November 2018
Macroprudential Surveillance Department
Monetary Authority of Singapore
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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” comprises Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam
- “Asia-10” comprises China (CHN), Hong Kong (HK), India (IND), Indonesia (IDN), Korea (KOR), Malaysia (MYS), the Philippines (PHL), Singapore (SGP), Taiwan (TWN) and Thailand (THA)
- “Euro zone” comprises Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain
- “European Union” (EU) comprises the euro zone, Bulgaria, Croatia, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden and the United Kingdom (UK)
- “G3” refers to the euro zone and United Kingdom, Japan, and the United States (US)
- “G7” refers to Canada, France, Germany, Italy, Japan, the United Kingdom and the United States
- “G20” refers to the Group of Twenty comprising Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Korea¹, Mexico, Russia, Saudi Arabia, South Africa, Turkey, the United Kingdom, the United States and the European Union

Abbreviations used for financial data are as follows:

- Currencies: Chinese Renminbi (RMB), Euro (EUR), Hong Kong Dollar (HKD), Indian Rupee (INR), Indonesian Rupiah (IDR), Japanese Yen (JPY), Korean Won (KRW), Malaysian Ringgit (MYR), Philippine Peso (PHP), Singapore Dollar (SGD), Taiwan Dollar (TWD), Thai Baht (THB), Vietnamese Dong (VND), US Dollar (USD)

Other Abbreviations:

- ABS Association of Banks in Singapore
- ABSD Additional Buyer’s Stamp Duty
- ACRA Accounting and Corporate Regulatory Authority of Singapore
- ADB Asian Development Bank
- AMF Autorité des marchés financiers
- ATO Asset Turnover
- AUM Assets Under Management
- B&C Building and Construction
- BCBS Basel Committee on Banking Supervision
- BIS Bank for International Settlements
- BoE Bank of England
- BoJ Bank of Japan
- BPS Basis Points
- BTC Bitcoin
- CAR Capital Adequacy Ratio

¹ Republic of Korea
CBOE  
Chicago Board Options Exchange

CBS  
Credit Bureau Singapore

CCP  
Central Counterparty

CCR  
Core Central Region

CCS  
Credit Counselling Singapore

CCyB  
Countercyclical Capital Buffer

CGIO  
Centre for Governance, Institutions and Organisations

CPI  
Consumer Price Index

CPMI  
Committee on Payments and Market Infrastructures

DBU  
Domestic Banking Unit

DDRS  
DTCC Data Repository (Singapore) Pte Ltd

DiD  
Difference-in-Differences

DOS  
Department of Statistics

D-SIBs  
Domestic Systemically Important Banks

DTCC  
Depository Trust & Clearing Corporation

EBIT  
Earnings Before Interest and Tax

EBITDA  
Earnings Before Interest and Tax, Depreciation and Amortisation

EC  
European Commission

ECB  
European Central Bank

ECF  
Equity Crowdfunding

EM  
Emerging Markets

EMEA  
Europe, Middle East and Africa

EPFR  
Emerging Portfolio Fund Research

ETF  
Exchange-Traded Fund

FI  
Financial Institution

FinTech  
Financial Technology

FSB  
Financial Stability Board

FSI  
Financial Stress Index

FSR  
Financial Stability Review

FX  
Foreign Exchange

GDP  
Gross Domestic Product

GFC  
Global Financial Crisis

GFMA  
Global Financial Markets Association

GFSR  
Global Financial Stability Report

GLS  
Government Land Sales

HCE  
Household Consumption Expenditure

ICR  
Interest Coverage Ratio

IE  
International Enterprise

IIF  
Institute of International Finance

IMF  
International Monetary Fund

INFRA  
Infrastructure Recovery and Assets

IORP  
Institution for Occupational Retirement Provision

IOSCO  
International Organisation of Securities Commissions

IPTO  
Insolvency and Public Trustee’s Office

IR  
Interest Rate

ISCA  
Institute of Singapore Chartered Accountants

ISDA  
International Swaps and Derivatives Association

IWST  
Industry-Wide Stress Test

JFMC  
Japan Financial Markets Council

LCR  
Liquidity Coverage Ratio

LGD  
Loss Given Default
<table>
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<th>Acronym</th>
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<td>MDR</td>
<td>Merchant Discount Rate</td>
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<td>Net Stable Funding Ratio</td>
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<td>National University of Singapore</td>
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<td>Probability of Default</td>
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<td>ROA</td>
<td>Return on Assets</td>
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<td>Singapore Interbank Offered Rate</td>
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<td>Sovereign Wealth Fund</td>
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<td>The Clearing House</td>
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<td>TSC</td>
<td>Transport, Storage and Communications</td>
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<td>URA</td>
<td>Urban Redevelopment Authority</td>
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<td>Vector Auto Regressive</td>
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<td>VIX</td>
<td>CBOE Volatility Index</td>
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PREFACE

The Monetary Authority of Singapore (MAS) conducts regular assessments of Singapore’s financial system. Potential risks and vulnerabilities are identified, and the ability of the financial system to withstand potential shocks is reviewed. The analyses and results are published in the annual Financial Stability Review (FSR). The FSR 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 financial sector in Section 2. Finally, a review of the corporate and household sectors is provided in Sections 3 and 4 respectively.

The production of the FSR was coordinated by the Macroprudential Surveillance Department (MSD) team that comprises Andrew Tan, Kenneth Gay, Ng Heng Tiong, Lily Chan, Alex Phua, Aloysius Lim, Ang Shu Qin, Angeline Lam, Cheryl Ho, Choo Chian, Denise Yeo, Evelyn Chen, Gael Soon, Howie Lee, Koh Zhi Xing, Kong Yu Chien, Kwek Kiat Cong, Lim Yong Long, Moses Soh, Tan Aik Khim, Teoh Shi-Ying, Wendy Lee, Wong Jian Xiang, and Wong Siang Leng under the general direction of Rosemary Lim, Executive Director (MSD) and Loo Siew Yee, Assistant Managing Director (Policy, Risk & Surveillance). The FSR also incorporates contributions from Banking Departments I, II & III, Capital Markets Intermediaries Departments I, II & II, Data Analytics Group, Economic Policy Group, Insurance Department, Markets Policy & Infrastructure Department, Monetary & Domestic Markets Management Department, Prudential Policy Department and Technology Risk & Payments Department, and Baskar Chinniah, Jonathan Ng, Jong Zhi Kai, Satish Nagdev and See Kwong Ee. The FSR reflects the views of the staff of MSD and the contributing departments.

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

Risks to global financial stability have increased, amid tighter financial conditions and trade tensions

Tightening global financial conditions have caused capital outflows from the region, and could create further pressures on regional currencies and the debt servicing abilities of sovereigns, corporates and households.

Vulnerabilities in emerging market (EM) economies have been exacerbated by global trade tensions. A protracted trade conflict could have wider ramifications on global economic growth through dampened business confidence, investment and productivity.

Singapore’s banking system, corporate, and household fundamentals remain resilient

Singapore’s banking system remains resilient despite increased uncertainty. Loan growth was healthy over the past year, while overall asset quality has improved. MAS assesses that domestic credit growth remains in line with economic conditions and does not observe any broad-based domestic credit overheating at this juncture. Hence, MAS will maintain the Countercyclical Capital Buffer (CCyB) at 0%.

Corporate balance sheets, including solvency and liquidity positions, have remained broadly stable amid a supportive operating environment. Firms in the trade-related sectors benefitted from the uplift in the global economy particularly in the earlier half of the year, but those in domestic-oriented sectors experienced a more uneven performance.

Household balance sheets have strengthened, alongside an improving employment outlook.

The property market cooling measures in July 2018 have moderated the pace of price increases and transaction activity. This will contribute to stronger household balance sheet positions over the medium term.

Looking ahead, Singapore corporates, banks and households need to guard against rising headwinds

While trade tensions have had limited impact on Singapore thus far, the negative spillovers could weigh on future corporate profitability through lower earnings. Tightening financial conditions could also strain the debt servicing ability of over-leveraged firms. Firms should exercise financial prudence and take steps to reduce balance sheet vulnerabilities.

An abrupt tightening of global financial conditions could accentuate foreign currency liquidity risks in the Singapore banking system. Banks need to actively monitor and manage their foreign currency liquidity risks as they expand their cross-border lending activities.

Households should continue to be cognisant of their ability to service their debt, given the headwinds of rising interest rates. With rental yields expected to remain weak, households should exercise prudence when taking up loans to fund property purchases.

MAS’ latest stress tests across the banking, corporate and household sectors indicate that the overall system is resilient. Nonetheless, continued vigilance is warranted as the likelihood of external shocks from tighter financial conditions and trade tensions materialising has increased, which in turn raises the risks to financial stability.
1 Global Environment

Tighter global financial conditions have resulted in outflows from Asia, which create pressure on regional currencies and could have negative implications for the debt servicing abilities of sovereigns, corporates and households. Global trade tensions have exacerbated vulnerabilities in EM economies, by posing downside risks to growth. In Europe, populist sentiment has resulted in heightened policy uncertainty, adding to the ongoing uncertainty arising from the UK’s exit from the EU.

Existing and new technologies have spurred innovation that could transform the financial intermediation landscape, but could also bring about new channels of risks. Policymakers must stay vigilant and stand prepared to understand, pre-empt and mitigate risks associated with technology, for instance from crypto-assets and cyber incidents.

Tightening Financial Conditions

Tighter global financial conditions have resulted in outflows from the region...

Ongoing US monetary policy normalisation, buoyed by healthy US economic growth, has cast a spotlight on vulnerabilities among some EMs.

Chart 1.1
Cumulative Net Flows: Asia-9

Source: MAS estimates, Emerging Portfolio Fund Research (EPFR)
Note: Asia-9 comprises Hong Kong, India, Indonesia, Korea, Malaysia, the Philippines, Singapore, Taiwan and Thailand.

Tighter global financial conditions sparked renewed outflows from Asia since April 2018 (Chart 1.1), after a period of strong inflows particularly in equities.

Thus far, there has been differentiated impact, with EMs that are perceived to be more vulnerable bearing the brunt of the sell-off.

Among EM Asian economies, those with twin deficits coupled with short-term external funding needs (Chart 1.2) have been harder hit (Chart 1.3), even if their macroeconomic fundamentals are generally sound. These more vulnerable economies have had to take measures to shore up their currencies, including by tightening domestic monetary policy or drawing down on reserves to support their currencies. These economies are also actively taking steps to narrow their current account deficits, for instance by raising import tariffs and re-evaluating import-intensive infrastructure projects.
Further developments in the weaker Europe, Middle East and Africa (EMEA) and Latin America (LATAM) EMs could also lead to broader EM aversion among investors.

Chart 1.4
Selected EM Currencies Against the US Dollar (% change from 8 to 13 August 2018²)

Source: MAS estimates, Bloomberg

EM Asian currencies experienced some contagion from events in Turkey, at the peak of the fall in value of the Turkish lira, though to a smaller extent than other vulnerable EMs (Chart 1.4).

² The Turkish lira experienced its largest fall in value from 8 to 13 August 2018.

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EM Asian currencies experienced some contagion from events in Turkey, at the peak of the fall in value of the Turkish lira, though to a smaller extent than other vulnerable EMs (Chart 1.4).

³ China, Hong Kong, India, Indonesia, South Korea, Malaysia, Singapore and Thailand.

⁴ The Institute of International Finance.
Looking ahead, the impact of US tariff actions could drive higher US inflation from costlier US imports, leading to faster-than-expected monetary policy normalisation and a further tightening of financial conditions. This could add to headwinds for EMs.

Against this backdrop of heightened volatility, international organisations such as the Financial Stability Board (FSB) and Bank for International Settlements (BIS) have expressed concerns that investment vehicles could potentially amplify market volatility during periods of market stress.

Notwithstanding these potential market risks, our comparative analysis of investment vehicles shows that exchange-traded fund (ETF) flows display less indications of procyclicality compared to actively-managed open-ended fund flows (See Box A “Do Exchange-traded Funds Pose Procyclicality Risks? – A Comparison with Open-ended Funds”).

**Global Trade Tensions**

**Rising trade tensions could pose downside risks to global growth**

EM vulnerabilities have also been exacerbated by global trade tensions, which have risen in intensity over the year.

Some impact can be seen in global equity markets (Chart 1.6), with larger sell-offs observed following the announcement of the tariffs on US$200 billion worth of China’s exports. Chinese and EM equities bore the brunt of the sell-offs and have continued to underperform, despite the recent rebound.

Chinese authorities have taken actions to promote economic stability amid growing concerns over prolonged trade tensions, by easing their overall macro policy stance and providing more liquidity in the banking system.

In the longer term, a protracted trade conflict would have wider ramifications on global economic activity through the confidence and investment channels.

The global Purchasing Managers’ Index has already been easing (Chart 1.7), and growing
trade frictions could increasingly weigh on global growth.

![Chart 1.7]

**Global Purchasing Managers’ Index**

Source: Bloomberg

**Political Uncertainty in Europe**

Populist sentiment has resulted in heightened policy uncertainty in Europe

In Europe, geopolitical developments continue to bear watching. Concerns over rising populism resurfaced in Italy’s 2018 general elections, where the anti-establishment Five Star Movement emerged with the highest number of votes.

Market uncertainty in Italy has remained elevated (Chart 1.8) amid ongoing discussions between the European Commission (EC) and Italy over Italy’s fiscal-loosening budget, with concerns that the populist platforms the ruling coalition had campaigned on could drive larger fiscal deficits and contribute to an escalation of tensions with the EC.

![Chart 1.8]

**Market-implied Probabilities of Default for Selected European Economies**

Source: MAS estimates, Thomson Reuters

Note: Based on market data on 5-year credit default swaps for sovereign bonds.

The UK’s path to leave the EU continues to be of concern. While progress has been made, uncertainty remains over the final terms of the UK’s exit. A disorderly Brexit could exacerbate the fragmentation of services provided by the European financial system.

For instance, the UK is a major centre for investment banking in Europe. In the absence of EU action, some EU clients will no longer be able to use the services of UK-based investment banks, and UK-based investment banks may be unable to service existing cross-border contracts. The continuity of existing derivative contracts between UK and EU banks could also be disrupted.5

**Risks Associated with Technology**

The increasing reliance on technology could bring about new channels of risks

Existing and new technologies have spurred innovation that could transform the financial

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5 UK HM Treasury (August 2018), “Banking, Insurance and Other Financial Services If There’s No Brexit Deal”.
intermediation landscape, but could also bring about new sources of risks.

The rise in popularity of digital tokens could create new pockets of vulnerabilities that warrant close monitoring, including the potential wealth effects of a fall in digital token valuations (See Box B “Monitoring Digital Token Markets: An Early Look at Frameworks and Techniques”).

Rapid digitalisation and adoption of FinTech in the financial sector also poses increasing cyber risk vulnerabilities. This has raised concerns about the potential systemic implications of cyber incidents on the financial system (See Box C “A Framework to Assess the Implications of Cyber Risk on Financial Stability”).

Policymakers should stay vigilant and stand prepared to analyse, understand, pre-empt and mitigate these risks.
Assets invested in ETFs have quadrupled to over US$5 trillion in the past decade. Over the same period, ETFs’ share of total investment fund assets has grown from 2.5% to around 8.5%. The growth of assets invested into ETFs, and the passive trading nature of the funds, have led to discussions internationally over potential procyclicality risks arising from ETF trading. In this box, we study the fund flow dynamics of ETFs against that of open-ended funds (OEFs).

Empirical research into potential procyclicality risks posed by ETF trading has been fairly nascent. Questions have been raised by international organisations such as the BIS, FSB and International Monetary Fund (IMF) over potential procyclicality risks associated with ETF trading. Such risks can be broadly characterised into two areas: (i) distortions to the underlying market, either through pricing inefficiency at the level of individual securities, or to aggregate price dynamics (for example, boosting market momentum), and (ii) amplification of market stress, if ETF market liquidity becomes impaired under certain circumstances. Market stress could be amplified should there be a liquidity mismatch between an ETF and the underlying securities which it references, or if authorised participants (APs) who are ETF liquidity providers step away from market-making during periods of market turbulence.

Research on these potential procyclicality risks posed by ETF trading has thus far been fairly nascent. Some studies have found indications of procyclicality risks where ETF ownership of securities has been associated with greater volatility in their underlying securities, and where the growth of ETFs has been linked with EM capital flows becoming more sensitive to the global financial cycle. On the other hand, BIS found that although ETF flows in the secondary markets exhibited the largest inflows and outflows relative to their asset size—consistent with ETFs being associated with a wide array of trading and investment strategies—their flows offset each other over the weeks within an episode in some instances. In the primary markets, the French Autorité des marchés financiers (AMF) observed that ETF primary flows in the French and Eurozone equity markets appeared to be fairly countercyclical when compared against significant changes in index performance, and a Hong Kong Securities and Futures Commission (HK SFC) analysis suggested that there is no strong relationship between ETF primary flows and index returns in the Hong Kong equity market.

ETFs passively track the index returns of specific benchmarks, and provide investors with low-cost access to a diversified portfolio of securities. An increasing proportion of investors are using ETFs as mainstream financial products, and the trend towards passive investing has drawn in not only individual investors but also institutional investors. Blackrock (2018), “Four Big Trends to Drive ETF Growth”.

For instance, a liquidity wedge could emerge between ETF prices and those of the underlying securities during stressful market conditions or large selling pressure from ETFs investors could overwhelm APs’ ability to support secondary market liquidity, thus potentially amplifying shocks to primary asset markets.


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7 For instance, a liquidity wedge could emerge between ETF prices and those of the underlying securities during stressful market conditions or large selling pressure from ETFs investors could overwhelm APs’ ability to support secondary market liquidity, thus potentially amplifying shocks to primary asset markets.


Against this backdrop, we studied potential procyclicality risks posed by ETFs vis-à-vis that of OEFs. We studied ETFs in relation to both actively-managed OEFs (active OEFs) and passively-managed OEFs (passive OEFs). Fund flow activities underlying ETFs and these two types of investment vehicles could have some similarities, driven by their respective investor base, in: (i) short-term fund flow dynamics between ETFs and active OEFs, given that investors previously invested in active OEFs are now increasingly switching at least part of their portfolio into ETFs; and (ii) long-term fund flow dynamics between ETFs and passive OEFs, given that such index-tracking products have increasingly drawn in a broader range of investor types such as institutional investors and financial advisers with longer-term investment horizons.13

Using data from EPFR Global, we examined the fund flow activities of ETFs, passive OEFs and active OEFs in both global equity and global corporate bond markets spanning the US markets, developed markets ex-US (DM ex-US), and EM. In particular, we assessed whether flows into such investment vehicles tend to be returns-chasing, and whether large outflows typically occur during times of market turbulence. The panel regression from 2003 to 2018 takes the following form:

\[ \text{Flow}_t = \alpha_t + \beta_1 \text{Return}_{t-1} + \beta_2 \text{Global Volatility}_t + \beta_k \text{Control}_{k,t} \]

where Flow, denotes weekly ETF, passive OEF or active OEF fund flows as a percentage of total investment vehicles’ assets invested into each of these major regional equity and corporate bond markets.14 The variable Return_{t-1} denotes weekly returns of benchmark indices (region-specific MSCI equity indices for equities, and Bloomberg Barclays indices for corporate bonds) and is used to examine momentum-chasing behaviour. The variable Global Volatility_t is used to examine the impact stemming from external shocks (VIX for equities, and the Merrill Lynch Option Volatility Estimate index (MOVE) for corporate bonds). Finally, Control_{k,t} is a vector of macro variables to control for global macro-financial conditions.14

In equity markets, the regression results suggest that ETF flows tend to be returns-chasing like active OEF flows, with the trend most pronounced in EMs

In equity markets, a one percentage point increase in returns is associated with equity ETF flows increasing by 0.02 percent of total assets over a week (Chart A1).15 A similar relationship is found in the case of active OEF flows. This suggests that equity ETF flows tend to be returns-chasing – similar to active OEF flows – and equity ETF holders tend to increase purchases when markets rally. Such returns-chasing behaviour could potentially exacerbate aggregate market movements in a rising market. In terms of sensitivity to global financial shocks however, global risk aversion as proxied by the VIX was statistically insignificant in explaining equity ETF flows, unlike for active OEF flows. This suggests that ETF investors do not necessarily pull back from equity markets as much as active OEF investors do, in response to global financial shocks.

