assets and the crypto ecosystem discussed above that increase the likelihood or impact of shocks within the ecosystem, the materialisation of which could become systemically disruptive if propagated to the wider financial sector.

The second category of financial stability implications arises from the changes to the structure of the financial system caused by the adoption of crypto-assets and the underlying technology. The changes could take the form of new modes of financial intermediation, a displacement of incumbent mediums of exchange and other financial services providers, which could accentuate the volatility of cross-border capital flows. Thus, there is the potential of disruption to the stability of the business models of banks and other regulated FIs, as well as non-trivial implications on the monetary and external stability of economies. Shadow finance could also emerge more prominently alongside the attendant vulnerabilities, given the potential for financial services to bypass regulations through the adoption of crypto-assets and the underlying technology.

Figure S2.1 Financial stability implications of the global crypto ecosystem

<table>
<thead>
<tr>
<th>Sources of financial stability risk</th>
<th>Crypto-asset and crypto ecosystem vulnerabilities</th>
<th>Changes to the structure of the financial system</th>
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<tbody>
<tr>
<td>Transmission to financial stability</td>
<td>Connections between crypto ecosystem and traditional financial system</td>
<td>Proliferation of stablecoins for payments</td>
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<td></td>
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<td>Proliferation of DeFi for financial intermediation</td>
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<td>Reduced frictions to cross-border capital flows</td>
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<td>Mitigants</td>
<td>Balance sheet and wealth effects</td>
<td>Dollarisation/“cryptoisation”</td>
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<td>Greater share of unregulated financial activity</td>
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<td></td>
<td>Confidence effects</td>
<td>Increased capital flow volatility</td>
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<td></td>
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<td>Sound macroeconomic fundamentals, and credible monetary and fiscal policy frameworks</td>
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<td></td>
<td></td>
<td>Efficient and trusted regulated financial system</td>
</tr>
</tbody>
</table>

Source: MAS

Financial stability implications of connections between the global crypto ecosystem and the traditional financial system

Linkages between the global crypto ecosystem and the traditional financial system can take several forms. Crypto ecosystem participants can hold traditional financial assets, which connect their balance sheets to traditional asset markets. In a similar vein, FIs in the traditional financial system could have exposures to crypto-assets and crypto ecosystem participants that link them to the crypto ecosystem. These linkages allow for global crypto ecosystem shocks to propagate to the traditional financial system, with attendant implications on wealth and confidence effects.
**Linkages between traditional asset markets and stablecoin issuers:** The presence of conventional assets in stablecoin issuers’ reserves establishes a direct link from stablecoin vulnerabilities to traditional financial asset markets. In particular, runs on stablecoins could force issuers into fire sales of (conventional) reserve assets. Price dislocations are more likely when these reserve assets are larger, more illiquid or liquidated in a short-span of time, creating one-sided markets that could trigger system-wide shocks, amplify other pre-existing vulnerabilities or interact with other shocks.

A proliferation of stablecoins as alternative mediums of exchange that are transacted on associated payment networks also exposes the financial system to the vulnerabilities of stablecoin issuers. If used widely as settlement instruments, financial market functioning could be affected by operational disruptions that disable stablecoin payment networks or by runs that cause stablecoin issuers to fail. FIs and the financial system would also be affected by interruptions to the flow of funds, potentially disrupting liquidity conditions.

**FIs’ exposures to crypto players and markets:** Transmission channels to the financial system are also created when FIs build up exposures to stablecoins and other crypto-assets. FIs’ direct holdings of stablecoins (or the reserve assets backing stablecoins) and crypto-assets could expose them to stablecoin runs and crypto-asset price corrections, leading to adverse wealth effects in the financial system. If exposures are unhedged, fluctuations in the prices of stablecoins or crypto-assets may inflict losses on FIs. A similar transmission channel is created through open positions in crypto-asset derivatives. The use of leverage may further amplify the balance sheet impact on FIs.