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13 To make a comparative assessment across the three investment vehicles, we separately considered ETF flows, passive OEF flows as well as active OEF flows. On ETF flows, the analysis only considered passively-managed ETFs as actively-managed ETFs (a) form a very small fraction of the total ETF assets (around 2%); and (b) are a fairly new development, with a correspondingly shorter data set.
14 Global macro-financial conditions were proxied using the Goldman Sachs global economic surprise index, as well as the US term premium. For corporate bonds, the study additionally controlled for region-specific macro-financial conditions, proxied using Goldman Sachs Financial Conditions Index and bond yields in the respective regions.
15 In absolute terms, a one percentage point increase in returns is equivalent to ETF inflows of US$1065 million into the US equity market (Chart A1). Given that the index returns of the US equity market over a typical week is 0.2%, the regression results would suggest ETF inflows of US$213 million over a typical week.
To examine the possibility that the degree of returns-chasing behaviour in equity ETF flows may vary between regions, the sample was split into three sub-samples: (i) US; (ii) DM ex-US; (iii) EM. The degree of returns-chasing behaviour appears to be most pronounced in the EM sub-sample (Chart A2). Specifically, a one percentage point increase in returns is associated with equity ETF flows increasing by 0.03 percent of total assets over a week in EM. Nevertheless, the extent of returns-chasing behaviour in the EM ETF flows remains lower than that of EM active OEF flows.

**Higher returns are associated with higher ETF flows to equities the following week...**

![Chart A1: Sensitivity of Equity Flows to a One Percentage Point Increase in Returns](image)

Source: MAS estimates, EPFR

**...with returns-chasing behaviour in equity ETF flows most pronounced in the EM sub-sample**

![Chart A2: Sensitivity of Equity Flows to a One Percentage Point Increase in Returns By Region](image)

Source: MAS estimates, EPFR

In corporate bond markets, ETF flows displayed signs of countercyclical behaviour, unlike active OEF flows.

The regression results for flows in the corporate bond markets show that a one percentage point increase in returns is associated with corporate bond ETF flows reducing by 0.03 percent of total assets over a week (Chart A3), which suggests some countercyclical behaviour. In terms of sensitivity to global financial shocks, we find that corporate bond ETF flows tend to behave countercyclically. A one standard deviation increase in the MOVE is associated with corporate bond ETF flows increasing by 0.02 percent of total assets over a week (Chart A4). In contrast, active OEF flows in corporate bond markets tend to be returns-chasing, suggesting that such flows tend to react procyclically in response to global financial shocks. A one percentage point increase in returns is associated with corporate bond active OEF flows increasing by 0.02 percent of total assets over a week, and a one standard deviation increase in the MOVE is associated with a reduction in corporate bond active OEF flows by 0.05 percent of total assets over a week.

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16 In absolute terms, a one percentage point increase in returns is equivalent to ETF outflows of US$761 million from the US corporate bond market (Chart A3). Given that the index returns of the US corporate bond market over a typical week is 0.1%, our regression results would suggest ETF outflows of US$76 million over a typical week.

17 In absolute terms, a one standard deviation increase in the MOVE is equivalent to ETF inflows of US$568 million in the US corporate bond market (Chart A4).
Higher returns are associated with lower ETF flows to corporate bonds the following week

Chart A3
Sensitivity of Corporate Bond Flows to a One Percentage Point Increase in Returns

An increase in global stress is associated with higher ETF flows to corporate bonds

Chart A4
Sensitivity of Corporate Bond Flows to a One Standard Deviation Increase in MOVE

In conclusion, ETF flows display less indications of procyclicality compared to active OEF flows to date. ETFs offer investors a low-cost option to a diversified portfolio with frequent on-market trading. Such features have led to the rapid growth of ETF assets over the past few years, with the trend expected to continue. At present, while ETFs could potentially pose some market risks, our results illustrate that: (i) equity ETF flows tend to be returns-chasing but do not display signs of sensitivity to global shocks; and (ii) corporate bond ETF flows tend to behave countercyclically during normal and stressed market conditions. In contrast, active OEF flows in both equity and corporate bond markets tend to be more returns-chasing as well as “flighty” in times of global stress.

Anecdotal evidence points to rising institutional participation in ETFs, particularly in Europe. Subject to data availability, one further area of study is whether the increasing participation of longer-term investors in ETFs could explain the less procyclical nature of ETFs vis-à-vis active OEFs.

As the composition of trading and investment strategies using ETFs changes over time, the net resultant fund flow dynamics may also evolve. Continued study to better understand the interaction between ETFs and the markets in which they are invested would add to global policymakers’ understanding of any financial stability implications associated with ETFs.

Source: MAS estimates, EPFR
Note: ^ refers to non-significant variables.

18 This trend of rising institutional participation in ETFs is particularly prevalent in Europe; the large ETF trade sizes observed on Euronext has been attributed, in part, to institutional investors. In contrast, the bulk of active OEF users would likely be retail investors. Central Bank of Ireland (2017), “Exchange Traded Funds Discussion Paper”. France AMF (February 2017), “ETFs: Characteristics, Overview and Risk Analysis – The Case of the French Market”. ICI Viewpoint (June 2015), “The IMF on Asset Management: Sorting the Retail and Institutional Investor Herds”.

---

### Chart A3

<table>
<thead>
<tr>
<th></th>
<th>ETF</th>
<th>Active OEF</th>
<th>Passive OEF</th>
</tr>
</thead>
<tbody>
<tr>
<td>US$ Million</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of Total Assets (RHS)</td>
<td></td>
<td></td>
<td></td>
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</table>

### Chart A4

<table>
<thead>
<tr>
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<th>ETF</th>
<th>Active OEF</th>
<th>Passive OEF</th>
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<tbody>
<tr>
<td>US$ Million</td>
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</tr>
<tr>
<td>% of Total Assets (RHS)</td>
<td></td>
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</tbody>
</table>
Box B

Monitoring Digital Token Markets: An Early Look at Frameworks and Techniques

Global interest in digital tokens, including from policymakers and international bodies such as the FSB\textsuperscript{19}, has increased after digital token valuations grew substantially in 2017. This box presents a preliminary framework, techniques and data sources for monitoring digital token markets. The findings suggest that digital tokens do not currently pose a material risk to financial stability in Singapore but bear close monitoring.

Rapid developments in digital token markets warrant close monitoring

The total market capitalisation of digital tokens rose rapidly in 2017 to a peak of around US$800 billion in January 2018, but has since fallen to under US$300 billion (Chart B1), driven in part by security incidents at major trading platforms and increased regulatory scrutiny.\textsuperscript{20} However, emerging signs of institutional interest in digital token markets\textsuperscript{21} and the further evolution of blockchain technology to address the limitations of existing chains\textsuperscript{22}, as well as development of products based on digital tokens e.g. digital token offerings, more commonly referred to as Initial Coin Offerings, could potentially drive renewed interest in digital tokens.

Monitoring developments has proven to be a challenge as data on digital token markets is not readily available from conventional channels. Data from entities regulated by MAS show that the degree of interconnectedness between financial institutions (FIs) and digital token markets in Singapore is currently small.\textsuperscript{23} However, the emergence of a digital token ecosystem (e.g. trading platforms, broker-dealers, wallet providers) that could fall outside regulators’ ambits calls for novel techniques and data sources to monitor digital tokens. Against this backdrop, MAS has undertaken work to strengthen our surveillance of digital token markets.

\textsuperscript{19} In July 2018, the FSB delivered a report to the G20 that (i) highlighted that digital tokens have raised issues around consumer and investor protection, and in money laundering and terrorist financing, and (ii) outlined its work on a framework for monitoring the financial stability risks arising from digital token markets. The report also summarised ongoing work by the CPMI, IOSCO and BCBS. FSB (July 2018), “Crypto-Assets: Report to the G20 on the Work of the FSB and Standard-Setting Bodies”.

\textsuperscript{20} Regulatory action differs among jurisdictions. Many jurisdictions have issued warnings aimed at educating investors on the potential pitfalls of investing in digital tokens. Several have imposed requirements to prevent money laundering and terrorism financing on trading platforms. Others have banned some or all digital token activities completely. Library of Congress (June 2018), “Regulation of Cryptocurrency Around the World”.

\textsuperscript{21} Some banks are facilitating trades in Bitcoin derivatives and exploring custody solutions for digital tokens. Several investment firms have also raised funds focused on digital token investments. Financial Times (August 2018), “Wall Street Starts to Dip its Toes in Crypto”.

\textsuperscript{22} Existing chains struggle to cope with high transaction volumes, incur high environmental costs, and create uncertainty around the finality of settlement. Ongoing experiments such as Bitcoin Lightning / Ethereum Plasma and Proof-of-Stake consensus mechanisms are efforts to improve on these issues. BIS Annual Economic Report (June 2018), “Cryptocurrencies: Looking Beyond the Hype”.

\textsuperscript{23} MAS’ scan of FIs shows that their direct (e.g. holdings of digital token assets and derivatives) and indirect exposures (e.g. extension of loans to digital token businesses) to digital token markets are currently minimal.
The digital token markets grew rapidly in 2017, but have since pulled back.

Bitcoin remains substantially bigger than other digital tokens.

Chart B1
Market Capitalisation of Digital Tokens

-source: Coinmarketcap-

Data from trading platforms provides a useful view of global trading activity...

This study focuses on Bitcoin (BTC) as it accounts for 51% of total market capitalisation (Chart B2). Data from digital token trading platform Application Programming Interfaces (APIs) allows monitoring of global shifts in trading activity (Chart B3). Substantial declines in the share of trading activity of a particular jurisdiction can serve as an early warning signal that the trading activity may flow to other jurisdictions, which has both financial stability and regulatory implications.24

Shifts in trading activity have implications on cross-border flows.

Chart B3
Global Fiat-BTC Trading Volumes

-source: MAS estimates, Cryptocompare-

...and facilitates deeper dives into the potential size of wealth effects in specific jurisdictions.

A potential channel through which digital tokens may affect financial stability is wealth effects, where declines in the value of households’ holdings of digital tokens could cause a drop in aggregate spending. MAS used the trading activity and inflows of SGD into BTC-SGD trades on major Singapore-based exchanges.

24 The pseudo-anonymity that blockchain technology provides may potentially increase money laundering risks. KPMG (June 2018), “Anti-Money Laundering in Times of Cryptocurrencies”. 

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as proxies for the potential wealth effects and associated risks in Singapore. Trading activity and directionality of flows can help to gauge confidence or sentiment effects and investor interest, while cumulative net inflows can aid in constructing bounds on the potential size of wealth effects.

Analysis suggests that wealth effects in Singapore are currently small. The lower-bound on the total volume of BTC-SGD traded since 2013 is estimated to be around S$9 billion which implies monthly trading volumes of less than 1% of those on the Singapore Exchange (SGX). Investor interest has also dipped substantially since January 2018 (Chart B4). Turning to BTC-SGD volumes, which were calculated by trade-level information from the APIs provided by major Singapore-based trading platforms, cumulative net inflows on trading platforms that disclose the directionality of their trades is estimated at around S$400 million (Chart B5). This is relatively small compared to Singaporean household assets of S$2 trillion at end 2017.

This approach (i.e. using trading activity and net inflows in a particular fiat to digital token pair to proxy activity by a jurisdiction’s participants) provides a useful tool to monitor and analyse digital tokens on a timely basis, given that the trading platform APIs are updated near real-time. Nevertheless, further work would be needed if the approach were to be applied in the case of more international currencies such as the euro, as the international profile of investors using those fiat currencies makes it more difficult to isolate the domestic wealth effects.

The blockchain also gives policymakers better visibility into entities in the digital token ecosystem which do not have an API

While trading platform APIs prove to be a valuable source of information on digital token markets, several major trading platforms and broker-dealers do not provide APIs. MAS has thus conducted further research into analysing the Bitcoin distributed ledger to monitor entities’ activities being broadcasted publicly on the blockchain.

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25 Those transacting in SGD are likely to be Singapore residents, and BTC is the largest digital token by market capitalisation.
Clustering on the blockchain can help to track the activity of unregulated entities

Figure B1
Explanatory Illustration of Clustering on a Blockchain

Source: MAS

As a proof of concept, MAS ran a clustering algorithm\(^{26}\) (written using an open-source Bitcoin blockchain parser\(^{27}\)) to find around 10,000 addresses that were controlled by a major wallet provider and broker-dealer in Singapore without an API (Figure B1). The additional visibility gained on its potential custodial holdings of BTC, peaking at US$20 million in January 2018 (Chart B6), supports the assessment that current exposures to digital tokens remain small.

Blockchain technology can be harnessed to monitor wealth effects... ...as well as cross-border flows in digital token markets

Chart B6
Blockchain Monitoring of Major Singapore-based Wallet Provider

![Blockchain Monitoring Chart](chart.png)

Source: MAS estimates, Bitcoin blockchain
Note: Cumulative balances since 1 January 2015.

Chart B7
Transfers of BTC from a Key Chinese Trading Platform to a Singapore Trading Platform

![Transfers Chart](chart.png)

Source: MAS estimates, Bitcoin blockchain
Note: The yellow lines demarcate key regulatory crypto announcements in China. These appear to have driven movement of BTC into a Singapore trading platform, but the estimated transfers remain small at less than S$10 million. Cumulative transfers since 1 January 2015.

\(^{26}\) Clustering techniques have been adopted in other studies of digital token blockchains. Sarah Meiklejohn, Marjori Pomarole, Grant Jordan, Kirill Levchenko, Damon McCoy, Geoffrey M. Voelker and Stefan Savage, Proceedings of the 2013 Conference on Internet Measurement Conference (2013), “A Fistful of Bitcoins: Characterizing Payments Among Men with No Names”.

These blockchain-level clustering techniques can also be used to monitor the magnitude and potential drivers of cross-border flows by analysing transfers of BTC between entities in different jurisdictions. One area of study is whether tightening regulatory measures in one jurisdiction could drive an inflow of digital token activity to another jurisdiction. Early analysis on the flow of funds from a key trading platform in an overseas jurisdiction to a Singapore trading platform – following the jurisdiction’s regulatory actions in digital token markets – suggests that while regulatory actions may be drivers of cross-border capital flows in digital token markets, the magnitude of such flows remains small (Chart B7).

**Aggregating public data can give a preliminary sense of digital token offerings activity**

The prevalence of digital token offerings underscores the rapid changes taking place in digital token markets, and the growing need for better surveillance in this area. Yet, there are no authoritative or verified sources on identifying specific digital token offerings and their countries of operations.

MAS has undertaken early work to aggregate information from online portals. One major caveat on this approach is that the data has been self-reported by token issuers to online portals, and not verified. Meanings of terms vary across portals and are ill-defined e.g. “country” could refer to (i) country of operations or (ii) domicile of offering vehicle, and the offering may or may not have been made in that country. Nevertheless, MAS’ early work allows regulators to gain a preliminary sense of digital token offerings activity globally. MAS’ data suggests that the cumulative self-reported amounts raised have grown in 2018 (Chart B8). From a financial stability perspective, the reported amounts raised through digital token offerings are much smaller than the total digital token market capitalisation (Chart B1) and do not currently present a material risk.

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**Cumulative digital token offerings volume grew in 2018 but not material to stability**

**Chart B8**

Self-reported Digital Token Offering Volumes by “Country”

- United States
- Switzerland
- Estonia
- Russia
- Gibraltar
- Singapore
- United Kingdom
- Hong Kong
- Canada

Index (1 Jan 18 = 1)

Source: MAS estimates, online digital token offering portals

Note: Volume raised indexed to one as of 1 January 2018, based on digital token offering’s self-reported “country of operations”.
Ongoing market developments continue to bear close monitoring, with such monitoring aided by new frameworks and data sources

MAS continues to monitor and study digital tokens and their underlying blockchain technology closely. While the indicators above suggest that digital token markets have cooled significantly in 2018 and financial stability implications in Singapore are presently small, early signs of increased integration between FIs and digital token markets may facilitate increased institutional involvement in digital tokens.

Various jurisdictions and authorities have been exploring different ways of strengthening surveillance of digital token markets. MAS’ early work suggests that while digital tokens create data gaps for authorities that traditional data sources may find challenging to fill, they also bring new, if unconventional, data sources that authorities can tap into. These data sources are rapidly changing, and MAS continues to refine and improve our surveillance framework as markets evolve and new sources of data become available.

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Box C
A Framework to Assess the Implications of Cyber Risk on Financial Stability

The financial sector’s move towards greater digitalisation and wider adoption of technological solutions has precipitated growing interest in the study of cyber risk.\(^\text{29}\)

Given the interconnectedness of the financial system and its importance to economic growth, one important area of study is how a cyber attack on an FI could lead to a systemic outcome.\(^\text{30}\) This box proposes a framework to assess the impact of a cyber incident on a bank, and assesses the likelihood that different types of cyber incidents could lead to a systemic outcome.

**Cyber attacks can be categorised into theft, disruption, or damage-related attacks**
Cyber attacks can be broadly categorised into three types, based on the harm that they inflict\(^\text{31}\):

- **Theft** – cyber attacks that extract items that are valuable to the perpetrator would be considered theft-related. Funds/monies, customer credentials and intellectual property or market-valuable information are likely targets of theft-related cyber attacks.\(^\text{32}\)
- **Disruption** – cyber attacks can temporarily disrupt business functionality, or degrade the availability of transactions or communications. Websites or servers, and internet-based businesses are examples of business functionalities that can be disrupted as part of a cyber attack.\(^\text{33}\)
- **Damage** – such cyber attacks affect data integrity, or damage system hardware or software or other equipment.

Historically, a large majority of reported cyber attacks affecting the financial sector worldwide have been theft or disruption-related (Chart C1).

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\(^\text{29}\) International Monetary Fund (June 2017), “FinTech and Financial Services: Initial Considerations”.

\(^\text{30}\) This refers to the outcome from a disruption to financial services that is caused by an impairment of all or parts of the financial system and has the potential to have serious negative consequences for the real economy. Bank for International Settlement (February 2010), “Systemic Risk: How to Deal With It?”.

\(^\text{31}\) Simon Ruffle, Andrew Coburn, Daniel Ralph, Gary Bowman, University of Cambridge Judge Business School, Centre for Risk Studies, (July 2013), “Cambridge Risk Framework, Profile of a Macro-catastrophe Threat Type – Cyber Catastrophe”.

\(^\text{32}\) Consumer businesses are relatively more likely targets, given the large amount of valuable customer information they possess. Fitch Ratings (April 2017), “Cybersecurity an Increasing Focus for Financial Institutions”.

\(^\text{33}\) Financial market infrastructures that provide services such as trading, payments, clearing and settlement are more likely targets of such attacks.
Nascent understanding of financial stability implications of cyber risk

The relationship between cyber attacks and financial stability is increasingly important to understand. The analysis of cyber risk has more often focused on the operational impact from an entity-level perspective or on technical aspects of cyber attacks, as opposed to financial stability impact. To date, there has also been no previous cyber event that has been viewed as systemic, to take reference from.

Several studies have noted the possibility of cyber risk having systemic implications. The Institute of International Finance (2017)\textsuperscript{34} has looked into possible cyber attack scenarios that could lead to systemic outcomes, and the resulting impact on affected FIs and the financial system. The World Economic Forum (WEF) (2016)\textsuperscript{35} describes the financial risks as well as potential systemic impact associated with a cyber event that disrupts payment, clearing and settlement arrangements. The Office of Financial Research (2017)\textsuperscript{36} suggests three channels through which cyber events can threaten financial stability – (i) lack of substitutability (of a service), (ii) loss of confidence in an FI or the wider financial system, and (iii) loss of data integrity.

On the other hand, Danielsson et al. (2016)\textsuperscript{37} posit that cyber risk is largely microprudential, and can have systemic implications only if timed to coincide with other non-cyber events that undermine confidence in the financial system and the authorities.

A framework to assess cyber risk and systemic impact in a more systematic manner

The transmission channels of a cyber scenario and the likelihood that it will result in a systemic impact can be assessed in a systematic approach via a framework. For the purpose of this analysis, systemic cyber risk

\begin{center}
\begin{figure}
\centering
\includegraphics[width=\textwidth]{chart_c1.png}
\caption{A large majority of reported cyber incidents affecting the financial sector worldwide are related to theft or disruption}
\end{figure}
\end{center}
refers to the potential for a cyber-related event, action or series of events or actions to have an adverse impact on the proper functioning of the financial system and, in consequence, on the economy.\textsuperscript{38}

Using the framework (Figure C1), we first assess the impact of any cyber scenario on a bank in terms of five microprudential risks, namely – liquidity, market, credit, operational and legal/reputational risk. Next, we consider second-order effects of the impact on liquidity and market risk, given that a negative impact on the legal and reputational aspect\textsuperscript{39} of a bank can lead to a loss of confidence in it. This could create a feedback loop and amplify liquidity and market risk. Lastly, using our assessment of the microprudential risks as well as how they could propagate to the wider financial system, we form an assessment of the likelihood that a particular cyber scenario leads to a systemic outcome.

\textbf{A framework to assess the systemicity of different types of cyber attacks in a systematic manner}

\textbf{Figure C1}

\textbf{Cyber Risk and Systemic Risk: A Framework}

\begin{itemize}
  \item Theft of monies and data from a bank;
\end{itemize}

\textsuperscript{38} Definition is adapted from WEF (2016).

\textsuperscript{39} Such reputational impact can arise from negative publicity, as well as legal impact as a result of liability or lawsuits from negligence, or disruptions that may have led to monetary losses on the part of the customer.

\textsuperscript{40} The scenarios considered are by no means exhaustive, but serve to illustrate a range of possible types of attacks, to identify possible transmission channels and their corresponding impact on banks.
While transmission channels of a cyber incident on financial stability are no different from other types of shocks, the speed of transmission of impact within the financial system is likely to be greater.

Cyber threats can potentially result in a systemic outcome through three broad channels, largely similar to the way other shocks are transmitted through the financial system:

- **Risk contagion** – a cyber attack on one bank could potentially lead to difficulties that spill over to other banks, given the highly interconnected nature of the financial system. For example, a cyber attack that renders a bank unable to promptly settle its interbank payments with other banks could lead to funding liquidity concerns in other banks reliant on those payments;

- **Risk concentration** – a cyber attack on a key financial market infrastructure, third-party service provider, or a systemically important bank could mean a loss of services that cannot be easily and promptly substituted; and

- **Erosion of confidence** – a widespread attack could trigger an erosion of confidence across several banks or the financial system.

Yet, one key difference between cyber risk and other traditional sources of shocks lies in the speed of materialisation of risks within the financial system. The impact of a cyber incident on one bank can quickly cause problems to materialise within that bank and transmit to the rest of the financial sector, much faster than some traditional forms of risk, such as credit risk, which would typically take a longer time to build up. It is thus pertinent that authorities develop a deeper understanding of the impact and transmission channels of various cyber attacks, in order to be able to respond in an appropriate and timely manner to minimise the risk that an attack leads to a systemic outcome.

An assessment of the impact of the cyber attack scenarios and the identification of the transmission channels based on the above framework allow us to better assess the probability that a particular type of attack can lead to systemic outcomes.\(^{41}\)

For example, if the microprudential risk involved in a particular cyber attack is liquidity risk, the relevant metric to assess the impact on the bank would be its liquidity buffers, or availability of liquid assets. In general, the likelihood that a theft-related cyber attack alone leads to stresses in a bank can be proxied by the size of a bank’s liquidity buffers – the smaller a bank’s liquidity buffers, the higher the probability that a theft-related cyber attack on a bank can lead to liquidity issues. Given that all banks in Singapore are required to meet all-currency and Singapore Dollar liquidity requirements\(^{42}\), it means that losses from theft will have to be of an extremely large magnitude for the bank to deplete all its liquid assets and incur liquidity issues that is likely to lead to spillover effects on the wider financial system, or to lead to a significant loss of confidence.

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\(^{41}\) This assessment does not take into account other factors, such as a bank’s level of cyber resilience, and also assumes that general market conditions are benign and do not itself already trigger a systemic event.

\(^{42}\) As prescribed under MAS Notice 649.
Theft and disruption-related cyber attacks have a low probability of becoming systemic...

Based on our framework and assessment from a Singapore context, the consequences of cyber attacks related to theft and disruption have a low probability of turning into a systemic event (Figure C3 in Appendix). This is because at the individual entity level, banks should have in place buffers (e.g. liquidity and capital buffers) to mitigate the impact of such attacks, which also help to minimise the likelihood of contagion effects propagating from such attacks.

...while cyber attacks that damage data integrity have a greater likelihood of a systemic outcome

In contrast, we assess that cyber attacks that damage data integrity have a greater likelihood of leading to a systemic outcome (Figure C3 in Appendix). Because data integrity is key in the financial sector, the loss of confidence in the damage scenario could be very severe. This is especially so if data manipulation has gone undetected for a prolonged period, as its impact would have propagated to a wider group of affected parties and any rectification would likely require a longer duration.

Figure C2 below illustrates one way to depict the systemicity of a particular type of cyber attack, based on the severity of loss it causes to an affected bank, as well as the number of entities that would be affected.44

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43 As an example, the global median time taken to detect a cyber intrusion from initial compromise is 146 days. FireEye (August 2016), “M-Trends Asia-Pacific: Organizations Must Improve at Detecting and Responding to Breaches”.

44 Illustration adapted from Cambridge Centre for Risk Studies (October 2014), “Cyber Catastrophe: Stress Test Scenario – Sybil Logic Bomb Cyber Catastrophe Scenario”.

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Figure C2

Systemicity of Various Cyber Attack Scenarios

Source: MAS estimates, Cambridge Centre for Risk Studies
But the most significant factor in determining if a cyber attack will lead to a systemic outcome is whether confidence can be preserved in the aftermath of the attack.

That said, confidence in banks and the financial system is a significant factor in determining if an attack will escalate and lead to a systemic outcome, given that confidence is a key source of contagion. While banks in Singapore can mitigate the impact of a cyber attack affecting their liquidity or solvency through their healthy capital and liquidity buffers, the impact of a loss of confidence on a bank can be hard to estimate or predict. The more severe the theft or damage done to data integrity, or the longer the disruption caused by a cyber attack, the larger the negative impact on confidence it will cause. A loss of confidence is likely to render the bank more vulnerable, with knock-on effects to the wider financial system (Figure C1), leading to a corresponding increase in the probability that the outcome becomes systemic.

Authorities can help to minimise contagion and preserve confidence, and hence help to reduce the likelihood of a systemic outcome. For example, authorities could work with banks and other affected entities to coordinate crisis communications (e.g. to reduce the chances of different entities sending conflicting messages), assure markets, and where necessary, coordinate temporary market closures or bank holidays to avoid market confusion and the spread of panic onto the wider financial system. Authorities are also able to extend liquidity assistance to banks to tide through the stress period, if necessary.

Strengthen cyber resilience and business continuity efforts, and encourage collaborations within the financial industry to counter cyber threats

The cyber threat landscape is constantly changing and motivations of threat actors will continue to evolve over time. Incidents such as the WannaCry ransomware campaign that hit several organisations and countries serve as a reminder that no one is immune to cyber threats. Enhancing the resilience of individual FIs to cyber attacks, as well as putting in place measures to promptly recover and resume services in the event of an attack, are critical in reducing the likelihood that an attack becomes systemic.

The analysis of past incidents and events indicates that the majority of cyber incidents could have been prevented if institutions practise basic cyber hygiene. MAS is focused on raising the overall cyber hygiene waterline for the financial sector, and has proposed cyber security measures that all FIs will be required to implement.

It is also critical that FIs put in place robust business continuity plans and test them regularly in a realistic manner to maintain a high state of preparedness. Early detection and an effective incident response can help to contain the consequences and mitigate the impact of a cyber attack not just within a bank, but also to the broader financial sector.

Lastly, collaboration within the global financial industry should continue to be encouraged, given its interconnected nature. One institution’s cyber incident can contribute to strengthening the defences of other institutions if information on cyber threats, incidents and lessons learnt are shared. Similar to

45 For example, a loss of confidence in a bank could lead to a run on deposits. In addition, if the loss of confidence becomes widespread across the financial sector, assets could rapidly fall in value. These could cause or exacerbate liquidity risk and market risk, respectively, for the bank.

46 MAS (September 2018), “Consultation Paper on Notice on Cyber Hygiene”.

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Information sharing between FIs, regulators stand to gain from sharing cyber threat information as it enhances their supervision and policy making in respect of cyber risks.
Appendix

Types of Cyber Attack Scenarios Considered for Analysis

Figure C3
Transmission Channels of Theft, Disruption and Damage-related Cyber Attacks

<table>
<thead>
<tr>
<th>Theft</th>
<th>Disruption</th>
<th>Damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Money Data Bank’s client-facing system</td>
<td>Bank’s trading system Bank’s access to payment system</td>
<td>Database of bank Database of major data provider</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Liquidity</td>
<td>Large theft required to draw down HQLA buffers Large monetary compensation required to draw down HQLA buffers</td>
<td>Some knock-on impact, as it causes unsettled transactions of other banks Loss of confidence/data creates unwillingness to transact with affected bank</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Market</td>
<td>Drop in asset value from loss of confidence, only if attack is widespread</td>
<td>Adverse market movements lead to losses of bank’s mark-to-market positions</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Credit</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Operational</td>
<td>-</td>
<td>-</td>
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<tr>
<td>Legal/ reputational*</td>
<td>LOW</td>
<td>LOW</td>
</tr>
<tr>
<td>Systemic</td>
<td>Unless SIFI and losses are of extremely large magnitude Unless SIFI and data breach is very severe such that it affects confidence</td>
<td>Unless attack is widespread, or sufficiently long to affect confidence</td>
</tr>
</tbody>
</table>

Source: MAS

Notes:

^ Bank client-facing systems refer to systems associated with the use of ATMs, online banking services, access to customer-related servers and other similar functions. For example, South Korea’s Nonghyup Bank’s computer system crashed in a cyber attack in 2012, resulting in customers being unable to use credit cards and ATMs for over a week.

# This refers to the scenario where an individual bank loses access to the payments system in which interbank transactions are processed.

* Two damage scenarios related to data integrity are considered — first, one where a bank suffers a hack in which its asset and liability data (e.g. consumer account balances, interbank-counterparty related data, as well as trading positions) are compromised, manipulated or deleted, and secondly, corruption of a major data provider’s database. In both cases, back-up systems are also compromised and the affected entities are unable to determine, in a timely manner, which data has been compromised. In the former, the bank is likely to face liquidity issues — apart from being unable to determine its financial position (given lack of data to track its own exposures as well as counterparties), it is likely that plummeting confidence will render other FIs unwilling to transact with it, and also cause the bank to face deposit runs. The latter is made worse due to the fact that deposit withdrawals are based on erroneous balances and withdrawal limits. Furthermore, the bank loses its ability to make necessary trades given an inaccurate assessment of its mark-to-market positions. In the latter scenario, manipulated and erroneous data is propagated to numerous downstream FI users, which rely on them for a variety of uses, including in their modelling, valuation and decision-support systems. This results, for example, in price setting that affects profitability, as well as execution of loss-making trades.

~ In almost all scenarios across the three categories, banks which have been targets of cyber attacks would suffer reputational impact from negative publicity and loss of confidence, as well as legal impact as a result of liability or lawsuits from negligence, or disruption that may have led to monetary losses on the part of the customer. For example, in the scenario where a bank’s trading system is disrupted, its inability to execute a trade on behalf of its client in a timely manner could render it liable to compensation claims.
2 Singapore Financial Sector

The banking system in Singapore remains resilient in 2018 against a backdrop of rising uncertainty in the macroeconomic landscape.

Overall loan growth remained healthy over the past year. Asset quality of the banks’ loan portfolios has also improved despite the pick-up in bank lending. Weaker segments, particularly the Transport, Storage and Communications (TSC) sector, have seen declines in NPL ratios. Nevertheless, banks should continue to maintain good credit underwriting standards and adequate provisioning buffers to mitigate potential credit risks.

While banks continue to hold surplus liquid assets well above regulatory requirements, abrupt tightening of global financial conditions could accentuate foreign currency liquidity risks. Banks should thus actively monitor and manage their foreign currency liquidity profiles as they continue to expand their cross-border lending activities.

Credit Growth

Both non-resident and resident lending increased at a healthy pace amid still resilient macroeconomic conditions

Overall credit continued to grow at a healthy pace in 2018 (See Panel 2A “Banking Sector: Credit Growth Trends”). The growth was most pronounced in non-resident non-bank loans, which increased by 9.8% year-on-year (YoY) in September 2018.

The growth in non-resident non-bank lending has been underpinned by credit intermediation from advanced economies to emerging Asia amid sustained economic momentum in the region (See Panel 2B “Banking Sector: Cross-border Lending Trends”).

While cross-border lending to emerging Asia has picked up since the upturn of the credit cycle in 2017, trade finance volumes have started to decline in recent months (Chart 2.1). This could be partly attributed to China’s modest economic slowdown.

Chart 2.1
Volume of Trade Bills and Non-bank Loans to Emerging Asia

Source: MAS

Domestic loan growth was broad-based across most sectors

Resident lending to most sectors registered healthy growth over the year. In particular, loans to the housing sector picked up in the first half of the year alongside improved sentiment and increased activity in the private residential property market (See Box J “Update on the Private Residential Property Market”). Additionally, lending to the Building and
Construction (B&C) sector has increased due to improved prospects for the sector as more public sector projects come on-stream.

Based on a survey conducted by MAS, banks cited tightening financial conditions and geopolitical uncertainties as potential concerns that might weigh on customer creditworthiness. Hence, banks may remain cautious in lending over the next two quarters.

Asset Quality Risks

Asset quality improved across most sectors

The banking system’s overall NPL ratio decreased to 1.9% in Q3 2018, from 2.1% a year ago (See Panel 2C “Banking Sector: Asset Quality and Liquidity Indicators”).

Of note, the NPL ratio for the manufacturing sector improved to 4.6%, supported by the healthy performance of the electronics, biomedical and transport engineering clusters.

In addition, the NPL ratio for the TSC sector declined since its peak in December 2017. Banks had in the second half of 2017 accelerated their recognition of NPLs in the underperforming Marine and Offshore Engineering (M&OE) subsector to reduce uncertainty over the asset quality outlook. In 2018, the asset quality of the TSC sector improved alongside a recovery in the outlook for the Oil and Gas (O&G) sector as crude oil prices had been increasing over the past year.

Banks continue to maintain adequate loan-loss provisioning buffers. Total provisioning coverage in the banking system remained healthy at 102% in Q3 2018. Specific provisions also rose to 59% from 45% a year ago. These buffers are further augmented by general provisions held at the head offices of foreign bank branches.

Banks should continue to maintain good credit underwriting standards and prudent provisioning

While asset quality has generally improved, banks should remain vigilant by maintaining sound underwriting standards and adequate provisioning buffers. Banks should also continue to actively monitor and mitigate the credit risks that come with increased lending activities.
Liquidity and Foreign Currency Funding Risks

Foreign currency loan-to-deposit (LTD) ratio has been increasing, and bears close monitoring

Foreign currency lending has increased alongside the pick-up in non-resident lending. This has in turn led to an increase in the foreign currency LTD ratio, which reached 129% in September 2018. The SGD LTD ratio has remained low at 87.1%.

Banks have strong capital and liquidity buffers to withstand shocks

Banks’ liquidity positions have remained strong amid tightening global funding conditions, with the domestic systemically important banks (D-SIBs) maintaining liquidity coverage ratios (LCRs) well above MAS regulatory requirements.

In particular, the banking system does not face USD funding gaps on an aggregated basis, with USD-denominated liabilities being more than sufficient to fund USD-denominated assets. Local banking groups have also mitigated liquidity risks by diversifying their USD funding sources across a wide range of geographies, industries, and funding instruments.

The funding structure of foreign banks in Singapore has also remained healthy, with non-bank deposits constituting more than 60% of total funding (Chart 2.3). This is further augmented by relatively stable net intragroup funding from the banks’ head offices. Conversely, reliance on less stable net unrelated interbank funding has remained low at less than 10% of foreign banks’ total liabilities.47

Nevertheless, USD funding costs are expected to rise due to US monetary policy normalisation. Non-US foreign bank branches that are more reliant on short-term or wholesale funding might be more vulnerable to USD liquidity stresses and outflows under stressed conditions.48

Chart 2.3
Funding Structure of Foreign Banks in Singapore

Source: MAS

MAS will continue to closely monitor and review banks’ liquidity risk management practices and assess the willingness and ability of foreign banks’ head offices to provide liquidity support to their branches in Singapore.

47 Observations of banking system trends during past crisis periods (Asian Financial Crisis and Global Financial Crisis) suggest that unrelated interbank funding was the least stable funding source. See MAS FSR Box E (November 2015), “Stress and Stability in Funding Networks: The Resilience of Singapore’s Banking System Funding Structure During Crisis Periods”.

48 Short-term or wholesale funding might not be raised directly by foreign bank branches in Singapore. Foreign banks can raise funding through the head office, or affiliated entities before providing intragroup fund transfers to the Singapore-based branch entities.
In addition, MAS has taken steps to strengthen the liquidity risk management framework for D-SIBs. Since January 2018, MAS requires all D-SIBs to maintain available stable funding on an ongoing, all-currency basis in order to meet the Net Stable Funding Ratio (NSFR) requirements. The implementation of NSFR will help enhance the banking system’s resilience to funding shocks over longer time horizons.

MAS also conducts an annual industry-wide stress test to assess the resilience of the banking system to adverse financial shocks, including rising interest rates. The results of the stress test underscored the ability of the banking system to withstand severe shocks. Strong capital and liquidity buffers built up over the years would enable the banks to absorb losses and meet the anticipated cash outflows, even after taking into account macro-financial feedback effects (See Box D “Industry-Wide Stress Test (IWST) 2018: Leveraging on Granular Housing Loan Data”).

Banks should continue to maintain strong liquidity buffers and manage their foreign currency risks prudently by developing liquidity contingency plans and diversifying their foreign currency funding sources.

Local Banking Groups

Local banking groups continue to experience strong growth in their loan books

Local banking groups’ loan books grew strongly over the year. Non-bank loan growth increased by 9.1% YoY as of Q3 2018, underpinned by an increase in non-resident lending. Local banking groups’ non-resident and resident loans grew 12% YoY and 5.9% YoY in Q3 2018 respectively (Chart 2.4).

Chart 2.4

Local Banking Groups’ Non-bank Loans Growth by Residency

Source: Local banking groups’ financial statements

The local banking groups continued to maintain healthy earnings and net profits over the past year (See Panel 2D “Banking Sector: Local Banking Groups”). This was supported by improved net interest margins of 1.8% in Q3 2018.

In terms of asset quality, local banking groups have more than adequate provisioning buffers

The local banking groups’ NPL ratio remained low at 1.5%, below the banking system’s NPL ratio of 1.9% in Q3 2018. In addition, the local China and a disorderly “Brexit” driving fears over further EU disintegration.
banking groups continue to maintain ample overall provisioning coverage of 191% in Q3 2018.

Local banking groups’ capital and liquidity positions remain strong

Capital and liquidity positions of the local banking groups remain robust, with the average capital adequacy ratios (CARs) and all-currency LCRs well above regulatory requirements. The LTD ratios of the local banking groups also remain below 100% (Chart 2.5). In particular, their USD LTD ratio remains well below 100% at 71.4% in Q3 2018. Nevertheless, local banking groups should continue to manage their risks carefully as they expand in the region.

Source: Local banking groups’ financial statements

MAS will continue to closely monitor and assess the potential financial stability risks to the banking system.
Panel 2A  Banking Sector: Credit Growth Trends

Overall loan growth remained healthy over the past year, but has moderated in recent months. The moderation is driven by the slowdown in non-resident non-bank loan growth.

Most domestic sectors experienced positive loan growth over the past year. Trade financing volumes have also remained stable.

The credit-to-GDP gap for Singapore remains negative at \(-6.1\%\) as at Q3 2018.
Panel 2B  Banking Sector: Cross-border Lending Trends

Cross-border lending volumes have grown over the past year, but have declined slightly in recent months due to a decrease in non-bank lending to emerging Asia.

Net lending to emerging Asia has increased over the past year, with net funding coming mainly from Europe and Developed Asia.

Local and Japanese banks continue to be the main net lenders to emerging Asia.
Asset quality improved slightly over the year, with overall non-bank NPL ratio decreasing to 1.9% in Q3 2018. Provisioning coverage remains adequate.

Singapore's banking system has sufficient resident deposits to fund resident loans. The foreign currency LTD ratio has increased to 129% (as at September 2018) and bears close monitoring.
Panel 2D  Banking Sector: Local Banking Groups

Local banking groups continue to maintain healthy earnings and net profits, supported by a stable net interest margin (1.8% in Q3 2018).

The local banking groups’ NPL ratio (1.5%) has remained low. In addition, the local banks continue to maintain ample total provisioning coverage of 191% of unsecured non-performing assets.