Loans to or investments in stablecoin issuers or crypto-asset market intermediaries also create transmission channels that propagate shocks to FIs. Runs on stablecoin issuers or operational disruptions to crypto exchanges could result in credit or capital losses for FIs if affected crypto entities become less profitable, have their debt servicing capabilities weakened, or become insolvent as a result.

In the event of a tail risk scenario materialising, incurred losses may be large enough to cause FIs to pull back from the provision of other types of financial activity to preserve capital requirements or stay within corporate risk thresholds. In extremis, losses may result in insolvencies or an outright failure. In either case, the functioning of the financial system is likely to be disrupted, with the impact likely to be more severe if the affected FI is systemically important.

**Broader wealth and confidence effects:** Large wealth effects are also likely to develop into confidence effects. Awareness of distress at FIs could lead to a reassessment of credit risk that tightens funding conditions for affected entities, be it through runs or higher market-based funding costs. This could in turn feed into liquidity stresses that further aggravate disruptions to the functioning of the FI.

As the traditional financial system tends to be intricately interconnected, adverse wealth or confidence effects at a single FI may spill over to others. On one hand, inter-entity exposures to the affected FI could propagate adverse wealth effects widely and rapidly. On the other, a loss of confidence in FIs more generally, regardless of whether there are material
wealth effects, could result in an indiscriminate pullback of liquidity or credit provision, which could have highly disruptive effects on the financial system.

Direct holdings of stablecoins and crypto-assets by non-financial corporates and households will similarly expose them to wealth effects caused by stablecoin runs or fluctuations in crypto-asset market prices. In terms of impact to the financial system, this may adversely affect the ability of the non-financial sector to meet outstanding liabilities to FIs. A deterioration of balance sheet health could also trigger a reassessment of credit risk that makes new or additional funding more expensive or unavailable.

Other financial stability implications from widespread adoption of crypto-assets and DeFi

The second category of financial stability implications concerns the proliferation of crypto-assets and DeFi in the domestic economy. Risk factors could include “dollarisation”, expansion of shadow finance and increased capital flow volatility.

A widespread use of stablecoins denominated in non-local currencies as payment instruments could amount to a dollarisation, also described as “cryptoisation” by the IMF (IMF, 2021), of economies. This could lead to a loss of monetary autonomy, as domestic financial conditions are driven by monetary policy that is underpinned by the reserve currency.

Meanwhile, growth in the volume of financial intermediation facilitated by DeFi protocols could increase the proportion of unregulated financial services activity in the economy. Operating in a decentralised manner and potentially without legally identifiable entities, DeFi protocols are inherently challenging for policymakers to effectively regulate or supervise. As a result, DeFi protocols could enable regulatory arbitrage. An evasion of regulation designed to mitigate the build-up of vulnerabilities could render the financial system less resilient to shocks. The scale and volume of financial intermediation facilitated by DeFi protocols could markedly increase with the proliferation of asset tokenisation, which expands the universe of assets that DeFi applications can interact with.

The borderless nature of, and ease of accessibility to, crypto-assets also increase economies’ vulnerabilities to cross-border capital flight. Crypto-assets, their markets, and DeFi are not inherently limited by geography. Indeed, given their accessibility via the internet, it is difficult to impose access restrictions by geography or residency. Additionally, crypto-asset markets are more widely accessible than traditional capital markets or payment networks, as participants have direct access through platforms that have no minimum investment quantum or user restrictions. As a result, crypto-assets are ubiquitous vehicle currencies for capital flows. Stablecoins could also be considered as safe haven stores of value in their own right. Consequently, cross-border capital flight in times of stress could be larger and more volatile with the proliferation of crypto-assets, increasing the external vulnerabilities of economies.

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105 Dollarisation refers to the use by residents of one country of assets or liabilities denominated in another country’s currency (Balino, 2003).
Mitigating risks to financial stability

The two categories of risk discussed in the previous section have their respective mitigants. For the first category, timely and well-designed firm-level regulation, surveillance and supervision would mitigate the vulnerabilities in the crypto ecosystem and any spillovers from its shocks to traditional FIs and markets. To the extent that crypto ecosystem activity and vulnerabilities are similar to those in the traditional financial system, a principle of “same activity, same risk, same regulatory outcomes” can guide the design of regulation.