Local banking groups’ capital and liquidity positions have remained strong, with CAR and all-currency LCR well above MAS’ regulatory requirements.
Panel 2E Insurance Sector

The insurance industry in Singapore remains well-capitalised. The average CARs for the direct life and direct general insurance industry were 236% and 334% as at Q3 2018, respectively.

Chart 2E1: CARs of Direct Life and Direct General Insurers

Source: MAS

New business premiums of the direct life insurance industry grew in 2018, largely attributable to growth of non-participating and investment-linked products. Net income fell mainly due to poorer investment performance as compared to 2017.

Chart 2E2: Direct Life Insurers: New Business Premiums

Source: MAS

Gross premiums of the direct general insurance industry increased in 2018, due to the increase in both Singapore Insurance Fund (SIF) and Offshore Insurance Fund (OIF) business. While the industry achieved investment profits, underwriting losses were reported in 2018.

Chart 2E4: Direct General Insurers: Gross Premiums

Source: MAS

Chart 2E5: Direct General Insurers: Operating Results

Source: MAS
Panel 2F  
**Over-the-counter (OTC) Derivatives**

MAS' OTC derivatives trade reporting data shows that Interest Rate (IR) is the largest asset class booked and traded in Singapore, followed by Foreign Exchange (FX), reflecting the role played by Singapore in the global OTC derivatives market.

**Early Trade Report:**

The majority of IR derivatives transactions in Singapore are IR swaps, and are denominated in Asia-Pacific currencies, suggesting a more regional base.

**Panel 2F1:** Share of Singapore’s OTC Derivatives Market by Asset Class and Notional Outstanding (End Sep 2018)

**Panel 2F2:** Breakdown of Top Five Economies in the Global OTC Derivatives Market by Annual Turnover

Forwards and swaps dominate Singapore’s FX derivatives market, in line with global trends. The majority of trades are conducted in DM currencies, suggesting that the FX derivatives market in Singapore serves an international base.

**Panel 2F3:** FX Derivatives by Product: Monthly New Trades

**Panel 2F4:** FX Derivatives by Currency: Monthly New Trades

The majority of IR derivatives transactions in Singapore are IR swaps, and are denominated in Asia-Pacific currencies, suggesting a more regional base.

**Panel 2F5:** IR Derivatives by Product: Monthly New Trades

**Panel 2F6:** IR Derivatives by Currency: Monthly New Trades

Note: Excluding cross currency swaps.
Box D
Top-Down Stress Test 2018:
Leveraging on Granular Housing Loan Data

MAS conducts an annual stress test of all major FIs in Singapore, to assess the resilience of individual institutions and the financial system as a whole to adverse macroeconomic and financial shocks. This box highlights key results from MAS’ 2018 top-down stress test.

Stress scenario features significant macroeconomic and financial stresses over a five-year horizon

The 2018 stress test assumes a protracted global downturn, amid heightened trade tensions resulting from protectionist measures in the US. At the same time, China’s debt overhang troubles intensify while Europe grapples with a disorderly “Brexit” and fears over further EU disintegration. The rest of Asia slips into recession and Asian currencies depreciate sharply, triggering capital outflows from the region and a fall in asset prices. Financial conditions tighten significantly, with increases in interest rates and credit spreads. Against such a scenario, Singapore experiences a recession with unemployment rising sharply and property prices falling by around 50%. Selected financial market stress parameters are provided in Table D1 below.

<table>
<thead>
<tr>
<th>Financial Market Parameters</th>
<th>Stress Scenario (2018 – 2022)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property prices</td>
<td>Cumulative drop of 50-55%</td>
</tr>
<tr>
<td>Oil prices</td>
<td>Cumulative drop of 50%</td>
</tr>
<tr>
<td>Equity prices</td>
<td>Cumulative drop of 30-50%</td>
</tr>
<tr>
<td>Regional currencies (vs USD)</td>
<td>Cumulative depreciation of 20-40%</td>
</tr>
<tr>
<td>Credit spreads</td>
<td>Cumulative increase of 350-700bps</td>
</tr>
<tr>
<td>Domestic interest rates</td>
<td>Cumulative increase of 130bps</td>
</tr>
</tbody>
</table>

The banking and insurance sectors remain resilient under severe shocks

The stress test results underscored the banking system’s ability to withstand severe shocks. All banks remained solvent, with their CARs well above Basel regulatory requirements in the stress scenario. In addition, banks have sufficient liquidity buffers to meet anticipated cash outflows under the prescribed stress conditions. The results hold even after taking into account second-order macro-financial feedback effects, which would exacerbate the deterioration of macroeconomic and financial conditions. For instance, NPLs are about 4% higher on average across the stress horizon given the prescribed external macroeconomic shocks.

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50 For the 2018 top-down stress test, MAS simulated a five-year stress scenario instead of the three-year scenario assumed in previous stress tests.
51 The scenario assumes that the US Federal Reserve halts rate hikes once the economy enters into recession.
Turning to asset quality, the TSC sector would be most severely impacted by the prescribed shocks, as firms are still recovering from a protracted downturn in the M&OE subsector. Nevertheless, the overall NPL ratio of the banking system remained below the historical high observed during the Asian financial crisis. Strong capital buffers built up over the years also enabled banks to absorb losses from higher stressed NPLs and write-offs.

For insurers, analyses that focused on equity and credit spread shocks also indicated that they remained resilient, with most insurers continuing to meet regulatory capital requirements under the stress scenarios. Insurers would also be able to take management actions such as changing asset allocations and increasing reinsurance coverage to strengthen their capital positions.

**Access to granular datasets can help augment MAS’ top-down stress test**

As part of MAS’ ongoing efforts to refine its stress testing capabilities, account-level data made available through recent enhancements in MAS’ surveillance framework was used to augment the top-down stress test. The high level of granularity from these datasets can yield more informative stress testing models and deeper insights into banks’ risk exposures. For instance, given that increases in probability of default (PD) and loss given default (LGD) under stress would vary across borrowers with different risk profiles, such granular data allows for the estimates of credit losses and capital requirements to be more sensitive to the heterogeneity of banks’ borrower profiles.

**Sensitivity analysis of mortgage servicing ratios (MSRs) and loan-to-value ratios (LTVs)**

MAS applied granular housing loan data in this year’s top-down solvency stress test, to enhance credit risk modelling of housing loans. Among the six locally-incorporated banks, housing loans constitute nearly one-fifth of their total exposures and warrant close monitoring. Deeper insights into the banks’ customer risk profiles and how credit quality might evolve based on different loan characteristics would better inform MAS’ macroprudential surveillance efforts.

MSRs and LTVs of borrowers from the six banks collected under the housing loan profile survey were subject to stresses based on the prescribed shocks. In addition, MAS assumed a decrease in household income proportional to that observed during the Global Financial Crisis (GFC), stratified by household income deciles. On the whole, results indicate that stressed MSRs and LTVs remained manageable under the stress scenario. However, borrowers from the lower income deciles may face more difficulties servicing their mortgage debt due to higher stressed MSRs.

While some banks could see larger increases in MSRs (Chart D1) due to their borrowers’ income profiles as well as loan characteristics (e.g. loan tenure and current effective mortgage rate), the relative loan quantum is smaller for borrowers with higher stressed MSRs (Chart D2). As such, banks would be in a better position to absorb losses or restructure such mortgages should households face debt servicing difficulties under a severe stress scenario. Nonetheless, banks should maintain prudent underwriting

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54 The relative loan quantum is computed as the size of a housing loan as a percentage of total housing loans extended by the same bank.
Financial Stability Review, November 2018

While some banks would see larger increases in MSRs under stress...

...the relative loan quantum of borrowers with higher stressed MSRs is lower

**Box and Whisker Plot of Increase in MSRs across Banks**

**Density Plot of Stressed MSRs against Relative Loan Quantum**

Source: MAS estimates
Note: The top and bottom whiskers represent the maximum and minimum increases in MSRs while the top, middle and bottom horizontal lines in the box represent the 75th, 50th and 25th percentiles respectively.

Source: MAS estimates
Note: The colour scale in the chart represents relative densities from dark red (most dense) – red – orange – yellow – white – blue – dark blue (least dense).

**MAS’ top-down stress test is integral to our financial stability assessment framework**

Top-down stress tests have become increasingly important to microprudential and macroprudential authorities since the wake of the GFC, and have seen a significant rise in their sophistication in the past decade. In MAS, it is used to benchmark and challenge the bottom-up results from FIs, assess second-order effects due to behavioural responses, and is an integral part of our financial stability assessment framework. MAS will continue to enhance its top-down stress test as a tool to assess the resilience of individual FIs and the financial sector as a whole.

standards as an unexpected snapback in interest rates and labour market downturn could place severe strains on households’ ability to service their mortgage obligations.
Box E
Assessing the Effects of Post-crisis Regulatory Reforms on Liquidity in the Singapore Government Securities (SGS)\textsuperscript{55} and MAS Bills Market

The FSB initiated in 2017 an evaluation of the effects of post-crisis regulatory reforms, by developing a framework to assess whether the reforms are achieving their intended outcomes and identify any material unintended consequences.\textsuperscript{56} In tandem, MAS established an evaluation framework, which covers four broad impact areas, comprising FIs, financial markets, financial end-users and the broader financial landscape.\textsuperscript{57} Internationally, there have been particular concerns over whether post-crisis reforms may have impaired liquidity conditions in specific financial markets. We provide an assessment of the effects of the reforms on liquidity in a key market in Singapore, the SGS and MAS bills market. We hope this box would contribute to the ongoing international assessment in a very challenging area.

SGS and MAS bills play a role in many areas, from yield curve setting to regulations and investment

The SGS and MAS bills market is important as it is used as the basis for the benchmark yield curve in Singapore as well as for fulfilling regulatory requirements. In addition, SGS bills and MAS bills are used as collaterals by banks to obtain secured funding in the repo market. SGS bond is an attractive investment asset particularly to investors who require low risk, long-term investments. SGS is also used for risk management purposes such as hedging of stocks/equities, or lowering of risk of fixed income portfolios.

Regulatory reforms implemented post-crisis in Singapore, and in other jurisdictions, may affect SGS and MAS bills market

The ten years since the GFC have seen a wide-ranging set of reforms across the financial sector, including banking, OTC derivatives and non-bank financial intermediation. As an international financial centre, Singapore adopts standards issued by the key standard-setting bodies such as the Basel Committee on Banking Supervision (BCBS), IOSCO (International Organisation of Securities Commissions) and Committee on Payments and Market Infrastructures (CPMI). While a number of the post-crisis reforms are already in place, many are still in the early days of implementation, with others yet to be implemented. We look to implemented reforms that provide sufficient data for assessments, to evaluate the effects these reforms may have on the SGS and MAS bills market. Accordingly, this study examines the effects of the Basel III capital reform (package announced in December 2010)\textsuperscript{58}, Basel III LCR reform\textsuperscript{59} and the margin requirements for non-centrally cleared OTC derivatives\textsuperscript{60}. Given the significant presence of foreign banks in Singapore and the connectedness of Singapore with the rest of the world, we consider both Singapore and other countries’ implementation of these reforms (Figure E1).

\textsuperscript{55} Unless specified otherwise, SGS refers to both SGS bonds and SGS bills.


\textsuperscript{57} See MAS FSR Box M (November 2017), “Evaluating the Effects of Post-crisis Regulatory Reforms”.


\textsuperscript{60} BCBS-IOSCO (March 2015), “Margin Requirements for Non-Centrally Cleared Derivatives” or MAS Guidelines (December 2016), “Margin Requirements for Non-Centrally Cleared OTC Derivatives Contracts”.
The Basel III capital reform, in particular the requirements for banks to hold more capital and to raise the quality of capital, may encourage holding of SGS and MAS bills by banks, given the low risk-weighting applied to such assets. Increased holding of SGS and MAS bills by banks would reduce the availability of these securities in the market or lower liquidity of the market, holding all else constant. On the other hand, banks may reallocate their exposures from SGS and MAS bills to higher yielding assets, in order to offset the impact of the higher capital requirements on return on equity; this would increase the liquidity in the SGS and MAS bills market, holding all else constant.

The LCR reform is expected to encourage the holdings of SGS and MAS bills, which are High Quality Liquid Assets (HQLAs). For both local and foreign banks, the impact, if any, should be in the same direction of encouraging SGS and MAS bill holdings.

Marginal requirements for non-centrally cleared OTC derivatives may raise the cost of derivatives including those for hedging any risks arising from holding SGS. For market participants in Singapore who are subject to MAS’ OTC rules, the most relevant derivatives would be SGD IR derivatives. For market participants outside Singapore and foreign participants based in Singapore, who are likely to be subject to foreign OTC reforms, FX derivatives involving SGD in one leg are additionally relevant. The higher cost of derivatives hedging may disincentivise SGS holdings.

**Figure E1**

Transmission Channels of Reforms relevant for SGS and MAS Bills

<table>
<thead>
<tr>
<th>SINGAPORE</th>
<th>POST-CRISIS REGULATORY REFORMS</th>
<th>EXTERNAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BASEL III CAPITAL (2010 package)</td>
<td>Low capital requirement for SGS may encourage its holdings</td>
<td>BASEL III CAPITAL (2010 package)</td>
</tr>
<tr>
<td>BASEL III LIQUIDITY (LCR)</td>
<td>Banks may shift from SGS to higher-yielding assets to offset impact of higher overall capital requirement on ROE</td>
<td>BASEL III LIQUIDITY (LCR)</td>
</tr>
<tr>
<td>OTC MARGIN</td>
<td>Treatment of SGS as HQLA would encourage its holdings</td>
<td>OTC MARGIN</td>
</tr>
<tr>
<td></td>
<td>Margin requirements raise derivative cost incl. for hedging SGS (interest rates*, FX) thus discouraging its holdings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low capital requirement for SGS may encourage its holdings</td>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Margin requirements raise derivative cost incl. for hedging SGS (FX), thus discouraging its holdings</td>
<td></td>
</tr>
</tbody>
</table>

*: Singapore’s central clearing requirement for interest rate swaps (IRS) kicked in only in October 2018 i.e. beyond the study period

Source: MAS

**Methodology**

In terms of methodology, we first employed the Difference-in-Differences (DiD) approach, which is increasingly used in policy assessment. DiD assesses whether a policy has affected a particular group of interest (“treatment group”) such that its post-treatment trend is significantly different from that of a group that has not been subject to the policy (“control group”). The DiD effect is reflected in the coefficient \( \beta_3 \) in the panel regression:

\[
Y_{it} = \alpha + \beta_1 T_{it} + \beta_2 D_{it} + \beta_3 T_{it} D_{it} + \beta_4 X_{it} + \epsilon_{it}
\]

\( 61 \) Under the standardised approach for credit risk, SGS and MAS bills qualify for a zero per cent risk weight.
Given the scope of reforms being considered, banks were our treatment group, while non-banks or non-financial stakeholders represented our control group. We formed the treatment and control groups by employing monthly data on SGS and MAS bills outstanding held with custodian banks, which contain broad categories of underlying holders of the securities. We included non-regulatory factors to control for other potential drivers of differences between the two groups. These factors included fundamental drivers of global investment decisions such as the yield spread between SGS and government securities of other countries and Singapore’s USD exchange rate, in addition to post-GFC developments such as unconventional monetary policies and heightened global risk aversion; Singapore’s industrial production and stock prices, often seen as indicators of where SGS yields and prices would be heading, were also included as non-regulatory drivers.

Given the multiple reforms involved, we employed a series of reform-centred DiD models using only the data immediately before and after each reform in each model, in order to isolate the effects of individual reforms as much as possible (Figure E2). Specifically, we selected the data sample such that the post-implementation period of the reform being evaluated covers only up to the month just before the next reform kicks in. For symmetry, we selected a similar number of datapoints for the pre-implementation period. This choice of data selection means that the effects of subsequent reforms were excluded, while the effects of interactions between the reform under study and existing reforms were included. Hence, the DiD estimate in fact captured the incremental effect, as opposed to the total effect, of the reform in question, over and above that of existing reforms. While it goes some way towards identifying the effects

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62 This attempt at isolating the effects of individual reforms is not possible for the US and EU OTC margin requirements, as they were implemented within four months of each other.
of each reform, this modelling strategy limits the number of datapoints available for estimation, given the
closeness of the reforms to one another. Thus, we also carried out an estimation for each reform using the
full data sample, to serve as comparison for the above estimates based on shorter data samples, while
recognising that it in fact captures the effects of all reforms.

Cumulative impact of post-crisis reforms on overall SGS and MAS bill holdings has been small
The results show that there have been impact from selected reforms, although their cumulative impact on
the overall holdings of SGS and MAS bills (covering all categories of security holders) has been small, at
around 0.16% points decline in annual growth (Chart E1). This is due in part to the offsetting effects of the
reforms, with different stakeholders having responded differently: some have increased their holdings,
some decreased and some have not changed their SGS and MAS bill activities.

Chart E1
Impact of Regulatory Reforms on Growth Rate of Overall SGS and MAS Bill Holdings

Source: MAS estimates
Note: The above bars measure the impact of reforms in terms of overall SGS and MAS bill holdings or the holdings of these
securities by all categories of holders. The bars capture the differences between the treatment groups (i.e. banks in Singapore
and banks outside Singapore) and their respective control groups (i.e. domestic non-financial stakeholders and external non-
bank stakeholders) in the change in the growth rate of SGS and MAS bill holdings, weighted by the market shares of the
treatment groups.

MAS’ implementation of the Basel III capital reform in 2013 has had no impact on the local banks, likely
due to the banks’ significant capital buffers prior to the reform. Likewise, the Basel III capital reforms
in the EU and the US, implemented a year later, have had no impact on the SGS and MAS bill holdings
of foreign bank branches in Singapore but have had a small impact on banks outside Singapore that
own the securities. In particular, banks outside Singapore have slowed their rate of accumulation of
SGS and MAS bills, reducing the annual growth rate of the overall holdings of these securities by around
0.08% points, probably as part of balance sheet reallocation. In terms of market liquidity, the action of
these banks in fact helps to alleviate any demand pressures on SGS and MAS bills, or is in the direction
of “increasing liquidity”.

The LCR reform, implemented in January 2015, has seen banks in Singapore increase their rate of
accumulation of SGS and MAS bills, which are HQLAs, contributing to a 0.26% points rise in the annual
growth rate of the overall holdings of the securities. As the LCR reform was implemented at the same
time by Singapore and other jurisdictions, and banks are affected by the reforms of both the home and
host jurisdictions, we are unable to identify which of the two reforms or whether both reforms,
account for the impact.
Singapore’s margin requirements for non-centrally cleared OTC derivatives, which commenced in September 2017, have led to a small decline in the annual growth rate of the overall SGS and MAS bill holdings, of around 0.34% points. The impact is expected to be even smaller\(^{63}\) when the central clearing requirement for IR swaps kicks in this year.\(^{64}\) So far, no impact has been seen from the US and EU OTC margin reforms, implemented in September 2016 and January 2017 respectively.

Liquidity measures generally find a downward trend in bond market illiquidity

Besides analysing changes in banks’ SGS and MAS bill holdings, we use a second approach to evaluate the effects of reforms on liquidity by examining changes in market liquidity indicators.

Charts E2 to E5 present monthly observations for four bond liquidity measures over the period January 2008 to May 2018. First, is the Amihud measure\(^{65}\), which attempts to capture the price impact of a trade by relating the returns of an asset to its traded volume. Lower values of the Amihud measure, as with the other three measures, suggest that the market is more liquid. Chart E2 shows the Amihud measure fluctuated within a relatively small band with five noticeable spikes, indicating periods of high illiquidity. Several illiquidity spikes are observed to coincide with the various reforms analysed in this study, in particular, the Singapore capital and OTC margin reforms as well as the LCR and US OTC margin reforms. The Amihud measure also exhibited a tendency for mean reversion over most of the data period, with standard unit root tests confirming that the series is stationary in levels.

The second liquidity measure used is an aggregated standardised turnover measure computed using the weekly turnover\(^{66}\) in total dollar volume, but inverted in Chart E3 to enable comparability across the four charts. While the turnover measure was generally more volatile before 2014, it has since become more stable. In more recent periods, the turnover measure has trended downwards, suggesting an improvement in bond market liquidity. Like the Amihud measure, some of the observed illiquidity spikes in the turnover measures correspond with certain reforms, particularly the EU and US capital reforms and the Singapore OTC margin reform.

\(^{63}\) The impact would be smaller as the cost of derivatives under central clearing requirement is generally lower than under margin requirement.


\(^{66}\) The turnover data used for the liquidity measure includes primary issuance data.
The third liquidity measure presented in Chart E4, the Amihud Risk measure, is based on the conditional standard deviation of the computed Amihud measure. It showed a structural break around 2014 Q3, where the downward trend in liquidity risk (or upward trend in liquidity), was preceded by increasing liquidity risk since the GFC. Noticeably, the measure has remained stable since 2015, at levels last seen in 2011–2012. Illiquidity spikes for the risk measure mostly coincide with the Singapore capital and OTC margin reforms, and the LCR reform.

The final measure referred to as the BPW measure\(^{67}\) (Chart E5), inherently captures the broader impact of liquidity on prices, above and beyond the effect of the bid-ask spread, and is based on the negative autocovariance in relative price changes.\(^{68}\) The BPW measure declined in illiquidity in terms of magnitude and volatility over the data period, while having noticeable illiquidity spikes that were similarly observed in the other liquidity measures.

**Liquidity of SGS bonds has increased over time while liquidity of SGS and MAS bills has improved lately**

To obtain indicators of overall market liquidity for SGS bonds, and for SGS and MAS bills, we construct two indices using principal components analysis. The indices are created from the first principal component of the four liquidity measures, capturing price impact, turnover, and liquidity risk.\(^{69}\)

Charts E6 and E7 show the two liquidity indices over the period from January 2012 to May 2018. Higher values of the index are associated with higher illiquidity, with both indices having at least five noticeable illiquidity spikes. Values of the bond liquidity index fluctuated around a mean of zero, with more instances of higher illiquidity prior to mid-2016. The bond liquidity index has been trending downwards since 2017, indicating that the SGS bond market has become increasingly liquid. In contrast, the bill liquidity index has increased in both magnitude and volatility.\(^{70}\) Even so, the bill liquidity index has fallen in recent years, suggesting improving liquidity for the bills. Both charts also show that the various reforms are associated


\(^{68}\) The lack of liquidity in an asset leads to transitory components in its prices that manifest as negative serially correlated price changes, which the BPW measure uses.

\(^{69}\) The SGS bond liquidity index was formed from the first principal component estimated over the post-GFC period in light of significant differences in factor loadings observed between the pre- and post-GFC sub-periods.

\(^{70}\) This in part also reflects the use of MAS bills as an instrument for MAS’ management of liquidity in the banking system. The issuance size of MAS bills, which will have an impact on trading liquidity, will depend on the net impact of autonomous money market factors.
with illiquidity spikes. Notably, the Singapore capital reform in Q1 2013 that reduced bond liquidity, and the US OTC margin reform in Q3 2016 that instead resulted in an increase in bond liquidity, are captured by the bond liquidity index.

Similarly, the bill liquidity index captures events surrounding the reforms, albeit with a lag. In the case of the Singapore capital reform, foreign capital reforms and liquidity reform, the bill liquidity index responded to these reforms after a 3-month lag, while the corresponding lag was 1-month for the Singapore and the US OTC margin reforms.  

Exhibit 6: Bond Liquidity Index

Source: MAS, SMU estimates

Exhibit 7: Bill Liquidity Index

Source: MAS, SMU estimates

Except for the LCR requirement, domestic reforms have had no significant impact on market liquidity and no discernible impact on real variables. To provide an indicative analysis of the impact of the six reforms on real variables, we conduct a series of counterfactual simulations based on a vector autoregressive (VAR) model. Chordia et al. (2005) and Goyenko and Ukhov (2009) also used the following VAR approach to evaluate the association between macroeconomic variables and market liquidity:

\[ X_t = c + \sum_{j=1}^{k} B_{ij} X_{t-j} + u_t \]

where \( X_t \) is a vector of endogenous variables that include the SGS bond liquidity index, market returns (based on the Straits Times Index), real GDP growth, and consumer price index (CPI) inflation. The reforms are introduced into the VAR model exogenously as binary variables that take the value of one for the particular reform, or zero otherwise. To conduct the counterfactual simulations, we form six alternative scenarios. In scenario 1, values of the first reform are set to zero, indicating the absence of this reform. The model is then solved iteratively for scenario 1 and the baseline, with the difference between simulated values of scenario 1 and the baseline capturing the impact of the first reform. Subsequent scenarios are overlayed on the preceding one, with their differences showing the impact of each reform.

The results unequivocally show that the six reforms have not had a statistically significant effect on real variables.

\[ \text{71 Unlike the bond liquidity index which fell in response to the US reform, the bill liquidity index increased, suggesting a reduction of liquidity in the bills market.} \]

Jurisdictions should continue with pace of reform and monitor effects as they unfold; MAS will do likewise and undertake further assessment, as necessary

Our analyses show that, individually, some of the post-crisis regulatory reforms have had an impact on banks’ SGS and MAS bill holdings as well as on the market liquidity of these securities. However, the cumulative impact of the reforms including any unintended effects have been small, and statistically insignificant for real variables. Market liquidity of the SGS and MAS bills market has improved recently and the market, on the whole, has continued to grow.

While the international community actively undertakes evaluation of effects of reforms, jurisdictions should continue with the reform implementation timeline and monitor the effects as they materialise. MAS will do likewise. The effects of some reforms, especially the recent ones, may unfold further, in particular as they interact with other reforms. More regulations are also scheduled to come into effect, e.g. the revised Basel III requirements finalised in December 2017 will be implemented under a transitional arrangement from January 2022. MAS will undertake further assessment, as necessary, especially as more data becomes available and to assess the cumulative, persistent effects of these reforms.

This box was prepared in collaboration with Dr. John Sequeira, Academic Director (Asian Financial Leaders Programme) and Associate Professor of Finance (Practice), Lee Kong Chian School of Business, Singapore Management University.
SMEs form a significant part of the economy and play an important role in Singapore’s current economic restructuring. Access to financing helps SMEs to better manage their cash flow and invest in growth. In Singapore, SMEs obtain external financing predominantly from banks. While bank credit to SMEs has been adequate and growing, financing options have also grown with the entry of alternative lenders. This box reviews the state of bank financing to SMEs in Singapore.

### Banks maintain healthy extension of credit to Singapore SMEs

MAS’ SME Financing Survey data shows that bank credit to SMEs has been healthy, growing at a compound annual rate of 6% between Q2 2012 and Q2 2017, and accounts for 22% of the banking system’s domestic corporate loans. Banks in Singapore lend to a diverse set of SME borrowers, ranging across different sizes and industries (See Panel 3A “Small and Medium-sized Enterprise Financing Conditions”). Micro and small enterprises (including unclassified SMEs) account for the majority of unique SME customers that banks lend to (91%); this corresponds to 57% of banks’ outstanding SME loan portfolio (Chart F1). As can be expected, the loan limits for medium enterprises tend to be higher, as medium enterprises generally borrow more for fixed and investment assets and have larger working capital needs (Chart F2).

Local banks are key players in the SME financing landscape in Singapore, accounting for 58% of total outstanding loans to SMEs. That said, other banks in Singapore also play an important part in SME financing. Foreign banks tend to lend more to medium enterprises relative to other SME segments, and offer larger loans than the local banks. Meanwhile, finance companies’ share in the micro loans market is the highest among the various SME segments (Chart F3). They also focus on SME borrowers with lower loan size requirements, as reflected by the lower distribution of limits granted on new SME loans (Chart F4). The segmentation among the lenders helps to meet the diverse funding needs across a spectrum of SMEs.

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73 SMEs are an essential participant in Singapore’s economic restructuring efforts as they contribute to almost half of Singapore’s nominal enterprise value-added and employ around two-thirds of the workforce in 2017. Department of Statistics Singapore.

74 Bank loans accounted for 91% of external financing products that SMEs applied for in 2017. SPRING Singapore (December 2017), “SME Financing Survey”.

75 The findings presented are based on Q2 2017 data gathered from local and foreign banks as well as finance companies in Singapore. An SME is defined as a corporation, partnership, limited liability partnership, sole proprietorship or trust with reported annual sales of less than $100 million. SMEs can be further categorised by annual sales into micro (less than $1 million), small (from $1 million to $10 million) and medium (from $10 million to $100 million) enterprises. Unclassified SMEs refer to SMEs with no further breakdown of annual sales available; these are likely to be new or micro enterprises.
The majority of SME borrowers that banks lend to are micro and small enterprises

**Chart F1**
SME Lending by Company Size

**Chart F2**
Limits on New SME Loans Granted by Company Size

**Source:** MAS SME Financing Survey

Different banks in Singapore target separate SME segments

**Chart F3**
Market Share of Outstanding SME Loans by Lender Type

**Chart F4**
Distribution of Limits on New SME Loans by Lender Type

**Source:** MAS SME Financing Survey

Finance companies also appear to serve SME borrowers with lower loan size requirements

Banks in Singapore maintain prudent underwriting standards for their loan portfolios

Banks in Singapore place an emphasis on the availability of collateral when extending credit to an SME, with the majority of outstanding SME loans collateralised (78%). SMEs in Singapore with access to bank credit generally do not face high borrowing costs if collateral is available. Secured loans generally have lower interest rates than unsecured loans, with the median interest rate of secured new loans at about a third of that on unsecured new loans (Chart F5).

SME borrowers with lower credit ratings may face greater difficulties in accessing bank financing. Banks require a higher level of collateralisation when extending credit to such SMEs to mitigate a higher probability of loan losses (Chart F6). In addition, these SME borrowers face higher spreads above

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76 Banks’ internal obligor ratings were mapped to the Standard & Poor’s credit rating scale.
benchmark interest rates on loans to account for increased risk (Chart F7). In contrast, a large proportion of the limits granted to SME borrowers with good credit ratings is unsecured, underlining that the level of collateral required is correlated to assessed risks of non-payment.

<table>
<thead>
<tr>
<th>The availability of collateral lowers borrowing costs</th>
<th>Banks require more collateral when extending credit to SMEs with lower credit ratings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chart F5 Distribution of Interest Rates on New Loans by Loan Collateralisation††</td>
<td>Chart F6 Distribution of the Level of Collateralisation across Borrower Credit Rating</td>
</tr>
</tbody>
</table>

Source: MAS SME Financing Survey
Note: The violin plot shows the probability density of the data at each interest rate value, i.e. the denser the area at each interest rate value, the greater the number of loans at that interest rate. Each red point refers to the median value.

SMEs with lower credit ratings also face higher spreads above benchmark interest rates to account for increased risk

Chart F7
Spreads above Benchmark Rates for New SME Loans by Borrower Credit Rating

Source: MAS SME Financing Survey

†† Unsecured loans for equipment/machinery purchases and trade financing purposes generally have below-median interest rates while unsecured loans for working capital have above-median interest rates. Similarly, interest rates on secured loans for working capital also trend above median.
Credit facility features appear to contribute more to differences in interest rates on SME loans compared to borrower-specific characteristics. This suggests that price differentials are due more to SMEs’ borrowing requirements based on loan type than specific company attributes. To assess the features that contribute to distinct differentials between SME loans, we applied a clustering technique on transactional data to segment the population of new SGD-denominated SME loans granted into disparate groups that share common characteristics (Table F1). This enables the identification of combinations of borrower-specific as well as facility-specific features that differentiate loans in one cluster from another. Preliminary analysis shows two distinct segments within the population of new SGD loans granted during the period of Q3 2016 – Q2 2017 (Chart F8).

While borrower-specific characteristics are more evenly distributed between the two identified segments, these segments exhibit more distinct differences in their distribution of interest rates as well as the composition of other facility-specific characteristics (Chart F9). For example, the cluster with a lower interest rate distribution consists predominantly of hire purchase loans for equipment and machinery purchases and secured by either equipment/machinery, vessels/vehicles or non-property collateral. Meanwhile, the cluster with a higher interest rate distribution distinctively captures term loans for working capital purposes and are primarily unsecured.

As objects within a cluster are deemed homogenous, this suggests that banks generally do not differentiate between the type of SME borrowers as much as the type of lending to these borrowers when it comes to loan price differentials. This could reflect the fact that banks in Singapore offer program lending to smaller SMEs, where underwriting decisions are managed on a portfolio basis rather than on an individual borrower basis as banks diversify their credit risk exposure across a variety of SMEs.

Table F1
List of Variables in Dataset Used for Clustering

<table>
<thead>
<tr>
<th>Variables</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Borrower-specific Characteristics</strong></td>
<td></td>
</tr>
<tr>
<td>Size of Company</td>
<td>• Unclassified</td>
</tr>
<tr>
<td></td>
<td>• Micro</td>
</tr>
<tr>
<td></td>
<td>• Small</td>
</tr>
<tr>
<td></td>
<td>• Medium</td>
</tr>
<tr>
<td>Industry of Company</td>
<td>• Agriculture, fishing, mining &amp;</td>
</tr>
<tr>
<td></td>
<td>quarring</td>
</tr>
<tr>
<td></td>
<td>• Building &amp; construction</td>
</tr>
<tr>
<td></td>
<td>• Business services</td>
</tr>
<tr>
<td></td>
<td>• General commerce</td>
</tr>
<tr>
<td>Legal Entity Type</td>
<td>• Company</td>
</tr>
<tr>
<td></td>
<td>• Limited liability partnership</td>
</tr>
<tr>
<td></td>
<td>• Limited partnership</td>
</tr>
<tr>
<td>Borrower Credit Rating</td>
<td>• AA</td>
</tr>
<tr>
<td></td>
<td>• A</td>
</tr>
<tr>
<td></td>
<td>• BBB</td>
</tr>
<tr>
<td></td>
<td>• RR</td>
</tr>
</tbody>
</table>

78 In this case, the Partitioning Around Medoids (PAM) clustering technique was applied. PAM is an iterative technique for clustering mixed data types to identify clusters based on the ten variables specified in Table F1. A medoid refers to an object within a cluster for which average dissimilarity between it and all the other members of the cluster is minimal. It corresponds to the most centrally-located point in the cluster.

79 As the fields in the dataset are non-exhaustive, the availability of more granular fields may reveal other clusters and contributors to loan price differentials. The collection of more granular data as well as the employment of other techniques can shed additional insights on the drivers of loan pricing in further studies.
Facility-specific Characteristics

<table>
<thead>
<tr>
<th>Facility Type</th>
<th>Loan Purpose</th>
<th>Loan Tenor</th>
<th>Collateral Type</th>
<th>Pricing Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factoring</td>
<td>Equipment/machinery purchases</td>
<td>&lt;6 months</td>
<td>Secured by commercial property</td>
<td>Fixed</td>
</tr>
<tr>
<td>Hire purchase</td>
<td>Project financing</td>
<td>6 months to &lt;1 year</td>
<td>Secured by industrial property</td>
<td></td>
</tr>
<tr>
<td>Revolving credit facility</td>
<td>Property/land/factory purchases</td>
<td>1 year to &lt;5 years</td>
<td>Secured by residential property</td>
<td></td>
</tr>
<tr>
<td>Term loan</td>
<td>Trade finance</td>
<td>5 years to &lt;10 years</td>
<td>Secured by cash/deposits</td>
<td></td>
</tr>
<tr>
<td>Trade facility</td>
<td>Working capital</td>
<td>≥10 years</td>
<td>Secured by equipment/machinery</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
<td>Open</td>
<td>Secured by vessels/vehicles</td>
<td></td>
</tr>
</tbody>
</table>

New SGD-denominated SME loans granted can be segmented into two distinct clusters...

...with obvious differences in their distribution of interest rates...

SMEs’ access to financing is also enhanced by government initiatives...

In Singapore, the government has taken a targeted approach to support SMEs’ access to financing. Enterprise Singapore offers a range of risk-sharing initiatives, which can be enhanced as necessary to
address concerns in the current environment, to facilitate SMEs’ access to bank credit.\textsuperscript{80} About 14% of SME borrowers that banks lend to are under government financing schemes as at Q2 2017.

Regulatory changes have also enhanced the financing landscape for SMEs. In February 2017, MAS announced that it would relax some business restrictions on finance companies to enhance their ability to provide financing to SMEs. This included raising the limit on a finance company’s aggregate uncollateralised business loans, which would allow finance companies to provide more unsecured credit to support their SME customers’ working capital needs.\textsuperscript{81}

...as well as the growth of alternative financing platforms
In recent years, crowdfunding has emerged as an alternative source of financing for start-ups and SMEs. Crowdfunding allows firms to raise funds from a large number of individuals, typically through an online platform. In June 2016, MAS announced measures to improve the access to securities-based crowdfunding (SCF) for start-ups and SMEs while enhancing the safeguards for investors.\textsuperscript{82} As of 31 December 2016, the amount of funds raised through SCF platform operators since business inception was S$120 million.\textsuperscript{83} Start-ups that lack track record as well as SMEs that do not meet banks’ lending criteria could tap on SCF platforms as an alternative source of funding.

The financing landscape in Singapore supports most SMEs’ needs
Most SMEs in Singapore have access to a variety of financing options. Different types of lenders are available to serve the various SME segments and meet diverse funding requirements. Banks in Singapore have demonstrated a willingness to lend to viable SMEs with varying risk profiles. In our study, we find that differentials in pricing are generally attributed more to facility-specific characteristics rather than borrower-specific characteristics. Nevertheless, collateral requirements can vary with borrowers’ assessed risk profiles.

The SME financing landscape is also supported by a myriad of government financing schemes, regulatory changes as well as the growth of alternative lenders. Alternative lenders both in Singapore and abroad have shown that new lending models may further help to increase the availability of financing, particularly for young and micro SMEs. MAS will continue to monitor the state of SME financing in Singapore and developments in new lending models to support the growth and development of SMEs.

\textsuperscript{80} Examples include the Micro Loan Programme (MLP) and the Loan Enterprise Finance Scheme. During the GFC, the government enhanced existing schemes such as increasing the risk-share of MLP loans to 90% from 50% pre-crisis, and launched special risk-sharing initiatives such as the Bridging Loan Programme to meet companies’ working capital needs (up to S$5 million loan quantum limit as well as an 80% risk share).

\textsuperscript{81} The limit on a finance company’s aggregate uncollateralised business loans will be phased in, from 10% to up to 25% of its capital funds.

\textsuperscript{82} SCF (either lending-based or equity-based) between corporates and investors is regulated by MAS under the Securities and Futures Act (Cap. 289) and the Financial Advisers Act (Cap. 110). On 8 June 2016, MAS announced measures to facilitate SCF in Singapore, including new guidelines on SCF-related advertising and Frequently Asked Questions to help market participants better understand the regulatory framework underpinning lending-based crowdfunding.
Box G
An Overview of the Securities Financing Market in Singapore

This box presents an assessment of the potential financial stability risks that securities financing transactions (SFTs)\(^{84}\) pose to the Singapore financial system.

Among global post-crisis regulatory reforms on non-bank financial intermediation activities, SFTs is one of five specific areas of focus\(^ {85}\)

In the aftermath of the GFC, the FSB developed policy recommendations to strengthen oversight and regulation of non-bank financial intermediation activities, including the SFT market. FSB noted that SFTs play crucial roles in supporting price discovery and secondary market liquidity, and in facilitating the implementation of various investment, risk management and collateral management strategies by financial intermediaries. Nonetheless, the use of securities lending and repos can lead to “bank-like” activities that could potentially pose financial stability risks.

Against this backdrop, MAS undertook a risk assessment of the SFT market in Singapore

The SFT market in Singapore stood at S$106.4 billion (by gross value of instruments)\(^{86}\) as of Q1 2017, accounting for less than 1% of the global SFT market and about 2.7% of Singapore’s financial system assets. Notwithstanding the relatively small size of the market and in line with FSB’s initiative, MAS conducted a risk assessment of the SFT market in Singapore, and explored potential channels along which SFT activities can pose systemic risks:

1. Credit growth outside the banking system. SFTs can facilitate credit growth and leverage build-up outside the banking system, and allow non-bank financial institutions (NBFIs) to conduct maturity and liquidity transformation activities.
2. Interconnectedness. Significant SFT counterparty exposures between financial sector entities may generate increased interdependencies within the financial system and amplify contagion risks arising from counterparty failures.
3. Procyclicality. Heavy reliance on SFTs for funding can increase system procyclicality as variation in asset prices (through fire sales) can drive funding levels through haircut changes or margin calls.
4. Market practices that amplify systemic risks. Collateral (including cash collateral) reuse practices, the collateral types underlying SFTs and haircut levels adopted can potentially amplify risks through the build-up of excessive leverage, or through contagion from the reuse of the same collateral for multiple transactions with different counterparties.