The second category of financial stability risks—dollarisation, capital flow volatility and shadow finance—reflect risk aversion to the holding of domestic fiat currency and the lack of access to affordable, efficient and competitive financial services. Accordingly, the mitigants lie in sound macroeconomic fundamentals, credible fiscal and monetary policy and a stable, efficient, and inclusive financial system.

**Firm-level regulation to mitigate risks from connections between the crypto ecosystem and the traditional financial system**

This section discusses aspects of regulatory frameworks being designed internationally and in Singapore that address the vulnerabilities of stablecoins and crypto-asset markets, as well as those that increase the resilience of traditional FIs to crypto ecosystem shocks.

MAS believes that the innovative combination of tokenisation and distributed ledger technology offers transformative economic potential, and encourages the exploration of distributed ledger technology and digital asset use cases. That said, MAS is equally cognisant of areas of risk that will become more salient as the digital asset ecosystem (and associated activities) grow in scale and complexity.

**Stablecoins:** Regulatory frameworks that specifically target stablecoins and their risks are in progress, as jurisdictions recognise the importance for issuers to maintain a high degree of value stability for stablecoins.

In Singapore, MAS has published a consultation paper setting out the proposed regulatory approach on stablecoin-related issuance and intermediation activities. It seeks to support the development of value-adding payment use cases for stablecoins, and key issuer requirements that relate to maintaining value stability of stablecoins, consumer disclosures on stablecoin features, and redemption rights and prudential standards (e.g. base capital and liquidity requirements). Rules governing the composition of issuers’ reserve assets, redemption policies, and disclosures are intended to reduce liquidity mismatches and other financial risks on stablecoin issuers’ balance sheets and enhance transparency for consumers. These measures could reduce the susceptibility of stablecoins to runs in times of stress. Maintaining value stability of stablecoins also reduces the risks of fire sales of traditional

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financial assets held as reserves, creating one-sided markets and dysfunction that spills over to other non-crypto market participants.

The FSB had previously published recommendations to promote consistent and effective regulation and supervision of “global stablecoin” arrangements, with a focus on addressing financial stability risks (FSB, 2020). It is currently in the process of consulting on further recommendations (FSB, 2022), which are similar to those that MAS are looking to put into place. In addition, stablecoin arrangements which pose systemic risk are also expected to meet applicable international standards, including the Principles for Financial Market Infrastructures published by the BIS’ Committee on Payments and Market Infrastructure (CPMI) and the International Organization of Securities Commissions (IOSCO).

**Crypto-asset markets:** Global regulators are stepping up their responses to mitigate risks posed by crypto-asset markets, including money laundering and terrorist financing. Technology and cyber-related risks, as well as the potential of significant financial losses for retail investors arising from market integrity issues, are other risks being looked into.

MAS is particularly concerned about the risk of consumer harm arising from speculative trading in cryptocurrencies, inadequate risk controls, fraud and market manipulation. In this regard, MAS proposed a set of regulatory measures in October 2022 that covers broad areas of consumer access, business conduct and technology, as well as industry best practices to address market integrity concerns. Business conduct measures requiring Digital Payment Token service providers to segregate customer assets, as well as measures to improve technology risk management, also reduce the concentration and technology risks faced by critical crypto-asset market intermediaries, mitigating crypto ecosystem vulnerabilities.