As part of the risk assessment, MAS augmented regulatory data by collecting more granular information (e.g. counterparty types, re-hypothecation activities) through a survey of major SFT participants in Singapore. All banks conducting SFTs were identified using regulatory data and asked to provide

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\(^{84}\) SFTs refer to repurchase/reverse repurchase agreements, and securities and borrowing lending transactions.

\(^{85}\) The five specific areas of focus include (1) the regulation of bank’s interactions with shadow banking entities, (2) regulatory reform of money market funds (MMFs), (3) regulation of other shadow banking entities (other than MMFs), (4) the regulation of securitisation and (5) the regulation of securities lending and repos.

\(^{86}\) These instruments refer to the securities that are sold or bought in a repo/reverse repo transactions and securities that are lent or borrowed in securities borrowing and lending transactions.
information on their SFT activities as of Q1 2017.\textsuperscript{87} NBFIs that are major players in the SFT market were also required to participate in the survey.

**Banks and fund managers are the major players in Singapore’s SFT market**

Banks and fund managers are the major players in the SFT market. Banks account for about 76\% of outstanding transaction volumes (Chart G1), and use SFTs for a variety of reasons, including liquidity management, market-making activities and service offerings for their wealth management clients. Fund managers also conduct SFTs as part of their investment strategies for the funds under their management. The fund managers surveyed are hedge fund managers and traditional fund managers that manage a mixture of hedge funds and traditional funds. Repurchase and reverse repurchase transactions dominate in the SFT market, accounting for about 73\% of outstanding SFTs as of Q1 2017.

![Chart G1: SFT Activities by Surveyed Entity Type - Q1 2017](chart)

**Domestic financial sector interconnectedness via SFTs is low, and facilitation of domestic credit growth outside the banking system is currently negligible**

From a counterparty perspective, domestic SFTs account for only about 10\% of all outstanding SFTs conducted by surveyed FIs (Table G1), where almost all transactions were between banks. Of the small volume (0.81\%) conducted among NBFIs or between banks and NBFIs, most transactions were conducted between insurers and banks/broker-dealers to facilitate effective collateral management.

On the other hand, most of the surveyed financial sector entities’ SFT exposures are to foreign counterparties. In particular, about 45\% of total SFTs are conducted between NBFIs, or between banks and NBFIs under the cross-border SFT category (Table G1). A closer look at the cross-border Bank-to-NBFI SFT segment suggests that these SFTs consist mainly of inter-dealer repo transactions, where banks conduct transactions with either broker-dealers or with central counterparties (for centrally cleared transactions). The cross-border NBFI-to-NBFI segment consists mainly of SFTs conducted between fund managers and

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\textsuperscript{87} For the purposes of this box, the scope of the SFT market extends to all SFT activities conducted by Singapore-based entities, regardless of whether they are transacting with an overseas or domestic counterparty. SFTs conducted with central banks were excluded as such transactions were not within the scope of FSB’s policy recommendations.
prime brokers, with fund managers relying on these transactions to finance long positions or borrow securities to cover short positions.88

While data suggests that the financial system is more vulnerable to cross-border contagion via SFT exposures, risks remain relatively contained. About 90% of all SFTs conducted by Singapore entities are primarily with central counterparties, global banks (mostly Tier 1) and prudentially consolidated prime brokers.

<table>
<thead>
<tr>
<th>SFT Market Size: S$106.4billion Transaction Type</th>
<th>Domestic SFTs (Between Singapore Entities Only)</th>
<th>Cross-Border SFTs (Between Singapore Entities and Foreign Counterparties)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank to Bank</td>
<td>10.1%</td>
<td>44.5%</td>
</tr>
<tr>
<td>Bank to NBFI</td>
<td>0.8%</td>
<td>31.1%</td>
</tr>
<tr>
<td>NBFI to NBFI</td>
<td>0.01%</td>
<td>13.5%</td>
</tr>
</tbody>
</table>

Source: MAS Securities Financing Survey

An examination of the risk characteristics of SFT activities suggests that systemic risks (fire sales, procyclicality) posed by SFT activities remain contained

An assessment of the risk characteristics of SFT activities, namely (1) collateral reuse activities and (2) the underlying collateral/instrument types, suggests that contagion risks and procyclicality effects posed by SFT activities are contained.

The survey data shows that both cash and non-cash collateral reinvestment remain uncommon among banks, with less than 10% of collateral being reused from outstanding transactions as of Q1 2017.89 Liquidity and maturity transformation using cash collateral also remains limited, with most being invested in short-tenure, liquid government securities and money market instruments.

In relation to the types of collateral used, SFTs backed by government securities tend to pose less systemic risk as price movements in government securities are less likely to be procyclical. This reduces the risk of fire sales or margin calls under market stress conditions.90 Survey findings suggest that banks tend to use government securities more frequently in their SFTs (58% of banks’ outstanding transactions by collateral

88 To obtain a more conservative estimate of SFT volumes, surveyed Singapore-based fund managers were asked to report SFT activities conducted for all the investment funds under their management, regardless of where the investment funds are domiciled. Most investment funds (>95% by AUM) managed by Singapore-based fund managers are domiciled overseas, which may explain why transactions between fund managers and domestic financial entities are negligible. For the purpose of this box feature, SFTs initiated by any Singapore-based fund manager with a foreign-based counterparty would be regarded as “cross-border” transactions.

89 While data on collateral reuse were not requested from surveyed NBFIs, some fund managers have reflected that they do engage in collateral reuse transactions as part of their investment strategies.

90 FSB conducted a quantitative impact study (QIS 1) across FSB member jurisdictions in 2013, and findings suggest that price movements of government securities tend not to be procyclical. In addition, haircuts on transactions backed by government securities have been stable over time at zero or low levels over three time periods, 2006 (pre-crisis), 2008 (crisis) and 2012 (post-crisis). FSB (August 2013 & October 2014), “Strengthening Oversight and Regulation of Shadow Banking: Policy Framework for Addressing Shadow Banking Risks in Securities Lending and Repos”.
A more detailed survey of banks’ SFT activities on a flow basis also shows that more than 90% of SFTs conducted by banks from Q2 2016 to Q1 2017 were collateralised by government securities.\footnote{91}

Notwithstanding the assessment that systemic risks posed by SFTs are currently low, recent trends suggest that banks are making greater use of SFTs to facilitate business activities. Although banks’ SFT activities remain small (2.6%) currently as a proportion of total banking system assets (Chart G2), there has been a growth in outstanding volumes of SFT activities over the past two years (Chart G3).

<table>
<thead>
<tr>
<th>SFT activities remain small as a proportion of total banking system assets...</th>
<th>...with growth in activities over the past two years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chart G2</strong></td>
<td><strong>Chart G3</strong></td>
</tr>
<tr>
<td>Banking System SFT Activities as a Proportion of Total Banking System Assets</td>
<td>Outstanding Volume of SFTs for Banking System</td>
</tr>
</tbody>
</table>

The SFT market provides an alternative market-based source of finance and reduces reliance on financing from the banking system. However, as the market grows, regular monitoring is warranted to assess if the increased SFT activity may result in more non-bank financial intermediation activities that potentially pose systemic risks.

Beyond potential risks posed by SFTs between banks and non-banks, survey and regulatory data suggest that SFTs form an increasingly significant part of the interbank market. As of Q1 2017, interbank SFT exposures amounted to about 10% of the outstanding domestic interbank transactions and 5% of total cross-border interbank transactions in the banking system. Survey data on transaction flows shows that banks engage in significant volumes of short-tenure SFT transactions although outstanding volumes may remain small at any one point in time. At this point, banks’ liquidity risks are well-mitigated by existing prudential regulation.\footnote{93}

\footnote{91} Only banks were required to provide more detailed information on their SFT activities as part of the survey, including aggregated information on all transactions conducted over the duration of the year (i.e. flow basis).

\footnote{92} Funding from repo transactions account for about approximately 1% of banking system funding as of September 2018.

\footnote{93} Banks in Singapore are subject to Minimum Liquid Assets and Liquidity Coverage Ratio (for D-SIBs) requirements. Starting in 1 January 2018, the capital requirements for locally-incorporated banks have also been revised to introduce a minimum leverage ratio requirement of 3%. This will limit the amount of leverage that these banks can potentially take on, including leveraged positions in the repo market.
While risks from NBFI SFT activity are also contained currently, careful monitoring is warranted to identify any potential vulnerabilities that may arise.

Notwithstanding the current assessment that NBFI SFT activities pose limited systemic risks, two observations on SFT activities in the NBFI sectors are noteworthy. First, survey data shows that NBFIIs such as fund managers can be significant SFT market participants as well. As of Q1 2017, fund managers account for nearly a quarter of outstanding SFT volumes in Singapore’s SFT market. Additionally, they commit a significant proportion (25%) of their assets under management (AUM) to SFT activities as part of their investment strategies (Chart G4). As the survey for NBFIIs only captures outstanding SFT volumes of larger SFT players at a point in time, it is possible that the actual scale of SFT activities among NBFIIs may be larger than what is suggested in the survey data.

Second, NBFIIs may engage in SFTs that exhibit riskier characteristics. The survey data suggests that fund managers engage in the use of SFTs backed by less liquid collateral (non-government securities), with some engaging in collateral reuse activity as part of their investment strategies. In addition, while domestic financial sector interconnectedness via SFT exposures is low, this does not necessarily preclude the facilitation of credit growth in the domestic NBFI sectors via SFTs with foreign counterparties. For example, fund managers generally tend to conduct the bulk of their SFTs with international prime brokers on behalf of investment funds under their management. Credit growth in domestic NBFI sectors can potentially give rise to the build-up of excessive leverage and liquidity transformation, which may increase the likelihood of defaults. This could in turn potentially impair market liquidity and generate spillovers to other financial subsectors and markets under severe stress conditions. Hence, potential systemic risks posed by NBFI SFT activity, as well as cross-border interconnectedness between domestic NBFI sectors and foreign counterparties, bear monitoring.

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94 As of Q1 2017, 38% of outstanding SFTs conducted by fund managers are being backed by government securities. In comparison, 58% of outstanding SFTs conducted by banks are backed by government securities. This is not unexpected as fund managers are more likely to engage in transactions in non-government securities as part of their investment strategies to achieve higher returns. For example, fund managers are likely to borrow non-government securities through securities borrowing and lending transactions to cover their short positions in these securities.
Overall, SFT activities in Singapore pose limited systemic risks to the domestic financial system

Our analysis of SFT activities in Singapore suggests that they do not pose significant systemic risks currently:

(1) On an aggregate basis, SFT activities in Singapore are small as a proportion of the global SFT market and overall business activities of financial sector entities in Singapore.

(2) Domestic financial interconnectedness is low and facilitation of credit growth outside the banking system is negligible currently. NBFI-to-NBFI SFTs are small in volumes, while banks' SFT activities are already subject to prudential regulation.

(3) Procyclicality effects and contagion risks are contained as collateral reuse activity is limited. SFTs that were backed by government securities also account for more than half of outstanding transactions as of Q1 2017.

Nevertheless, survey and regulatory data suggest that the SFT market is likely to grow in size given growing reliance on SFTs to facilitate business activities. Therefore, MAS intends to augment its data collection efforts\(^\text{95}\) to better monitor and assess the potential systemic risks posed by SFT activities.

\(^{95}\text{MAS is augmenting its data collection efforts through the revision of banking regulatory returns, which will come into effect in 2020. The revised returns will allow for better monitoring of the bulk of SFT activities conducted by Singapore financial sector entities.}\)
Box H
Drivers of Domestic Credit — Do Spillover Effects of Macroprudential Policies Matter?

The aim of macroprudential policy is to reduce the risks to the domestic financial system as a whole and dampen feedback loops that amplify the impact of economic shocks. However, the application of macroprudential policy might generate spillover effects on other economies. While strengthening the resilience of a financial system reduces cross-border financial contagion, there could also be some unintended effects on financial flows in other jurisdictions over the short-term. These could arise from shifts in credit supply intermediation by foreign banks or portfolio diversification by investors.

This box examines the spillover effects from various types of macroprudential policies in foreign jurisdictions on domestic banking flows, by analysing detailed data on loans of foreign banks operating in Singapore.

Macroprudential policies can be broadly categorised into four groups...
A wide range of macroprudential policies has been developed internationally, particularly following the GFC. Macroprudential policies can be categorised into the following four groups based on their functions, which are broadly in line with international classifications (e.g. IMF-FSB-BIS (2016) and IMF (2017)): (i) capital-based policies are used to manage banks’ capital buffers to safeguard their solvency; (ii) liquidity-related policies are used to address build-up of liquidity and foreign exchange risks; (iii) sector-specific policies are used to reduce default risk arising from specific areas, including the property sector; and (iv) cross-sectional/ structural measures are used to improve resilience of systemic institutions and reduce structural vulnerabilities within banks.

...with more instances of adjustments in macroprudential policy in recent years, especially in Asia
In recent years, we have observed a greater reliance on macroprudential policies to mitigate systemic risk. Asia in particular has had experience in the use of macroprudential measures, having implemented measures even pre-GFC (see Charts H1 and H2). The use of property- and liquidity-related policies have been the most extensive, aimed at moderating property cycles and ensuring stable funding profiles for banks. Cross-sectional/ structural policies have been increasingly used in the post-GFC period, mainly arising from Basel reforms to enhance the resilience of D-SIBs that are key nodes in the domestic financial system. Adjustments to capital-based policies have generally been less relied upon by comparison, though they have also seen increased use more recently.

Existing literature on assessing spillover impact of macroprudential policies has been limited, without a common consensus on their effects
Studies on cross-border credit spillover from foreign macroprudential policies remain limited to date. A review of the available literature also suggests no clear conclusion on the direction and magnitude of the cross-border credit spillover effects. Takáts and Temesvary (2017) show that macroprudential policies

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98 Előd Takáts and Judit Temesvary, BIS Working Papers No. 683 (December 2017), “Can Macroprudential Measures Make Crossborder Lending More Resilient?”.
Applied in home banking systems do not affect growth of cross-border bank lending outflows (during the taper tantrum episode). HKMA (2016) and Buch and Goldberg (2016), in comparison, find evidence of cross-border spillover effects onto other banking systems. Further, the magnitude of spillover effects from different policy instruments is not clear. HKMA (2016) shows that the size of spillover effects for capital requirements and reserve requirements are larger than those for sector-specific prudential measures, whereas Buch and Goldberg (2016) find that changes to LTV ratios (sector-specific measures) and liquidity instruments are more likely to affect cross-border bank credit than adjustments to capital requirements.

### Chart H1

**Adjustments to Macroprudential Policies in Asia**

- Capital-based
- Liquidity-related
- Sector specific (property-related)
- Cross-sectional/structural

Source: MAS estimates, Database by Cerutti (2016)

**Note**: Positive figures represent tightening of macroprudential policies and negative figures indicate loosening of macroprudential policies.

Asia has had experience in the use of macroprudential policy... while the use of macroprudential policy in the rest of the world mainly took off post-GFC

### Chart H2

**Adjustments to Macroprudential Policies in the Rest of the World**

- Capital-based
- Liquidity-related
- Sector specific (property-related)
- Cross-sectional/structural

Source: MAS estimates, Database by Cerutti (2016)

Given the increased reliance on macroprudential policies internationally, and the active foreign bank participation in Singapore, it would be important to understand the nature and significance of cross-border credit spillover effects. With a suite of macroprudential policies targeting different risk segments, it would be useful to determine whether potential spillover effects are differentiated by policy instruments and points of origination (i.e. source of home jurisdictions).

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99 Hong Kong Monetary Authority, Research Memorandum 07/2016 (July 2016), “International Banking and Cross-Border Effects of Regulation: Lessons from Hong Kong”.


101 Countries in Asia include China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, and Thailand.

102 Eugenio Cerutti, Ricardo Correa, Elisabella Fiorentino, and Esther Segalla, IMF Working Paper WP/16/110 (June 2016), “Changes in Prudential Policy Instruments-A New Cross-Country Database”. Macroprudential policies refer to policies directed at domestic macroeconomic vulnerabilities, which are unrelated to capital flows. Additional macroprudential policies such as debt servicing ratios, property taxes, liquidity requirements, liquidity limits and currency-based measures have also been added to the list of policy measures in the dataset developed by Cerutti et al. (2016).

103 Countries in the rest of the world include Australia, Canada, France, Switzerland, UK, and US.
Data and methodology
We estimated panel regressions on quarterly data from 20 banks across nine countries\textsuperscript{104}, from Q3 2009 to Q1 2018, to examine the impact of macroprudential policies in foreign jurisdictions on Singapore. Control variables such as bank characteristics, financial and economic conditions in Singapore (including domestic macroprudential policies\textsuperscript{105}), as well as financial and economic conditions in foreign jurisdictions were included.

The analysis focused on the transmission effects operating through foreign banks, as their operations to service regional group activities, and co-movements among their branches/subsidiaries could respond to macroprudential policy adjustments in their home country.

The regressions took the following form:

\[
Y = E(Y) + \epsilon = f(x_1, x_2, x_3, x_4; \beta_0, \beta_1, \beta_2, \beta_3, \beta_4) + \epsilon
\]

where \(Y\) is the foreign banks’ loan growth. \(E(Y)\) is the average value of \(Y\) and \(\epsilon\) represents the error term. \(x_1, x_2\) and \(x_3\) represent the independent variables to capture bank characteristics, Singapore financial and economic conditions (including domestic macroprudential policies), foreign financial and economic conditions. \(x_4\) can be further broken down into the four groups of macroprudential policies implemented in foreign jurisdictions (Table H1). \(\beta_1, \beta_2, \beta_3\) and \(\beta_4\) represent the estimated coefficients of the respective groups of independent variables and \(\beta_0\) is the constant term.

The regression analysis considered if spillover effects could be differentiated along two dimensions, namely source of flows (by type and origination of policy tools) and receiving end of flows (by type of loans). First, as different macroprudential policies are used to target different risks, one would expect spillover effects (if any) to be differentiated depending on the type of measure used. Second, the size of spillover effects could vary by the home country in which the macroprudential policy was originally implemented, reflecting geographical proximity, for example. As such, the analysis considered the varying intensities of spillovers from Asia relative to that from the rest of the world. Third, various categories of banking loans with varying risk profiles could be impacted differently by spillover effects. Consequently, the impact on both mortgage loans and total loans was assessed separately.

Table H2 provides some summary results of the panel regression. The specifications were found to be robust to different model specifications in terms of independent variables and time period chosen. In addition, the estimation generally yielded good fits to the historical data.

\[\text{Footnotes:}\]
\textsuperscript{104} Loans from the 20 banks cover about one-third of foreign non-bank loans in Singapore banking system. The 20 banks are selected based on their non-bank lending size in Singapore, as well as availability of bank characteristics data. Four out of nine countries are from Asia (China, Hong Kong, Thailand, and Malaysia), and the rest are from the rest of the world (US, France, Australia, Canada and Switzerland).

\textsuperscript{105} Domestic macroprudential policies include the four groups of policies, namely: (i) capital-based policies, (ii) liquidity-related policies, (iii) sector-specific policies (property-related) and (iv) cross-sectional/structural policies.
Table H1
Type of Instruments by Macroprudential Policy Group

<table>
<thead>
<tr>
<th>Macroprudential Policies</th>
<th>Type of Instruments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital-based policies</td>
<td>→ CCyB</td>
</tr>
<tr>
<td></td>
<td>→ Leverage ratio</td>
</tr>
<tr>
<td></td>
<td>→ Dynamic loan-loss provisioning</td>
</tr>
<tr>
<td>Liquidity-related policies</td>
<td>→ Foreign currency loans limits</td>
</tr>
<tr>
<td></td>
<td>→ Domestic and foreign reserve requirement ratios</td>
</tr>
<tr>
<td></td>
<td>→ Levy or tax on FIs’ balance sheet</td>
</tr>
<tr>
<td></td>
<td>→ Liquidity requirements (e.g. LCR and NSFR)</td>
</tr>
<tr>
<td>Sector-specific policies</td>
<td>→ LTV limits</td>
</tr>
<tr>
<td>(property-related)</td>
<td>→ Debt-to-income ratio</td>
</tr>
<tr>
<td></td>
<td>→ Housing taxes</td>
</tr>
<tr>
<td></td>
<td>→ Risk weights on housing loans</td>
</tr>
<tr>
<td>Cross-sectional/ structural policies</td>
<td>→ Systemically important institution requirements (e.g.</td>
</tr>
<tr>
<td></td>
<td>framework for D-SIBs and high loss absorbency requirement)</td>
</tr>
<tr>
<td></td>
<td>→ Limits on interbank exposure</td>
</tr>
<tr>
<td></td>
<td>→ Concentration limits on assets</td>
</tr>
<tr>
<td></td>
<td>→ Caps on credit growth</td>
</tr>
</tbody>
</table>

Table H2
Summary Panel Regression Results

<table>
<thead>
<tr>
<th>Policies107</th>
<th>Foreign Banks with Parent in Asia</th>
<th>Foreign Banks with Parent in Rest of the World</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growth in Total Loans (I)</td>
<td>Growth in Mortgage Loans (II)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Growth in Total Loans (III)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Growth in Mortgage Loans (IV)</td>
</tr>
<tr>
<td>Capital-based</td>
<td>7.8***</td>
<td>10.8**</td>
</tr>
<tr>
<td>Liquidity-related</td>
<td>0.5</td>
<td>0.2</td>
</tr>
<tr>
<td>Sector-specific (property-related)</td>
<td>1.7**</td>
<td>3.4**</td>
</tr>
<tr>
<td>Cross-sectional/ structural</td>
<td>–7.4***</td>
<td>–12.7***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2.4***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.6</td>
</tr>
</tbody>
</table>

Source: MAS estimates

Notes: 1. ***, ** and * represent statistical significance at the 1%, 5% and 10% levels, respectively. 2. The standard errors for the equations range from 0.88 to 1.00. Durbin-Watson statistics for the equations were in the 1.32 to 1.90 range.