**Banks’ crypto-asset exposures:** Banks are systemically significant entities in the financial system. It is hence important to limit the financial stability risk posed by connections between banks and crypto-asset markets, and to enhance the resilience of banks to shocks from crypto-markets. To this end, the Basel Committee for Banking Supervision (BCBS) has proposed for banks’ crypto-asset exposures to be subject to risk-based prudential requirements (BCBS, 2022). Under the latest proposal, crypto-assets will be classified into groups based on their characteristics and nature of backing. Broadly, higher capital and liquidity requirements will be applied to crypto-assets that are unbacked or have no effective stabilisation mechanisms, enhancing their resilience to potential shocks. The BCBS’ approach is guided by the principle of “same risk, same activity, same treatment”, and extends existing prudential frameworks to encompass crypto-assets. These proposals ensure that banks hold adequate capital and liquidity reserves to mitigate the impact of crypto-asset market

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107 The Principles for Market Infrastructures are a set of 24 principles that seek to mitigate systemic, legal, credit, liquidity, general business, custody and investment, and operational risks faced by financial market infrastructures such as payments systems. These principles provide guidance on establishing a legal basis for financial market infrastructure activities, their governance structure, and a framework for the comprehensive management of risks. They can be viewed at [https://www.bis.org/cmpi/publ/d101a.pdf](https://www.bis.org/cmpi/publ/d101a.pdf).

vulnerabilities on their balance sheets, thus reducing the likelihood of crypto ecosystem shocks causing systemic disruption.

Other risks from the adoption of crypto-assets and the underlying technology in traditional financial services

**Sound macroeconomic fundamentals, and credible fiscal and monetary policy:** Dollarisation and capital flow volatility are not unfamiliar financial stability risks, particularly for small, open economies. While the proliferation of crypto-assets and DeFi may allow these risks to manifest themselves through novel mechanisms, their mitigants remain unchanged. Sound macroeconomic fundamentals and credible fiscal and monetary policy prevent a loss of confidence in the domestic monetary system that leads to dollarisation and capital outflows.

**Stable, efficient and trusted regulated financial system:** The likelihood of dollarisation and a growth of shadow finance depend on the value proposition of stablecoins as payment instruments, and DeFi as modes of financial intermediation relative to existing solutions in the traditional financial system. Even in an economy like Singapore where existing payment networks are low-cost and efficient and its financial system stable and trusted, there is a need for policies that encourage financial system development and competition in the regulated financial sector. More comprehensive efforts to increase financial inclusion will reduce the likelihood that regulated financial intermediaries get displaced by unregulated DeFi activity.

**Conclusion**

Financial innovation has the potential to improve the process of financial intermediation and the operation of the financial system more generally. Digital assets and the technologies that underpin them, including crypto-assets and DeFi, may prove to increase financial system efficiencies that benefit market participants and other agents in the real economy. For example, the tokenisation of assets and their deployment on blockchain networks may reduce settlement times and costs for cross-border payments, trade finance, and in capital markets. However, as discussed in this special feature, crypto-assets and DeFi present an array of vulnerabilities, some of which are inherent to the crypto-asset ecosystem. These vulnerabilities could pose material risk to financial stability through linkages with the traditional financial system. Crypto-asset and DeFi could also cause more fundamental changes to the structure of financial systems, which could not only accentuate familiar macrofinancial vulnerabilities but also create new ones.

As with other risks to financial stability, firm-level regulation will play an important role in mitigating the vulnerabilities presented by crypto-assets and DeFi at source. The regulation and supervision of other financial intermediaries’ exposures to this space would also be essential. The role of international standard setting bodies and other international organisations in coordinating and achieving globally consistent outcomes will be key. Sound macroeconomic fundamentals with credible fiscal and monetary policy-making, and the presence of a stable, trusted and competitive financial system, will also reduce the likelihood of financial stability risks.
Even as digital assets and their underlying technologies are explored for their merits, it will be important to continually assess the risk that they pose. MAS continues to monitor developments in the crypto-asset space, not only for financial stability concerns set out in this Feature, but also for other objectives such as money laundering/terrorist financing, consumer protection, and market conduct and functioning.

References


Chainalysis (@chainalysis), “2/ At this rate, 2022 will likely surpass 2021 as the biggest year for hacking on record. So far, hackers have grossed over $3 billion dollars across 125 hacks.”, Twitter, Oct 13, 2022, 5:39 a.m., https://twitter.com/chainalysis/status/1580312149557026817


Special Feature 3

Financial Stability Implications of Digital Banks

Introduction

Technological innovations have accelerated the digital transformation of financial services, leading to the emergence of digital banks globally. The entry of digital banks to Singapore's financial system is expected to spur financial innovation and enhance financial inclusion. At the same time, financial stability risks and prudential concerns also come to the fore. These could spring from excessive competition and risk-taking, in the context of new and untested business models, with potentially broader implications for the overall stability of the financial system.

This Feature identifies the ways in which digital banks can impact the competitive dynamics of the financial system, and suggests a framework to monitor the impact on overall financial system stability.

The impact of competition on risks in the banking sector

Under the “competition-fragility” view in the literature of banking, the emergence of new service providers can erode market power, decrease profit margins, and result in reduced franchise value. This could lead to banks, be it incumbents or new entrants, taking on more risk. For example, banks may venture into exposures of lower credit quality to protect market share. Digital banks may also engage in predatory practices to build market share in their initial years (e.g. by offering preferential pricing, paying unsustainably high interest to attract deposits). More generally, banks’ riskier behaviour in the face of increased competition may reduce profitability and impede their ability to build buffers against unexpected losses (Martinez-Miera and Repullo, 2010). This could increase the fragility of the banking system, although risk-based capital and liquidity requirements that are calibrated based on banks’ business risk profiles are mitigants.

The alternative “competition-stability” view posits that increased competition in banking systems is efficient and stable for three reasons. First, competition might spur efficiency improvements, which should in turn lead to greater stability (OECD, 2011). This could come about from improvements in screening/credit risk assessments of borrowers, the governance of funded projects, and the management of bank risk (Corbae and Levine, 2018). Second,
efficiency-boosting competition tends to lower rents of the incumbents, specifically the net interest margin. The reallocation of the surplus to households and corporates, in the form of higher deposit rates and lower lending rates, could strengthen the resilience of banks’ counterparties, and in turn enhance bank stability (Boyd and De Nicolo, 2005). Third, the entry of new providers creates a more diversified and competitive financial system, which can reduce concentration risk and hence overall systemic risks. Greater diversity in the sources of credit in the economy would allow for alternative funding options in the event of individual bank failures, and also provide consumers with greater choice and more competitive pricing generally.

There is no consensus on which view prevails. Regulators will have to actively monitor market conditions, to assess what the prevailing state of the world is regarding the impact of competition, so as to strike a balance between the stability benefits and the fragility costs of competition. Where necessary, supervisory tools and prudential safeguards should be used to mitigate the potential fragility repercussions of competition.

**Digital bank entrants**

While the initial entry of digital banks may directly erode the market share of incumbents, the competition may not be a zero-sum game in its steady state, as there is potential to enlarge the overall market size. With innovative business models, digital banks can complement the offerings of traditional banks to meet the needs of currently underserved individuals and businesses. A study by Google et al. (2019) found that 74% of adults in Southeast Asia are unbanked or underbanked. In this case, digital banks could expand the overall market size by enhancing financial inclusion for underserved segments and broadening the suite of available products and services, instead of solely engaging in a value-destructive competition with traditional banks.

Through the innovative use of data and technology, digital banks can come up with new processes and channels to deliver financial products and services, in turn reducing costs and improving access for customers. Digital banks could leverage new business models and strong technological capabilities to broaden financial inclusion for underserved segments such as youths or micro-SMEs. Specifically, digital banks may rely less on the posting of collateral when granting loans, as they can leverage customer data from their non-financial affiliates and reduce information asymmetry in their credit assessments (Chen et al., 2022). In China, for example, more than 80% of MYbank’s new customers in 2021 were first-time borrowers. In Korea, generally considered as having a high degree of banking penetration, Kakao Bank provided close to KR₩1 trillion in credit to underserved segments (typically self-employed individuals or young people entering the labour market) in 2019, surpassing the annual amount of such lending extended by all banks between 2016–2018 (Choi, 2020). Such competitive practices could also spur existing banks to continue upgrading and innovating, resulting in efficiency gains for the overall financial system.