106 Specifications of panel regressions include control variables such as bank characteristics, financial and economic conditions in domestic and foreign jurisdictions, as well as domestic macroprudential policies. Our results are found to be robust to alternative specifications such as the addition of inflation rate and growth in asset size of banks, as well as removal of domestic macroprudential policies. Separately, our Wald test results do not reject the null hypothesis that coefficients of foreign macroprudential policies on loan growth remain unchanged with and without domestic macroprudential policies, with probabilities ranging from 73 percent to 99 percent.

107 This refers to tightening of macroprudential policies in other jurisdictions. The policies include total number of times macroprudential policies were adjusted.
While macroprudential policies implemented by foreign jurisdictions have had some spillover effects on Singapore banking loans, other underlying factors appear to be more prominent

The decompositions of changes in loan and mortgage growth, derived from the regression estimates, show that bank loans by foreign branches are predominantly driven by their banks’ characteristics and financial and economic conditions in Singapore, including domestic macroprudential policies. The role played by foreign macroprudential policies is comparatively minor (Charts H3 to H6). A bank with higher capital buffer, deposits and liquid assets would have the capacity to increase exposures to Singapore. Likewise, strong economic cycles and lower cost of borrowing in Singapore are important drivers of changes in loan growth, more so than conditions associated with foreign financial and economic conditions, and macroprudential policies. Having tighter sector-specific macroprudential policies in Singapore have reduced foreign banks’ loan growth and subsequently, moderated the size of positive spillover effects from foreign macroprudential policies on loan growth. Thus, while there is some evidence that loan growth is influenced by regulatory changes in foreign banks' home country, they are not significantly constrained by these regulations.

Macroprudential policies implemented in Asia have had a larger impact on loan growth compared to the rest of the world

The regression results show that spillover effects from foreign macroprudential policies as well as financial and economic conditions originating in Asia had a larger impact on domestic loan growth compared to the rest of the world. Regression coefficient estimates of foreign macroprudential policies on loans growth suggest that spillover effects from Asian macroprudential policies were of a larger magnitude and higher statistical significance (Table H2). Two factors could have distinguished macroprudential policies of Asia from the rest of the world. First, there have been more instances of macroprudential policy adjustments (both tightening and loosening) in Asia, compared to the rest of the world. Second, the close proximity of Singapore to other Asian countries facilitate easier funds movement for both banks and investors, given their familiarity in the region.

The results also show that macroprudential policy adjustments from Asia had relatively stronger spillover effects on mortgage loan growth compared to total loan growth, with larger estimated coefficients across most policy instruments (column I and II of Table H2). Growth in total loans is subject to international banking flows and exposed to numerous other factors, thus less likely to be influenced by shocks originating from any single jurisdiction.

Capital-based and cross-sectional/structural policy measures appear to have larger cross-border effects

Among the policy instruments, capital-based, sector-specific (property-related), and cross-sectional/structural policies have had effects on loan growth by foreign banks in Singapore, while liquidity-related instruments appear to have an insignificant impact. Liquidity-related requirements are often used to encourage stable funding profiles, which might have larger impact on banks’ deposits rather than on loans. Further, a number of banks already had liquidity ratios (e.g. LCR etc) close to the foreign imposed regulatory requirements, and were likely to make fewer adjustments to their balance sheets. In contrast, capital-based and cross-sectional/structural policy instruments are more targeted at banks’ assets, which might

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108 Our regression results of Singapore macroprudential policies on loan growth are consistent with our understanding of the measures. Singapore’s sector-specific measures have reduced mortgage and overall loan growth for foreign banks while capital-based policies and cross-sectional/structural policies, which often work through banks’ capital ratios, have insignificant impact on foreign banks’ loan growth. Singapore’s liquidity-related policies, similar to foreign ones, tend to have a larger impact on deposits than loans.
induce a more direct effect on banks’ lending and balance sheets. Sector-specific policies tend to be domestic in nature, and are mainly borrower-based instruments such as housing taxes, LTV limits and debt servicing ratios used to influence buying behaviour; hence, they have a relatively smaller impact on bank loans in Singapore.

Bank loans in Singapore are driven by a combination of factors, including macroprudential policies in foreign jurisdictions.

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Legend

- Foreign Macroprudential Policies
- Foreign Financial and Economic Conditions (excl. Foreign Macroprudential Policies)
- Singapore Financial and Economic Conditions (incl. Domestic Macroprudential Policies)
- Bank Characteristics

Source: MAS estimates

Note:
1. Singapore financial and economic conditions include nominal GDP gap, property price gap, interest rate and four groups of domestic macroprudential policies. Foreign financial and economic conditions include GDP gap and property price gap. Bank characteristics include change in group T1 capital ratio, share of group liquid assets against total assets, share of group deposits against total assets, and Singapore office’s net due to related banks against total liabilities.
2. Decompositions of factors explain model estimated but not actual total loan growths and mortgage loan growths.
Potential policy implications
Loans by foreign banks are driven by a combination of factors, with bank characteristics, and Singapore financial and economic conditions as the main drivers. Though foreign macroprudential policies have had a minor role to play thus far, their spillover effects are expected to increase in tandem with the increasing reliance on macroprudential policy globally, including in the Asian region.

There is more scope for coordination of measures to address macroprudential risks that are more cross-border in nature and thus estimated to have larger spillover effects. Some policy tools require cooperation to be effective. The CCyB is one of them, and Singapore has reciprocity arrangements with BCBS members to ensure effective implementation and reduce spillover effects due to regulatory arbitrage. For sector-specific measures where macroprudential risks may be of a local nature, spillover effects are more contained and there is less need for coordination.

Whether cross-border credit spillovers prove to be significant may depend on the foreign banks’ overall liquidity and capital buffer, and how financial and economic cycles across home and host countries are interlinked. Tightening capital-based macroprudential policy in the home country could promote bank loan growth and lead to further overheating during an upswing in the host country’s financial cycle, especially in a scenario when large foreign banks have excess liquidity and capital buffers back in their head offices. However, the same macroprudential policy stance could instil confidence and help the host financial system re-equilibrate during a downturn.

An awareness of the potential spillover effects could thus strengthen the formulation of domestic macroprudential policies, with resultant enhancements to their effectiveness and efficiency.
3 Singapore Corporate Sector

Corporate balance sheets have remained broadly stable amid a supportive operating environment. Trade-related sectors such as manufacturing and TSC benefitted from the uplift in the global economy, while domestic-oriented sectors experienced more uneven performance across sectors.

Overall, corporate debt profiles remain sound. MAS’ stress tests of corporate balance sheets suggest that most corporates can withstand the interest rate and earnings shocks. Nonetheless, firms should exercise financial prudence and remain cautious of the headwinds, including downside risks from escalating trade tensions and expected tightening of financial conditions, which could weigh on corporate profitability and debt servicing ability.

Corporate Sector Earnings Remained Firm

Corporate profitability remained firm, supported by healthy economic conditions. Corporate balance sheets have remained firm amid sustained demand in global economic activity. The median return on assets (ROA) of firms listed in Singapore rose slightly from 2.7% in Q2 2017 to 3% in Q2 2018 (Chart 3.1).

In contrast, performance was more varied across the domestic-oriented sectors. The construction sector continued to be weighed down by the contraction in construction demand, although there are early signs that the decline in contract awards could be bottoming out. Certified progress payments decreased 5.6% YoY in Q2 2018, though the pace of the slowdown eased, compared to a decrease of 27% in Q2 2017. Median ROA for the construction sector fell from 3.5% in Q2 2017 to 1.3% in Q2 2018. Nonetheless, stronger construction demand is expected to support earnings, with the value of construction contracts awarded rising 43% in H1 2018 compared to the same period last year, led by a boost in public sector demand from civil engineering works and building projects.

Against the backdrop of global economic uncertainties, the general outlook for the manufacturing and services sectors turned more cautious in the recent quarter (Chart 3.2). In particular, within the manufacturing sector...
sector, the electronics and precision engineering subsectors had the least optimistic outlook given rising uncertainties from ongoing trade tensions. While overall corporate profitability has remained resilient, trade tensions could pose risks to trade-related sectors that are vulnerable to a downturn in external conditions.

**Chart 3.2**

General Business Outlook for Manufacturing & Services Sector (Net Weighted Balance)

The number of companies wound up was broadly stable, at 85 in H1 2017 as compared to 88 in H1 2018, and in line with the long-run historical average (Chart 3.3).

Singapore banking system’s corporate NPL ratio decreased from 2.7% in Q3 2017, to 2.4% in Q3 2018 (Chart 3.4). The decline was led by an improvement in asset quality for trade-related sectors alongside the uplift in global economic activity. Manufacturing and TSC sectors’ NPL ratios decreased to 4.6% and 9.7% respectively as of Q3 2018, compared to 5.1% and 11.3% in Q4 2017. While corporate defaults remain benign, firm-level characteristics and market data should continue to be closely monitored as they provide insights into the early identification of corporate distress. Indeed, excessive credit, coupled with low profitability, are significant characteristics of firms facing distress (See Box I “Early Identification of Corporate Distress in Singapore”).

**Chart 3.3**

Corporate Bankruptcies

Global oil prices had been increasing over the past year, albeit with some volatility. Global offshore rig utilisation rates have shown signs of a pick-up, hovering around 75%, up from 70% a year ago.

However, weaknesses persist in certain oil-related sectors such as the M&OE subsector. Offshore Support Vessel (OSV) charter and
utilisation rates remain subdued from the supply overhang in the offshore market. The median ROA of oil-related firms in Singapore has remained weak, although it has improved slightly from −6.4% in Q2 2017 to −4.6% in Q2 2018. While the M&OE subsector continues to grapple with overcapacity issues and depressed margins, the recovery in oil prices should boost upstream activity and bolster demand for offshore services going forward. Business sentiment in the M&OE subsector has also turned more positive as firms anticipate a pick-up in orders amid higher oil prices (Chart 3.5).

![Chart 3.5](chart.png)

**General Business Outlook for M&OE Subsector (Net Weighted Balance)**

Source: EDB – Survey of Business Expectations of the Manufacturing Sector

Note: “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.

Banks have been actively managing their risks arising from the O&G sector, and remain well-buffered against further stress after increasing provisions in the second half of 2017. As at end-June 2018, the banking system’s exposure to the O&G and related supporting services sector remains contained at less than 10%. The results of MAS’ 2018 stress test show that the banking system would remain resilient under a severe stress scenario which incorporated a sharp fall in oil prices (See Box D “Top-Down Stress Test 2018: Leveraging on Granular Housing Loan Data”).

Nonetheless, banks should continue to maintain sound credit underwriting standards and monitor asset quality risks prudently.

**Property firms able to weather expected moderation in residential property market**

Earlier periods have seen robust activity in the property market on the back of an upswing in the en-bloc cycle. Consequently, property firms have seen improving profitability, with median ROA on an upward trend, increasing from 3.7% in Q2 2017 to 4.1% in Q2 2018 (Chart 3.6). However, the sector has turned more cautious since the round of property market measures implemented in July this year (See Box J “Update on the Private Residential Property Market”).

![Chart 3.6](chart.png)

**Median ROA for Property Firms**

Source: MAS estimates, Thomson Financial

While property firms tend to take on higher leverage due to the capital-intensive nature of the industry (Chart 3.7), the sector remains resilient at the firm level. The median interest coverage ratio (ICR) for property firms held steady at about four times in Q2 2018, above

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109 As a proportion of total exposures (i.e. including non-bank loans, debt securities and contingent liabilities).

110 Property firms include firms engaged in real estate management, development and REITs.
the overall median across all corporates, while the current ratio stood at 1.4 times in Q2 2018, suggesting that property firms have sufficient liquidity and remain well-placed to meet their debt obligations. In particular, while larger developers with diversified income streams and geographical exposure tend to have higher debt-to-equity ratios, they also have stronger ICRs compared to smaller and less-diversified developers.111

Corporate Debt Profiles
Remain Sound

Aggregate corporate leverage broadly stable,
corporate debt profiles remain sound

Corporate debt-to-GDP stood at 154% in Q2 2018, compared to 151% a year ago. The increase was driven primarily by bank lending to the B&C and General Commerce sectors (Chart 3.8).

The moderation of aggressive land bids on the back of the recent round of property measures should benefit the long-term stability of the property sector and encourage prudence among property firms. That said, continued vigilance is needed, with the impending increase in interest rates and as rental yields are expected to remain weak. Property firms should exercise prudence, taking into account the significant increase in the upcoming supply of private housing units in the near term.

The median debt-to-equity ratio stood at 59% for larger developers, compared to 35% for smaller developers.111

While overall corporate leverage has picked up, corporate debt profiles remain sound at the firm level. The median debt-to-equity ratio of listed firms decreased from 44.6% in Q2 2017, to 37.6% in Q2 2018 (Chart 3.9), which will limit risks from interest rate and exchange rate shocks. Instances of bond defaults since 2015 have been mainly confined to the O&G-related sectors. Alongside the pick-up in oil price, there have been fewer instances of defaults over the past year. Further, investors have turned more discerning when assessing the attractiveness of bonds, as disclosure standards are enhanced amid increased market transparency.112 The bond maturity

111 The median debt-to-equity ratio stood at 59% for larger developers, compared to 35% for smaller developers.

112 In 2017, MAS introduced credit rating grants to encourage more rated issuances in the domestic bond
profile of Singapore firms remains well termed out, with bonds due within the next two years making up about 35% of outstanding bonds (Chart 3.10).

Most firms should be able to service their debt obligations, with the median ICR of listed firms at a healthy ratio of three times in Q2 2018 (Chart 3.11). In addition, the median current ratio remains stable at 1.6 times, suggesting that corporates have adequate liquidity (Chart 3.12).

Stress test shows most firms resilient to interest rate and earnings shocks

MAS’ corporate stress test suggests that most corporates would remain resilient to interest rate and income shocks, with cash reserves providing additional buffers. Under a stress scenario of a 25% increase in interest costs and a 25% decline in Earnings Before Interest and Tax, Depreciation and Amortisation (EBITDA), the percentage of firms-at-risk increases from 32% to 42% of all corporates, and their share of debt-at-risk increases from 19% to 38% (Chart 3.13). However, after taking cash reserves into consideration, the share of firms-at-risk refers to firms with an ICR of less than two. Debt-at-risk refers to the amount of corporate debt held by firms with an ICR of less than two.
at-risk would drop to 5% and debt-at-risk to 3%.

Firms have taken steps to manage interest rate and exchange rate risks. Of the 30 largest firms-at-risk, approximately 80% of them use interest rate derivatives or fixed-rate bonds to mitigate the risk of future interest rate movements, and about 75% use natural hedging or FX derivatives to hedge against currency risk.

Firms have also continued to enhance their corporate governance frameworks, although room for further improvement remains (Chart 3.14). Companies with stronger corporate governance have been found to exhibit stronger firm profitability, healthier debt profiles and greater resilience to external shocks.\(^{114}\)

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115 The SBF-DP SME Index quarterly index is produced jointly by DP Information Group and the Singapore Business Federation. It provides a 6-month outlook of SMEs’ business sentiment in relation to external economic conditions and activities. The index remained relatively stable over recent quarters at 51.5 in Q2 2018.
(See Box F “A Review of the SME Financing Landscape in Singapore”).

**Corporates should remain prudent and guard against balance sheet vulnerabilities**

Continued growth in the global economy has benefitted the trade-related sectors, which have seen improved financial positions compared to the domestic-oriented sectors. That said, downside risks remain from escalating trade tensions that could dampen business sentiment and global growth. This could have larger spillover effects on the trade-related sectors, which are more vulnerable to disruptions in the external environment.

Firms should continue to exercise financial prudence and remain cautious of downside risks to economic growth. Tightening financial conditions could strain the debt servicing ability of over-leveraged firms. Such strains could be amplified should trade tensions intensify.
Panel 3A  Small and Medium-sized Enterprise Financing Conditions

Bank lending to SMEs has increased over the past year, with the number of SME customers remaining stable.

Chart 3A1: SME Loans Outstanding

Source: MAS

The B&C and General Commerce sectors continued to account for the majority of SME loans.

Chart 3A3: SME Loans by Sector (as at H1 2018)

Source: MAS

The SME NPL ratio rose to 5.1% in H1 2018 due to continued weakness in the M&OE subsector.

Chart 3A5: SME NPL Ratio

Source: MAS

The share of outstanding SME loans secured by property has risen slightly.

Chart 3A4: Outstanding SME loans by Type of Collateralisation

Source: MAS

Banks’ NIMs on SME loans remained stable at 1.6% in H1 2018.

Chart 3A6: NIM on SME Loans

Source: MAS
The prolonged low interest rate environment post-GFC has resulted in rising corporate debt-to-GDP ratios across Asian economies. In Singapore, aggregate corporate debt-to-GDP has increased from 100% in 2007 to 154% in Q1 2018, although it has stabilised around 150% since 2016 (Chart 3.8).

Given the potential for significant economic losses resulting from corporate defaults, early identification of potential corporate distress would be useful to various stakeholders, particularly policymakers, creditors, and investors. Recent analysis on corporate vulnerability relies on corporate leverage indicators such as debt-to-equity ratios and debt repayment indicators such as the ICR. It is important to assess whether these often-used indicators are reliable predictors of corporate distress, and whether other variables should also be closely monitored. This box aims to identify predictive indicators of corporate distress for firms in Singapore using a machine learning technique known as gradient boosted trees.

Corporate distress is often defined by bankruptcy filings...

Previous studies examining corporate distress have mostly associated distress with corporate bankruptcy filings, where corporates are already unable to meet their financial obligations. Altman (1968) defines corporate distress as a firm filing for bankruptcy. Likewise, Klein (2016) looked at share of NPLs and bankruptcies in the corporate sector as an indicator of distress. Altman (1968) identified five financial ratios effective in predicting corporate bankruptcy. These were working capital to total assets, retained earnings to total assets, earnings before interest and tax (EBIT) to total assets, market value of equity to total liabilities and sales to total assets. The first part of our analysis identifies corporate distress among all public and private firms in Singapore based on corporate bankruptcy filings as an indicator of distress.

...though some studies have also used financial ratios as an indicator of distress

Financial ratios have also been used as an indicator of distress. An example is Senapati and Ghosal (2016), which define distress as when a firm’s accumulated losses are more than 50% of its net worth. The IMF (2013) finds that indicators of debt sustainability based on net free cash flows helped to assess medium and long-term risks. In addition, Martinis and Ljubaj (2016) note that using net free cash flows allows for assessing the sensitivity of debt sustainability to various macroeconomic scenarios as it is able to capture interest rate and earnings shocks. The second part of our analysis focuses on larger firms, which pose higher systemic risks; since they have fewer instances of bankruptcy and as such, a similar definition as Senapati and Ghosal (2016) is adopted. Though it is a challenge to define clearly identifiable dates of distress based on financial ratios, this approach takes into account firms’ historical performances, and

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118 By using firm-level financial statement data obtained from the Singapore business registry. This dataset provides firm-level information on both private and publicly-listed firms.
120 Net worth refers to total equity of firm.
122 Ana Martinis and Igor Ljubaj, Croatian National Bank (June 2016), “Corporate Debt Overhang in Croatia: Micro Assessment and Macro Implications”.

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allows for earlier identification of firms that are at a stage of corporate decline that precedes corporate bankruptcy.

Data and methodology
We used a machine learning approach known as gradient boosted decision trees\textsuperscript{123} to identify key variables for the prediction of corporate distress. The model used data from 700 public firms and 60,000 private firms in Singapore from 2007 to 2017.

The use of machine learning methods has been increasingly adopted for studies on corporate distress in recent years. The appeal of machine learning lies in its ability to uncover generalisable patterns from large amounts of data, and subsequently apply what it has learnt to new, unseen samples. This is a particularly useful tool in analysing corporate data, which tends to involve very large data sets across multiple entities. Zieba et al. (2016) compared the use of statistical and machine learning techniques for corporate bankruptcy prediction and found promising results for the machine learning approaches such as random forest and gradient boosted trees. Mattsson and Steinert (2017)\textsuperscript{124} further compared the performance of various machine learning techniques such as random forest, gradient boosting and artificial neural network, in evaluating an indicator of distress of Polish companies and found that the gradient boosting algorithm performed best.

For the purpose of this study, we included – in addition to the list of variables selected by previous studies mentioned earlier – other firm-level indicators such as the ICR, debt-to-EBITDA, and stock prices. Building on earlier studies to reflect changes in the operating environment for corporates, we also include sectoral and macroeconomic indicators as part of the selected variables. Financial ratios such as the median debt-to-equity and debt-to-EBITDA for each sector are considered to account for sector-specific characteristics. For instance, sectors that are capital-intensive, such as the B&C sector, could potentially have higher levels of debt. Macroeconomic indicators such as the country's GDP growth as well as its interbank rates are also included to account for changes in the economic environment that could influence firms' performances across various time periods.

Our findings suggest that firm-level characteristics rank higher in relative importance than industry-specific and macroeconomic indicators for predicting distress of domestic firms
For both private and publicly-listed firms in Singapore, we find that the cash asset ratio, asset turnover (ATO) and ROA rank higher in relative importance in terms of predicting corporate distress (Chart I1). The cash asset ratio measures a firm’s liquidity or its ability to meet short-term obligations. Hence, the lower the firm’s ability to meet its short-term obligations, the higher the probability of the firm being in distress. The ATO and ROA measure the efficiency in which a firm can generate revenue and profits using its assets. A low ATO and ROA may signal inefficient asset utilisation by management, and hence a higher probability of distress. In the 2017 MAS FSR, we explored drivers of corporate leverage in Asia and found that corporate leverage is positively correlated with the share of tangible assets and the growth in firm size. Following on from the findings of the 2017 study, the identified variables suggest that corporate distress

\textsuperscript{123} The objective of the technique is to minimise loss of the model, where the technique first sets out a naïve model, and calculates the error rate based on that. It continuously builds new models to predict and reduce the error rate, and combines the new models into an ensemble model.

was likely due to deteriorating fundamentals, where the expansion in assets (or leverage) were not matched with improved liquidity and profitability.

Our findings also predict a slight increase in the proportion of larger firms\textsuperscript{125} expected to face distress this year (Chart I2). Larger firms tend to be more exposed to global uncertainties as compared to smaller ones that are more dependent on domestic conditions, and hence face more external risks such as trade tensions and financial volatility that could impact on profitability and in turn, increase the risk of corporate distress.

Given that vulnerabilities have increased among the larger firms, which might pose higher systemic risks, we have constructed a similar model in order to identify potential distress indicators at a higher prediction rate. The revised model uses listed firms in Singapore as a proxy for larger firms, given that firm-level financial information for listed firms are more complete and allows our model to capture additional relationships in the data and enhance the accuracy for predicting corporate distress. Due to the relatively low occurrence of bankruptcy filings for listed firms\textsuperscript{126}, we have defined corporate distress as firms that have had half their net worth eroded by accumulated losses.

Our findings show that similar indicators measuring profitability and leverage, which reflect a firm’s fundamentals, such as ROA, equity-to-asset and equity-to-fixed assets rank higher in relative importance for predicting distress of publicly-listed firms (Chart I3). As profitability drops and leverage increases, the firm is less likely to service its debt obligations, and this increases the likelihood of distress. We find that equity-related ratios rank higher in importance for predicting distress of listed firms, in comparison with our full sample of firms. This could be due to listed firms’ larger reliance on shareholder funds, and hence, equity-related ratios that the model identified may be a better reflection of overall financial strength as they reflect the proportion of assets owned by shareholders. In addition, a firm’s stock price, which

\textsuperscript{125} Larger firms refer to firms with greater than S$10 million in assets.

\textsuperscript{126} This is likely due to these firms’ ability to access both debt and equity markets for additional liquidity when needed. Such options might not be readily available to smaller non-listed firms.
captures investors’ views towards the firm and prices in future earnings potential, also ranked high in relative importance. As such, a significant drop in a firm’s stock price may be indicative of potential distress.

Based on the above assessment, firm-level characteristics rank higher in importance than industry-specific and macroeconomic indicators. While industry-specific factors contribute to changes in corporate leverage\(^\text{127}\), it is found that firm-level characteristics are better predictors of corporate distress, with strong firm-level fundamentals key to weathering poor growth performance of respective industries. In addition, firms with stronger fundamentals could also be a reflection of better management and decision-making that safeguards against external risks, making them less susceptible to changes in the macro environment.

From a sectoral perspective, the model predicts a drop in distress across most sectors, with the exception of the construction and services sector. The O&G sector remains the most vulnerable with the highest proportion of firms expected to face distress (Chart I4). In addition, manufacturing and TSC firms with linkages to the O&G sector have also been impacted by the downturn in the oil industry. That said, the proportion of distressed firms is predicted to decrease, likely due to increased oil prices over recent quarters. The construction and services sector is expected to see a slight rise in the proportion of firms facing distress. The construction sector had faced pressure in recent quarters due to the slowdown in private projects and tighter margins. Industrial services firms that are related to the construction industry have also had their profitability affected from the slowdown. However, outlook for the construction sector is expected to improve alongside stronger construction demand led by public sector projects.

Profitability, as measured by ROA, is most important in predicting corporate distress

<table>
<thead>
<tr>
<th>Chart I3</th>
<th>Feature Importance for Public Firms Based on Gradient Boosted Decision Trees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return on Assets</td>
<td>Stock Price</td>
</tr>
<tr>
<td>Stock Price</td>
<td>Equity Growth</td>
</tr>
<tr>
<td>Equity Growth</td>
<td>Equity to Fixed Assets</td>
</tr>
<tr>
<td>Equity to Assets</td>
<td>Interest Exp. to Debt</td>
</tr>
<tr>
<td>Interest Exp. to Debt</td>
<td>Equity to Assets</td>
</tr>
<tr>
<td>Equity to Assets</td>
<td>Asset Impairment</td>
</tr>
<tr>
<td>Asset Impairment</td>
<td>Moving Avg Stock Price</td>
</tr>
<tr>
<td>Moving Avg Stock Price</td>
<td>Working Cap. To Assets</td>
</tr>
</tbody>
</table>

Source: MAS estimates, Bloomberg

<table>
<thead>
<tr>
<th>Chart I4</th>
<th>Proportion of Distressed Firms by Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2017</td>
</tr>
<tr>
<td>O&amp;G sector remains most vulnerable</td>
<td></td>
</tr>
</tbody>
</table>

Source: MAS estimates, Bloomberg

Summary of findings

With the help of gradient boosted trees, we have examined the relationship between corporate distress and various firm, industry, and macro level variables. Our assessment shows that using a mix of variables, taken from historical firm-level financial data, as well as market pricing, can be useful in predicting

\(^{127}\) In MAS FSR Box A (November 2017), “Drivers of Corporate Leverage in Asia”, we find that a firm’s leverage is positively correlated with the median leverage of the industry it belongs to.
corporate distress. In addition, firm-level financial and market data can provide additional insights and are key indicators that predict distressed firms. Our findings support the notion that excessive credit (measured by leverage ratios), coupled with low profitability, are significant characteristics of Singapore firms facing distress.

A predictive model for corporate distress broadens the toolkit of policymakers in conducting surveillance of corporate health. The model provides an early warning of possible future corporate distress and helps in the early identification of near-term corporate vulnerabilities. This increases the time available for policymakers to address micro- and macro-financial stresses in a timelier fashion.

Further research in the use of machine learning approaches for distress predictions can incorporate further types of data. For example, corporate governance metrics that capture management quality or information from annual reports or audit reports that reflect the quality of accounting information can provide further insights into firm performance and management.
4  Singapore Household Sector

Household balance sheets continue to strengthen, alongside steady economic growth and an improving employment outlook.

While household debt growth remains in line with income growth over the past year, housing loans – a main contributor to household debt – have increased, in tandem with the pick-up in housing demand. The household debt-to-GDP ratio could increase and reach unsustainable levels, should the earlier strong price momentum and buying activity continue unabated. Households should continue to take into account their ability to service their debt, given headwinds of rising interest rates flowing from ongoing US monetary policy normalisation. With rental yields expected to remain weak, households should exercise prudence when considering taking up loans to fund property purchases.

Household Balance Sheets Continue to Strengthen

The growth in household net wealth has accelerated over the past year (from 7.3% YoY in Q3 2017 to 8.9% YoY in Q3 2018) due to growth in financial and property assets. The YoY growth of assets has continued to outpace the growth of liabilities over the last two years (Chart 4.2). Financial assets grew by 6.3% YoY in Q3 2018, down from 8.5% YoY in Q3 2017 (Chart 4.3). Residential property assets grew 7.0% YoY in Q3 2018, as private residential property prices increased sharply, by a cumulative 8.8% between Q4 2017 and Q3 2018, alongside increased transaction activity.

Household Balance Sheets Continue to Strengthen

Growth in household net wealth has accelerated over the past year

On an aggregate basis, Singapore’s household balance sheets remain healthy, with net wealth at four times of GDP (Chart 4.1). Liquid assets such as cash and deposits exceed total household liabilities, providing households with strong financial buffers.

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Households continued to accumulate financial assets. As a share of household assets, financial assets grew to 56.3% in Q3 2018, from 51.1% five years ago.

Household leverage indicators are stable but could deteriorate quickly if housing loans rise unsustainably

Household debt-to-GDP ratio has stabilised at around 73% since 2013 and remains just below the long-run average. The risk profile of housing loans is resilient, with top-down stress tests indicating that MSRs and housing LTVs remained manageable under the prescribed stress scenario (See Box D “Top-Down Stress Test 2018: Leveraging on Granular Housing Loan Data”).

Household debt grew 3.0% YoY in Q3 2018. The main growth contributor was housing loans from FIs, which increased by 3.4% YoY in Q3 2018 (Chart 4.4). As of July 2018, in tandem with a pick-up in residential property demand, the value of new housing loans rose by 30% YoY.

Unsecured credit situation has improved, with fewer borrowers accumulating excessive debt

Growth in outstanding loans from credit/charge cards has increased 7.1% YoY in Q3 2018. Notwithstanding this, the credit card...
charge-off rates remain stable at 6.0% since 2014 (Chart 4.6).

![Chart 4.6 Credit Card Charge-off Rates](image)

Source: Credit Bureau of Singapore

The unsecured credit situation has improved significantly following MAS’ moves to strengthen the unsecured credit rules from 2013. With the phasing in of the industry-wide borrowing limit, the number of borrowers with high unsecured debt (more than 18 times their monthly incomes) has more than halved since 2015. This is expected to go down further as households continue to pay down their debt ahead of the industry-wide borrowing limit being lowered to 12 times of monthly income in June 2019.

The number of individual bankruptcy orders remains below the long-run average (Chart 4.7). The first nine months of 2018 saw 1,230 cases, down from 1,253 cases in the same period last year.

![Chart 4.7 Individual Bankruptcies](image)

Source: MinLaw, IPTO

**Households Should Continue to Exercise Financial Prudence**

Households should continue to be prudent in managing their finances amid external headwinds

The overall employment outlook is expected to improve in 2019. The slack in the domestic labour market, at the macro level, has been absorbed, and wage growth is expected to strengthen from last year.

While the domestic labour market has improved, there could be significant headwinds on the horizon. With global trade tensions and rising interest rates brought about by ongoing US monetary policy normalisation, households should exercise prudence in managing their finances.

The recent property market cooling measures have moderated the pace of price increases and transaction activity. This will help to strengthen household balance sheets in the long run.

Nonetheless, households considering property purchases should carefully consider the impact of interest rate increases and the upcoming
supply of new units in the medium term (See Box J “Update on the Private Residential Property Market”).
In July 2018, the government raised the Additional Buyer’s Stamp Duty (ABSD) rates and tightened LTV limits on residential property mortgages, to moderate the property market cycle. The adjustments were made amid a strong uptick in both prices and transaction volumes over the past year, propelled by higher domestic economic growth, still-low interest rates, and positive market sentiments alongside aggressive land bids from developers.

Such sharp increases in prices, if left unchecked, could have run ahead of economic fundamentals and raised the risk of a destabilising correction later, especially with rising interest rates and the strong pipeline of housing supply. Large, unmoderated property price swings would compromise on asset price and financial stability in the economy and be harmful to many, especially home owners.

There are early signs that this suite of cooling measures has helped to temper the upswing in the property market, with a slowdown in the increase in private housing prices, reduction in total private housing transaction volume, and more cautious land sales activity in Q3 2018.

**Prices have increased sharply since Q3 2017, but have moderated in the latest quarter...**

Overall private residential property prices increased a cumulative 9.1% in the four quarters since Q3 2017 (Chart J1), reversing the gradual cumulative decline of 11.6% over the preceding 15 quarters.

Following the July measures, property prices increased by 0.5% in Q3 2018, significantly lower than the 3.4% increase in the previous quarter. Some developers have reduced prices at selected projects. In the latest quarter, prices in the Rest of Central Region (RCR) and Outside Central Region (OCR) fell by 1.3% and 0.1% respectively, whereas prices in the Core Central Region (CCR) rose by 1.3% (Chart J2).
The pace of property price increases moderated in Q3 2018

Different market segments have registered broadly similar trends

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**Chart J1**
QoQ Change in Private Property Price Index

**Chart J2**
Private Property Price Index by Region

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**Source:** Urban Redevelopment Authority (URA)

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...alongside a moderation in transaction activity

Buying sentiment also appears to have dampened. Prior to July, the take-up rate at new project launches and resale activity had been strong, alongside supportive macroeconomic conditions and still-low interest rates (Chart J4). Total transactions from Q3 2017 to Q2 2018 were 13% higher than that recorded over the same period in the previous year (Chart J3). New sales recorded strong increases, with several project launches seeing robust sales despite being priced higher than neighbouring projects. In the secondary sales market, transaction volume reached an eight-year high of 5,000 units in Q2 2018, in part due to the re-entry of some en-bloc property owners into the market to purchase replacement units. Sub-sale transactions, a proxy for speculative activity, remained low.

Following the measures, total transaction volume moderated to around 6,000 units in Q3 2018, 26% and 28% lower compared to Q2 2018 and Q3 2017 respectively. The decline was mainly attributable to a slowdown in the resale market.
Transaction activity has moderated post cooling measures

While the 3M SGD SIBOR has increased over the past year, it remains low

---

**Chart J3**
Number of Private Residential Property Transactions

<table>
<thead>
<tr>
<th>Year</th>
<th>New Sale</th>
<th>Resale</th>
<th>Subsale</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>2011</td>
<td>3</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>2012</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>2013</td>
<td>5</td>
<td>5</td>
<td>2</td>
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<tr>
<td>2014</td>
<td>6</td>
<td>4</td>
<td>3</td>
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<tr>
<td>2015</td>
<td>7</td>
<td>3</td>
<td>2</td>
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<tr>
<td>2016</td>
<td>8</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>2017</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: URA

**Chart J4**
3M SGD SIBOR

 mientras, the rental market has shown early signs of improvement

Vacancy rates have continued to decline from the peak of 8.9% in Q2 2016 to 6.8% in Q3 2018. Nonetheless, it remains comparable to the historical average of around 6.6% over the past decade (Chart J5). Rentals rose for the third consecutive quarter in Q3 2018, after four straight years of decline, amid the declining vacancies. Nonetheless, rentals were 11.9% lower compared to the peak in Q3 2013 (Chart J6). If interest rates rise and rentals stay weak for the foreseeable future, some borrowers, especially those that have transacted close to the peak in 2013, could face difficulties meeting mortgage repayments on their investment properties.

**Vacancy rates for private residential property have improved**

**Rental prices show early signs of recovery after a gradual decline**

**Chart J5**
Vacancy Rates for Private Residential Property

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>10</td>
</tr>
<tr>
<td>2001</td>
<td>9</td>
</tr>
<tr>
<td>2002</td>
<td>8</td>
</tr>
<tr>
<td>2003</td>
<td>7</td>
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<tr>
<td>2004</td>
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<tr>
<td>2005</td>
<td>5</td>
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<tr>
<td>2006</td>
<td>4</td>
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<tr>
<td>2007</td>
<td>3</td>
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<tr>
<td>2008</td>
<td>2</td>
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<td>2009</td>
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<tr>
<td>2017</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: URA

**Chart J6**
Private Property Rental Index

<table>
<thead>
<tr>
<th>Year</th>
<th>Per Cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>120</td>
</tr>
<tr>
<td>2005</td>
<td>110</td>
</tr>
<tr>
<td>2006</td>
<td>100</td>
</tr>
<tr>
<td>2007</td>
<td>90</td>
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<tr>
<td>2008</td>
<td>80</td>
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<tr>
<td>2009</td>
<td>70</td>
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<tr>
<td>2010</td>
<td>60</td>
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<td>2011</td>
<td>50</td>
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<tr>
<td>2012</td>
<td>40</td>
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<tr>
<td>2013</td>
<td>30</td>
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<tr>
<td>2014</td>
<td>20</td>
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<tr>
<td>2015</td>
<td>10</td>
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<tr>
<td>2016</td>
<td>0</td>
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<tr>
<td>2017</td>
<td>0</td>
</tr>
<tr>
<td>2018</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: URA

Land sales activity has moderated

Collective sales activity ramped up through 2017 to H1 2018, as developers sought to replenish their land banks. More than 70 residential projects were sold through en-bloc transactions in the 19-month period till July 2018, compared to only seven deals in total between 2015 and 2016. Developers have also been
bidding aggressively for Government Land Sales (GLS) sites. As at Q3 2018, around 14,200 new units of private housing from sold en-bloc sites and GLS projects will be progressively added to the supply inventory when developers obtain planning approval for the new projects.

Since July, developers have been more cautious with their bids for GLS sites. Transactional land sales activity has moderated over the past few months. En-bloc activity has also slowed significantly. Of the en-bloc tenders that closed after the introduction of the latest round of cooling measures, only a few projects were successfully sold (Chart J7).

![En-bloc activities have moderated](source: URA)

**Housing loans have risen, but asset quality remains strong**

Outstanding housing loans accounted for about 16.0% of total non-bank loans in September 2018, and has increased by 3.3% YoY in September 2018. With the increased transaction activity in the earlier part of this year, new housing loans had risen to an average of S$3.8 billion per month in the first seven months of 2018, up from S$3.4 billion over the same period last year. While it has moderated in recent months, new housing loan trends bear close watching (Chart J8).

The asset quality of housing loans nevertheless remains strong. The share of loans that are more than 30 days in arrears was 1.0% and the NPL ratio was 0.4% in Q3 2018, unchanged from a year ago (Chart J9). MAS’ stress test results indicate that the banking system would be resilient to a sharp drop in property prices of up to 50% over a three-year period.
New housing loans have risen, following the increase in property transactions

Chart J8
New Housing Loans

[Graph showing New Housing Loans from 2011 to 2018]

Source: MAS

Asset quality of housing loans remains strong

Chart J9
Share of Housing Loans that are More Than 30 Days in Arrears and Non-performing Housing Loan Ratio

[Graph showing NPL Ratio and Share of Housing Loans in Arrears from 2006 to 2018 Q3]

Source: MAS, CBS

Conclusion

There are early signs that the July 2018 property market cooling measures have helped temper the pace of price increase and land sales activities. Total transaction volumes have also fallen. Nonetheless, continued vigilance is called for amid rising interest rates and the upcoming supply of new units in the medium term. Prospective buyers should remain prudent in their buying decisions and factor in likely increases in their debt servicing burdens.