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110 The unbanked refers to individuals with no access to basic banking services such as a bank account, while the underbanked refers to individuals that are not well served or have unmet needs in financial services such as limited access to credit cards or long-term savings products.
However, the same ability of digital banks to leverage technology and scale rapidly to drive efficiency gains in the banking system could also introduce new risks or reshape existing microprudential and macroprudential risks.

Digital banks are exposed to the same microprudential risks as existing traditional banks, including both financial (e.g. liquidity, credit) and operational (e.g. technology) risks. However, the nature of their business models could accentuate some of these risks. For example, the use of new technologies, especially those not commonly used by traditional banks, could embed new risks that digital banks and/or regulators may not be familiar with. Digital banks’ focus on the unbanked or underbanked segments is particularly salient. As such borrowers may not have sufficient credit history, there is a risk that making lending decisions based on alternative data that has not been tested through a full credit cycle could lead to higher-than-expected credit losses in a downturn. In addition, a lack of experience in the delivery of financial services may correlate with increased vulnerability to disruptions or financial losses arising from outages in normal business processes and operations.

The crystallisation of microprudential risks could also introduce macroprudential risks to the broader financial system, particularly if a digital bank achieves a large financial scale and has stronger linkages with other FIs. For example, digital banks have been found to have a much larger share of interbank loans than traditional banks, suggesting that they are more interconnected than traditional banks with the rest of the banking system (IMF, 2022). The increased interconnectedness could in turn amplify contagion risks arising from counterparty failures. In addition, increased competition could also erode incumbents’ profitability and reduce their ability to build capital organically. In response, incumbents could engage in risk-taking practices, albeit at the cost of heightened vulnerabilities and increased financial stability risks should these banks be systemically important.

The Singapore experience: Incumbent banks’ response

In Singapore, the incumbent banks had been investing heavily in digital transformation to expand their digital offerings and better cater to customers’ needs prior to the introduction of the digital banks. For example, they: (i) partnered with FinTechs to deliver more customised solutions, (ii) built digital banks in overseas markets, leveraging a lower-cost operating model to acquire customers, and (iii) adopted more customer-centric approaches, by integrating financial choices with traditionally non-financial needs (MAS, 2020). Continued investments in such initiatives will enable the incumbent banks to compete against the digital banks in terms of customer experience and quality of financial products and services.

Promoting sustainable competition in Singapore

MAS’ operating terms for the new digital banks have been calibrated to ensure a level playing field while guarding against financial stability risks. First, digital bank applicants are required to demonstrate sustainable business models, so that competition is not value-

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111 The IMF study found that digital banks’ client base tends to be younger and likely to be less loyal, implying that their deposits are less sticky. As a result, digital banks could end up with lower balances in the more stable funding types such as deposits, and hence more reliant on less stable funding types such as interbank loans.
destructive. MAS will monitor market dynamics and impose additional requirements or restrictions to deter unsustainable banking practices. Second, the digital banks are subject to the same prudential requirements (including capital and liquidity requirements) as existing banks. Third, MAS will phase in the permissible activities of digital full banks via a three-stage process, to minimise risks to retail depositors and mitigate the risks of untested business models. In the initial stage, the new digital entrants will be subject to restrictions, such as on the size and scope of their operations. The restrictions will be progressively lifted based on the performance of the digital full bank (including a consideration of the strength of its internal controls, compliance track record, customer management ability, and sustainability of business performance, among others). In time, digital banks in Singapore can complement the incumbent local banks in anchoring domestic financial stability.

Assessing the impact on financial stability

The impact of new digital bank entrants on the banking system and overall financial stability can be assessed through a two-stage framework as set out in Figure S3.1.

Figure S3.1 Implications of digital banks on financial stability

The framework first assesses the potential benefits and risks through two channels of impact to the banking system, namely competition and efficiency:

- **Competition:** Greater choice in the banking system increases customers’ propensity to switch to other banks, leading to less concentrated market shares. That said, while incumbents and new entrants may target the same customer segments, digital banks remain a relatively new concept in Singapore’s banking landscape, and customers may hence be inclined to adopt a “wait and see” approach before banking fully with a digital bank. A survey by PricewaterhouseCoopers (2019) found that 67% of Singapore customers would continue using their existing bank account as their primary account even after

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112 For the purpose of this analysis, financial stability refers to the capacity of the financial system to withstand shocks, containing the risk of disruptions in the financial intermediation process and other financial system functions that are severe enough to adversely impact the real economy (FSB, 2021).
opening a digital bank account. To assess the impact to competition, potential indicators to monitor could include the total size of deposits and loans in the banking system (to inform changes in market sizing), as well as banks’ market share and number of depositors and borrowers (to assess shifts in each bank’s customer base).

- **Efficiency:** Digital banks spur incumbent banks to innovate and improve efficiency to compete. Efficiency improvements, whether on the revenue or cost sides, will boost profitability. Improved profitability matters for financial stability, given that profits are an important source of capital, enabling banks to build strong buffers to absorb credit losses. Efficiency gains could also benefit consumers in the form of cheaper, faster, and more convenient financial services, as both new entrants and incumbents seek to enhance their offerings in the new competitive landscape. Potential indicators to monitor include bank profitability ratios such as return on equity or return on risk-weighted assets (to assess revenue efficiency) or cost ratios like cost-to-income (to assess operating efficiency).

Next, we consider the implications of competition and efficiency for financial and operational vulnerabilities.

- **Credit risk:** Banks may be encouraged to target riskier (previously underserved) segments without putting in place adequate risk management practices, leading to increased credit risks. For example, digital banks have been found to serve younger individuals with lower incomes and lower credit scores by granting them loans that are mostly unsecured or concentrated around risky sectors, such as commercial real estate (IMF, 2022).

- **Liquidity risk:** A smaller retail deposit base due to increased competition would decrease banks’ access to stable sources of funds.

- **Profitability:** Greater competition and lower profitability will impact banks’ ability to generate capital organically, impacting the level of regulatory capital and capital adequacy.

- **Technology risk:** The digital transformation of finance increases banks’ exposure to a range of technology risks, including cyber risks. This could arise from malicious activity, such as cyberattacks on banks’ infrastructure to exfiltrate sensitive financial data or disrupt core information technology systems, or attacks on customers to carry out fraudulent financial transactions (e.g. scams). Technology risks could also come about from operational incidents (e.g. system failures or malfunctions) given the increased reliance on technology. In either case, technology risks have the potential to cause disruptions in the provision of financial services. In extremis, this could also have an adverse impact on the reputation of a bank, leading to a loss of confidence.

- **Third-party/outsourcing risk:** The greater use of technology could result in an increased reliance on common third-party service providers, who could themselves face disruption and propagate risks to banks and the wider financial sector. Banks could also face challenges with regard to monitoring and managing outsourced activities, and could be vulnerable to loss of control over such outsourced activities. Moreover, concentration risk among banks could arise if the same set of entities are involved in the provision of a single product or service (e.g. cloud services), creating complex operational dependencies.
Next Steps

Three out of the four newly licensed digital banks in Singapore have announced the launch of operations in Q2/Q3 2022. With their operations still at a nascent stage, the lack of data and information poses constraints to assessing the financial stability implications of the new digital banks. In addition, MAS’ phased approach regarding digital banks’ size and scope of operations implies that their impact to the banking system may not be quickly apparent. Nevertheless, as the new digital banks gain traction, MAS will be ramping up the monitoring of the indicators identified above, which can be used for future quantitative analysis of the health and stability of the financial sector.

References


Chen, S, D’Silva, D, Packer, F, Tiwari, S (2022), “Virtual Banking and Beyond”, BIS Papers, No. 120.


